



FOREST SERVICE HANDBOOK PACIFIC SOUTHWEST REGION (R5) VALLEJO, CALIFORNIA

FSH 2409.12 - TIMBER CRUISING HANDBOOK CHAPTER 20 - ESTIMATING TREE VOLUME AND WEIGHT

Supplement No.: 2409.12-2016-1

Effective Date: 2/29/2016

Duration: This supplement expires 5 years from the effective date unless superseded or removed earlier.

Approved: Randy Moore, Regional Forester

Date Approved: 2/29/2016

Posting Instructions: Handbook supplements are numbered consecutively by Handbook number and calendar year. Post by document; remove the entire document and replace it with this supplement. Retain this transmittal as the first page(s) of this document.

Last Change: 2409.12-2014-2 to Chapter 60

New Document: 2409.12_20, 24 Pages

Superseded Document(s): 2409.12-2010-1

Digest: Deterioration rates for fire killed Incense cedar is included and deterioration rates for fire killed Douglas-fir have been corrected in 22.31e - Exhibit 1. Document has been edited to meet 508 Compliancy standards.

22 - TREE VOLUME DETERMINATION

22.3 - Estimating Tree Defect and Net Tree Volume

To obtain net volume for appraisal and sale, reduce the gross volume of individual trees by non-sawtimber volume. Use two primary systems to deduct volume from trees: (1) sound “average” trees: Regional average cull of merchantable logs based on lumber recovery studies (scaling cull) excluding logs smaller than regional average minimum utilized top diameter (MUTD), or (2) defective trees: cull in the utilized bole estimated by the cruiser with the computer program automatically excluding logs above MUTD. (sec. 22.31a, ex. 04.)

The Region determines average scaling cull deductions from recovery studies at sawmills and from average breakage of upper logs tree top utilization studies of representative logging operations on Forest Service timber sales. Cruisers must estimate additional breakage within the utilized bole or the appraiser must add it as a flat factor. Use additional breakage factors only when the timber site is on excessively rocky, broken ground.

To compute net volume of each measured tree, deduct the average non-sawtimber top portion of the bole (above MUTD). This deduction accounts for loss from rot and breakage during felling. The remaining portion of the tree is called the “utilized bole”. On rocky or uneven ground, deduct for additional breakage in the utilized bole for individual trees or by a flat factor for an area. A flat factor of one to two percent is ordinarily sufficient to account for above-average breakage.

For trees on the ground or trees to be mechanically harvested, use the minimum diameter inside bark that will be used in the timber sale contract for the project as the MUTD for the tree in cruise processing.

Current sawtimber standard for a cull log is less than 25 percent sound. A merchantable tree must contain at least one log, ten feet long and six inches in diameter on the small end. Apply cull percent to gross volume in utilized bole.

22.31 - Defect Deduction Methods

The Forest Supervisor may provide cull deduction guidelines to quantify defect in standing trees. Use these guidelines with tables found in the Timber Cruiser Reference Guide, form R5-2400-28A (as revised).

Defect amount based upon type and extent of visible defect indicators are guides only. Cruisers may make adjustments based on tree vigor, local conditions, defect location, and cruiser judgment.

Guidelines for determining cull deduction from dead tree deterioration are in section 22.31e. percentages may vary greatly on a site specific basis. Use other documented values based on local conditions, if available. Apply percents after deducting for visible defect.

The following are Regional green tree deduction guidelines. Each Forest Supervisor may adjust these suggested deduction guidelines to suit local conditions. Lacking documented local guidelines, cruisers shall follow these Regional guides. Several of the following guides use 24 inches DBH as an unambiguous measure to differentiate old growth trees (over 150 years old) from young growth trees. Forest Supervisors may establish and document a different DBH limit to define old growth for cruising guides if they fit local conditions more accurately.

Assumptions:

1. There are usually external indicators that indicate decay in standing trees.

2. The extent of decay in standing trees cannot be realistically estimated to accuracy less than two feet vertical distance or 1/4 of log circumference. Therefore, minimum log cull deductions will be 1/8 log. See Exhibit 01 below for example.
3. Cull deductions are based on averages which require a fairly large sample for accuracy.
4. Cull deductions of 1/8 (two foot deduction) or more of a full log translate into percent cull deduction in utilized bole (Exhibit 01). Insert the total defect percentage in column 11 of the Timber Cruiser Reference Guide, form R5-2400-28A (as revised). If using Forest Service cruise data entry software, defects (by log) may be entered by log position.
5. A deduction of 1/16 (six percent or one foot deduction) may be added to a log if it is included with other defect. Treat each log separately.
6. When two or more types of defect affect the same portion of the tree, use the defect that indicates the greatest amount of volume loss.
7. New cruisers must spend time in the field observing felled trees and must work with experienced cruisers to gain necessary judgment skills.

22.31 - Exhibit 01- LOG CULL PERCENTS

Vertical Distance Estimated Cull	Amount of 16 feet Log Affected
2 to 3 Feet	13 percent
greater than 3 to 5 Feet	25 percent
greater than 5 to 7 Feet	38 percent
greater than 7 to 9 Feet	50 percent
greater than 9 to 11 Feet	63 percent
greater than 11 to 12 Feet	75 percent
greater than 12 Feet	100 percent

22.31a - Volume Distribution in Trees

1. Distribution of Gross Utilizable Volume. Use the Log Height Class, Range, and Number of Logs Table (ex. 01) and determine the number of 16.5 foot logs to a six-inch DIB top for the measured tree height. Exhibit 01 relates the number of 16.5 foot logs to the total measured height of the tree. Select the height range that contains the total height. Next, use the percent Distribution of Total Tree Board Foot Volume by 16-foot logs to Average Utilized Top Table (ex. 02), which displays the percent of volume represented by each 16-foot log in the utilizable portion of the bole.
2. Computation of Defect percentages.
 - a. No Visible Defect. Field Data Recorders do not automatically calculate and deduct regional average cull (hidden defect) in merchantable logs for each measured tree. Use the Average Scaling Cull Table (22.31a - Exhibit 03) and record hidden defect in the Forest Service cruise data entry software.
 - b. Visible Defect. Cruise data entry programs allow visible defect percentages to be entered by log position. If tree data is collected manually, cruisers shall

estimate defect on a per log basis and convert to a percentage of the tree.
Prorate average scaling cull percent to the tree's visible defect percentage.

Example: Douglas-fir has velvet top conk on the ground (root). The deduction is 1/2 of the butt log (sec. 22.31b). The tree is 130 feet HT x 30 inches DBH. Exhibit 01 shows that a 130 foot tree contains seven logs. Exhibit 02 shows that the first log of a seven log tree contains 24 percent of total tree board foot volume to utilized top. Also, a 30 inches Douglas-fir has 4 percent average scale cull, as shown in Exhibit 03.

Therefore: 1/2 first log x 24 percent volume = 12 percent cull

100 percent - 12 percent = 88 percent x 4 percent scaling cull = 3.52 percent

12 percent visible defect + 3.52 percent average scale cull = 15.52

Round to 16 percent cull (enter in Timber Cruise Book).

Cull percents less than 0.5 are rounded down; cull percents 0.5 and greater are rounded up.

22.31a - Exhibit 01-HEIGHT CLASS, RANGE, AND NUMBER OF LOGS

Total Height (10 feet class)	Height Range(Feet)	No. 16.5 foot Logs to 6 inches DIB Top
30	26-35	1
40	36-45	1-2
50	46-55	2
60	56-65	3
70	66-75	4
80	76-85	4
90	86-95	5
100	96-105	6
110	106-115	6
120	116-125	7
130	126-135	7
140	136-145	8
150	146-155	9
160	156-165	9
170	166-175	10
180	176-185	10
190	186-195	11
200	196-205	12
210	206-215	12
220	216-225	13

Total Height is measured from forest floor to tip.

On the No. 16.5 foot logs, match young growth (under 150 years) or small diameter (under 24 inches) with shorter of paired log heights.

**22.31a - Exhibit 02- PERCENT DISTRIBUTION OF TOTAL TREE BOARD FOOT VOLUME
 BY 16-FOOT LOGS TO AVERAGE UTILIZED TOP**

Log Number	1	2	3	4	5	6	7	8	9	10	11
1	100										
2	70	30									
3	55	35	10								
2/	(61)	(39)	(1/)								
4	41	31	20	8							
2/	(44)	(34)	(22)	(1/)							
5	34	29	22	15	(1/)						
6	28	24	20	16	12	(1/)					
7	24	21	18	16	13	8	(1/)				
8	22	20	18	16	14	10	(1/)	(1/)			
9	19	18	17	14	12	11	9	(1/)	(1/)		
10	17	16	14	13	12	11	9	8	(1/)	(1/)	
11	16	15	15	13	13	11	9	8	(1/)	(1/)	(1/)
12	15	14	13	12	11	11	9	8	7	(1/)	(1/)

1/ Logs to the right of the line are unutilized based on R-5 average cull and breakage studies in 1964 and 1975.

2/ The top log of 3 and 4 log young growth tree (under 150 years) is unutilized; use percent shown in parentheses.

22.31a - Exhibit 03- AVERAGE SCALING CULL IN UTILIZED BOLE

Percent of Gross Utilized Volume

DBH*	All Pines	True Fir	DF	IC
8	0	0	0	0
10	0	0	0	0
12	1	0	0	0
14	3	1	1	0
16	3	1	1	0
18	4	2	2	0
20	4	2	2	1
22	4	3	2	2
24	4	4	2	4
26	4	5	3	6
28	4	5	3	8
30	5	6	4	10
32	5	6	4	11
34	5	7	5	13
36	5	7	5	15
38	5	8	6	17
40	5	8	6	19
42	6	9	7	21
44	6	10	7	23
46	6	11	8	25
48	6	11	8	26
50	6	12	8	28
52	6	13	8	30
54	6	14	9	32
56	6	14	9	34
58	7	15	10	36
60	7	15	10	38
62	7	16	11	40
64	7	16	11	40
66	7	17	12	40
68	7	17	12	40
70	8	19	13	40
72	8	20	14	40
74	8	20	14	40
76	8	21	15	40
78	8	21	15	40

*Use the 2-inch DBH class to determine deduction. The DBH range for a 22inch DBH class is 21.0 inches - 22.9 inches.

22.31a - Exhibit 04-AVERAGE DIB TIP UTILIZED (MUTD) (FOR CULL ESTIMATION)

DBH	PP	SP	RF	WF	DF	IC	DBH
8	6	6	6	6	6	6	8
10	6	6	6	6	6	6	10
12	6	6	6	6	6	6	12
14	7	7	7	7	7	7	14
16	7	7	7	7	7	7	16
18	8	8	8	8	8	8	18
20	8	8	8	8	8	8	20
22	9	9	9	9	9	9	22
24	9	9	9	9	9	9	24
26	11	11	11	11	11	11	26
28	11	11	11	11	11	11	28
30	12	12	12	13	12	11	30
32	12	12	12	13	12	11	32
34	13	13	12	14	13	12	34
36	13	13	12	14	13	12	36
38	14	14	13	15	14	12	38
40	14	14	13	15	14	12	40
42	15	15	14	17	14	13	42
44	15	15	14	17	14	13	44
46	16	16	15	18	15	14	46
48	16	16	15	18	15	14	48
50	17	17	16	20	16	15	50
52	17	17	16	20	16	15	52
54	19	18	18	22	17	17	54
56	19	18	18	22	17	17	56
58	20	19	19	24	18	18	58
60	20	19	19	24	18	18	60
62	22	20	20	26	19	19	62
64	22	20	20	26	19	19	64
66	24	21	22	28	20	21	66
68	24	21	22	28	20	21	68
70	26	22	23	31	20	22	70
72	26	22	23	31	20	22	72
74	28	23	25	34	21	23	74
76	28	23	25	34	21	23	76
78	30	24	27	36	22	24	78

*Use the 2-inch class to determine MUTD.

22.31b - Rots

Cruisers shall use the guidelines contained in this section unless documented local information is available. The guidelines are developed from "Cruiser's Guide for Defect Estimates in Blue Mountains of Oregon" by Paul E. Aho, and local experience by Forest Service scalers and plant pathologists.

1. Butt Swell (the flared-out end of a butt log). Cull Deduction (all species). Make no deduction for butt swell unless associated with conks, scars, or other abnormalities. Apply the cull deduction for the appropriate defect.
2. Conks.
 - a. Incense-cedar (*Oligoporus amarus*) Fungus - Pencil Rot.
 - (1) Information.
 - (a) Found on incense-cedar.
 - (b) Enters through fire scars or other wounds, and most commonly, branch stubs.
 - (c) Conks are most commonly found on the first two logs. Conks destroyed by birds, worms, or insects have "shot-hole cups". ("Shot-hole cups" are small areas in the bark that resemble a shot gun pattern. These areas are not always cupped.)
 - (2) Cull Deduction.
 - (a) If conk or shot-hole cup is found in the butt log, deduct 16 feet above and eight feet below each conk or shot-hole cup.
 - (b) If conk or shot-hole cup is found above the butt log, deduct 16 feet above and below each conk or shot-hole cup. Make no deduction in the first eight feet of the butt log. For example, with a conk at 20 feet, deduct up to 36 feet and down to nine feet above the forest floor for a total linear deduction of 27 feet.
 - b. Indian Paint (*Echinodontium tinctorium*) Fungus - Rust-Red Stringy Rot.
 - (1) Information.
 - (a) Occurs mainly on true fir and hemlock.
 - (b) Conks occur mainly on trunk at limb stubs and knots but may also rarely occur on branches.
 - (c) A single Indian Paint fungus conk indicates extensive decay.
 - (d) Hoof-shaped; upper surface rough, black, furrowed, and cracked; lower surface covered with coarse, hard, grayish spines (teeth); interior brilliant rust or brick red.
 - (e) May be confused with red ring rot at a distance.
 - (2) Cull Deductions.
 - (a) If conk is single, small, and on a young tree, the deduction is eight feet below and eight feet above conk. Small is defined as three inches wide or less, and a young tree is less than 150 years old.
 - (b) If lowest conk is located at 32 feet or less from the forest floor, cull from 12 feet below lowest, to 21 feet above highest conk.
 - (c) If lowest conk is located more than 32 feet from the forest floor, but still in the bottom 1/3 of the tree, cull lower 2/3 of the tree.
 - (d) If lowest conk is located more than 32 feet from the forest floor, and in the top 1/3 of tree, cull upper 2/3 of the tree.

- (e) If lowest conk is located more than 32 feet from the forest floor, and in the middle 1/3 of the tree, cull from 20 feet below lowest, to 21 feet above highest conk.
- (f) If there are two or more conks separated by 25 feet or more, cull entire tree.
- c. Red Ring Rot - *Phellinus* (*Fomes*) *pini* Fungus.
- (1) Information.
- (a) Commonly occurs on Douglas-fir, ponderosa pine, lodgepole pine, and sugar pine, causing white speck rot.
- (b) May also occur in incense-cedar, true firs, and hemlock.
- (c) Conks occur mainly on trunk at limb stubs and knots, but also may occur on branches.
- (d) Bracket-like to hoof-shaped; brownish-black upper surface with concentric furrowed rings; brown lower surface.
- (e) Size and condition of conk indicates age and extent of cull. The larger the conk, the more related decay.
- (f) A single, small conk or a concentrated group of conks, indicate localized cull.
- (g) A series of conks indicates extensive decay.
- (h) Decay is more severe in pure stands, on shallow soils, and on steep slopes.
- (i) Swollen knots often indicate the presence of this fungus (see Swollen Knots, para. (7)).
- (2) Cull Deduction (Douglas-fir only).
- (a) Deduct four feet above and below a small (three inches wide or less) conk.
- (b) Deduct eight feet above and below a medium-sized (over three inches to six inches wide) conk.
- (c) Deduct 16 feet above and below for large (over six inches wide) conks.
- (d) If vertical distance between highest and lowest conks in a group exceeds 1/2 tree height, cull entire tree regardless of conk size.
- (3) Cull Deduction (Hemlock and true fir).
- (a) For trees less than 150 years old (less than 24 inches DBH), deduct eight feet above and below each conk.
- (b) For trees 150 years old and older (24 inches DBH and greater), deduct 16 feet above and below each conk.
- (4) Cull Deduction (pine and incense-cedar). Deduct two feet above and four feet below each conk found.
- (5) Cull Deduction (Young Growth Ponderosa pine)
- (a) One or more conk(s) over 4 feet from log end. Deduct 4 feet.

- (b) One or more conk(s) equal to or less than 4 feet from log end. Deduct 2 feet for each end of log affected.
- (c) Do not deduct more than 8 feet from any log.
- (6) Cull Deduction (Rotten Knots). Live or dead limbs or limb stubs that show evidence of decay or rot. Associated with Red Ring Rot - *Phellinus* (*Fomes*) *pini* Fungus. (All species).
 - (a) No deduction is necessary unless there is evidence of swelling.
 - (b) If a knot shows evidence of a conk, treat it as a conk for defect deduction.
 - (c) If the knot appears rotten, but there is no sign of a conk, then treat as a swollen knot if swelling is present. Use the swollen knot cull deductions for the appropriate species. If not swollen, no deduction is necessary.
- (7) Cull Deduction (Swollen Knots). Bumps or bulges broken open and commonly associated with *Phellinus* (*Fomes*) *pini* Conk (Red Ring Rot Fungus).
- (8) Swollen Knot Deduction (Douglas-fir only). Deduct four feet above and four feet below the swollen knot(s).
- (9) Swollen Knot Deduction (Hemlock and true firs).
 - (a) For trees less than 150 years old (less than 24 inches DBH), deduct four feet above and below each swollen knot.
 - (b) For trees 150 years and older (24 inches DBH or greater), deduct eight feet above the highest swollen knot down to eight feet below the lowest swollen knot.
- (10) Swollen Knot Deduction (pine and incense-cedar species). Do not deduct for swollen knots in pine and incense-cedar species.
- d. Quinine (*Fomitopsis officinalis*) Fungus - Brown Trunk Rot.
 - (1) Information.
 - (a) Occurs on Douglas-fir, Ponderosa pine, Sugar pine, and rarely, incense-cedar.
 - (b) Rarely found, but indicates extensive rot. Occurs on trunk at branch stubs or on wounds.
 - (c) Hoof-shaped, older conks cylindrical; chalky white to grayish; inside soft and white with bitter flavor.
 - (2) Cull Deduction (All species). One conk culls entire tree.
- e. Velvet Top (*Phaeolus schweinitzii*) Fungus - Red-Brown Butt Rot.
 - (1) Information.
 - (a) Conks occur mainly on forest floor around base of tree, but also may occur on bole at base of tree. (Conks resemble the droppings of cattle.)
 - (b) Upper surface red-brown; velvety when fresh; becomes corky with age.
 - (2) Cull Deduction (All species).
 - (a) Cull the butt log if conk found on bole of tree.

- (b) If conk is found on forest floor within the dripline of tree, or on roots with an obvious association to the tree, deduct eight feet of butt log.
- 3. Fomitopsis Cajanderi (Light Brown Yellow Top Rot) (All Species).
 - a. Information: Usually found in coastal areas. Occurs on all species but most common on Douglas-fir. Conks resemble Fomes pini, but are rose tinged (pink) when fresh then turn yellow then brown with age.
 - b. Cull deduction (all species). Deduct 8 feet above and below each conk or group of conks.
- 4. Cracks and Scars.
 - a. **Frost Crack.**
 - (1) Information. A separation of the bark with no or very little loss of bark and a minimum of the outer wood (cambium) exposed.
 - (2) Cull Deduction (All species).
 - (a) Deduct two feet if the crack is straight and extends the full length of the log.
 - (b) If the crack spirals around the log, deduct a minimum of two feet for each quarter of the log circumference affected.
 - (c) For butt logs only, if the crack contacts the forest floor, deduct .25 feet (.13 feet for incense-cedar) for each affected foot. For example, a nine foot long frost crack, on a white fir, contacts the forest floor; (9 feet - 1 foot stump = 8 feet) $8 \text{ feet} \times .25 = 2 \text{ feet}$, or $1/8$ log.
 - (d) Cull deductions are additive for multiple frost cracks that do not extend the full length of the log. Deduct $1/8$ log volume (2 feet) for each 16 feet linear length of multiple frost cracks. For example, a butt log has three, eight foot long frost cracks totaling 24 feet. $2 \text{ feet} + 1 \text{ foot} = 3 \text{ feet}$ (13 percent or $1/8$) deduction. Another example is, 35 feet of multiple frost cracks in a log would give you two 16 foot linear lengths, and therefore, 4 feet or $1/4$ (25 percent) log volume deduction.
 - b. **Lightning Scar (All species).**
 - (1) Information. The spiral effect of lightning which results in bark being stripped from the bole in a band, usually one to six inches wide.
 - (2) Cull Deduction (All species). Deduct the percent of the merchantable log affected by the scar. Recent scars are usually superficial and do not require defect deduction. Look for sawdust, insect holes, or other signs of advanced deterioration which indicate the need for a defect deduction.
 - c. **Fire and Other Basal Scars (make contact with forest floor).**
 - (1) Information.
 - (a) Ignore wounds less than ten years old unless they create a void in the log.
 - (b) Basal scars are in contact with the forest floor and are important defect indicators for all species.

- (c) The injury may be overgrown with bark or callus, but the bark will show ingrowth over the wound. Include ingrowth when measuring scar size.
- (2) Criteria (for other than true fir and incense-cedar).
 - (a) Scars are measured at the widest point of the scar and include healed over bark. The circumference of the tree at the widest point of the scar is divided into quarters or faces. Cull deduction is determined by the number of quarters or faces covered by the scar.
 - (b) Small scars are less than half the circumference of the tree.
 - (c) Large scars are those that equal or exceed 1/2 of the tree circumference.
- (3) Cull Deduction (with no evidence of rot or abnormal swelling).
 - (a) For small scars on Douglas-fir or ponderosa pine, make no deduction. For scars on white pine species, deduct two feet (13 percent).
 - (b) For large scars, take a four foot (25 percent) deduction for each quarter (face) or partial quarter of the log circumference occupied by the scar.
- (4) Cull Deduction (with evidence of rot or abnormal swelling).
 - (a) For small scars, deduct four feet (25 percent) for each quarter (face) or partial quarter of the log circumference occupied by the scar.
 - (b) For large scars, cull the first log.
- (5) Cull Deduction (true fir).
 - (a) 0 to 10 years No deduction.
 - (b) 11 to 20 years Deduct to upper limits of scar.
 - (c) 21 plus years Deduct for scar, plus nine feet above the scar or swelling.
- (6) Cull Deduction (incense-cedar). Determine the number of quarters or faces affected by the basal scar (same process used with pine species). Determine the height of the scar and related swelling. For each quarter (face) or partial quarter, deduct one foot per 4 feet of height. Double the deduction if sawdust, insect hole, or other signs of advanced deterioration are present. Do not deduct higher than the affected area. (See 22.31b - Exhibit 01 at the end of this chapter.)

d. Holes at Ground Line in Standing Trees (true fir only).

- (1) Information. Trees with holes that penetrate the cambium in the root collar area (at or near forest floor) usually indicate some type of root rot.
- (2) Cull Deduction. Deduct eight feet of the butt log.

e. Trunk Scars (do not extend to forest floor).

- (1) Information.
 - (a) An injury to a tree resulting in a loss of bark above the forest floor, not in contact with the ground, which exposes the cambium to the elements.

- (b) The injury may be overgrown with bark or callus, but the bark will show ingrowth over the wound. Include ingrowth when measuring scar size.
- (2) Cull Deduction (Other than true fir).
 - (a) For scars less than 16 feet in length, showing no evidence of rot, bleeding, or swelling, make no deduction.
 - (b) For scars 16 feet or greater in length, showing no evidence of rot, bleeding, or swelling, deduct two feet for each 16 feet of log(s) affected.
 - (c) For scars two feet or greater in length, with bleeding or showing evidence of rot, deduct to the limits of scar and any swelling as a result of the scar.
- (3) Cull Deduction (true fir). Deduct for the scar plus one foot below and two feet above scar.
- (4) Cull Deduction (incense-cedar).
 - (a) Minimal, if any, rot or swelling occurs in incense-cedar as a result of a trunk scar.
 - (b) Deduct the void within the merchantable log created by trunk scar.
 - (c) Although there may be signs of sawdust, insect activity, or weathering, additional deductions are not needed.

22.31c - Sweep and Crook

- 1. **Sweep** (All species).
 - a. Information. Sweep is a gradual bow in the bole of the tree that leaves the merchantable log.
 - b. Deduction. Deduct the portion of the log outside the bend of log merchantability. As a general rule, a deduction of 1/2 the length of sweep is appropriate.
- 2. **Crook** (All species).
 - a. Information. Crook is an abrupt deflection in the stem.
 - b. Deduction. Deduct the portion of the log that is within the limits of the crook.
- 3. **Dead or Broken Top** (All species).
 - a. Information.
 - (1) Ignore recently killed or broken tops, and dead or broken tops where the defect deduction does not extend into the merchantable bole (see sec. 22.31a, Exhibit 01).
 - (2) "Old" tops must exhibit one or more of these characteristics:
 - (a) Fine limbs (one-inch and less in diameter) missing.
 - (b) Bark slipped from main stem.
 - (c) Woodpecker excavation.

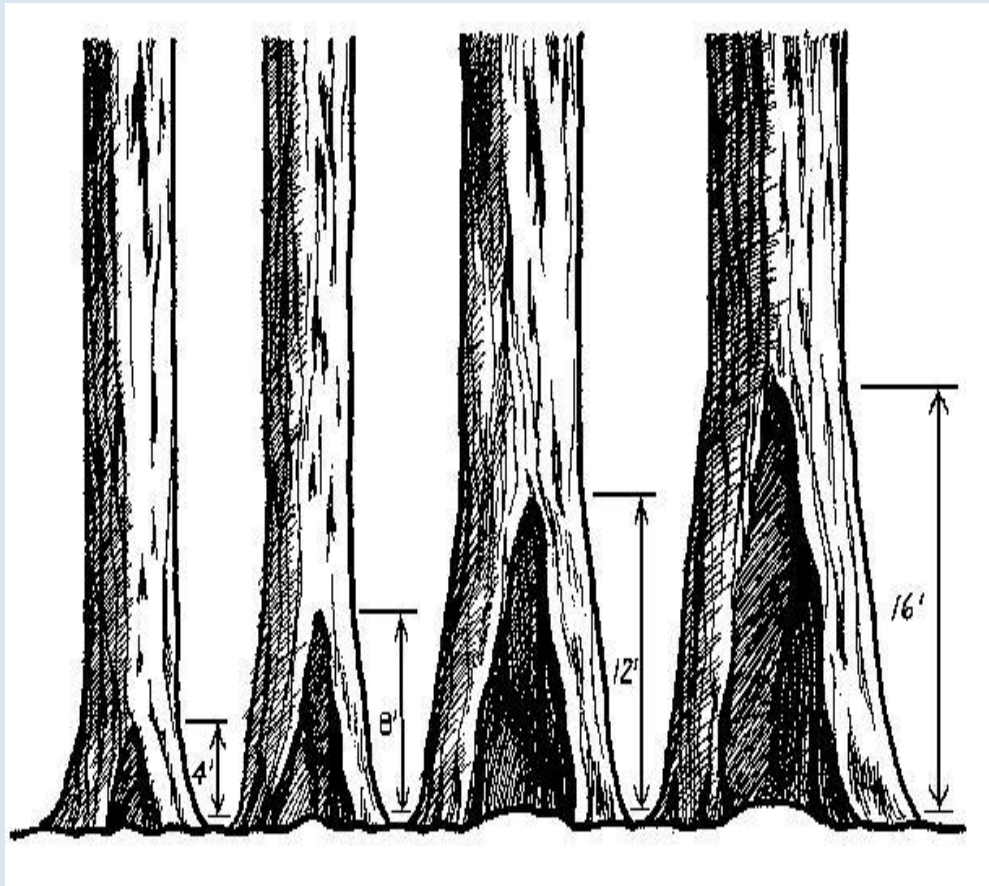
- (d) Wood fiber decayed or deeply weathered (checks or cracks wider than 1/10 the diameter of the stem).
 - b. Cull Deduction (incense-cedar). Deduct two feet below break or visible evidence of "older" top.
 - c. Cull Deduction (All other species). Deduct four feet below break or visible evidence of "older" top.
4. **Dead Sucker Limbs** (All species).
- a. Information. Limb or limb stub will usually appear to protrude from the stem at an unnatural angle, and quite often appears to be unnaturally large in comparison with other limbs at similar locations on the trunk.
 - b. Cull Deduction. Deduct four feet below a large dead sucker limb. On young growth trees, dead sucker limbs are often small in relative size and generally have 2 feet or less defect in a log. For these types of trees, deduct no more than 2 feet (13 percent) for log(s) affected by sucker limb. Make no deduction for live sucker limbs.
5. **Mistletoe Cankers** (All species).
- a. Information.
 - (1) Decay or evidence of dead wood must be associated with this indicator.
 - (2) No decay fungi are admitted if the bark is tight.
 - (3) Decay occurs when the bark slips and exposes the wood.
 - b. Cull Deduction. Deduct to the limits of the swelling associated with open wounds.
6. **Pistol Butt** (All species).
- a. Information. A tree with a sharp crook near the butt; often caused by snow pressure giving the appearance of a pistol grip, hence the name "pistol butt".
 - b. Cull Deduction. Project log cylinder down to stump height and deduct that portion of the log.
 - c. Note: If a pistol butt is over 6 feet in length, consider it sweep and deduct according to that rule.
7. **Trees That Fork** (All species).
- a. Information. Trees fork for several reasons with the two most common factors being genetics and the result of new leaders produced from an old broken top. This type of fork will show an "elbow" shaped curve where the new leader(s) have turned out and up and may result in more defect than genetically produced forks.
 - b. Cull Deduction.
 - (1) For genetically produced forks; if the DBH is less than 24 inches, deduct 2 feet (13 percent) for each fork, measured from the crotch down; if the DBH is 24 inches or greater, deduct two to four feet (13 percent to 25 percent) for each fork, measured from the crotch down.

- (2) For forks produced from new leaders where the original leader is evident, deduct two feet (13 percent) for incense-cedar, and four feet (25 percent) for all other species. If the original leader is not evident then follow the procedures for genetically produced forks.

8. Trees Containing Foreign Material: (All Species).

- a. Information: Treat all trees containing foreign material, such as insulators, spikes, nails or wires that may create a safety hazard in the milling process or logging equipment in the following manner;
 - (1) If the tree is to be removed, identify and point to the object with a painted arrow. It is preferable to use a different color paint than that which was used to mark the tree.
 - (2) If the tree is covered with foreign material and too costly to remove, it should be considered as a wildlife tree and not marked to be cut.
- b. Cull Deduction: Examine each log to determine the following:
 - (1) Can the foreign material be readily removed? If so, make no deduction.
 - (2) If not, make a length deduction for the portion of the log affected in even 2 foot multiples.
 - (3) In cruisers judgment, cull any log(s) if it would result in a safety hazard to individuals or equipment.

22.31b - Exhibit 01- Incense - Cedar Basal Scar Cull Deduction



22.31b - Exhibit 01 shows a basal scar on Incense-cedar for 4 foot, 8 foot, 12 foot, and 16 foot scar heights above a 1 foot stump. The deduction is the number of feet to deduct from the butt log is listed in the following tables. Use the "Sound" column if the wood showing in the scar is sound. Use the "Rot" column if sawdust, insect holes, or other signs of advanced deterioration are present in the wood.

4 Foot Basal Scar

Faces	Sound	Rot
1	1	2
2	2	4
3	3	4
4	4	4

8 Foot Basal Scar

Faces	Sound	Rot
1	2	4
2	4	8
3	6	8
4	8	8

12 Foot Basal Scar

Faces	Sound	Rot
1	3	6
2	6	12
3	9	12
4	12	12

16 Foot Basal Scar

Faces	Sound	Rot
1	4	8
2	8	16
3	12	16
4	12	16

22.31e - Breakage and Hidden Defect

Tree Deterioration and Cull Determination for Dead Trees.

1. Information. Both tree description and associated cull following tree death are highly dependent on tree species, diameter, and local conditions. The rate of deterioration is further dependent on climate, elevation, aspect, and in the case of fire killed trees, the intensity of the fire.
2. Cull Deduction. The cull deduction guidelines in Exhibit 01 are taken from "Deterioration of Fire-Killed and Fire-Damaged Timber in the Western United States" (Lowell, Willits, and Krahmer, PNW-GTR-292, April 1992), and from "Rate of Deterioration of Fire Killed Timber in California" (Kimmey, USDA Circular 962, August 1955.) This data may be used to estimate deterioration on older dead trees. The data used to develop Exhibit 01 was collected throughout the state of California, and represents average conditions within the region. These general estimates of volume loss due to deterioration should only be used for timber sales which will be scaled. The cull deductions listed are in addition to visible defect. Deterioration estimates made using procedures published in "Deterioration of Fire-Killed Timber in Southern Oregon and Northern California" (Lowell and Cahill, 1996) may be used on the Klamath, Six Rivers, and Shasta-Trinity National Forests.

Because the extent of deterioration can be highly variable, a fall, buck, and scale analysis of deterioration may be used to increase the accuracy of cruising dead material, when it is judged that estimates from the published documents don't fit the actual situation.

Use the higher of the average scaling cull for green trees (from 22.31a - Exhibit 3) or deduction percentages in the following tables, but don't combine both.

When applying a volume deduction for deterioration, determine the period of time from the death of the tree to the mid-point of the sale contract to select cull percentages in the following tables.

22.31e - Exhibit 01-TREE DETERIORATION GUIDE

TRUE FIR

Four Classes of Mortality:

1. Current mortality, trees dead up to one year.

Description: May not fade until May-August of the year following beetle attack or cause of death; will be dead one year in July-September of the same year tree fades. Full foliage in spring. Foliage rapidly fading from green through yellow to reddish-brown to brown. May drop over half the faded foliage during the summer. Will retain most fine branches into the first winter. Fresh volvatus conks. Sapwood is green to early stages of rotting.

Use the average scaling cull for green trees from 22.31a - Exhibit 3 if it is larger than the following values.

Deduction from PNW-GTR-292 for One Year:

DBH in.	10	20	30	40	50	60	70
Percent Cull	23	19	14	12	11	10	10

2. Trees dead more than one, up to two years.

Description: Will generally drop 75 to 100 percent of foliage. Will drop many fine branches, but retain most primary branches. Bark may slough on upper stem. Saprot present. Volvatus conks are common. Pinicola conks may begin to appear.

Deduction from PNW-GTR-292 for Two Years:

DBH in.	10	20	30	40	50	60	70
Percent Cull	80	66	50	44	41	40	38

3. Trees dead three to five years.

Description: Most primary branches gone. Bark sloughing is common. Breakage of main stem. Begin to topple. Volvatus conks drying up. Pinicola conks obvious. Considerable rot throughout the sapwood.

Deduction from PNW-GTR-292 for 3-5 Years:

DBH in.	10	20	30	40	50	60	70
Percent Cull, 3rd year	88	76	62	57	52	50	50
Percent Cull, 4th year	92	83	73	69	67	65	65
Percent Cull, 5th year	96	90	85	81	80	80	80

4. Older dead; probably dead more than five years.

Description: Deterioration complete. Only the largest diameter trees and stobs remain. Many stems fallen. Often only decayed wood is left within a bark cylinder.

Deduction: all volume can be assumed to have deteriorated after 5 years.

PONDEROSA/JEFFREY PINE

Four classes of mortality:

1. Current mortality, trees dead up to one year.

Description: Full foliage which fades from yellow-green through straw color to red to orange to brown. Will generally retain much of the brown foliage into the first winter. Blue stain present. Volvatus conks forming.

Deduction: 0 percent

2. Trees dead more than one, up to two years.

Description: Most of the foliage is shed. Some small branches shed. Cracks appear in the bark. Blue stain and rotting sapwood present.

Deduction from PNW-GTR-292 for Two Years:

DBH in.	10	20	30	40	50	60	70
Percent Cull	52	47	42	37	33	28	26

3. Trees dead three to five years.

Description: Very little foliage remaining. Most branches, and some tops, are shed. Bark sloughing. Smaller diameter (under 30 inches) trees beginning to fall. Volvatus conks drying up. Considerable sapwood deterioration. Heartwood deterioration beginning.

Deduction from PNW-GTR-292 for 3-5 Years:

DBH in.	10	20	30	40	50	60	70
Percent Cull 3rd Year	88	79	70	62	55	48	43
Percent Cull 4th Year	92	85	76	70	64	58	53
Percent Cull 5th Year	96	90	83	79	75	70	67

4. Older dead; probably dead more than five years.

Description: Deterioration complete. Often a buckskin stob.

Deduction: 100 percent

SUGAR PINE

Four Classes of mortality:

1. Current mortality; trees dead up to one year.

Description: Full foliage which fades from yellow-green through straw color to red to orange to brown. Will generally retain much of the brown foliage into the first winter. May be signs of current woodpecker activity. Blue stain present. Volvatus conks forming.

Deduction: Less than 3 percent for all diameters

2. Trees dead more than one, up to two years.

Description: Most of the foliage is shed. Some small branches shed. Cracks appear in the bark. Blue stain common. Saprot beginning.

Deduction from PNW-GTR-292 for Two Years:

DBH in.	10	20	30	40	50	60	70
Percent Cull	50	42	35	30	25	22	20

3. Trees dead three to five years.

Description: Very little foliage remaining. Most branches, and some tops, are shed. Bark sloughing. Smaller diameter (under 30inches) trees beginning to fall. Volvatus conks drying up. Considerable sapwood deterioration. Heartwood deterioration beginning.

Deduction from PNW-GTR-292 for 3-5 Years:

DBH in.	10	20	30	40	50	60	70
Percent Cull 3rd Year	70	58	49	42	38	35	32
Percent Cull 4th Year	75	63	54	48	44	40	38
Percent Cull 5th Year	75	67	59	53	49	47	44

4. Older dead; probably dead more than five years.

Description: Deterioration almost complete. Often a buckskin stob. Sound volume will only be in larger logs, the lower logs in large trees.

DOUGLAS-FIR

Four Classes of Mortality:

1. Current mortality, trees dead up to one year.

Description: 20 percent or more foliage present; 75 percent or more fine twigs present. Limbs, top, and bark intact. Sapwood green, or only slight stain. Volvatus conks forming.

Use the average scaling cull for green trees from 22.31a - Exhibit 3 if it is larger than the following values

Deduction for One Year:

DBH in.	10	20	30	40	50	60	70
Percent Cull	16	11	8	6	5	4	4

2. Trees dead more than one, up to two years.

Description: May have 10 percent or more foliage remaining. Small branches begin falling. Sloughing of bark beginning on smaller trees. Some sapwood deterioration. Volvatus conks common. Pinocola conks on smaller diameter stems.

Use the average scaling cull for green trees from 22.31a - Exhibit 3 if it is larger than the following values

Deduction for Two Years:

DBH in.	10	20	30	40	50	60	70
Percent Cull	55	45	34	27	22	17	14

3. Trees dead three to five years.

Description: Some foliage (less than 10 percent) may be remaining. Small branches falling. Some top breakage. Bark sloughing beginning on larger trees. Saprot common. Volvatus and Pinicola conks present.

Deduction for 3 to 5 Years:

DBH in.	10	20	30	40	50	60	70
Percent Cull 3rd Year	60	48	38	30	24	20	17
Percent Cull 4th Year	71	70	51	43	36	20	17
Percent Cull 5th Year	78	75	60	51	43	22	20

4. Older dead; probably dead more than five years.

Description: No foliage remaining. Less than 10 percent of twigs remaining. Larger limbs falling. About 50 percent with broken tops. Bark sloughing. Considerable saprot.

INCENSE CEDAR

The region is currently in the process of collecting data for deterioration of fire killed Incense cedar. Use the average scaling cull for green trees from 22.31a - Exhibit 3 if it is larger than the following values.

1. For trees dead less than one year, make no deduction.
2. For trees dead from 1 to 2 years, make a deduction of 5 percent of the volume unless there has been a previous large fire in the same area within 4 years. If there has been a previous fire, use a deduction of 30 percent for trees less than 30 inches DBH.
3. For trees dead 2 to 3 years, deduct 35 percent for trees less than 30 inches DBH. Use the average scaling cull for green trees from 22.31a - Exhibit 3 if it is larger than 30 inches.
4. For trees dead 3 years or more, use a check or advanced log scaler to evaluate the rate of defect on the ground near the time of timber sale.

End - 22.31e - Exhibit 01

22.42 - Fall, Buck, and Scale

Use the Regional standards in this section to produce consistent cruise estimates.

1. Randomly select sample trees based on a DBH frequency distribution method. Identify and map selected trees.
2. Use minimum scaling diameter in timber sale contract.
3. Use a minimum log length from the timber sale contract. Cut logs into lengths common to local industry practices.
4. Buck designated sample trees into logs so that they may be ground scaled. Start measuring log from short side of butt end. If the entire ends of bucked logs cannot be seen, a double cut "cookie" must be made. This double cut shall be two inches wide and rolled out of the cut. Do not include cookie in the trim allowance.
5. Treat broken chunks, highly defective material, and extremely knotty material as separate segments and record the type of defect.
6. Use the sample data collection record found in FSH 2409.12a, section 12 - Exhibit 02, or the Field Data Recorder Program using Fall, Buck, and Scale found in the National Cruise Program R5 User's Guide, Input Requirements and Reports.