4.3.2.7 Positions 37 to 44 Pathological Remarks

Pathological indicators are recorded when observed on the bole or a merchantable secondary leader (see Section A.4.2) of the tree. The exceptions are:

- *Phaeolus Schweinitzii*, which will occur on the ground near the base of the tree.
- Scars on root collars.

There are qualifications to many of the pathological indicators, such as age of scars, position of fork or crook, size of rotten branches, etc (please refer to Pathological Classification of Trees - Appendix 4, for a detailed description of pathology).

Pathological Indicators located above 10 cm top diameter (inside bark) are not to be recorded.

Refer to the box entitled "Path Code by Tree Third". This indicates the numerical coding to be used in this section. The tree is schematically divided into thirds, with the bottom (BOT) blocks representing the bottom third, the middle (MID) block the middle third, and the top (TOP) block the top third. The shading indicates in which third or thirds the defects occur based on the codes 1 through 7. If the defects occur in the bottom third only, "1" is entered in the defect column. If a defect occurs in both the middle and top thirds, "5" is entered; etc.

Path Code by Tree Third

	1	2	3	4	5	6	7
TOP							
MID							
BOT							

The column heads under "PATH REMARKS" are self-explanatory except for the last two: "Rotten Br." means "Rotten Branch"; "D. or B. Top" means "Dead or Broken Top". All the pathological indicators listed must be recorded in the third(s) where they occur.

Refer to the Risk Group Ratings by Pathological Indicators in Table 18 for pathological occurrence by species and forest inventory zones.

BACK

A.4.2.3 Scars

A scar is an injury caused by external forces which has damaged the cambial layers of the tree and exposes either the sap wood or heartwood (or both) to potential attack by wood rotting fungi. These wood rotting fungi are ever present in forest stands and are carried widely by air currents.

Forms of scars - both open and closed scars will be recorded.

Open scars:

- open scars appear as areas of exposed wood of varying sizes and shapes (see Figure A.20 Open Scars), and
- scars are slow to heal over and the wood tissues of the tree may remain exposed for a considerable time allowing entrance of wood rotting fungi.

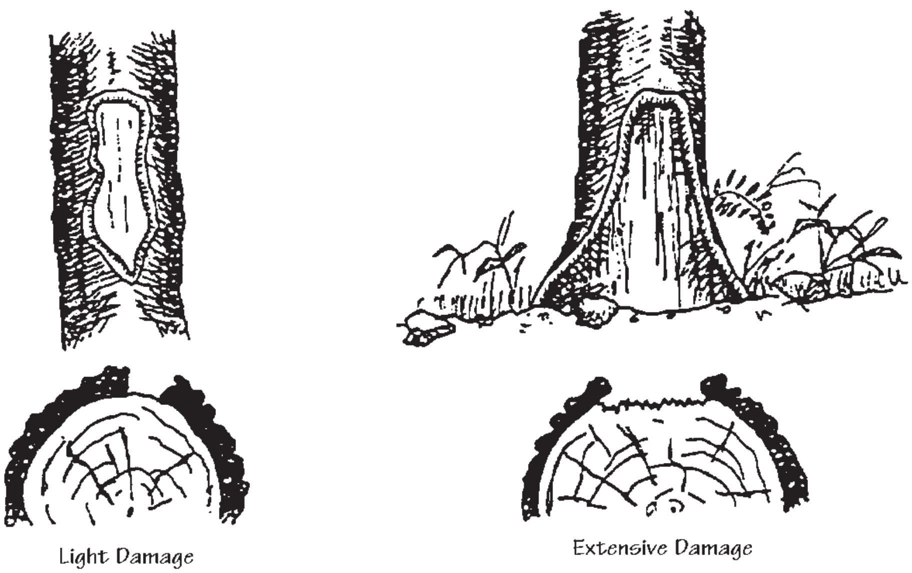

Figure A.20 Open Scars

For root scars to be eligible calls, the scar must be on the portion of the root that is exposed before it enters the ground (see Figure A.21 Root Scars.).

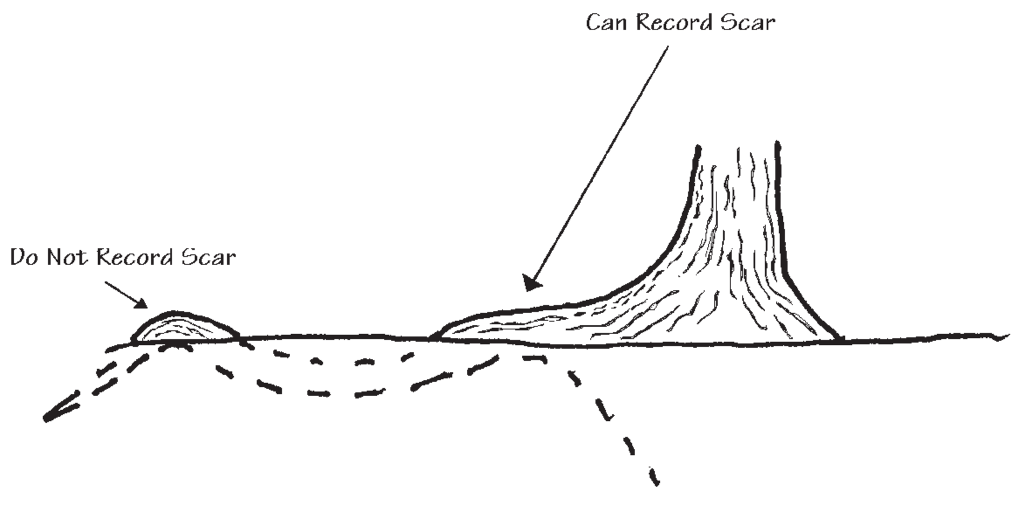

Figure A.21 Root Scars.

Closed scars:

- closed scars appear as slight to pronounced indentations of the bark in the case of early scarring which has healed over, or as pronounced scar tissue or callous growth in the case of later scarring. The latter type of scars frequently show considerable resin flow (see Figure A.22 Closed Scars.).

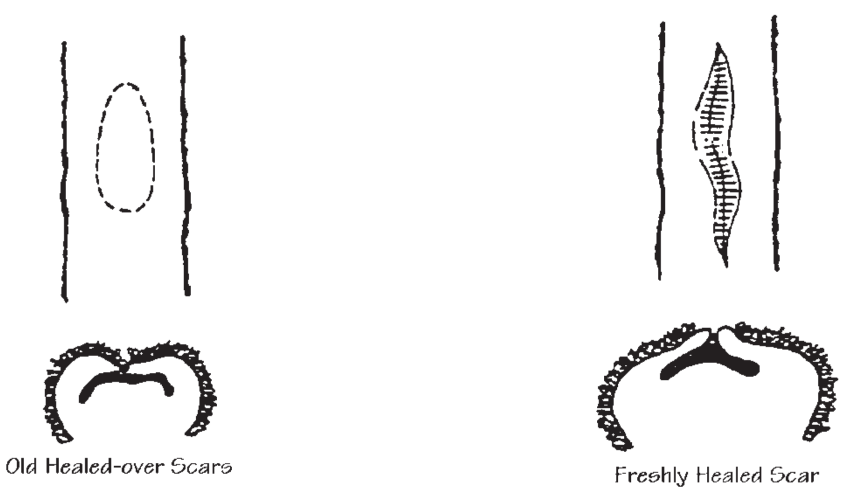

Figure A.22 Closed Scars.

The volume and decay studies of the past thirty years identified only scars visible to the naked eye without the use of binoculars or other lens. The scars were assessed without chopping into the indicator. To be compatible with these initial assessments, the same methodology must therefore be followed today. This also is the most practical method of observation at present.

A scar may or may not have visible decay associated with it.

The decay studies have scars with both decay and no decay in the data base.

Age of scar:

- a scar shall not be recent in origin. This is interpreted as the injury having not occurred within approximately the past five years[3],
- the scar or catface should show greyed or weathered wood. Weathered wood shall be described as:
  - dried and some "sun checking" evident,
  - usually associated with change of wood colour to a greyish tone,
  - callous growth should also be evident where the tree is attempting to grow over the scar, and
  - decay does not have to be evident.

Location of scar:

- a scar should be recorded if the damage occurs on any portion of the trunk of the main stem or on the secondary leader (only if the secondary leader contains a merch log),
- a scar which extends from the first third of the tree into the upper 1/3 of the tree on which the top is dead will be recorded as a scar "4" by convention. The objective is not to double call the pathological indicators in the upper 1/3 of the tree,
- scars occurring completely below the point of germination, either on the trunk or an exposed root adjacent to the trunk, will be recorded as a scar, and
- do not record scars above 10 cm top diameter[4].

[3] *Recent pathological damage was not included in the loss factor data.*

[4] P*athological factors above 10 cm top diameter were not included in the loss factor data.*

Causes of scars:

Scars may be caused by many external forces, such as:

1. Fire:

   - old fire scars that have healed over appear typically as slight ridging of the bark and may have very old callous tissue on the bark, whereas more recent fire scars or ones resulting from severe damage appear as open catfaces or hollowing of the stem,

   - fire scars are usually confined to the base of the tree, and

   - fire scars may be important indicators of decay. Trees growing in forest stands (i.e., south or west facing slopes with pioneer species such as Douglas fir or Lodgepole Pine) having a history of fire should be examined carefully for evidence of charred wood in root crotches or on exposed roots.

   See Section A.6.2 in Damaged Stands (Appendix 6).

2. Lightning:

   - lightning can cause extensive damage to the top and stem of the tree. It typically appears as narrow to wide strips of torn wood, often extending down the entire length of the tree and often in the form of a spiral around the stem.

3. Damage by a falling tree:

   - trees are frequently scarred by other trees falling against them. Scars of this type are common in selectively logged stands or decadent stands where windfall trees are more common. Look for evidence that a fallen tree might have rubbed off the branches along the side of the tree.

4. Machinery damage:

   - machinery can cause extensive damage, especially where selective logging has occurred, and

   - these scars are usually confined to the lower trunk, but they may also occur on the upper trunk when damage is caused by rigging lines.

5. Blazes:

   - blazes are entry points for decay fungi if they penetrate into the cambium layer.

6. Breakage of branches, secondary leaders or suckers from the bole of the tree:

   - high winds or heavy snow may cause the branches to break from the main stem creating exposed wood on the bole of the tree.

7. Falling rocks (see Figure A.23 Scars Caused by Rock Slides and Falling Rocks)

   - rock slides or individual rock movement can cause extensive damage to trees in their path,
   - scars caused by rocks are usually confined to the basal portion of the trunk on the uphill side, and
   - falling rocks may scar trees a considerable height above the ground, either due to snow levels at the time of injury or bouncing rocks on steeper slopes. Rock damage is often evident on trees adjacent to road construction where blasting has occurred.

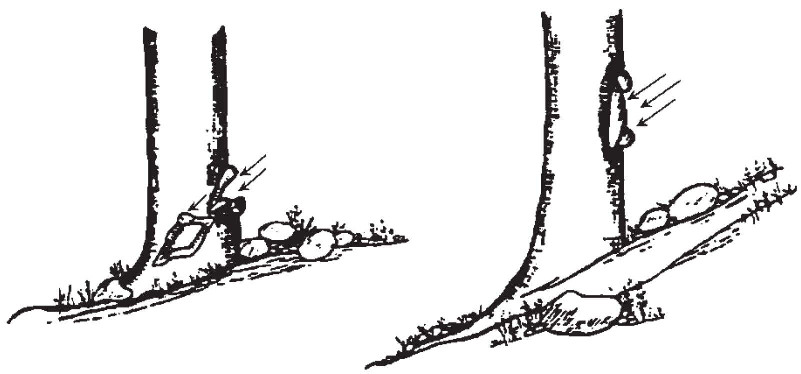

Figure A.23 Scars Caused by Rock Slides and Falling Rocks

8. Animal/bird damage:

   - wood must be exposed,
   - bear, moose, deer etc. can cause damage by removing areas of bark and cambium from the trunks of many trees,
   - rodents and beavers also cause damage to trees by gnawing on areas of the trunk,
   - woodpecker holes of considerable size provide entrance for wood rotting fungi, however, sap sucker holes are not scars, and
   - care must be taken to exclude superficial damage caused by these agents.

9. Cankers caused by fungi (see Figure A.24 Cankers Caused by Fungi.):

   - only cankers with exposed weathered wood are called, and
   - cankers caused by fungi result in the death of localized areas of bark and cambium on the trunks of trees. Eventually the dead bark is sloughed off exposing the underlying wood. There is usually evidence of repeated callous growth, and for this reason cankers are frequently mistaken for mechanical scars. Cankers are usually flattened

BACK

and elongated, and may be indefinite in contour. The exposed wood is often stained and impregnated with resin. Fruiting bodies of the fungus may also be in evidence.

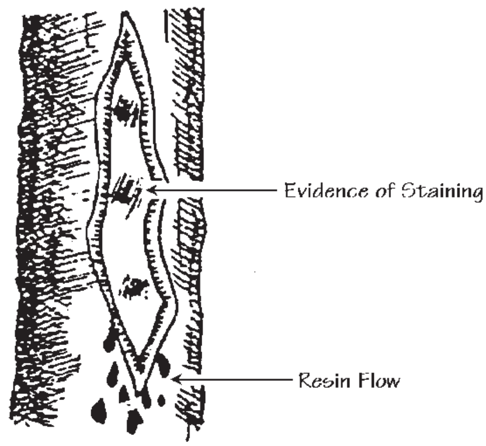

Figure A.24 Cankers Caused by Fungi.

Abnormalities similar to scars but not classified as scars:

Black knots:

- black knots frequently develop around unhealed knots and wounds. A superficial saprophytic fungus, which feeds on the exuded sap, causes the blackness. Black knots are quite sound and when cut into with an axe do not signify decay.

Burls and galls:

- burls and galls develop from abnormal cell growth in trees and are not associated with scarring, however scars occurring on burls and galls will be recorded.

Dry side:

- dry side results from the death of the cambium through bruising by other trees or by other physiological causes. Dry side may appear as a narrow to wide strip or as a localized area on the side of a tree. The bark remains over the affected area and provides protection against wood rotting fungi. Dry side is not a scar unless the bark has sloughed (is missing).

Sap sucker holes:

- sap sucker holes are superficial in extent and have no established significance for causing decay.

Insect borings:

- borings by bark beetles or other insects are generally recent in origin and they are not pathological indicators.

A.4.2.4 Fork or Pronounced Crook

A fork or crook is the result of damage to the main leader of the tree where one or more lateral limbs take over as the main stem. Fork or crook is called if severe enough to indicate that the original injury exposed the wood and provided an entrance point for decay fungi. Fork or crook is to be recorded between the root collar and the minimum top diameter specified in the cutting authority document.

Forks are recorded for any of the following conditions:

1. The main stem is markedly forked to indicate that 2 or more leaders have resulted from serious damage to the original leader (see Figure A.25 Types of Forks and Crooks Which are Recorded, Example A and B).

2. The diameter of the main stem changes excessively from its normal taper to indicate that a serious injury has occurred. For cruising purposes, the diameter change must be at least 10 percent (Figure A.25 Types of Forks and Crooks Which are Recorded, Example C and D).

3. Where there is no evidence of a broken top in the stem at the fork/crook position and neither of the leaders are merchantable, record fork/crook.

Crooks are recorded if:

1. There is at least a 10 percent diameter change in the bole above and below the crook (see Figure A.25 Types of Forks and Crooks Which are Recorded, Example F).

2. The offset is severe enough to indicate that damage occurred to the main stem. For cruising purposes, the offset must be at least 50 percent of the diameter of the tree at the crook (see Figure A.25 Types of Forks and Crooks Which are Recorded, Example E).

Some forks and crooks are not recorded (see Figure A.40 Illustrates Forks and Crooks Which are Not Suspect). Forks and Crooks may be a growth characteristic of the tree species (for example deciduous species) or may have developed from malformation of the terminal leader due to insect or mistletoe attack. In addition, a fork may be confused with a branch. Forks or crooks which are not recorded are as follows:

1. Crooks with a minor offset (for cruising purposes, an offset less than 50 percent of the diameter of the tree at the crook).

2. Small sharply angled branches or spikes (for cruising purposes, less than a 10 percent change in the diameter of the main stem).

3. Natural forking in deciduous tree species.

BACK

Risk Group Ratings by Pathological Indicators (Table 18)

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
Cw	All FIZ	Immature	1-80	Any indicator		
		Old Immature	81-120	No indicators	Any indicator	
	FIZ D to I	Mature	121+	No indicators or large rotten branch	Any other indicators	
	FIZ A, B, C, J	Mature	121+	No indicators or either frost crack or fork/crook	Any other indicator(s)	
	*Exceptions	Mature	121+	Height ≥ 40.5 m.	Height < 40.5 m.	
CY	All FIZ	Immature	1-80	Any indicator		
	All FIZ	Old Immature	81-120	No indicators	Any indicator	
	All FIZ	Mature	121+	No indicators	Any indicator	

*Applies to the following PSYUs and TFL 30:

- Bowron
- Longworth
- Monkman
- Purden
- Robson

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
Fd	All FIZ	Immature	1-80	Any indicator		
	FIZ A, B, C	Old Immature	81-120	Any indicator		
	FIZ D to I	Old Immature	81-120	No indicators	Any indicator	
	FIZ A, B, C	Mature	121+	No Indicators or 1 of dead/broken top or large rotten branch or frost crack	Any other indicator other than conk or blind conk	Conk or blind conk
	FIZ D, H	Mature	121+	No Indicators or 1 of mistletoe or large rotten branch or frost crack	Any other category or combination	
	FIZ E, F, G	Mature	121+	No Indicators or 1 of large rotten branch or mistletoe.	Any other category or combination	
	FIZ I	Mature	121+	No Indicators or 1 of dead/broken top, mistletoe, large rotten branch, or frost crack	Any other category or combination(s) other than conk or blind conk	Conk or blind conk

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
B	All FIZ	Immature	1-80	Any indicator		
		Old Immature	81-120	No indicators	Any indicator	
		Mature	121+	No indicator or forks/crooks	3 or less indicators	Conk or blind conk or 4 or more other indicators
H	All FIZ	Immature	1-80	Any Indicator		
	All FIZ	Old Immature	81-120	No indicators	Any indicator	
	FIZ A	Mature	121 +	D or B Top, large rotten branch, mistletoe, frost crack, fork/crook or scar	2 or 3 indicators	4 or more categories or conk or blind conk
	FIZ B, C	Mature	121 +	D or B Top and/or mistletoe	frost crack or fork/crook or scar or indicators in 2 or 3 categories	4 or more categories or rotten branch, conk, or blind conk
	Kingcome Local & TFLs 6, 25, 37, 43, 45, and 47	Mature	121 +	No indicators or one or both of D or B top or mistletoe	frost crack, fork/crook, scar or rotten branch or 2 or more categories	4 or more categories or conk or blind conk

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
	FIZ D to K	Mature	121 +	No indicators	No more than 3 of any indicator other than conk/blind conk	Conk/blind conk or 4 or more of any other indicators

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
S	All FIZ	Immature	1 - 80	Any indicator		
	FIZ A, B, C	Old Immature	81 - 120	Any indicator		
	FIZ D to L	Old Immature	81 - 120	No indicators	Any indicator	
	FIZ A, B, C	Mature	121 +	D or B Top, rotten branch, mistletoe, frost crack, fork/crook, scar	More than 1 indicator or Conk or Blind conk	
	FIZ D to L	Mature	121 +	No indicators	Any other than conk/blind conk	Conk/blind conk
L	All FIZ	Immature	1 - 80	Any indicator		
		Old Immature	81 - 120	No indicators	Any indicator	
		Mature	121 +	No indicators	Any other than conk or blind conk	Conk or blind conk

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
PL	All FIZ	Immature	1 - 60	Any indicator		
	All FIZ	Old Immature	61 - 120	No indicators	Any indicator	
	FIZ A, B, C	Mature	121 +	No indicators	Any indicator	
	FIZ D to L	Mature	121 +	No indicators	Any other than conk/blind conk	Conk/blind conk
Pw	All FIZ	Immature	1 - 80	Any indicator		
and		Old Immature	81 - 120	No indicators	Any indicator	
Pa		Mature	121 +	No indicators	Any indicator	
Py	All FIZ	Immature	1 - 80	Any indicator		
		Old Immature	81 - 120	No indicators	Any indicator	
		Mature	121 +	Fork/crook	Any indicator other than fork/crook	

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
Ac	FIZ A to J	Immature	1-20	Any indicator		
	FIZ K, L	Immature	1-40	Any indicator		
	FIZ A to J	Old Immature	21 - 40	Any indicator		
	FIZ K, L	Old Immature	41 - 80	Fork/crook	Any other than fork/crook	
	FIZ A to J	Mature	41 +	Any indicator		
	FIZ K, L	Mature	81 - 140	Fork/crook	Any other than fork/crook	
	FIZ K, L	Over Mature	141 +	Any indicator		
At	FIZ A to J	Immature	1-20	Any indicator		
	FIZ K, L	Immature	1-40	Any indicator		
	FIZ A to J	Old Immature	21 - 40	Any indicator		
	FIZ K, L	Old Immature	41 - 80	Any indicators other than conk or blind conk	Conk or blind conk	
	FIZ A to J	Mature	41 +	No indicators	Any	

Species	Location	Age Group	Age Range	Risk Group 1	Risk Group 2	Risk Group 3
	FIZ K, L	Mature	81 - 140	Fork/crook	Any other than fork/crook or conk or blind conk	Conk or Blind Conk
	FIZ K, L	Over Mature	141 +	Any indicator		
E	All FIZ	Immature	1 - 20	Any indicator		
		Old Immature	21 - 40	Any indicator		
		Mature	41 +	No indicators	Any Indicator	
D	All FIZ	Immature	1 - 20	Any indicator		
		Old Immature	21 - 40	Any indicator		
		Mature	41 +	Any indicator		
Mb	All FIZ	Immature	1 - 20	Any indicator		
		Old Immature	21 - 40	Any indicator		
		Mature	41 +	No indicators	Any indicator	

Sampling Procedures

The cruiser holds the prism exactly over plot centre and looks at a tree across the upper edge of the prism, and so views it simultaneously above the prism and also through the prism. The tree image seen through the prism will be laterally displaced. The prism must be over the sample centre as the prism forms the vertex of the angle being projected.

If the displacement is greater than the diameter of the tree, the tree is "out"; if smaller the tree is "in"; if the same, the horizontal distance to the tree must be measured because it is borderline (see Figure 4.4 "In", "Out" and "Borderline" Trees.). The prism will be "swept" around plot centre and all live and dead trees equal to or larger than the minimum specified size for the "in plot" trees will be recorded.

The cruiser must pay special attention when assessing the trees as “in” or “out”. An oddly shaped tree may appear to be “in” or “out” when viewed through a prism from the plot centre, but may have different results if measured using the borderline measurement method.

If a shatter extends through DBH and either the standing or down portion of the tree fall outside of the plot, use the portion of the tree with greater than 50% of the basal area at breast height to determine if the tree is “in” or “out” and assign applicable damage codes (See Section A.6.3)

If a boundary tree is to be harvested or stubbed and it is “in”, apply the walkthrough method and record its details once or twice as identified in the walkthrough method procedures.

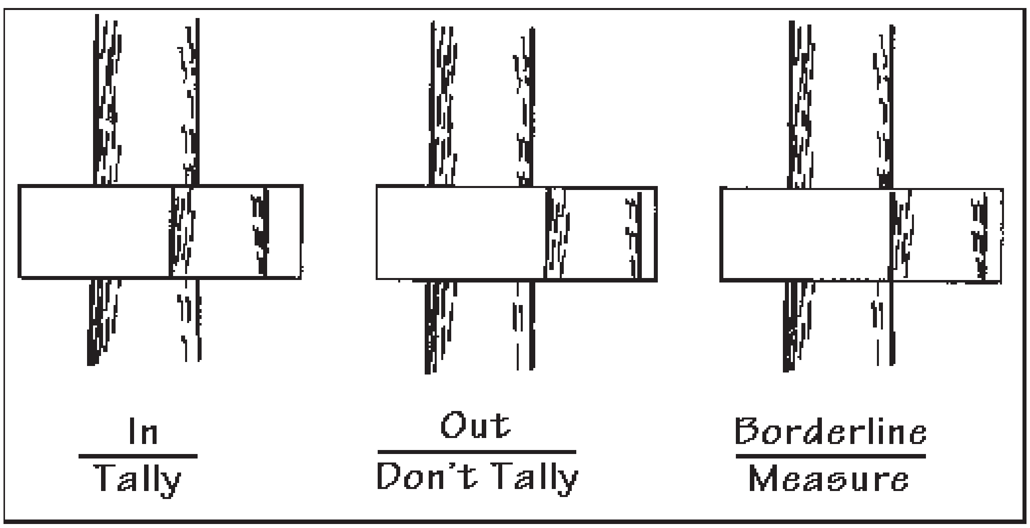

Figure 4.4 "In", "Out" and "Borderline" Trees.

BAF Selection

Changing BAFs within a timber type polygon may introduce a bias in the reporting of summary stand statistics. The BAF may be changed once within each timber type polygon. Once the change is made, the BAF cannot be changed again regardless of stand composition. More than one BAF change in a timber type polygon may result in the rejection of the cruise. The determination of the BAF must not be made at plot centre. When a BAF change is made, the location of the BAF change must be noted on the cruise field notes or cruise cards.

The BAF may only be changed to a BAF value within 50% of the original BAF value, unless there are extenuating circumstances and a professional rationale is provided. For example, if the original BAF selected is 10 and a new BAF is selected, the new BAF must be between 5 and 15. If the original BAF selected is 14, the new BAF must be be between 7 and 21.

Prism Slope Correction

Since each tree on the area may have its own unique slope angle from the centre, each tree must be considered individually in making slope corrections (see Horizontal Distance Correction in Appendices). In borderline situations, trees are to be measured as described in the following section.

Borderline Trees (Variable Plot Cruises)

When sighting a tree through a prism or relascope, the exact in/out status cannot always be determined. The correct status of borderline trees in measure and count plots must be determined by using the following procedure:

1. Determine the horizontal distance from the plot centre to the face of the tree trunk at breast height. The plot centre is the point at which the plot marker (stake, pin, etc) enters the ground and not the top of the marker.
2. Add one half of DBH to the horizontal distance to determine the horizontal distance from the tree centre to the plot centre.
3. Multiply the plot radius factor times DBH. This represents the plot radius for the tree. In variable cruising every tree has its own plot radius depending on its diameter and the angle of the prism being used (see Variable Plot Sampling in Appendices).
4. If the horizontal distance from the tree to the plot centre is less than or equal to the plot radius, the tree is considered “in”. If the horizontal distance from the tree to the plot centre is greater than the plot radius, the tree is considered “out”.
5. Record the measured slope distance and slope percent on the cruise tally card and run a single pencil line through the tree details if the tree is “out”.

All "borderline" trees must be measured and the measurements recorded for checking purposes.

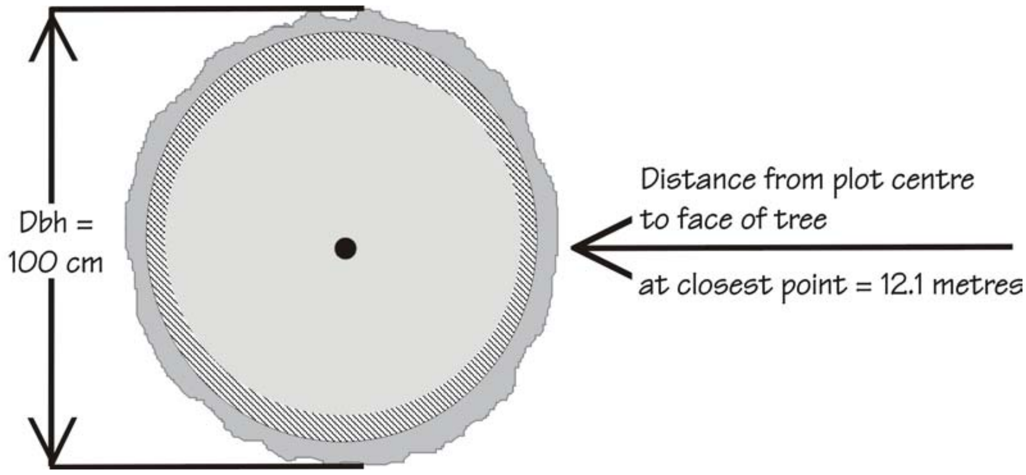

Figure 4.5 Borderline Tree Measurements - Variable Plot.

Example:

Borderline tree of 100 cm DBH, measured with a BAF 16 Prism (see Figure A.1 Illustration of Basal Area/Hectare.)

$$PRF = \frac{1}{2\sqrt{BAF}} = \frac{1}{2\sqrt{16}} = 0.125$$

Plot radius of 100 cm tree = 0.125 x 100 = 12.50 m.

Distance to centre of tree = 12.1 m + $\left(\frac{100cm}{2} = 0.5m\right) = 12.60\,m$.

The measured distance exceeds the plot radius of the tree, therefore the tree is out and not tallied. Record the measured horizontal distance on the tally card and run a single pencil line through the tree details if the tree is out.

This method will be used for check cruising:

(PRF minus 0.005) times DBH = the plot radius distance for the tree from plot centre to the face of the tree.

The following table shows plot radius factors for a selection of prism basal area factors:

Basal Area Factor	Plot Radius Factor Tree Center	Plot Radius Factor Tree Face	Basal Area Factor	Plot Radius Factor Tree Center	Plot Radius Factor Tree Face
2	0.3536	0.3486	13	0.1387	0.1337
3	0.2887	0.2837	14	0.1336	0.1286

Basal Area Factor	Plot Radius Factor Tree Center	Plot Radius Factor Tree Face	Basal Area Factor	Plot Radius Factor Tree Center	Plot Radius Factor Tree Face
4	0.2500	0.2450	15	0.1291	0.1241
5	0.2236	0.2186	16	0.1250	0.1200
6	0.2041	0.1991	18	0.1179	0.1129
6.25	0.2000	0.1950	20	0.1118	0.1068
7	0.1890	0.1840	20.25	0.1111	0.1061
8	0.1768	0.1718	24	0.1021	0.0971
9	0.1667	0.1617	25	0.1000	0.0950
10	0.1581	0.1531	30.25	0.0909	0.0859
11	0.1508	0.1458	32	0.0884	0.0834
12	0.1443	0.1393	64	0.0625	0.0575

Leaning or "Down" Trees

Leaning and down trees must be measured from the centre of the tree at breast height to the plot centre in order to determine whether a tree is “in” or “out”. When a tree is laying on the ground, the measurement is made from the centre of the top side of the tree at breast height to the plot centre.

Hidden Trees

If a tree cannot be sighted easily it must be treated as a borderline tree, the trees plot radius calculated and the distance from the plot centre to the tree measured.

Walkthrough Method

The Walkthrough Method must be used for variable plot appraisal cruises. The walkthrough method is based on a description of the procedure from Dr. Iles book entitled “*A Sampler of Inventory Topics*”.

The following general procedures must be followed in the establishment of a walkthrough plot:

Do not tally trees that fall outside the cruise area. Walkthrough plots must not be used near boundaries that are difficult to define in the field, such as timber type and harvest method boundaries. In those situations it is appropriate to use a full sweep plot.

All “in” or “out” tree distance measurements are recorded on a horizontal basis and are measured at 1.3 metres breast height.

If a boundary tree is to be harvested or stubbed and it is “in”, apply the walkthrough method and record its details once or twice as identified in the following procedures.

BACK

Regular Boundary – see Figure 4.6 Walkthrough Method - Regular Boundary.

Measure the bearing and distance from the plot centre to the centre of the “in” tree and then measure an equal distance beyond the centre of the tree on the same bearing from plot centre. Record the tree details twice if the measurement is outside the cruise area. Record separate tree numbers for each tree. Record the tree details once if the measurement is inside the cruise area.

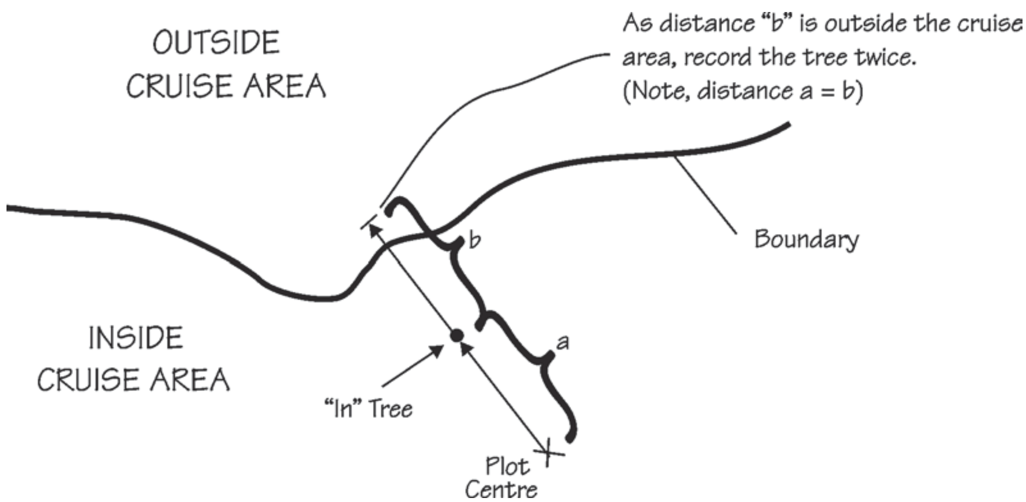

Figure 4.6 Walkthrough Method - Regular Boundary.

Use the walkthrough method at all flagged and traversed harvest boundaries, non-forest type boundaries identified on the cruise plan and road rights of way centrelines (as specified later in this section).

Irregular Boundary – see Figure 4.7 Walkthrough Method - Irregular Boundary.

If the point bearing and distance places the point back inside the cruise area then record the tree once.

BACK

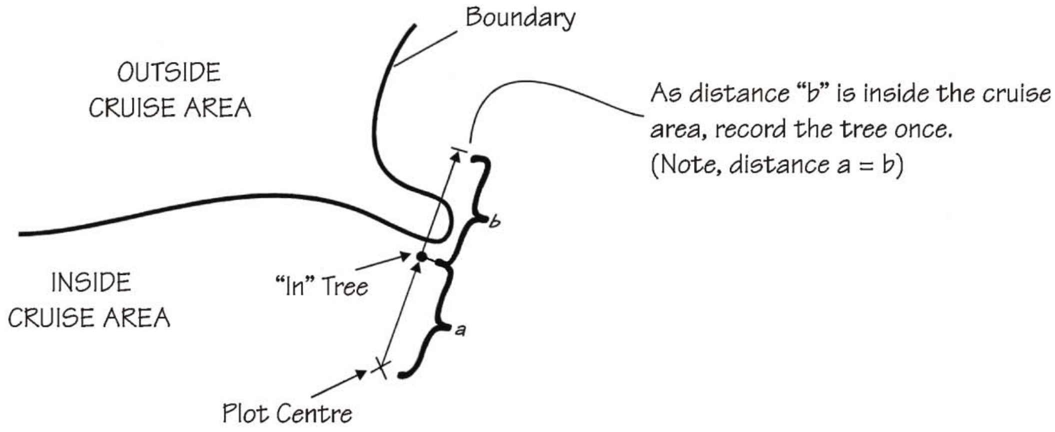

Figure 4.7 Walkthrough Method - Irregular Boundary.

Unmarked Boundary – see Figure 4.8 Walkthrough Method - Unflagged and Harvested Rights of Way.

When an unmarked opening boundary is encountered (e.g. a cleared road right of way, NP patch identified on cruise plan), the block edge for walkthrough purposes is determined by projecting a line between the outer most face of the merchantable trees on the edge of the opening. If this does not result in a reasonable block edge, then the edge may be determined by projecting a line along the edge that represents a normal stand form in that location.

If a non-harvested road right of way (R/W) forms the block boundary and the road R/W is to be harvested under road permit but is not marked in the field, the road centreline will be used as the block boundary. Removal of road R/W area under the road permit will remove area from the cutting permit, but the sampled cruise plots will be included in the cruise compilation for the cutting permit.

If a road centreline is used as a boundary rather than the correct block boundary, there will be a small bias involved with sampling area between the block boundary and road centreline. This small bias is acceptable to the MFLNRO.

If the road R/W is to be harvested under cutting permit or the licensee is not sure under what tenure the timber will be removed, the block harvest area and cruised area must include the full R/W boundaries (both sides of the centreline).

If the type of tenure for the road area is changed after cruising, it will be considered a change to the cruise plan and assessed accordingly.

Please refer to Figure 4.8 Walkthrough Method - Unflagged and Harvested Rights of Way. for examples of how to apply the walkthrough method to unflagged and harvested rights of ways.

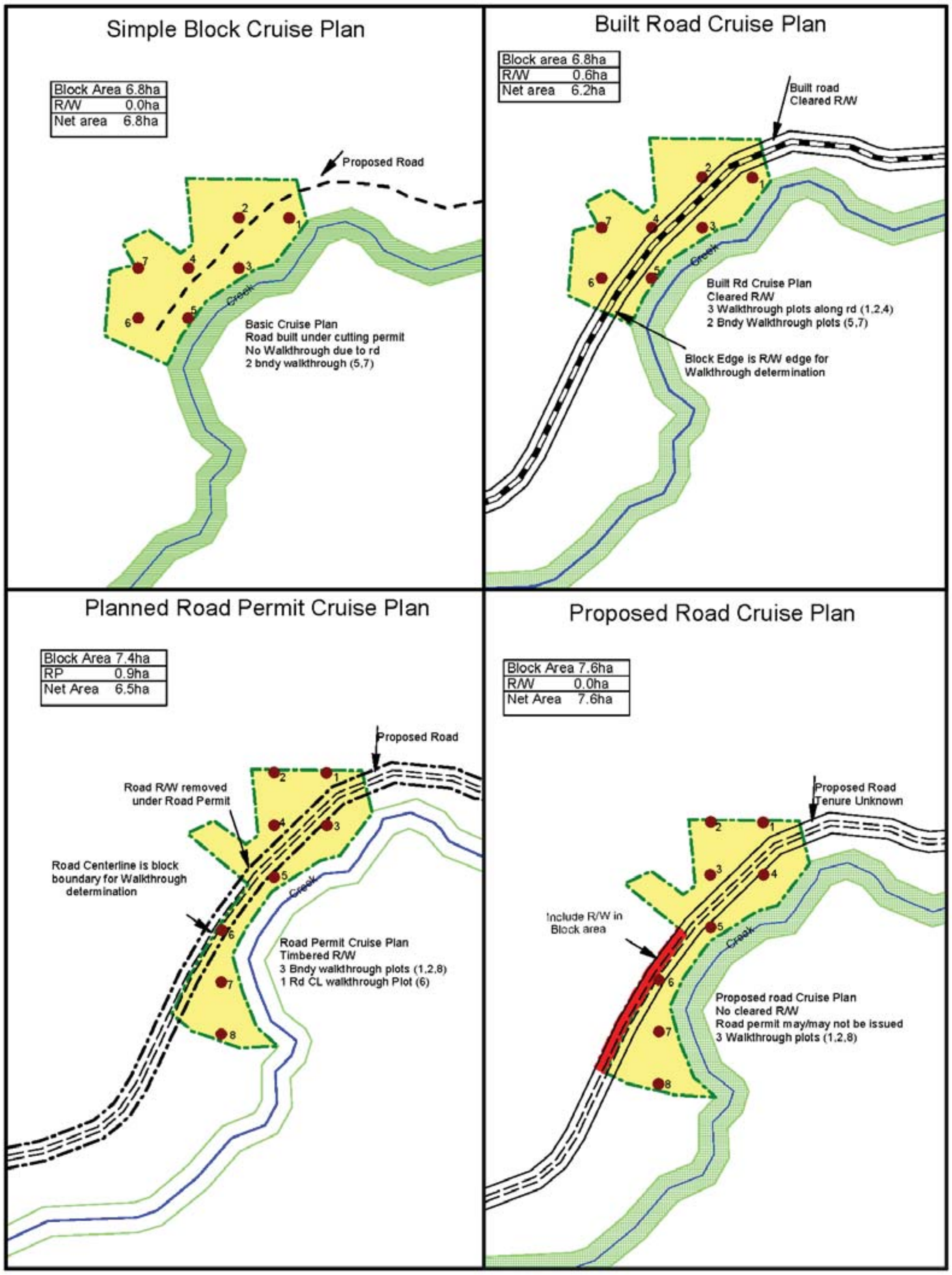

Figure 4.8 Walkthrough Method - Unflagged and Harvested Rights of Way.

Tree Class 9 (Dead Potential; Younger Immature Dead Potential in Interior)

Tree class 9 dead potential trees are immature and contain at least 50.0% of the tree's original volume. Tree Class 9 shares the characteristics of both the immature dead potential (Tree Class 3) and younger immature tree classes (Tree Class 8). Therefore, the The guidelines for Tree Class 3 and Tree Class 8 apply.

Ages

In over mature stands, the establishment of age is not critical except for interior cedar over 141 years as it requires a different top diameter for compilation.

The age correction to breast height is found in the Site Index Tables for British Columbia – All Species in the appendices.

Tree class 3, 7 and 9 trees – record age as counted and corrected. Do not add the number of years that the tree has been dead.

Age of sample trees is determined by a ring count from an increment borer core, taken at diameter breast height (DBH). The pith must be included in the core to properly count the age of the tree. In cases where the pith is not contained in the core, and is missed by an estimated three years or more, the tree must be re-bored.

Sufficient trees must be bored for age to ensure the correct maturity classes, except Lodgepole pine where the inventory age will be used to determine the correct age classes. The number of trees that need to be drilled will be dependent upon the maturity profile in each plot.

Use the following procedure for determining the tree classes for interior Lodgepole pine (PL):

- Overlay the most recent Forest Cover Inventory or Vegetation Resource Inventory (VRI) polygon coverage on the cruise plan map.

- Identify the projected age or the age class code for each overlaying polygon. The projected age can be retrieved from the Vegetation Tab in Mapview or from the licensee forest cover mapping system. The age class codes can be retrieved from the most recent TFL or WL inventory maps.

  https://webmaps.gov.bc.ca/imfs/imf.jsp?site=mapview

- The age of each interior Lodgepole pine tree tallied in a plot is the projected age or the corresponding age of the inventory polygon in which the plot is located.

Refer to the age class code from the table below to determine the corresponding age range.

Code Age	Age Class Limits	Allowable Tree Classes
1	1 to 20 years	8, 9
2	21 to 40 years	
3	41 to 60 years	
4	61 to 80 years	1, 2, 3
5	81 to 100 years	
6	101 to 120 years	
7	121 to 140 years	5, 7
8	141 to 160 years	
9	250 + years	

Note: Tree Classes 4 and 6 are allowed for all age classes.

Examples of determining PL tree age and tree classes:

1 - Mapview

The polygon projected age is 125 years old. Therefore, the PL trees in the plots in the polygon are classified as mature tree classes 5 or 7.

#2 - Tree Farm Licence
The polygon age class is 4, which corresponds to 61 to 80 years. Therefore, the PL trees are older immature tree classes 1, 2 or 3.

4.3.1.23 Positions 55 to 57 Slope Percent

Record the most severe slope measurement in any direction to a point 15 m slope distance from the plot centre and within the block. Plot slope must be recorded in both measure and count plots. If the slope is not recorded, it will be compiled as zero slope.

The plot slope reading must be confined to the harvesting method area that the plot centre is located within if the harvesting method boundary is known when the field work is performed.

Plot slope data is required for all road rights-of-way areas contained within a cutting authority. Plot slope is not recorded on road cuts or fills.

It is recommended that a ribbon is hung at the point where the plot slope was taken to assist with check cruises.

4.3.1.24 Positions 58 to 61 Year/Month

Record the year and month that the fieldwork was performed. The date must be recorded by the cruiser and entered into the cruise compilation.

4.3.2 Card Type 2

4.3.2.1 Position 1 Tree Details

This card contains the individual tree details.

4.3.2.2 Positions 25 to 26 Tree Number

Number trees consecutively from number 1 (do not duplicate numbers on any plot). Plot trees selected as sample trees maintain the same number in Sample Tree Details (Card Type 3).

4.3.2.3 Positions 27 to 29 Total Height

All heights entered here will be used in the calculation of individual tree volume. Heights must be recorded to the nearest 0.1 m.

The "One Hundred Percent Method" is the mandatory method of tree height determination. All tree heights must be either measured or estimated. The use of a clinometer or electronic measuring device is recommended for tree height measurements and estimates. A lower top reading generally indicates a more precise measurement, so readings should be kept below 100 percent.

The height curve method is restricted to use in stump cruises or where severe damage due to wind shear or freezing has occurred (see Chapter 6 Stump Cruising). Severely damaged stands must be identified on the cruise plan and submitted to the Regional Executive Director or their designate for sampling alternatives.

Project the original height of trees with broken tops (as per Figure 4.9 Example of Where to Measure the Height on Trees with a Broken Top or Fork/Crook. below).

4.3.2.3.1 Trees with Broken Tops

If a tree has a broken top, the height of the tree must be estimated. There are three methods used to estimate the height of a tree with a broken top:

1. If the broken top segments are available on the ground, add the length of these segments to the standing portion of the stem.

2. Project the original height of the tree with a broken top (see Figure 4.9 Example of Where to Measure the Height on Trees with a Broken Top or Fork/Crook.). Use adjacent trees and comparable tree heights to estimate heights of trees with broken tops. Trees that are acceptable for comparison are:
   a) Same/ similar species,
   b) same 10 cm diameter class (10-20, 21-30, 31-40, etc.),
   c) live top,
   d) if no live tops, then an intact dead top.

3. Where no suitable trees exist within the stand to base an estimate on, project the height of the tree based on the species' natural taper.

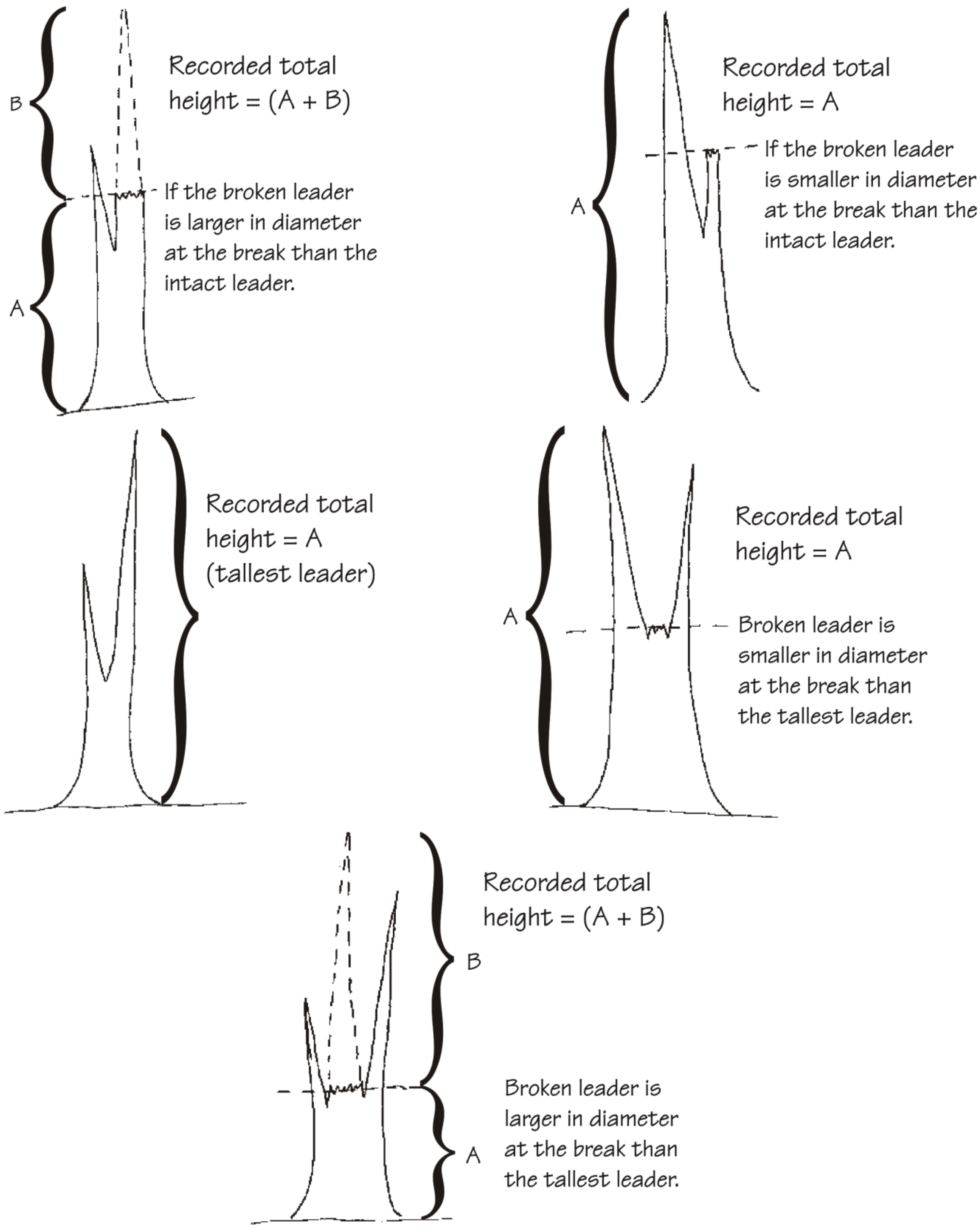

Figure 4.9 Example of Where to Measure the Height on Trees with a Broken Top or Fork/Crook.

BACK

4.3.2.3.2 Leaning Trees

The following method should be used for measuring the tree length of trees leaning more than ten degrees (B) from the vertical (see Figure 4.10 Measuring Height of Leaning Trees.). The angle A must be 90 degrees.

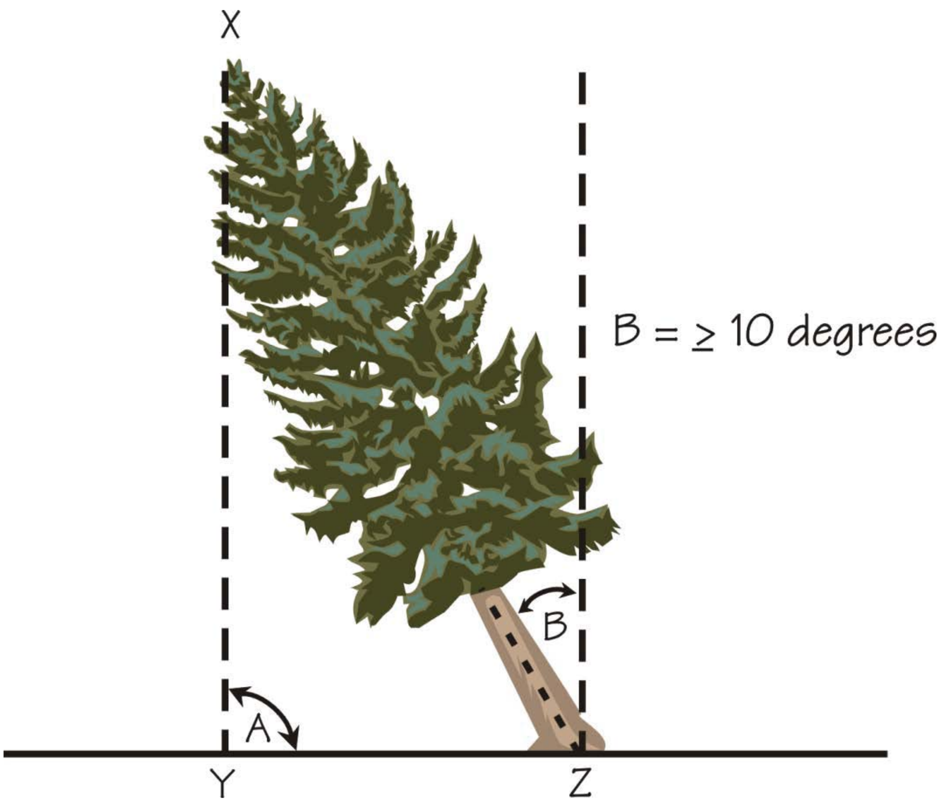

Figure 4.10 Measuring Height of Leaning Trees.

1. Calculate the vertical distance from the ground (Y) to the top of the tree (X) using a clinometer or electronic measuring device from a point perpendicular to the lean of the tree (i.e., A = 90 degrees).

2. Measure the horizontal distance from the centre of the tree (Z) to a point directly under the top of the leaning tree (Y).

3. Calculate the tree length by using the Pythagorean formula for right triangles:

$$Tree\ Length(m) = \sqrt{\left(length\ XY_{(m)}\right)^2 + \left(length\ YZ_{(m)}\right)^2}$$

The degree of lean will not be a check cruising item, however, tree length will be considered the true tree height.

4.3.2.3.3 Deciduous Tree Heights

In order to obtain a reasonable height for deciduous trees, ensure the height is measured from an adequate distance from the tree when measuring the highest point. It is recommended that the angle of measurement is less than 100 percent. This will assist in distinguishing the highest point on the tree from lower branching or forks.

4.3.2.4 Positions 30 to 31 Species

All living and dead, standing and down trees which are listed in this section (except dead and down tree class 4 that do not meet the minimum CGNF standard on the Coast) and which meet or exceed the timber merchantability specifications must be recorded when present in a plot.

Enter the appropriate commercial species symbol. Genus symbol letters must be "Capitalized" or upper case. Species symbols should be upper case also (entry is left oriented).

Genus Symbols - These symbols must always be entered for the proper implementation of the volume equations and loss factors.

Species Symbols:

1. The specific symbol for broadleaf maple (Mb), the pines (Pl, Pw, Pa, Py), aspen (At) and cottonwood (Ac) must be entered for the proper implementation of the loss factors and volume equations.

2. The species symbols for other species such as the spruces, hemlock and balsams (*Abies* sp.) should only be used when positive identification can be made in the field and the appraisal requires it. Species specific symbols for *Abies amabilis, grandis* and *lasciocarpa* must be entered for Interior cruises. Coastal Call Grade Net Factor cruises must use species specific symbols for Tsuga mertensiana (Hm), if known. Tsuga heterophylla can use H or Hw.

4.3.2.4.1 Commercial Tree Species Names and Symbols

Common Name of Genus/Species	**Scientific Name of Genus/Species**	**Genus Symbol***	**Species Symbol***
Alder	*Alnus*	**D**	
Red Alder	*A. rubra*		Dr
Balsam (*Abies* sp.)	*Abies*	**B**	
Alpine fir	*A. lasiocarpa*		Bl
Amabilis fir	*A. amabilis*		Ba
Grand fir	*A. grandis*		Bg
Birch	*Betula*	**E**	
Common paper birch	*B. papyrifera*		Ep
Alaska paper birch	*B. neoalaskana*		En

4.3.2.17 Position 60 Miscellaneous

Root Rot	**Description**
J = light	Tree within a disease centre or within 10 m of a tree or stump that is symptomatic or killed by root disease.
K = moderate	Tree with root disease crown symptoms.
L= heavy	Tree with root disease confirmed by stain, decay, fruiting bodies or basal resinous.

Interior Dead Potential White Pine Log Grade Algorithm

Sap rot and weather checks can be collected in the root rot column, column 60.

The sap rot and weather check codes are as follows:

a. record by tree third as per pathological indicator location codes 1 to 7,

b. record codes 1 to 7 for tree thirds that will not be suitable to produce at least 50 percent lumber.

Refer to the Interior Dead Potential White Pine Log Grade Algortihm (Appendix 7) for a more detailed description of the algorithm.

The hemlock and dead white pine grade algorithms are used for interior appraisals. The hemlock algorithm is found in Section A.7.2 (Interior Hemlock Algorithm Flow Chart) and the white pine algorithm is found in Section A.7.1.3 (Dead Potential White Pine Log Grade Algorithm). Sap rot and suncheck codes are required for the dead potential white pine algorithm. The procedure is outlined in A.7.1.2 .

4.3.2.18 Positions 61 to 63 Damage Codes

Damage codes are to be recorded as they appear at the time of the cruise with no attempt to predict the future condition of the trees.

The codes are for appraisal reporting purposes and for net volume adjustment purposes in the compilation.

All damage types will be compiled for net volume. Where multiple damage is recorded for a single tree, the most severe damage type will be compiled for that tree.

All damage types will be reported in the cruise as a percentage of the cruise net volume.

See the Damaged Stands appendix (Appendix 6) for further information.

Damaged Stands (Appendix 6)

Trees are assigned damage codes for volume and value adjustments. Each tree is assessed and coded as it appears at the time of the cruise with no attempt to predict the future condition of the trees. Where damage is tallied, it will be compiled and reported.

Damaged tree volumes and LRF's are adjusted using the loss factors. In addition, the cruise compilation reports identify tree volume within the damage code categories to enable cost and value adjustments in appraisal.

Each code has a different effect in the compilation. Damage codes result in the modification of risk group and corresponding adjustments to net volume.

Depending on the patchiness of the damage, consider whether these patches should be treated as unique timber types when designing the sampling plan.

A.6.1 Pest Damage

The following insect damage codes apply to all appraisal cruises and will be entered in column 61 of the cruise tally sheet (Figure 4.1 Cruise Tally Sheet – FS 205C (front side).). Standard cruising methods as outlined in the *Cruising Manual* are to be followed with all beetle attack trees on the cutting authority coded with the appropriate Bark Beetle Code.

A.6.1.1 Bark Beetle Descriptions

The most common and destructive infestation the cruiser will encounter are caused by the following bark beetles:

Mountain pine beetle attacks Lodgepole, Ponderosa and White pine (however, Whitebark, Limber and exotic pines could also be infested).

Douglas fir beetle attacks Douglas fir and sometimes Western larch.

Spruce beetle attacks mainly White and Englemann spruce in the Interior.

Western pine beetle attacks Ponderosa pine.

Western balsam bark beetle attacks mainly Subalpine fir (*Abies lasiocarpa*).

See the following website for photos and descriptions of common forest pests:

https://www2.qa.gov.bc.ca/assets/gov/environment/air-land-water/land/forest-health-docs/field_guide_to_forest_damage_in_bc_web.pdf

A.6.1.2 Attack Codes for Balsam (*Abies* sp.), White Pine, Yellow Pine and Lodgepole Pine

Code	**Description**
1	Green Attack
2	Red Attack
3	Grey Attack

These attack codes (based on crown and bole symptoms) are applicable to the following insects:

- The mountain pine beetle (*Dendroctonus ponderosae*) and the lodgepole pine beetle (*Dendroctonus murrayannae*) in lodgepole pine (*Pinus contorta*-PL), yellow pine (*Pinus ponderosa*-PY) and white pine (*Pinus monticola*-PW).
- The western pine beetle (*Dendroctonus brevicomis*) in yellow pine (*Pinus ponderosa*-PY).
- The western balsam bark beetle (*Dryocoetes cofusus*) in alpine fir (*Abies lasiocarpa*-BL).

Green Attack Code 1

Since the mountain pine beetle and the western pine beetle normally complete their life cycles in one year, the Green Attack code will represent trees that have been infested ten to twelve months or less. The crown is green but pitch tubes are evident on the lower bole and the inner bark will contain characteristic gallery patterns and immature stages of the beetles. Successfully attacked trees usually die within a few weeks following initial attack even though their crowns may stay green up to twelve months. How long the crown of an infested tree stays green depends on climate, soil, topography and tree species. White pine and yellow pine infested by mountain pine beetle often start discolouring by fall or mid-spring.

Red Attack Code 2

This code represents trees that, on average, had been attacked during the previous two seasons. The crowns first fade to straw colour, then to red and finally to rust colour before the needles fall off the tree. By the time the foliage is rust coloured, the beetles have usually left these trees to infest green trees. The boles of many trees in this category may be heavily worked by woodpeckers, making them susceptible to checking.

Grey Attack Code 3

This code will represent trees that are dead and have grey needles except *Abies lasiocarpa*, which can have grey or red needles. The bole of the older kills will have much checking and loose bark. However, pitch tubes on the bark of the lower bole and/or bark beetle galleries under the bark will be readily discernible.

The western pine beetle has a different gallery pattern than the mountain pine beetle, but infested trees go through the same sequence of foliage changes after attacks by either beetle. Therefore, the same attack code is applicable.

The western balsam bark beetle usually completes its life cycle in two years. Therefore, both green and red attacked trees will contain brood. Also quite often there is no evidence of pitch tubes on the trunk of infected trees. Therefore, the boles of balsam fir need to be examined at close range for signs of boring dust in the crevices of the bark and/or small round holes in the bark that signify entry or emergence by this beetle. Thus, in the green infected stage, attacked trees are quite difficult to find.

Grey attack trees that have been dead for many years often no longer show evidence of beetle attack. In beetle attacked stands, it is acceptable for check cruisers to extend the “benefit of the doubt” on Grey Attack Code 3 classifications if these trees show signs of significant bark loss and other signs of long-time mortality but no remaining bark beetle signs (beetles, pitch-tubes, frass, exit holes, blue stain, etc.). Cruisers are still expected to look for beetle sign and to rationalize their damage codes if they suspect these sign to be removed, obscured, or faded.

Lodgepole Pine Beetle Attack Code Definition

Green Attack Code 1 (Risk Group 2)	Trees attacked have green needles, but other colours may also be present. Green attack must contain greater than or equal to 5% green coloured needles.
Red Attack Code 2 (Risk Group 2)	Trees attacked have red, fading and possibly some grey needles. Red includes straw to rust colour. Red attack must contain less than 5% green needles and greater than or equal to 5% red needles.
Grey Attack Code 3 (Risk Group 2)	Trees attacked have grey or no needles. Grey attack must have less than 5% red needles.

A.6.1.3 Blister Rust Code 4 (Risk Group 2, White Pine)

Normally used in stands where white pine is a major species (more than 20 percent of the volume) and is seriously infected with blister rust. This code can be used in a normal old growth H-C type containing a few scattered mature PW trees.

All other insect attack codes take precedence over Blister Rust, Code 4.

A.6.1.4 Attack Codes for Spruce, Douglas Fir

Code	Description
5	Green Strip Attack – S and F
6	Green Full Attack – S and F
7	Grey Attack – S and F
8	Red Attack – Fir only

The first three codes are applicable to the spruce and fir beetle.

Spruce foliage turns yellowish for a brief period in the winter season following an attack before the needles drop off the tree. Therefore, spruce was not included in the red attack. Infested trees with faded crowns should be included in the green (dead) full attack.

Green Strip Attack Code 5 (Path/Tree Class = Risk Group, Fir and Spruce)

The trees in this code will be infested in a strip on the lower bole where broods either failed or succeeded in completing their development. In either case, the attacks did not kill the trees. These trees will live on, at least until subsequent attacks (which can happen quite often) completely girdle the bole. Green strip attacked Douglas fir in well established infestations are usually much less common than green fully attacked trees. The loss factors are unaffected by this code.

Green Fully Attacked Code 6 (Risk Group 2, Fir and Spruce)

The trees in this code still have green foliage, but the attack by the bark beetles has completely girdled the tree. Some of these trees will have a considerable amount of their bark removed by woodpeckers lowering the value because of checks and splits.

In the case of Douglas fir, the beetle usually has a one year life cycle. The attack is usually in May and June. The crowns of infested trees stay green from a few months to a year after attack. Do not code as Tree Class 3. The compilation program will downgrade these trees to Risk Group 2.

Grey Attack Code 7 (Highest Risk Group and has to be dead, Fir and Spruce)

This code represents trees which are dead and have grey needles. Little or no foliage is left, the boles of the older kills may have much checking and loose bark. The compilation program downgrades these trees to the highest risk group.

Red Attack Code 8 (Risk Group 2, Fir)

This code is reserved for Douglas fir where the red foliage remains on the tree for an average of two years. The compilation program downgrades these trees to Risk Group 2. If they have conk or blind conk they will be compiled as Risk Group 3.

A.6.1.5 Defoliators (Path/Tree Class = Risk Group, All Species)

This damage category includes hemlock looper, budworms, moths and other defoliators. If the classification is doubtful, assess the cambium on the north side at DBH.

- Code X - trees with living cambium. Tree classes 1, 2, 5, 6, 8, and
- Code Y - trees with dry cambium. All tree classes are allowed.
- All other insect attack codes take precedence over defoliator, codes x and y except code 4, Blister Rust.

A.6.2 Fire Damage

The following fire damage codes apply to all appraisal cruises and will be entered in column 62 of the cruise tally sheet (Figure 4.1 Cruise Tally Sheet – FS 205C (front side).):

A.6.2.1 Light Damage - Code A

Damage consisting of scorched bark and foliage but no charring in the merchantable portion of the stem. Bark scorching greater than or equal to 5 years after the date that the fire was recorded by the Ministry of Forests, Lands and Natural Resource Operations does not qualify for the fire damage coding.

Classification: The risk group will be determined by the tree class and pathology.

A.6.2.2 Moderate Damage - Code B

Damage of any age consisting of some shallow charring of wood fibre in the merchantable portion of the stem.

Classification: Assign the tree class and record the pathological indicators as normal.

The compilation program will down grade risk group 1 trees to risk group 2.

A.6.2.3 Heavy Damage - Code C

Damage of any age consisting of extensive shallow charring or deep charring in the merchantable portion of the stem. Multiple deep checks in trees less than 30 cm DBH with fire damage also qualify for heavy damage.

Classification: Assign the tree class and record the pathological indicator as normal. The compilation program will down grade these trees to the highest risk group.

> Trees are coded as they appear at the time of the cruise only and not at the anticipated time of harvesting.

Definitions:

"**Merchantable section**" means the section of the stem between 30 cm stump and the 10 cm or 15cm top diameter inside bark as per the appropriate timber merchantability standards. Damage outside of these limits was not included in the loss factor data.

"**Charring**" means the actual destruction of wood by fire. There must be identifiable damage to a surface area greater than100 cm^2.

"**Shallow charring**" means charring which is greater than 100 cm^2 in surface area and less than one-third of the radius of the tree.

"**Extensive Shallow charring**" means charring in the bottom third of the tree that has 3 or more areas (each at least 100 cm^2) of exposed and charred wood fibre or the cumulative total of charred areas is greater than 300 cm^2.

"**Deep charring**" means where charring is deeper than one-third of the radius of the tree.

"**Multiple deep checks**" means where more than 1 check is deeper than one-third of the radius of the tree.

> 1. Surface checking may occur as the result of fire damage but this does not affect the tree classification.
> 2. Trees are coded as they appear at the time of the cruise and not at the anticipated time of harvesting.

A.6.3 Down Trees

The following Down Tree Codes apply to all appraisal cruises and will be entered in column 63 of the Tally Sheet (Figure 4.1 Cruise Tally Sheet – FS 205C (front side).) if they are located in the merchantable portion[1] of living or dead potential trees and the tree is:

Damage Code E

- Uprooted
- Uprooted with one clean break.
- Standing and one clean break in the bottom or middle third.
- Standing and any shattered breaks in the middle third.

A clean break is shorter in length than the diameter of the stem at the break. The compilation program will assign the risk group by tree class and pathological indicators.

A tree with a break below stump height will be considered uprooted.

Damage Code G

- Uprooted with more than one clean break .
- Uprooted with any shattered breaks.
- Standing with any shattered break in the bottom third.
- Standing with one clean break in the bottom third and an additional break in the merchantable portion of the tree.

A shattered break is longer in length than the diameter of the stem at the break. The length of shatter is measured from stump height (ie. only the length of the shatter in the merchantable portion of the stem is considered). The compilation program will down grade these trees to the highest risk group.

If the tree is partially uprooted or broken and supported by another standing tree, assign the appropriate down tree code (except Tree Classes 4 and 6). Blowdown codes are not asssigned to Tree Class 4 or 6 trees.

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[1] *The merchantable portion of the tree is from 30cm stump height to a 10cm or 15cm top diameter inside bark as per the appropriate timber merchantability standards. Damage outside of these limits was not included in the loss factor data.*

If a shatter extends through DBH and either the standing or down portion of the tree fall outside of the plot, use the portion of the tree with greater than 50% of the basal area at breast height to determine if the tree is “in” or “out” and assign applicable damage codes (See Section 4.3.1.15).

(Natural causes only)

Uprooted	Uprooted with one clean break in merchantable portion of the tree	Uprooted and two or more clean break or one shattered break in merchantable portion of the tree	Ice Damage or Wind sheared			
			Top 1/3	Middle 1/3	Bottom 1/3	
Record E	Record E	Record G	**No down tree code.** Call dead or broken top if ≥ 5 years old	Record E only for clean or shattered breaks Call dead or broken top if ≥ 5 years old	Record E **for clean breaks** Call dead or broken top if ≥ 5 years old	Record G **for one clean break in bottom 1/3 and one other clean break any merchantable portion of the tree or one or more shattered breaks** Call dead or broken top if ≥ 5 years old

Note: Record all trees in plot if DBH is in the plot (natural or man influenced)
Damage codes can only be recorded for natural occurrences. No codes for hand felled or mechanical influences.
Do not record uprooted TC 4 or TC 6.

Figure A.4 Damage Call Matrix for Uprooted, Ice Damaged and Wind Sheared Trees

Figure A.5 Example of Mechanical Damage

4.3.2.5 Positions 32 to 35 DBH

Enter the diameter at breast height to the nearest 0.1 centimetre for each tree equal to or above the timber merchantability specifications. Whole numbers are recorded as decimals (e.g., 12.0 not 12).

4.3.2.5.1 High Side

High side is defined as the highest point of the ground around the base of the tree. Kick aside any loose litter and debris. If obstacles obstruct the base of the tree at the high side, measure breast height (1.3 m) from the high side of the ground and *not* from the top of the obstacle. Road fills are considered obstacles.

If high side is lower than the point of germination (POG), then measure breast height (1.3 m) starting from the POG.

If the lower portion of the stem has sweep, pistol grip or the tree is on the ground, then measure breast height (1.3 m) along the curve and parallel to the centre line of the tree.

4.3.2.5.2 Horizontal Distance from Plot Centre

This is the measured horizontal distance from the plot centre to the face of standing trees at breast height (1.3 m) plus half the DBH. Leaning and down trees must be measured from the centre of the tree at breast height to the plot centre (see Section 4.3.1.15). When a tree is laying on the ground, the measurement is made from the centre of the top side of the tree at breast height to the plot centre.

4.3.2.5.3 Diameter of trees forked at or near DBH

A tree that is forked below breast height will be measured as two trees. If the diameter tape cannot be wrapped around the circumference of the tree at breast height because the forks are too close together, then measure the diameter at the nearest opportunity above the fork and adjust for DBH accordingly. Note on the tally card that the diameter has been estimated. Refer to Figure 4.11 Two Trees or One..

A tree that is forked at or above DBH will be measured as one tree. If there is swelling at DBH due to the fork, measure the tree at the nearest available location and estimate the diameter at DBH. Note on the tally card that the diameter has been estimated. Refer to Figure 4.11 Two Trees or One..

BACK

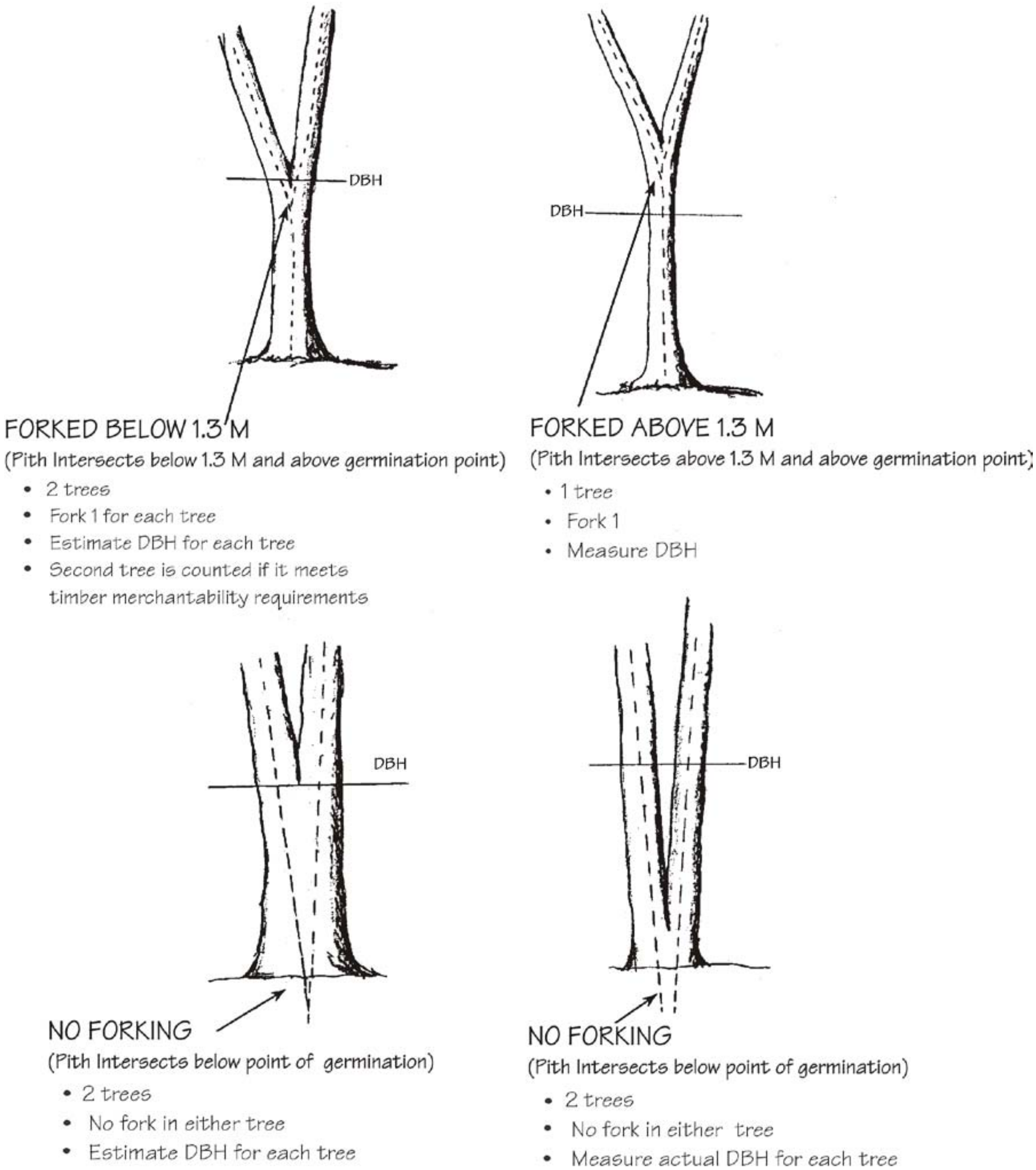


Figure 4.11 Two Trees or One.

Also see Pathological Classification of Trees (Appendix 4) for details regarding forks and crooks.

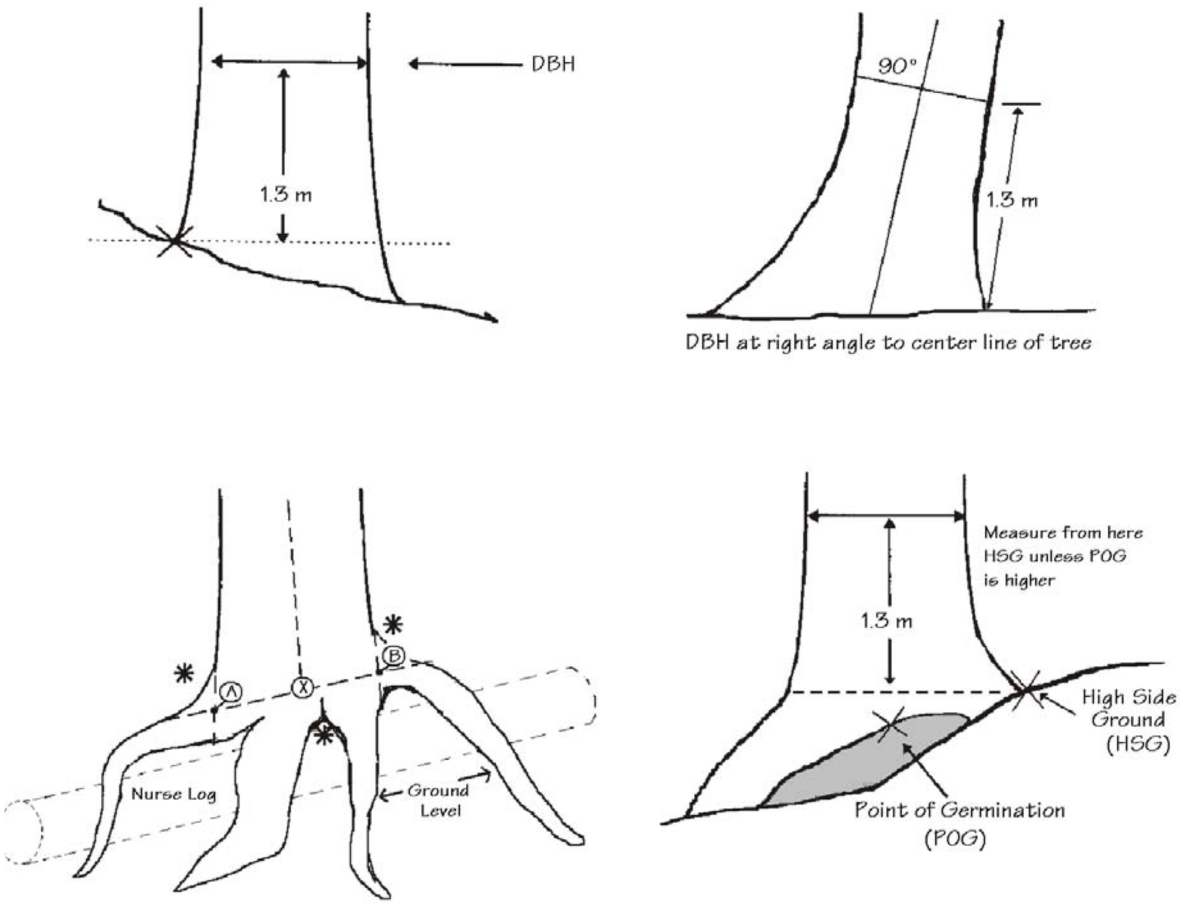
If there are burls, galls or swelling obstructing a normal taper measurement for a tree at breast height, then measure above and below the abnormalities and estimate the diameter from the two measurements. Note on the tally card that the diameter has been estimated.

Do not make allowances for missing bark at breast height.

Breast height must still be established at 1.3 m from the high side ground when there is snow on the ground.

Trees that have been cut into pieces or that have had pieces removed will be measured if 50 percent or more of their gross volume is still on site (or the remaining piece meets the minimum standard for Coastal CGNF). Measure DBH 1.0 metre from the butt end of the log. The tree height will be measured or estimated from the butt end of the log to the top plus 0.3 metres to allow for a stump height.

The plot radius for the logs will be measured to their DBH using the same method as for uprooted trees (see Section 4.3.1.15).



High side location when POG clearly above ground level, nurse logs/stumps, hummucky/rocky ground, erosion and upturned stumps.

(X) POG defined by the midpoint of the low root centre and a transect line to the midpoint of the highroot centre.

(A) to (B) The POG is the point where this transect line intersects the pith.

* Indicates incorrect locations for highside and POG on this tree.

Figure 4.12 Breast height in Relation to High Side.

3.6 Plot Slopes (Section 4.3.1.23)

The following standards apply to the measurement of plot slope. To support the audit process, the cruiser may establish flagging tape at the location used to determine the maximum slope at 15m slope distance from plot centre.

Either (a) or (b) must be exceeded before the standard is determined to be incorrect.

- **a. Plot slopes:** >= 90.0 percent of the plots must be within plus or minus 5.0 slope percentage points of the actual slope reading.
- **b. Block or Cutting Permit**: the average variation of all slopes checked must be within plus or minus 5.0 slope percent.

4.3.1.23 Positions 55 to 57 Slope Percent

Record the most severe slope measurement in any direction to a point 15 m slope distance from the plot centre and within the block. Plot slope must be recorded in both measure and count plots. If the slope is not recorded, it will be compiled as zero slope.

The plot slope reading must be confined to the harvesting method area that the plot centre is located within if the harvesting method boundary is known when the field work is performed.

Plot slope data is required for all road rights-of-way areas contained within a cutting authority. Plot slope is not recorded on road cuts or fills.

It is recommended that a ribbon is hung at the point where the plot slope was taken to assist with check cruises.

4.3.1.24 Positions 58 to 61 Year/Month

Record the year and month that the fieldwork was performed. The date must be recorded by the cruiser and entered into the cruise compilation.

4.3.2 Card Type 2

4.3.2.1 Position 1 Tree Details

This card contains the individual tree details.

4.3.2.2 Positions 25 to 26 Tree Number

Number trees consecutively from number 1 (do not duplicate numbers on any plot). Plot trees selected as sample trees maintain the same number in Sample Tree Details (Card Type 3).

4.3.2.3 Positions 27 to 29 Total Height

All heights entered here will be used in the calculation of individual tree volume. Heights must be recorded to the nearest 0.1 m.

The "One Hundred Percent Method” is the mandatory method of tree height determination. All tree heights must be either measured or estimated. The use of a clinometer or electronic measuring device is recommended for tree height measurements and estimates. A lower top reading generally indicates a more precise measurement, so readings should be kept below 100 percent.

The height curve method is restricted to use in stump cruises or where severe damage due to wind shear or freezing has occurred (see Chapter 6 Stump Cruising). Severely damaged stands must be identified on the cruise plan and submitted to the Regional Executive Director or their designate for sampling alternatives.

All pathological indicators must be recorded for each tree in the tree third where they occur to properly assign the appropriate loss factor. Tree classification will be made on the basis of the above signs of decay only. See 'Metric Diameter Class Decay, Waste and Breakage Factors' for the specifications of Risk Groups and Risk Group Ratings by Pathological Indicators (Table 18 in Appendices) for risk group assignments by pathological indicators.

Tree Class 3 (Dead Potential; Older Immature Dead Potential in Interior)

Tree Class 3 is dead standing or down timber which is estimated to contain at least 50 percent of its original gross volume in soundwood (firmwood) content. All dead potential standing and down trees must be tallied.

Trees with green and/or red needles are considered live trees and will be classified based on pathological indicators. Standing or windfall trees with grey or no needles will be considered dead trees; except for mountain pine beetle attacked lodgepole pine where a tree with less than 5.0% red needles will be considered dead.

For net merchantable volume compilation, dead potential stems will have the highest Risk Group deduction for the species, except Lodgepole Pine which will use Risk Group 2 Loss Factors.

Refer to Sound Wood Factors for Saprot (Table 19) and the Ten Metre Log Table in the Appendices to assist in the determination of 50.0 percent soundwood content.

Decay should be determined at various intervals on the tree, preferably at the mid-point of each third of down trees.

1. Dead Standing

   Decay percent is difficult to assess on standing trees. "Sounding" can be helpful, but must only be done in safe conditions.

2. Dead Down

   Good judgement must be exercised in applying tree classes to down material. Since some species are more resistant to decay than others, decisions will be influenced by the tree species involved and local climatic conditions. C, Cy, F, S, P and L are the most decay resistant species and are less likely to exhibit extensive sloughing bark and conks. Other species exhibiting these characteristics are more likely to be "Dead Useless". However, it should be remembered that in drier areas, dead and down Pl and Py may be entirely bark-free yet still be relatively sound.

Pathology is required on all dead potential trees on the coast and dead potential hemlock, white pine and balsam (*Abies* sp.) in the interior for use in the log grade algorithms.

The only exception to the green and/or red needle rule is for *Abies lasciocarpa* in the Interior, where the following guidelines will apply:

Indications – One or More Must be Present

1. Sap-rot and/or,

2. Deep checking and/or,

3. Loose or shedding bark.

Contraindications – None can be Present for Tree Classes 3, 7 and 9 Trees

1. Live Cambium.

2. Green needles.

3. Pitching that is on the end of a log or on exposed wood and not under the bark.

4. Live bark beetles are present.

If there is any doubt after applying the indicators and contraindicators, then the tree will be classified as green.

Tree Class 4 (Dead Useless)

Dead standing trees that have less than 50.0 percent of their original gross volume in soundwood (firmwood) content or otherwise fail to meet the criteria of a dead potential tree as described above as Tree Class 3 will be classified as "dead useless" trees.

In the Interior, only standing Tree Class 4 trees greater than 3 metres in height are tallied. In the Interior, the actual observed height and the estimated DBH must be recorded.

On the Coast, only Tree Class 4 trees that contain a CGNF minimum 8 m standard U grade log are tallied. On the Coast, the original tree height and DBH are required for CGNF measurements and must be recorded.

Tree Class 4 trees that are not self supporting are not to be tallied as they are considered down trees.

Tree Class 5 (Mature)

Tree Class 5 trees are living mature trees which are considered:

a. A coniferous tree greater than 120 years old in a stand with age in 10’s of 12 or less.
b. A deciduous tree greater than 40 years old in a stand with age in 10’s of 4 or less.

Two exceptions exist:

a. Aspen and Cottonwood in FIZ K and L where tree classes 5 or 7 will be used for trees 141 years and older,

Dead Potential 50% Threshold Calculations

Sound Wood Factors for Saprot (Table 19)

$$\%\,Sound\ Fibre = \left(\frac{DIB - 2 * Saprot\ Depth}{DIB}\right)^{\wedge}2$$

A spreadsheet to calculate sound wood using the above equation can be found at the following website:

Cruising Calculations

*Diameter	Saprot Depth - cm														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
20	0.81	0.64	0.49	0.36	0.25	0.16	0.09	0.04	0.01						
25	0.85	0.71	0.58	0.46	0.36	0.27	0.19	0.13	0.08	0.04	0.01				
30	0.87	0.75	0.64	0.54	0.44	0.36	0.28	0.22	0.16	0.11	0.07	0.04	0.02		
35	0.89	0.78	0.69	0.60	0.51	0.43	0.36	0.29	0.24	0.18	0.14	0.10	0.07	0.04	0.02
40	0.90	0.81	0.72	0.64	0.56	0.49	0.42	0.36	0.30	0.25	0.20	0.16	0.12	0.09	0.06
45	0.91	0.83	0.75	0.68	0.60	0.54	0.47	0.42	0.36	0.31	0.26	0.22	0.18	0.14	0.11
50	0.92	0.85	0.77	0.71	0.64	0.58	0.52	0.46	0.41	0.36	0.31	0.27	0.23	0.19	0.16
55	0.93	0.86	0.79	0.73	0.67	0.61	0.56	0.50	0.45	0.40	0.36	0.32	0.28	0.24	0.21
60	0.93	0.87	0.81	0.75	0.69	0.64	0.59	0.54	0.49	0.44	0.40	0.36	0.32	0.28	0.25
65	0.94	0.88	0.82	0.77	0.72	0.66	0.62	0.57	0.52	0.48	0.44	0.40	0.36	0.32	0.29
70	0.94	0.89	0.84	0.78	0.73	0.69	0.64	0.60	0.55	0.51	0.47	0.43	0.40	0.36	0.33
75	0.95	0.90	0.85	0.80	0.75	0.71	0.66	0.62	0.58	0.54	0.50	0.46	0.43	0.39	0.36
80	0.95	0.90	0.86	0.81	0.77	0.72	0.68	0.64	0.60	0.56	0.53	0.49	0.46	0.42	0.39
85	0.95	0.91	0.86	0.82	0.78	0.74	0.70	0.66	0.62	0.58	0.55	0.52	0.48	0.45	0.42
90	0.96	0.91	0.87	0.83	0.79	0.75	0.71	0.68	0.64	0.60	0.57	0.54	0.51	0.47	0.44
95	0.96	0.92	0.88	0.84	0.80	0.76	0.73	0.69	0.66	0.62	0.59	0.56	0.53	0.50	0.47
100	0.96	0.92	0.88	0.85	0.81	0.77	0.74	0.71	0.67	0.64	0.61	0.58	0.55	0.52	0.49
105	0.96	0.93	0.89	0.85	0.82	0.78	0.75	0.72	0.69	0.66	0.62	0.60	0.57	0.54	0.51
110	0.96	0.93	0.89	0.86	0.83	0.79	0.76	0.73	0.70	0.67	0.64	0.61	0.58	0.56	0.53

* Use estimated diameter inside bark at the top of first third of tree.

Useful Formulas

Volume of Tree = 1/3 $\pi R^2 L$, where R = tree dbh and L = tree length
Volume of Cylindrical Rot = $\pi R^2 L$, where R = the radius of the rot and L = rot length
Volume of Conical Rot = 1/3 $\pi R^2 L$, where R = the radius of the rot and L = rot length
% Sound = $100 - \dfrac{\text{Volume of Rot}}{\text{Volume of Tree or Log}}$

Ten Meter Log Table

The purpose of these tables is to assist timber cruisers in calculating the 50% firmwood threshold for dead potential trees. Timber cruisers may choose to either use a general or species/maturity specific table to calculate the 50% firmwood threshold, but should document which tables they use.

The following gross 10m log volume table is a general table for all species and top size based on a weighted average volume for a range of 10cm DBH classes and 5m tree height classes.

Volume % by 10m Log						
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6
15	96	4				
20	84	16				
25	72	27	1			
30	65	30	5			
35	57	31	11	1		
40	52	31	15	2		
45	49	29	17	5		
50	46	28	18	7	1	
55	42	27	19	10	2	
60	40	25	19	11	4	1

The following tables are specific to species, maturity and top size.

Douglas Fir/Larch/White Pine 10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	97	3					100
20	81	19					100
25	69	31					100
30	60	34	6				100
35	53	33	14				100
40	47	32	18	3			100
45	43	30	20	7			100
50	40	28	20	10	2		100
55	38	27	20	12	3		100
60	35	25	20	13	6	1	100

Douglas fir used to generate the table.

Western & Mountain Hemlock							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	85	15					100
25	74	26					100
30	65	31	4				100
35	56	34	10				100
40	51	32	15	2			100
45	47	31	17	5			100
50	44	30	18	7	1		100
55	43	28	18	9	2		100
60	39	27	19	11	4		100

Western hemlock used to generate the table.

Spruce							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	85	15					100
25	74	26					100
30	65	30	5				100
35	58	31	11				100
40	52	31	15	2			100
45	47	30	17	6			100
50	43	28	19	9	1		100
55	45	27	17	9	2		100
60	42	25	18	10	4	1	100

Sitca spruce used to generate the table.

Cypress							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	83	17					100
25	72	28					100
30	64	31	5				100
35	59	30	11				100
40	53	30	15	2			100
45	49	28	18	5			100
50	46	27	18	8	1		100
55	43	26	18	10	3		100
60	40	24	18	12	5	1	100

Cypress used to generate the table.

BACK

Western Red Cedar							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	86	14					100
25	75	25					100
30	68	28	4				100
35	61	29	10				100
40	55	29	14	2			100
45	52	27	16	5			100
50	53	25	15	6	1		100
55	49	25	16	8	2		100
60	46	24	16	10	4		100

Western red cedar used to generate the table.

Balsam							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	84	16					100
25	71	29					100
30	62	32	6				100
35	55	33	12				100
40	48	33	16	3			100
45	45	31	18	6			100
50	42	30	19	8	1		100
55	40	28	19	10	3		100
60	37	27	19	11	5	1	100

Balsam genus used to generate the table.

Lodgepole, Ponderosa and Whitebark Pine							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	72	28					100
25	74	26					100
30	67	28	5				100
35	60	30	10				100
40	53	30	15	2			100
45	50	29	16	5			100
50	48	28	16	7	1		100
55	48	27	16	7	2		100
60	45	26	17	9	3		100

Lodgepole pine used to generate the table.

BACK

Deciduous							
10m Log % - 10cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	87	13					100
25	76	24					100
30	68	29	3				100
35	59	31	10				100
40	54	31	14	1			100
45	48	31	17	4			100
50	44	29	18	8	1		100
55	47	27	17	7	1		100
60	44	27	17	9	3	1	100

Alder/Aspen/Maple/Cottonwood used to generate the table.

Douglas Fir/Larch/White Pine							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	84	16					100
25	70	30					100
30	61	34	5				100
35	53	34	13				100
40	47	32	18	3			100
45	43	30	20	7			100
50	40	28	20	10	2		100
55	38	27	20	12	3		100
60	35	25	20	13	6	1	100

Douglas fir used to generate the table.

Western & Mountain Hemlock							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	85	15					100
25	74	26					100
30	65	31	4				100
35	56	34	10				100
40	51	32	15	2			100
45	47	31	17	5			100
50	44	30	18	7	1		100
55	43	28	18	9	2		100
60	39	27	19	11	4		100

Western hemlock used to generate the table.

BACK

Spruce							
10m Log % - 15cm Top (Coast Immature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	88	12					100
25	76	24					100
30	66	30	4				100
35	59	31	10				100
40	53	31	15	1			100
45	47	30	18	5			100
50	44	28	19	9			100
55	45	27	17	9	2		100
60	42	26	18	10	4		100

Sitca spruce used to generate the table.

Cypress							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	86	14					100
25	73	27					100
30	65	31	4				100
35	59	31	10				100
40	53	30	15	2			100
45	49	28	18	5			100
50	46	27	18	8	1		100
55	43	25	18	11	3		100
60	40	24	18	12	5	1	100

Cypress used to generate the table.

Western Red Cedar							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	90	10					100
25	77	23					100
30	68	29	3				100
35	61	30	9				100
40	55	29	15	1			100
45	52	28	16	4			100
50	53	26	15	6			100
55	49	25	16	8	2		100
60	46	24	16	10	4		100

Western red cedar used to generate the table.

Balsam							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	86	14					100
25	72	28					100
30	62	33	5				100
35	55	33	12				100
40	49	33	16	2			100
45	45	31	18	6			100
50	42	30	19	8	1		100
55	40	28	19	10	3		100
60	37	27	19	11	5	1	100

Balsam genus used to generate the table.

Lodgepole, Ponderosa and Whitebark Pine							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	89	11					100
25	76	24					100
30	69	28	3				100
35	60	30	10				100
40	53	30	15	2			100
45	50	29	16	5			100
50	43	28	19	9	1		100
55	48	27	16	7	2		100
60	45	26	17	9	3		100

Lodgepole pine used to generate the table.

Deciduous							
10m Log % - 15cm Top (Coast Mature)							
Total Height (m)	Log 1	Log 2	Log 3	Log 4	Log 5	Log 6	
15	100						100
20	91	9					100
25	77	23					100
30	66	29	4				100
35	59	32	9				100
40	53	32	14	1			100
45	48	31	17	4			100
50	44	29	19	8			100
55	46	26	16	11	1		100
60	43	27	17	9	3		100

Alder/Aspen/Maple/Cottonwood used to generate the table.

Pathological Classification of Trees (Appendix 4)

Within mature stands, or stands approaching maturity, (i.e., older immature stands) individual trees contain varying amounts of decay. In stands of this type the estimation of cull is subject to considerable error. Therefore, it would be advantageous to know which trees are likely to contain decay, particularly those which are likely to contain excessive amounts of decay. Pathological studies have shown that two broad classes of living trees are clearly recognizable in stands of this character. The classification of trees is made on the basis of the presence or absence of external signs of decay, and each class of tree will represent a different potential loss factor within the stand.

A.4.1 Class of Trees

All living trees measured on each sample plot will be classed as:

- Residual, or
- Suspect.

A.4.1.1 Residual Trees

Residual trees are living trees which bear none of the external indicators of decay listed in A.4.1.2.

Examples of signs and defects on residual trees are listed in Section A.4.3 and Figure A.40 Illustrates Forks and Crooks Which are Not Suspect.

A.4.1.2. Suspect Trees

Suspect trees are living trees which bear one or more of the following external indications of decay, on or immediately adjacent to the trunk of the tree within the limits specified in this appendix:

1. Conks.
2. Blind conks (swollen knots).
3. Scars.
4. Fork or pronounced crook.
5. Frost crack.
6. Mistletoe trunk infections.
7. Rotten branches.
8. Dead or broken top.

The amount of decay indicated by signs will be subject to considerable variation within species and individual trees. For example, frost cracks may be highly significant as indicators of decay on a particular species in the stand as a whole, but not as significant on individual trees.

> **"Suspect" classifications will be made on the basis of the above listed signs of decay only; no other abnormalities are to be used.**
>
> **See Risk Group Ratings by Pathological Indicators (Table 18) for Pathological Occurrence by Species and Forest Inventory Zones.**

BACK

1 **Conk**

2 **Trunk Mistletoe**

3 **Frost Crack**

4 **Fork**

5 **Scar**

6 **Dead or Broken Top**

Figure A.14 Suspect Trees.

A.4.2 Signs and Defects Indicative of Decay in Standing Trees

The following is a brief description and explanation of the external indications of decay listed in this Appendix.

Coast – Pathological indicators must be recorded on all live and dead potential trees.

Interior – Pathological indicators must be recorded on:

i. All live trees, and
ii. dead potential white pine, balsam (*Abies* sp.) and hemlock trees, and
iii. dead potential lodgepole pine trees with conk and blind conk.

Do not record pathological indicators occurring above the top diameter timber merchantability specification[2].

Secondary Leaders

Record all pathological indicators on secondary leaders if the leader is alive and of merchantable size. Conks of an identifiable heart rot fungi may be called on non-merchantable live secondary leaders. Do not record any pathological indicators on non-merchantable dead secondary leaders.

Record pathological indicators on dead, merchantable secondary leaders for cedar and cypress only.

Record all pathological indicators on dead potential trees for the coastal log grade algorithm, however do not record sap rot fungi as conk.

A.4.2.1 Conks

Conks are the fruiting bodies (sporophores) of decay fungi, and are definite and reliable indicators of decay. Conks can occur anywhere on the main stem, branches, and exposed roots of the tree, but appear most frequently around knots and on the underside of both dead branch stubs and live branches. Fruiting bodies can also occur on slash, however slash conks are not suspect indicators. It is important to be able to differentiate between the fruiting bodies of slash fungi that occur on live and dead branches, wounds and roots of living trees and those of suspect indicators found on living conifers and hardwoods. For cruising purposes, only specific root, butt and heart rot conks are suspect indicators (see Figure A.19 Residual and Suspect Indicators and Their Host Species for a list of Residual and Suspect indicators, as well as their host species native to British Columbia).

On conifers, the suspect indicators which must be recognized are *Echinodontium tinctorium, Phellinus (Fomes) pini, Phaeolus (Polyporous) schweinitzii* and *Fomitopsis pinicola*. On hardwoods, the suspect indicators to recognize are *Phellinus igniarius* and *Phellinus tremulae*.

[2] *The merchantable portion of the tree is from 30cm stump height to a 10cm or 15cm top diameter inside bark as per the appropriate timber merchantability standards. Pathological factors outside of these limits were not included in the loss factor data.*

The major hear rot conks are hard, thick, woody-like perennial structures, and form singly at branch stubs or in small clusters on the underside of living branches. An exception to this is the mushroom-shaped to bracket-like sporophore of *P. schweinitzii* which is annual, but may persist for more than two years. Conks vary in size and shape and therefore are hard to spot, particularly when they are just developing, or when they occur on the upper trunk.

Before recording suspect conks on living branches in the upper crown, there must be conks of the suspect indicator heart rot fungi evident in the stand.

Conks of *E. tinctorium* and *P. pini* frequently appear as small hoof-like or shelf-like structures on the underside of dead branch stubs and/or lower trunk of an infected tree. Moss-covered branch stubs and burls often resemble conks, particularly when viewed from directly below; it is important, therefore, to view the tree from the side before making a decision.

Slash conks that occur on dead wood of living trees can be both annual (small, thin, leathery) and perennial, and are often more numerous, and occur anywhere on the tree. Slash conks that occur on old exposed wounds are not acceptable as suspect indicators with the exception of *F. pinicola*, which is considered a suspect indicator only when occurring on large, old wounds on live trees, as studies have found that its presence indicates significant decay. *F. pinicola* is common on dead trees, and when it occurs on dead branches, it is not considered a suspect indicator.

Conks of *Phaeolus schweinitzii*

P. schweinitzii is the cause of brown cubical rot and butt rot of most conifers, however Douglas-fir and spruce are the most susceptible. The fruiting bodies may occur:

- on the base of a tree,
- on the ground up to 2 m from the tree where no exposed roots are evident, or
- on the exposed roots.

If a *P. schweinitzii* conk is located mid-way between:

1. Two living susceptible trees, only one tree is considered to be infected. If one tree is a highly susceptible species (e.g. Douglas-fir) and the other is a less susceptible tree (e.g. western red cedar), the most susceptible species is considered to be infected.
2. A living tree and a stump showing brown cubical rot, and it is not on a root of the live tree, it is assumed to be associated with the stump.

Conks of *Phaeolus schweinitzii* Vs. conks of *Inonotus tomentosus*

It may be easy to confuse conks of *P. schweinitzii* (shown in Figure A.19 Residual and Suspect Indicators and Their Host Species and Figure A.41 Suspect Indicators) with those of *I. tomentosus* (Figure A.42 Residual Indicators), as the fruiting bodies can be somewhat similar in appearance. Particular care should be taken in identification of these pathogens.

BACK

Young conks of *P. schweinitzii* may often look the same as young conks of *I. tomentosus*, however conks of *I. tomentosus* are usually smaller (usually < 10 cm in diameter than those of *P. schweinitzii*, which can be up to 25 cm in diameter. In addition, conks of *P. schweinitzii* are often darker than those of *I. tomentosus*. *P. schweinitzii* usually appears shelf-like when growing on a stem, stalked and stipate when growing on the ground. Its upper surface has concentric rings, and is red-brown and velvety in appearance. The lower surface of the fruiting body can appear a tan yellow-green in colour, and can turn a brown colour when bruised. In contrast, the fruiting bodies of *I. tomentosus* are stalked and found on the ground and around infected trees. The upper surface usually appears yellow-brown to rust-brown in colour, and becomes a darker brown with age and when wet.

Figure A.15 Example of P. schweinitzii.

A.4.2.2 Blind Conks

Blind conks are pronounced swellings or depressions around knots caused mainly by *P. pini* on conifers and *P. tremulae* on aspen (see Figure A.16 Example of Blind Conk in a Knot. to Figure A.18 Blind Conk and Sound Knot.). If identified correctly, blind conks are definite indicators of decay. The swelling or depression results from the tree attempting to heal over an abortive conk, a newly developing conk, or a point from which an old conk has dropped. Non-typical forms may appear as small branch holes or branch stubs at the base of trees. This form is often found in over-mature Douglas-fir and balsam (*Abies*) species in the coast-interior transition zone (e.g. Boston Bar). Consequently, over-mature trees with basal branch stubs should be examined for blind conk.

Calling Blind Conks

Accessible indicators:

- Must be verified by cutting with an axe or equivalent implement. This will reveal a bright yellow or buff-colour of the conk.

Inaccessible indicators:

- Record only those indicators which have a high chance of being blind conk, such as large swollen knots and large caved-in knots. They must be similar to the ones that have been identified in the stand.
- Do not call small knots and knot indicators on any species.

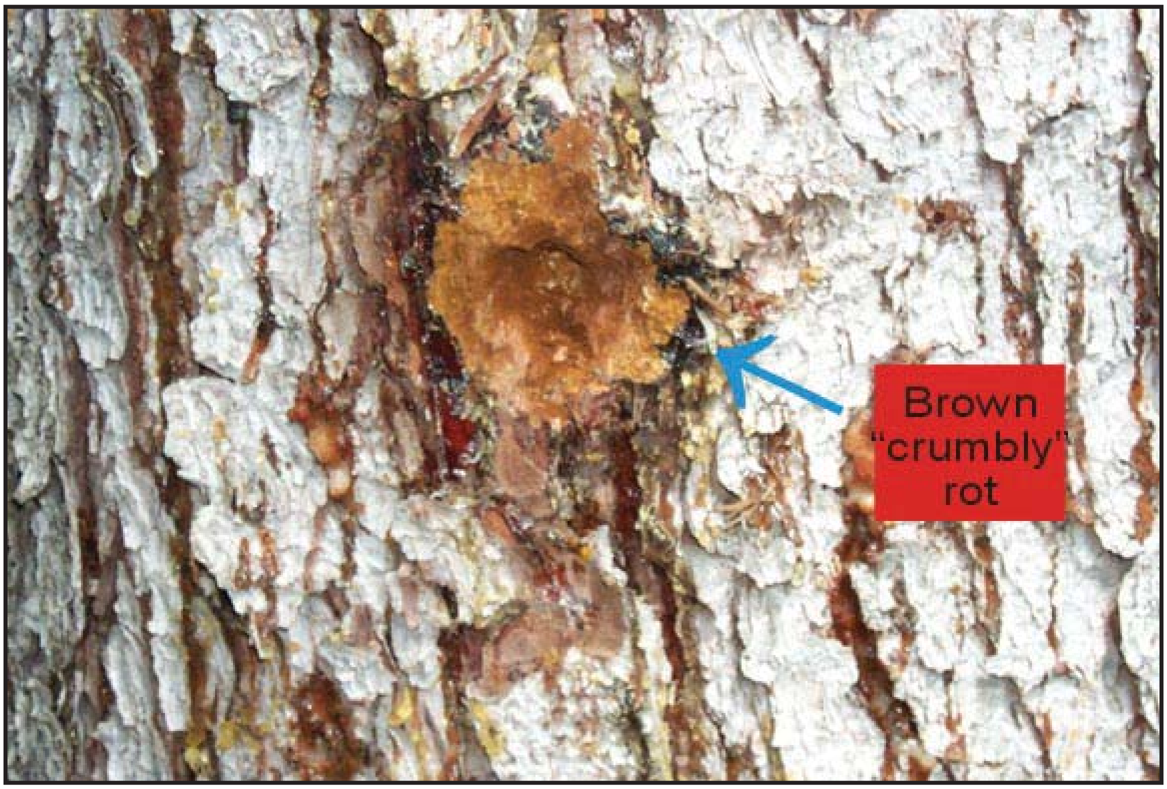


Figure A.16 Example of Blind Conk in a Knot.

BACK

Figure A.17 Non-blind Conk in a Knot.

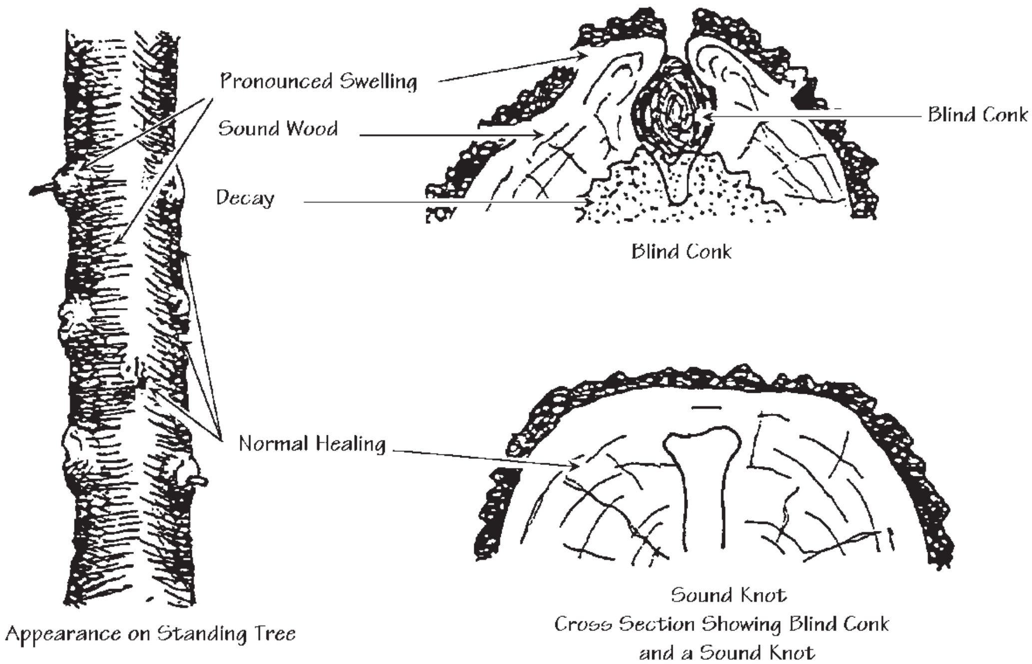


Figure A.18 Blind Conk and Sound Knot.

Residual Trees (Do not record these indicators – See Figure A.42 Residual Indicators)

Root and Butt Rots

Species	Common BC Native Host Species
Armillaria spp.	Ba, Bg, Bl, Lw, Se, Sw, Ss, Pl, Pw, Py, Fd, Tw, Cw, Hw, Ep, At, Act, Qg, W spp.
Heterobasidion annaosum	Ba, Bg, Sw, Ss, Fd, Cw, Hw, Mb, Dr
Inonotus tomentosus	Ba, Bl, Fd, Hw, Lw, Pa, Pl, Py, Se, Sw, Ss
Phellinus weirii	Fd, Bg, Hm, Se, Ss, Bl, Hw, Lw, Pl, Pw, Py
Rhizina undulata	Cw, Fd, Hw, Lw, Pl, Se, Ss, Sw

Heart Rots

Ceriporiopsis rivulosa	Ba, Cw, Fd, Hw, Sw, Ss
*Fomes fomentarius**	D spp., Act, Acb, E spp.
Fomitopsis officinalis	Ba, Bg, Fd, Hw, Lw, Pl, Pw, Py, Se, Ss
Fomitopsis pinicola - **Found anywhere other than on large, old scar**	Ba, Bg, Bl, Cw, Fd, Hm, Hw, He, Lw, Pl, Pw, Py, Se, Ss, Sw, Dr, Ep, A spp., Act
Ganoderma applanatum	Ba, Bg, Cw, Fd, Hm, Hw, Se, Sw, D spp., A spp., E spp., M spp., Q spp., W spp.
Hericium abietis	Ba, Bg, Bl, Hm, Hw, Ss
Laetiporus sulphureus	Ba, Bg, Bl, Bp, Cw, Fd, Hw, L spp., Py, Pw, S spp., Qg
Neolentinus kauffmanii	Ss
Perenniporia subacida	Ba, Bg, Bl, Cw, Fd, Hw, Lt, Pl, Pw, Se, Ss, Sw, D spp., R spp., Act, E spp., M spp., W spp.
Phellinus hartigii	Ba, Bl, Fd, Hw
*Pholiota populnea**	Act
*Piptoporus betulinus**	Ep
Postia sericeomollis	Ba, Cw, Yc, Fd, Hw, Lw, Pl, Py, Se, Ss, Sw
*Spongipellis delectans**	Act
Sterium sanguinolentum	Ba, Bg, Bl, Cw, Fd, Hm, Hw, Lt, Lw, Pl, Pw, Py, Se, Sw
Veluticeps fimbriata	Ba, Bg, Bl, Fd, Hm, Hw, Se, Ss

Suspect Trees (Record these indicators – See Figure A.41 Suspect Indicators)

*Root and Butt Rots ***

Species	Common BC Native Host Species
Phaeolus schweinitzii	Ba, Bl, Cw, Fd, Hw, Lt, Lw, Pl, Pw, Py, Ss, Sw, Qg

Heart Rots

Echinodontium tinctorium	Ba, Bg, Bl, Cw, Fd, Hw, Hm, Ss, Sw
Fomitopsis pinicola - **Only if found on large, old scar**	Ba, Bg, Bl, Cw, Fd, Hm, Hw, He, Lw, Pl, Pw, Py, Se, Ss, Sw, Dr, Ep, A spp., Act
Phellinus igniarius*	D spp., R spp., Act, E spp., G spp., M spp., W spp.
Phellinus tremulae*	At
Phellinus pini	Ba, Bg, Bl, Cw, Yc, Fd, Hm, Hw, Lw, Pj, Pl, Pw, Py, Sb, Se, Ss, Sw

** deciduous hosts only*
*** Root rots can be recorded (codes J, K and L), but they do not affect the appraisal compilation.*

Figure A.19 Residual and Suspect Indicators and Their Host Species

A.4.2.3 Scars

A scar is an injury caused by external forces which has damaged the cambial layers of the tree and exposes either the sap wood or heartwood (or both) to potential attack by wood rotting fungi. These wood rotting fungi are ever present in forest stands and are carried widely by air currents.

Forms of scars - both open and closed scars will be recorded.

Open scars:

- open scars appear as areas of exposed wood of varying sizes and shapes (see Figure A.20 Open Scars), and
- scars are slow to heal over and the wood tissues of the tree may remain exposed for a considerable time allowing entrance of wood rotting fungi.

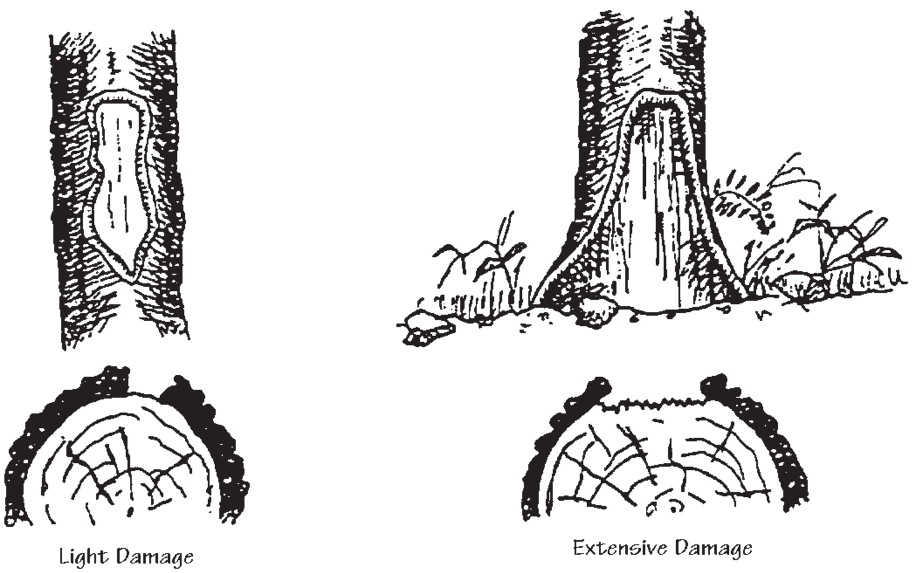


Figure A.20 Open Scars

For root scars to be eligible calls, the scar must be on the portion of the root that is exposed before it enters the ground (see Figure A.21 Root Scars.).

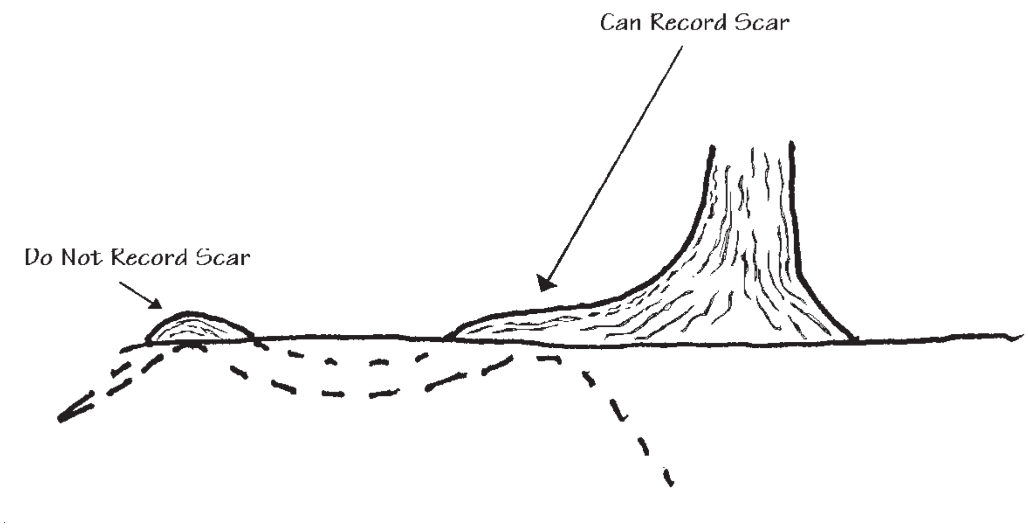


Figure A.21 Root Scars.

Closed scars:

- closed scars appear as slight to pronounced indentations of the bark in the case of early scarring which has healed over, or as pronounced scar tissue or callous growth in the case of later scarring. The latter type of scars frequently show considerable resin flow (see Figure A.22 Closed Scars.).

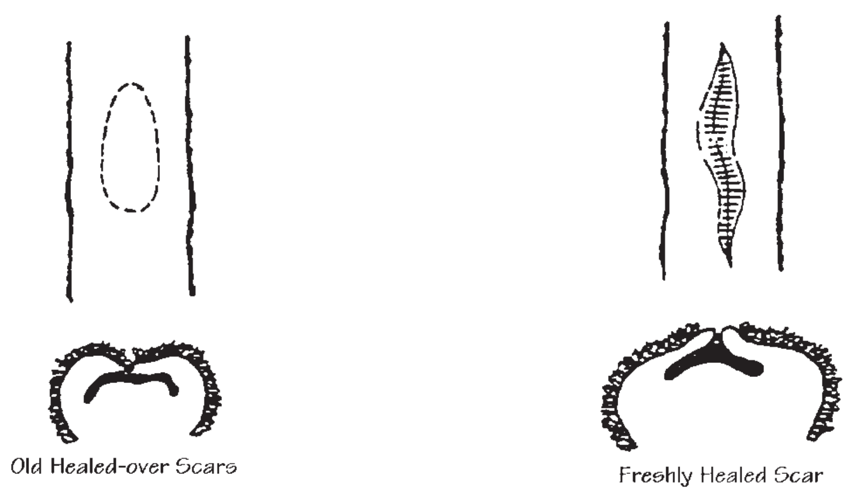


Figure A.22 Closed Scars.

The volume and decay studies of the past thirty years identified only scars visible to the naked eye without the use of binoculars or other lens. The scars were assessed without chopping into the indicator. To be compatible with these initial assessments, the same methodology must therefore be followed today. This also is the most practical method of observation at present.

A scar may or may not have visible decay associated with it.

The decay studies have scars with both decay and no decay in the data base.

Age of scar:

- a scar shall not be recent in origin. This is interpreted as the injury having not occurred within approximately the past five years[3],
- the scar or catface should show greyed or weathered wood. Weathered wood shall be described as:
  - dried and some "sun checking" evident,
  - usually associated with change of wood colour to a greyish tone,
  - callous growth should also be evident where the tree is attempting to grow over the scar, and
  - decay does not have to be evident.

Location of scar:

- a scar should be recorded if the damage occurs on any portion of the trunk of the main stem or on the secondary leader (only if the secondary leader contains a merch log),
- a scar which extends from the first third of the tree into the upper 1/3 of the tree on which the top is dead will be recorded as a scar "4" by convention. The objective is not to double call the pathological indicators in the upper 1/3 of the tree,
- scars occurring completely below the point of germination, either on the trunk or an exposed root adjacent to the trunk, will be recorded as a scar, and
- do not record scars above 10 cm top diameter[4].

[3] *Recent pathological damage was not included in the loss factor data.*

[4] P*athological factors above 10 cm top diameter were not included in the loss factor data.*

Causes of scars:

Scars may be caused by many external forces, such as:

1. Fire:

   - old fire scars that have healed over appear typically as slight ridging of the bark and may have very old callous tissue on the bark, whereas more recent fire scars or ones resulting from severe damage appear as open catfaces or hollowing of the stem,
   - fire scars are usually confined to the base of the tree, and
   - fire scars may be important indicators of decay. Trees growing in forest stands (i.e., south or west facing slopes with pioneer species such as Douglas fir or Lodgepole Pine) having a history of fire should be examined carefully for evidence of charred wood in root crotches or on exposed roots.

   See Section A.6.2 in Damaged Stands (Appendix 6).

2. Lightning:

   - lightning can cause extensive damage to the top and stem of the tree. It typically appears as narrow to wide strips of torn wood, often extending down the entire length of the tree and often in the form of a spiral around the stem.

3. Damage by a falling tree:

   - trees are frequently scarred by other trees falling against them. Scars of this type are common in selectively logged stands or decadent stands where windfall trees are more common. Look for evidence that a fallen tree might have rubbed off the branches along the side of the tree.

4. Machinery damage:

   - machinery can cause extensive damage, especially where selective logging has occurred, and
   - these scars are usually confined to the lower trunk, but they may also occur on the upper trunk when damage is caused by rigging lines.

5. Blazes:

   - blazes are entry points for decay fungi if they penetrate into the cambium layer.

6. Breakage of branches, secondary leaders or suckers from the bole of the tree:

   - high winds or heavy snow may cause the branches to break from the main stem creating exposed wood on the bole of the tree.

7. Falling rocks (see Figure A.23 Scars Caused by Rock Slides and Falling Rocks)

   - rock slides or individual rock movement can cause extensive damage to trees in their path,
   - scars caused by rocks are usually confined to the basal portion of the trunk on the uphill side, and
   - falling rocks may scar trees a considerable height above the ground, either due to snow levels at the time of injury or bouncing rocks on steeper slopes. Rock damage is often evident on trees adjacent to road construction where blasting has occurred.

Figure A.23 Scars Caused by Rock Slides and Falling Rocks

8. Animal/bird damage:

   - wood must be exposed,
   - bear, moose, deer etc. can cause damage by removing areas of bark and cambium from the trunks of many trees,
   - rodents and beavers also cause damage to trees by gnawing on areas of the trunk,
   - woodpecker holes of considerable size provide entrance for wood rotting fungi, however, sap sucker holes are not scars, and
   - care must be taken to exclude superficial damage caused by these agents.

9. Cankers caused by fungi (see Figure A.24 Cankers Caused by Fungi.):

   - only cankers with exposed weathered wood are called, and
   - cankers caused by fungi result in the death of localized areas of bark and cambium on the trunks of trees. Eventually the dead bark is sloughed off exposing the underlying wood. There is usually evidence of repeated callous growth, and for this reason cankers are frequently mistaken for mechanical scars. Cankers are usually flattened

and elongated, and may be indefinite in contour. The exposed wood is often stained and impregnated with resin. Fruiting bodies of the fungus may also be in evidence.

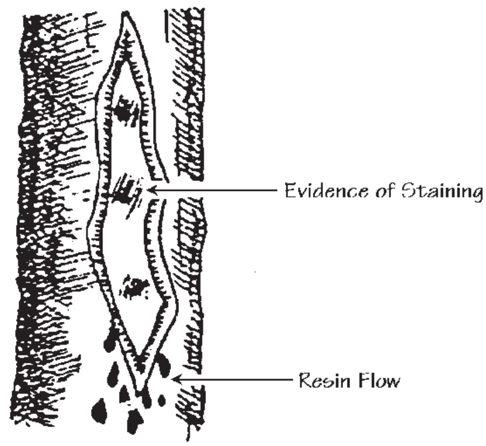


Figure A.24 Cankers Caused by Fungi.

Abnormalities similar to scars but not classified as scars:

Black knots:

- black knots frequently develop around unhealed knots and wounds. A superficial saprophytic fungus, which feeds on the exuded sap, causes the blackness. Black knots are quite sound and when cut into with an axe do not signify decay.

Burls and galls:

- burls and galls develop from abnormal cell growth in trees and are not associated with scarring, however scars occurring on burls and galls will be recorded.

Dry side:

- dry side results from the death of the cambium through bruising by other trees or by other physiological causes. Dry side may appear as a narrow to wide strip or as a localized area on the side of a tree. The bark remains over the affected area and provides protection against wood rotting fungi. Dry side is not a scar unless the bark has sloughed (is missing).

Sap sucker holes:

- sap sucker holes are superficial in extent and have no established significance for causing decay.

Insect borings:

- borings by bark beetles or other insects are generally recent in origin and they are not pathological indicators.

A.4.2.4 Fork or Pronounced Crook

A fork or crook is the result of damage to the main leader of the tree where one or more lateral limbs take over as the main stem. Fork or crook is called if severe enough to indicate that the original injury exposed the wood and provided an entrance point for decay fungi. Fork or crook is to be recorded between the root collar and the minimum top diameter specified in the cutting authority document.

Forks are recorded for any of the following conditions:

1. The main stem is markedly forked to indicate that 2 or more leaders have resulted from serious damage to the original leader (see Figure A.25 Types of Forks and Crooks Which are Recorded, Example A and B).

2. The diameter of the main stem changes excessively from its normal taper to indicate that a serious injury has occurred. For cruising purposes, the diameter change must be at least 10 percent (Figure A.25 Types of Forks and Crooks Which are Recorded, Example C and D).

3. Where there is no evidence of a broken top in the stem at the fork/crook position and neither of the leaders are merchantable, record fork/crook.

Crooks are recorded if:

1. There is at least a 10 percent diameter change in the bole above and below the crook (see Figure A.25 Types of Forks and Crooks Which are Recorded, Example F).

2. The offset is severe enough to indicate that damage occurred to the main stem. For cruising purposes, the offset must be at least 50 percent of the diameter of the tree at the crook (see Figure A.25 Types of Forks and Crooks Which are Recorded, Example E).

Some forks and crooks are not recorded (see Figure A.40 Illustrates Forks and Crooks Which are Not Suspect). Forks and Crooks may be a growth characteristic of the tree species (for example deciduous species) or may have developed from malformation of the terminal leader due to insect or mistletoe attack. In addition, a fork may be confused with a branch. Forks or crooks which are not recorded are as follows:

1. Crooks with a minor offset (for cruising purposes, an offset less than 50 percent of the diameter of the tree at the crook).

2. Small sharply angled branches or spikes (for cruising purposes, less than a 10 percent change in the diameter of the main stem).

3. Natural forking in deciduous tree species.

4. If the damage is less than 5 years old and/or occurs above the minimum timber merchantability specifications specified in the Timber Utilization Policy (Coast or Interior)[5].

5. Flattening of the top of the tree caused by wind or natural outgrowth.

6. Candelabra branches in coniferous species.

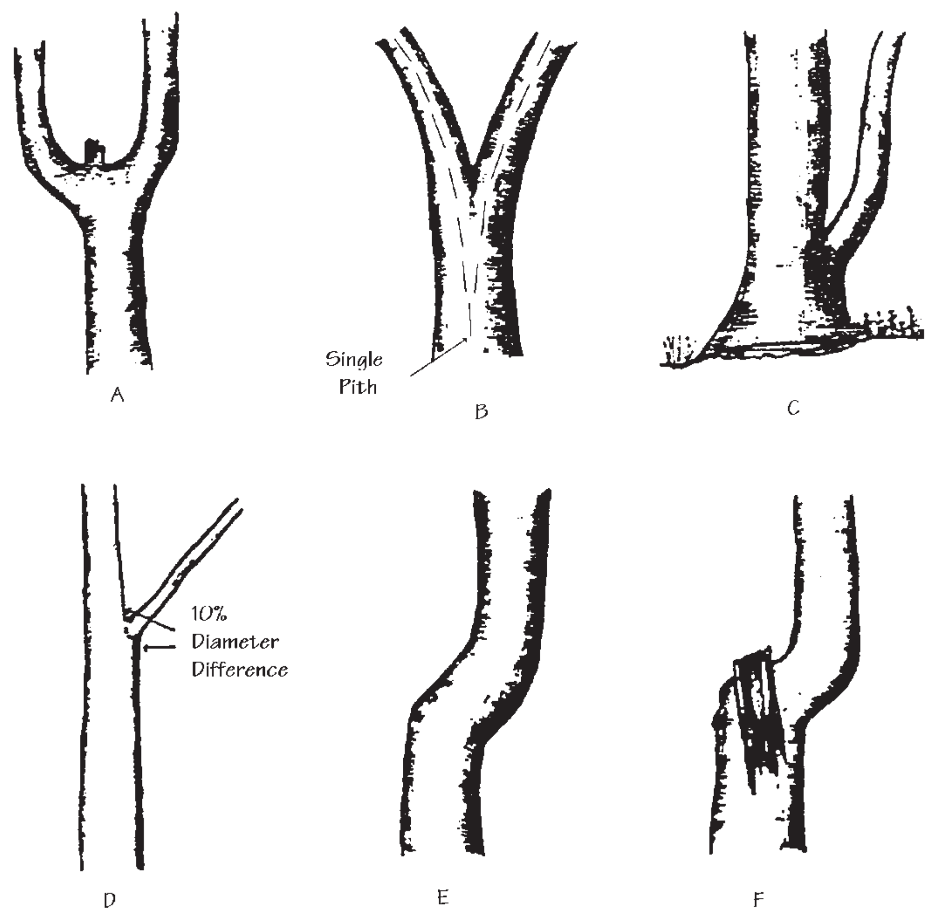


Figure A.25 Types of Forks and Crooks Which are Recorded

Examples A and B illustrate forks which occur in the merchantable portion of the trunk. Example C illustrates forks which occur on the basal portion of trees. Examples E and F illustrate pronounced crook.

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[5] *Recent pathological damage and pathological factors above 10 cm top diameter were not included in the loss factor data.*

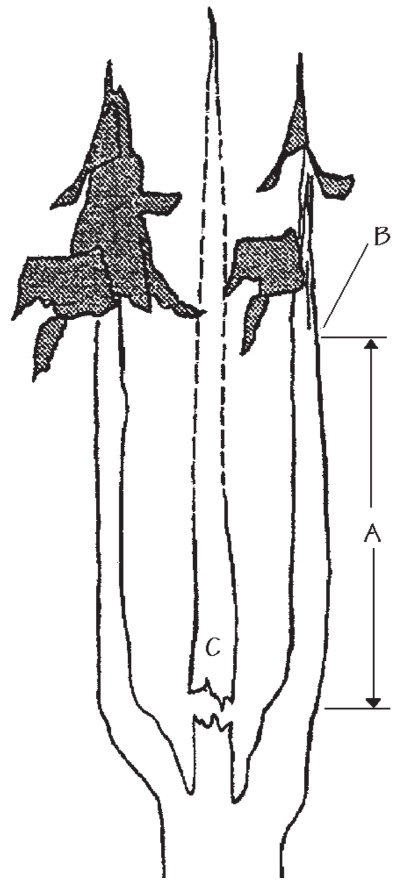


Figure A.26 Fork or Crook and/or Dead or Broken Top

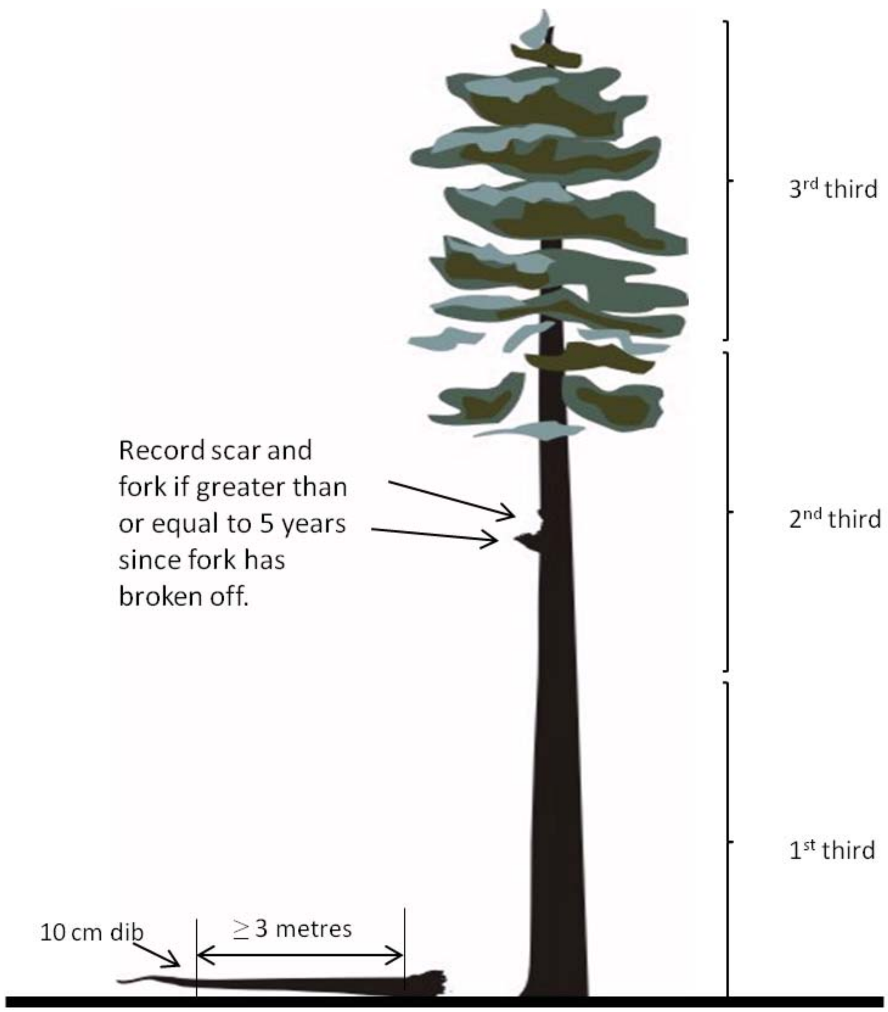
1. If the ‘forked’ leaders exceed the dimensions of a log as defined by the merchantability specifications (i.e., “A” is estimated to be greater than 3 m, and “B” is greater than 10 cm dib) record the pathological defect as a ‘fork’.

2. If the leader material is relatively small in size (i.e., less than 3 m in length) record the defect as a “dead or broken top”.

3. In no instance should you “double call” any pathological indicators (i.e., either call a fork or a dead top, not both!).

   ‘A’ is estimated length of log that could be obtained from the ‘forked’ leader.
   ‘B’ is estimated to 10 cm top.
   ‘C’ is dead top or broken top.

If a merchantable fork has broken off and has been on the ground for greater than or equal to 5 years, the fork and scar may be recorded.



Record down tree code if fork broke from first or second third of tree.

Segment of Cruise Tally Card (FST 205)

Tree Number	Height	Species	DBH	Tree Class	Conk	Blind Conk	Scar	Fork/Crook	Frost Crack	Mistletoe	Rotten Branch	Dead/Broken Top	Down Tree
01	40.0	F	60.0	2			2	2					E

Figure A.27 Fork/crook.

Record a down tree code (clean break) since the fork is long enough to produce a merchantable log. Record fork and scar if the injury is at least 5 years old. See Section A.6.3 in Damaged Stands (Appendix 6) for the down tree codes. See Section A.4.2.3 for details regarding the coding of scars and see Section A.4.2 for details regarding the coding of pathology on secondary leaders.

A.4.2.5 Frost Cracks

- frost cracks result from deep radial splitting of the trunk caused by uneven expansion of the wood after sudden and pronounced drops in temperature,
- the cracks usually originate at the base of the trunk and extend up the tree following the longitudinal grain of the tree (see Figure A.28 Appearance of Frost Crack on Standing Trees),
- frost cracks are often repeatedly opened by wind stresses or by low temperatures which freeze the moisture within the cracks and expands and splits the tree further,
- repeated healing of the wood produces considerable callous tissue giving the wood a pronounced ribbed appearance, and
- frost cracks must have occurred at least 5 years previously before they can be recorded[6].

Frost cracks are often associated with severe basal decay.

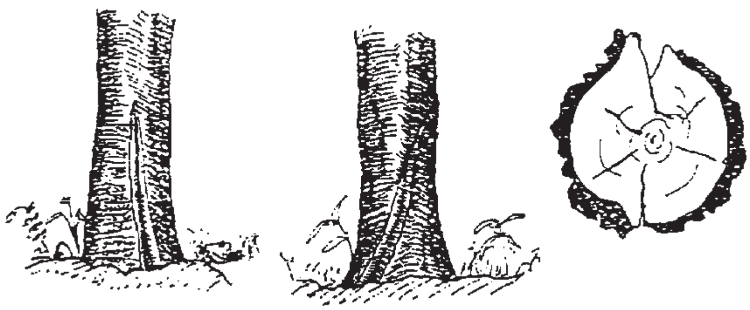


Figure A.28 Appearance of Frost Crack on Standing Trees

[6] *Recent pathological damage and pathological factors above 10 cm top diameter were not included in the loss factor data.*

A.4.2.6 Mistletoe Trunk Infections

Trunk infections of mistletoe are indicated either by abnormal swelling or malformations of the trunk at the point of infection, or by clusters of dead and broken branches on the trunk or on hypertrophied branches immediately adjacent to the trunk (see Figure A.29 Trunk Infections of Mistletoe).

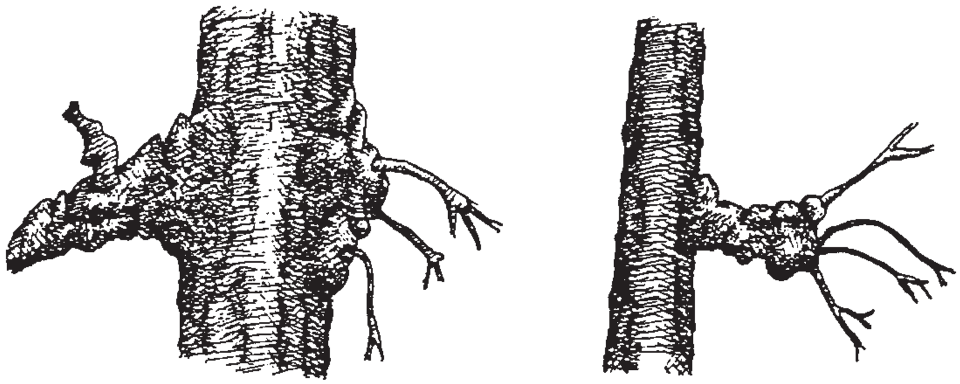


Figure A.29 Trunk Infections of Mistletoe

Wood-rotting fungi gain entrance to the trunk through the dead hypertrophied branches or branch stubs where the swelling is on, or adjacent to the trunk.

Do not record mistletoe on living limbs or limbs that are swollen only at some distance from the trunk. Record only those branch infections in which the swelling has clearly extended to trunk (see Figure A.30 Branch Infections of Mistletoe).

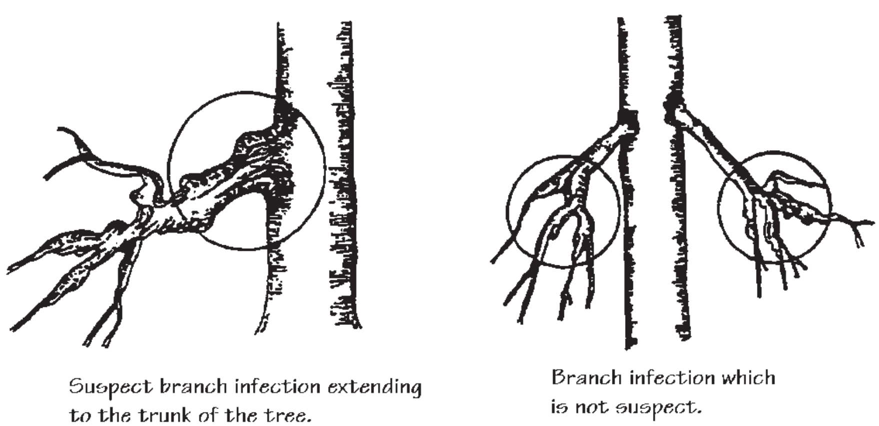


Figure A.30 Branch Infections of Mistletoe

A.4.2.7 Large Rotten Branches

Large rotten branches are dead branches that are large (over 10 cm DIB) and are clearly decayed. These branches are usually broken off within a couple of metres of the trunk. Decayed heartwood close to or at the branch base should be obvious. The branches may be found at any position on the tree, but are generally confined to a position below the base of the live crown. This indicator is typically found on over-mature trees (see Figure A.31 Rotten Branches.).

Large rotten branches should not be confused with the normal decay of dead branches. It should be associated with large branches that have broken off, exposing a large heartwood surface to decay producing fungi, thereby potentially infecting the adjacent trunk.

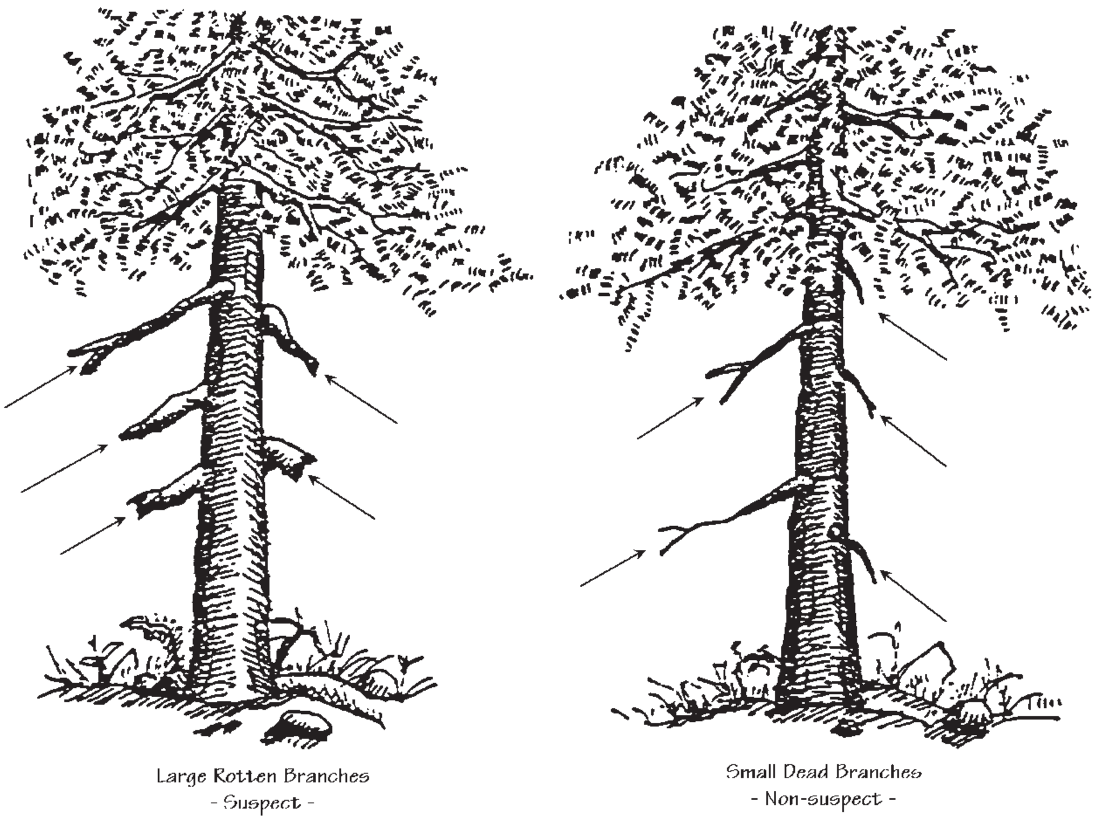


Figure A.31 Rotten Branches.

A.4.2.8 Dead or Broken Top

Definition:

- where the tree top or complete stem has died due to various physiological causes.

Causes of dead tops

Dead tops may be caused by several factors such as:

- insect attack,
- drought conditions,
- sun scald, and
- physiological death.

The recording of dead tops:

- a dead top must be obviously weathered, indicating that death occurred at least five (5) years ago and below the 10 cm top before it will be recorded as a pathological indicator[7].

Causes of broken tops

- wind breakage,
- snow damage, and
- damage from falling trees, etc.

Standing trees that are broken in the bottom third will have a windthrow damage code assigned. In this instance, do not record a dead or broken top in the first third unless the broken top occurred at least 5 years previously.

If a fork is present at a broken top position, record the fork if a merchantable log (3 m long and 10 cm top) can be recovered from the fork. If the fork is not of merchantable size, record the d or b top. Do not call both indicators (see Figure A.26 Fork or Crook and/or Dead or Broken Top).

If a candelabra is present at a broken top position, record d or b top.

[7] *Recent pathological damage and pathological factors above 10 cm top diameter were not included in the loss factor data.*

Flat topped trees

When trees attain their potential height for a specific site, the tendency for the top of the crown to flatten out is prevalent especially in certain species such as Douglas fir. This flattening of the crown is not indicative of damage to the tree and will not be recorded as a pathological indicator.

A.4.3 Abnormalities which are not Recorded

The following abnormalities are not indicative of decay and are, therefore, not recorded.

A.4.3.1 External Evidence of Butt Rot not Associated with Suspect Abnormalities

Butt rot may be evident in exposed roots or within root crotches. However, unless one or more of the suspect abnormalities appears on the tree, such trees will not be classed as suspect. It is defect of this nature which contributes to the decay loss factor associated with the residual tree class.

A.4.3.2 Flutes

Pronounced flutes on the trunk are a common growth characteristic of many species. They have no decay significance except in the case of interior cedar where the fold may hide an open scar leading to a hollow or decayed tree centre (see Figure A.32 Flutes).

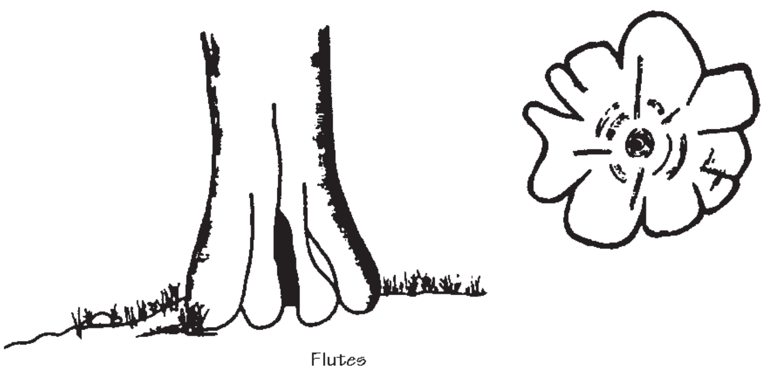


Figure A.32 Flutes

A.4.3.3 Candelabra Branches

“Candelabra” branches develop as a result of abnormal branch growth and as such are confused with suspect forking. Branching of this type has no decay significance. It is important to note that candelabra branches do not originate as a fork in the trunk of a tree (see Figure A.33 Candelabra Branches). Do not record defect on candelabras.

Figure A.33 Candelabra Branches

A.4.3.4 Branch Fans

Branch fans which appear most commonly as 'fans' of branches originating from burl-like swellings on the trunks (see Figure A.34 Branch Fans) are not suspect.

Figure A.34 Branch Fans

A.4.3.5 Black Knots

Black knots frequently develop around unhealed knots and wounds. The blackened appearance develops from a superficial saprophytic fungus which feeds on the exuded sap. Black knots are quite sound when cut into with an axe and have no decay significance (see Figure A.35 Black Knots).

Figure A.35 Black Knots

A.4.3.6 Burls and Galls

Burls and galls develop from abnormal cell growth in trees and although formidable in appearance, have no decay significance (see Figure A.36 Burls and Galls).

Scars on burls will be recorded.

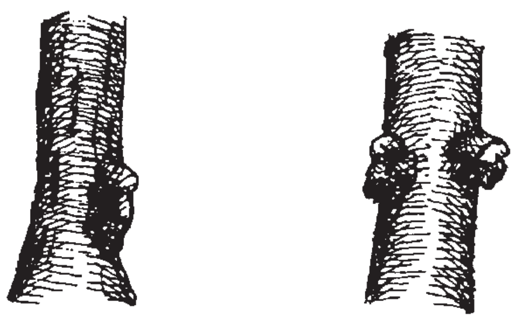


Figure A.36 Burls and Galls

A.4.3.7 Sweep

Sweep which is a slight curvature or distortion of the trunk has no decay significance (see Figure A.37 Sweep.).

Figure A.37 Sweep.

A.4.3.8 Exposed Roots

Exposed roots and buttress roots have no established decay significance unless scarring is present above ground level (see Figure A.38 Exposed Roots.).

Figure A.38 Exposed Roots.

A.4.3.9 Other

Spiral Grain

Spiral grain is a growth characteristic of trees and has no decay significance.

Dry Side

Dry side results from the death of the cambium resulting from bruising by other trees or from other physiological causes. Dry side appears as a narrow to wide strip down the side of the tree or as small localized areas. The bark often remains intact over the dead areas. Although dry side may be responsible for the complete rejection, or degrade of a pole tree, it has no established decay significance. Dry side is not a scar unless the bark has sloughed (is missing).

Sap Sucker Holes

Sap sucker holes are superficial in extent and have no established decay significance. They are in marked contrast to suspect scarring caused by woodpeckers (see Figure A.39 Bird Damage.).

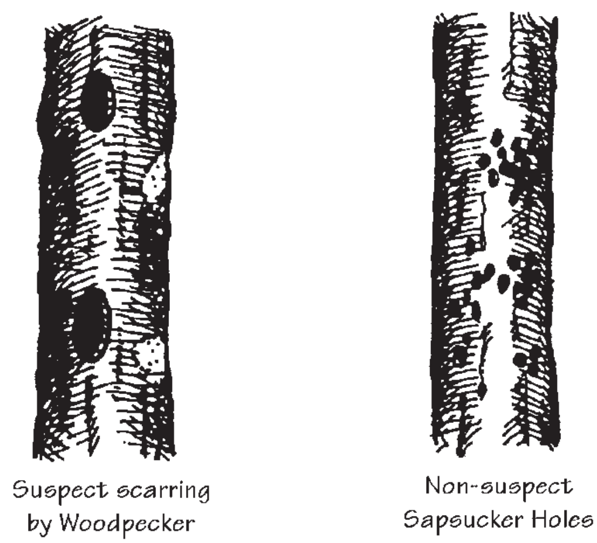


Figure A.39 Bird Damage.

Insect Borings

Borings by bark beetles or other insects have no established decay significance and will not be classed as suspect.

Non- suspect Forking

Figure A.40 Illustrates Forks and Crooks Which are Not Suspect shows two types of non- suspect forking most commonly occurring in deciduous trees. Deciduous trees with "U" shaped forks containing a dead branch are definitely suspect. Non- suspect forking is more "V" shaped.

Trees growing in clumps, such as birch, should not be classed as suspect on this characteristic alone.

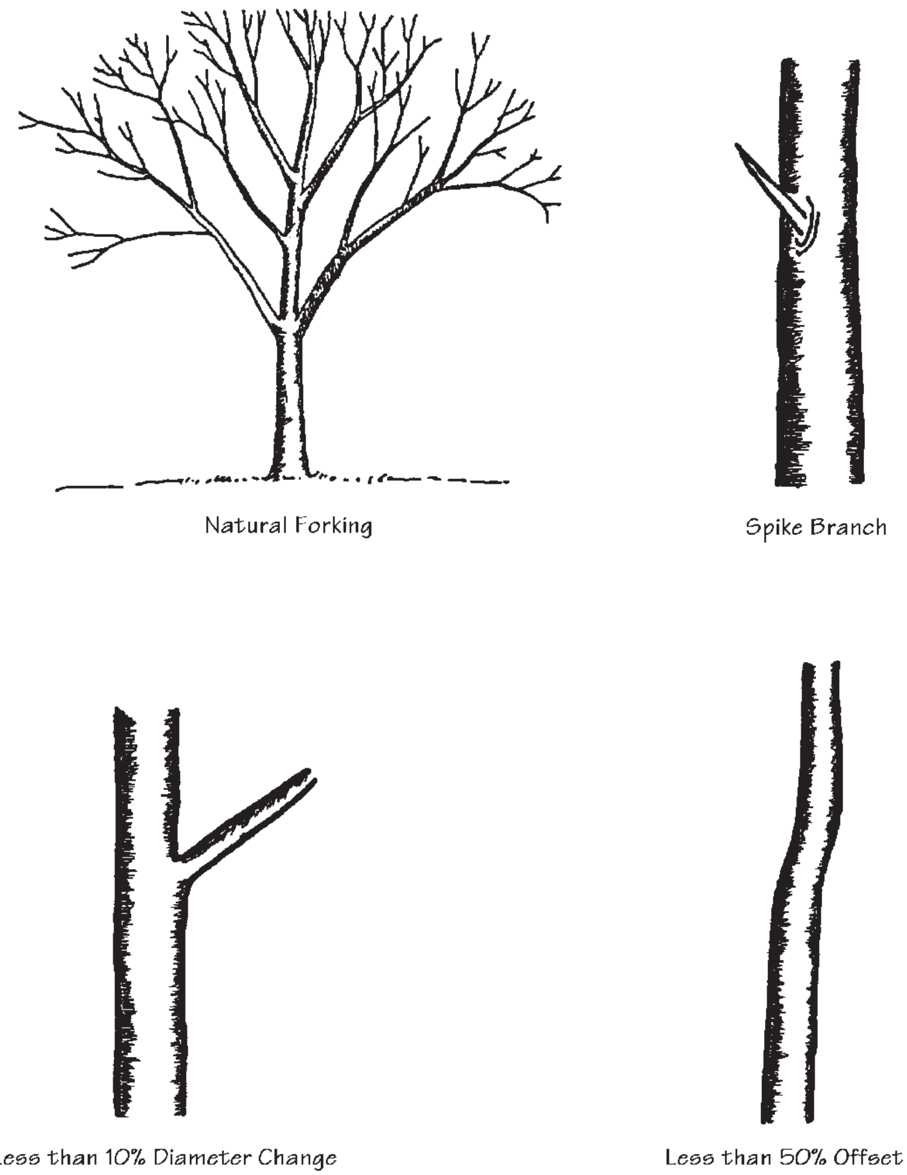


Figure A.40 Illustrates Forks and Crooks Which are Not Suspect

BACK

A.4.4 Some Common Decays of Forest Tree Species in British Columbia

Brief descriptions of the major root diseases, heart rots, sap rots and canker diseases of coniferous and deciduous tree species in British Columbia have been included in Figure A.41 Suspect Indicators and Figure A.42 Residual Indicators as an aid to their identification in the field. Pathological studies have shown that although most tree species are subject to attack by a large number of wood-rotting fungi, only a few are treated as suspect indicators. Suspect as well as residual pathogens are described in this comprehensive table.

Refer to Section A.4.2.1 for additional information.

Suspect Indicators (Figure A.40 – Record these indicators)

Root and Butt Rots

Current (left) and previous year's (right) sporophores of *P. schweinitzii* (Photo credit R. Reich).

Shelf-like conk of *P. schweinitzii* and brown cubical decay (Photo credit R. Reich).

***Phaeolus schweinitzii* (Fr.:Fr.) Pat.**

Schweinitzii Butt Rot, Brown Cubical Butt Rot

Hosts: Ba, Bl, Cw, Fd, Hw, Lt, Lw, Pl, Pw, Py, Ss, Sw, Qg

On conifers, common in Douglas-fir, spruce and pine. Occasionally found on hardwoods in all regions of BC.

Sporophores: Annual, spongy to leathery, stipate. Upper surface reddish-brown, velvety with concentric rings and light yellowish margin. Context yellow-green to light brown, lower surface yellow-green, turning brown when bruised. Pores regular to daedaloid.

Decay: The incipient stage may be difficult to detect, often appearing as a light yellow stain. At a late stage the wood becomes brittle and breaks into large cubes which are reddish-brown in colour. An odour of anise is often associated with advanced decay.

Entrance: Roots.

Activity: A cellulose-destroying heart rot, generally confined to the roots and basal log.

Remarks: Very general distribution throughout North America. Occurs in trees of all ages. Young trees may be killed outright, older trees become subject to windfall. Sporophores develop on roots and freshly felled trees, and provide a valuable index of infection.

Heart Rots

Sporophore of *E. tinctorium* (Photo credit R. Reich).

Sporophore of *E. tinctorium* *in lower light conditions.*

Brown stringy rot cause by *E. tinctorium* on Mountain hemlock (Photo credit R. Reich).

Echinodontium tinctorium (Ell. & Ever).

Brown Stringy Trunk Rot

Hosts: Ba, Bg, Bl, Cw, Fd, Hw, Hm, Ss, Sw

Reported on a large number of coniferous hosts. Of major importance in British Columbia on western hemlock, alpine fir and amabilis fir. Reported on the coast only at higher elevations and in the north.

Sporophores: Perennial, hard, woody, sessile, ungulate. Upper surface black and furrowed. Context brick-red. Lower surface grey.

Decay: The incipient stage may appear as light yellow to brown or water-soaked stain. Later, the wood darkens to a reddish-brown to brownish-yellow colour. Small rust coloured spots, and occasionally red streaks may develop. Finally, the wood is reduced to a brown, fibrous, string mass.

Entrance: Infections occur on living branches after 35 to 45 years, but normally do not become established in the trunk for another 100 years. Conditions affecting entry into the trunk are unknown.

Sporophores of *F. pinicola on interior spruce* (Photo credit R. Reich).

Fruiting bodies of *F. pinicola on subalpine fir* (Photo credit R. Reich).

Brown crumbly rot decay with white mycelium.

Fomitopsis pinicola (Sw.:Fr.) P. Karst.

(_Fomes pinicola_ (Sw.:Fr.) Cooke)

Brown Crumbly Rot, Red Belt Fungus

Note: This is only a suspect indicator on a living tree if found on a large, old scar.

Hosts: Ba, Bg, Bl, Cw, Fd, Hm, Hw, Lw, Pl, Pw, Py, Se, Ss, Sw, Dr, Ep, Ac, At

Common on most conifers and hardwood species in BC.

Sporophores: Perennial, woody to leathery, sessile, variable, ungulate, bracket-like, occasionally effused-reflexed. Upper surface dark brown to black. Outer margin often reddish or otherwise lighter in colour. Context cream to light brown. Lower surface white, often tinged with yellow. Poroid, pores small and regular.

Decay: The incipient stage may appear as a light brown discolouration. Later the wood breaks into small brown cubes which are soft and crumbly. White felts of mycelium may be formed in the shrinkage cracks.

Entrance: Scars, dead tops, insect injuries, etc.

Activity: A cellulose-destroying trunk rot, occurring in the heartwood or sapwood.

Remarks: Very common in dead trees, slash, and other forest litter, thus occasionally known as the scavenger fungus. May be associated with decay in living trees, frequently gaining entrance through scars. Also an important rot contributing to the deterioration of killed stands, especially by fire and insects. Sporophores develop infrequently on living trees.

BACK

***Phellinus igniarius* (L.:Fr.) Quél.**

(*Fomes igniarius* (L.) Gill.)

White Trunk Rot, White Heart Rot, Hardwood Trunk Rot

Sporophore of *P. igniarius* (Photo credit R. Reich).

Hardwood trunk decay of *P. igniarius*.

Hosts: D spp., R spp., Act, E spp., G spp., M spp., W spp.

Occurs mainly in hardwoods. Common in aspen and birch.

Sporophores: Perennial conks are usually hoof-shaped, but sometimes shelf-like and may obtain a width of 20 cm or more. The upper surface is greyish-black to black, dull or shiny, smooth when younger, becoming rough and cracked with age. The under surface is brown with mouths of tubes small and circular in outline. Context is rusty-brown, often interspersed with grey or white mycelium flecks.

Decay: Incipient stage has yellowish-white spots, streaks, or larger areas in the heartwood, the whole usually surrounded by a yellowish-green to brownish-black zone. In the advanced stage the wood is light in weight, soft, whitish and rather uniform in texture, with fine black lines running throughout. In aspen, the incipient wood is faintly coloured from light pink to straw-brown, in the intermediate stage of decay, the wood is straw to chocolate-brown, but is still hard and firm. In the advanced stage, all soft, punky wood irrespective of colour is included.

Entrance: Unknown – probably on branches and wounds.

Activity: Sporophores form on standing trees and on slash. The presence of a single sporophore generally indicates a considerable volume of decay.

Sporophore of *Phellinus tremulae* (Photo credit R. Reich).

Section of decay caused by *P. tremulae* (Photo credit R. Reich).

Phellinus tremulae (Bondarzev) Bondarzev & Borisov in Bondarzev

(_Fomes igniarius_ (L.:Fr.) J. Kickx fil. f. _tremulae_ Bondarzev)

(_Fomes igniarius_ var. _populinus_ (Neuman) Camp.)

Aspen Trunk Rot

Hosts: At

Found only in trembling aspen.

Sporophores: Perennial, hard, woody, growing up to 20 cm wide and 10 cm thick. Generally triangular shaped in longitudinal section with upper and lower surfaces at angles of about 45º from horizontal. Upper surface is grey-black to black, deeply zoned, and appears roughened when old. Lower surface has small, regular pores. Context is rust-brown, often interspersed with white mycelium flecks.

Decay: Incipient stage appears as yellow-white zone in heartwood, usually surrounded by yellowish-green zone. In the advanced stage, the soft yellow-white zone usually contains black zone lines running throughout. Zone lines often surround the decay column as well.

Entrance: Unknown – probably on branches.

Activity: Sporophores form on branch scars, on living and dead standing trees, as well as on slash.

Sporophore of *P. pini*.

Longitudinal section of decay caused by *P. pini* (Photo credit R. Reich).

Cross section of decay caused by *P. pini* (Photo credit R. Reich).

Phellinus pini (Thore:Fr.) Ames

Fomes pini (Thore:Fr.) Fr.

Red Ring Rot, Conk Rot, White-pitted rot, Pecky Rot, Honeycomb Rot

Hosts: Ba, Bg, Bl, Cw, Yc, Fd, Hm, Hw, Lw, Pj, Pl, Pw, Py, Sb, Se, Ss, Sw

Occurs essentially on all conifers in British Columbia, very common in hemlock, spruce and Douglas-fir. Also known to occur on hardwoods.

Sporophores: Perennial, woody to punky, sessile, ungulate, occasionally effused-reflexed if on branches. Upper surface dark brown and furrowed. Context cinnamon brown. Lower surface light brown. Poroid, pores regular to daedaloid.

Decay: The incipient stage may appear as a reddish stain. Later small white, spindle-shaped pits develop parallel to the grain.

Entrance: Unknown – probably branches and wounds.

Activity: A lignin destroying heart rot, mostly occurring in the trunk.

Remarks: One of the most important decay fungi in British Columbia. Of greater importance on good sites. Conks develop on living trees and provide a valuable index to hidden defect. Also recognized through the occurrence of blind conks (punk knots) which constitute early or abortive stages in the development of sporophores.

Figure A.41 Suspect Indicators

Residual Indicators (Figure A.41 – Do not record these as conk, but may be recorded in root rot column 60 of the cruise tally sheet)

Root and Butt Rots

Clusters of *Armillaria* mushrooms.

Roots and base of tree affected by armillaria root rot.

***Armillaria* spp.**

***Armillaria ostoyae* (Romagnesi) Herink**

***Armillaria sinapina* (Bérubé & Dessureault)**

***Armillaria gallica* Marxmüller & Romagnesi**

***Armillaria cepistipes* Velanovsky**

***Armillaria nabsnona* Volk & Burdsall**

Armillaria Root Disease

Hosts: *Armillaria ostoyae* **-** Ba, Bg, Bl, Lw, Se, Sw, Ss, Pl, Pw, Py, Fd, Tw, Cw, Hw, Ep, At, Act, Qg, W spp.

Armillaria species are found on a broad range of conifers and deciduous trees in British Columbia.

Armillaria ostoyae has the greatest impact on conifer management. Other *Armillaria* species are considered weakly pathogenic on live broadleaved trees, and do not kill healthy conifers.

Sporophores: Mushrooms occur at the base of infected live and dead trees, as well as colonized stumps. Also commonly found on scar-associated dead wood on living trees. Mushrooms appear cream to brown coloured with a distinct ring on the stem. Caps grow 5-10 cm wide. Most obvious on resinous tress, where fungus is present at the root collar, resin exudes through the bark of the lower bole, and under bark showing resin sis, and white mycelial fans occur in the bark and cambial zone. Another aid in the identification of *Armillaria* is the presence of rhizomorphs. The rhizomorphs of parasitic *A. ostoyae* are observed as being Y-shaped, and the rhizomorphs of saprophytic *A. sinapina* are T-shaped in appearance.

Decay: Incipient decay is yellow to brown in colour,

	roots often appear water-soaked. Decayed wood later becomes stringy, gelatinous and very wet. **Remarks:** Dead and diseased trees can occur scattered throughout stands, however they most commonly occur in disease centres. These centres appear as openings in the canopy, and can range in size, potentially reaching approximately 0.1 ha in mature stands.

***Heterobasidion annosum* (Fr.:Fr.) Bref.**

***Fomes annosus* (Fr.:Fr.) Cooke**

Annosus Root and Butt Rot, Pine Root Fungus

Sporophores of *H. annosum* at base of tree.

Incipient decay caused by *H. annosum*.

Stringy root decay caused by *H. annosum*.

Hosts: Ba, Bg, Sw, Ss, Fd, Cw, Hw, Mb, Dr

Occurs on most hardwoods and conifers. Common in western hemlock. Range is generally west of the coast mountains and in the ICH biogeoclimatic zones.

Sporophores: Perennial, woody to leathery, sessile, ungulate or bracket-like to resupinate. The upper surface is dark-coloured to black, zonal with acute margins. The context is white to cream coloured. Poroid, pores small and regular.

Decay: The incipient stage may appear as a reddish-brown stain. In the advanced stage the wood is reduced to a white stringy or spongy mass containing numerous black flecks running parallel to the grain. In the final stage the wood may be completely destroyed.

Entrance: Roots and scars.

Activity: Heartwood and occasionally sapwood decomposition of lignin, and to a lesser and slower extent, cellulose. Generally confined to root and butt sections.

Remarks: Sporophores are generally produced on dead material or on the under-surface of roots exposed to the atmosphere. Capable of causing extensive root rot in young stands. Also occurs as a common decay of mature timber.

BACK

O. tomentosa **fruiting bodies (Photo credit R. Reich).**

Wet *O. tomentosa* fruiting body on forest floor (Photo credit R. Reich).

Tangential view of advanced honeycomb decay caused by

O. tomentosa **(Photo credit R. Reich).**

End view of decay caused by *O. Tomentosa* (Photo credit R. Reich).

Onnia tomentosa **(Fr.) P. Karst**

Inonotus tomentosus **(Fr.:Fr.) S. Teng.**

Polyporus tomentosus **(Fr.:Fr.)**

(Fr.) P. Karst.

Tomentosus Root Rot

Hosts: Ba, Bl, Fd, Hw, Lw, Pa, Pl, Py, Se, Sw, Ss

Occurs on a broad range of conifers in British Columbia, found most frequently in northern and central spruce-pine forests, and at higher elevations in southern British Columbia.

Sporophores: Found on ground around infected trees. Annual, leathery, stalked. Small fruiting bodies (usually < 10 cm diameter). Shelf-like fruiting bodies sometimes found on dead roots and base of infected trees. Upper yellow-brown to rust-brown, velvety, becomes dark brown with age and when wet.

Decay: Incipient stage can appear as reddish-brown stain in heartwood. In the advanced stage, the elongated or rectangular-shaped pits appear in the heartwood which are separated by reddish-brown firm wood. Stem cross-sections display honeycombed appearance which can also often be observed on stump surfaces.

Entrance: From tree to tree at points of root contact, and by airborne basidiospores through fine roots.

Activity: Extensive butt call, reduced increment growth, windthrow. Disease and mortality often appears in groups and results in stand openings.

Phellinus weirii (Murrill) R.L. Gilbertson

Poira weirii (Murrill) Murrill

Inonotus weirii (Murrill) Kotl. & Pozar

Laminated Root Rot

Hosts: *Highly susceptible* – Fd, Bg, Hm. *Susceptible* – Se, Ss, Bl, Hw, Lw. *Tolerant* – Pl, Pw, Py. *Resistant* – Cw

Two forms of the disease have been identified – the Douglas-fir and cedar forms. They can be distinguished by symptoms and host preference. Described above are hosts of the Douglas-fir form of the disease.

Fruiting Bodies: White or tawny to mauve mycelium often found at root collar on or in bark. Crust-like brown mycelium growth often occurs over ectotrophic mycelium at root collar with appearance of blistering paint. Fruiting bodies annual, nut rare. Appear as brown crust-like layers. Light buff with narrow white margins when fresh. Uniformly dark brown when aged, and may remain for up to 2 or 3 years. Exposed surface poroid, pores small and irregular.

Decay: Incipient stage may appear as red-brown stain on fresh stump tops, or cross sections of major roots. In living trees infection rarely extends past 1 m up the stem. In advanced stage stained wood softens and annual rings separate to form laminated sheets of decay with accumulations of reddish-brown mycelium forming between the layers. Decayed wood becomes pitted.

Entrance: Root contact. Fungus has potential to remain viable in dead stumps and roots for decades.

***P. weirii* fruiting body on Douglas-fir.**

Black stain on base of Douglas-fir caused by *P. weirii*.

Incipient decay caused by *P. weirii* in Douglas-fir.

Heart Rots

Decay caused by *C. rivulosa* in western red cedar.

***Ceriporiopsis rivulosa* (Berk. & Curtis) Gilb. & Ryvarden**

***Poria rivulosa* (Burk. & Curtis) Cooke**

***Poria albipellucida* D. Baxter**

White Butt Rot, White Laminated Rot

Hosts: Ba, Cw, Fd, Hw, Sw, Ss

Widely distributed throughout the range of these conifer hosts in British Columbia.

Sporophores: White, annual, thin, resupinate and poroid. Fruiting bodies are rare, not especially useful for identification of presence of decay. Occur mostly on slash.

Decay: Incipient stage appears as yellow discoloration in heartwood. This discolouration is sometimes surrounded by a blue to red stain. As the wood dries radial cracks may form. Annual rings separate in late stage of decay to form a crumbly mass or coarse laminations. Decay symptoms are sometimes not evident in freshly cut wood, but become more conspicuous as wood dries.

Remarks: Considered the most important butt rot of western red cedar in coastal regions of BC. Decay symptoms are most useful for identification of this disease. If decay is present butt logs of mature trees are often significantly damaged since decay develops readily in early life of the tree.

Fomes fomentarius (L.:Fr.) J. Kicks fil.

White Spongy Trunk Rot

Hosts: D spp., Acb, Act, E spp.

Occurs on and is widely distributed throughout its deciduous hosts in British Columbia.

Sporophores: Perennial, can be woody or leathery, usually hoof-shaped. Upper surface smooth with a thick crust, zoned, and is grey to brown or black in colour. Context is a thin brown layer located between the upper crust and the old tube layers. The lower surface is pale brown, concave and poroid. Pores are small and regular. Conk age can be estimated relatively accurately by counting the distinct layers of tubes which are laid down annually.

Decay: In the incipient stage the wood remains firm and signs of decay appear as light brown discoloration. In the advanced stage of decay the wood is yellow-white in colour, often containing brown or black zone lines. Wood in the advanced stage is softy and spongy. Decayed wood may have a mottled appearance as small radial cracks are filled with a yellow mycelium.

Entrance: Infection occurs through exposed dead wood tissue by spread of airborne spores.

Activity: Rot can be present in sapwood and heartwood in living and dead timber. Fruiting bodies can be found on living trees, dead trees, and on slash. Presence of fruiting bodies often indicates heartwood is not merchantable.

Sporophores of *F. Fomentarius* (Photo credit R. Reich).

Cross section of *F. fomentarius* sporophore and advanced stage of trunk decay.

Sporophore of *F. officinalis* (Photo credit R. Reich).

Sporophore of *F. officinalis*.

Advanced decay caused by *F. officinalis* in western larch.

***Fomitopsis officinalis* (Villars.:Fr.) Bondartsev & Singer**

***Fomes officinalis* (Villars.:Fr.) Faull.**

***Fomes laricis* (Jacq.) Murrill**

Brown Trunk Rot, Quinine Fungus

Hosts: Ba, Bg, Fd, Hw, Lw, Pl, Pw, Py, Se, Ss

Distributed widely throughout host range in British Columbia.

Sporophores: Hoof-shaped to long and pendulous. Variable in size, can be up to 40 cm in diameter. Upper surface is zoned and white when fresh, turning dark grey or light brown when dried. A white powdery or chalky coating can be present. The context is white or grey, and toughens with age. The lower surface is poroid, and is also white when fresh, and dries to a light brown color. Pores are small and uniform.

Decay: During the incipient stage of decay a light yellow to red-brown stain appears, and in Douglas-fir can be seen as a purple discolouration. The stain may extend considerably beyond the advanced decay. In advanced stages of decay the wood will break into thick cubes with mycelia felts which are white in colour often forming in the shrinkage cracks.

Activity: Fungus is capable of destroying most of the wood volume of a tree, and fruiting bodies present are indicative of this. Fruiting bodies appear frequently on larch, but are less common on other species. The sporophore context has a characteristic bitter taste, which is what gives the fungus one of its common names ‘quinine fungus’.

Ganoderma applanatum (Pers.) Pat.

Fomes applanatus (Pers.) Gill.

Polyporus applanatus (pers.) Wallr.

White Mottled Rot, Applanatus Rot, Picture Conk

Typical sporophores of _G. apllanatum_.

Hosts: Ba, Bg, Cw, Fd, Hm, Hw, Se, Sw, D spp., A spp., E spp., M spp., Q spp., W spp.

Occurs commonly on deciduous trees, but also on a broad range of conifers in British Columbia, affecting trees in all regions of BC.

Sporophores: Perennial, leathery to woody, sessile, applanate. Upper surface is light brown to grey and often shiny. Context is dark brown. The lower surface is white, turning dark brown when bruised. Poroid, with regular pores.

Section of white mottled rot caused by _G. applanatum_.

Decay: The incipient stage may appear as a light stain or infected wood may have a bleached appearance and be difficult to detect. In the advanced stage the decay is characterized by a mottled appearance. The wood is white or light coloured, soft and spongy, and often contains zone lines and accumulations of mycelium.

Entrance: Scars.

Activity: Heartwood and sapwood decomposition of lignin and to a lesser and slower extent cellulose. May occur in the butt or trunk.

Remarks: Sporophores develop infrequently on living trees. The lower surface of fresh sporophores may be permanently marked on contact. Brownish spores may be carried to the upper surface giving a dusty brown appearance to the sporophore.

Coral-like fruiting body of *Hericium abietis*.

Advanced stage of decay caused by *H. abietis*.

Hericium abietis (Weir ex Hubert) K. A. Harrison

Hydnum abietis Weir ex Hubert

Yellow Pitted Rot

Hosts: Ba, Bg, Bl, Hm, Hw, Ss

Host range restricted to west of the rocky mountains in British Columbia.

Sporophores: Annual, soft, fleshy. White with many downward-directed coral-like spines which are 1-2 cm long when developed fully.

Decay: Incipient stage appears as yellow to brown stain in heartwood. Elongated pits appear in advanced stage of decay which may contain yellow to white mycelium. In cross section, the decay pits appear irregular to honeycomb.

Entrance: Wounds.

Activity: Fruiting bodies are generally found on slash and on ends of cut logs. May for on wounds of living trees. Presence of fruiting bodies indicates extensive stem decay.

Sporophores of *L. sulphureus*.

Decay caused by *L. sulphureus*.

Laetiporus sulphureus **(Bull.:Fr.) Murrill**

Polyporus sulphurous **(Bull.:Fr.) Fr.**

Brown Cubical Rot, Sulphur Fungus

Hosts: Ba, Bg, Bl, Bp, Cw, Fd, Hw, L spp., Py, Pw, S spp., Qg

Common on most hardwoods and conifers, including oak, true fir and spruce in all regions of British Columbia.

Sporophores: Annual, spongy to leathery, sessile or stalked (stem eccentric), applanate to bracket-like. The upper surface is orange-yellow. The context is white to yellow. The lower surface is a sulphur-yellow colour and poroid with regular pores. Old sporophores appear white and brittle.

Decay: The incipient stage may appear as a light brown stain. Later the wood breaks into small brown cubes. The decay may have a ‘rippled’ appearance in longitudinal section and white mycelia felts may develop in the shrinkage cracks.

Entrance: Scars, dead branch stubs.

Activity: A cellulose decomposing heart rot and occasionally sap rot. May occur in the butt or trunk, but generally in the trunk.

Remarks: Sporophores develop infrequently on living trees but are easily recognized by their shape, size and colour. They decompose quickly following insect attack and weathering and seldom remain on the host past one season.

Neolentinus kauffmanii (A. H. Smith) Redhead & Ginns

Lentinus kauffmanii **A. H. Sm. in Bier and Nobles.**

Brown Pocket Rot of Sitka Spruce

Sporophores of *N. kauffmanii*.

Pocket rot decay caused by *N. kauffmanii*.

Hosts: Ss

Restricted to the range of Sitka spruce in British Columbia.

Sporophores: Pinkish-tan mushrooms, small in size. Usually occurring on areas of exposed, advanced decay of fallen or split dead trees.

Decay: Boundaries of advanced decay are often delimited by wood that appears sound, however adjacent pockets may occasionally merge to form a continuous decay column. Wood breaks down within the pockets to form small, soft brown cubes. In advanced stages of decay wood crumbles away completely leaving hollow pockets which are well-defined.

Remarks: Decay cannot be detected in standing timber since fruiting bodies form only on infected wood which is exposed to air.

The Spongy Butt Rot Complex:

***Perenniporia subacida* (Peck) Donk, *Corticum galactinum* (Fries) Bur, *Odontia bicolor* (Alb. & Schw. Ex. Fr.) Bres.**

Stringy Butt Rot, Spongy Butt Rot, Feather Rot

Hosts: Ba, Bg, Bl, Cw, Fd, Hw, Lt, Pl, Pw, Se, Ss, Sw, D spp., R spp., Act, E spp., M spp., W spp.

Widely distributed through its range of deciduous and coniferous species found in all ranges of British Columbia.

Sporophores: Superficially similar in the three species: Annual to perennial and resupinate. White, yellow or buff in colour. The surface of *C. galactinum* is smooth and waxy. *O. bicolor* becomes cracked with age and covered with short fragile evenly-distributed teeth. *P. subacida* has small circular pores and is leathery to crust-like.

Sporophores of *P. subacida*.

Decay: The incipient stage may appear as a light stain. Later, small white pits develop and coalesce to form masses of spongy white fibres containing small black flecks. The annual rings may separate to form a laminate decay. Finally, the wood is reduced to a spongy mass.

Entrance: Roots.

Activity: A lignin and to a slower and lesser extent, cellulose, decomposing heart rot and sap rot which is generally confined to the roots and butt.

Remarks: *P. subacida* which was formerly considered the sole causal fungus in some hosts is now believed to be the least important of the fungi commonly associated with the disease. White spongy butt rot is widely distributed throughout North America, and is common in mature age classes. Sporophores of the three fungi associated with this rot are generally found on the under-surfaces of old logs.

Sporophores of *P. hartigii.*

Advanced decay caused by *P. hartigii*.

Phellinus hartigii (Allesch. & Schnabl.) Bondartsev

Fomes hartigii Allesch. & Schnabl.

Fomes robustus P. Karst

Phellinus robustus (P. Karst.) Bourd. & Galzin

White Trunk Rot of Conifers

Hosts: Ba, Bl, Fd, Hw

Widely distributed throughout host range in British Columbia.

Sporophores: Perennial. Hoof-shaped, usually 5-15 cm wide when formed on stem and generally resupinate when formed on lowers surfaces of branches. The upper surface is dark brown to black. The lower surface is brown and poroid, with small circular pores.

Decay: Incipient stages of decay often appear as a straw-coloured to purple stain which may be irregular in shape. In the advanced stages, wood often appears bleached with occasional light brown areas or streaks, usually numerous zone lines are present. Decay sometimes occurs in a section of wood which extends in from the sapwood, and is often associated with wounds, dead branches, or with dwarf mistletoe infections which have killed part of the cambium.

Entrance: Wounds, dead branches, mistletoe infections.

Activity: Usually kills tissues localized near the point of infection, but can spread upwards and downwards 1-2m from each fruiting body. Decayed trees are prone to wind damage, and often breakage occurs up to 6m from the ground.

Pholiota populnea (Pers.:Fr.) Kuyper & Tjall.-Buekers

Pholiota destruens (Brond)

Yellow Laminated Butt Rot of Poplars

Mushrooms of _P. populnea_ on a cut log.

P. populnea mushrooms.

Hosts: Act

Widely distributed throughout its host's range in British Columbia.

Sporophores: Large gilled mushrooms which often occur in clusters. Mushroom cap is light brown and covered with white scales when fresh. Gills white when immature, turning to dark brown as spores mature. The stem is white or light brown, also covered with scales, and a white annulus (small ring) is present.

Decay: In the incipient stage the decay appears as buff to dark brown streaks in the heartwood. In the advanced stages of decay white patches for which give the wood a slight mottled appearance. Wood becomes uniformly yellow to tan and laminated in the final stage of decay.

Remarks: Thought to be the most damaging decay fungus found in cottonwood. It is found on living trees as well as on slash, however it tends to persist for longer on living trees, and will only remain active in stumps and logs for a few years.

Sporophores of *P. betulinus.* Young sporophore (above), older sporophore (below).

Cubical decay caused by *P. betulinus.*

Piptoporus betulinus (Bull.:Fr.) P. Karst.

Polyporus betulinus (Bull.:Fr.) Fr.

Brown Cubical Rot of Birch

Hosts: Ep

Found throughout the range of birch in British Columbia.

Sporophores: Annual, leathery, stout stipe. Can have a fairly large cap, up to 15 cm deep, 25 cm wide, and 6 cm high. The upper surface is light brown and becomes darker brown and scaly with a margin extending below the pore surface. The pore surface is white when fresh, and becomes light brown and tooth-like with age. Pores are circular. The context is white and easily separates from the tube layer when fresh.

Decay: The decayed wood is yellowish-brown in colour, and will crack into cubes. In the cracks thin, white mats of mycelium will form. In the advanced stages of decay, the wood is light weight and will easily crumble into powder.

Entrance: Dead branches.

Activity: A bark, sapwood and heartwood rot, only attacking hardwoods. Often present in dead branches of dying trees.

***Postia sericeomollis* (Romell) Jülich**

***Oligoporus sericeomollis* (Romell) Pouz.**

***Polyporus sericeomollis* Romell**

***Poria sericeomollis* (Romell) Egeland**

***Poria asiatica* (Pilát) Overh.**

Brown Cubical Butt and Pocket Rot of Cedar, Pecky Rot

Advanced decay in western red cedar caused by *P. sericeomollis*.

Longitudinal section of brown cubical decay.

Hosts: Ba, Cw, Yc, Fd, Hw, Lw, Pl, Py, Se, Ss, Sw

Reported on most conifers and is widely distributed throughout the range of its hosts in British Columbia.

Sporophores: Annual, resupinate, white in colour, growing up to 15 cm wide. Sporophores appear as thin crusts on the outer surfaces of dead wood or slash. Fruiting bodies rarely occur on living trees, but are more commonly found on the ends of logs or on slash.

Decay: The incipient stage of decay is characterized by straw coloured to pale yellow-brown wood. In the advanced stage of decay, the wood turns light brown in colour and brittle. It breaks down into cubes and usually forms a cylinder or rot when in the butt. It can also form a series of isolated pockets which can run together to form arcs or concentric rings. Sometimes a thin, white mycelium weft will form between the cubes of decayed wood.

Entrance: Unknown.

Remarks: This decay is common in the butt logs of western red cedar, and though it has a broad host range, it seldom infects live trees other than western red cedar. The fungus is most common in the butt, but can develop at all levels in the stem.

Sporophores of *S. delectans*.

Spongipellis delectans (Peck) Murrill

Polyporus delectans Peck

Brown Stringy Trunk Rot of Hardwoods

Hosts: Act

Has only been found on black cottonwood in British Columbia, but has been reported on maple, alder and oak in other parts of North America.

Sporophores: Annual, fleshy to leathery. Grow in various shapes, but are usually shelved. The upper surface, context and lower surface is white when fresh, and dries to a light brown colour. Poroid with small regular pores.

Decay: During the incipient stage buff to light brown streaks appear in the heartwood. During the advanced stage of decay the wood becomes dark brown and light-weight. It is usually stringy, but can be laminate. The decay will at first form pockets of various size, and will usually merge to form a column in time.

Entrance: Branch stubs and/or branch scars.

Activity: In living and dead trees, the fungus occurs mainly as a trunk rot, and rarely as a butt rot. Decay is usually confined to the heartwood in living trees.

Sporophores of *S. sanguinolentum*.

Red heart rot caused by *S. sanguinolentum*.

Stereum sanguinolentum (Albertini & Schwein.:Fr.) Fr.

Haematostereum sanguinolentum (Albertini & Scwein.:Fr.) Pouzar

Stereum balsameum Peck

Red Heart Rot, Bleeding Conk

Hosts: Ba, Bg, Bl, Cw, Fd, Hm, Hw, Lt, Lw, Pl, Pw, Py, Se, Sw

Occurs on conifers, and is very common in true fir, pine and white spruce. It is widely distributed throughout its range of hosts in British Columbia.

Sporophores: Annual, leathery, resupinate to effused-reflexed, forms in this crust-like layers. The upper surface is zoned, and grey to light brown in the effused-reflexed form. The lower surface is roughened or wrinkled, and is also grey to light brown, but turns blood-red when bruised (only when fresh).

Decay: The incipient stage is firm and appears as a reddish-brown stain. In the advanced stage the wood becomes light brown to reddish-brown, dry and friable, the wood becoming a fibrous, stringy mass. Mycelial sheets, white to buff in colour, may develop during advanced decay.

Entrance: Broken tops and scars of living trees.

Activity: A lignin and generally, to a slower or lesser extent, cellulose, destroying heart rot.

Remarks: A very important decay-producing fungus, also occurs commonly as a slash destroyer. Sporophores develop occasionally on living trees, but are of limited value as indicators of defect, owing to their infrequent occurrence, small size, and colour.

BACK

***Veluticeps fimbriata* (Ellis & Everh.) Nakas.**

***Hymenochaete fimbriata* Ellis & Everh.**

***Stereum rugisporum* (Ellis & Everh.) Burt**

Brown Cubical Pocket Rot

Hosts: Ba, Bg, Bl, Fd, Hm, Hw, Se, Ss

Distributed widely throughout its host ranges in British Columbia.

Sporophores: Perennial, small, resupinate or shelf-like. Upper surfaces are dark brown to black. Context is brown. Lower surfaces are grey to light brown and roughened. The hymenial (spore producing) surface can be smooth to warted and usually cracked.

Decay: The incipient stage of decay produces a wet dark brown to black stain which occurs in streaks or patches. The advanced stage of decay develops in pockets which are enclosed by apparently sound wood. In the final stages, the pockets merge to form an almost continuous column of decay. The decayed wood is friable and often associated with dark stain and cobweb-like mycelium, often with an odour which resembles stored apples.

Activity: A commonly occurring trunk rot in conifers. Once thought of as only a destroyer of slash. Fruiting bodies may form on old logs and dead material on the ground, as well as on the scarred faces of living trees. If present, it can also continue to develop in seasoned timber.

Sap Rots

Sporophores of *C. purpureum*.

Stain associated with decay caused by *C. purpureum*.

***Chondrostereum purpureum* (Pers.:Fr.) Pouzar**

***Stereum purpureum* Pers.:Fr.**

Silver Leaf Disease

Hosts: Bl, Cw, Fd, Hw, Dr, At, Act, Acb. Ep, M spp., W spp.

Found on conifers, hardwoods and common on angiosperms. Widely distributed throughout its host range in British Columbia.

Sporophores: Annual, resupinate to semi-pileate, often occurring in groups. Extend out from surface 2-4cm. Upper surface is greyish white to purple and tomentose with indistinct, light coloured marginal zones. The spore producing surface is smooth to wrinkled, is bright purple when fresh and a brown-violet colour when it is old. Fruiting bodies are thin (1-2.5 mm) and contain a black line in cross section.

Foliar Identification: Silver/leaden lustre occurring on leaves of some hosts. Midribs and margins of affected leaves will become brown.

Damage: A weak parasite on some hardwoods, killing some branches or trees of some hosts, however *C. purpureum* is largely a saprophyte, and is not considered an economically important pathogen to conifer species in BC.

Cryptoporus volvatus (Peck) Shear

Polyporus volvatus Peck

Grey-Brown Sap Rot

Sporophores of _C. volvatus_.

Cross section of _C. volvatus_ sporophore.

Sap rot decay caused by _C. volvatus_ in an MPB affected tree.

Hosts: Ba, Bg, Bl, Fd, Hw, Pl, Pw, Py, Ss, Sw

Widely distributed throughout its host range in British Columbia, but most commonly found on beetle-killed and fire-killed Douglas-fir.

Sporophores: Annual, leathery, pouch-like. The upper surface is smooth, yellow to light brown, and turns white with age. The lower surface, is brown, poroid, but is covered with a membrane that continues from the upper surface (forming a pouch), until later, when an opening forms at the base and spores are released.

Decay: Causes narrow bands of cream to light grey discolorations in the outer sapwood. In the advanced stages the decayed wood becomes light brown, cubical and crumbly.

Activity: Causes damage to the outer 1-2 cm of sapwood, therefore volume losses are not large, or are nonexistent. The fungus develops rapidly in dead standing trees, usually the year after death. The fungus can also be used as an indicator of beetle-kill in Douglas-fir.

Gleophyllum sepiarium **(Wulfen:Fr.) P. Karst.**

Lenzites saepiaria **(Wulfen:Fr.) Fr.**

Brown Cubical Sap Rot

Sporophore of *G. sepiarium*.

Sporophores of *G. sepiarium*.

Hosts: Ba, Bg, Bl, Cw, Fd, Hw, Pl, Pw, Py, Sb, Se, Ss, Sw, A spp., Ep

Widely distributed throughout its host range in British Columbia.

Sporophores: Annual, leathery, small, shelf-like, occasionally stalked. Form in cracks and checks on fallen logs and slash. The upper surface is light to dark cinnamon-brown and zoned. At first it appears velvety, but becomes roughened as it matures. The context is brown. The lower surface is brown and contains gill-like structures (lamellae).

Decay: In the incipient stage decay appears as yellow to yellow-brown pockets of discolouration located in the sapwood or outer heartwood. In the advanced stage of decay, a typical brown cubical rot is present with yellow to yellow-brown mycelia located in the shrinkage cracks.

Activity: Presence of fruiting bodies usually indicates extensive decay, affecting the entire sapwood and some heartwood. Most commonly found on slash and fire-killed trees. Sometimes found on living trees, and dead sapwood under scars. Also found occasionally on fence posts or other wooden structures.

Trichaptum abietinum **(Dickson:Fr.) Ryvarden**

Hirschioporus abietinus **(Dickson:Fr.) Donk**

Polyporus abietinus **(Dickson:Fr.) Donk**

Pitted Sap Rot

Sporophores of *T. abietinum* (Photo credit R. Reich).

Sporophores of *T. abietinum* (Photo credit R. Reich).

Hosts: Ba, Bg, Bl, Cw, Fd, Hw, Lw, Pa, Pl, Pw, Py, Sb, Ss, Sw, Ra

Found on a wide range of coniferous hosts in British Columbia, and affects trees in all ranges of BC.

Sporophores: Annual, small and thin, effused-reflexed or shelf-like. Form in abundance in crevices of bark. The upper surface is somewhat hairy, zoned and light grey when fresh. Upper surfaces may appear green or black in older specimens due to algal growth. When fresh the lower surface is purple, and turns light brown with age. Pores are angular, and tissue between them becomes elongated and splits into irregular spines or ridges.

Decay: In the incipient stage the wood becomes soft and light yellow to tan coloured. Small pits develop in the advanced stage of decay which are elongated in the direction of the grain. They may be filled with fibrous material but will later become void. Cross section of decay appears as honeycombed.

Activity: Causes sapwood decay, fruiting bodies found abundantly on dead trees and forest litter. Primarily a saprophytic deteriorating agent, but also capable of casing sap rot and heart rot in living trees.

Canker Diseases

Black fungal mass of *I. obliquus* (Photo credit R. Reich).

Trunk rot caused by *I. obliquus*.

***Inonotus obliquus* (Pers.:Fr.) Pilát**

***Polyporus obliquus* (Pers. :Fr.) Fr.**

***Poria obliqua* (Pers. :Fr.) P. Karst**

Sterile Conk Trunk Rot of Birch

Hosts: Ep, rarely on Act.

Widely distributed throughout host range in British Columbia, but also occurs on other hardwood species elsewhere in North America.

Conks: Sterile. Conspicuous perennial black fungal masses erupting from bark cankers, commonly 20-30 cm diameter. The surface of the conk is rough and cracked, and internal tissue is yellow-brown to rust-brown, having a punky texture.

Sporophores: Small, annual. Form under bark or outer layers of wood surrounding sterile conks on dead standing or fallen trees. Quickly degraded through insect and weather damage, making them less conspicuous.

Decay: A heart rot in living birches similar to that caused by *Phellinus (Fomes) igniarius*. Incipient decay is whitish-yellow and in irregular zones. Advanced heartwood decay produces alternating zones of white and light reddish-brown wood, and moves to the sapwood after the tree dies. White mycelium veins can often be found near cankers, and dark zone lines are a feature of decayed wood.

Entrance: Dead branch stubs, trunk wounds and pre-existing cankers.

Activity: Extensive sapwood and heartwood decay. Infected trees often severely damaged.

BACK


Subtle, resinous *E. deformans* stem infection (left), and subtle, non-resinous stem infection (right) (Photo credits R. Reich).

Cross section of *Elytroderma* infected trunk (Photo credit R. Reich).


Advanced *Elytroderma* stem infection (left), and spinning stem infection with associated live lower limb (right) (Photo credit R. Reich).

Elytroderma deformans (Weir) Darker
Hypoderma deformans Weir
Elytroderma Stem Canker, Elytroderma Needle and Shoot Disease

Hosts: Pl, Py

Restricted to hard, 2 and 3 needle pines. Found throughout the interior of British Columbia on lodgepole pine.

Remarks: Although typically noted as a disease affecting the needles and shoots of hard pines, *E. deformans* also causes stem infections, which have not been described in the literature to date. This section will describe the stem infections of *E. deformans* for identification in the field.

Stem Infections: Typically sunken, somewhat diamond-shaped cankered portions of the stem, which may be somewhat spiralled or straight depending on the grain of the tree. Outer bark is usually rough and cracked, and sometimes slightly resinous. Cankers may persist to rotation or may result in the premature mortality of the tree through chronic growth loss in completely girdled stems. Older cankers may develop ridges and become flared at the sides.

Damage: Infected trees can be girdled completely, though the inner bark typically remains live. Stem infections appear to have little impact on survival of young trees, but over time cankers appear to increase in severity. Most stem infections appear to occur before age 10, and spread at a fairly even rate both horizontally and vertically. Cankers on mature trees can be several meters in length and may resemble stalactiform blister rust infections.

Entrance: Infection is by windborne ascospores, which mature and are discharged in late summer and early fall under favourable (wet) conditions. Infection typically occurs on the current year's foliage, with symptoms of flagging foliage by the following spring. Infection can spread to the bark and cambium becoming a perennial canker infection of the stem and/or branches.

Rusts

Sporulating diamond-shaped *C. coleosporioides* stem infections on young lodgepole pine (Photo credit R. Reich).

Long diamond shaped cankers of C. coleosporioides with concentric strips of squirrel feeding damage to bark (Photo credits R. Reich).

***Cronartium coleosporioides* Arthur**

***Cronartium stalactiforme* Arth. & Kern**

Stalactiform Blister Rust

Hosts: Pl, Py, Pj in natural forests.

Restricted to 2 and 3 needle hard pines in British Columbia. Also found on introduced hard pine varieties in BC.

Alternate (telial) Hosts: Paintbrush (*Castilleja miniata*), cow-wheat (*Melampyrum lineare*), and yellow rattle (*Rhinanthus minor*). Yellow owl's clover (*Orthocarpus luteus*) and bracted lousewort (*Pedicularis bracteosa*) have been found to be alternate hosts through artificial inoculation.

Identification: Perennial cankers can be found on the branches or stems of living hosts. Cankers are elongate, often diamond-shaped, and may display thickened bark due to swelling. Squirrel feeding damage on cankered areas of mature trees is common leaving areas of exposed wood. During late spring and summer, swollen areas produce white to orange aecial blisters which rupture and orange aeciospores are released to be disseminated by wind, rain and animals. During the fall and winter the presence of *C. coleosporioides* can be recognized due to size and shape of cankers, as well as their sunkeness, dead bark, and associated resinosis.

Entrance: Basidiospores which are produced on the telial horns of alternate hosts germinate in appropriate climatic conditions, infecting the tree through the stomatal openings of needles. Infection travels down the branch, and eventually into the stem.

Damage: Stem defects in older trees may result in decreased wood quality and increased susceptibility to abiotic damage such as caused by wind and heavy snow, as well as other pathogens such as stem decays.

Comandra blister rust stem infection (Photo credit R. Reich).

Stem canker caused by *C. Comandrae* with associated squirrel feeding on infected bark (Photo credit R. Reich).

Cronartium comandrae Peck

Comandra Blister Rust

Hosts: Pl, Py

Found in British Columbia where alternate host and host ranges overlap.

Alternate (telial) Hosts: False/bastard/northern toadflax (*Geocaulon lividum or Comandra livida*), Pale comandra (*Comandra umbellata*).

Identification: Perennial cankers can be found on the branches or stems of living hosts. Cankers grow radially as well as vertically, often girdling small branches and stems. Cankers of *C. comandrae*, similar to those of *C. coleosporioides*, are also prone to chewing by rodents and lagomorphs. During late spring and summer, swollen areas produce orange aecial blisters which rupture releasing orange aeciospores to be disseminated by wind, rain and animals.

Entrance: Basidiospores infect the tree through the stomatal openings of needles, travelling down the branch, and eventually into the stem.

Damage: Mortality usually occurs at an early age resulting in few mature trees with cankers.

Remarks: Cankers of *C. comandrae* and *C. coleosporioides* may appear similar to the untrained eye, however they can be distinguished by canker shape and size, as well as by microscopic examination of aecia. Cankers of *C. comandrae* usually tend to grow faster radially than they do vertically, therefore *C. coleosporioides* cankers are more elongate, and tend to be larger, as well as have a characteristic diamond shape to them.

***Cronartium comptoniae* Arthur**

Sweetfern Blister Rust

Stem swelling and hypertrophied ridges of sweetfern blister rust on young lodgepole pine (Photo credit R. Reich).

Hypertrophied ridges caused by sweetfern blister rust on lodgepole pine (Photo credit R. Reich).

Hosts: Pl, Pj, Py in natural forests.

Restricted to 2 and 3 needle hard pines in British Columbia. Restricted to areas where host and alternate host ranges overlap.

Alternate Host: Sweet gale (*Myrica gale*).

Identification: Appears as an elongate, diamond-shaped swelling on stems and branches, often girdling small branches and stems. During late spring and summer, swollen areas produce white to orange aecial blisters which rupture and orange aeciospores are released to be disseminated by wind, rain and animals. At other times of the year non-sporulating cankers can be identified by their size and shape, sunken dead bark and resin sis. Cankers of *C. comptoniae*, similar to those of *C. coleosporioides* and *C. comandrae*, are not as prone to chewing by rodents and lagomorphs.

Entrance: Basidiospores which are produced on the telial horns of alternate hosts germinate in appropriate climatic conditions, infecting the tree through the stomatal openings of needles, travelling down the branch, and eventually into the stem.

Damage: Severe losses in plantations of pine located near swampy sweet gale habitats can occur, however these habitats are rare in BC.

Remarks: Distinguishing between *C. comptoniae* and *C. coleosporioides* can be difficult, as cankers and scars may appear similar to the untrained eye. The distinguishing feature is the hypertrophied ridges of *C. comptoniae*.

BACK

Stem and branch gall caused by *E. harknessii* (Photo credit R. Reich).

Cobra-shaped tree resulting from an *E. harknessii* hip gall (Photo credit R. Reich).

Western gall rust affected tree (Photo credit R. Reich).

Endocronartium harknessii (J. P. Moore) Y. Hiratsuka

Peridermium harknessii J. P. Moore

Western Gall Rust

Hosts: Pl, Py, Pj in natural forests.

Restricted to hard 2 needle pines in British Columbia. Also found on introduced 2 needle hard pine species in BC. The disease is widespread throughout BC, affecting hosts throughout their ranges.

Identification: Woody swellings (galls) are formed on branches and stems of infected trees. Galls are generally globose, but may be deeply fissured and irregularly shaped. In late spring blisters form beneath the bark of galls which contain orange coloured spores. Spores are exposed when bark sloughs off of the calls.

Entrance: Trees are infected by the spores of the fungus through the epidermis on elongating shoots, therefore all galls are formed initially on one-year-old growth.

Damage: Damage is not usually significant when occurring on branches, however stem galls can lead to serious growth losses and malformations as well as mortality. Malformations due to galls present on the main stem, especially in younger trees can predispose the tree to damage by abiotic factors such as wind or heavy snow.

Remarks: *E. harknessii*, unlike other stem rusts, does not require an alternate host to complete its life cycle. Optimal climatic conditions for infection often occur every several years, as with other rust pathogens. This is known as the "wave year" phenomenon.

Figure A.42 Residual Indicators