<u>Suggested Survey Methodology for Measuring the Stocking of Secondary Structure</u>

Revised Sept. 21, 2012

The intention of the Forest Planning and Practices Regulation amendments to protect secondary structure is that forest professionals would walk potential cutblocks in lodgepole pine leading stands prior to cutblock layout and cruising to determine if an "**adequate stocking density**" of "**suitable secondary structure**" is either present or absent. Areas $\geq$ 5 hectares in size where there is "adequate stocking density" of "suitable secondary structure" would need to be excluded from proposed cutblocks or harvested in a manner that protects an adequate stocking density of suitable secondary structure, unless the regulation, a result or strategy in an FSP or the district manager provides an exemption from doing so.

The term "**suitable secondary structure**" has been defined to describe saplings (Layer 3), poles (Layer 2), sub-canopy and canopy trees (Layer 1) that are likely to survive a MPB infestation and are of a species that has been approved for use in establishing a free growing stand on the particular site. If the applicable forest stewardship plan (FSP) identifies a tree species as being preferred, acceptable or otherwise suitable for use in the establishment of a free growing stand, on a site, then the species qualifies as a suitable secondary structure species for that site. For situations where there is no FSP (e.g. a Small Scale Salvage forestry licence to cut), tree species listed as preferred or acceptable for a site in the Ministry of Forests' publication "Reference Guide to FDP Stocking Standards" will qualify as a suitable secondary structure species for that site. The definition also requires "suitable secondary structure" trees to have sufficiently good form, health and vigor to provide merchantable trees for future harvesting.

Determining if Secondary Structure Trees are Healthy

Secondary structure damage criteria for determining the acceptability even-aged coniferous trees is included in this procedure (Appendix B) to assist forest professionals in exercising their judgment in identifying if secondary structure trees are healthy and of reasonably good form and vigour. This version of the damage criteria anticipates that most secondary structure trees will be saplings which will require 40 to 50 years to reach a merchantable size and includes some comments on how to assess damage on mature secondary structure trees.

Secondary structure trees should be assessed as having acceptable vigour if they appear to be growing well enough to release and develop into merchantable timber. Forest professionals should be guided by the following considerations when determining if secondary structure trees have acceptable vigor:

- trees should have sufficient continuous live crown with healthy foliage
- trees with both spindly stem form and sparse foliage may not be acceptable
- if the pine overstorey has been dead for several years, it is desirable, but not essential, for secondary structure trees to exhibit recent improvements in foliage color, needle length and growth,
- smaller trees should be securely rooted so that they can't be easily pushed over

Overstorey Lodgepole pine

When assessing the stocking of suitable secondary structure, overstorey lodgepole pine is only considered as contributing to well spaced density if there is greater than 10 m^2/ha of live Pli basal area. It is recommended that basal area measurements and the decision to include live overstorey pine in the well spaced density tally are made at each plot.

Adequate Stocking Density

To satisfy the regulation definition of "**adequate stocking density**" there must be at least the following minimum numbers of healthy, suitable secondary structure trees per hectare that achieve the specified minimum heights. The regulation also requires the trees to be a minimum of 1.6 meters apart from each other.

Minimum # of Trees/Ha	Minimum Height
700	6 meters
900	4 meters

The intent is to rely on forest professionals to make a reasonable determination of whether there are any lodgepole pine leading stands $\geq$ 5 hectares in size within a proposed cutblock where there is an adequate stocking density of suitable secondary structure. For many lodgepole pine leading stands it will be apparently obvious that an adequate stocking density of suitable secondary structure simply doesn't exist. In such situations there is no expectation that a systematic survey would be undertaken to determine the stocking of suitable secondary structure.

To avoid non-compliance with the FPPR section 43.1 requirement to not harvest in a "targeted pine leading stand", licensees and BCTS may need to complete a survey in pine leading stands where the stocking of suitable secondary structure appears to be close to the minimum threshold for what is defined as "adequate stocking density". The following guidelines are suggested as a survey method for determining if an "adequate stocking density" of "suitable secondary structure" exists in these borderline areas.

Plot Size and Well Spaced Criteria

The suggested procedure is to use silviculture survey methodology to estimate the average number of well spaced suitable secondary structure trees per hectare using 3.99 meter radius plots with a maximum of 8 well spaced trees allowed per plot. The regulation establishes the minimum distance between well spaced secondary structure trees of 1.6 meters.

Plot Layout

Plots should be established on a systematic grid (e.g. 100 X 100 meter grid) with a random starting location, to provide systematic coverage over the area. A minimum of one plot per hectare should be established to determine the average number of well spaced, suitable secondary structure trees per hectare that are equal to or exceed the specified heights of 4 or 6 meters.

Plot Information to be Recorded

The following is suggested information that should be recorded at each plot:
Plot #
# of WS[1] suitable secondary structure trees, by species, that are $\geq$ 4.0 m tall & < 6.0 m tall
# of WS suitable secondary structure trees, by species, that are $\geq$ 6.0 m tall & < 17.5 cm dbh
# of WS suitable secondary structure trees, by species, that are $\geq$ 6.0 m tall & $\geq$ 17.5 cm dbh

It is suggested that the $\geq$ 6.0 height class could be divided into two subclasses to identify the stocking of merchantable and un-merchantable secondary structure trees. This information can be useful for determining if the secondary structure is largely composed of merchantable trees or smaller trees. Optional comments can be recorded on significant forest health factors, blowdown potential or other circumstances to justify an exemption from not harvesting the area or support a decision to avoid harvesting the area. Directly below is a possible plot card layout for recording the number of well spaced suitable secondary structure trees by tree species into height classes.

When selecting well spaced trees in each plot, preference should be given to trees in the $\geq$ 6 m height class as fewer of these taller trees are required per hectare for the area to have an adequate stocking density of suitable secondary structure. Once a sufficient number of plots have been established on the area, the average number of well spaced suitable secondary structure trees of all species should be calculated for the two height classes. If there is an

[1] WS = Well Spaced trees greater than 1.6 meters apart

average of more than 700 well spaced secondary structure trees/ha $\geq$ 6.0 m tall, the area is considered to have an adequate stocking density of suitable secondary structure.

If the surveyed area has an average of less than 700 well spaced suitable secondary structure trees/ha $\geq$ 6.0 m. tall, the average number of well spaced suitable secondary structure trees/ha $\geq$ 6.0 m tall should be added to the average number of well spaced suitable secondary structure trees/ha $\geq$ 4.0 m. tall to determine if there are more than 900 well spaced suitable secondary structure trees/ha $\geq$ 4.0 m. tall. If there is an average of more than 900 well spaced suitable secondary structure trees/ha $\geq$ 4.0m tall, the area is considered to have an adequate stocking density of suitable secondary structure.

If the surveyed area has an average of less than 700 well spaced suitable secondary structure trees/ha $\geq$ 6.0 m. tall and less than 900 well spaced suitable secondary structure trees/ha $\geq$ 4.0 m. tall, there would be no legal requirement to protect the secondary structure on the area unless $\geq$ 5 ha areas containing an adequate stocking density of suitable secondary structure can be stratified out of the larger area.

Attached in Appendix A, is an example card format for recording Secondary Structure information (developed by Fort St. James staff)
If you require additional information please contact Kevin Astridge at 250 387-8909 or Dave Weaver at 250 387-4768.

Appendix A – Example Card Format for recording Secondary Structure (origin Fort St. James staff 2012)

Secondary Stand Structure Plot Card	Surveyor Name	Survey Date Y / M/ D / /	Page of
Licensee: Licence No.:	Cutting Permit:	Block:	Plot Radius:

Plot # & location UTM or Lat\Long	Live Trees ≥4m (species)			≥12.5cm dbh Layer 1 in plot (species)			Well Spaced (1.6m) live trees ≥4m tall			Well Spaced (1.6m) live trees ≥6m tall			Comments
	Total	Sx		Total	Sx		Total	Sx		Total	Sx		
		Fdi			Fdi			Fdi			Fdi		
		Pli			Pli			Pli			Pli		
		Bl			Bl			Bl			Bl		
	Total	Sx		Total	Sx		Total	Sx		Total	Sx		
		Fdi			Fdi			Fdi			Fdi		
		Pli			Pli			Pli			Pli		
		Bl			Bl			Bl			Bl		
	Total	Sx		Total	Sx		Total	Sx		Total	Sx		
		Fdi			Fdi			Fdi			Fdi		
		Pli			Pli			Pli			Pli		
		Bl			Bl			Bl			Bl		
	Total	Sx		Total	Sx		Total	Sx		Total	Sx		
		Fdi			Fdi			Fdi			Fdi		
		Pli			Pli			Pli			Pli		
		Bl			Bl			Bl			Bl		
	Total	Sx		Total	Sx		Total	Sx		Total	Sx		
		Fdi			Fdi			Fdi			Fdi		
		Pli			Pli			Pli			Pli		
		Bl			Bl			Bl			Bl		
	Total	Sx		Total	Sx		Total	Sx		Total	Sx		
		Fdi			Fdi			Fdi			Fdi		
		Pli			Pli			Pli			Pli		
		Bl			Bl			Bl			Bl		
	Total	Sx		Total	Sx		Total	Sx		Total	Sx		
		Fdi			Fdi			Fdi			Fdi		
		Pli			Pli			Pli			Pli		
		Bl			Bl			Bl			Bl		
	Total	Sx		Total	Sx		Total	Sx		Total	Sx		
		Fdi			Fdi			Fdi			Fdi		
		Pli			Pli			Pli			Pli		
		Bl			Bl			Bl			Bl		
Total													

Appendix B ***SECONDARY STRUCTURE DAMAGE CRITERIA FOR EVEN-AGED CONIFEROUS TREES (version 2).***

LOCATION OF DAMAGE	TYPE OF DAMAGE	TREE BEING ASSESSED IS UNACCEPTABLE IF:	HOST SPECIES	LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES	COMMENTS
STEM	**Wound** (including sunscald and girdling)	• the tree has a girdling wound which is greater than 33% of the stem circumference, or • the tree has a wound which is equal to or greater than 1m in length.	All	**Biotic causes**: bear AB, cattle AC, hare AH, moose AM, porcupine AP, squirrel AS, beaver AZ, atropellis canker DSA **Abiotic causes**: sunscald NZ, logging TL, mechanical TM,fire NB, windthrow NW	A **wound** is defined as an injury in which the cambium is dead (e.g., sunscald) or completely removed from the tree exposing the sapwood. Measure the wound across the widest point of the exposed sapwood (or dead cambium when the tree is damaged by sunscald). Healed over wounds (=scars) are acceptable.
STEM	**Insect mining at root collar**	• the tree is currently attacked by a bark-mining insect such as a weevil or a beetle and exhibits symptoms such as foliage discoloration, thinning and/or reduced height growth increments	Pl, Sx	root collar weevil IWW, red turpentine beetle, IBT, lodgepole pine beetle IBL	Only trees that are symptomatic should be checked for insect infestation or mining damage. Non-symptomatic trees are presumed to be unaffected by insect mining.
STEM	**Deformation** (including crook, fork, browse, and dead or broken top)	• the pith is horizontally displaced more than 30 cm from the point of defect and originates above 30 cm from the point of germination, or	All	**Biotic causes**: Bear AB, cattle AC, deer AD, elk AE, moose AM, defoliators ID, spruce leader weevil IWS, lodgepole pine terminal weevil IWP, sequoia pitch moth ISQ, **Abiotic causes**: frost NG, hail NH, snow NY, drought ND, logging TL, mechanical TM, Deep planting TP	For **horizontal displacement** see Figure 1.
		• the tree has a fork in the lower 2/3 of the stem and the smaller of the stems is >¼ the diameter of the main stem, or	All		For **forking**, see Figure 2.
		• the tree has a dead or broken top at a point that is >5 cm in diameter.	All		
STEM	**Lean and sweep**	• the tree leans >30° from the vertical with or without growth correction (sweep)	All	flooding NF, snow NY, slides NS, wind NW, mechanical TM	
STEM	**Suppressed**	• the tree has a height to diameter ratio > 100 • or, tree has < 20% Live Crown	All (except Pli)	Suppressed light environment, leading to high potential for competition induced mortality VT	**Note:** Only trees that are clearly not expected to reach rotation should be deemed unacceptable
		• height to diameter ratio >80 • or tree has <30% live crown • or leader growth <15 cm	Pli L1 Subcanopy & L2 & L3		
		• the tree has a height to diameter ratio > 100 • or tree has <10% live crown	Pli Layer 1 Canopy >10 m^2		
STEM	**Infection** (including cankers and galls)	• any infection occurs on the stem, except DSG	All	comandra blister rust DSC, stalactiform blister rust DSS white pine blister rust DSB, western gall rust DSG,	**Note**: Wounds caused by rodent feeding around rust cankers should have stem rust recorded as the causal agent.
		• DSG stem gall affects >25% of stem circumference	Pl, Py		

LOCATION OF DAMAGE	TYPE OF DAMAGE	TREE BEING ASSESSED IS UNACCEPTABLE IF:	HOST SPECIES	LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES	COMMENTS
STEM	**Bark mining**	• Any of the following signs are visible: pitch tubes, boring dust, exit holes on bark surface, galleries under the bark	Pl, Sx, Fd	Douglas-fir beetle IBD, mountain pine beetle IBM, spruce bark beetle IBS, Ips pini IBI, *Pityogenes* & *Pityophthorus* IBP	**Note:** pitch tubes can be associated with trees that have successfully repelled bark beetles, bark must be removed above pitch tube to confirm successful attack (successful galleries will be filled with frass and **not** pitch, contain adult beetles and/or larval galleries). Stressed trees are susceptible to secondary bark and twig beetles.
BRANCH	**Infection** (cankers)	• an infection occurs on a live branch less than 20 cm from the stem.	Pw, Pl, Py	white pine blister rust DSB, comandra blister rust DSC, stalactiform blister rust DSS	
BRANCH	**Gouting**	• any adelgid **gouting** occurs on a branch.	Ba, Bg, Bl	balsam woolly adelgid IAB.	**Gouting** is defined as excessive swelling of a branch or shoot caused by balsam woolly adelgid, and is often accompanied by misshapen needles and buds. It is most common on branch tips and at nodes near the ends of branches. Consult a recent distribution map to identify the geographic extent of this pest.
FOLIAGE	**Dothistroma**	• > 50% of tree foliage has been removed by Dothistroma in ICH, CWH, and SBS biogeoclimatic zones.	All P	Dothistroma needle blight, DFS	See Figure 3
FOLIAGE	**Douglas-fir tussock moth and hemlock looper**	• >60% of tree foliage has been removed due to hemlock looper of Douglas-fir tussock moth.	Fd, Hw	Douglas-fir tussock moth (IDT), hemlock looper (IDL)	
FOLIAGE	**Other defoliating insects and disease**	• >80% of tree foliage has been removed due to foliage disease.	All other conifers Note: Lw	foliage diseases DF, defoliating insects ID	Note: Lw is a deciduous tree so defoliation has less impact, Repeated defoliation attacks will result in dead branches, apply the >80% rule to obviously dead branches, not just defoliated branches as with other conifer species See Figure 3
FOLIAGE	**Elytroderma needle cast systemic infection**	• The top 2/3's of the tree is affected and the growth is clearly stunted.	Pl, Py	Elytroderma needle cast DFE	Note: To confirm infection the surveyor must observe signs of the pathogen as small dark streaks on dead foliage
STEM OR BRANCH	**Dwarf mistletoe infection**	• Any layer 1 and 2 tree with a Hawksworth rating >3 (Figure 4). • any infection occurs on the stem or a live branch of layer 3 trees. • a susceptible tree is located within 10 m of an overtopping tree, which is infected with dwarf mistletoe.	Hw, Pl, Lw, Fd	Douglas-fir dwarf mistletoe DMF,hemlock dwarf mistletoe DMH, larch dwarf mistletoe DML, lodgepole pine dwarf mistletoe DMP,	**Note:** To confirm infection, the surveyor must observe mistletoe aerial shoots or basal cups on regeneration or on live or dead fallen brooms. **Overtopping tree** is a tree that is in an overtopping layer.

LOCATION OF DAMAGE	**TYPE OF DAMAGE**	**TREE BEING ASSESSED IS UNACCEPTABLE IF:**	**HOST SPECIES**	**LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES**	**COMMENTS**
ROOTS	**Root disease**	• sign(s) or a definitive combination of symptoms of root disease are observed.	All	armillaria root disease DRA, blackstain root disease DRB laminated root rot DRL, annosus root disease DRN tomentosus root rot DRT,	**Signs** are direct evidence of the pathogenic fungus including fruiting bodies, distinctive mycelium or rhizomorphs. **Symptoms** include foliar chlorosis or thinning, pronounced resin flow near the root collar, reduced recent leader growth, a distress cone crop, and wood decay or stain. An individual symptom is not sufficient to identify a root disease.
		• infected tree found in plot. See comments for well-spaced tree net down calculation. The multiplier for all root disease infected trees is 1.	All	armillaria root disease DRA,	**Note:** All conifer species are considered susceptible. All broadleaf species are considered **not susceptible** for survey purposes only.
			Fd, Bg,Hw,Sx, Se, Lw	laminated root rot DRL.	**Note:** Cw, Pl, Pw, Py, and all broadleaf species are considered **not susceptible** for survey purposes only.
			Fd, Pl, Pw, Sx	black stain root disease DRB.	**Note:** All other conifers and broadleaf species are considered **not susceptible** for survey purposes only
			Se, Sx, Fd, Pl	tomentosus root rot DRT.	**Note:** Bg, Bl, Cw, Cy, Pw, Py, and all broadleaf species are considered **not susceptible** for survey purposes only.
			Ba, Hw, Ss, Fd	annosus root rot DRN	**Note:** Cw, Cy, Pw, Pl, Py, and all broadleaf species are considered **not susceptible** for survey purposes only.
				. .	**Example:** How to apply net down for all root diseases. If root disease-infected trees are found in the plot: 1. In the first sweep, determine the total number of healthy, well-spaced trees using the prescribed minimum inter-tree distance (MITD) (e.g., 12 trees); 2. In a second independent sweep, determine the number of well-spaced **infected** trees using MITD (e.g., 1 infected tree); 3. From the number of **susceptible** healthy well-spaced trees found in step 1, subtract the **number of well spaced infected trees.** The result (e.g., 11 trees) is the adjusted number of healthy, well-spaced trees tallied for the plot. . .

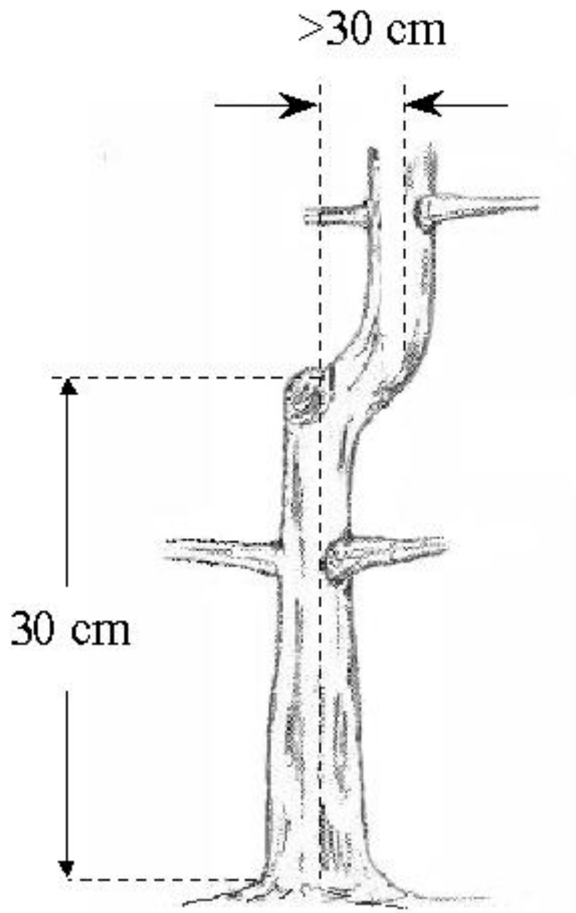


Figure 1. Determining horizontal displacement when assessing stem deformation. This is only done when the tree has five seasons' growth after damage occurs.

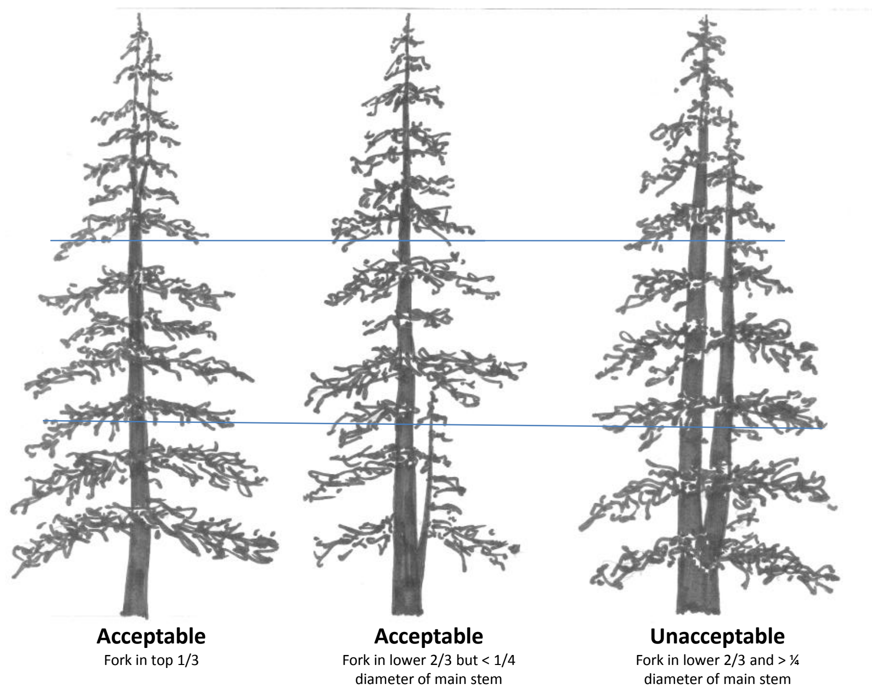
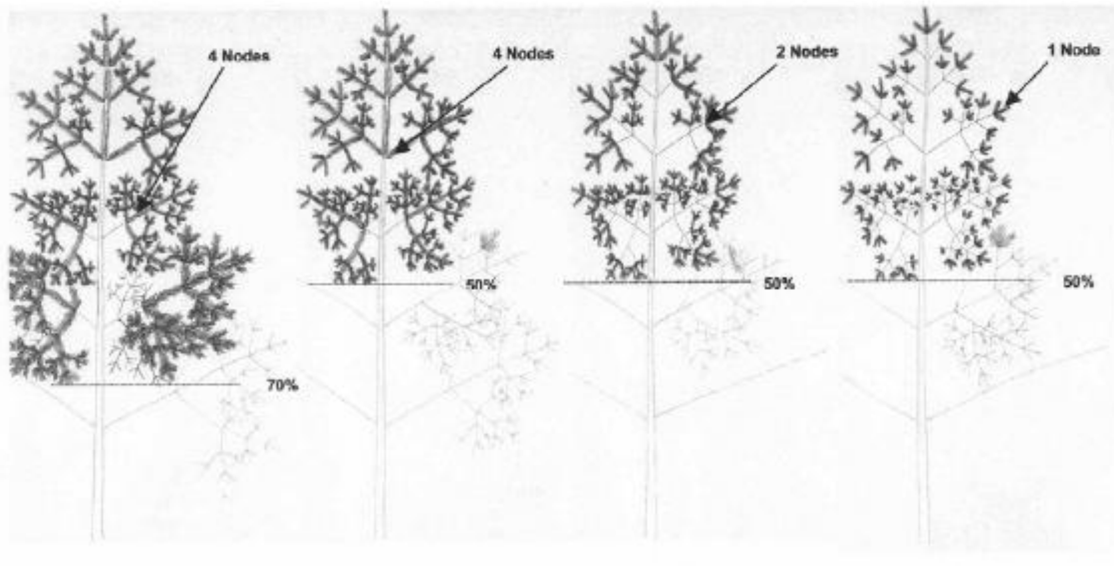


Figure 2. Acceptable and unacceptable forking in age class 2 & 3 conifers.



a)
70% Live Crown
4/4 Healthy Nodes
70% X 100%
= 70%

b)
50% Live Crown
4/4 Healthy Nodes
50% X 100%
= 50%

c)
50% Live Crown
2/4 Healthy Nodes
50% X 50%
= 25%

d)
50% Live Crown
¼ Healthy Nodes
50% X 25%
= 12.5%

Figure 3. Calculating defoliation for Dothistroma-afflicted conifers.

Instructions

Step 1 Divide live crown into thirds.

Step 2 Rate each third separately. Each third should be given a rating of 0, 1, or 2 as described below:

(0) no visible infections

(1) light infection (1/2 or less of total number of branches in the third infected

(2) heavy infection (more than 1/2 total number of branches in the third infected).

Step 3 Add ratings of thirds to obtain rating for total tree.

Example

If this third has no visible infections, its rating is (0).

If this third is lightly infected, its rating is (1).

If this third is heavily infected, its rating is (2).

The tree in this example gets a rating of: 0 + 1 + 2 = 3.

Figure 4. The Hawksworth six-class dwarf mistletoe rating system.

Definitions

basal resinosis (pitching): copious exudation of pitch at the base of the stem at or below the root collar. This symptom often is associated with armillaria root disease or attack by Warren's root collar weevil.

decay: the disintegration of plant tissue. The process by which sound wood is decomposed by the action of wood-destroying fungi and other microorganisms.

fork: two or more leaders have originated from the loss of a leader or apical shoot. At free-growing age, a fork is considered persistent if it has not differentiated in height between competing leaders by more than 5 cm after five years of growth since the leader damage occurred. Forks may provide entry points for decay fungi, are points of weakness during felling, and may create waste in the highest value first log.

gall: nodule or lump of malformed bark or woody material caused by a variety of damaging agents, such as western gall rust and some insects.

gouting: excessive swelling of a branch or shoot, often accompanied by misshapen needles and buds. Most common at nodes on branches and frequently caused by balsam woolly adelgid on true firs (*Abies* spp).

Height to diameter ratio: height in meters divided by dbh in meters.

infection: characterized by a lesion or canker on stem or branches or by swelling around the entrance point of a pathogen.

injury: damage to a tree by a biological, physical or chemical agent.

scar: a wound completely healed-over by callus tissue

wound: an injury where cambium is dead (e.g., sunscald) or completely removed. Wounds often serve as entry points for decay fungi