Northern Interior Forest Region (East) **Province of British Columbia Ministry of Forests & Range** **Standard Operating Procedure** Number: 10-2	SUBJECT: Ground detection and assessment procedures for mountain pine beetle, *Dendroctonus ponderosae* Hopkins, and Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins in the Northern Interior Forest Region (East)	
	CHAPTER 10	MANUAL Res. Mg't Policy Manual SECTION 10.2

Purpose:

To establish uniform procedures for ground detection and assessment of damage by mountain pine beetle, *Dendroctonus ponderosae* (MPB) and Douglas-fir beetle, *Dendroctonus pseudotsugae* (DFB) in the Northern Interior Forest Region (East) (see SOP 10.1 for spruce beetle ground detection procedures). Depending on the method employed (below), these procedures will enable surveyors to determine: 1) the location and status of individual attacked trees in patches, 2) the location (area, boundary, and pattern) of the beetle attack across a stand, 3) the percent and intensity of attack in the past 3 years, and 4) the stand structure and potential for management options. Walkthroughs or probes as described herein are the recommended ground survey procedures for determining MPB and DFB attack densities. **These procedures should not be conducted in conjunction with timber cruises nor should timber cruising precede at least a general walkthrough.** Timber cruisers may not be sufficiently experienced in beetle ground surveys, and beetle attack data from cruise plots is not detailed enough for proper beetle management planning.

I. Definitions:

Walkthrough for Tree Marking - a **detailed** ground reconnaissance conducted by an **experienced** beetle surveyor in order to determine **precise locations of attacked trees** in patches. After aerial observation of discoloured trees, a ground crew usually follows a GPS coordinate to the first mapped location. All attacked trees are mapped and then the crew navigates to the next patch and records it and so on. The objective is to manage beetles by either sanitation harvesting of single trees or small groups of trees by conventional methods or helicopters, use of pheromone baits for MPB, or fall and burn. Such stands, or portions therein, can be typically managed for at least one more year by non-clearcut methods.

General Walkthrough - a **non-systematic** preliminary ground reconnaissance conducted by an **experienced** beetle surveyor in order to determine **rough estimates** of the extent and intensity of beetle attack across the stand prior to the recommendation of any possible tree marking, probing or other management decision. The configuration and extent of general walkthroughs are site-specific decisions usually made by the surveyor. The District may specify a minimum length of probing, e.g., 50 - 100 m, be included from a representative area within the walkthrough boundary. General walkthroughs will most likely be employed in stands where the attack is heavy and more widespread, and thus the entire stand will likely be managed as a unit.

Probe - a systematic and detailed secondary ground reconnaissance conducted by at least a two-person crew, one of which should be sufficiently familiar with beetle biology, identification, and this procedure. Probing will indicate the extent, intensity, vigour, and year(s) of beetle attack. It will also provide additional information on stand species composition, diameter, and general susceptibility. Probe lines are spaced no further than 100 m apart (see pg. 5). Although general walkthroughs are sufficient in most areas, probing is recommended in all **sensitive** areas which may have high wildlife values, aboriginal land claims, high visual quality objectives, or other constraints requiring more detailed and systematic survey information.

Salvage Harvesting: harvesting operations primarily designed to recover timber damaged or degraded by fire, **an old insect attack**, wind, or disease before the potential wood products become unmerchantable. Control of forest health factors such as bark beetles is incidental and is not the primary objective of salvage logging.

Sanitation Harvesting: harvesting operations specifically designed to maximize the extraction of **currently infested** or infected stands in order to reduce the damage caused by forest pests and to prevent their spread. Currently infested lodgepole pine (Pl) or Douglas-fir (Fd) are those which have been attacked by MPB or DFB, respectively, in 2009 on a 1- or 2-year cycle or, on occasion, those attacked in 2008 on a 2-year cycle.

II. Initial Detection (Sketchmapping)

All susceptible Pl and Fd stands are normally aerially sketchmapped before any type of walkthroughs are undertaken. Since foliage of attacked Pl and Fd can take 7-9 months to fade and become noticeable from the air, sketchmapping in late summer or early fall merely maps trees attacked the previous year and is a starting point from which walkthroughs are planned. Hazard rating of Pl and Fd stands are described in the *Bark Beetle Management Guidebook*. Hazard rating for Fd can result in a misleading low factor if a few veteran, highly susceptible Fd comprise a minor component in a PlFd or Pl(Fd) stand. Sketchmapping will provide preliminary information contained in Table 1.

Table 1. Preliminary Information from Sketchmapping

Sketchmapping Classification	Percent "Discoloured" Trees*	Suggested Priorities for General Walkthroughs**
Light	0 - 5	2nd or 3rd
Moderate	6 - 15	1st
Heavy	16+	2nd or 3rd

* based on total stems

** partly based on District's objectives/discretion and stand hazard rating

III. Secondary Detection (Ground Surveys)

A. Walkthroughs for Tree Marking simply record the location and status of attacked trees in patches and are nothing more than marking trees for single tree treatment or small-patch sanitation and/or salvage harvesting. Once patches of "discoloured" Pl or Fd crowns are mapped from aerial sketchmapping, photographs, or global positioning satellite (GPS) equipment, a compass line is run towards the patch but through the most susceptible timber type(s). Wherever infested trees (normally only codes 1 & 2) are encountered on a survey line, a new patch infestation search is undertaken. Starting at an arbitrary "centre" of the patch, all susceptible hosts within 50 m of this are examined and, if necessary, coded for beetle attack, mapped, and spray painted for single-tree treatment or removal. If single tree treatment of infested trees is the objective, normally only successfully-attacked code 1 & 2 trees require coding, mapping, and marking. If further infested trees are found within the 50 m zone, the infestation centre is extended, and a further 50 m zone is examined. This process continues until no further infested trees are found. If desirable, uninfested trees can be blazed with a hatchet and/or spray painted with a different colour so they are not inadvertently re-examined by one or more different crew members.

Walkthrough for Tree Marking contracts will specify colours for flagging tape and tree marking paint, mapping scales (e.g., 1:5,000), and other reporting requirements as outlined in the Mapping section on page 14.

B. General Walkthroughs will determine **rough estimates** of:

1) the **size** (ha), **boundary**, and **pattern** (spatial distribution) of the infestation across a stand;
2) the **incidence and severity** of the infestation as measured by:
   -the percentage of Pl and Fd attacked in the last 3 years, i.e., 2009, 2008, and 2007 (or previous); and
   -the beetle attack densities on Pl and Fd and the success and vigour of the new MPB broods as measured by a few random phloem samples (pg. 9);
3) **stand hazard** (or susceptibility) **and risk** (of further attack) can be calculated if 10-20 special prism plots are established in conjunction with this survey (see Bark Beetle Management Guidebook);
4) **access, operability**, and **integrated resource management issues**;
5) a **sanitation and salvage harvesting priority rating** (pg. 13); and
6) the **necessity to obtain further information or take other action** as detailed below.

Based on a general walkthrough, the surveyor will classify the area/stand and recommend one of the 3 broad options in column 3 of Table 2

Table 2. MPB & DFB Management Options After General Walkthroughs[a]

Walkthrough Classification	Sanitation Harvest Rating[b]	Beetle Management Recommendations[c]
Light	0 - 599	**Leave** (monitor, baits, trap trees, etc..)
Moderate	600 - 999	**Walkthrough for Tree Marking** or **Probe** (to obtain more detailed information)
Heavy	1000+	**Recommend Operational Cruising** (prior to expeditious sanitation/salvage logging)[d]

[a] See top of page 5 for Table footnotes

Footnotes for Table 2 on page 4

[b] See formula in Table 6 (pg. 14) which mainly weights 2009-attacks (2008- or older attacks are a minor consideration).

[c] All recommendations must consider access and integrated resource management issues. The precise thresholds for management action may vary by District or even by operating areas within a District (see *Bark Beetle Management Guidebook* for further information).

[d] Assuming road access exists or could be in the near future.

C. Probing will determine **detailed estimates** of:

1) the **size** (ha), **boundary**, and **pattern** (spatial distribution) of the infestation;
2) the **incidence and severity** of the infestation as measured by:
   -the percentage of Pl or Fd attacked in the last 3 years, i.e., 2009, 2008, and 2007 (or previous); and
   -the attack densities and success of the attacking beetles and the vigour of the new broods as measured by a series of phloem samples (pg. 9);
3) **stand hazard** (or susceptibility) **and risk** (of further attack) can be calculated if 10-20 special prism plots are established in conjunction with this survey (see Bark Beetle Management Guidebook);
4) **access, operability**, and **integrated resource management issues**; and
5) a **sanitation and salvage harvesting priority rating** (pg. 13); and
6) the necessity for possible **beetle management action** within the stand.

If probing is recommended after general walkthroughs (from Table 2), then delineated stands will be grid-probed via systematic parallel probe lines consisting of 10 m-wide strips (5 m on each side of centre line) and spaced 100 m apart (Fig. 1). All trees greater than 12.5 cm dbh for Pl and 17.5 cm for Fd within the 10 m-wide strip will be recorded within one of the existing diameter classes on the *Beetle Probe Card* (*FS 1111a*) (Fig. 1 - example). As information will be summarized by 100 m long strips, all probe lines should be run to the nearest 100 m.

All beetle-attacked trees will be recorded as codes 1-6 as per the *Regional Bark Beetle Codes* summarized in Table 3 and recorded on the *F.S. 1111a* in numerical form (Fig. 2). As necessary, probers should remove a

Figure 1. Layout of MPB or DFB Probe Lines (Sampling Units and Pixels)

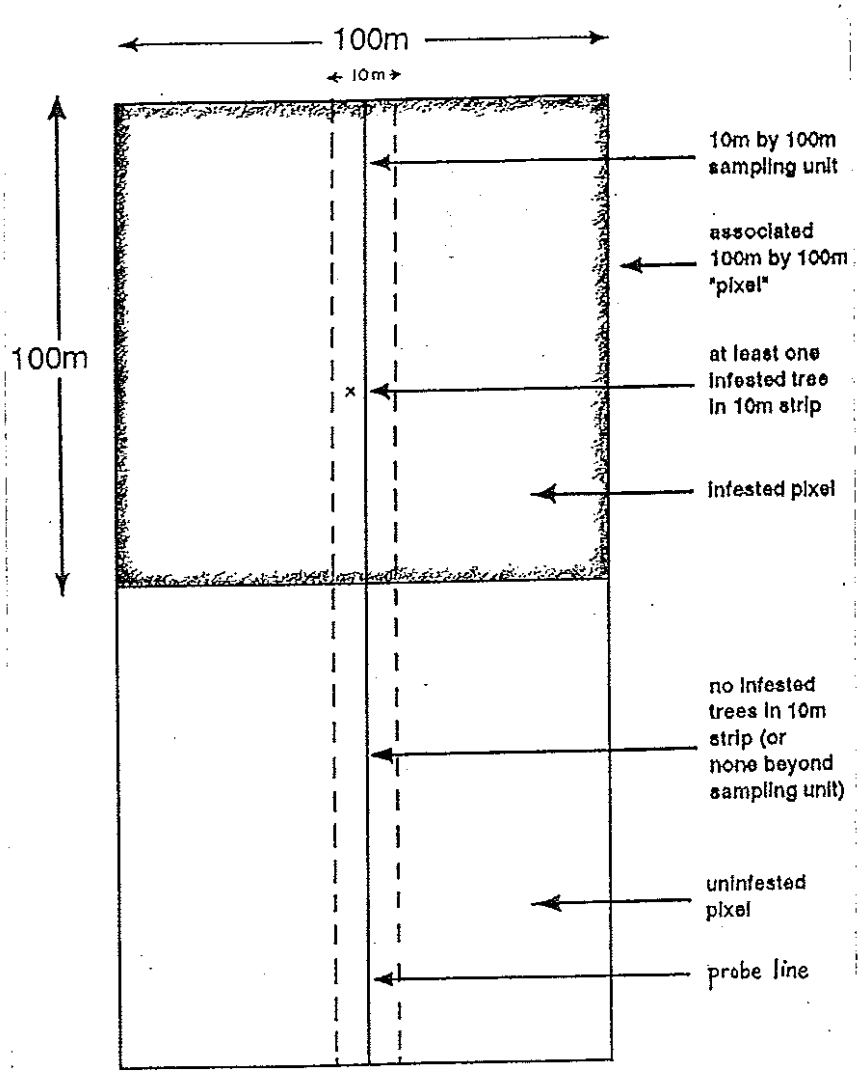


Table 3. Bark Beetle Codes for MPB & DFB[a]

Code no.	Year of attack	Year[b] and type of attack
1	Most recent	2009 - Full
2	Most recent	2009 - Strip
3	Second recent	2008 - Full
4	Second recent	2008 - Strip
5	Third recent	2007 - Full
6	Third recent	2007 - Strip

[a] a complete summary of the signs and symptoms of attack for each code is available from the Regional Forest Entomologist.

[b] fill in the appropriate years of attack in the blank lines as illustrated. They will always be in pairs for the past 3 years of attack.

Figure 2. Beetle Probe Card (*FS 1111a*) with filled in example.

BRITISH COLUMBIA **BEETLE PROBE CARD**

LOCATION	ELEVATION	LATITUDE	PAGE	OF
Chilko R. north helispot	1150 m	53°	1	3

BEARING	STRIP LINE NO	STRIP WIDTH	DISTANCE	BEETLE SPECIES
245°	3	10 m	0-100 m	☐ SB ☒ MPB ☐ DFB

DIAMETER CLASS	SURFACE AREA FACTOR	NUMBER OF HEALTHY HOSTS	BARK BEETLE CODE BY YEAR OF ATTACK						OTHER TREE SPECIES	
			1	2	3	4	5	6	MAIN	OTHER
									S	A
12.5 - 17.4	2.0	1							1	
17.5 - 25.0	3.3	2							3	
25.1 - 30.0	5.3	3		1					3	1
30.1 - 35.0	7.1	3	⊙						☒	1
35.1 - 40.0	9.4	☐	1	2	2	1			2	2
40.1 - 45.0	11.6	☒ 1	2		2	⊡	1		2	2
45.1 - 50.0	13.8	☐	2	1	2		1		1	3
50.1 - 55.0	16.2	2	△		1		2		1	3
55.1 - 60.0	18.7	3	▽				1			1
60.1 -	25.3	1								
TOTALS		44	8	3	8	2	6		27	14

△ BARK SAMPLES 15cm x 15cm	NO. ENTRANCE HOLES	NO. PARENT ADULTS	NO. LARVAE	NO PUPAE	NO. CALLOW ADULTS	FRESH (GREEN) BLOWDOWN	
						Attacked	Unattacked
1a	2	3	☒☐				
1b	2	2	☒ 2				

COMMENTS
⊙ = pitchout
▽ = 2-year cycle
⊡ = also code 2

CREW NAMES	DATE Y	M	D
Bill Jones + Mary Smith	09	11	10

FS 1111A RPG 00/02 7530981049 (100/bd)

small portion of phloem from infested trees within their 10 m strip to ensure coding accuracy. All attacked trees will also be mapped on the *Compass and Traverse Sheet* (*F.S. 375*) or similar (Fig. 3 - example) which will accompany the completed *FS 1111a.*

Unless footnoted to the contrary in the comments section on the *FS 1111a*, it is assumed that beetle attacks on individual trees are: successful, on a 1-year cycle, and have occurred in 1 year. Any variances to these most common conditions can be recorded by encircling the coding dots on the *FS 1111a* and *FS 375* with a symbol as listed in Table 4 and depicted in Fig.'s 2 & 3.

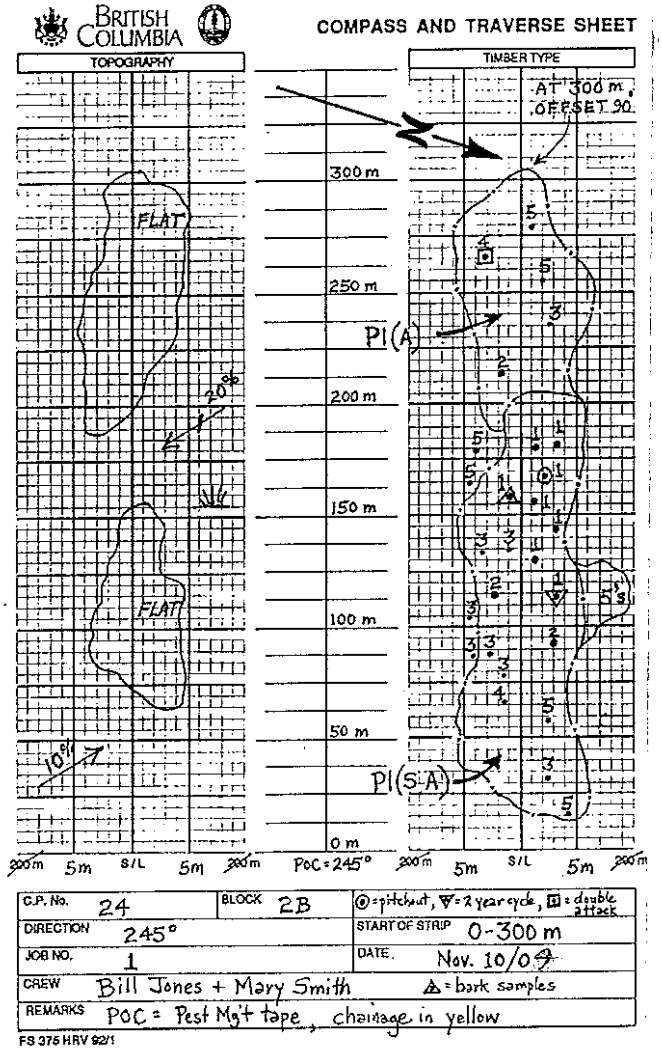
Table 4. Symbols to Footnote Variances in Common Beetle Attack Conditions

Condition	Symbol
Pitch Out	O
2-Year Cycle	∇
Double Attack	ρ

Trees that are "double-attacked " (attacked in 2 consecutive years) are always coded on the *FS 1111a* and depicted on the *FS 375* by the first year of attack and footnoted with the square symbol (ρ) (Fig.'s 2 & 3).

To determine relative beetle attack densities and brood densities between areas during probing, a total of 20 **most-recently attacked** Pl or Fd (i.e., 2009-attacks based on the current date) must be sampled per area/stand. Ideally, one tree should be sampled approximately every 200 m along the probe line within infestations. At each sample tree, two 15 cm x 15 cm (225 cm^2) bark samples are removed at dbh; one from the north side and one from the south and the appropriate information tallied as depicted in the lower portion of the *FS 1111a* (Fig. 2). In large diameter Fd stands having very thick bark, it may be easier to estimate the number of entrance holes based on the number of egg galleries that originate in the sample. All sample trees must also be clearly delineated (e.g., by an upright triangle) on the F.S. 375 (Fig. 3) and FS1111a (Fig. 2). While some of these samples will undoubtedly be "clumped" (e.g., 5 trees within 300 m), the overall objective is to obtain a relative comparison of beetle attack densities (for Pl and Fd) and brood densities (for Pl only) between areas/stands probed. A few such samples should also be taken during general walkthroughs. Bark sample data also provides a key bark beetle coding check for probing supervisors and Forest Service and Licensee field monitors. Table 5 can be used to rate the mean beetle attack densities and larval densities between areas probed in order to further

Fig. 3. The Compass and Traverse Sheet (*F.S. 375*) with filled in example



rank sanitation logging priorities.

Table 5. MPB and DFB Attack Densities and MPB Larval Density Ratings

Mean no. entrance holes per 225 cm² phloem sample*	Mean attack density	Mean no. living MPB larvae per 225 cm² phloem sample*	Mean larval density
< 1	low	< 4.9	low
1.0 - 1.9	moderate	5.0 - 14.9	moderate
2.0 - 3.9	high	15.0 - 24.9	high
> 3.9	severe	> 24.9	severe

* Assumes samples taken from Sept. 15 - March 31 from a population in the first fall/winter of a 1-year cycle

i) Probe Line Delineation

The initiation and termination of all probe lines should be clearly marked with highly visible flagging tape which indicates:

1) the geographic location, unit number, and probe/strip line number, e.g., *Dust Cr., Probe A, SL #4;*
2) the "point-of-commencement" (*P.O.C*) or "point of termination" (*P.O.T.*) and bearing, e.g., *P.O.C. - 260°*; and
3) the crew number/name and date, e.g., *Crew #3, Nov. 15/09*

Along the length of the probe line, flagging tape should be hung at appropriate intervals (approximately every 30-50 m) indicating the bearing so that anyone standing anywhere on the line at a later date can follow it without using a compass or GPS unit. Every 100 m interval along the line should be marked with different or longer flagging tape, e.g., *0 + 100 m.* Wherever the crew changes direction, offset bearings and distances must also be clearly indicated by flagging tape, e.g., *0 + 500 m, offset 90° + 100 m.*

ii) Probe Data Calculations and Summarization

Beetle code data collected on the *F.S. 1111a* must be multiplied by the corresponding "*mean surface area (of bark) per m²*" (*S.A.* factor) (*Fig. 2*, column 2) (for strip-attacks, i.e., codes 2, 4, & 6, use 0.5) and the products transposed to the *Beetle Infestation Summary Sheet* (Table 6 - example). Summarized data will then provide:

1) the proportion of the block infested (based on the number of infested 100 m x 100 m pixels);
2) the percent attack in the past 3 years.

If road access exits into the probed area/stand or a road could be constructed soon, the District should calculate the *Sanitation and Salvage Harvest Priority* (SSHP) value (Table 6 - bottom formula). If *salvage* wood can not be utilized for particular products such as plywood, the second component in the formula can be omitted. The SSHP value must be carefully considered in context with other operational factors and constraints.

On the completion of probing, data from *F.S. 1111a's* and *F.S. 375's* should be summarized by area, stand, or other unit into an appropriate spreadsheet or table to indicate the following minimum information:

1) Contract number (if relevant);
2) Geographic reference, e.g., *Chilako R. north*";
3) Opening number (if available), mapsheet, unit, and block numbers ., e.g., *93-0-11-e, Unit 2e, Block 1*;
4) Names of probers;
5) Date of the probe;
6) Total m probed;
7) Total ha probed;
8) Total no. of healthy Pl or Fd tallied;
9) Total no. of attacked Pl or Fd by beetle codes 1 - 6;
10) Total no. of all Pl or Fd tallied;
11) Percent attack for each beetle code 1 - 6;
12) Percent attack in each of the last 3 years, i.e., for 2009, 2008, and 2007 (from Table 6);
13) Proportion of the block infested (from Table 6);

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Table 6. MPB & DFB Infestation Summary Sheet

DBH Class	Healthy Hosts	2009 1	2	2008 3	4	2007 5	6	Other Species
12.5 - 17.4	2.0							2.0
17.5 - 25.0	6.6							16.5
25.1 - 30.0	15.9		2.65					26.5
30.1 - 35.0	35.5	7.1						78.1
35.1 - 40.0	68.8	9.4	4.70	18.8	4.7			47.0
40.1 - 45.0	127.6	23.2		34.8	5.8	11.6		46.4
45.1 - 50.0	96.6	27.6	6.90	27.6		13.8		69.0
50.1 - 55.0	48.6	16.2		16.2		48.6		64.8
55.1 - 60.0	74.8	18.7				18.7		18.7
60.1 +	25.3							
Totals	a 498.7	b 102.2	c 14.25	d 97.4	e 10.5	f 92.7	g	h 369

STEPS

1. Proportion of Block Attacked = $\frac{\text{No. of Attacked Pixels}}{\text{Total No. of Pixels in Survey}}$

2. Percent attack assumes 90-95% of beetles are/were on a 1-year life cycle.
   - The results from all attacked pixels should be used.
   - The number of code 1, 3, & 5 trees on the Beetle Prober Card should be multiplied by the SAF**
     For codes 2, 4, & 6 use 0.5 (which represents approximately half of a tree). Transfer the products of the multiplication to the individual code columns by diameter class on the above infestation summary sheet.

   - % 2009 Attack = $\frac{102.2 + 14.25}{815.75}$ x 100 = *14.3%*
   - % 2008 Attack = $\frac{97.4 + 10.5}{815.75}$ x 100 = *13.2%*
   - % 2007 Attack = $\frac{92.7 + 0}{815.75}$ x 100 = *11.4%*
   - % Host in Stand = $\frac{815.75}{1184.75}$ x 100 = *68.9%*

Sanitation & Salvage Harvesting Priority Rating (calculate if required by the District)

$$\left(\%\,2009 + \frac{\%\,2008}{2} + \frac{\%\,2007}{3}\right) \times \%\ \text{Host} = _____$$

$$\left(14.3 + \frac{13.2}{2} + \frac{11.4}{3}\right) \times 68.9 = 1701.8$$

* For lodgepole pine only

** Surface area factor (mean area per diameter class)

14) Mean attack density for MPB or DFB and mean larval density for MPB (from Table 5);
15) Percent Pl or Fd in the stand; and
16) Percent other conifers by species.

iii) Mapping

An appropriate 1:10,000 scale summary forest cover map for each probed area/stand must also be included which contains:

1) a 10,000 map scale and north arrow;
2) an opening number or unit and mapsheet number which matches the spreadsheet data;
3) clearly plotted probe lines with UTM coordinates tied into a physical feature indicating *P.O.C.'s, P.O.T.'s*, strip line numbers, bearings, and distances;
4) from probing: a colour stratification of infested areas (by stems/ha, polygon, or sub-polygon) into 3 categories of combined 2009 + 2008 attacks:
   - light - 0 - 5%
   - moderate - 6 - 9%
   - heavy - 10% +
5) a 4-character label must be added to the attacked map polygon indicating the percent attack in the past three years and the percent Pl or Fd (healthy plus attacked) in the stand, i.e., *5,8,6,70* in a MPB attacked Pl stand equates to a 5% attack in 2009, 8% in 2008, 6% in 2007 (or previous), and 70% Pl; and
6) as a contract option, all adjacent DFB trap trees, baited and/or single-tree treated Pl, and recent Fd blowdown can also be included on the map as per Ministry of Forests cartographic standards.

iv) Additional Probe Information

Further information can also be specified depending on District/Licensee requirements and the experience of the probing crew and their consulting company, and can include:

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1) topography and operability for winter or summer logging;

2) integrated resource management concerns such as riparian zones, wildlife habitat, landscape values, etc..

3) vigour of the beetle population considering its:
- possible origin and attack history in the stand;
- potential for spread considering host susceptibility, physical tree damage, the next major flight, and the percent 1- and 2-year cycle beetles; and
- impacts of woodpecker activity, host resistance, weather, and other population limiting factors.

4) site specific recommendations for MPB or DFB management such as:
- sanitation logging (clearcut, group selection, diameter limit, and single tree "snip and skid");
- DFB conventional trap trees or MPB lethal trap trees;
- semiochemical grid-baiting or patch-baiting of standing trees;
- utilization and remedial actions required for hazard reduction (e.g., low stumps and blowdown extraction for DFB); and
- further detection requirements, e.g., walkthroughs for tree marking.

Acting as the Regional Executive Director
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