



SPRUCE BEETLE GROUND SURVEY GUIDELINES

OMINECA & NORTHEAST REGIONS

B.C. MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS

Purpose:

To establish uniform procedures for ground detection and assessment of damage by spruce beetle, *Dendroctonus rufipennis*, in the Prince George, Mackenzie, and Dawson Cr. Timber Supply Areas. These procedures will enable surveyors to determine: 1) the location (area, boundary, and pattern) of spruce beetle attack, 2) the percent and intensity of beetle attack in the past 3 years, and 3) the stand structure and potential for management options. Walkthroughs, probes, and a hybrid of both as described herein are the recommended ground survey procedures for determining spruce beetle attack locations and severities. **These procedures should not be conducted in conjunction with timber cruises nor should timber cruising precede at least a walkthrough.** Timber cruisers may not be sufficiently experienced in spruce beetle ground detection, and beetle attack data from cruising is not detailed enough for proper beetle management planning.

Definitions:

Strip Line/Sampling Strip - a 10 m wide x 100 m long (1000 m²) ground survey unit usually extended to the nearest 50 -100 m past the last recorded beetle-attacked spruce. Strip lines are run with all types of ground surveys but the data collected within will vary by the survey method.

Pixel - a 100 m wide x 100 m (10,000 m² or 1 ha) long ground survey unit in which a **strip line** traverses. The strip line is a 10% sample of the pixel and during probes determines if the entire pixel is classified as infested or not infested and to what extent.

Mini-pixel - a 10 m x 10 m (100 m²) ground survey unit that is installed during **hybrid method** ground surveying. This 100 m² sampling unit can represent 10% of a 1000 m² area or 5% of a 2000 m² area.

Walkthrough - a non-systematic preliminary ground reconnaissance conducted by an experienced individual (recommend 2-person crew for safety) in order to determine **rough estimates** of the extent and intensity of beetle attack prior to the recommendation of any possible probing or other management decision. The configuration and extent of walkthroughs are often site-specific decisions made by the surveyor. It may be specified that a minimum length of probing, e.g., 50 - 100 m, be included from a representative area within the walkthrough boundary.

Probe - a systematic and detailed secondary ground reconnaissance conducted by at least a two-person experienced crew. 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. 4). Probing is the recommended method in all moderately-attacked areas and locations which may have sensitive values such as wildlife habitat, First Nations issues, high visual quality objectives, or other values/constraints requiring more detailed and systematic survey information before a management decision can be made.

Hybrid Method - a systematic and partially detailed ground reconnaissance conducted by at least a two-person experienced crew where walkthrough lines are run on a more systematic or grid-like basis but spaced wider than 100 m apart. Where beetle-attacked trees are encountered, the surveyor has the option of establishing a 10 m x 10 m “mini-pixel” in this infested location if it is representative of the stand(s) before moving on and continuing the walkthrough line. The continuing walkthrough can revert to a probe line if required and then revert back to a walkthrough line when suitable.

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

Sanitation Harvesting - logging 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 spruce are those which have been attacked by spruce beetle in 2016 on a 1- or 2-year cycle or those attacked in 2015 on a 2-year cycle.

Phloem Samples - To determine relative beetle attack densities and brood densities between areas surveyed via any of the 3 survey methods, a total of 20 *most-recently* attacked spruce (i.e., 2016-attacks based on the current date) must be sampled per area/stand. On each selected tree, two 15 cm x 15 cm (225 cm²) bark samples are removed at dbh; one from the north side and one from the south and the appropriate information tallied as per the method on pg. 11.

Initial Detection (Sketchmapping)

All susceptible spruce stands are normally aerially sketchmapped before any walkthroughs are undertaken. Since foliage of attacked spruce can often take 13-15 months to fade and become noticeable from the air, sketchmapping merely maps previously killed trees and is a starting point from which walkthroughs are planned. Susceptible spruce stands usually have an average d.b.h. of 41 cm or more with 65% or more of spruce in a well-drained creek bottoms or on low benches. Sketchmapping will provide preliminary information contained in Table 1.

Table 1. Preliminary Information from Sketchmapping

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

* based on total stems

** at each District's discretion

Walkthroughs will determine “**rough**” 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 spruce attacked in the last 3 years, i.e., 2016, 2015, and 2014 (or previous); and
 - the attack densities and success of the attacking beetles and the vigour of the new broods as measured by a few random phloem samples;
- 3) the **risk of beetle spread** within (and to outside) the stand based on stand susceptibility and beetle pressure;
- 4) **access, operability, and integrated resource management issues**;
- 5) a **sanitation and salvage harvesting priority rating** (Table 5, pg. 10); and
- 6) the **necessity to obtain further information or take other action** as detailed below.

Based on walkthroughs or the hybrid method, the surveyor will classify the area/stand and recommend one of the 3 broad options in column 3 of Table 2

Table 2. Spruce Beetle Management Options After Walkthroughs

<u>Walkthrough Classification</u>	<u>Sanit./Salv. Harvest Rating*</u>	<u>Beetle Management Recommendations**</u>
Light	0 - 599	Leave (monitor, trap trees, baits, etc..)
Moderate	600 - 999	Hybrid Method or Probe (to obtain further information)
Heavy	1000+	Recommend Layout for Cruising and expeditious sanitation logging)***

* see formula in Table 5 which mainly weights 2016- and 2015-attacks (2014- or older attacks are a minor consideration).

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

*** assuming road access exists or could be in the near future.

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 spruce attacked in the last 3 years, i.e., 2016, 2015, and 2014 (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;
- 3) **the risk of beetle spread** within (and to outside) the stand based on stand susceptibility and beetle pressure;
- 4) **access, operability, and integrated resource management issues**; and
- 5) a **sanitation and salvage harvesting priority rating** (see Table 5, pg. 10); and
- 6) the necessity for possible **beetle management action** within the stand

A **Hybrid Method** survey will determine information more detailed than a walkthrough but less detailed than a probe but will still provide the following information:

- 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 spruce attacked in the last 3 years, i.e., 2016, 2015, and 2014 (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;
- 3) **the risk of beetle spread** within (and to outside) the stand based on stand susceptibility and beetle pressure;
- 4) **access, operability, and integrated resource management issues**; and
- 5) a **sanitation and salvage harvesting priority rating** (see Table 5, pg. 10); and
- 6) the necessity for possible **beetle management action** within the stand

The intention of the hybrid method is to increase sampling from perhaps 5% coverage obtained from an average walkthrough (depends on size of the stand, number of lines and their spacing) to 10% (equal to a probe) if the 10 m x 10 m “mini-pixel” is an appropriately representative 10% sample of 1000 m². Instead of tallying every tree >17.5 cm dbh in a 10 m x 100 m pixel to help determine stand composition and beetle attack, a surveyor may want to install a mini-pixel to determine the species composition and percent attack by dbh class and then, as the walkthrough continues, simply GPS and record the code of every attacked spruce. In any given stand, surveyors might begin with a walkthrough, revert to a hybrid method and install a mini-pixel, and/or even revert to a probe on a portion(s) of their survey area - all in the same entry without having to return to the site later. Alternatively, surveyors could run all their walkthroughs first as a coarse filter and then only return to those few sites that require the hybrid method or probing.

Figure 1. Layout of Spruce Beetle Ground Survey Lines (Strip Lines and Pixels)

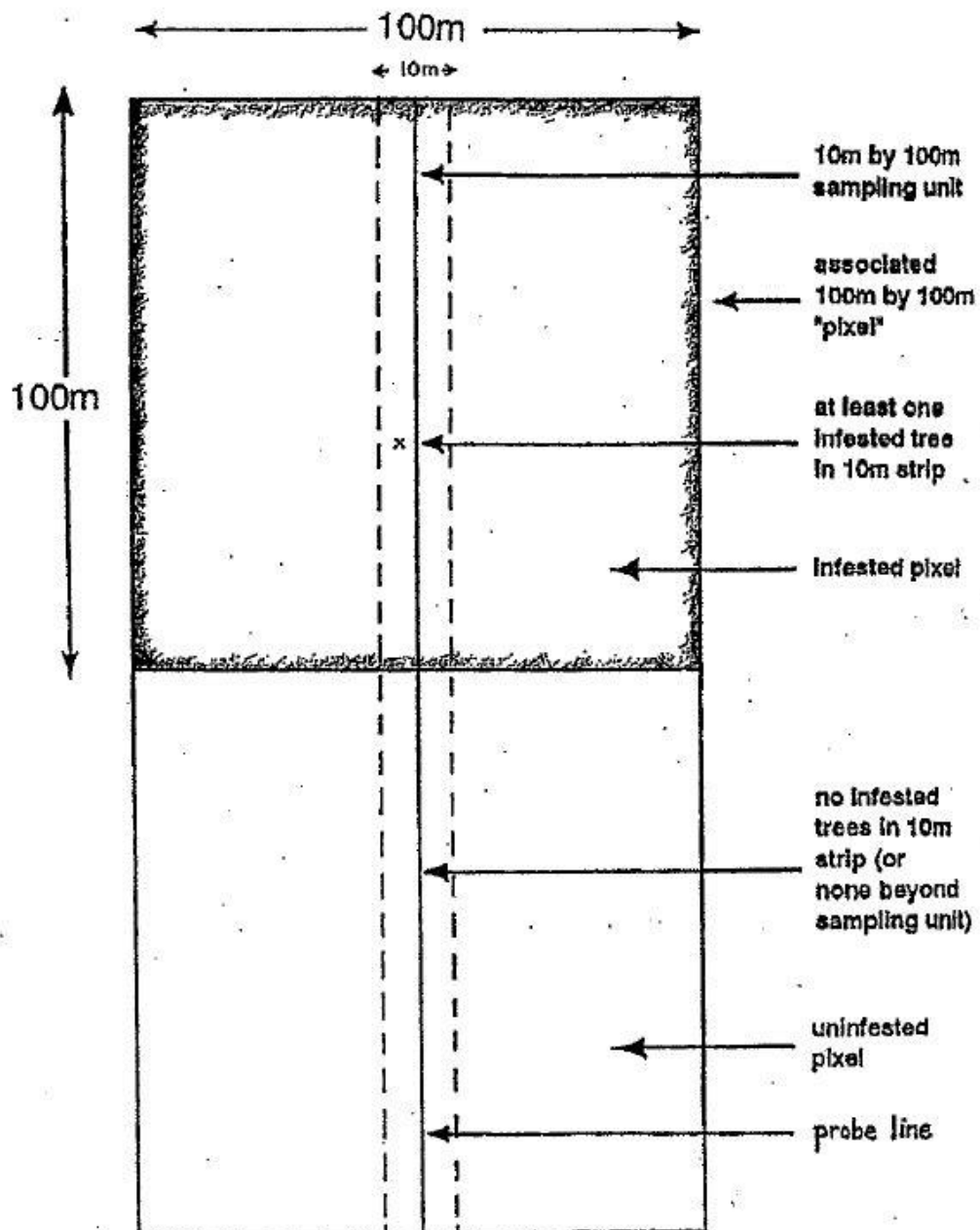


**Figure1: layout of spruce beetle
sampling units and associated pixels**

Figure 2. Spruce Beetle Probe (Ground Survey) Card (FS 1111) with filled in example.

BRITISH COLUMBIA		SPRUCE BEETLE PROBE CARD							
LOCATION <i>Hook Lake</i>		10 U 599584 E 6075671 N							
PAGE 1 OF 3									
BEARING <i>245° SL-1</i>		DISTANCE <i>0-100 m</i>							
STRIP WIDTH <i>10 m</i>									
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	
17.5 - 25.0	3.3	.							B PI
25.1 - 30.0	5.3	..							□
30.1 - 35.0	7.1	..	.						..
35.1 - 40.0	9.4	..	.	.	..	.			☒
40.1 - 45.0	11.6	□	..	.	☐	.	.		☒ ..
45.1 - 50.0	13.8	☒	☉	..	..	.			☒ ..
50.1 - 55.0	16.2	□	.	.		..			..
55.1 - 60.0	18.7	..	.						.
60.1 +	25.3	.							
TOTALS		40	8	3	8	2	5		44 8
BARK SAMPLES 15cm x 15cm	NO. ENTRANCE HOLES	NO. PARENT ADULTS	NO. LARVAE	NO. PUPAE	NO. CALLOW ADULTS	FRESH (GREEN) BLOWDOWN			
						Attacked	Unattacked		
1a	..	..	☒ □			.			
1b	.	..	☒ ..						
COMMENTS									
- 90% on a 2-year cycle - a few pitchouts on smaller diam. stems ☐ also code 2									
CREW NAMES						DATE			
John Smith + Bill Jones						Y M D 15 11 20			

FS 1111 RPG 2000/01 7530881048 (100b0d)

As an example, if three separate but adjacent stands are initially surveyed by walkthroughs, the surveyor might return to a portion of one of the strip lines that is representative of the area covered and install a mini-pixel before leaving the area. With proper planning, walkthroughs usually reveal sufficient information to make a management decision on 80% of infested sites.¹

If probing is recommended after walkthroughs or a hybrid method (from Table 2), then delineated stands should 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 17.5 cm dbh within the 10 m-wide strip will be recorded within one of the existing diameter classes on the *Spruce Beetle Probe Card* (FS 1111) (Fig. 2 - example) or *Beetle Probe Card* (FS 1111A). As information will be summarized by 100 m long strips, all probe lines should be run to the nearest 100 m.

All spruce 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. 1111* in numerical form (Fig. 2). Probers must remove at least a small portion of phloem from every infested tree 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 1111*.

Table 3. Bark Beetle Codes for Spruce Beetle*

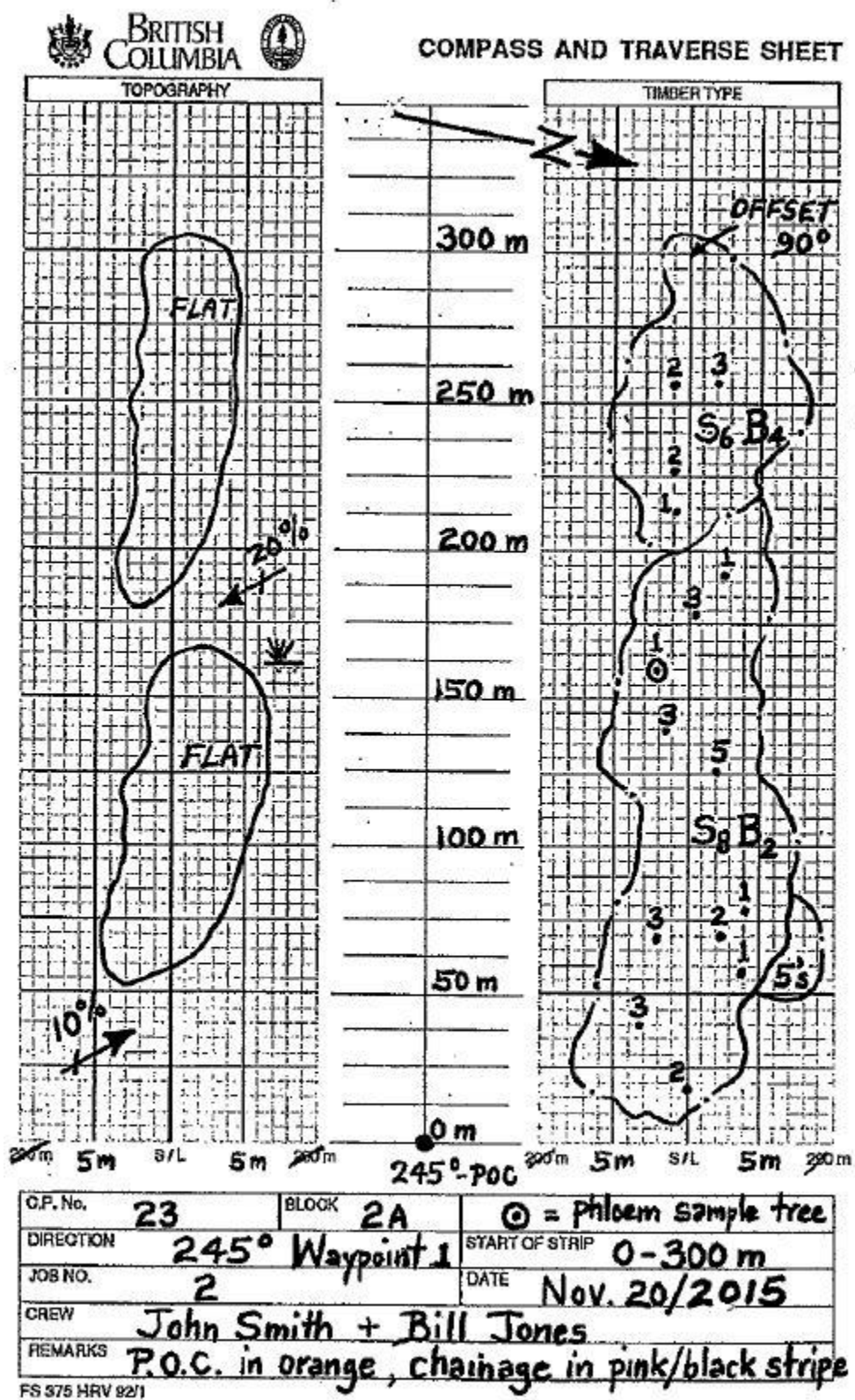
Code <u>no.</u>	Year of <u>attack</u>	Year** and type <u>of attack</u>
1	Most recent	<u>2016</u> - Full
2	Most recent	<u>2016</u> - Strip
3	Second recent	<u>2015</u> - Full
4	Second recent	<u>2015</u> - Strip
5	Third recent	<u>2014</u> - Full
6	Third recent	<u>2014</u> - Strip

* a complete summary of the signs and symptoms of attack for each code is available from the *Spruce Beetle Coding Sheet*.

** 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.

¹ Beetle ground surveys funded by the provincial *Landbased Investment Strategy Account* cannot be used to lay out boundaries for cutting permit applications. Block layout costs are recoverable by licensees as an appraisal cost claim.

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



To determine relative beetle attack densities and brood densities between areas during the hybrid method or probing, a total of 20 *most-recently* attacked spruce (i.e., 2016-attacks based on the current date) must be sampled per area/stand. Ideally, one tree should be sampled approximately every 200 m along the line. At each sample tree, two 15 cm x 15 cm (225 cm²) bark samples are removed at dbh with a hatchet; one from the north side and one from the south and the appropriate information tallied as depicted in the lower portion of the *FS 1111* (Fig. 2). Such sample trees must also be clearly delineated (e.g., by a circle or GPS reference) on the F.S. 375 (Fig. 3). 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 and brood densities between areas/stands surveyed. It is recommended that a few such samples be taken during walkthroughs. Bark sample data also provides a key bark beetle coding check for survey supervisors and Ministry and licensee field monitors. Table 4 can be used to rate the mean beetle attack densities and larval densities between areas surveyed in order to further rank sanitation logging priorities.

Table 4. Spruce Beetle Attack Density and Larval Density Rating

Mean no. entrance holes per 225 cm ² phloem sample	Mean attack density	Mean no. living larvae per 225 cm ² 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 July 15 - March 31 from a population in the first year of a 2-year cycle

Survey Line Delineation

Even though computer tablets with mapping software are gaining in popularity for survey navigation and data entry, the initiation and termination of all beetle survey lines should be clearly marked with highly visible flagging tape which indicates:

- 1) the geographic location, waypoint reference, and survey line number, e.g., *Windfall Cr., GPS pt. D, Probe A, SL #5*;
- 2) the "point-of-commencement" (P.O.C) or "point of termination" (P.O.T.) and bearing, e.g., *P.O.C. - 270°*; and
- 3) the crew number/name and date, e.g., *Crew #2, Oct. 28/16*

Along the length of the survey line, flagging tape should be hung at appropriate intervals (approximately every 30-50 m) indicating the general direction of the line so that anyone standing anywhere on the line at a later date (e.g., a field auditor) can follow it without solely relying on GPS and/or a mapping software file. Every 100 m interval along the line should be marked with different or longer flagging tape, e.g., $0 + 100\text{ m}$. Wherever the crew changes direction, the GPS location and offset bearings and distances must also be clearly indicated by flagging tape, e.g., GPS pt. E, *offset* $90^\circ + 100\text{ m}$.

Probe Data Calculations and Summarization

Beetle code data collected on the *F.S. 1111* 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 *Spruce Beetle Infestation Summary Sheet* (Table 5 - 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 exists into the surveyed area/stand or a road could be constructed soon, the District should calculate the *Sanitation and Salvage Harvest Priority* value (Table 5 - bottom formula). If *salvage* wood cannot be utilized for particular products such as veneer, the third component in the formula can be omitted. Complete details on the rationale for the formula are provided in the *Bark Beetle Management Guidebook*.

On the completion of a survey, data from *F.S. 1111*'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., "*Parsnip R. south*";
- 3) Opening number (if available), mapsheet, unit, and block numbers, e.g., *93-0-11-e, Unit 2e, Block 1*; GPS commencement waypoint;
- 4) Names of surveyors;
- 5) Date of the survey;
- 6) Total m surveyed;
- 7) Total ha surveyed;
- 8) Total no. of healthy spruce tallied;
- 9) Total no. of attacked spruce by beetle codes 1 - 6;
- 10) Total no. of all spruce tallied;
- 11) Percent attack for each beetle code 1 - 6;
- 12) Percent attack in each of the last 3 years, i.e., for 2016, 2015, and 2014 (from Table 5);
- 13) Proportion of the block infested (from Table 5);
- 14) Mean attack density and mean larval density (from Table 4);
- 15) Percent spruce in the stand; and
- 16) Percent other conifers by species.

Table 5. Spruce Beetle Infestation Summary Sheet

DBH Class	Healthy Hosts	2016		2015		2014		Other Species
		1	2	3	4	5	6	
17.5 - 25.0	3.3							3.3
25.1 - 30.0	10.6							31.8
30.1 - 35.0	21.3	7.1						35.5
35.1 - 40.0	47.0	9.4	4.7	18.8	4.7			103.4
40.1 - 45.0	81.2	23.2	5.8	34.8	5.8	11.6		139.2
45.1 - 50.0	151.8	27.6	6.9	27.6		13.8		193.2
50.1 - 55.0	113.4	16.2		16.2		48.6		32.4
55.1 - 60.0	56.1	18.7						18.7
60.1 +	25.3							
Totals	510	102.2	17.4	97.4	10.5	74.0	0	557.5

STEPS

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

2. Percent attack within infested portion (assumes 85% + beetles are on a 2-year life cycle).

- The results from all attacked pixels should be used.
- The number of trees on the SB Probe Card should be multiplied by the SAF* with products calculated separately for each row and column individually in the above table.

• % 2016 Attack = $\frac{102.2 + 17.4}{811.5} \times 100 = 14.7\%$

• % 2015 Attack = $\frac{97.4 + 10.5}{811.5} \times 100 = 13.3\%$

• % 2014 Attack = $\frac{74 + 0}{811.5} \times 100 = 9.1\%$

• % Host in Stand = $\frac{811.5}{1369} \times 100 = 59.3\%$

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

(% 2016 + $\frac{\% 2015}{1.5}$ + $\frac{\% 2014}{4}$) x % Host = _____

(14.7 + $\frac{13.3}{1.5}$ + $\frac{9.1}{4}$) x 59.3 = 1539.5

* Surface area factor (mean area per diameter class)

Mapping

An appropriate 1:10,000 scale summary forest cover map for each surveyed area/stand must also be included (paper or digital file) 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 survey lines with GPS coordinates tied into a physical feature(s) indicating *P.O.C.*'s, *P.O.T.*'s, strip line numbers, bearings, and distances;
- 4) a colour stratification of infested areas into 3 categories of combined 2016 + 2015 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 spruce (healthy plus attacked) in the stand, i.e., 5,8,6,70 which equates to a 5% attack in 2016, 8% in 2015, 6% in 2014 (or previous), and 70% spruce; and
- 6) as a contract option, all adjacent trap tree patches and recent blowdown can also be included on the map as per the Ministry's cartographic standards.

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Additional Survey Information

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

- 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 it's:
 - possible origin and attack history in the stand;
 - Potential for spread considering the next major flight and the percent 1- and 2-year cycle beetles; and
 - Impacts of woodpecker activity, host resistance, and other population limiting Factors.
- 4) Site specific recommendations for spruce beetle management such as:
 - Sanitation logging (clear-cut, patch removal, single tree "snip and skid" or combination thereof);
 - trap trees;
 - Pheromone grid-baiting of standing trees;
 - Utilization and remedial actions required for hazard reduction (e.g., slash management, low stumps and blowdown extraction); and
 - further recommended detection via more ground surveys and/or heli-GPS)



For additional information on spruce beetle suppression, please contact your local FLNR office.

