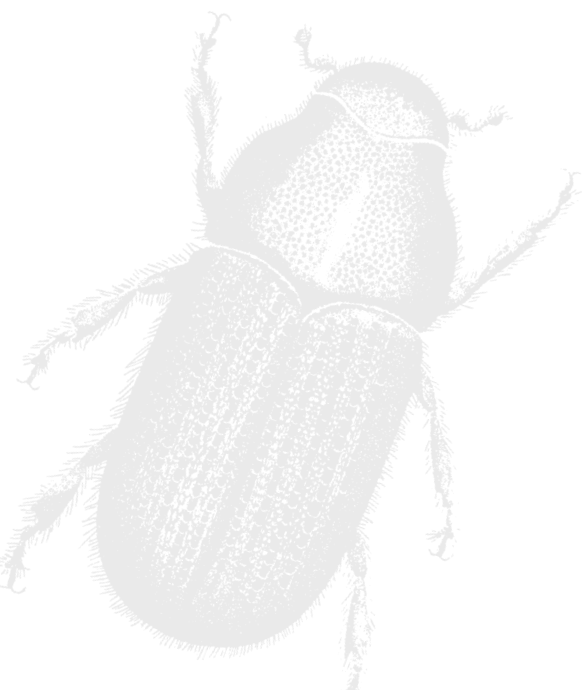


# **Mountain Pine Beetle Detection and Management in Alberta**



**Government  
of Alberta ■**



## **Table of Contents**

	Page
1. Introduction	1
2. Life cycle	2
3. Damage symptoms	6
4. Identifying MPB	9

# 1. Introduction

The mountain pine beetle (*Dendroctonus ponderosae* Hopkins, MPB) is native to western Canada. It attacks all pine including lodgepole, limber, white bark and jack pine. Over the past 40 years the range of mountain pine beetle has expanded, possibly due to changes in the area of climatically suitable habitat<sup>1</sup>. It is thought that fire suppression in combination with climate change<sup>2</sup> has recently resulted in the largest insect epidemic in the history of British Columbia (BC). Populations in Alberta are increasing due to mild winters, dry summers and the influx of beetles immigrating from BC through the Rocky Mountains. The Alberta government is aggressively suppressing populations in Alberta to prevent an epidemic of the scale such as in British Columbia. This guide is to aid the detection of MPBs in the field and their effective control in Alberta.

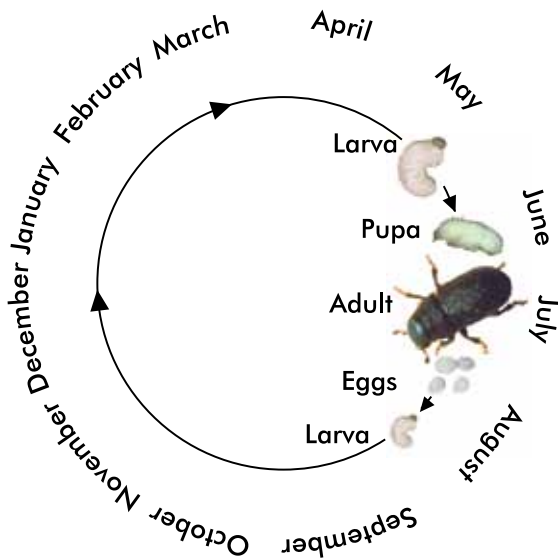
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<sup>1</sup> Taylor S.W., Carroll A.L., Alfaro R.I., Safranyik L. (2006) Forest, climate and mountain pine beetle outbreak dynamics in western Canada. Pp. 67-94 in L. Safranyik and W.R. Wilson, eds. *The mountain pine beetle: a synthesis of biology, management, and impacts on lodgepole pine*. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia. Pp. 304

<sup>2</sup> Carroll A. L., Taylor S. W., Régnière J., Safranyik L. (2004) Effects of climate change on range expansion by the mountain pine beetle in British Columbia. *Mountain Pine Beetle Symposium: Challenges and Solutions*. October 30-31, 2003, Kelowna, British Columbia. Shore T.L., Brooks J.E., Stone J.E. eds. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Information Report BC-X-399, Victoria, BC. Pp. 298.

## 2. Life Cycle

Throughout most of its range the generation time of the MPB is one year (Figure 1). Generally, adult MPBs attack host trees in late July or early August and create galleries within which they lay their eggs. The eggs hatch and larvae develop over the fall. Typically, MPBs over-winter as larvae, pupate in the spring and emerge from the host as fully-grown adults.



**Figure 1** MPB life cycle.

Typically, it takes one year for eggs to hatch, larvae to grow, pupae to moult to adult beetles. However, temperatures may cause variation in the life cycle. In particular, beetles at the northern limits of its distribution may take more than one year to develop. In such populations all of the possible life stages may occur in a single tree at one time, although it is more common for one or two consecutive life stages to occur at one time.

## Adults

Mature beetles are reddish brown to black and 5 to 7 mm long (Figure 2a). They emerge from the tree by chewing small round holes in the bark, then fly in search of new host trees during late July to September. When a new host is found, the female beetle bores an oval hole into the bark and constructs a vertical egg gallery that eventually may be 25 to 30 cm long. The gallery is uniformly wide along its length, has a "J-shaped" hook at the bottom, and is packed with boring dust except for the top few centimetres (Figure 2b).

The gallery extends within the inner bark and usually scores the cambium and outer sapwood. The attacking female releases pheromone compounds that attract other females as well as male beetles that are necessary for mating.



**Figure 2a** Mountain pine beetle adult, *Dendroctonus ponderosae* Hopkins. J. J. Witcosky (2002) USDA Forest Service, Rocky Mountain Region Archives, [www.forestryimages.org](http://www.forestryimages.org)



**Figure 2b** Mountain pine beetle galleries.

## Eggs

In late summer to early fall, small white eggs are laid singly in niches along the sides of the vertical egg galleries. They hatch into larvae about two weeks later. On average, the adult female produces 60 eggs<sup>1</sup>.

## Larva

The larvae are white, legless grubs with brown heads (Figure 2c). They excavate horizontal tunnels (galleries) as they feed in the phloem.



**Figure 2c** Mountain pine beetle larva. They are white grubs with brown heads. When fully grown they are approximately 6 mm long. S. Tunnock (2001) USDA Forest Service, [www.forestryimages.org](http://www.forestryimages.org)

While developing, they go through four stages called instars and continue to elongate and widen the tunnels as they grow. They over-winter under the bark in various instars, maturing by late June of the following year. When mature, larvae construct oval-shaped chambers to pupate. The normal over-wintering stage is the larva, although some pupae and adults may also over-winter.

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<sup>1</sup> Furniss, R.L. and V.M. Carolin. (1977) Western forest insects. Forest Service Miscellaneous Publication No. 1339. Washington, DC: USDA, Forest Service.

## Pupa

The mature larvae remain dormant in pupal cells for a short period of time, transforming to pupae by early July, and then to adult beetles. Pupae are white and may show some adult-like characteristics, e.g., wing buds (Figure 2d).



**Figure 2d** Mountain pine beetle pupa. Pupae grow to approximately 5 mm long. USDA Forest Service (2002) Rocky Mountain Region Archives, [www.forestryimages.org](http://www.forestryimages.org)

## Teneral or Callow Adults

Teneral or callow adults are fully formed adult beetles that have not deposited their hard exoskeleton (Figure 2e). This stage is the only stage, other than the adult, that can survive being exposed to the elements.



**Figure 2e** Mountain pine beetle teneral adult. These young adults are pale coloured and soft. They darken and harden under the bark before they emerge from the tree. USDA Forest Service (2002) Rocky Mountain Region Archives, [www.forestryimages.org](http://www.forestryimages.org)



### 3. Damage Symptoms

#### External signs on the bole

- Pitch tubes surrounding beetle entry holes (cream to pinkish coloured mixtures of resin and boring dust) (Figure 3)
- Boring dust in bark crevices, particularly at the root-collar (Figure 4)
- Small round adult emergence holes approx. 2.5 mm in diameter (Figure 5)
- Bark flakes from wood-pecker activity (Figure 6)
- Bark flakes on the ground (particularly conspicuous on snow)



**Figure 3** Pitch tube on pine tree attacked by MPB.



**Figure 4** Boring dust on the base of the tree.



**Figure 5**  
Emergence  
holes where  
adult beetles  
exited.



**Figure 6** Woodpeckers  
peck the bark off infested  
trees to get to the larvae and  
beetles beneath it.

As other bark beetles may cause pitch tubes, boring dust, emergence holes and bark flakes, all of the above symptoms are not sufficient to determine MPB as cause.

## Fading crowns

Successfully attacked trees are killed and their crowns fade from loss of moisture. The foliage changes its colour from green to yellow in the first few months after attack, followed by bright red, brown and eventually grey (Figure 7).



**Figure 7** Pine trees attacked by MPB with fading crowns.

## Symptoms under the bark

These are the most reliable indicators of MPB infestation. In August, shortly after beetles have attacked the tree they construct vertical galleries in the phloem with a diagnostic slight hook at the bottom (Figure 2b). Usually the bottom of the galleries is packed with boring dust. When completed, galleries may reach 2 m in length although galleries of approx. 30 cm are more common. Larval tunnels extend horizontally from the egg-galleries. In the year after the attack oval pupal chambers may be visible at the ends of some larval tunnels.

## 4. Identifying MPB

Signs of attack by other beetle species can look very similar to MPB attack. However, these other species mostly do not cause damage of the same severity as the MPB and do not need not be controlled. In order to save time in the field it is necessary to distinguish MPBs from other bark beetles. The most common associated beetles are listed in Table 1 and photographs are given in Figures 8 to 12. Identifying the MPB can be achieved by examining the adult beetle and its gallery for the following features<sup>1</sup>:

- MPB gallery pattern shows a characteristic hook at the bottom of the vertical egg-gallery with larval feeding tunnels extending horizontally from the egg-gallery (Figure 2b).
- Head of adult beetle clearly visible from above (compare Figure 2a with 11a and 12a)

**Table 1** Four common beetle species in lodgepole pine.

	MPB	Lodgepole pine beetle	Red turpentine beetle	Engraver beetles
Colour (adults)	Brown to black	Front is dark brown and back is reddish brown	Reddish brown	Dark reddish brown to black
Size	5 - 7 mm	5 - 8 mm	8 - 12 mm	3 - 5 mm
Adult body shape	Large, stout, body; head visible from above	Large, stout, body; head visible from above	Large, stout, body; head visible from above	Cavity at rear end of body; head not visible from above
Gallery	Vertical egg gallery, horizontal larvae mines, "J"-shape; egg niches along each side of gallery	Vertical; shaped irregularly, shallow expansions along side(s) of gallery, no egg niches.	Gallery is 1-3 cm wide; branched and irregularly caved; packed with granular reddish frass	Central chamber from which several egg galleries fork or radiate; star, "y" or "x" shaped
Part of bole attacked	Attacks may occur on the entire bole up to the crown	Lower part of bole, stumps	Attacks are concentrated at or near ground level	Attack spaces in between galleries of other beetles
Figure	2a-e	8a-c	9a-c	10a-c

<sup>1</sup> Arnett R. H., Thomas M. C. (2002) American beetles. CRC Press LLC, Florida, U.S.A. Pp. 861



**Figure 8a** Lodgepole pine beetle, *Dendroctonus murrayanae* Hopkins. D. Jensen (1922) University of Alberta, Strickland Museum.



**Figure 8b** Lodgepole pine beetle (*Dendroctonus murrayanae*) larvae. Note the brown anal shields that MPB larvae do not have. Province of British Columbia (2001)



**Figure 8c** lodgepole pine beetle gallery with adult. The gallery is vertical but shaped irregularly. Eggs are laid in groups on either side of the gallery and larvae feed communally, i.e. not in individual galleries.



**Figure 9a** Red turpentine beetle, *Dendroctonus valens*. Pest and Diseases Image Library (2006) [www.forestryimages.org](http://www.forestryimages.org)



**Figure 9b** Gallery of red turpentine beetle with a group of larvae.



**Figure 9c** Gallery pattern of red turpentine beetle, *D. valens*. Since the adult red turpentine beetle is larger than MPB its galleries are also wider and deeper. K. E. Gibson (2006) USDA Forest Service, Ogden Archives, [www.forestryimages.org](http://www.forestryimages.org)





**Figure 10a** Pine engraver, *Ips latidens* (LeConte). R. Long (2002) Simon Fraser University, [www.forestryimages.org](http://www.forestryimages.org)



**Figure 10b** Declivital spines on adult male, *Ips latidens* (LeConte). R. Long (2002) Simon Fraser University, [www.forestryimages.org](http://www.forestryimages.org)



**Figure 10c** *Ips* gallery patterns. Holsten (2000) USDA Forest Service; D. McComb (2000) USDA Forest Service; S. Tunnock (2001) USDA Forest Service, [www.forestryimages.org](http://www.forestryimages.org)



**Figure 11a** Conifer ambrosia beetle, *Trypodendron lineatum* (Olivier). Adults are 2.7 to 3.5 mm long and dark brown to black with four pale stripes. The body is rounded and the head is not visible from above. M. Jurc (2006) University of Ljubljana, [www.forestryimages.org](http://www.forestryimages.org)



**Figure 11b** Ambrosia galleries differ from bark beetle galleries since ambrosia beetles feed on sapwood. Galleries penetrate the bark and extend to sapwood and heartwood. J-F. Abgrall (2005) CEMAGREF, [www.forestryimages.org](http://www.forestryimages.org)



**Figure 12a** *Hylurgops* spp. Adults are 3.4-5 mm long and are reddish brown to rusty brown or black. The body is small and stout and the head is not visible from above. E. R. Hoebeke (2006) Cornell University, [www.forestryimages.org](http://www.forestryimages.org)



**Figure 12b** Gallery patterns of *Hylurgops* spp. S. Kinelski (2004) and W. M. Ciesla (2003) Forest Health Management International, [www.forestryimages.org](http://www.forestryimages.org)



**Figure 12c** *Hylurgops* adult, larvae and pupae in pine log. W. M. Ciesla (2002) Forest Health Management International, [www.forestryimages.org](http://www.forestryimages.org)

## **Ground Survey Procedures**

### **Table of Contents**

	Page
1. Concentric Survey Procedures	1
2. Transect Survey Procedures	11
3. Walk Through Detection Survey Procedures	17
4. Appendix 1: Tree Height Calculation with a clinometer	21
5. Appendix 2: Performance Measures	22

# 1. Concentric Survey Procedures

## Goal

Detect currently infested trees at sites with red-attack trees located from aerial surveys.

## Equipment

GPS, compass and map

Knife/hatchet

Clinometer and diameter tape

Red and pink pest management flagging tape

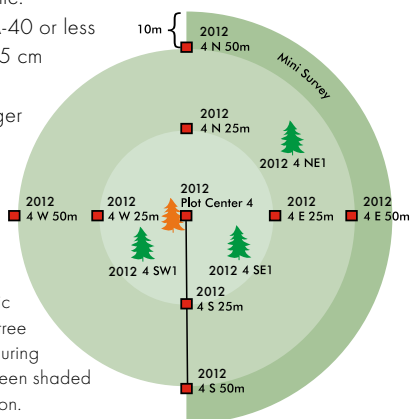
Black permanent marker and pencil

Data sheet

## Procedure

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hddd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude.
2. Use GPS location provided by the Project Manager to find the plot centre. If the GPS location was derived during a Heli-GPS survey, it will be associated with a red or fading tree.
  - If GPS point is not close to red/fading trees, do a 25 meter sweep to locate red/fading trees.
  - If red/fading trees at GPS point is non-mpb tree, do a 25 meter sweep to ensure no MPB trees at the site.An "unsuccessful attack" (UA-40 or less entrance holes or less than 15 cm DBH) tree found within the 25 metre sweep will not trigger full plot layout.
3. Select an uninfested tree close to the fading tree as the plot centre.

**Figure 1** Plot layout for concentric survey. Plot centre is an uninfested tree close to the fading tree identified during the aerial survey. All trees within green shaded areas must be checked for infestation.



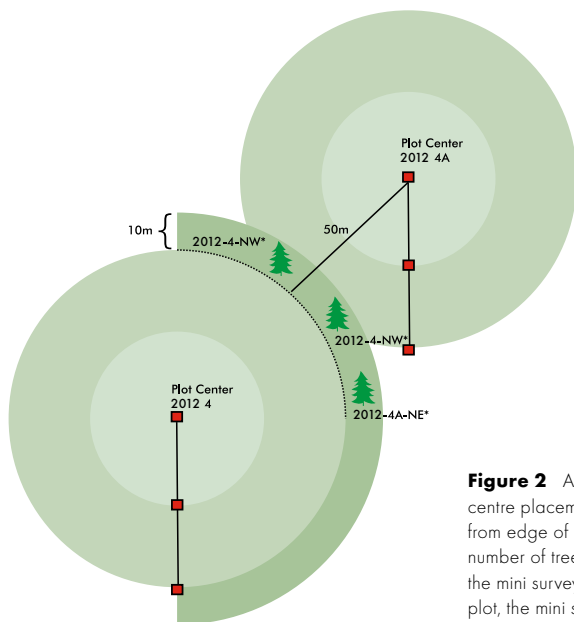
4. If the plot centre location provided will result in some of the plot being located in a permanent sample plot (PSP), adjust the plot centre to ensure none of the plot will be located within the PSP.
5. Double flag the tree at the plot centre with red Pest Management flagging. Label flagging with the beetle year (August 15 of current year - August 14 of following year), the site number, the words "PLOT CENTRE", and the survey date (e.g. 2012 4 PLOT CENTRE, Jan 14).
6. Take the GPS location of the plot centre and record it on the data sheet. Record the positional accuracy.
7. Measure 50 m in all cardinal directions from the plot centre, flagging 25 m and 50 m on each line with red Pest Management flagging (Figure 1). Flagging must be tied onto an uninfested tree, or if a tree can not be found then any suitable marker can be used to tie a flag. Tie the knot of the flagging facing towards plot centre. Label each red flag with the beetle year, the site number, direction and distance from the plot centre (e.g. 2012 4 S 25m).
8. Examine every pine tree within the entire plot for entrance holes, pitch tubes and/or boring dust using the red flags as reference points.
9. If a tree has 40 or less entrance holes the tree does not have to be controlled as it is considered an 'unsuccessful attack' (UA). If a MPB infested tree is less than 15cm at DBH, regardless of the number of entrance holes on the tree, it is also an 'unsuccessful attack' and does not have to be controlled. While surveying, count the number of UA trees and record the total number of UA trees in the plot on the data sheet.
10. Flag each attacked tree greater than 15cm at DBH that has living brood/ beetles, with more than 40 entrance holes, with pink Pest Management flagging tape and label it with the beetle year, the site number, quadrant and the tree number. For example, if the site number is 4, trees in the plot will be 2012-4-NW1, 2012-4-NW2, 2012-4-SE1, etc. Tie the knots of the flagging towards plot centre. Trees that have been wood-peckered and meet the current attack threshold will be pink flagged.
11. Draw a dot at the approximate location of each of the trees requiring control (pink flagged trees) on the crosshair map on the data sheet. If there are more than 20 trees per quadrant, write the total in the quadrant summary field and do not draw dots on the map. Forked trees are counted by the number of stems below DBH (1.3m from the ground).

12. Measure and record the DBH (include one decimal place) and tree height (rounded to the nearest 0.5 meter) of a tree that is representative of the currently infested trees (pink flagged) in the plot. Write "REP TREE" on the flagging of the measured tree. Map location of rep tree on data sheet field map using "R". See Survey Procedures Appendix 1 for height measurement instructions using a clinometer. If there are only UA trees at the site, no "REP TREE" measurements are required.
13. When tallying pink flagged trees, 'Red' trees have 100% of their needles red while 'Green' trees are attacked in the current year and are generally green but may show signs of fading.
14. If pink flagged tree(s) are located beyond the 25 m inner circle, i.e. between the 25 m and 50 m markers, complete a "mini-survey" 10 m past the 50 m marker of the two nearest quadrants (Figure 1). On the map portion of the data sheet, fill in the dotted line of the two quadrants surveyed in the mini-survey. UA trees do not trigger a mini-survey.
15. Attacked trees found within the 10m mini survey may trigger a new concentric survey plot (additional plot). If mini-surveys are triggered around the entire parent plot (i.e. two mini-surveys), the trees in the portions of the mini-surveys bordering any two adjacent quadrants will be combined to determine whether an additional plot will be triggered. The Project Manager will determine how many trees are required to trigger the additional plot. It will vary by Corporate Area. UA trees do not warrant an additional concentric survey. Trees found during the mini survey are to be tallied with the parent plot.
16. If an additional plot is triggered, move the new plot centre 50 meters away from the edge of the parent plot. Move the plot center in the same bearing from the parent plot centre to the tree(s) in the mini-survey that triggered the additional plot. If the additional plot location does not meet a threshold of >25% pine composition (of stems >15cm) then the plot can be moved up to 50m in either direction while staying 50m from the parent plot edge. If a suitable location is not found it can be dropped with comments explaining the situation.
17. Number the additional plot by using the parent adjacent site number and a letter. For example, if a green tree is identified outside the 50 m plot boundary near site number 4, the new site number will be 4a. (Figure 2)

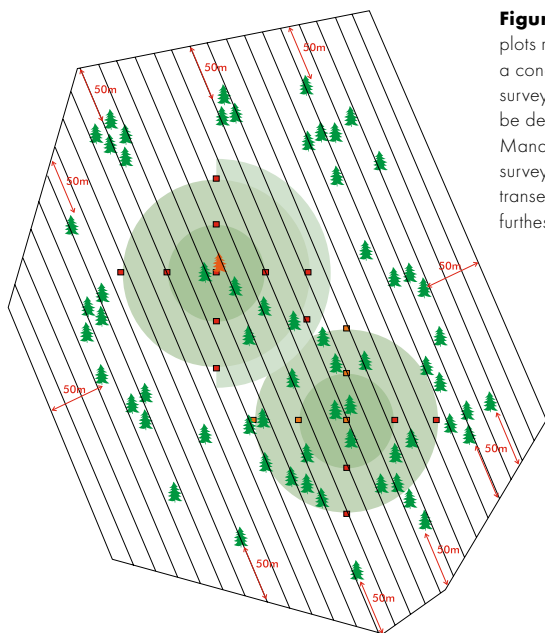
18. To avoid overlap, note the location of other plots in the vicinity before making a new plot.
19. There will be a threshold number of concentric plots (parent plus additional) set by the Project Manager for switching to a transect survey. This threshold will vary by Corporate Area. If there are more infested trees outside of the allowed number of concentric plots check with the Project Manager on direction for continuing the survey.
20. If the number/location of attacked trees does not require a mini-survey or additional plot, but attacked trees are located adjacent to the plot, they may be voluntarily pink flagged. Voluntary pink flagging is encouraged within slivers of un-surveyed land resulting from the placement of multiple additional plots. Voluntary pink flagged trees are to be tallied with the nearest plot (in the appropriate green or red needle column), mapped on the concentric survey tally card map with a "V", and noted in the comments field (preferably include GPS coordinates of tree locations).
21. If GPS locations of other sites are found within a parent concentric plot, record the absorbed site number on the datasheet in the Survey Comments box. Do not perform another concentric survey and do not fill in a tally card for the absorbed site.
22. Whitebark and limber pine have been designated as Endangered in Alberta. If either of these species are attacked in the plot, record the number of attacked trees in the appropriate box on the datasheet. The attacked whitebark and limber pine are not totalled separately from the trees with live brood total.

## Removing Baits

21. Some of the sites may be baited. **Collect and remove all baits. Bring them to the Project Manager.** Remove any existing flagging from the tree and re-label and flag any infested tree using the above procedures. Write the bait number(s) on the data sheet.



**Figure 2** Additional plot centre placement to be 50m from edge of original plot. If the number of trees found during the mini survey triggers a new plot, the mini survey trees are to be tallied with the parent plot.



**Figure 3** The number of plots required to switch from a concentric to a transect survey vary by area and will be determined by the Project Manager. If a transect survey is initiated, run the transect lines 50m past the furthest infested tree.

## Deploying Baits

22. If concentric surveys are completed during a summer operation and baits are to be deployed as a cautionary procedure (i.e. in case control crews cannot get to the site before the beetles develop and fly), follow the Baiting Procedures. On the crosshair map of the Mountain Pine Beetle Concentric Ground Survey datasheet place the letter "B" at the approximate location from the plot centre.



## **Previously Identified Trees**

23. For any trees that have flagging and numbers from a previous years operations or trees numbered during a summer program, the Project Manager will determine if the old trees need treatment (possible 2 year lifecycle).
24. For old trees that do not require treatment (i.e. beetles have developed and flown) remove the existing flagging.
25. For old trees that still require treatment, remove all old flagging and replace it with new pink flagging. Label them using the new numbering system outlined above.

## **Incidental Sites**

26. While walking from the access location or from site to site, surveyors may detect current attacked trees that are not associated with fading or red trees. If this occurs, the patch of currently infested trees may trigger a new incidental concentric plot. The Project Manager will determine how many current attacked trees are required to trigger the incidental plot. UA trees do not warrant an incidental plot.
27. If a new incidental concentric plot is triggered, number the site using the last concentric site number and a letter (i.e. 2012-392A).
28. Record in the survey comments how the site was found (i.e. found while walking from site 392 to 393).

## **Data Collection**

**Record all information on the Mountain Pine Beetle Concentric Survey data sheet**



## Instructions for Concentric Survey data sheet

1. Name of the Project, e.g. Willmore or Kananaskis. A project is a geographically defined area that contains several Infestations. Projects and Infestations are assigned by the Project Manager.
2. Name of ESRD corporate area, e.g. Foothills (SW3) or Clearwater (SW2)
3. The beetle year begins August 15 and spans until August 14 the following year.
4. The Project Manager is usually the Forest Health Officer for the corporate area.
5. The date (calendar year) the survey was conducted.
6. The Infestation will be assigned by the Project Manager. E.g. Smoky River in the Willmore Project or Spray Lakes in the Kananaskis Project.
7. Site Number, e.g. 4.
8. If you work for ESRD under a contract, indicate your full name.
9. Describe how to get to the plot centre from the access location recorded in 11, e.g. walk 50 m north from helipad, or quad 25 km south of road, etc.
10. Circle the access type used to get to the plot.
11. Measure latitude and longitude of access location (helipad or roadside truck parking location). Set your GPS to NAD83 and measure in degrees/minutes/ decimal minutes (hddd°mm.mmm'). Record the positional accuracy of the GPS.
12. Measure latitude and longitude of the tree identified as the plot centre. Record the positional accuracy of the GPS.
13. Count the number of trees with green needles (i.e. current attack) that are flagged pink. Count the number of trees with red needles that are flagged pink. Total the number of attacked trees. If there are no tallies, record a '0'.
14. Record the estimated number of UA trees within the plot.
15. Of the total number of currently attacked trees how many are whitebark and how many are limber pine trees?
16. Record the representative tree height and DBH for infested trees only. Record the tree number measured.
17. If you find a bait, remove it and bring it to the Project Manager. Record the bait number (written on bait package).
18. Place a dot for each pink flagged tree at the approximate location on the cross hair map. For all quadrants, total the number of flagged trees in the quadrant summary field. If there are more than 10 trees per quadrant, do not draw dots but record the total in the quadrant summary field (e.g. SE 15 in bottom right corner of crosshair map). Write "B" for baits deployed. Write "R" at the location of the representative tree.
19. Surveyors may write down any additional comments. Record if the site is a non-MPB site or if any sites are absorbed by the plot here.

1 - Forked trees should be counted by the number of stems below DBH (1.3m from the ground).

## Mountain Pine Beetle Concentric Ground Survey

Project Name: <u>1</u>		Beetle Year: <u>3</u>	
Corporate Area: <u>2</u>		Project Manager: <u>4</u>	
Survey Date: <u>5</u> / <u>5</u> / <u>dd</u>		Infestation: <u>6</u> MPB Site Number: <u>7</u>	
Contract #/ Company Name; SRD Crew #, or Surveyor names: <u>8</u>			
Site/Location Description: <u>9</u>		Access: (circle one) Heli <input type="checkbox"/> OHV <input type="checkbox"/> Truck <input type="checkbox"/> Other <input type="checkbox"/>	
Access Location: (Deg Min Dec)      Positional accuracy: <u>11</u> ±		Plot Center: (Deg Min Dec)      Positional accuracy: <u>12</u> ±	
Lat: _____		Lat: _____	
Long: _____		Long: _____	
Forked trees: count number of stems below DBH			
# of attacked trees with LIVE brood marked for control <u>13</u>		Estimated Number of UA Trees	
Green Needles      Red Needles      Total		Species of Trees Attacked	
Pink Flagging      Pink Flagging      Total		Whitebark Pine      Limber Pine	
14		15	
16		17	
DBH: _____		DBH: _____	
NW _____		NE _____	
SW _____		SE _____	
S		E	
N		25m	
18		19	
Survey Comments		"B" - Baited Trees      "R" - Rep Trees	

Rev. 0810

## 2. Transect Survey Procedures

### Goal

Systematic identification of 100% of the attacked trees within a transect survey site (or other predefined area).

### Equipment

GPS

Compass and map

Knife/hatchet

Clinometer and diameter tape

Red and pink pest management flagging tape

Black permanent marker and pencil

Data sheet

### Procedure

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hddd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude.
2. Before conducting the transect survey, the Project Manager will:
  - Delineate the transect survey site on a cover type map or on aerial photos.
  - If the site is too large to survey with one crew, it should be subdivided into zones. The zones are to be identified by a letter. The name of each zone will therefore consist of the site number and a letter (e.g. 5a, 5b, 5c, etc.).
3. Determine the direction of transects based on topography or other landscape features.
4. The contractor/surveyor determines the flagged line spacing of transects based on factors such as the number of attacked trees, density of the stand and slope, from a minimum of 10 m up to a maximum of 50 m.
5. Locate the origin of the first transect line to be surveyed according to the schematic map (a corner of the survey polygon). Record the location on the Transect Ground Survey data sheet.
6. Double flag the transect line origin with red pest management flagging on an un-infested tree and label with the beetle year (August 15 -August 14 in the following year), the word "ORIGIN", site number (with zone if used), transect line number, bearing and the survey date (e.g. if the site number is 5, the first transect line origin will be labelled "2012 Origin 5-1 360°, Jan 14"). Sequentially number the transect lines.

7. Every 50 m along each transect line, an un-infested tree should be flagged red and labelled with the beetle year, the site number (and zone if used), transect line number and distance (e.g. 2012 5-1 150 m).
8. Examine every pine tree between transect lines i.e. transect line 1 survey area is located between transect flag lines 1 and 2. Look for entrance holes and/or boring dust.
9. If a tree has 40 or less entrance holes the tree does not have to be controlled as it is considered an 'unsuccessful attack' (UA). If a MPB infested tree is less than 15 cm at DBH, regardless of the number of entrance holes on the tree, it is also an 'unsuccessful attack' and does not have to be controlled. While surveying, count the number of UA trees and record the number on the data sheet.
10. Flag each attacked tree greater than 15cm at DBH with more than 40 entrance holes and that has living brood/beetles, with pink pest management tape and label it with the beetle year, the site number, transect line number and tree number. For example, 2012 5-1-3 is the 3rd tree along transect line 1, in site number 5. Tie the knot of the flagging facing towards the transect line it is associated with.
11. On the data sheet, record the attacked tree number, its GPS location and the estimated distance along the transect line.
12. A distinct patch of adjacent attacked trees can be represented by a single GPS location taken from the centre of the patch. All trees within one patch will be labelled identically. All patches are numbered with the beetle year, the site number, the transect line number, and then the tree number (for example 2012 5-1-3 is the 3rd tree/patch along transect line number 1 in site number 5). Record the number of trees in the patch. If trees are found all along the transect line and not in distinct patches, record this in the survey comments box.
13. Measure and record the DBH (include one decimal place) and tree height (rounded to the nearest 0.5 meter) of a tree that is representative of the currently infested trees (pink-flagged) along the transect line. Write "REP TREE" on the flagging of the measured tree. See Survey Procedures Appendix 1 for height measurement instructions using a clinometer.
14. When tallying trees with live brood (pink flagged trees) 'Red' trees have 100% of their needles red while 'Green' trees are attacked in the current year and are generally green but may show signs of fading.
15. Continue surveying along transect line until reaching the end of the survey area as indicated on the schematic map.

16. Double flag the transect line end with red pest management tape on an un-infested tree and label with the beetle year, the word "END", site number (with zones if used) transect line number, and back bearing (e.g. if the site number is 5 and the line number is 1, the line end will be labelled "2012 End 5-1 0°).
17. Whitebark and limber pine have been designated as Endangered in Alberta. If either of these species are attacked in the plot, record the number of attacked trees in the appropriate box on the datasheet. The attacked whitebark and limber pine are not totalled separately from the trees with live brood total.

## **Removing Baits**

18. Some of the sites may be baited. Collect and remove all baits. Bring them to the Project Manager. Remove any existing flagging from the tree and re-label and flag any infested tree using the above procedures. Write the bait number on the data sheet.

## **Deploying Baits**

19. If the transect surveys are completed during a summer operation and baits are to be deployed as a cautionary procedure (i.e. in case control crews cannot get to the site before the beetles develop and fly), follow the Baiting Procedures and use the Mountain Pine Beetle Containment Bait Deployment data sheet.

## **Previously Identified Trees**

20. For any trees that have flagging and numbers from the previous years operations, the Project Manager will determine if the old trees need treatment (possible 2 year lifecycle – or trees numbered during a summer program)
21. For old trees that do not require treatment (i.e. beetles have developed and flown) remove the existing flagging.
22. For old trees that still require treatment, remove all old flagging and replace it with new flagging. Label it using the numbering system outlined above.

## **Data Collection**

**Record all information on the Transect Survey data sheet**



# Mountain Pine Beetle Transect Ground Survey/Control

Project Name: <u>1</u>		Beetle Year: <u>2</u>		Corporate Region: <u>3</u>		Project Manager: <u>4</u>	
Survey Date: <u>5</u> <u>month</u> <u>day</u> <u>year</u>		Contract#/Company Name: <u>6</u>		Infestation: <u>7</u>		MPB Site Number: <u>8</u>	
Access Location: (Degrees-minutes decimal) Lat: <u>9</u> <u>°</u> <u>'</u> <u>"</u> Long: <u>10</u> <u>°</u> <u>'</u> <u>"</u>		Positional accuracy: <u>10</u> ± <u>11</u>		Line Origin: (Degrees-minutes decimal) Lat: <u>10</u> <u>°</u> <u>'</u> <u>"</u> Long: <u>11</u> <u>°</u> <u>'</u> <u>"</u>		Line End: (Degrees-minutes decimal) Lat: <u>11</u> <u>°</u> <u>'</u> <u>"</u> Long: <u>12</u> <u>°</u> <u>'</u> <u>"</u>	
Transect Line No.: <u>12</u>		Line Length: <u>15</u> m		Line Survey Comment: (eg. location description) <u>16</u>			
Line Bearing: <u>13</u>		Line Spacing: <u>14</u> m					
Surveyors Names: <u>17</u>		Representative Tree/Patch # Height: <u>18</u> DBH: <u>19</u>		Access: (circle one) Hall OHV Truck Other <u>19</u>			

Tree or patch No.	Location (Degrees-minutes decimal) Lat (ex) 53 46.2345 Long (ex) -119 44.6862	Meters from line origin	# of attacked trees with LIVE brood marked for control				Estimated # of UA Trees	Species of Trees Attacked Whitebark Pine Lambert Pine Other
			Pink Flagging		Total			
			Green Needles	Red Needles				
20	Lat: <u>21</u> Long: <u>22</u>						24	25
Comments: <u>26</u>								
	Lat: <u>  </u> Long: <u>  </u>							
Comments								
	Lat: <u>  </u> Long: <u>  </u>							
Comments								
	Lat: <u>  </u> Long: <u>  </u>							
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Comments								
	Lat: <u>  </u> Long: <u>  </u>							
Comments								
	Lat: <u>  </u> Long: <u>  </u>							
Comments								

## Instructions for Transect Survey data sheet

1. Name of the Project, e.g. Willmore or Kananaskis. A project is a geographically defined area that contains several Infestations. Projects and Infestations are assigned by the Project Manager.
2. The beetle year begins August 15 of the current year and spans until August 14 the following year.
3. Name of ESRD corporate area, e.g. Foothills (SW3) or Clearwater (SW2)
4. The Project Manager is usually the Forest Health Officer for the corporate area.
5. The date (calendar year) the survey was conducted.
6. If you work for ESRD under a contract, indicate your contract number or company name. Indicate your full name.
7. The Infestation will be assigned by the Project Manager. E.g. Smoky River in the Willmore Project or Spray Lakes in the Kananaskis Project.
8. Site Number, e.g. 4.
9. Measure latitude and longitude of access location.<sup>1</sup> Record the positional accuracy of the GPS.
10. Enter the GPS location of the tree identified as the origin of the transect line.<sup>1</sup> Record the positional accuracy of the GPS.
11. Enter the GPS location of the tree identified as the end of the transect line.<sup>1</sup> Record the positional accuracy of the GPS.
12. Record the transect line number. Use a new data sheet for each transect line.
13. Record the transect line bearing and use a compass, not the GPS. Make sure your compass declination is set up properly. Check with the Project Manager for the correct setting.
14. Distance between transect lines in m.
15. Record the total length of transect line.
16. Record any comments about the site. Describe the site and how to get to it from the access, e.g. walk 50m from helipad.
17. Indicate names of surveyors.
18. Record the representative tree height and DBH for infested trees only. Record the tree number measured.
19. Circle the main mean of access.
20. Record tree or patch number (only unique number, i.e. 3 for the third tree/patch along transect line 1 at site number 5 labelled 2012 5-1-3). The next infested tree/patch will receive the next number in the sequence (e.g. 2012 4-1-4).
21. Record latitude and longitude of tree or patch.<sup>1</sup>
22. Distance from the origin of your transect line in m.
23. Count the number of trees with green needles (i.e. current attack) that are flagged pink. Count the number of trees with red needles that are flagged pink. Total the number of attacked trees. If there are no tallies, record a '0'.
24. Total the number of trees that require control (have pink flags). If there are no tallies, record a "0".
25. Of the total number of currently attacked trees how many are whitebark and how many are limber pine trees.<sup>2</sup>
26. Enter any comments about the tree or patch here. For example, if a large patch extends over two transect lines, indicate the other transect line it crosses. If trees are found all along the transect line and not in distinct patches spaced along the line, record this here. If you find a bait, remove it and bring it to the project manager. Record the bait number here.
27. If there are more trees to record for a transect line than can fit on the front page of the data sheet, continue on the back. Do not record more than one transect line on one data sheet.

<sup>1</sup> - in degrees/minutes/decimal minutes (hhdd°mm.mmm') using NAD 83

<sup>2</sup> - Forked trees should be counted by the number of stems below DBH (1.3m from the ground)

## 3. Walk Through Detection Survey

### Goal

To confirm the presence of MPB, the intensity of an infestation, the values at risk and the site/stand characteristics that may affect treatment tactics. This is a general overview of the damage in the management area in a relatively short period of time to help determine the best management strategies. The walk through detection survey may identify the need for a more detailed concentric or transect ground survey to identify attacked trees.

### Timing

To confirm the presence of MPB the survey should be conducted between Sept 15 and July 1 of the same beetle year. To assess attack in a stand to be harvested, the Walk Through Detection Survey could be conducted along with block layout after the beetle flight (Sept 15), as long as harvest is complete prior to next flight (July 1). If harvest is not completed until after the beetle flight (Sept 15), another survey will have to be conducted.

### Equipment

GPS, compass and map  
Knife/hatchet  
Pencil and notepad  
Data sheet

### Procedures

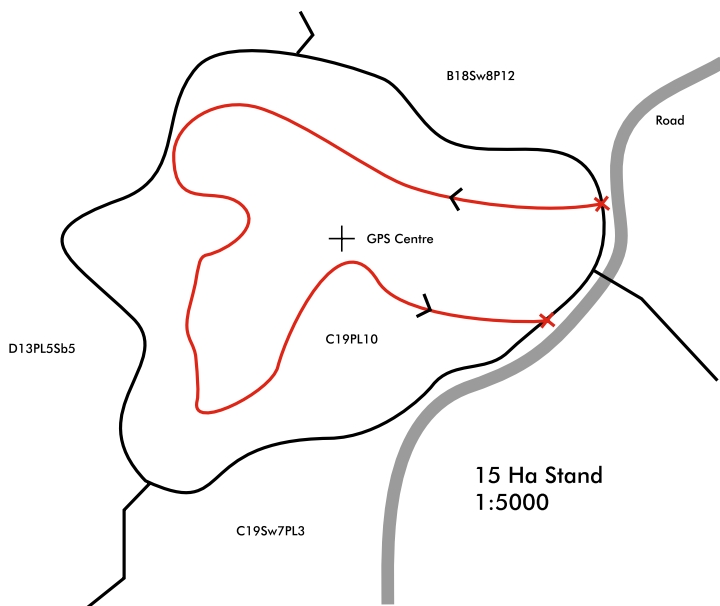
1. Walk through the block/stand/area to determine presence of MPB ensure thorough coverage to provide an accurate assessment. See example route below which illustrates the approximate amount of coverage required. Actual route walked will vary from stand to stand.
2. Target potential trees in stand for attack (forked trees, dry ridge, wood-pecker trees).
3. Keep track log on GPS of route walked.
4. Record GPS location of one tree or patch of infested tree in order for confirmation of infestation of stand.
5. Assess access and operability (existing access, slope, proximity of watercourses, etc.).

6. If required, assess stand characteristics (size, composition, density, tree age, etc.); and values at risk (fisheries, wildlife habitat, watershed, aesthetics, etc.).
7. If percent infested is the goal of the survey, run a compass line(s) through the stand counting the number of infested and uninfested pine found 1 meter on either side of the line. The length of line(s) should reflect the size of stand.

## Data Collection

Record location of confirmed MPB attack, percent infested area, and stand characteristics on the Walk Through Detection Survey data sheet.

## Sample Walk Through Detection Route



## Mountain Pine Beetle Walk Through Detection Survey

Project Name: \_\_\_\_\_ 1

Beetle Year: 2

Corporate Area: 3

Project Manager: \_\_\_\_\_ 4

Survey Date: \_\_\_\_/\_\_\_\_/\_\_\_\_  
vvvv mm dd

Infestation/FMU: 6

Surveyor names: 7

Block/Poly # 8

### Stand Characteristics

Access: Lat. 0 9 ' Long. 0 0 0

Site/Location Description: 11

☐ Heli   ☐ OHV   ☐ Truck   ☐ Other

Rep Tree #:	DBH:	Height:	12	Operability:	13
-------------	------	---------	----	--------------	----

## Causal Agent of Dead or Fading Pine

☐ MPB   ☐ Other, description: 14

## MPB Population Information (if possible)

Gallery formed ☐ Yes **15** ☐ No

Life Stages found: 16

### Individual Infested Patches

[illegible]

## Comments

23

## Stand Level MPB Infestation Assessment (if MPB widely distributed in Stand)

# of uninfested pine:	24	Infested Pine %:	26
-----------------------	----	------------------	----

# of infested pine:	Linear Meters Surveyed (2m. wide):
---------------------	------------------------------------

## Comments

28

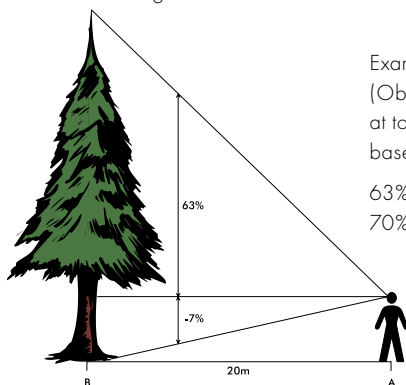
## Instructions for Walk Through Detection Survey data sheet

1. Name of the Project, e.g. Willmore or Kananaskis. A project is a geographically defined area that contains several Infestations.
2. The beetle year begins August 15 and spans until August 14 the following year.
3. Name of ESRD corporate area, e.g. Foothills (SW3) or Clearwater (SW2).
4. The Project Manager is usually the Forest Health Officer for the corporate area.
5. The date (calendar year) the survey was conducted.
6. The Infestation will be assigned by the Project Manager, e.g. Smoky River in the Willmore Project or Spray Lakes in the Kananaskis Project.
7. If you are an ESRD employee, indicate your name or if you work for ESRD under a contract, indicate your contract number or company name.
8. Record the Block or polygon number.
9. Measure latitude and longitude of the access location. Set your GPS to NAD83 and measure in degrees/minutes/decimal minutes (hddd°mm. mmm').
10. Check the main means of access.
11. Describe how to get to the stand from the access location recorded in 11, e.g. walk 50 m north from helipad, quad 25 km south of road, etc.
12. Record the representative tree height and DBH for infested trees only. Record the tree number measured.
13. Indicate if the site is operable or not.
14. Record the causal agent (reason) for the dead or fading pine at site.
15. If the causal agent is MPB, indicate if there are galleries formed.
16. Record any MPB life stages found e.g. adults, larvae etc.
17. Number the patches of infested trees found.
18. Surveyors do not record anything in this box. A FIRES number will be assigned by the ESRD designate if site is to be entered into the provincial database.
19. Record the number of current mass attacked trees with brood in the patch.
20. Record the number of UA (unsuccessful attacked) trees in the patch.
21. Measure latitude and longitude of the infested tree or patch of infested trees in the stand.
22. If the site is controlled, indicate the control date.
23. Record any comments about the infested trees.
24. Estimate the number of uninfested pine.
25. Estimate the number of infested pine.
26. Calculate the infested pine percent.
27. Record the number of linear meters surveyed.
28. Record any comments about the stand level infestation.

## Appendix 1

### Tree Height Calculation using a Clinometer

1. Stand a measured horizontal distance away from tree, making sure you can see both the top and the bottom clearly.
2. Sight the top of the tree for the top % reading.
3. Sight the bottom of the tree for the bottom % reading.
4. Calculate the total % height using the following formula:  $\% \text{ Top} - \% \text{ Bottom} = \text{Total \% height}$
5. Compute the tree height using the following formula:  $\text{Total \% Height} \times \text{horizontal distance} = \text{tree height}$

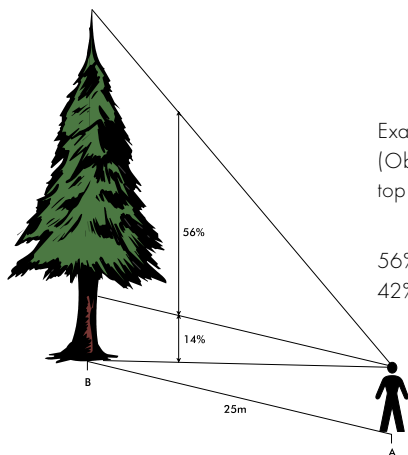


Example 1

(Observer looking up at top of tree **and** down base of tree)

$$63\% - (-7\%) = 70\%$$

$$70\% \times 20\text{m} = 14\text{m}$$



Example 2

(Observer looking up at top **and** base of tree)

$$56\% - (14\%) = 42\%$$

$$42\% \times 25\text{m} = 10.5\text{m}$$

## Appendix 2

### Performance Measures

Category	Allowable Error
Pitch tube judgment on unsuccessful attack	$\pm 5$ pitch tube
DBH measurement for unsuccessful attack	$\pm 1$ cm
Plot layout distance	$\pm 3$ m
Plot center GPS location (tree/patch location for transect)	$\pm 15$ m
Representative tree	$\pm 1$ cm DBH $\pm 2$ m Height
Stump Height	Height may vary by area but no more than 30cm bark height on remaining stump





## **Control Procedures**

### **Table of Contents**

	Page
1. Introduction	1
2. Locating trees to be treated	1
3. Treatments	2
3.1. Conventional fall and and burn	2
3.2. Conventional fall and peel	4
3.3. Rotary Wing Assisted Fall and Burn	5
3.4 Mechanical Fall and Burn	6
3.5 Whole tree chipping	7
4. Appendix 1: Control stump marking summary	11

# Control Procedures

## 1. Introduction

There are several different procedures that can be used to control MPB infestations. All of the procedures kill live beetles before they have a chance to develop and fly to new pine trees. The Project Manager may determine the technique to be used.

## 2. Locating trees to be treated

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hddd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude
2. The locations of treatment trees are recorded in one of two formats depending on how the stand was surveyed.
  - a. If using results from a concentric survey:
    - i) Locate the plot centre tree indicated on the MPB Concentric Ground Survey sheet. It will be flagged with red pest management flagging labelled with the beetle year, the site number, the words "PLOT CENTRE" and the survey date (e.g. 2012 137 Plot Centre Dec 13).
    - ii) All trees that are to be felled and burned will be flagged with pink pest management flagging and labelled with the beetle year, the site number, quadrant and tree number (e.g. 2012 137 NW1).
    - iii) Approximate locations of trees to cut will be indicated on the cross hair map of the MPB Concentric Ground Survey sheet (if less than 10 per quadrant).
  - b. If using the results of a transect survey:
    - i) Locate the tree/patch to be controlled by going to the GPS location supplied for each tree/patch in the transect area.
    - ii) All trees that are to be felled and burned will have been flagged with pink pest management flagging and labelled with the beetle year, the site number (and zone if used), transect line number, and tree/patch number (e.g. 2012 4-3-1).
    - iii) Red flags labelled with the beetle year, the site number (and zone if used), transect number and distance (e.g. 2012 5-1 50 m) are located every 50 m along the transect line. The end of a transect line is indicated by a double flagged tree (red) that is labelled with the beetle year, the word "END", site number (and zone letter if used), transect number and bearing (e.g. 2012 END 5-1 0°).

3. Extra treatment trees (i.e. trees with live MPB brood) found by the control crew that were not previously flagged with Pink pest Management flag are not allowed unless verified by QI or an ESRD representative.
4. Approved extra treatment trees must have a double vertical line marked with the chain saw on the bole and stump "II".
5. If there are excess treatment trees (pink flagged) in the field as compared to the survey sheet, the excess trees must be left in the quadrant indicated by the survey sheet. These extra treatment trees may be controlled once verified by QI or a department representative.

### 3. Treatments

#### 3.1 Conventional fall and burn

1. Fall, limb and buck treatment trees into manageable sized pieces.
2. Treatment tree must be bucked and limbed up to 10 cm diameter.
3. If it is necessary to cut trees that are not infested with MPB (incidental trees), trees must be cut to lie flat and bucked into maximum 8' sections. Stumps must be marked at the cut surface with a chainsaw single vertical line 'I'. Incidental trees are defined as being trees with >10cm dbh.
4. Stump heights for treatment and incidental trees must not exceed 30 cm at point of germination (see Appendix 1 for diagram) or as outlined in the control contract.
5. Using dead material and accelerant (oil, diesel fuel), build a fire. Once the fire is burning well, add treatment tree pieces.
6. Take care not to damage or scorch other standing trees in the area. If, on any conifer >15cm dbh, greater than 25% of the crown is scorched



**Figure 1** Pitch tubes on a tree attacked by mountain pine beetle.

or  $>0.5\text{m}^2$  (e.g. 40cm X 1.25m) of bole surface is scorched then the tree must be felled, limbed to lay flat and bucked into 8 foot sections.

7. Ensure fire remains burning by adding more dead material, limbs, etc.
8. Monitor the burning of the green pieces to ensure all the bark and cambium is completely destroyed. Pieces may need to be turned to ensure complete burning (Figure 2).
9. If the infested tree is not burned on the stump, all bark that is higher than 30 cm on the bole (from point of germination) must be removed.
10. Once burning is complete, take appropriate action to ensure the fire does not spread (Figure 4).
11. Complete the daily data entry requirements as specified in the contract (burn pile report, control summary, etc).



**Figure 2** Burn pile with infested logs. Rotate logs to ensure that all of the bark is burnt.

### 3.2 Conventional fall and peel

1. Fall pink flagged tree(s) and limb up to a top size of 10 cm.
2. If it is necessary to cut trees that are not infested with MPB (incidental trees), trees must be cut to lie flat and bucked into maximum 8' sections. Stumps must be marked at the cut surface with a chainsaw single vertical line 'I'. Incidental trees are defined as being trees with >10cm dbh.
3. Stump heights for treatment and incidental trees must not exceed 30 cm at point of germination (see Appendix 1 for diagram) or as outlined in the control contract.
4. Using a mechanical planer attachment on a chainsaw, drawknife or another acceptable tool, debark the tree completely up to a top size diameter of 10 cm.
5. Treatment trees must be bucked into maximum 8' sections.



**Figure 3** Left: Beetles can emerge from stumps if they are not treated. Right: Control crew member peeling a stump to ensure that beetles living in the stump cannot survive.



**Figure 4** After all the bark is burnt, spread the logs and ensure the fire is out.

6. Complete the Daily Control Report.
7. The Project Manager will provide direction on how to dispose of the bark and debris.

### **3.3 Rotary wing assisted fall and burn**

1. Pre-locate all burn pile locations. All burn pile locations must be pre-approved by the ESRD designate.
2. All pink flagged trees must be felled and must remain on site for a 24-48 hour period at the discretion of the ESRD designate to ensure that only treatment trees are being treated.
3. After trees have been felled and flown to the burn pile location, ignite fire and ensure that the bark and cambium of all infested trees is completely destroyed.
4. Tree must be treated up to 10 cm diameter or as per contract specification.

5. If it is necessary to cut trees that are not infested with MPB (incidental trees), trees must be cut to lie flat and bucked into maximum 8' sections. Stumps must be marked at the cut surface with a chainsaw single vertical line 'I'. Incidental trees are defined as being trees with >10cm dbh.
6. Stump heights for treatment and incidental trees must not exceed 30 cm at point of germination (see Appendix 1 for diagram) or as outlined in the control contract.
7. Take care not to damage or scorch other standing trees in the area. If, on any conifer >15cm dbh, greater than 25% of the crown is scorched or >0.5m<sup>2</sup> (e.g. 40cm X 1.25m) of bole surface is scorched then the tree must be felled, limbed to lay flat and bucked into 8 foot sections.
8. Complete the daily data entry requirements as specified in the contract (burn pile report, control summary, etc).

### **3.4 Mechanical Fall and Burn**

Mechanical fall and burn is characterized by the use of any type of machinery (other than a chainsaw) to cut or move trees.

1. Pre-locate access routes that are suitable for the equipment being used. Assess all water course crossings required for access. The location and type of all water course crossings to be constructed by the contractor requires pre-approval from the local ESRD designate, and shall follow section 6.0 and 11.4 of the Operating Ground Rules applicable to the area of work.
2. Information specific to the location and type of water course crossings, and the status/date of the construction or removal, must be submitted in the format and timeframe indicated by the ESRD designate. Be aware that crossings of industry dispositions may require industry approval. All approvals are the responsibility of the contractor. Be aware of all road use agreements and weight restrictions.
3. When choosing in-stand access trails, the ESRD expectation is to keep the number of incidental trees to a minimum. A recommended guideline is to choose routes that minimize the number of merchantable trees that are felled.
4. Rutting and ground disturbance must be kept to a minimum and must not exceed the requirements set out in section 9 of the Operating Ground Rules applicable to the area of work.



5. After trees have been felled and are at the burn pile location(s), ignite fire and monitor the burning of the treatment tree pieces to ensure all the bark and cambium is completely destroyed. Pieces may need to be turned to ensure complete burning.
6. Treatment trees must be treated up to 10 cm diameter or as per contract specification.
7. All incidental trees within the plot must be burned (to a 10cm top) to reduce debris and to facilitate quality inspection. Incidental trees outside the plot will be limbed to lie flat and bucked into 8' sections, and laid parallel to the trail if cut to access the plot. Incidental trees are defined as being trees with >10cm dbh.
8. Stump heights for treatment and incidental trees must not exceed 30 cm at point of germination (see Appendix 1 for diagram) or as outlined in the control contract.
9. Take care not to damage or scorch other standing trees in the area. If, on any conifer >15cm dbh, greater than 25% of the crown is scorched or >0.5m<sup>2</sup> (e.g. 40cm X 1.25m) of bole surface is scorched then the tree must be cut and burned (to a 10 cm top).
10. Complete the daily data entry requirements as specified in the contract (burn pile report, control summary, etc).

### **3.5 Whole tree chipping**

1. Pre-locate access routes that are suitable for the equipment being used. Assess water course crossings required for access. The location and type of all water course crossings to be constructed by the contractor requires pre-approval from the local ESRD designate, and shall follow section 6.0 and 11.4 of the Operating Ground Rules applicable to the area of work. Be aware that crossings of industry dispositions may require industry approval. All approvals are the responsibility of the contractor. Be aware of all road use agreements and weight restrictions.
2. When choosing in-stand access trails, the ESRD expectation is to keep the number of incidental trees to a minimum. A recommended guideline is to choose routes that minimize the number of merchantable trees that are felled.
3. Rutting and ground disturbance must be kept to a minimum and must not exceed the requirements set out in section 9 of the Operating Ground Rules applicable to the area of work.

4. Treatment trees must be treated up to 10 cm diameter or as per contract specification.
5. Stump heights for treatment and incidental trees must not exceed 30 cm at point of germination (see Appendix 1 for diagram) or as outlined in the control contract.
6. If it is necessary to cut trees that are not infested with MPB (incidental trees), all incidental trees within or outside the plot must be limbed to lie flat and bucked into 8' sections. Incidental trees are defined as being trees with >10cm dbh.
7. The chip mat cannot exceed 10cm. Chips must be spread out as widely and as evenly as possible. Chip size must not exceed 5.1cm in width and 24cm in length with both bark and sapwood attached.
8. Complete the daily data entry requirements as specified in the contract (burn pile report, control summary, etc).

**Control Procedures**  
Rev.2013

## Instructions for filling in the MPB Daily Control report

1. Name of the Project. A project is a geographically defined area that contains several Infestations. Projects and Infestations are assigned by the Project Manager.
2. Name of ESRD corporate area, e.g. Foothills (SW3) or Clearwater (SW2).
3. If you work for ESRD under a contract, indicate your contract number.
4. Record the name of your company.
5. The date the datasheet was posted to the MPB Operations SharePoint site.
6. Site/Patch Number, as per the survey card e.g. 4.
7. Date the activity took place.
8. Indicate the control treatment type used.
9. Number of trees felled is the number of pink flagged trees at the site that were felled that day.
10. Record the number of trees flown from the site to the heli-assist burnpile.
11. Number of trees controlled is the number of trees controlled that day. This may be different than the number felled (less than if not all trees felled were treated that day).
12. Additional trees may not be allowed and will be discussed in the contract.
13. Record the number of burn piles established at the site that day.
14. Site complete will be checked off only when infested trees have all of bark and cambium completely destroyed (or as per chip size standards when chipping). Site complete status will be checked only for the day (row) when all work was completed. Keep previous row entries for the site unchecked.
15. Check once burn pile is extinguished
16. Check if the control completed was due to a "Follow-up Required" by QI.
17. Check if the site was inspected by the internally Quality Checker.
18. Indicate if the survey card was incorrect.
19. Record the controller names and any comments regarding the site.

### General Instructions

1. MPB Daily Control Report is to be updated daily then uploaded to SharePoint. Upload as excel file, do not convert to PDF. Update 'Posted Date' in the header information prior to uploading.
2. Each row is to only includes the work completed that day - numbers are not cumulative (this applies to all columns reporting tree numbers or establishment of burn piles).
3. Keep spreadsheet sorted by ascending Site/Patch #, and then by ascending Date.
4. For Sites/Patches with multiple row entries (e.g. at a 10 tree site you felled 10 trees on Feb 2, and controlled 10 trees on Feb 3), the final row entry of the site is the only one where 'Site Complete' will be 'Y'.
5. Insert/add rows as required. Note - check boxes must be copied and pasted to new row(s).
6. Do not delete sites from the list once control is complete or pile is extinguished.

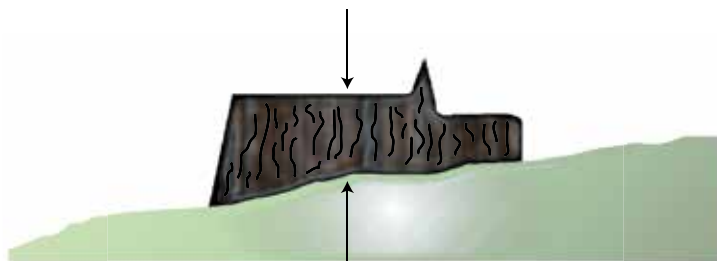
## Appendix 1

### Control Stump Marking Summary

STUMP MARKING SUMMARY	
Treatment Type	Stump Markings
Treatment (pink flagged)	Burned or debarked above 30 cm (from point of germination)
Extra Treatment	II
Non MPB (e.g. hazard trees)	I

### Stump Height Measurement at Point of Germination

Measure stump height at the point of germination, and to the midpoint of the undercut and back cuts if the cuts are uneven.



tab page

back of tabbed page

## **Quality Inspection**

### **Table of Contents**

	Page
1. Level 1 Survey QI Procedures	1
2. Level 1 Control QI Procedures	7
3. Aerial Survey QI Procedures	17
4. Green:Red QI Procedures	19



# 1. Level 1 Survey Quality Inspection Procedures

## Goal

15% of all surveyed sites or surveyed meters should be inspected for accuracy and quality of information. Inspectors should follow closely behind the crews (target maximum three day lag) to determine if there are any deficiencies in detection or plot layout. Follow-up may also be required on additional plots.

## Timing

While surveys operations are ongoing.

## Equipment

GPS, compass, map

Yellow, red, pink pest management flagging tape

Data sheets

Black permanent marker and pencil

Camera

Knife/hatchet

## Procedure

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hddd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude.
2. QI should follow closely behind the crews to ensure inspections are distributed throughout each infestation, or as directed by the Project Manager.
3. Hang yellow pest management flagging at plot center or line origin. Indicate QI crew names and QI survey date.
4. Assign all applicable deficiencies to the plot. Quality Inspectors are to fix deficiencies in the parent plot during check and apply demerits accordingly.
5. If inspecting transect surveys, QI must inspect entire lines instead of portions of lines.
6. Assess the following:
  - Field Inaccuracies
    - a) Missed Treatment Tree
      - Missed a tree that meets the pink flagged thresholds (>40 entrance holes, >15cm)

- Double numbered and/or not tallied correctly (e.g. two trees of NW2, 12 trees in the forest; only 11 recorded on total of tally sheet)
  - Number of deficiencies equals number of occurrences
- b) Excess Treatment Tree
- Tree is flagged pinked but does not meet threshold
  - Tree tallied on data sheet but doesn't exist in field
  - Tree not tallied on data sheet but exists in field, and does not meet pink flag thresholds
  - Number of deficiencies equals number of occurrences
- c) Plot Center tree (or line origin/end) not to standard
- Infested tree as plot center tree (or line origin/end)
  - No double ribbon
  - Majority of plot located in non-pine area (<25% pine composition of stems >15cm DBH)
  - Location of plot center tree results in plot being partially located within a permanent sample plot
  - Number of deficiencies equals number of occurrences
- d) Plot/line layout
- Plot layout ribbons in wrong locations (distance from plot centre)
  - Plot layout flagging on infested tree
  - Number of deficiencies equals number of occurrences
- e) Incomplete coverage of survey area
- Be absolutely certain that surveyors have not checked whole plot regardless whether missed pink flagged trees are found or not (i.e. no tracks in snow)
  - Maximum one occurrence
- f) Representative tree diameter/height inaccurate
- Measurements are outside of allowable error margins
  - Maximum 2 occurrences
- g) Representative tree not representative
- Broken top
  - Gross misjudgement of rep tree selection
  - Maximum one occurrence
- h) Ribboning/Labeling error
- Missing or incorrect information on plot layout flagging (e.g., plot number, beetle year, direction, distance) (max one occurrence per error type e.g. wrong beetle year on 9 plot layout ribbons = 1 occurrence)

- Two trees with same tree number (number of deficiencies equals number of occurrences i.e. 2 tree NW3 = 1 occurrence, 2 tree NW3 and 2 tree NW7 = 2 occurrences etc.)
- Missing tree number on flagging (number of deficiencies equals number of occurrences)
- Skipped a tree number (NE3, NE5) (occurrence # based on # of deficiencies)
- Wrong ribbon colour used (maximum one occurrence)
- Treatment tree flagging not oriented with knot facing plot centre (occurrence # based on # of deficiencies)

#### Plot Card Inaccuracies

- i) Form not filled out to standard or illegible
  - Helipad or other forms of access not identified properly (i.e. is the access recorded? Does the record match the site?)
  - GPS records given in the incorrect units
  - Empty fields on the data sheet where there should be "0"s
  - Surveyor writing illegible
  - Incorrect site number (e.g., two site numbers are mixed up but all other data is correct)
  - Number of deficiencies based on number of occurrences
- j) Field Map
  - Did not map infested trees properly (location of dots when <10 trees)
  - Did not map when should have (less than 10 trees)
  - Quadrant tally incorrect (but total number of trees correct)
  - Did not map rep tree location on field map
  - Number of deficiencies based on number of occurrences
- k) Incorrect plot centre (or tree/patch) coordinates (>±1.5m)
  - Maximum one occurrence
- l) Incorrect access coordinates (>±1.5m)
  - Maximum one occurrence

#### Data Inaccuracies and data management

- m) Scanning and posting of cards (>24 hr)
  - Maximum one occurrence
- n) Database entry timeline (>24 hr)
  - Maximum one occurrence

- o) Data entry error
  - FIRES data not matching data sheet
  - Number of deficiencies based on number of occurrences
- p) In progress sites not marked complete within 72 hours
  - Maximum one occurrence

Other areas of concern

- q) Baits not collected and/or baited tree not re-flagged
    - Maximum 2 occurrences
  - r) Garbage located on site
    - Take pictures
    - Maximum one occurrence
7. Indicate deficiencies on the Survey Quality Inspection data sheet and correct the original survey data sheet where necessary. Initial any changes made to the original survey data sheet.
  8. Hang yellow pest management flagging on tree, if applicable, with deficiency. Indicate in writing on yellow flagging what deficiency was found (e.g. "missed treatment tree"). Hang the correct pest management flagging, if applicable, to correct the deficiency.
  9. QI will only call for a follow up survey in the following situations:
    - a) there are missed trees in the mini-survey triggering an additional plot to be surveyed, or
    - b) the plot is at an incorrect location or the additional plot has been placed in an incorrect location.
  10. ESRD designate to mark in FIRES any additional plots for follow-up based on poor QI assessments (e.g. completed by same crew, etc.). Although the plot marked for follow-up was not visited in the field, a QI assessment will be created with the comments indicating that follow-up is based on poor QI assessment on another plot (referenced) completed.

## **Instructions for filling in the Concentric Survey Quality Inspection data sheet**

1. Name of the Project you are working on, e.g. Willmore or Kananaskis. A project is a geographically defined area that contains several Infestations.
2. The beetle year begins August 15 and spans until August 14 the following year.
3. Name of SRD corporate area, e.g. Foothills (SW3) or Clearwater (SW2).
4. The Project Manager is usually the Forest Health Officer for the corporate area.
5. The date the inspection was conducted (yyyy mm dd).
6. Indicate if you are an SRD employee, or if you work for SRD under a contract. Provide your contract number or company name.
7. Indicate full name(s) of inspector(s).
8. Circle the appropriate status of the plot In progress – if the inspection was conducted as mentoring on a site as the survey was being completed Complete – if the inspection was conducted on a site marked as complete by the surveyor.
9. The Infestation will be assigned by the Project Manager. E.g. Smoky River in the Willmore Project or Spray Lakes in the Kananaskis Project.
10. Site number, e.g. 4
11. If coordinates for access must be corrected and positional accuracy of GPS.
12. If coordinates for plot center must be corrected and positional accuracy of GPS.
13. If representative tree measurements must be corrected.
14. Mark appropriate field inaccuracies and number of occurrences.
15. Mark appropriate plot card inaccuracies and number of occurrences.
16. Mark appropriate data inaccuracies and data management issues and number of occurrences.
17. Mark appropriate other areas of concern and number of occurrences.
18. Include comments to provide additional or supporting information related to inaccuracies.
19. Check the box if no deficiencies found or follow up required.

# Mountain Pine Beetle Level 1 Concentric Survey Quality Inspection (QI)

Project Name: _____	1	Beetle Year: _____	2	No deficiencies	19
Corporate Area: _____	3	Project Manager: _____	4	Follow up required	
Inspection date: _____	5	Contract #/Company Name: _____	6		
Inspector 1: _____	7	Inspector 2: _____	8		
Infestation: _____	9	MPB Site #: _____	10	Survey site status: In Progress/ Complete	
Revised access coordinates: _____	11	Lat. _____ Long. _____		Positional accuracy of field checks	±m
Revised concentric centre coordinates: _____	12	Lat. _____ Long. _____		Positional accuracy of field checks	±m
Revised representative tree measurements: _____	13	Height _____ m DBH _____ cm			

## FIELD INACCURACIES

Type	Check if applicable	Number of Occurrences
Missed treatment tree	<input type="checkbox"/>	green 14 red
Excess treatment tree	<input type="checkbox"/>	
Plot centre tree not to standard	<input type="checkbox"/>	
Plot layout	<input type="checkbox"/>	
Incomplete coverage of survey area	<input type="checkbox"/>	
Representative tree diameter/height inaccurate	<input type="checkbox"/>	
Representative tree not representative	<input type="checkbox"/>	
Ribbing/Labeling error	<input type="checkbox"/>	

## DATA INACCURACIES & DATA MANAGEMENT

Type	16	Check if applicable	Number of Occurrences
Scanning and posting of card (>24 hr)		<input type="checkbox"/>	
Database entry timeline (<24 hr)		<input type="checkbox"/>	
Data entry error		<input type="checkbox"/>	
In progress sites not marked complete within 72 hrs		<input type="checkbox"/>	

## OTHER AREA OF CONCERN

Type	17	Check if applicable	Number of Occurrences
Baits not collected and/or baited tree not re-flagged		<input type="checkbox"/>	
Garbage located onsite		<input type="checkbox"/>	

## PLOT CARD INACCURACIES

Type	15	Check if applicable	Number of Occurrences
Form not filled out to standard or illegible		<input type="checkbox"/>	
Field map		<input type="checkbox"/>	
Incorrect plot centre coordinates (>+/-15m)		<input type="checkbox"/>	
Incorrect access coordinates (>+/-15m)		<input type="checkbox"/>	

## COMMENTS

18

## **Instructions for filling in the Transect Survey Quality Inspection data sheet**

1. Name of the Project you are working on, e.g. Willmore or Kananaskis. A project is a geographically defined area that contains several Infestations.
2. The beetle year begins August 15 and spans until August 14 the following year.
3. Name of SRD corporate area, e.g. Foothills (SW3) or Clearwater (SW2).
4. The Project Manager is usually the Forest Health Officer for the corporate area.
5. The date the inspection was conducted (yyyy mm dd).
6. Indicate if you are an SRD employee, or if you work for SRD under a contract. Provide your contract number or company name.
7. Indicate full name(s) of inspector(s).
8. The Infestation will be assigned by the Project Manager. E.g. Smoky River in the Willmore Project or Spray Lakes in the Kananaskis Project.
9. MPB Site number, e.g. 36
10. Transect line number, e.g. 4
11. Meters checked, e.g. 0m to 475m
12. Total meters checked, e.g. 475m
13. Circle the appropriate status of the survey line. In progress – if the inspection was conducted as mentoring on a site as the line was being completed.  
Complete – if the inspection was conducted on a line marked as complete by the surveyor.
14. If coordinates for access must be corrected and positional accuracy
15. If coordinates for line origin must be corrected and positional accuracy of GPS.
16. If coordinates for line end must be corrected and positional accuracy of GPS.
17. Indicate revised line length if appropriate.
18. If representative tree measurements must be corrected.
19. Mark appropriate field inaccuracies and number of occurrences.
20. Mark appropriate plot card inaccuracies and number of occurrences.
21. Mark appropriate data inaccuracies and data management issues and number of occurrences.
22. Mark appropriate other areas of concern and number of occurrences.
23. Include comments to provide additional or supporting information related to inaccuracies.
24. Check the box if no deficiencies found or follow up required.

## Mountain Pine Beetle Level 1 Transect Survey Quality Inspection (QI)

Project Name: _____	1	Beetle Year: _____	2	No deficiencies	24
Corporate area: _____	3	Project Manager: _____	4	Follow up required	
Inspection date: _____	5	Contract #/Company Name: _____	6		
Inspector 1: _____	7	Inspector 2: _____	9		
Infestation: _____	8	MPB Site #: _____	10		
Meters Checked: _____	11	Total Meters Checked: _____ m	12		
Revised access coordinates: _____	14	Lat. _____ Long. _____		Positional accuracy of field checks _____ ±m	
Revised origin coordinates: _____	15	Lat. _____ Long. _____		Positional accuracy of field checks _____ ±m	
Revised end coordinates: _____	16	Lat. _____ Long. _____		Positional accuracy of field checks _____ ±m	
Revised line length: _____	17	18 Revised representative tree measurements:			
		Height _____ m	DBH _____ cm		

## 21 DATA INACCURACIES & DATA MANAGEMENT

Type	Check if applicable	Number of Occurrences
Scanning and posting of card (>24 hr)	<input type="checkbox"/>	
Database entry timeline (>24 hr)	<input type="checkbox"/>	
Data entry error	<input type="checkbox"/>	
In progress sites not marked complete within 72 hrs	<input type="checkbox"/>	

**22 OTHER AREA OF CONCERN**

Type	Check if applicable	Number of Occurrences
Baits not collected and/or baited tree not re-flagged	<input type="checkbox"/>	
Garbage located on site	<input type="checkbox"/>	

## COMMENTS 23


## 19 FIELD INACCURACIES

Type	Check if applicable	Number of Occurrences	
		green	red
Missed treatment tree	<input type="checkbox"/>		
Excess treatment tree	<input type="checkbox"/>		
Plot origin/seed tree not to standard	<input type="checkbox"/>		
Line layout	<input type="checkbox"/>		
Incomplete coverage of survey area	<input type="checkbox"/>		
Representative tree diameter/height inaccurate	<input type="checkbox"/>		
Representative tree not representative	<input type="checkbox"/>		
Ribboning/Labelling error	<input type="checkbox"/>		

## 20 PLOT CARD INACCURACIES

Type	Check if applicable	Number of Occurrences
Form not filled out to standard or illegible	<input type="checkbox"/>	
Field map	<input type="checkbox"/>	
Incorrect tree/patch coordinates (>+/-15m)	<input type="checkbox"/>	




# Level 1 Control Quality Inspection Procedures

## Goal

15% of all Level I control treatments must be inspected. Inspectors should follow closely behind the control crews (target a maximum three day lag) to determine if there are any deficiencies within or outside the plot related to control treatments ground rule standards, or other areas of concern.

## Timing

While control operations are ongoing.

## Equipment

GPS, compass, map

Yellow, red, pink pest management flagging tape

Data sheets

Black permanent marker and pencil

Camera

Knife/hatchet

Tape measure

## Procedure for Conventional Fall and Burn/Fall and Peel

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hddd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude.
2. QI should follow closely behind the crews to ensure inspections are distributed throughout each infestation, or as directed by the Project Manager.
3. Assess the following:
  - a) Treatment tree(s) not controlled to standard
    - Pink flagged not felled, flown or controlled to standard.Reasons pink flag trees are considered not controlled to standard:
    - Bark and cambium not completely destroyed (if burning) (includes stump untreated above 30cm)
    - Bark still attached (if peeling) (includes stump untreated above 30cm)
    - Debris not disposed of according to instructions (if peeling)
    - Tree not controlled to a 10 cm top

- b) Other areas of concern
  - Scorched tree not felled, limbed to lay flat, bucked into 8 foot sections
  - Incidental tree (>10cm dbh) not limbed to lie flat or not bucked into 8' sections
  - Stump of treatment or incidental tree >30cm height
  - Danger tree located on site or at burn pile location
  - Stump of incidental tree not marked with a chainsaw "I"
- c) Data entry and data management
  - Scanning and posting of cards (>24 hr)
  - Database entry timeline (>24 hr)
  - Data entry error
  - In progress sites not marked complete within contract specific timeframe
  - Garbage located on site
- 4. Indicate deficiencies on the Control Quality Inspection data sheet.
- 5. If there are any trees with current attacks that were not flagged by the survey crews, record the information on the Survey Quality Inspection data sheet, not on the Control Quality Inspection data sheet.
- 6. QI will only call for a follow up control in the following situations:
  - a) Treatment tree(s) not controlled to standard
  - b) Scorched tree not felled, limbed to lay flat, or bucked into 8 foot sections
  - c) Incidental tree (>10cm dbh) not limbed to lie flat or not bucked into 8' sections
  - d) Stump of treatment or incidental tree >30cm height

## **Procedure for Mechanical Fall and Burn**

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hdd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude.
2. QI should follow closely behind the crews to ensure inspections are distributed throughout each infestation, or as directed by the Project Manager.
3. Assess the following:
  - a) Treatment tree(s) not controlled to standard
    - Pink flagged not felled, flown or controlled to standard
 Reasons pink flag trees are considered not controlled to standard:
    - Bark and cambium not completely destroyed (includes stump untreated above 30cm)
    - Tree not controlled to a 10 cm top

- b) Other areas of concern
    - Scorched tree not felled, limbed to lay flat, or bucked into 8 foot sections
    - Incidental tree (>10cm dbh) not limbed to lie flat or not bucked into 8' sections
    - Incidental tree (>10cm dbh) within the plot not burned to a 10 cm top (mechanical only)
    - Stump of treatment or incidental tree >30cm height
    - Danger tree located on site or at burn pile location
    - Chip mat exceeds 10cm in depth
    - Garbage located on site
  - c) Ground Rule Standards
    - Watercourse crossing not installed or removed as per ground rule standard
    - Rutting or ground disturbance exceeds ground rule standard
  - d) Data inaccuracies and data management
    - Scanning and posting of cards (>24 hr)
    - Database entry timeline (>24 hr)
    - Data entry error
    - In progress sites not marked complete within contract specific timeframe
4. Indicate deficiencies on the Control Quality Inspection data sheet.
  5. If there are any trees with current attacks that were not flagged by the survey crews, record the information on the Survey Quality Inspection data sheet, not on the Control Quality Inspection data sheet.
  6. QI will only call for a follow up control or remedial work in the following situations:
    - a. Treatment tree(s) not controlled as per standard
    - b. Scorched tree not felled, limbed to lay flat and bucked into 8 foot sections
    - c. Incidental trees not disposed of as per standard
    - d. Watercourse crossing not installed or removed as per ground rule standard
    - e. Rutting or ground disturbance exceeds ground rule standard
    - f. Stump of treatment or incidental tree >30cm height

## Procedure for Rotary Wing Assisted Fall and Burn

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hddd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude.
2. QI should follow closely behind the crews to ensure inspections are distributed throughout each infestation, or as directed by the Project Manager.
3. Assess the following:
  - a) Treatment tree(s) not controlled to standard
    - Pink flagged not felled, flown or controlled to standardReasons pink flag trees are considered not controlled to standard:
    - Bark and cambium not completely destroyed (includes stump untreated above 30cm)
    - Tree not controlled to a 10 cm top
  - b) Other areas of concern
    - Scorched tree not felled, limbed to lay flat and bucked into 8 foot sections
    - Incidental tree (>10cm dbh) not limbed to lie flat or not bucked into 8' sections
    - Stump of treatment or incidental tree >30cm height
    - Danger tree located on site or at burn pile location
    - Stump of incidental tree not marked with a chainsaw "I"
    - Garbage located on site
  - c) Data entry and data management
    - Scanning and posting of cards (>24 hr)
    - Database entry timeline (>24 hr)
    - Data entry error
    - In progress sites not marked complete within contract specific timeframe
4. Indicate deficiencies on the Control Quality Inspection data sheet.
5. If there are any trees with current attacks that were not flagged by the survey crews, record the information on the Survey Quality Inspection data sheet, not on the Control Quality Inspection data sheet.
6. QI will only call for a follow up control in the following situations:
  - a. Treatment tree(s) not controlled to standard
  - b. Scorched tree not felled, limbed to lay flat and bucked into 8 foot sections
  - c. Incidental tree (>10cm dbh) not limbed to lie flat or not bucked into 8' sections
  - d. Stump of treatment or incidental tree >30cm height

# Procedures for Whole Tree Chipping

## Background

Trees infested with MPB can be controlled by chipping them into small enough pieces so that the number of surviving beetles, larvae or pupae is sufficiently reduced to prevent further infestation of healthy trees. During the chipping process the beetles are mechanically destroyed or die due to starvation, desiccation or freezing. All trees must be completely chipped as per the contract specifications.

## Goal

At least 15% of all sites controlled by chipping infested trees should undergo Quality Inspection. The Quality Inspection should be conducted within the first three days of chipping commencement to ensure the standard is being met. Quality Inspection should be conducted on a regular basis to ensure operators' performance does not compromise the standard.

## Equipment

Datasheet

Pencil

Permanent Marker

Disk 5.1cm (2 inches) in diameter or a screen\* of 5.1cm

Tape measure (at least 1m long)

4 liter bucket (for example, an ice cream pail)

Plastic bags

Calculator if necessary

*\*Please note, the contractors are required to supply a screen as part of their contracts*

## Procedures

1. Look over the entire site for large pieces that are greater than 24cm long and 5.1cm in width with both bark and sapwood attached. If the site is very large, a smaller sampling area can be identified where the number of infested trees to be treated is known.
2. Assess the large pieces for evidence of attack (pitch tubes, entrance holes, blue stain, or beetle life-stages).

3. If there is one piece with intact bark that is larger than 1m long and 5.1cm in width with evidence of attack, the site was not adequately treated. If there are more than 5 pieces larger than 24cm in length and 5.1cm in width per tree, with intact bark and evidence of attack, the site was not adequately treated.
4. Gather two buckets of chips per tree. Sample at least 10% of the trees at a site. Scoop chips into a 4 litre bucket from random places of the chip pile. If the chips are spread over a large area and not in discrete piles, collect a representative sample of the chips from the entire site.
5. a) If using a screen with 5.1cm mesh size: Run the collected chips through the screen. Rotate the chips caught on the screen to allow all chips that fit through the holes to fall through. Count the number of chips with bark and sapwood attached that do not fall through the screen.  
 b) If using a disk 5.1cm in diameter: Compare all chips in the bucket with bark and sapwood attached with the disk. If the chip is larger than the disk, test whether it exceeds the size of the disk in two perpendicular directions (i.e. in width and length). Count the number of chips exceeding 5.1cm in both width and length. Average the number for all bucket samples. The thresholds for acceptable treatment are the following (also see Table 1):
  - Holding Zone: 10 chips with bark and sapwood greater than 5.1cm in width and length
  - Leading Edge Zone: 5 chips with bark and sapwood greater than 5.1cm in width and length

**Table 1** Bark chip thresholds for acceptable treatment of MPB infested sites

Length	Width	Other criteria	Thresholds for acceptable treatment
Greater than 5.1cm	Greater than 5.1cm	Sapwood and bark attached	Leading Edge: 5 chips on average per 4 L bucket sample Holding Zone: 10 chips on average per 4 L bucket sample
Greater than 24cm but smaller than 1m	Greater than 5.1cm	Sapwood and bark attached with evidence of attack	5 pieces per tree
Greater than 1m	Greater than 5.1cm	-----	0 pieces per site

6. If the average number of chips larger than 5.1cm exceeds the threshold, collect the chips that exceeded 5.1cm from each bucket and put them into a plastic bag. Label the bag with the site number and sample number, e.g. 1734-1.
7. Assess the following:
  - a) Treatment tree(s) not controlled to standard
    - Pink flagged not felled, flown or controlled to standard
 Reasons pink flag trees are considered not controlled to standard:
    - Tree not controlled to a 10 cm top
    - Stump not treated above 30cm
    - Chips exceed size/quantity threshold - include comments
  - b) Other areas of concern
    - Incidental tree (>10cm dbh) not limbed to lie flat or not bucked into 8' sections
    - Stump of treatment or incidental tree >30cm height
    - Danger tree located on site or at burn pile location
    - Stump of incidental tree not marked with a chainsaw "I"
    - Chip mat exceeds 10 cm depth
    - Garbage located on site
  - c) Ground Rule Standards
    - Watercourse crossing not installed or removed as per ground rules
    - Rutting or ground disturbance exceeds ground rule standard
  - d) Data entry and data management
    - Scanning and posting of cards (>24 hr)
    - Database entry timeline (>24 hr)
    - Data entry error
    - In progress sites not marked complete within contract specific timeframe
8. Indicate deficiencies on the Control Quality Inspection data sheet.
9. If there are any trees with current attacks that were not flagged by the survey crews, record the information on the Survey Quality Inspection data sheet, not on the Control Quality Inspection data sheet.
10. QI will only call for a follow up survey in the following situations:

- a) Treatment tree(s) not controlled to standard
- b) Incidental tree (>10cm dbh) not limbed to lie flat or not bucked into 8' sections
- c) Chip mat exceeds 10 cm depth
- d) Watercourse crossing not installed or removed as per ground rules
- e) Rutting or ground disturbance exceeds ground rule standard
- f) Stump of treatment or incidental tree >30cm height



## **Instructions for filling in the Control Quality Inspection data sheet**

1. Name of the Project you are working on, e.g. Willmore or Kananaskis. A project is a geographically defined area that contains several Infestations.
2. The beetle year begins August 15 and spans until August 14 the following year.
3. Name of ESRD corporate area, e.g. Foothills (SW3) or Clearwater (SW2).
4. The Project Manager is usually the Forest Health Officer for the corporate area.
5. The date (calendar year) the survey was conducted (yyyy mm dd)
6. Indicate if you are an ESRD employee, or if you work for ESRD under a contract. Provide your contract number or company name.
7. Indicate full name(s) of inspector(s).
8. The Infestation will be assigned by the Project Manager, e.g. Smoky River in the Willmore Project or Spray Lakes in the Kananaskis Project
9. Site Number, e.g. 4
10. Indicate the appropriate control type.
11. Mark number of pink flagged trees not felled, not flown, or not controlled. Mark number of missed (+) or excess (-) trees. Mark # of stumps not treated above 30cm.
- 12-14. Check boxes for any of the listed deficiencies, as well as the number of occurrences. Provide comments.
15. Provide further details in the comments field.
16. Check the box if no deficiencies found or follow up required.

# Mountain Pine Beetle Level 1 Concentric Control Quality Inspection (QI)

Project Name: 1 Beetle Year: 2 4 No deficiencies 16  
 Corporate Area: 3 Project Manager: 4 Follow up required  
 Inspection date: 5 Contract #/Company Name: 6  
 Inspector 1: 7 Inspector 2: \_\_\_\_\_  
 Infestation: 8 MPB Site #: 9  
 Control type (circle): 10 Conv. fall & burn Conv. fall & burn Mechanical fall & burn Whole tree chipping Other

## TREATMENT TREES NOT CONTROLLED TO STANDARD

# of Stumps (over 30cm) Not Treated Properly			
# of Stumps (over 30cm) Not Treated Properly			
Not Felled	Not Flown	Not Controlled	Not Treated Properly

Reasons pink flag trees are considered "Not Controlled":

- Bark and cambium not completely destroyed (if burning)
- Bark still attached (if peeling)
- Debris not disposed of according to instructions (if peeling)
- Tree not controlled to a 10 cm top
- Chips exceed size/quantity threshold (if whole tree chipping) - include comments

## GROUND RULE STANDARDS (Specific to mechanical or chipping operations)

Type	Check if applicable	Number of Occurrences
Watercourse crossing not installed or removed as per ground rule standard	<input type="checkbox"/>	
Rutting or ground disturbance exceeds ground rule standard	<input type="checkbox"/>	

## DATA INACCURACIES & DATA MANAGEMENT

Type	Check if applicable	Number of Occurrences
Scanning and posting of cards (>24 hr)	<input type="checkbox"/>	
Database entry timeline (>24 hr)	<input type="checkbox"/>	
Data entry error	<input type="checkbox"/>	
In progress sites not marked complete in given time	<input type="checkbox"/>	

## COMMENTS

15

## OTHER AREAS OF CONCERN

Type	Check if applicable	Number of Occurrences
Scorched tree not felled, limbed to lay flat, or bucked into 8' sections	<input type="checkbox"/>	
Incidental tree not limbed to lie flat or not bucked into 8' sections	<input type="checkbox"/>	
Incidental tree within the plot not burned to a 10cm top (mechanical only)	<input type="checkbox"/>	
Stump of treatment or incidental tree >30cm height	<input type="checkbox"/>	
Danger tree located on site or at burn pile location	<input type="checkbox"/>	
Stump of incidental tree not marked with a chainsaw 'T'	<input type="checkbox"/>	
Chip mat exceeds 10 cm in depth	<input type="checkbox"/>	
Garbage located on site	<input type="checkbox"/>	

## 3. Aerial Survey Quality Inspection Procedures

### Goal

Inspectors should follow closely behind the crews to determine if there are any deficiencies in detection or accuracy.

### Timing

While surveys are ongoing.

### Equipment

GPS, compass, map

Camera

Knife/hatchet

### Procedure

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hddd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude.
2. 100% of the area identified by the Project Manager must be surveyed. Determine the extent of the surveys by creating and reviewing a map with the identified area and surveyor track logs. Area GIS support may be necessary for mapping.
3. In the Primary and Secondary Areas 10% and 5% of the sites/area respectively must be surveyed. The Project Manager will randomly determine the location of the sites to be inspected.
4. Assess the following from the air:
  - ~ Are tree counts accurate?
  - ~ Were there sites missed?
  - ~ Do the polygon boundaries encompass all the infested trees?
  - ~ Is the polygon infestation level accurate?
  - ~ Do the sites GPSed follow instructions from Project Manager regarding the number of trees to survey?
5. If deficiencies are found, 5 - 10 additional sites of that surveyors sites will be audited. If all additional sites fail, that surveyor will be removed from the survey project and lose certification. That surveyor must be replaced with another certified surveyor. If less than all the sites fail, corrective action or removal from the project will be at the discretion of the Project Manager

6. The Quality Inspector will record missed patches of red and/or fading trees. If deficiencies are found, corrective action or removal from the project will be at the discretion of the Project Manager

### **Performance Measures**

- Polygon boundaries must encompass all fading/red trees
- Polygon infestation severity estimated must be within +/- 10%
- A minimum number of sites must be ground truthed for mortality agent. This number will be set locally.
- If surveys are completed after September 1, G:R surveys may need to be conducted as per direction of the Project Manager

### **Primary Area**

- Tree Counts
  - ~ 1 or 2 trees: +/- 0 trees
  - ~ 3 - 10 trees: +/- 1 tree
  - ~ 11 - 24 trees: +/- 4 trees
  - ~ 25+: +/- 10 trees
- Patches of 3 or more trees only are to be GPSed unless Program Manager directs surveyor to GPS 1 or 2 red or fading trees
- Detect 100% of patches of >3 trees within 5%
- A minimum of 2% up to a maximum of 20% must be ground truthed. The Project Manager will determine prior to beginning of survey.

### **Secondary Area**

- Tree Counts
  - ~ 5 - 25 trees: +/- 5 trees
  - ~ 25+: +/- 10 trees
- Patches of 5 or more trees only are to be GPSed unless Program Manager directs surveyor to GPS sites with less red or fading trees
- Detect 100% of patches of >5 trees within 20%
- Detect 100% of patches of >25 trees within 5%
- A minimum of 1% up to a maximum of 5% must be ground truthed. The Project Manager will determine prior to beginning of survey.

## 4. Green:Red Survey Quality Inspection Procedure

### Goal

Inspectors should follow closely behind the crews to determine surveys are being completed correctly.

### Timing

While survey operations are ongoing.

### Equipment

GPS, compass, map

Data sheets

Black permanent marker and pencil

Camera

Knife/hatchet

### Procedure

1. Set GPS to NAD83 and collect data in degrees/minutes/decimal minutes (hddd°mm.mmm'), e.g. N51°11.055' latitude, W116°21.101' longitude.
2. Access site as per data sheet.
3. Locate plot centre
4. Survey all pine trees within an approximate 50m radius concentric plot around plot centre and assess:
  - Both Green and Red tree counts accurate to:
    - ~ 1 - 4 trees: +/- 1 tree
    - ~ 5 - 10 trees: +/- 2 trees
    - ~ 11 - 24 trees: +/- 3 trees
    - ~ 25+ trees: +/- 4 trees
  - Tallied trees have at least 40 hits per tree to be considered a successfully attacked tree.
  - 10%, up to a maximum of 10 trees, of the successfully attacked trees were examined for beetle presence, life stages present, and to define the year of attack.