

Changes to VEG_COMP_LYR_R1_POLY to account for Mountain Pine Beetle Losses in 2012

Background:

British Columbia (B.C.) is currently experiencing the largest mountain pine beetle infestation ever recorded in North America. By the year 2017, the MPB is forecast to destroy about 57 per cent of the merchantable pine volume that was on the provincial land base at the start of the infestation.

A recognised weakness in the provincial forest cover inventory is the difficulty to update for catastrophic natural events like the impact of the mountain pine beetle.

Three key questions must be answered to determine the impact of MPB on the Forest Inventory.

- How to decide if the pine is dead? (What tools, rules and when?)
- What attributes do users need? (age, height, live density, dead stems per ha, volume live, and volume dead)
- Has the inventory been estimated using conditions prior to the MPB disturbance or post the MPB disturbance. This is illustrated in examples 1 and 2 below.

Conversion of live standing volume to dead volume follow predictions made using the provincial MPB model and the 2010 aerial overview surveys. The Year of Disturbance for this stand mortality is determined using satellite image analysis to determine the Year of Death. The loss predictions were applied to the individual forest cover polygons to provide an analysis ready dataset for strategic decision makers.

Information on the Provincial Mountain Pine Beetle prediction model is found here:

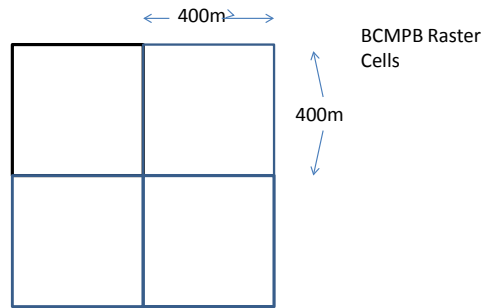
<http://www.for.gov.bc.ca/hre/bcmpb/>

Methodology:

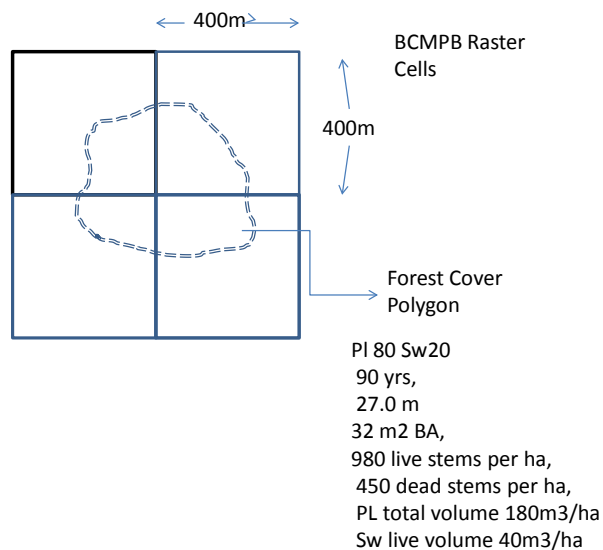
Example 1: To account for the volume losses in a given VRI stand in an inventory done prior to MPB the following data changes were completed:

1. To account for the losses for MPB killed forest stands two datasets have been used:
 - Year of Death (YOD). It was completed for 22 impacted forest districts using satellite imagery between 2000 and 2008. This identifies stands that have changed to „Red Attack“ during this period. The analysis was unable to identify the initial „Green Attack“. Methodology for the YOD mapping is found here: http://www.for.gov.bc.ca/hts/rs/beetle_detection.html
 - BCMPB (cumkill2010). It is a cumulative kill raster dataset. For more information see: <http://www.for.gov.bc.ca/hre/bcmpb/>

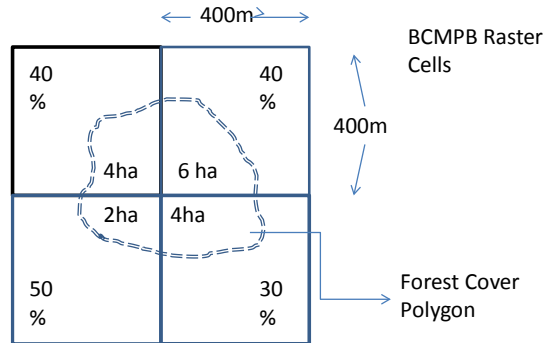
The BCMPB rasters are cells of 16ha. In each cell is a single percentage cumulative kill for the pine.



2. The BCMPB data was used to determine the amount of pine killed, dead stems per ha and dead volume per ha and dead stems per ha (Appendix 1):
 - Provincial forest cover was overlaid with BCMPB data layer. This layer is not restricted to the 22 Timber Supply Areas. As a result some beetle kill is found on the eastern portions of coastal Timber Supply Areas like Midcoast or the Fraser TSA.
 - Percent of pine killed in the VRI polygon was determined by the area weighted of total BCMPB percent of pine killed with the VRI polygon. Pine is considered to be lodgepole pine (Pl, Pli, Plc), ponderosa or yellow pine (Py), whitebark pine (Pa), and western white pine (Pw).



- The percent of pine killed was used to determine the dead volume per ha. The live volume per ha was recalculated as the total vol.



Area weighted total BCMPB Kill:
 live pine vol/ha= original live pine
 vol/ha*(1-cumulative kill factor)

Live pine vol/ha=180(1-0.40)=
 108m³/ha

Dead pine volume = original live pine
 vol/ha*(cumulative kill factor)
 Dead pine volume = 180(0.40) =
 72m³/ha

Pl 80 Sw20
 90 yrs,
 27.0 m
 32 m² BA,
 980 live stems per ha,
 450 dead stems per ha,
 PL total volume 180m³/ha
 Sw live volume 40m³/ha

40		40
%		%
	4ha	6 ha
	2ha	4ha
50		30
%		%

Area weighted total BCMPB Kill:
 live pine vol/ha= original live pine vol/ha*(1-
 cumulative kill factor)

- 1) Live pine vol/ha=180(1-0.40)= 108m³/ha*
6ha=648m³
- 2) Live pine vol/ha=180(1-0.30)=
126m³/ha*4ha=504m³
- 3) Live pine vol/ha=180(1-0.50)=
90m³/ha*2ha=180m³
- 4) Live pine vol/ha=180(1-0.40)=
108m³/ha*4ha=432m³

Dead pine volume = original live pine
 vol/ha*(cumulative kill factor)

- 1) Dead pine volume = 180(0.40) =
72m³/ha*6ha=432m³
- 2) Dead pine volume = 180(0.30) =
54m³/ha*4ha=216m³
- 3) Dead pine volume = 180(0.50) =
90m³/ha*2ha=180m³
- 4) Dead pine volume = 180(0.40) =
72m³/ha*4ha=288m³

<

40 %	40 %
4ha	6 ha
2ha	4ha
50 %	30 %

Total live volume
=648+504+180+432=1764m³

Total Dead Volume =
432+216+180+288=1116m³

<

40 %	40 %
4ha	6 ha
2ha	4ha
50 %	30 %

Live volume per ha=total live volume/area
Live Volume per ha= 1764/16 =110m³/ha

Dead volume per ha= total dead
volume/area = 1116/16=70m³/ha

<

40 %	40 %
4ha	6 ha
2ha	4ha
50 %	30 %

Percentage Kill= total dead/total live + dead
 $=1116/(1764+1116) = 39\%$

The dead stems per ha and live stems per ha was calculated.

<

40 %	40 %
4ha	6 ha
2ha	4ha
50 %	30 %

Dead stems/ha=Original live stems/ha*%Pine*Percentage kill
 +dead stems/ha

Dead stems/ha= ((980*0.8)*0.39)+ 450= 756 dead stems per ha

Live stems/ha= original live stems per ha- new dead stems per ha

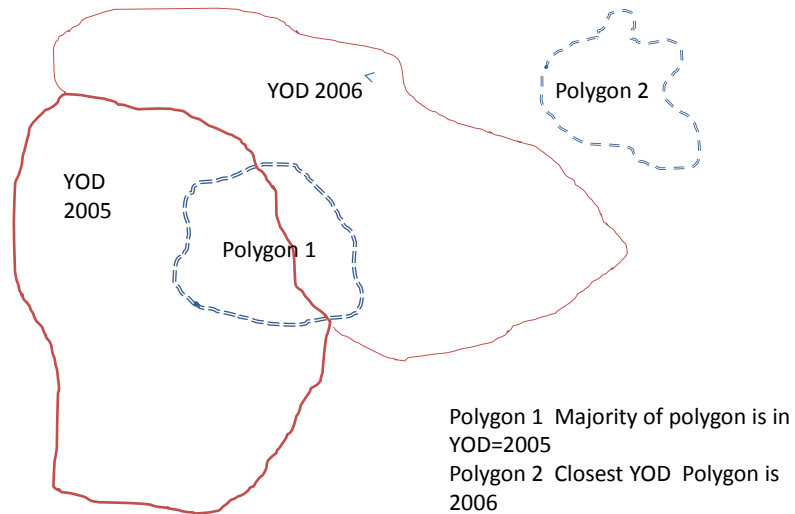
Live stems/ha= 980-306= 674 live stems/ha

- The calculated volume information was done for all utilization levels, 12.5,17,5 and 22.5.

■

3. The YOD data was used to determine the Year of infestation for each VRI polygon identified by the BCMPB as having dead pine..

- Provincial forest cover was overlaid with YOD data layer.
- For polygons with more than one YOD identified, the YOD value that accounts for the largest area with the polygons becomes the YOD for the entire polygon.
- For polygons where no year of death was identified the YOD was based on the nearest year of death polygon in the YOD dataset.



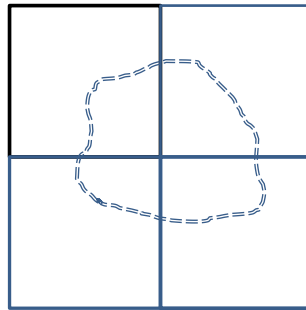
Example 2: For a given VRI stand in the inventory done after MPB

For the newer inventory areas, since the dead pine information was captured for the live and dead stems per ha and the species composition already, the dead volume per ha was calculated using a different approach (Appendix 1) :

- Calculated the ratio of the total live stems and dead stems for pine from the captured information.
- The dead volume information was calculated using the same ratio of the live stems per ha and dead stems per ha for pine. The live volume per ha was recalculated accordingly.

- The calculated volume information was done for all utilization levels, 12.5, 17.5 and 22.5.

Post MPB Polygon



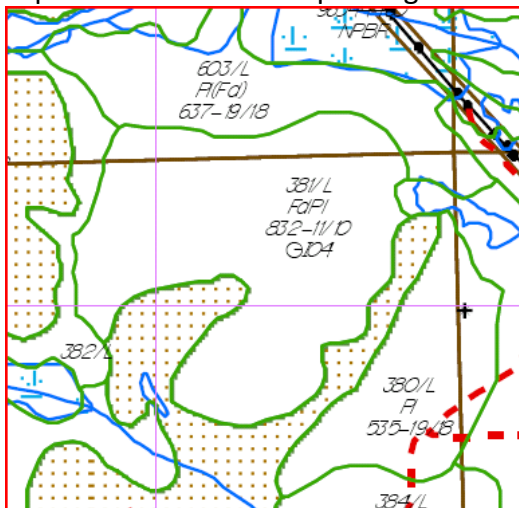
Forest Cover Polygon

Sw 80 PI20
 90 yrs,
 27.0 m
 32 m2 BA,
 280 live stems per ha,
 1450 dead stems per ha,
 Sw live volume 40m3/ha
 PL live volume 15m3/ha



Live Pine stems per ha = $280 * 0.2 = 56$ stems per ha
 Live pl volume per stem = $15 \text{ m}^3 / \text{ha} / 56$
 stems/ha = $0.27 \text{ m}^3 / \text{stem}$
 Dead PI volume = $1450 \text{ stems/ha} * 0.27 \text{ m}^3 / \text{stem} = 388$
 m^3 / ha

4. For stands impacted by a volume reduction the EARLIEST_NONLOGGING_DIST_TYPE is updated to 'I' to reflect Insect and the EARLIEST_NONLOGGING_DIST_DATE was updated to the year of death determined from YOD data set.
6. The STAND_PERCENTAGE_DEAD column was populated with the calculated percentage dead (in this example 39%).
7. The map label was updated to reflect the disturbance history. This helps identify impacted stands when plotting forest cover maps.



1. For a given VRI stand in the inventory done prior to MPB

Appendix 1

Methodology for example 1: To account for the volume losses in a given VRI stand in an inventory done prior to MPB

θ_p : original pine percentage in species composition;

v : original total stand volume;

n : the number of overlaid BCMPB polygons;

a_k ($k=1, 2, 3 \dots n$): the area of the k^{th} BCMPB overlay polygon;

a : area of the stand, $a = \sum_{k=1}^n a_k$

ρ_k : percentage kill of the k^{th} BCMPB overlay polygon;

v_{pk} : live pine volume of the k^{th} BCMPB overlay polygon, where $v_{pk} = v * \theta_p * (1 - \rho_k)$;

v_{dk} : dead pine volume of the k^{th} BCMPB overlay polygon, where $v_{dk} = v * \theta_p * \rho_k$

Area weighted live pine volume: v_{lp}

$$v_{lp} = \frac{1}{a} \sum_{k=1}^n a_k * v_{pk}$$

Area weighted dead pine volume: v_{dp}

$$v_{dp} = \frac{1}{a} \sum_{k=1}^n a_k * v_{dk}$$

Percentage of total kill: ρ

$$\rho = \frac{1}{a} \sum_{k=1}^n a_k * \rho_k$$

For live and dead trees per ha (tph), replace the volume items with tph

Methodology for example 2

For a given VRI stand in the inventory done after MPB

v : stand volume;

θ_p : pine percentage in species composition;

t_l : total live stems per ha;

t_d : total dead stems per ha

t_{lp} : lived pine stems per ha, $t_{lp} = t_l * \theta_p$

v_p : live pine volume, $v_p = v * \theta_p$

The dead pine volume: v_{dp}

$$v_{dp} = \frac{t_l * v_p}{t_{lp}}$$

