Provincial Level Projection of the Current Mountain Pine Beetle Outbreak:

Appendix 1: Spatial Metadata

Supported by the
Mountain Pine Beetle Initiative of the Canadian Forest Service
and the BC Forest Service

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April 2004

Purpose of the document

This document specifies the spatial data used by the BCMPB (Provincial Scale Mountain Pine Beetle Projection Model). It also describes in some detail the methods used to generate the spatial data. The document is not intended to provide enough detail to completely reproduce the data. Rather we intend that this appendix could provide enough information for a well informed reader to gain some understanding about how the data was compiled.

Spatial layers used by the model

Table 1 lists all of the spatial data used by the model. The layers are divided into 5 types:

1. Beetle related information is used to initiate the beetle projection model. All of the layers used by the model are, in fact, calculated from other information, primarily the annual severity of attack data extracted from the provincial aerial overview data. The method of extracting that information is described in the section titled Beetle Population Data.
2. Initiation layers represent the non-recovered losses experience to 2002 and 2003 as a result of the infestation from 1999. Those layers are used to "initiate" the NRLs at the correct level.
3. Forest Cover data was obtained from two separate sources as described in the section titled Forest Cover Data.
4. Management consists of that information required by the forest management submodel. It is data that is used to either direct or constrain harvesting and single tree treatments.
5. Reporting Strata are required to develop the indicator files. Reporting strata do not influence the behaviour of the model. Rather they are used in a post-processing step to "cut" the results by areas of interest to specific clients.

Additional metadata for the spatial layers used by the model and for layers used to create the layers used by the model can be found in BCMPB_SpatialMetadata.xls.

Table 1. Spatial layers used by the model (BCMPB).

Layer Name	Layer Description	Layer Type	Calculated
habitatCo	Beetle habitat	Beetle	Yes
svCombine02	combined severity in 2002	Beetle	Yes
svCombine03	combined severity in 2003	Beetle	Yes
cumPressure3	Cummulative beetle pressure in 2002	Beetle	Yes
cumPressure4	Cummulative beetle pressure in 2003	Beetle	Yes
cumKill02	Cummulative percentage of pine killed in 2002	Beetle	Yes
cumKill03	Cummulative percentage of pine killed in 2003	Beetle	Yes
localPressure3	local beetle pressure 2002	Beetle	Yes
localPressure4	local beetle pressure 2003	Beetle	Yes

timeSinceKill02	Time since the last beetle kill in 2002	Beetle	Yes
timeSinceKill03	Time since the last beetle kill in 2003	Beetle	Yes
nrl02	Non recovered losses in 2002	Initiation	Yes
nrl03	Non recovered losses in 2003	Initiation	Yes
pcpClassCo	Percent pine classified	Forest Cover	Yes
ageCo	age of the forest	Forest Cover	No
itg_b	Inventory type groups	Forest Cover	No
pcpCo	Percent pine	Forest Cover	No
spc_pine_b	Pine species	Forest Cover	No
sindex_b	Site index	Forest Cover	No
vol_b	Total timber volume	Forest Cover	No
volpine_b	Volume of pine	Forest Cover	No
Dist2Road	Distance to roads	Management	Yes
NearestRoadLoc	Location of the nearest road	Management	Yes
bmu03	Beetle management unit designation in 2003	Management	No
bmuname	Beetle Management unit id by name	Management	No
dem	Digital elevation model	Management	No
ebbma03	Emergency bark beetle management area designations in 2003	Management	No
mgmtunits	Forest management units (TSAs and TFLs)	Management	No
thlbtrue	Timber harvesting landbase	Management	No
vqo	Visual quality objectives	Management	No
rmz2	Generalized Resource management zones	Reporting Strata	Yes
abec_bc	Biogeoclimatic subzone variants	Reporting Strata	No
cariherd	Caribou herds	Reporting Strata	No
gbearpopn	Grizzly bear populations	Reporting Strata	No
lu	Landscape Planning Units	Reporting Strata	No
spupl	Pine seed planning units	Reporting Strata	No
parks	Provincial and National Parks	Reporting Strata	No
provtrue	Provincial land mass	Reporting Strata	No
rmz	Resource management zones	Reporting Strata	No
spusx	Spruce seed planning units	Reporting Strata	No

Beetle Population Data

The annual kill for each year from 1999 to 2003 was obtained from the Provincial Aerial Overview ("the overview") data. The method involved overlaying a 1200 meter grid on the polygonal and spot data from the overview. The area affected in each grid cell was then calculated as the area in a severity class multiplied by the mid-point of the kill estimate for that severity class. For the spot data the area of the spot was used. The following ARC/INFO macro shows how the calculations were performed for one year of the overview data. A description of how the 1200 meter grid data was converted to a 400 meter grids is provided in Appendix 3.

```
/* Create overlay of fishnet and points and polygon data
/* and summary tables of points and polygon data
Precision Double Highest
&echo &brief

/* point overlay
 Identity C:\Work\mpb\indata\mofairoverdataraw\prvspot03
C:\Work\mpb\indata\mpbpopn\fishnet C:\Work\MPB\InData\MPBPopn\spot03 Point #
Join

/* point statistics
Statistics C:\Work\mpb\indata\mpbpopn\spot03.pat
C:\Work\MPB\InData\MPBPopn\spot03.freq fishnet#
Sum NUM_TREES
Sum spot_area
end

/* point output
infodbase spot03.freq spot03

/* polygon overlays and calculations
Identity C:\Work\mpb\indata\mofairoverdataraw\prvpoly03
C:\Work\mpb\indata\mpbpopn\fishnet C:\Work\MPB\InData\MPBPopn\poly03 Poly
0.000001 Join
additem poly03.pat poly03.pat perckill 4 4 f 2
additem poly03.pat poly03.pat areakill 8 18 f 5
tables
        select poly03.pat
        reselect severity = 'L'
        calc perckill = 0.05
        select poly03.pat
        reselect severity = 'M'
        calc perckill = 0.20
        select poly03.pat
        reselect severity = 'S'
        calc perckill = 0.50
```

```
        select poly03.pat
        reselect severity = 'V'
        calc perckill = 0.50

        select poly03.pat
        calc areakill = area * perckill
quit


/* polygon statistics
STATISTICS C:\Work\mpb\indata\mpbpopn\poly03.pat
C:\Work\MPB\InData\MPBPopn\poly03.freq FISHNET#
Sum AREA
Sum PERCKILL
Sum AREAKILL
end


/* polygon output
infodbase poly03.freq poly03

/* gets the area killed into an attribute in fishnet.  adds poly and spot area
/* add area killed attribute
/* This is the second time around so we don't need to add additem fishnet.pat fishnet.pat
areakill03 8 18 f 5

/* create indices for more rapid calculations
indexitem fishnet.pat fishnet#

indexitem poly03.freq fishnet#
indexitem spot03.freq fishnet#
/*  Create relates
relate add rpoly03 poly03.freq info fishnet# fishnet# linear ro
relate add rspot03 spot03.freq info fishnet# fishnet# linear ro
/* Do calculations sum-spot_area is in ha so is multipled by 5000 to give 50% attack in
meters squared
/* this give equivalent units to sum-areakill
tables
select fishnet.pat
 calc areakill03 = 0
 calc areakill03 = rpoly03//sum-areakill
 calc areakill03 = areakill03 + ( rspot03//sum-spot_area * 5000 )
quit
```

Forest Cover Data

All of the forest cover data used in the model was obtained from two separate sources. The majority of the data, for all area managed as Timber Supply Areas was obtained from the provincial “corporate” spatial database known as the Land and Resource Data Warehouse (LRDW). The methods of obtaining the information and converting it to 400 meter grids are described below. For some areas of the province the LRDW does not contain any data. These primarily are:

- large areas of private land on Vancouver Island and the in the southern east Kootenays;
- most Tree Farm Licenses (TFLs); and
- some large parks created prior to the advent of digital forest cover mapping.

Data for the parks was made available as a result of the work done on the 1994 Forest and Range Recreation Resource Analysis. The authors obtained the 1956 continuous forest cover mapping for the missing parks. The information was digitized, the labels were converted to modern formats and the data on age and volume was projected to the current date. Some updates for major depletions were incorporated through visual interpretation of satellite imagery. Data for TFLs was obtained by the Crown in 1996 as part of a project that was designed to complete the forest cover mapping for the province. Unfortunately there is no available source of forest cover data for the private land. The TFL and Parks data was incorporated into

The LRDW Forest Cover data were extracted in 1:250,000 NTS map sheet "blocks" from the Ministry of Sustainable Resource Management's Land and Resource Data Warehouse using Arc/Info. Each of the resulting 1:250,000 Arc/Info "Coverages" were populated with the forest stand information required for this study. Percent Pine and Pine Species were also calculated for each forest stand. Coverages containing only a single forest inventory theme were created (e.g. stand age) for each map sheet. This was done so that the coverages reflected the spatial distribution the inventory theme rather than the spatial distribution of the stands. Each 1:250,000 forest inventory theme coverage was converted to an Arc/Info raster "Grid" using a raster resolution of 400 m by 400 m. For each forest inventory theme, the 1:250,000 raster grids were joined together to create a single raster grid which covered the entire province. Each province-wide grid was converted to Arc/Info ASCII format for subsequent use in SELES.

A similar process was used to extract the data for TFLs and Parks from the “continuous forest cover dataset”. The two datasets were then combined such that if LRDW data was available it was used otherwise the continuous forest cover data was used.

Management (forest) data

The following management data layers were obtained directly from their sources and simply converted to a 400 meter grid

- bmu03
- bmuname

- dem
- ebbma03
- mgmtunits
- vqo

The road related layers (Dist2Road and NearestRoadLoc) were calculated based on the location of roads as represented in the LRDW. Any road related feature code was used to indicate the presence of a road.

Development of a spatially explicit timber harvesting landbase (THLB) (thlbtrue) for the entire province was a non-trivial task. There were 3 principal problems:

1. A large quantity of data in varying formats had to be processed;
2. All the expressions of percent inclusion in the THLB had to be converted to 100% in or 100% out of the THLB; and
3. THLB for the Tree Farm Licenses is not readily available and had to be estimated.

The initial input data was provided primarily as district files either in ARC coverage (vector) and ARC grid (raster) format. Depending on the area, in some instances there was areas of overlap between data sets. One or more attributes relating to the THLB were present in all the data sets and all data sets had a attribute that contained the THLB inclusion factor (in percent). It is this attribute that was used to create the provincial THLB grid. Most, but not all of the data sets have an attribute that classified the THLB by type of inclusion where:

- "X" = outside THLB
- "N" = within THLB but zero percent inclusion
- "P" = partial inclusion in THLB
- "C" = one hundred percent inclusion in THLB

Since only the percentage of inclusion within the THLB was of interest, the above inclusion classification was not retained in the final provincial (THLB_BC) data set.

The procedure for creating the THLB grid from the input data is outlined below:

1. If the data set was in ARC coverage format, the dataset all items except those relating to the THLB were dropped, sliver polygons were removed if necessary and the coverage was dissolved with the #ALL option in ARC. In some cases this 'clean-up' greatly reduced the size of the dataset.
2. Coverages were converted to GRID with a 50 metre x 50 metre cell size using the POLYGRID command in Arc.
3. Depending on the original data set, areas with an inclusion factor value of zero OR a 'no-data' could be either: a) areas outside the THLB, b)areas within the THLB but with a zero inclusion factor or c) areas outside the spatial extent of the original coverage. All 'no data' areas of each GRID were converted to zero using the CON and ISNULL commands in GRID. This was done to ensure all areas within the BLOCKMEAN processing window were used in the computation. This provided consistency with how each dataset was processed (as zero and no data values could mean the same or different things)

and to prevent overestimating the percentage of THLB inclusion which occurs when areas with 0 percent inclusion have a 'no-data' value (as they are then excluded from determining the mean value in BLOCKMEAN).

4. Each 50 metre grid was aggregated into a grid with a 400 metre by 400 metre cell size using the BLOCKMEAN GRID function. Since all ISNULL areas were previously converted to zero, all 50 metre cells within the processing window were used in determining the mean value.
5. All areas with zero value were converted to ISNULL in preparation of the appending process whereby the single grids were appended together to create a provincial dataset. This was done so that where areas of overlap occurred, areas with a zero value from one grid (representing areas outside the original coverage area) did not 'erase' the overlapping areas of another grid during the append process where the inclusion factor was greater than zero
6. The analysis environment was set to a provincial extent. Xmin ymin xmax ymax values were as follows: 270000 330000 1874400 1736400. All individual grids were then appended together to create the final provincial dataset of THLB inclusion. Since the order of input determines the priority in areas of overlap in cases of overlap, those data sets seen as more accurate were appended first. THLB_BC is the final output (400m x 400m, floating point type).

The resulting grid contained a "percent inclusion" in the THLB that was a continuous value from 0 to 1. We converted that to only 0 or 1 by randomly including cells in the THLB based on the percentage inclusion.

The area within a Tree Farm License was place in the THLB if it met all of the following criteria:

- Forested
- Site Index greater than 7
- Not deciduous
- Slope less than 40%
- Elevation less than 1800 meters.

Subsequently an additional 2.5% of the cells in each TFL were removed from the THLB

Reporting strata

The spatial layers for the reporting strata were obtained directly from the LRDW and simply converted to 400 meter grids.