

Spruce Beetle Hazard Rating Documentation Version 1.2

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Project Area: Province of BC

Background:

Spruce Beetle is a pest of increasing concern in British Columbia

Hazard rating systems provide an objective framework for evaluating the risk of a particular pest, at the stand level, based on a series of quantifiable factors known to be correlated with hazard.

Overview:

This documentation provides detailed information on the process used to create the Spruce Beetle Hazard spatial dataset using the most appropriate information and processes. It will also document the data structure of the resultant dataset.

This dataset was created for FLNRO Resource Practises Branch in Victoria, by the Geospatial Services group in Kamloops.

Project Scope:

The project involves creating Spruce beetle hazard rating datasets for the Province of British Columbia, on a TSA basis, on non-TFL lands.

Data Sources:

Vegetation: VRI exported from the BCGW in December of 2013.
Basal Area: Present in the VRI attribute table
TRIM DEM: GIS Warehouse

Process:

The process for creating the hazard rating model was based upon version 10 of the Shore/Safranyik susceptibility and risk rating system.

The rating system describes several major susceptibility factors used to create the final hazard rating:

Hazard Rating = $10 * ((Q * A * P * L * S2) ** 0.5$

Factor Q: Site Quality

The site quality was implemented using site index as a surrogate. The site index classes used here were provided by Bob McDonald.

<u>Site Index</u>	<u>Site Quality</u>	<u>Factor</u>
>18	Good	1.14
12-18	Medium	0.60
<12	Poor	0.27

Factor A: Age

The age factor was implemented as outlined in the rating system document. The proj_age_1 attribute was used from the inventory to estimate age.

<u>Age</u>	<u>Factor</u>
>120	1.21
100-120	0.74
<100	0.07

Factor P: Proportion of Susceptible Basal Area

This value is expressed as a percentage and is calculated using the formula below:

$$P = (\text{basal area of spruce } \geq 17.5 \text{ cm}) / (\text{basal area of all species } \geq 12.5 \text{ cm}) * 100$$

Basal area of Spruce was calculated by multiplying the total percentage of Spruce in the stand (expressed as a proportion) by the basal area of the stand. Species codes included as Spruce were {'S','SS','SE','SW','SX','SXW','SXL','SXS'}

Factor L: Location

The location factor was implemented almost exactly as outlined in the new methodology. The formula was modified slightly to use the absolute value of the longitude as GIS systems represents all longitudes west of Greenwich, England as negative, and the formula requires an unsigned value to work correctly.

$$L = (24.4 * \text{abs(longitude)}) - (121.9 * \text{latitude}) - (\text{elevation (m)}) + (4408.1)$$

Factor L can be obtained based on the output value of Y and the aspect of the stand, in the table below.

<u>Aspect</u>	<u>L >= 0</u>	<u>0 >= L >= -400</u>	<u>-400 > L >= -900</u>	<u>L < -900</u>
North	1.08	1.01	0.7	0.4
Other	1.01	0.94	0.6	0.21

The lat and lon coordinate used is that of the label point of the stand polygon. The elevation was calculated as an average elevation for the stand, based on TRIM digital elevation model data which had been resampled to a 50 metre resolution.

Using the above value the intermediate variables S1 can be calculated:

$$S1 = Q * A * P * L$$

Factor S2: Stand Density and Growth Rate

Factor S2 can be determined from the table below. Calculating the value of Y, is a multi-step process, and is detailed in several formulae below the table.

	<u>Y >= 40</u>	<u>39 > Y >= 20</u>	<u>Y < 20</u>
S2	0.67	0.40	0.13

The percentage of spruce killed (Y) can be estimated by the formula below:

$$Y = (99 * Z - 1) / (Z + 1)$$

Z can be calculated as follows:

$$Z = e^{(-0.53 - 1.92 * \ln(X) + 0.006 * (N))}$$

Where:

N = number of spruce trees per ha >= 12.5 cm

e = 2.718, the base of natural logarithms

X can be calculated as follows:

$$X = (12.961 - 1.360 * \ln(T))$$

Where:

T = number of trees per hectare of all species \geq 12.5 cm dbh

The final susceptibility rating can then be calculated as:

$$S = 10 * (S1 * S2)^{0.5}$$

Resultant Data Model:

The overarching goal for the resultant dataset, was to retain all the core attributes which are typically used to characterize a stand, as well as all attributes used as inputs to the hazard rating calculation. In addition it was also considered a goal to retain the individual hazard rating factors, within the resultant dataset. This approach would allow individuals to re-calculate the hazard rating based on a modified approach, such as for example, discounting one of the hazard factors.

Data dictionary for the full resultant dataset

<i>Attribute Name</i>	<i>Description</i>	<i>Definition</i>	<i>Valid Values</i>	<i>Comments</i>
<i>Feature_id</i>	Unique ID	Char 32		VRI attribute
<i>Opening_ind</i>	Opening indicator	Char 1		VRI attribute
<i>Non_Productive_Descriptor_CD</i>	Non-productive code	Char 5		VRI attribute
<i>Non_Productive_Code</i>	Non-productive code	Char 10		VRI attribute
<i>Species_cd_1</i>	Species 1 (layer 1 rank1)	Char 10		VRI attribute
<i>Species_cd_2</i>	Species 2	Char 10		VRI attribute
<i>Species_cd_3</i>	Species 3	Char 10		VRI attribute
<i>Species_cd_4</i>	Species 4	Char 10		VRI attribute
<i>Species_cd_5</i>	Species 5	Char 10		VRI attribute

Attribute Name	Description	Definition	Valid Values	Comments
Species_cd_6	Species 6	Char 10		VRI attribute
Species_Pct_1	Species 1 percentage	Float		VRI attribute
Species_Pct_2	Species 2 percentage	Float		VRI attribute
Species_Pct_3	Species 3 percentage	Float		VRI attribute
Species_Pct_4	Species 4 percentage	Float		VRI attribute
Species_Pct_5	Species 5 percentage	Float		VRI attribute
Species_Pct_6	Species 6 percentage	Float		VRI attribute
Proj_age_1	Stand projected age	Integer 2		VRI attribute
Proj_height_1	Stand projected height	Numeric 6		VRI attribute
Crown_closure	Crown closure	Integer 2		VRI attribute
Site_index	Site Index	Numeric 6		VRI attribute
Basal_Area	Stand basal area	Double 8.8		VRI attribute
VRI_Live_Stems_Per_HA	Number of live stems per hectare	Float 4.4		VRI attribute
Quad_Diam_175	Quad mean diameter at 17.5 cm utilization level	Float 4.4		VRI attribute
Geometry_Area	Polygom area in metres	Double 12.8		VRI attribute

Attribute Name	Description	Definition	Valid Values	Comments
	squared			
<i>Live_vol_per_ha_spp1_175</i>	Live volume per hectare for species 1 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Live_vol_per_ha_spp2_175</i>	Live volume per hectare for species 2 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Live_vol_per_ha_spp3_175</i>	Live volume per hectare for species 3 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Live_vol_per_ha_spp4_175</i>	Live volume per hectare for species 4 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Live_vol_per_ha_spp5_175</i>	Live volume per hectare for species 5 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Live_vol_per_ha_spp6_175</i>	Live volume per hectare for species 6 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Dead_vol_per_ha_spp1_175</i>	Dead volume per hectare for species 1 at 17.5 cm utilization level	Double 8.8		VRI attribute

Attribute Name	Description	Definition	Valid Values	Comments
<i>Dead_vol_per_ha_spp2_175</i>	Dead volume per hectare for species 2 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Dead_vol_per_ha_spp3_175</i>	Dead volume per hectare for species 3 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Dead_vol_per_ha_spp4_175</i>	Dead volume per hectare for species 4 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Dead_vol_per_ha_spp5_175</i>	Dead volume per hectare for species 5 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>Dead_vol_per_ha_spp6_175</i>	Dead volume per hectare for species 6 at 17.5 cm utilization level	Double 8.8		VRI attribute
<i>VRI_Live_Stems_Per_HA</i>	Number of live stems per hectare	Float 4.4		VRI attribute
<i>Quad_Diam_175</i>	Quad mean diameter at 17.5 cm utilization level	Float 4.4		VRI attribute
<i>Geometry_Area</i>	Polygon area in metres squared	Double 12.8		VRI attribute

Attribute Name	Description	Definition	Valid Values	Comments
<i>Live_Vol_Per_Ha_ALL_SPRUCE_175</i>	Live volume per hectare for all Spruce species at 17.5 cm utilisation level	Double 8.8		
<i>Dead_Vol_Per_Ha_ALL_SPRUCE_175</i>	Dead volume per hectare for all Spruce species at 17.5 cm utilisation level	Double 8.8		
<i>Lon</i>	Longitude of stand centre point	Float 4.5		Derived from feature geometry
<i>Lat</i>	Latitude of stand centre point	Float 4.5		Derived from feature geometry
<i>Elevation</i>	Stand mean elevation	Integer 2		Derived from TRIM digital elevation model
<i>Aspect</i>	Aspect class	Integer 2	Classes: -1=flat 0 = north 1 = east 2 = south 3 = west	Derived from TRIM digital elevation model
<i>Site_Quality</i>	Site Quality	Char 1	Classes: G = Good M = Medium P = Poor	Site Index > 18 12-18 < 12

<i>Attribute Name</i>	<i>Description</i>	<i>Definition</i>	<i>Valid Values</i>	<i>Comments</i>
<i>Pct_spruce</i>	Percentage of spruce in stand	Integer 2		Derived by summing spruce percent across all 6 species
<i>Basal_Area_Spruce</i>	Spruce basal area at 12.5 cm dbh	Float 4.4		Derived by multiplying pct_spruce by Basal_Area
<i>L_value</i>	Value used to calculate the location factor	Integer 2		Derived from lat, lon and elevation
<i>X_value</i>	Estimate of mean radial growth	Float 4.1		Derived from tree density
<i>Z_value</i>	Value used in the calculation of stand density and growth rate	Float 4.1		Derived from tree density and estimate of mean radial growth
<i>Y_value</i>	Value used in the calculation of stand density and growth rate	Float 4.1		Derived from z_value
<i>Factor_q</i>	Site quality factor	Float 4.1		Derived from site index
<i>Factor_a</i>	Stand age factor	Float 4.1		Derived from stand age
<i>Factor_p</i>	Proportion of susceptible spruce basal area factor	Float 4.1		Derived from estimate of basal area

Attribute Name	Description	Definition	Valid Values	Comments
Factor_l	Location factor	Float 4.1		Derived from l_value
Factor_s1	Product of factors q, a p, and l.	Float 4.1		Derived from factor_q, factor_a, factor_p, factor_l
Factor_s2	Factor incorporating stand density and growth rate	Float 4.1		Derived from y_value
Haz_rating	Overall hazard rating	Float 4.1	Ranges from 0 to 100	
Haz_class1	Hazard rating class 1 – 20% hazard rating classes.	Char 3	Haz_rating: (no input data)	Class Value
			0	NIL = nothing
			0.001 – 4.999	VL = very low
			5-19.999	L = low
			20-39.999	LM = low/med
			40-59.999	M = medium
			60-79.999	H = high
			80-100	VH = high

Attribute Name	Description	Definition	Valid Values	Comments
Haz_range1	The range of hazard rating in the hazard class	Char 6		Example: "20-40"
Haz_class2	Hazard Rating Class 2 – 33% hazard rating classes	Char 3	Haz_rating: (no input data) 0 0.001 – 4.999 5-32.999 33-65.999 66-100	Class Value NTA = No Typing Available NIL = nothing VL = very low L = low M = medium H = high
Haz_range2	The range of hazard rating in the hazard class	Char 6		Example: "20-40"
Hectares	Area of stand polygon in hectares	Float 4.2		Derived from feature geometry