Provincial Level Projection of the Current Mountain Pine Beetle Outbreak:

An Overview of the Model (BCMPBv.2) and Results of Year 2 of the Project

Appendix 4. Details of the Shelf-Life Model

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We define shelf life as "the length of time after death that a tree will be useable for a given product." Therefore, "shelf-life" is product specific and differs for sawlogs, OSB, pulp, bio fuels, woodpecker habitat, etc. A corollary of this concept is that the actual volume of timber in an MPB killed stand may remain the same for some significant length of time but it will change in character as time progresses.

A narrative version of our conceptual model of shelf-life is:

- There is a relationship between time since death and applicable products for (stands of) pine trees killed by MPB.
- Beetle killed logs will be useable as sawlogs (dimensional lumber) during the winter and summer harvesting seasons immediately following their death.
- For (X) subsequent years they loose their bark and begin to deteriorate in quality (with some minor checking) but essentially the entire volume will continue to be useable as sawlogs.
- From (X) to (N) years, the volume that can be used as sawlogs will decline in a linear fashion to the point where none of it is useable for dimensional lumber.
- From (X) to (M) some portion of the volume, in addition to that useable as sawlogs, will be useable for "alternative purposes", for example, chips, biofuel, etc. The decline in the amount of total usable wood (from (Y > X) to (M) years) will occur in a linear fashion.
- (N) and (M) will vary depending on the biogeoclimatic subzone and will be shorter in duration in wetter subzones and longer in dries subzones.

We model a conservative[1], optimistic and pessimistic set of shelf-life assumptions as follows:

<u>Conservative</u>

All volume available for all products for **<u>3 years</u>** after death.

Subzones	Time to complete deterioration of sawlog volume	Time to complete deterioration of "alternative" volume
Dry	7	15
Moist	6	13
Wet	5	10

Note that this means that after 4 years in a moist subzone two thirds of the volume would be available for sawlogs.

[1] based on information used in Thrower, J.S. 2003. Shelf-life tables and ingress assumptions for the Vanderhoof IFPA second innovative analysis. Vanderhoof IFPA TFP-004

Pessimistic

All volume available for all products for **2 years** after death.

Subzones	Time to complete deterioration of sawlog volume	Time to complete deterioration of "alternative" volume
Dry	5	10
Moist	4	8
Wet	3	5

Note that this means that after 3 years in a moist subzone one half of the volume would be available for sawlogs.

Optimistic

All volume available for all products for **4 years** after death.

Subzones	Time to complete deterioration of sawlog volume	Time to complete deterioration of "alternative" volume
Dry	15	25
Moist	8	18
Wet	7	15

Note that this means that after 6 years in a moist subzone two thirds of the volume would be available for sawlogs.

These relationships are shown graphically in Figure 1 where “alternative” volumes are labelled “chips”.

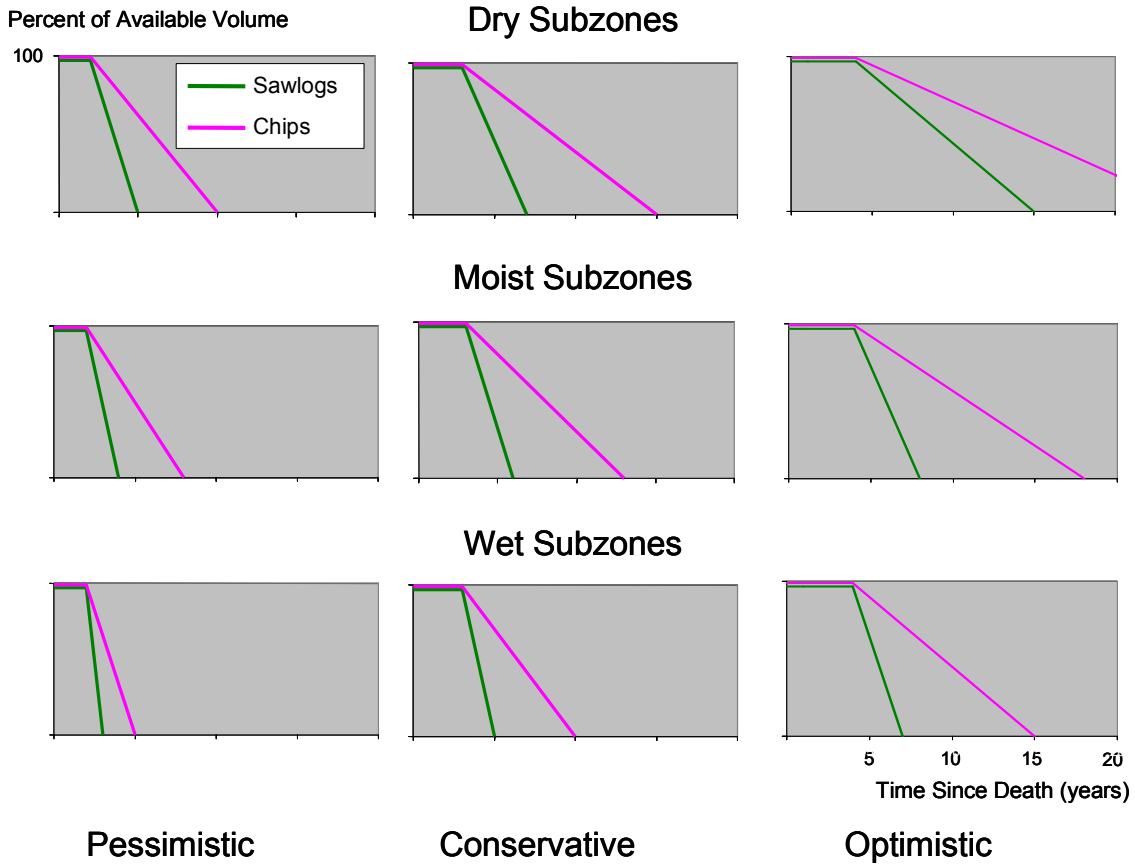

Figure 1. Relationship between time since death and the amount of volume available for the sawlog and “alternative” (chip) industries in dry, moist and wet subzones under pessimistic, conservative and optimistic assumptions.

In order to implement this conceptual model we developed a process for grouping subzones into dry, moist and wet categories that would correspond to slow, moderate and fast degradation rates of timber quality

In general it is assumed that the rate at which standing fiber will degrade from sawlog to chips and then to unmerchantable bears some relationship to the moisture regime of the climate. Degradation is the result of 2 factors; checking and sap rot. Checking is assumed to be more severe and more rapid in moister climates because ring width is positively correlated with growing season moisture and narrow rings are denser and hence less susceptible to checking. In addition, it is believed that more checking may occur in moister climates because shrinkage may be more severe as the wood looses moisture and winter freeze thaw cycles may be more pronounced. Sap rot is assumed to occur more rapidly in wetter climates (particularly growing season moisture) because moisture is an important determinant of the ability of those fungi to grow and reproduce.

The relationships described above are relatively poorly understood. For that reason we rely on a categorization of Biogeoclimatic Subzones into 3 groups; slow, moderate and rapid degradation rates. This is done rather than using actual climatic maps because the Biogeoclimatic Subzones integrate a number of climatic variables and because forest practitioners are familiar with the zoning and can provide input and criticism based on local knowledge.

In order to implement the concepts described above we did the following:

- Obtain data from and overlay Biogeoclimatic Subzones on growing season (May to September) and total annual precipitation data (based on PRISM Climate Surfaces).
- Overlay Biogeoclimatic Subzones on percent of timber volume that is pine.
- To simplify the process, eliminate some subzones from the ranking procedure for one of three reasons:
    - Those that need not be considered because they are in non-susceptible climatic zones (AT, CWH, MH, CDF, BWBS and SWB – see BCMPB documentation for rationale).
    - Those that need not be considered because pine volume is a minor (<10%) component of the total volume or they are a parkland or woodland subzone.
    - Those that could not be considered because climatic data was not available (newly mapped).
- Rank the remaining subzones based on total annual precipitation and growing season precipitation. For each ranking divide the subzones into 3 groups based on:
    - An equal number of subzones in each group
    - An equal area in each group
    - One third of the range of the precipitation occurring in each group.
- For each variable (total and growing season precipitation) compare the 3 ranking and assign an overall rank where 2 or 3 of the individual ranks agree. This worked for all but one subzone in total precipitation, which received 3 different ranks.
- Compare the overall ranks for both variables and assign a final rank where both agree. Where there is disagreement use expert (Del Meidinger) knowledge of the climates of the subzones to resolve the difference.
- For completeness:
    - Assign a rating to low percentage pine subzones based on the amount of summer precipitation relative to other ranked zones
    - Assign a rating to subzones with no climate data based on similarity with other ranked zones.
    - Assign moderate degrade rate to all subzones in climatically unsuitable areas.

The results of this process are shown in the map in Figure 2 and in detail in Table 2

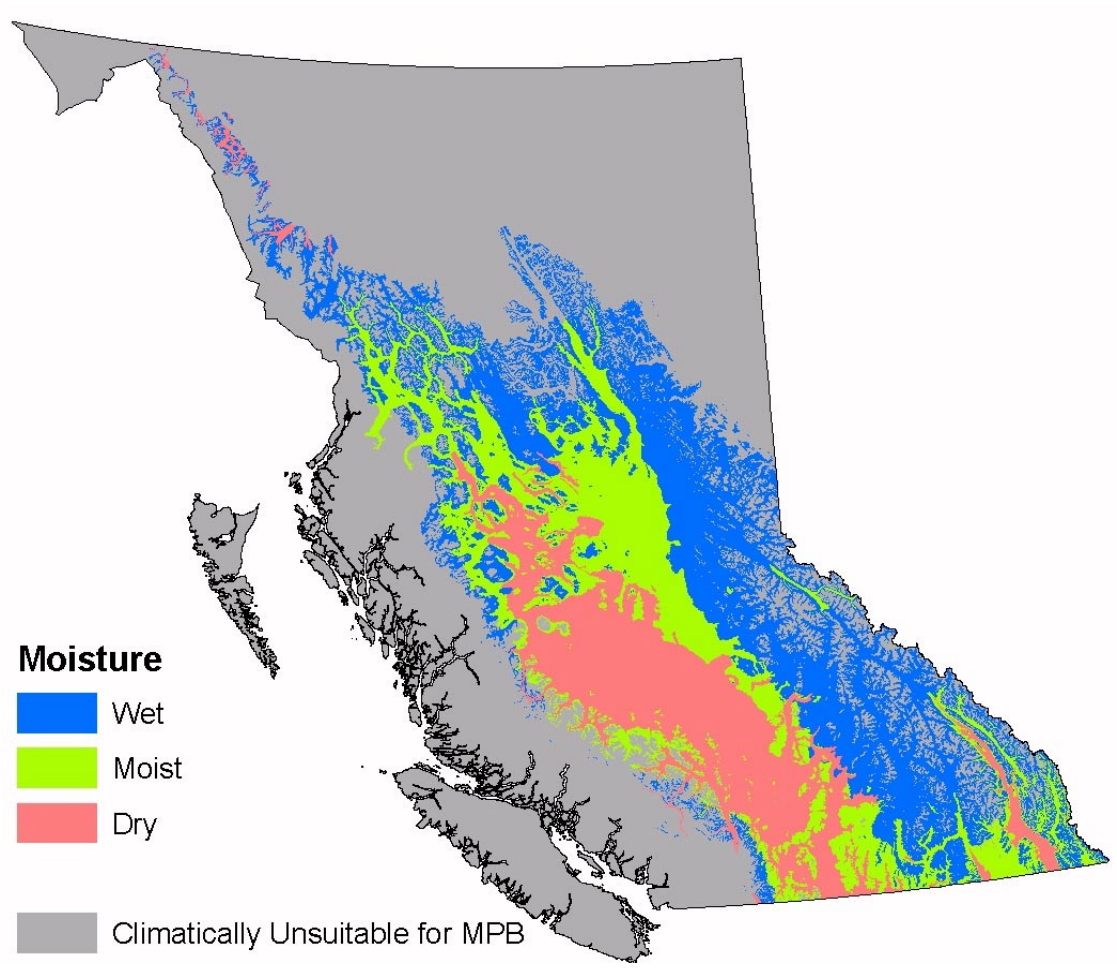

Figure 2. Categorization of subzones into moisture regimes for the purpose of estimating fibre degradation rates.

Table 1 Moisture rankings by Biogeoclimatic subzone (colour coding indicates decision criteria provided at the end of the table).

			Precipitation (mm)	
Categories	Subzone	Moisture Ranking	Total	Growing Season
In	SBS wk	wet	766	327
Pine < 10 %	SBS vk	wet	1,037	403
Pine < 10 %	ICH wk	wet	1,064	400
In	ICH wc	wet	1,074	340
Pine < 10 %	ICH vk	wet	1,257	433
Pine < 10 %	ICH vc	wet	868	313
In	ICH mw	wet	913	334
In	ICH mm	wet	894	355
No Data	ESSFwvp	wet	#N/A	#N/A
Pine < 10 %	ESSFwv	wet	1,103	382
No Data	ESSFwmw	wet	#N/A	#N/A
Parkland	ESSFwmp	wet	1,305	426
In	ESSFwm	wet	1,211	393
Parkland	ESSFwkp	wet	967	410
Pine < 10 %	ESSFwk	wet	1,162	463
No Data	ESSFwcw	wet	#N/A	#N/A
Pine < 10 %	ESSFwcp	wet	1,514	498
Pine < 10 %	ESSFwc	wet	1,267	458
No Data	ESSFvvp	wet	#N/A	#N/A
No Data	ESSFvv	wet	#N/A	#N/A
Pine < 10 %	ESSFvcp	wet	1,744	522
Pine < 10 %	ESSFvc	wet	1,617	498
Pine < 10 %	ESSFmwp	wet	1,732	407
In	ESSFmw	wet	1,565	357
No Data	ESSFmvp	wet	#N/A	#N/A
In	ESSFmv	wet	728	349
Pine < 10 %	ESSFmmp	wet	1,340	397
In	ESSFmm	wet	1,201	483
No Data	ESSFmkp	wet	#N/A	#N/A
Pine < 10 %	ESSFmk	wet	1,650	394
No Data	ESSFmcp	wet	#N/A	#N/A
In	ESSFmc	wet	903	333
Parkland	ESSFdkp	wet	1,220	473
In	ESSFdk	wet	1,085	426
In	SBS mw	moist	647	313

In	SBS mm	moist	724	324
In	SBS mk	moist	668	279
Pine < 10 %	SBS mh	moist	548	265
In	SBS mc	moist	644	267
In	SBS dw	moist	588	271
In	SBS dh	moist	739	312
In	MS un	moist	1,203	284
In	MS dv	moist	1,055	250
In	MS dm	moist	672	256
In	MS dk	moist	772	306
In	ICH mk	moist	712	295
Pine < 10 %	ICH mc	moist	832	327
In	ICH dw	moist	792	270
No Data	ICH dm	moist	#N/A	#N/A
In	ICH dk	moist	690	287
In	ESSFxv	moist	857	256
Parkland	ESSFxcp	moist	625	260
In	ESSFxc	moist	712	278
Parkland	ESSFdvp	moist	677	191
In	ESSFdv	moist	915	235
No Data	ESSFdmw	moist	#N/A	#N/A
No Data	ESSFdmp	moist	#N/A	#N/A
No Data	ESSFdm	moist	#N/A	#N/A
No Data	ESSFdkw	moist	#N/A	#N/A
No Data	ESSFdcw	moist	#N/A	#N/A
Parkland	ESSFdcp	moist	1,090	320
In	ESSFdc	moist	833	316
In	SBS un	dry	624	236
In	SBS dk	dry	522	224
In	SBPSxc	dry	418	198
In	SBPSmk	dry	542	273
In	SBPSmc	dry	517	208
In	SBPSdc	dry	506	263
In	PP xh	dry	367	152
In	PP dh	dry	436	201
In	MS xv	dry	538	250
In	MS xk	dry	527	221
In	MS dc	dry	752	210
In	IDF xw	dry	351	174
Pine < 10 %	IDF xm	dry	396	215
In	IDF xh	dry	431	182
In	IDF ww	dry	998	216
Pine < 10 %	IDF un	dry	527	200

In	IDF mw	dry	572	245
In	IDF dw	dry	652	183
In	IDF dm	dry	521	223
In	IDF dk	dry	470	212
In	ICH xw	dry	639	217
In	BG xw	dry	361	177
In	BG xh	dry	325	148
Out Climate	AT un	not ranked	1,587	521
Out Climate	AT unp	not ranked	1,408	487
Out Climate	BWBSdk	not ranked	501	248
Out Climate	BWBSmw	not ranked	506	325
Out Climate	BWBSun	not ranked	1,009	425
Out Climate	BWBSvk	not ranked	1,223	391
Out Climate	BWBSwk	not ranked	619	374
Out Climate	CDF mm	not ranked	1,089	200
Out Climate	CWH dm	not ranked	2,069	453
Out Climate	CWH ds	not ranked	1,588	329
Out Climate	CWH mm	not ranked	2,845	432
Out Climate	CWH ms	not ranked	2,133	462
Out Climate	CWH un	not ranked	1,081	215
Out Climate	CWH vh	not ranked	3,467	870
Out Climate	CWH vm	not ranked	3,603	785
Out Climate	CWH wh	not ranked	2,161	529
Out Climate	CWH wm	not ranked	2,237	643
Out Climate	CWH ws	not ranked	1,841	453
Out Climate	CWH xm	not ranked	1,906	332
Out Climate	MH mm	not ranked	3,132	714
Out Climate	MH mmp	not ranked	#N/A	#N/A
Out Climate	MH un	not ranked	2,214	649
Out Climate	MH wh	not ranked	4,138	1,053
Out Climate	MH whp	not ranked	#N/A	#N/A
Out Climate	SWB dk	not ranked	1,176	506
Out Climate	SWB mk	not ranked	665	387
Out Climate	SWB mks	not ranked	#N/A	#N/A
Out Climate	SWB un	not ranked	639	296
Out Climate	SWB vk	not ranked	1,638	564

Formatting	Decision process
	Agreement between summer and annual precip rating
wet	Expert opinion
moist	
dry	
wet	Pine < 10% or parkland - Falls in group based on summer precip alone
moist	
dry	
wet	No climate data - rating based on similarity of subzones
moist	
dry	
not ranked	Climate out so ranking is irrelevant