Invermere TSA Predictive Ecosystem Mapping Knowledge Base Report

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1.0 Attribute Description

1.1 Slope - SLP

The Slope Attribute is represented by the attribute code SLP. The method of measurement used is percent slope. The units of measure are meters as slope is being measured in length of meters in rise divided by length of meters in run. Slope is the average slope within a 25m x 25m pixel. Slope describes the pixel entity. The Slope attribute describes data that is in ordered classes. For information on the making of the slope input layer and the slope attribute please see Section 3.2.2 in the *Invermere TSA Predictive Ecosystem Mapping Input Data Quality and Processing Report* (Ketcheson et al., 2004). The slope classes are described in table 1.

Table 1. Slope Classes

Slope Class	Description
1	0 to 10%
2	10% to 25%
3	25% to 50%
4	50% to 80%
5	80+%

1.2 Aspect - AS

The Aspect Attribute is represented by the attribute code AS. The method of measurement used is degrees azimuth. The unit of measure is decimal degrees. Aspect is the average aspect within a 25m x 25m pixel. Aspect describes the pixel entity. This Aspect attribute describes data that is in ordered classes. For information on the making of the aspect input layer and the aspect attribute please see Section 3.2.3 of the *Invermere TSA Predictive Ecosystem Mapping Input Data Quality and Processing Report* (Ketcheson et al., 2004). The aspect classes are described in table 2.

Table 2. Aspect Classes

As Code	Description
1	135deg to 285deg (Warm)
2	285deg to 135deg (Cool)
3	Neutral

1.3 Landscape Facets – LFACET

The Landscape Facet attribute is represented by the attribute code LFACET. The data is categorical. Landscape Facet describes the pixel entity. For information on the making of the Landscape Facet input layer and the LFACET attribute please see Section 3.7. in the *Invermere TSA Predictive Ecosystem Mapping Input Data Quality and Processing Report* (Ketcheson et al., 2004). The Landscape Shape classes are described in table 3.

Table 3. Landscape Facet Classes

Numeric Code	Character Code	Description
1	CRT	Sharp Crest
2	LCR	Level Crest
3	DSH	Upper Shedding Shoulder
4	USH	Upper Swale
5	BSL	Planar Back Slope
6	DBS	Divergent Back Slope
7	CBS	Convergent Back Slope
8	TER	Terrace
9	MSW	Mid Slope Swale
10	TSL	Toe Slope
11	FSL	Foot Slope
12	TSW	Toe Slope Swale
13	LSM	Lower Slope Mound
14	LLS	Level Lower Slope
15	LSW	Lower Slope Swale
20	LAKE	Lake
21	WETLAND	Wetland
78	RIPARIAN	Riparian

1.4 Project Mask – MASK

The Project Mask Attribute is represented by the attribute code MASK. This data is considered to be categorical. MASK is described for each pixel entity, determining whether or not each pixel is within the study area. For information on the making of the Project Mask input layer and the MASK attribute please see Section 3.1.1 in the *Invermere TSA Predictive Ecosystem Mapping Input Data Quality Processesing Report* (Ketcheson et al., 2004).

Table 4. The MASK attribute

MASK Codes	Description
1	Within the study area
0	Not within the study area

1.5 Avalanche –AV

The avalanche attribute data is described by the AV attribute. For information on the methods used to generate the Avalanche input layer and the AV attribute please see Section 3.5.1 in *The Invermere TSA Predictive Ecosystem Mapping Input Data Quality and Processing Report* (Ketcheson et al., 2004). This data set is categorical. The categories of information are described in the table below. The AV attribute describes the presence or absence of an avalanche path within a given pixel entity.

Table 5. AV Categories

Avalanche Code	Description
0	No Avalanche Path
1	Avalanche Path

1.6 Double Line Water Features – TWTR_D

Double line water features are described by the TWTR_D attribute. For information on the methods used to generate the Double Line Water features input layer and the TWTR_D attribute please see Section 3.1.2.1 in *The Invermere TSA Predictive Ecosystem Mapping Input Data Quality and Processing Report* (Ketcheson et al., 2004). This data set is categorical. The categories of information are described in Table 6 below. The TWTR_D attribute describes the presence or absence of hydrographic features within a given pixel entity.

Table 6. TWTR Categories

Feature Line Code	TRIM 1 Description	Polygon Feature	Polygon Code
GA90000110	Stream/River - Left Bank	River	2
GA90000120	Stream/River - Right Bank	River	2
GB15300000	Lake – Definite	Lake >= 50 ha.	1
GB15300000	Lake – Definite	Pond <= 50 ha.	9
GB15300130	Lake – Indefinite	Shallow Open Water	10
GB15300140	Lake – Intermittent	Shallow Open Water	10
GB24300000	Reservoir – Definite	Reservoir	3
GE25850000	Sand Bar	Sand Bar	5
GC17100000	Marsh	Marsh	6
GC30050000	Swamp	Swamp	7
GD12300000	Glacier	Glacier	8
GE14850000	Island – Definite	Island	4

1.7 Single Line Water Features – TWTR_S

Single line water features are described by the TWTR_S attribute. For information on the methods used to generate the single line water features input layer and the TWTR_S attribute please see Section 3.1.2.2 in *The Invermere TSA PEM Input Data Quality and Processing Report* (Ketcheson et al., 2004*)*. This data set is categorical. The categories of information are described in Table 7 below. The TWTR_S attribute describes the presence or absence of hydrographic features within a given pixel entity.

Table 7. TWTR_S Categories

Feature Line Code	TRIM 1 Description
GA24850000	River/ Stream – Definite
GA24850140	River/ Stream – Indefinite
GA24850150	River/ Stream – Intermittent

1.8 Forest Cover Rock – FC_ROCK

The occurrences of rock outcrops in the VRI data are captured in the Forest Cover Rock layer and are described by the FC_ROCK attribute. For information on the methods used to generate the Forest Cover Rock layer and the FC_ROCK attribute please see Section 3.3.2 in *The Invermere TSA PEM Input Data Quality and Processing Report* (Ketcheson et al., 2004). This data set is categorical. It describes either the presence or absence of rock outcrops on the landscape for each pixel entity. The categories of data for the FC_ROCK attribute are listed below in Table 8.

Table 8. FC_ROCK Categories

Description	Code
Rock Present	1
Rock Absent	0

1.9 Forested Areas – FORESTED

Forested areas are described by the FORESTED attribute. For information on the methods used to generate the Forested Areas input layer and the FORESTED attribute please see Section 3.4.1 in *The Invermere TSA PEM Input Data Quality and Processing Report* (Ketcheson et al., 2004). This data set is categorical. It describes either the presence or absence of forest on the landscape for each pixel entity. The categories of data for the FORESTED attribute are listed below in Table 9.

Table 9. Forested Categories

Description	Code
Forest Present	1
Forest Absent	0

1.10 Alpine Forest – AF

Alpine forest ecosystems are described by the AF attribute. For information on the methods used to generate the Alpine Ecosystems input layer and the AF attribute please see Section 3.3.1 in *The Invermere TSA PEM Input Data Quality and Processing Report (Ketcheson et al., 2004).* This data set is categorical. It describes either the presence or absence of alpine forest ecosystems on the landscape for each pixel entity. The categories of data for the AF attribute are listed below in Table 10.

Table 10. AF Categories

Description	Code
Alpine Forest Present	1
Alpine Forest Absent	0

1.11 Urban Areas – URBAN

Urban areas are described by the URBAN attribute. This includes built up areas, hydro right of ways, and highway right of ways. For information on the methods used to generate the Urban Areas Input Layer and the Urban attribute please see Section 3.3.3 in *The Invermere TSA PEM Input Data Quality and Processing Report (Ketcheson et al., 2004)*. This data set is categorical. It describes the presence or absence of urban areas within each pixel entity on the landscape. The categories available to the URBAN attribute are listed below in Table 11.

Table 11. URBAN Categories

Description	Code
Urban Present	1
Urban Absent	0

1.12 Generalized Materials Mapping – DRN

The surficial materials input layer was used to locate specific areas of shallow soils, bedrock and coarse terraces. All attributes in the data set conform to the *Standard for Digital Terrestrial Ecosystem Mapping in British Columbia* (Ecological Data Committee, 2000). For information on the methods used to generate the Generalized Materials Mapping and the DRN attribute please see Section 3.6 in *The Invermere TSA PEM Input Data Quality and Processing Report (Ketcheson et al., 2004)*. Types of material described by the DRN attribute are listed below in table 12.

Table 12. Targeted Materials Mapping Criteria

Material Code	Description
R	100% bedrock or talus
R1	Up to 25% bedrock or talus and 75% shallow materials (veneers or very thin veneers)
R2	Between 25-50% bedrock or talus and 50% shallow materials (veneers or very thin veneers)
R3	Between 50- 75% bedrock and talus and the remainder shallow materials (veneers or very thin veneers)
D	100% shallow materials (veneers or very thin veneers)
TD	Coarse textured terrace
TM	Medium to fine textured terraces
W	Non-treed Wetlands

1.13 Open Range – OR

Open Range areas are described by the OR attribute. For information on the methods used to generate the Open Range Input Layer and the OR attribute please see Section 3.3.4 in *The Invermere TSA PEM Input Data Quality and Processing Report (Ketcheson et al., 2004)*. This data set is categorical. It describes the presence or absence of open range within each pixel entity on the landscape. The categories available to the OR attribute are listed below in Table 13.

Table 13. Open Range Classes

Description	Code
Open Rage	1
Not Open Range	0

1.14 Biogeoclimatic Subzone/Variant -BEC

The biogeoclimatic subzone/variant input layer and the BEC attribute describe the locations of the BEC subzone/variant combinations throughout the study area. For information on the methods used to generate the BEC input layer please see Section 3.5 of *The Invermere TSA PEM Input Data Quality and Processing Report (Ketcheson et al., 2004)*. This data set is categorical. The categories available to the BEC attribute are listed below in Table 14.

Table 14. BEC Subzone/Variant Classes

Description	Code
ESSF dku	1
ESSF dk1	2
ICH mk1	3
IDF dm2n	4
MS dk	5
AT un	6
ESSF dk2	7
IDF dm2	8
IDF xk	9
ESSF wmu	10
ESSF wm	11
PP dh2	12

2.0 Inferencing Elements

The first run raster site series allocation divided the landscape into 2376 potential classes based on the combination of BEC Subzone/Variant, Landscape Facets, Slope Class, and Aspect input layers. The classes available to each of these input layers are listed below in Table 15.

Table 15. First Run Input Layer Attributes

BEC	Landscape Facet	Slope class	Aspect
ESSF dku	Sharp Crest	1 (0 to 5%)	Gentle – j
ESSF dk1	Level Crest	2 (5 to 25%)	Warm – w
ICH mk1	Upper Shedding Shoulder	3 (26-50%)	Cool - k
IDF dm2n	Upper Swale	4 (51-75%)	
MS dk	Planar Back Slope	5 (75 – 100%	
AT un	Divergent Back Slope	6 (>100%)	
ESSF dk2	Convergent Back Slope		
IDF dm2	Terrace		
IDF xk	Mid Slope Swale		
ESSF wmu	Toe Slope		
ESSF wm	Foot Slope		
PP dh2			

After the first run the results were then combined with a new set of inferencing elements to further refine the model. These new elements were derived from the Generalized Materials Mapping.

Once the second run was refined a third set of elements was introduced. These elements were absolutes such as water bodies, rock outcrops, and wetlands.

3.0 Knowledge Base Development and Testing

The PEM model uses the spatial input layers and attaches a potential site series, or combination of site series to the combination of input layer attributes. Those results are modified by secondary spatial attributes such as distance from water, depth of materials and type of materials.

3.1 First Run Site Series Allocation

We have implemented an improved method of site series allocation within the knowledge tables that is based on GIS slope, aspect, and landscape facet combinations that are key to delineation of the site series based mapping entities.

Initially we query the input layers and derive all combinations of first run variables. The area of each BEC variant that falls within each combination was determined.

The model building plot data was also summarized into the same variable combination categories, but also includes the field based BEC variant and site series call as an additional variable. The plot data is sorted by site series and the frequency of the each variable combination was noted. A site series was then assigned to the variable combination based on its frequency of occurrence within that site series as indicated by the field data in Appendix 3 of Ketcheson et al. 2004. When more than one site series occured on a particular combination a map entity is assigned to that combination and a probability of each site series is assigned. The proportion of site series within a mapping entity is based on the frequency of occurrence of that site series within the variable combination. In this way every potential landscape position is allocated a site series or a mapping entity that consists of proportions of site series observed in the field to occur on that unique combination of BEC, landscape facet, slope class and aspect.

This forms the basis of the first run of the raster PEM. The knowledge bases that assign each variable combination to a site series or mapping entity can be found in Appendix 2 of Ketcheson et al. 2004. The first run raster PEM is now ready for second run modifications using secondary queries using specific surficial materials attributes. These queries can be found in Appendix 7 of the Ketcheson et al. 2004.

3.2 Second Run Generalized Terrain Mapping Modifications

The results of the first run site series allocations were then modified using a set of queries looking for specific terrain types. These targeted types we used to identify specific site series or break ties within the first run data set.
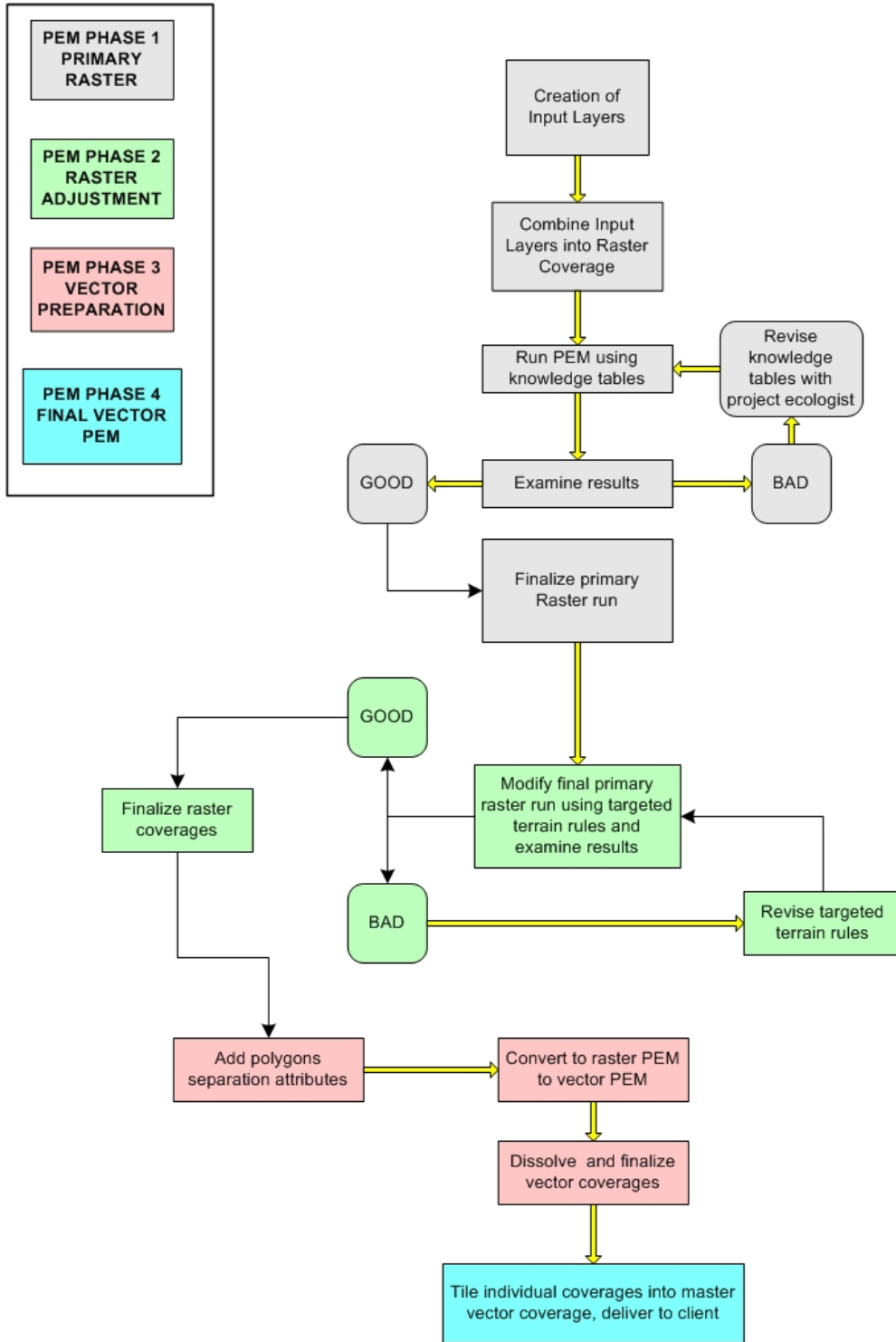
3.3 PEM Model Overview

An overview of the PEM model used is depicted in Figure 1. It basically consists of four stages where the landscape shape derived raster result is modified by spatial attributes from the surficial

materials mapping data. This approach was very successful in the Okanagan PEM (Ketcheson et al 2002).

PEM PHASE 1 PRIMARY RASTER

PEM PHASE 2 RASTER ADJUSTMENT

PEM PHASE 3 VECTOR PREPARATION

PEM PHASE 4 FINAL VECTOR PEM

Creation of Input Layers

Combine Input Layers into Raster Coverage

Run PEM using knowledge tables

Revise knowledge tables with project ecologist

GOOD — Examine results — BAD

Finalize primary Raster run

GOOD

Finalize raster coverages

Modify final primary raster run using targeted terrain rules and examine results

BAD — Revise targeted terrain rules

Add polygons separation attributes

Convert to raster PEM to vector PEM

Dissolve and finalize vector coverages

Tile individual coverages into master vector coverage, deliver to client

Figure 1. Invermere 2003 PEM Model Overview

4.0 Results

4.1 PEM Model Map Entity Allocation by BEC Variant

The Invermere PEM model allocated both the Timber Harvesting Landbase and the Non-Timber Harvesting Landbase to a site series or map entity. The map entities and there representation within the BEC variant are reported in Appendix 4 of the Invermere TSA Predictive Ecosystem Mapping Project Report (Ketcheson et al, 2004).

5.0 References

Ecological Data Committee Ecosystems Working Group/Terrestrial Ecosystems Task Force. Prepared for the Resource Inventory Committee. 2000. Standards for Terrestrial Ecosystem Mapping (TEM) – Digital Data Capture in British Columbia. Version 3.

Ketcheson, M., T. Dool, L. Bradley, G. Kernaghan, J. Shypitka, T. Robertson, K. Misurak, V. Lipinski and D. Ross. 2002. Okanagan TSA Dry Belt Predictive Ecosystem Mapping (PEM) and Site Index Adjustment. An unpublished report to Glen Dick, Okanagan Innovative Forest Practices Association, Lumby BC.

Ketcheson, M.V., T. Dool, L. Bradley, G. Kernaghan, K. Lessard V. Lipinski and R.A. MacMillan. 2004. Invermere TSA Predictive Ecosystem Mapping Final Project Report. Prepared for Vivian Jablanzcky, Slocan Forest Products, Radium, BC.