

# **TERRESTRIAL ECOSYSTEM MAPPING OF THE INDIAN LANDSCAPE UNIT**

**(SOO TIMBER SUPPLY AREA)**

**Prepared for:**

**Soo DFAM Committee**

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March 2006





**Date: March 31<sup>st</sup>, 2006**

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Attention: Ian Robertson, FIA Coordinator

*Reference:* **Terrestrial Ecosystem Mapping within the Soo TSA: Indian Landscape Unit**

Dear Ian:

Please find enclosed the final project deliverables for the Indian LU TEM project:

#### Non-Spatial Attribute Databases

- TEM project database - ([tem\\_4489\\_mta.csv](#))
- TEM polygon database - ([tem\\_4489\\_evp.csv](#))
- Venus 5.0 (ground inspection) database - ([tem\\_4489\\_eci.mdb](#))
- Excel (visual inspection) database – ([tem\\_4489\\_eci.xls](#))

#### Reports and Legends

- Map legend – ([tem\\_4489\\_ml.rtf](#))
- Expanded (vegetation) legend – ([tem\\_4489\\_el.pdf](#))
- Final Report - ([tem\\_4489\\_rpt.pdf](#))

#### ARC/INFO Spatial Databases

- TEM polygon information - ([tem\\_4489\\_evp.e00](#))
- TEM field plot data - ([tem\\_4489\\_eci.e00](#))

#### Other Deliverables

- Typed airphotos (with numbered ecosystem polygons and labeled BGC lines)
- Original field forms



Please contact me if you have any further questions or comments on the submitted deliverables.  
We look forward to an opportunity to work with you again in the future.

Yours truly,

A handwritten signature in black ink, appearing to read "Scott Hawker".

Scott Hawker, B.Sc., R.P.Bio.  
Project Manager

Timberline Forest Inventory Consultants Ltd.

## ACKNOWLEDGEMENTS

Terrestrial ecosystem mapping of the Indian Landscape Unit is the result of the efforts of many people.

Corey Erwin (MOE) provided input throughout the project initiation and helped refine the scope and the specific objectives of this project. Dr. Geoffrey Cushon (Regional Ecologist, MoFR) provided valuable comments and insights into the sampling plan discussions and in the placement of the preliminary alpine tundra (AT) and parkland (MHmmp) biogeoclimatic boundaries.

The digital photo control was completed by Andrew Neale of Andrew Neale Digital Mapping (Victoria, BC) and the subsequent monorestitution was completed by Eros Pavan, RPF, Timberline Forest Inventory Consultants Ltd. Nick Zukanovic and Marcel Morin, Timberline Forest Inventory Consultants Ltd., provided their GIS expertise throughout the project.

Field data collection was completed by the following staff of Timberline Forest Inventory Consultants Ltd.: Scott Hawker (RPBio; project manager), Anthony Collett (PGeo), Cameron King (RPF) and Andy Ferguson (RPF).

Doug Hopwood, RPF of Ecotrust Canada, with staff from the Tsleil-Waututh Nation, arranged for truck and quad transportation to and within the landscape unit. Mike George of the Tsleil-Waututh Nation provided water taxi service between Deep Cove and the mouth of the Indian River. The skilled staff of Black Tusk Helicopter Inc. (Squamish, BC) provided safe and efficient helicopter transport throughout the landscape unit.

Helen Reid, RPBio and Claudia Houwers, RPBio, of Madrone Environmental Services Ltd. (Duncan, BC), provided a third-party quality assurance (QA) review of the polygon classification phase, reviewing many photos representing each of the biogeoclimatic units in the project area. The resulting QA report has been attached as an Appendix to this report.

This project was funded through the Forest Investment Account (FIA) allocations of the Soo Defined Forest Area Management (DFAM) committee. Thanks to Ian Robertson, RPF and David Marquis, RPF for their continued support and confidence in Timberline throughout this project.

## EXECUTIVE SUMMARY

The Indian Landscape Unit (LU) is a somewhat remote area located on the northern end of Indian Arm, which extends north from the tip of Indian Arm along the Indian River valley. It encompasses 14,959 hectares. In order to catalogue the resources of this LU, Soo Timber Supply Area forest licensees, through Forest Investment Account funding, commissioned a terrestrial ecosystem mapping project of the landbase. The purpose of the project was to complete ecosystem mapping of the Indian LU at a 1:20,000 map scale.

Mapping was completed according to the *Standards for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998), although the project followed a non-standard approach, as outlined in this document. As per standard TEM projects, the ecosystem mapping was based on the three level ecosystem classification framework, which includes ecoregion units, biogeoclimatic units and ecosystem units. According to licensee requests, several modifications were made to the 1998 Terrestrial Ecosystem Mapping (TEM) standards.

The following variances from a standard TEM project applied to this project:

- Pre-stratification of terrain polygons was not completed (not a standard terrain base).
- Ecosystem delineation / classification was not completed within the alpine tundra (AT) BGC unit.
- Structural stage was not mapped.
- FS882 (detailed ecosystem plots) were not completed in the field.
- Project area excluded provincial park boundary.

The following four biogeoclimatic (BGC) units were mapped in the project area:

1. CWHvm1 Submontane Very Wet Maritime Coastal Western Hemlock Variant
2. CWHvm2 Montane Very Wet Maritime Coastal Western Hemlock Variant
3. MHmm1 Windward Moist Maritime Mountain Hemlock Variant
4. MHmmp1 Windward Moist Maritime Mountain Hemlock Parkland Variant

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# 1 INTRODUCTION

## 1.1 Project Background

The Indian Landscape Unit (LU) is a somewhat remote area located on the northern end of Indian Arm, which extends north from Burrard Inlet. It encompasses 14,959 hectares and is accessible primarily by seasonal logging roads, boat or helicopter. The districts of Squamish, North Vancouver and West Vancouver surround this LU.

This landscape unit falls partly under the jurisdiction of the Ministry of Forests and Range's (MoFR) Squamish Forest District. The Squamish Forest District oversees timber resource extraction for this area. Volume based tenures held by International Forest Products Ltd. and BC Timber Sales make up the majority of forest tenure holdings in the LU (Squamish Forest District Landscape Unit Planning Team 2003).

In 2001, the Tsleil-Waututh First Nation purchased all of the private land in the Indian River valley, totaling approximately 300 ha. In 2004, the Tsleil-Waututh Nation was awarded Woodlot License 1929, which provides an opportunity to manage 400 ha of Crown Land in the Indian River valley along with the Tsleil-Waututh private land. In September 2004, the Tsleil-Waututh concluded a Forest Agreement with the BC Ministry of Forests. Under the terms of that agreement, the Tsleil-Waututh will be invited to apply for a Non-Replaceable Forest Licence (NRFL) to harvest 11,600 m<sup>3</sup> per year for five years. The operating area for the NRFL will be within the Indian River watershed

In order for the stakeholders to adequately manage the LU within the scope of the Squamish Forest District, it is necessary to have a catalogue of the terrestrial features within the landbase. Terrestrial ecosystem mapping (TEM) provides one component of this catalogue. Ecosystem maps, along with associated interpretations, provide valuable information for various forest management and planning uses, such as landscape unit planning, forest development planning, and the development of biodiversity and wildlife management strategies (RIC 1998).

## 1.2 Objectives

The purpose of the project is to map and describe the terrestrial ecosystems within the Indian Landscape Unit at an operational 1:20,000 scale. The participating Defined Forest Area Management (DFAM) licensees may make use of this data for timber supply reviews (TSR) and various other ecosystem-based analyses.

Terrestrial ecosystem mapping of the Indian LU was funded through the Soo DFAM committee's Forest Investment Account (FIA) allocation.

### 1.3 Study Area

The 14,959 ha Indian LU study area is located on the southern mainland coast of BC and covers portions of the following 1:20,000 scale BCGS mapsheets: 092G065, 092G066, 092G056 and 092G046. Provincial park areas have been excluded for this project.

Figure 1 shows an overview map of the Indian LU within the Squamish Forest District (boundary shown in red) and Figure 2 depicts the landscape unit itself.

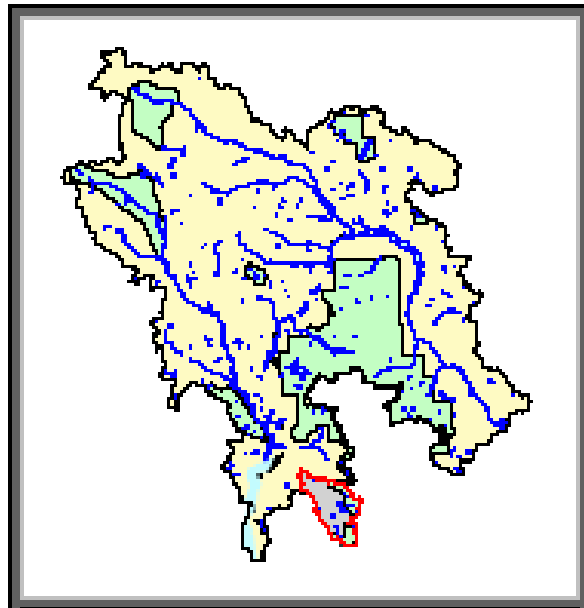


Figure 1. Location of the Indian LU within the Soo TSA.

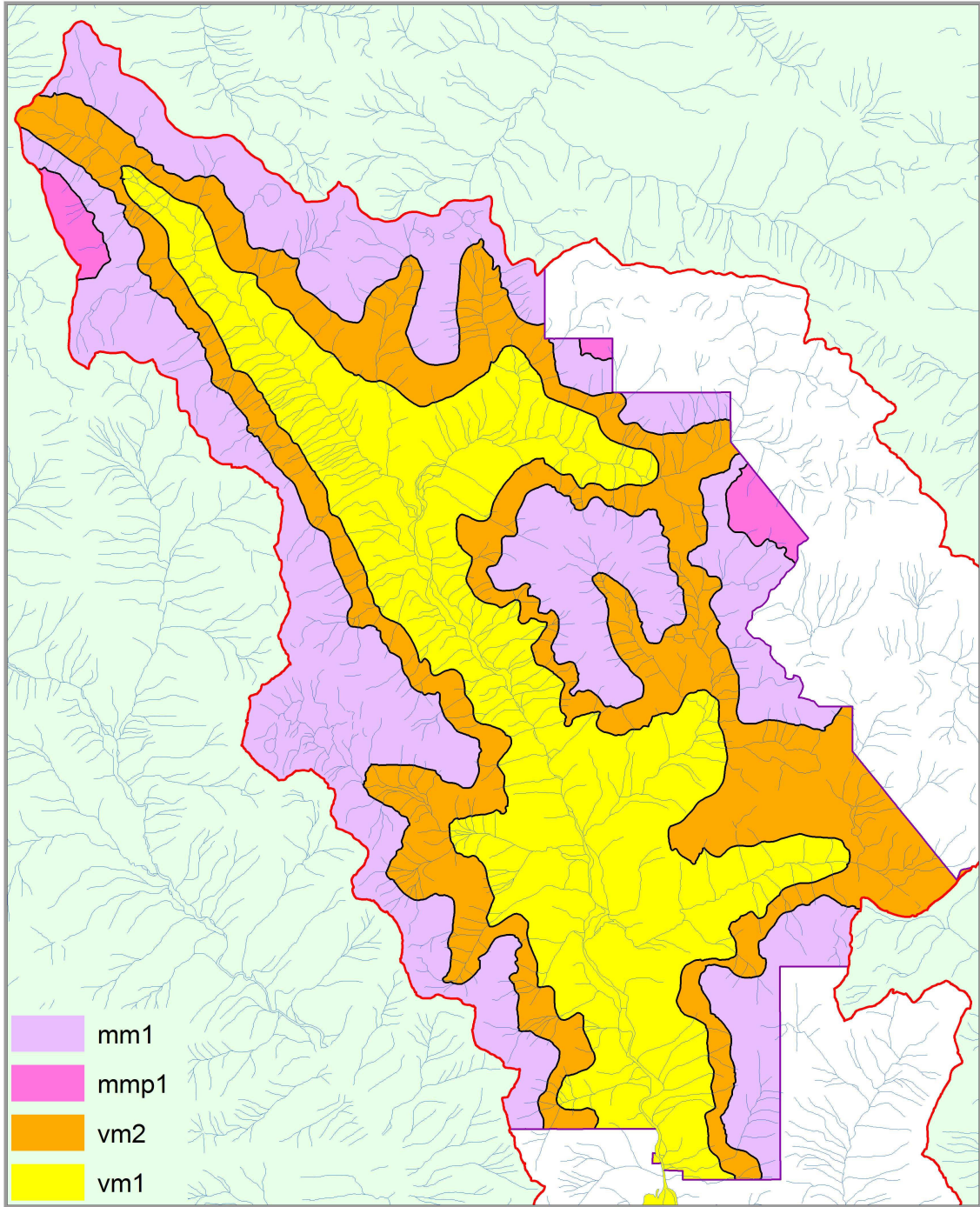


Figure 2. Indian LU study area (with parks excluded)

This landscape unit encompasses the Indian River watersheds. Major creek tributaries in the study area include the Brandt, Forestry, Meslillooet, Hixon, Young and Caledonian Creeks. This landscape unit is subject to a maritime climate with warm and dry summers and cool, wet winters.

The topography is typically steep and rugged, with an abundance of bedrock outcrops, rocky slopes (of thin to very thin morainal and colluvial veneers) and rubbly colluvial deposits on lower slopes as a result of the frequent gullied and sliding/avalanching terrain.

As the landscape unit is dominated by steep, rocky coastal terrain, there is an abundance of slides, rock falls, gully erosion and snow avalanches. Such active processes give rise to a variety of vegetation communities not typically found within stable, forested terrain. Coarse colluvial surficial materials dominate the many slide paths and much of the lower slope areas.

As typical along much of the Coast mountains, podzolic soils are prevalent within the study area. Podzolic soils are characterized by deep reddish to yellow-brown B horizons, dominated by accumulations of iron and aluminum oxides and humified organic matter. They typically develop in coarse to medium-textured, well drained, parent materials (often granitic) parent materials, under coniferous forest vegetation in humid climates. They are widely found on till and colluvium throughout the Indian study area.

## 2 ECOSYSTEM UNIT MAPPING - BACKGROUND

Ecosystem mapping is based on the three level ecosystem classification framework defined by BC's Resource Inventory Committee (RIC 1998); this framework consists of ecoregion units, biogeoclimatic units and ecosystem units. Ecosystem unit labels consist of three components: site series, site modifier(s) and a structural stage. Site series are defined within the existing MoFR biogeoclimatic ecological classification system.

Non-forested ecosystem units (i.e. avalanche units, parkland forest, heathland, and wetlands) may also be encountered that are presently not included in the MoFR site series classification. Definitions and codes for these units need to be obtained from the Ministry of Environment Provincial Site Series Code list.

### 2.1 Ecoregion

The ecoregion classification system is used to stratify BC's terrestrial and marine ecosystems into discrete geographical units. This system describes areas of similar climate, physiography, oceanography, hydrology, vegetation and wildlife potential (Demarchi 1993). Ecoregion boundaries are delineated on 1:2,000,000 and 1:50,000 terrestrial ecosystem maps. There are five levels of classification. The two highest levels, Ecodomains and Ecodivisions, place BC in a global context. The three lowest levels, Ecoprovinces, Ecoregions and Ecoregions, relate segments of the province to one another.

### 2.2 Biogeoclimatic Subzones

Within each ecoregion unit, biogeoclimatic (BGC) units are used to identify zonal climates and ecosystems. A zonal site is one that best represents the regional climate of an area. Subzones are subsets of zones and consist of unique sequences of geographically related ecosystems (Meidinger and Pojar 1991). Figure 3 below depicts the ecoregion and biogeoclimatic unit label as they appear on typical ecosystem maps (RIC 1998).

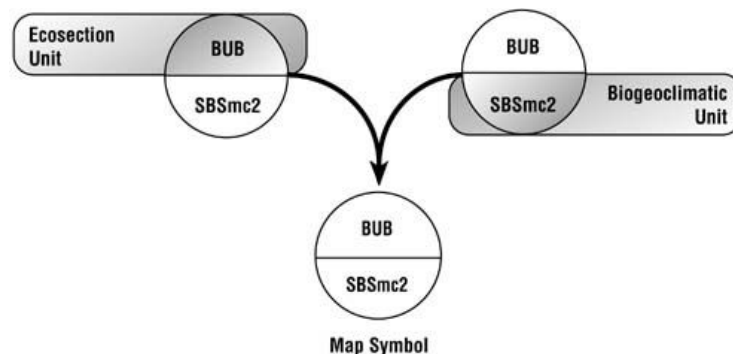


Figure 3. Symbols for Ecoregion and Biogeoclimatic Units

## 2.3 Biogeoclimatic Variants

Biogeoclimatic variants are a subdivision of a subzone. Because each subzone has considerable variability, variants are used to further reflect differences in climate. These climatic variations give rise to changes in vegetation, soil and ecosystem productivity (Meidinger and Pojar 1991). Figure 4 below (RIC 1998) illustrates the symbols used for biogeoclimatic units.

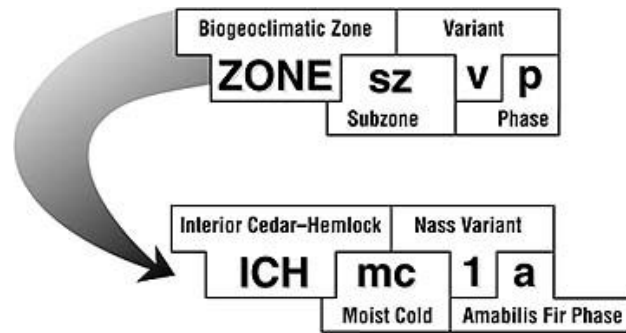


Figure 4. Symbols for biogeoclimatic units

## 2.4 Ecosystem Units

Ecosystem units incorporate the site series of biogeoclimatic classification in addition to physical attributes and structural stages. Generally, site series are relatively homogenous with regard to soils, surficial materials, topographic position, topoclimate and trends of secondary succession. Ecosystem units are typically composed of three components: site series, site modifiers, and structural stage. Ecosystem units have also been developed for non-forested ecosystems presently not included in the MoFR's site series classification system.

### 2.4.1 Site Series

Site series are the first component of an ecosystem unit. Site series have been developed to describe variation at the site level within the biogeoclimatic units (RIC 1995, 1998). The site series describe all land areas capable of supporting a specific climax plant association and reflecting a specified range of soil moisture and nutrient regimes within a subzone or variant (RIC 1995, 1998). A two-letter symbol is assigned to each site series; the codes are unique to each biogeoclimatic subzone and variant.

### 2.4.2 Site Modifiers

Site Modifiers are used to refine site series into more specific ecosystem units based on distinguishing site, soil and terrain characteristics. Typical (or assumed) environmental conditions (modifiers) have been defined for each site series defined within the MoFR's biogeoclimatic classification system (RIC 1998). Site modifiers are used for sites that differ from the described typical situation.

Table 1 below lists the available site modifiers, as defined by the BC Resource Inventory Committee (1998). Within the CWH and MH zones, aspect modifiers apply to slopes greater than 35% slope.

**Table 1. Standard TEM Site Modifiers**

Code	Criteria
<i>Topography</i>	
a	active floodplain <sup>1</sup> – the site series occurs on an active fluvial floodplain (level or very gently sloping surface bordering a river that has been formed by river erosion and deposition), where evidence of active sedimentation and deposition is present.
g	gullying <sup>1</sup> occurring – the site series occurs within a gully, indicating a certain amount of variation from the typical, or the site series has gullying throughout the area being delineated.
h	hummocky <sup>1</sup> terrain (optional modifier) – the site series occurs on hummocky terrain, suggesting a certain amount of variability. Commonly, hummocky conditions are indicated by the terrain surface expression but occasionally they occur in a situation not described by terrain features.
j	gentle slope – the site series occurs on gently sloping topography (less than 25% in the interior, less than 35% in the CWH, CDF, and MH zones).
k	cool aspect – the site series occurs on cool, northerly or easterly aspects (285°–135°), on moderately steep slopes (25%–100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones).
n	fan <sup>1</sup> – the site series occurs on a fluvial fan (most common), or on a colluvial fan or cone.
q	very steep cool aspect – the site series occurs on very steep slopes (greater than 100% slope) with cool, northerly or easterly aspects (285°–135°).
r	ridge <sup>1</sup> (optional modifier) – the site series occurs throughout an area of ridged terrain, or it occurs on a ridge crest.
w	warm aspect – the site series occurs on warm, southerly or westerly aspects (135°–285°), on moderately steep slopes (25%–100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones).
z	very steep warm aspect – the site series occurs on very steep slopes (greater than 100%) on warm, southerly or westerly aspects (135°–285°).
<i>Soil</i>	
c	coarse-textured soils <sup>2</sup> – the site series occurs on soils with a coarse texture, including sand and loamy sand; and also sandy loam, loam, and sandy clay loam with greater than 70% <b>coarse fragment volume</b> .
p	peaty material – the site series occurs on deep organics or a peaty surface (15–60 cm) <sup>3</sup> over mineral materials (e.g., on organic materials of sedge, sphagnum, or decomposed wood).
s	shallow soils – the site series occurs where soils are considered to be shallow to bedrock (20–100 cm).
v	very shallow soils – the site series occurs where soils are considered to be very shallow to bedrock (less than 20 cm).

<sup>1</sup> Howes and Kenk 1997

<sup>2</sup> Soil textures have been grouped specifically for the purposes of ecosystem mapping.

<sup>3</sup> Canada Soils Survey Committee, 1987

### 3 METHODOLOGY: ECOSYSTEM MAPPING

This project was completed as per the terms agreed to by the Soo Timber Supply Area DFAM committee and the Ministry of Environment's TEM representative. The following variances from a standard TEM project applied to this project:

- Pre-stratification of terrain polygons was not completed (not a standard 'terrain-based' approach).
- Ecosystem delineation / classification was not completed within the alpine tundra (AT) BGC unit and, as a result, the AT zone remains as large, island polygons. Note that each resultant alpine polygon was given a generic TEM label to describe the approximate amount of rock, ice or snow and krummholz.
- Structural stage attributes were not assigned to the TEM polygons during polygon classification. Structural stage attributes are currently being applied as part of a separate Vegetation Resources (Timber) Inventory being completed concurrently for the Indian LU.
- FS882 (detailed ecosystem plots) were not completed in the field. The field program consisted of a combination of ground inspections and visual inspections in an approximate ratio of 70% visual inspections and 30% ground inspections.
- In addition to the excluded alpine tundra (AT) area, the project area excluded park lands.

#### 3.1 Polygon delineation: Non-standard approach

Although this project did not use a standard approach to delineating bioterrain polygons (as the end user did not wish to collect the terrain information to develop a comprehensive terrain database), it should be noted that the process to delineate the ecosystem polygons followed the same basic principles that are followed in the delineation of standard TEM bioterrain polygons (i.e. an initial stratification of the landscape according to the physical conditions, such as slope position and soil moisture, that influence ecosystem development and expression).

The Indian LU ecosystem polygons were delineated to reflect the following criteria:

- surficial materials and texture (affecting soil drainage);
- surface expression (landform and thickness);
- slope position;
- topography;

- TEM aspect class (cool and warm); and
- geomorphological process (i.e. gullying, avalanching, meandering river etc).

In the end, although it cannot be considered a standard bioterrain approach, the process was overseen by a professional geoscientist with many years of bioterrain, terrain and terrain stability mapping experience in support of various terrestrial ecosystem mapping projects. In reviewing many of the delineated base polygons, Timberline's Geoscientist agreed that the resultant polygons were very similar to a standard TEM bioterrain polygon base.

### **3.2 Field Planning**

In a previous fiscal year, a preliminary sampling plan was developed prior to the commencement of field work. This plan identified the biogeoclimatic units and potential ecosystem units expected in the area (i.e. a draft working legend of expected map units was developed). In devising a preliminary plan, aerial photographs and overview maps were closely examined to identify accessible areas for potential field sampling. In addition, phone discussions were held with various contractors, licensees and First Nation members familiar with the area at an operational level. The potential sampling sites were selected to provide a cross section of the biogeoclimatic units and topographic relief present within the landscape unit.

### **3.3 Field Sampling**

#### **3.3.1 Field Sampling**

Field sampling was completed over the 6 days between July 27<sup>th</sup> to 29<sup>th</sup> 2005 and August 2<sup>nd</sup> to August 4<sup>th</sup> 2005. Each two-person field crew consisted of an experienced ecologist and an assistant Forester familiar with coastal tree and plant species and site interpretation techniques. Access throughout the landscape unit was achieved by the use of 4WD truck, quad and helicopter. The location of all ground inspection and visual inspection field plots were marked and recorded on the air photographs at the time of field sampling.

#### **3.3.2 Field Plots**

A total of 199 field plots were completed within the Indian LU study area. This total consisted of a total of 83 ground inspections (G) and 116 ground-based visual inspections (V). On the ground, the crews ensured, wherever possible, that the chosen sampling locations expressed homogeneous site, soil and vegetation characteristics. The Field Manual for Describing Terrestrial Ecosystems (Ministry of Forests and BC Environment, 1998) provided the methodology for data collection at the ground inspections locations. Standard TEM Ground inspection forms (GIF) were completed for the ground inspections and some of the visual inspections. The majority of the visual inspections were recorded as notes on field note paper.

### 3.4 Data Entry and Analysis

The ground inspection data was entered into Venus 5.0 software and the visual inspections were entered into a Microsoft Excel database for summary. Both of the databases are submitted with this project.

Upon completion of the field studies, the project ecologist reviewed the field forms for completeness and accuracy and ensured that all plot locations were accurately transferred into the GIS spatial database.

### 3.5 Ecosystem mapping

Following completion of the field sampling and subsequent review of the field data, the ecosystem polygons were digitized into a digital file (monorestitution). The polygons were then plotted on a base map that included contour lines and TRIM hydrology features.

The biogeoclimatic unit boundaries were initially placed on the photos (before field sampling) and subsequently digitized with the TEM ecosystem polygons. The ecosystem unit labels were then created by the project ecologist by examining the air photos using a combination of a large mirror stereoscope and a smaller (pocket) stereoscope for enhanced resolution (increased magnification).

The ecosystem polygon labels can be a simple unit (one single site series) or have up to three deciles per polygon (complex label). Each label includes a site series number (or code) and a mapped modifier(s), where the site conditions differed from the typical (assumed) situation described for a particular site series.

The mapping was subject to a third-party review for completeness and accuracy of mapping, as outlined in Section 5.2. Madrone Environmental Services Ltd. was retained to provide this quality assurance (QA) review and report. Timberline provided Madrone with samples of photos across all BGC units in this assessment. Madrone prepared a detailed QA report to summarize the comments.

The mapped ecosystem polygons were entered into a modified TEM ecosystem polygon database (Excel format: 'polygon.csv' file). The core data found in the ecosystem database for each polygon includes the following:

- BCGS Mapsheet Number
- Polygon number (ECP\_Tag)
- Data source (Photo Interpreted, Ground Inspection, or Visual Inspection)
- Flight line (project specific) and photo number
- Ecoregion code,
- Biogeoclimatic zone, subzone, variant and phase,

- Ecosystem labels [decile, site series, modifier(s): recorded up to three times per polygon]
- User-defined field: Small “point-feature” habitat elements that are <20% of the polygon area or smaller than 1 ha (i.e. RO, TA, OW etc... that may be of importance for future habitat analysis).

Draft ecosystem maps were created in ARC/Info format by combining the base map coverage, polygon digital files and the ecosystem databases.

### 3.6 Expanded Vegetation Legend

A condensed expanded (vegetation) legend was created in Microsoft Excel. Whereas a standard legend has a detailed list of vegetation species by structural stage, this legend does not differentiate based upon structural stage. The legend provides the following information for each BGC unit and each mapped ecosystem unit (site series):

- description of the typical situation in which the unit is found;
- assumed modifiers and typical soil moisture regime;
- provincial site series map code, mapped modifiers;
- dominant (i.e. present in approximately >50% of the field plots);
- associated vegetation species by layer (tree, shrub, herb and moss); and
- field plots established within each unit.

For the units not described with field plots, the typical situations and vegetation lists have been largely derived from a combination of the provincial map code list and the current Land Management Handbook for the Vancouver Forest Region (LMH28).

### 3.7 Limitations

Much of the accessible lower elevation slopes have been harvested in the preceding 30 to 40 years, making it difficult to complete ground samples in adequate mature (to old) mesic forest habitats. This made it very difficult to assess the ecosystems for purposes of describing zonal sites and refining the elevation boundaries.

## 4 RESULTS: MAPPED BGC UNITS AND ECOSYSTEMS

A summary of ecosystem units mapped in the project area is provided below.

### 4.1 Ecosession

The Indian LU falls entirely within the Pacific Ranges Ecoregion (see Figure 5). According to Demarchi (1996), this ecoregion “is the southern-most mountain range of the Coast Mountains in British Columbia. It includes the coastal islands, channels and fjords east of Queen Charlotte Sound, otherwise it lies east of the Georgia Depression Ecoprovince. The mountains are characteristically high and rugged.”

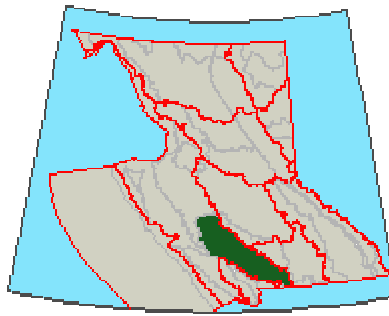


Figure 5. Pacific Ranges Ecoregion

The Pacific Ranges Ecoregion consists of four Ecosessions. The Indian LU falls entirely within the Southern Pacific Ranges Ecosession. This ecosession “is an area of high rainfall on steep, rugged mountains located east of the Georgia Depression Ecoprovince and north of the lower Fraser River.”

### 4.2 Biogeoclimatic Units

Table 2 summarizes the area of each BGC unit mapped within the Indian Landscape Unit.

Table 2. Area summary of mapped BGC units

BGC Unit	Name	Area (Ha)
CWHvm1	Submontane Very Wet Maritime Coastal Western Hemlock Variant	5,045
CWHvm2	Montane Very Wet Maritime Coastal Western Hemlock Variant	4,398
MHmm1	Windward Moist Maritime Mountain Hemlock Variant	5,260
MHmmp1	Windward Moist Maritime Mountain Hemlock Parkland Variant	256

A detailed description (expanded legend) of the ecosystems mapped in each of the biogeoclimatic units, along with the dominant and associate vegetation species, is provided on separate tables in Appendix 1.

Following are descriptions of each of the BGC units found within the Indian LU. Descriptions are adapted from *A Field Guide for Site Identification and interpretation for the Vancouver Forest Region: Land Management Handbook Number 28* (Green and Klinka 1994).

#### 4.2.1 CWHvm1

Within the Coast Forest Region, the CWHvm1 variant occurs at lower elevations on the mainland coast and is the most extensive unit in the region. Along the lower mainland coastline, it typically occurs above the CWHdm subzone. Reported elevation limits range from sea level (or above CWHdm) to approximately 650m. In the Indian LU, at approximately 650 metres elevation, the vm1 grades into the vm2, which is differentiated from the vm1 by the presence of yellow cedar, mountain hemlock and pipecleaner moss, primarily in slightly wetter areas.

The CWHvm1 unit typically has a wet, humid climate with cool summers and mild winters with little snowfall. Forested sites within the vm1 variant are typically dominated by western hemlock and amabilis fir with lesser amounts of western red cedar. The understory is well-developed; vegetation species include red huckleberry, Alaskan blueberry, step moss and lanky moss. Minor amounts of herbs, including deer fern, bunch berry, five-leaved bramble and queen's cup, may also be found.

The following vegetated site series have been mapped within the CWHvm1 variant:

- 01 – AB HwBa-blueberry
- 02 – LC HwPl-cladina
- 03 – HS HwCw-salal
- 04 – RS CwHw-swordfern
- 05 – AF BaCw-foamflower
- 06 – HD HwBa-deer fern
- 07 – AS BaCw-salmonberry
- 09 – SS Ss-salmonberry
- 10 – CD Act-red osier dogwood
- 11 – CW Act-willow
- 14 – RC CwSs-skunk cabbage
- 00 – AW red alder-fern
- 00 – HW shrub carr
- 00 – SA Sitka alder-salmonberry avalanche chute

#### 4.2.2 CWHvm2

Within the Coast Forest Region, the CWHvm2 variant occurs above the CWHvm1 variant. The reported elevation limits range from approximately 650 to 1000 metres. In the study area, the vm2 variant grades into the MHmm1 variant at approximately 900 metres. The MHmm1 variant typically has a hemlock component in the tree layer consisting of greater than 50% of mountain hemlock.

The CWHvm2 variant typically has a wet, humid climate with cool, short summers and cool winters with substantial snowfall. Forested sites within the vm2 are typically dominated by western hemlock and amabilis fir. There are lesser amounts of western red cedar, yellow cedar and mountain hemlock (wetter sites support more mountain hemlock and yellow cedar). Understory vegetation species include Alaskan blueberry, five-leaved bramble, step moss, lanky moss and pipecleaner moss.

The following vegetated site series have been mapped within the CWHvm2 variant:

- 01 – AB      HwBa-blueberry
- 02 – LC      HwPl-cladina
- 03 – HS      HwCw-salal
- 04 – RS      CwHw-swordfern
- 05 – AF      BaCw-foamflower
- 06 – HD      HwBa-deer fern
- 07 – AS      BaCw-salmonberry
- 09 – YG      CwYc-goldthread
- 10 – LS      Pl-Sphagnum
- 11 – RC      CwYc-skunk cabbage
- 00 – SA      Sitka alder - salmonberry avalanche chute

#### 4.2.3 MHmm1

Within the Coast Forest Region, the MHmm1 variant occurs at high elevations in maritime areas of the mainland coast. Reported elevation limits range from approximately 800 metres to 1350 metres. In the study area, the MHmm1 variant has been mapped up to approximately 1350-1400 metres. In the project area, the MHmm1 variant is mapped above the CWHvm2 variant. At higher elevations throughout the study area, the MHmm1 unit grades into the MHmmp1 unit, which is characterized by open amabilis fir and mountain hemlock dominated parkland forests, with an abundance of mountain heathers (*Cassiope* and *Phyllodoce*) in the herb layer.

The MHmm1 has long, wet, cold winters and short, cool, moist summers. Snowfall is typically high, with substantial snowpacks that can last into July. Forested sites within the mm1 variant are typically dominated by mountain hemlock, amabilis fir and yellow cedar. The common understory species include Alaskan blueberry, oval leaved blueberry and pipecleaner moss.

The following vegetated site series have been mapped within the MHmm1 variant:

- 01 – MB HmBa-blueberry
- 02 – MM HmBa-mountain heather
- 03 – MO BaHm-oak fern
- 04 – AB HmBa-bramble
- 05 – MT BaHm-twistedstalk
- 06 – MD HmYc-deer cabbage
- 07 – YH YcHm-hellebore
- 08 – YS HmYc-Sphagnum
- 09 – YC YcHm-skunk cabbage
- 00 – CA tufted clubrush - asphodel wetland
- 00 – MH Hm-mountain heather parkland/heath
- 00 – MK mountain hemlock krummholz
- 00 – MR mountain heather - racomitrium scrub
- 00 – SA Sitka alder - salmonberry avalanche chute
- 00 – SB sedge burnet meadow
- 00 – PS partridge - sedge meadow
- 00 – AA Ba - Alaskan blueberry (MHmm2 unit)
- 00 – AM herbaceous Meadows (MHmmp1 unit)

#### 4.2.4 MHmmp1

Within the project area, the MHmmp1 unit is mapped above approximately 1350 metres. The open parkland forests contained a mixture of amabilis fir and mountain hemlock trees. Openings between treed islands are typically dominated by carpets of mountain heathers (*Cassiope mertensiana* and *Phyllodoce empetriformes*), with moister openings dominated by *Carex* sedges, *Veratrum viride*, *Valeriana sitchensis* and grasses. Large surface blocks and exposed rock are common features in the parkland region.

In some areas, the steep topography and cold microclimate pushes down the mmp1 unit, such that mmp1 ecosystem units have been mapped within areas defined on the map as the MHmm1 variant.

The following vegetated site series have been mapped within the MHmmp1 variant:

- 00 – MH Hm-mountain heather parkland / heath
- 00 – MR mountain heather - racomitrium scrub
- 00 – AA Ba - Alaskan blueberry (MHmm2 unit)
- 00 – BJ BaBl - juniper (MHmmp2 unit)

## 5 QUALITY CONTROL

### 5.1 Internal Quality Control

Internal quality control was undertaken through all phases of this project. This included internal reviews of preliminary ecosystem delineation, review of preliminary BGC boundaries, especially in placement of parkland and alpine boundaries, and a final review of all field forms for logic and completeness of data.

The final deliverables were subject to a quality control process before final submission of the deliverables. In this process, Timberline's project manager:

1. deleted all small 'sliver polygons' (typically < 1ha);
2. checked the spatial and non-spatial data to ensure a 1:1 link of the polygon data;
3. reviewed the database to ensure all deciles of complex map units add to 100%;
4. reviewed the database to ensure the correct application of site modifiers (for the assumed and mapped modifiers);
5. reviewed the database to ensure that the provincial standard TEM codes have been applied to the ecosystems;
6. reviewed the database to ensure that no duplicate or blank fields remain for any of the polygons;
7. visually assessed the final dataset to ensure that every polygon within a specific BGC unit has been mapped appropriately (for example, to ensure there are no CWHvm2 labels within the CWHvm1 BGC unit); and
8. completed a final review of the Venus and Excel databases for completeness.

### 5.2 External Quality Control

An independent review of the ecosystem classification was completed in March 2006, by Madrone Environmental Services Ltd. In their assessment, Claudia Houwers, RPBio, and Helen Reid, RPBio, reviewed many different photos representing many different flight lines and each of the BGC units in the area. They specifically looked for consistency of mapping, appropriate and consistent use of ecosystem codes and site modifiers, logic in classification, BGC elevation placement, and completeness of the field forms. The final QA report from Madrone is attached in Appendix 2.

## 6 REFERENCES

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### Reference Material

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## **APPENDIX 1: EXPANDED LEGEND WITH VEGETATION SPECIES**

## **APPENDIX 2: THIRD-PARTY QUALITY ASSURANCE (QA) REPORT**