

# TERRESTRIAL ECOSYSTEM MAPPING BUNSTER LANDSCAPE UNIT



## **Prepared For:**

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**March 31, 2010**



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Attention: Ian Robertson, RPF, FIA Coordinator

**Reference: Terrestrial Ecosystem Mapping within the Sunshine Coast TSA: Bunster Landscape Unit**

Ian,

Please find enclosed the final project deliverables for the Bunster Landscape Unit TEM project:

Non-Spatial Attribute Databases

1. TEM project database - ([tem\\_5640\\*\\_mta.csv](#))
2. TEM polygon database - ([tem\\_5640\\_evp.csv](#))
3. Venus 5.0 (ground inspection) database - ([tem\\_5640\\_eci.mdb](#))
4. Excel (visual inspection) database - ([tem\\_5640\\_eci.xls](#))

Reports and Legend

5. Map legend - ([tem\\_5640\\_ml.pdf](#))
6. Expanded (vegetation) legend - ([tem\\_5640\\_el.pdf](#))
7. Final Report - ([tem\\_5640\\_rpt.pdf](#))

ARC/INFO Spatial Databases

8. TEM polygon information - ([tem\\_5640\\_evp.e00](#))
9. TEM field plot data - ([tem\\_5640\\_eci.e00](#))

Other Deliverables (available upon request)

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

*\* Business Area Project ID (BAPID, supplied from the Ministry of Environment)*

Please contact me if you have any further questions or comments on the submitted deliverables.

Sincerely,

A handwritten signature in blue ink, appearing to read "S. Hawker".

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

Timberline Natural Resource Group Ltd.

## ACKNOWLEDGEMENTS

Terrestrial ecosystem mapping of the Bunster Landscape Unit could not have been successfully completed without the efforts of many people.

This project was funded through the Forest Investment Account (FIA) and was coordinated by the participating Sunshine Coast TSA Licensee Group members. Ian Robertson, R.P.F., Forsite Consultants Ltd., acted as the FIA Administrator on behalf of the Sunshine Coast TSA Licensee Group.

Ecological data collection was completed by the following Timberline staff: Scott Hawker, R.P.Bio. (Project Manager), Jim Webb, B.I.T., Rachelle Robitaille, R.P.Bio., and Tanya Seebacher, M.Sc., B.I.T. The skilled staff of Oceanview Helicopters provided safe and efficient helicopter transport.

Digital photo control was completed by Andrew Neale of Andrew Neale Digital Mapping (Victoria, BC). Data capture (via monorestitution) was completed by Eros Pavan, R.P.F., of Timberline. Nick Zukanovic and Eros Pavan of Timberline provided their GIS expertise throughout the project.

Helen Reid, R.P.Bio., provided an independent third party quality assurance review of the field data collection and final classification (mapping), with emphasis on the quality and consistency of calls between the mappers and on the correct use of the TEM map codes and site modifiers.

## EXECUTIVE SUMMARY

The 55,425 hectare Bunster Landscape Unit is situated within the Sunshine Coast Forest District, to the north of Powell River.

In order to catalogue the ecological resources of the Bunster Landscape Unit, the Sunshine Coast Timber Supply Area Licensee Group commissioned a terrestrial ecosystem mapping (TEM) project within this LU. The purpose of the project was to complete a TEM of the landscape unit for use in future timber supply reviews and other resource management activities. A total of **1,873** terrestrial ecosystem polygons were mapped within this landscape unit.

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, and discussions between the mapping contractor, licensee and Ministry of Environment staff in a previous fiscal year, several modifications were made to the 1998 TEM standards. The following variances from a standard TEM project applied to this project:

- Terrain attributes were not mapped,
- Structural stage attributes were not mapped,
- The sampling intensity targets applied largely to the productive forest land base (i.e. parkland ecosystems were not as intensively field sampled; they were largely photo interpreted),
- FS882 field forms were not completed in the field,
- The Coastal Mountain-heather Alpine (CMA) zone was neither mapped nor classified, and
- The expanded legend did not provide a detailed listing of vegetation species by structural stage.

The following five biogeoclimatic units were mapped in the project area:

- CDFmm Moist Maritime Coastal Douglas-fir Subzone
- CWHxm1 Eastern Very Dry Maritime Coastal Western Hemlock Variant
- CWHdm Dry Maritime Coastal Western Hemlock Subzone
- CWHvm2 Montane Very Wet Maritime Coastal Western Hemlock Variant
- MHmm1 Windward Moist Maritime Mountain Hemlock Variant

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# 1 INTRODUCTION

## 1.1 Project Background

The Bunster Landscape Unit (LU) supports a range of natural resource, recreation and wildlife values and a diversity of social and cultural values and influences. Stakeholders must balance these resource needs with community and ecological requirements. One step in creating a balance between economic, community and ecological requirements is to catalogue the terrestrial ecosystems within the land base through the terrestrial ecosystem mapping (TEM) process.

As defined in the current TEM standards (RIC 1998), terrestrial ecosystem mapping is the stratification of a landscape into discrete map units, according to a combination of ecological features, primarily climate, physiography, surficial material, bedrock geology, soil and vegetation.

Together, the ecological features result in distinctive and repeatable site conditions and climax vegetation communities (site series) across the landscape. Each site series depicts a specified range of vegetation species and site productivity that can be found in a particular location. Ecosystem polygons are essentially lines that demarcate the site series or site series complexes.

TEM data forms a planning framework for a wide range of land or ecosystem-based management applications including:

- base-case analysis in timber supply reviews (TSR),
- ecosystem distribution and sensitivity analysis,
- long-term ecological monitoring,
- habitat supply modeling and assessment,
- rare ecosystem, plant or animal mapping or modeling,
- forest development, silviculture, site productivity (SIBEC) planning,
- riparian, biodiversity planning,
- wildfire risk analysis, and
- various other operational and strategic planning initiatives.

The Sunshine Coast TSA Licensee Group commissioned this project with funding from the Forest Investment Account (FIA). This project contained several Ministry-approved variances from the TEM standards (RIC 1998).

## 1.2 Objectives

The objectives of this ecosystem mapping project within the Bunster Landscape Unit were to:

- complete field data collection for the previously-delineated photos;
- field sample the forested landscapes to TEM Survey Intensity Level 4;
- assess the biogeoclimatic (BGC) lines, providing new elevation rules and extents, as necessary;
- map and describe the terrestrial ecosystems;
- provide a seamless digital coverage of the terrestrial ecosystems (with localized biogeoclimatic information); and to
- prepare deliverables for submission to the Ministry of Environment's Ecological Reports Catalogue (EcoCAT).

## 1.3 Study Area

### 1.3.1 Location

The 55,425 hectare Bunster Landscape Unit is situated within the Sunshine Coast Forest District, north of Powell River. It stretches from the City of Powell River, at its south end, to Sarah Point, at the extreme northwest tip of Malaspina Peninsula. In general terms, it consists of the land base between Desolation Sound and the Powell Lakes chain, which form its eastern boundary. It includes the drainage basin of the Theodosia River, in addition to numerous other smaller creek and river systems.

The landscape unit covers portions of the following seven BCGS mapsheets:

- 092F097, 092F098
- 092K006, 092K007, 092K008, 092K017, 092K018

Given the proximity to Powell River and other Sunshine Coast communities, the Bunster Landscape Unit supports a wide range of natural resource, water, recreation, and wildlife values and a diversity of social and cultural values and influences. As described by Smart *et al.* (2000) in the Bunster Landscape Unit Plan, this landscape unit has a very high proportion of sites accessible for forest operations, compared to other landscape units within the Sunshine Coast Forest District. This enhances many of the timber resource values and is important for local employment opportunities.

There are many forms of ownership and tenure within this landscape unit, all of which influence the management decisions, including Private land, Crown forest, Indian reserve, municipality, Provincial Forest, woodlots, Forest and Tree Farm license, Provincial park, community watershed, UREPs and timber salvage areas. Apart from generating local employment opportunities, residents in this area value the forest lands

for a wide variety of uses, including aesthetics, recreation (walking, hiking and biking *etc.*), wildlife viewing and botanical forest product harvesting, to name a few.

Figure 1 presents an overview map of the Sunshine Coast Forest District (Sunshine Coast Timber Supply Area).

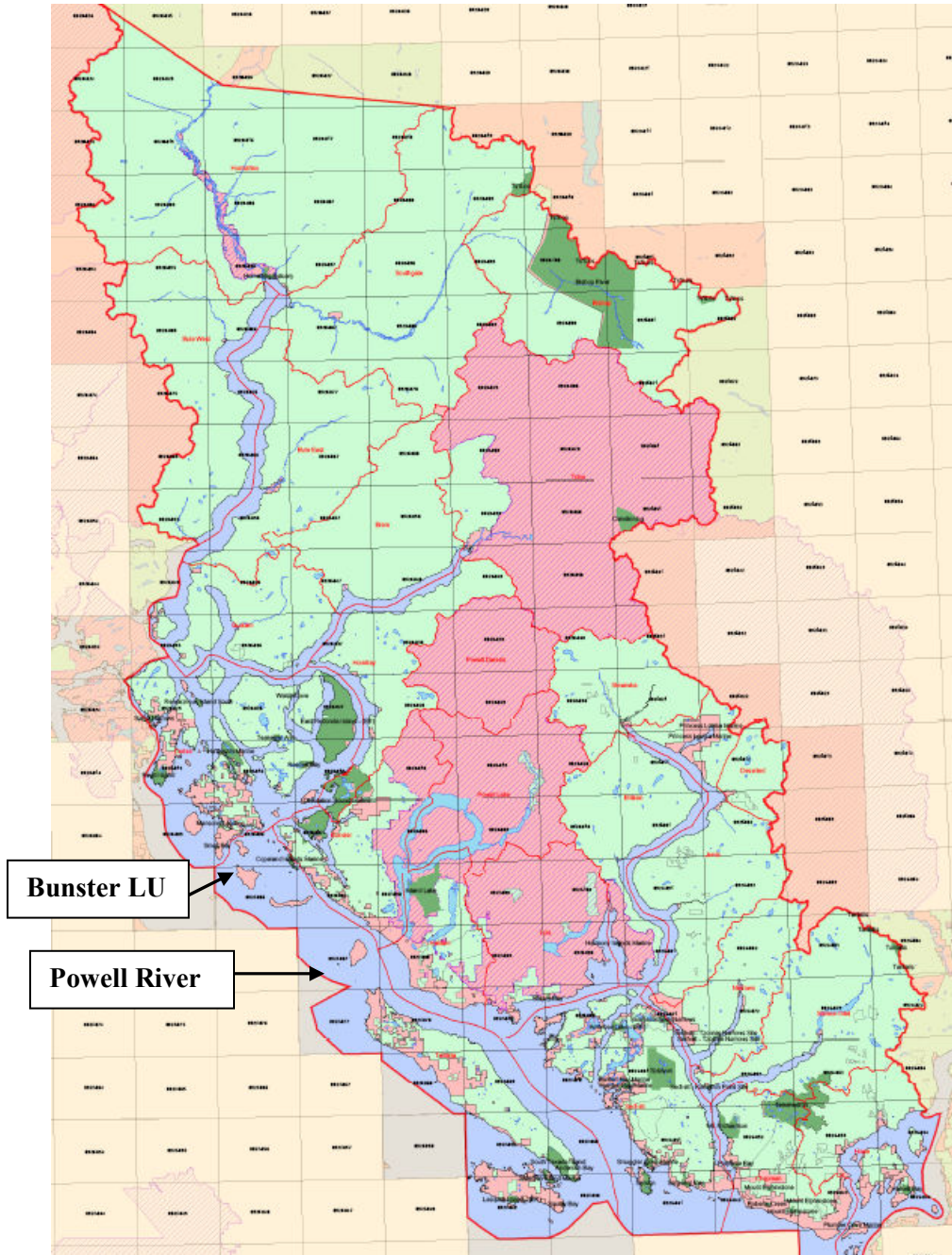


Figure 1. Sunshine Coast Timber Supply Area

Situated adjacent to Desolation Sound, the Bunster LU boundary is illustrated in Figure 2 (the pale green areas included in the mapping).

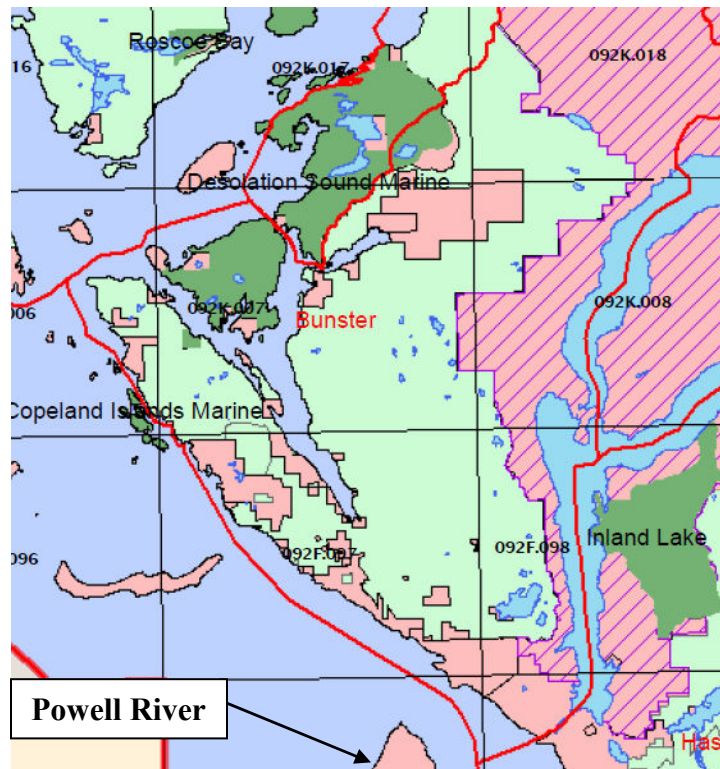
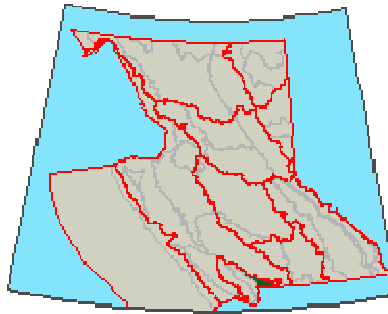


Figure 2. Bunster LU boundary overview

### 1.3.1.1 Biophysical Classification

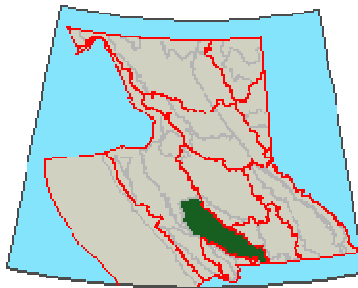
There are two related systems for describing landscapes in BC. The Ecoregion Classification System is a hierarchical system that provides a broad view of geographical relationships (Demarchi 1996). The Biogeoclimatic Ecosystem Classification (BEC) system provides another hierarchical classification method from the landscape to the site level (Pojar *et al.* 1987). The BGC subzones, which are a hierarchical unit within this system, are unique to each ecosection.

The Bunster Landscape Unit falls within the Lower Mainland and Pacific Ranges Ecoregions. The Lower Mainland Ecoregion (Figure 3) represents an area of reduced rainfall, although the precipitation increases towards the Coast Mountains (Demarchi 1996). Although it consists of two Ecosections, the western half of the Bunster LU falls entirely within the Georgia Lowland (GEL) Ecosection.



**Figure 3. Lower Mainland Ecoregion**

The Pacific Ranges Ecoregion (Figure 4) includes 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 throughout this ecoregion (Demarchi 1996). The eastern portion of the Bunster LU falls within the Southern Pacific Ranges Ecoregion.



**Figure 4. Pacific Ranges Ecoregion**

The BGC subzones and variants mapped within each of the ecosections in the Bunster LU are described in Table 1 and Table 2. The elevation ranges and descriptions are adapted from Green and Klinka's (1994) *A Field Guide for Site Identification and Interpretation for the Vancouver Forest Region: Land Management Handbook Number 28*. Further descriptions and notes on the distribution of each unit, including the elevations at which each biogeoclimatic unit has been mapped for this project, are included in Section 3.

**Table 1. Field Guide descriptions of the BGC units within the GEL Ecoregion**

Ecoregion	BGC Unit	Name	Elevation Range (m)	Climate
<i>Georgia Lowland</i>	CDFmm	Moist Maritime Coastal Douglas-fir Subzone	0 - 150 m	warm, dry summers and mild, wet winters (mildest climate in Canada)
	CWHxm1	Eastern Very Dry Maritime Coastal Western Hemlock Variant	0 - 650 m	warm, dry summers and moist, mild winters with relatively little snowfall
	CWHdm	Dry Maritime Coastal Western Hemlock Subzone	0 - 650 m	warm, relatively dry summers and moist, mild winters with little snowfall
	CWHvm2	Montane Very Wet Maritime Coastal Western Hemlock Variant	650 - 1000 m	wet, humid climate with cool, short summers and cool winters; heavier snow than vm1

**Table 2. Field Guide descriptions of the BGC units within the SPR Ecoregion**

Ecoregion	BGC Unit	Name	Elevation Range (m)	Climate
<i>Southern Pacific Ranges</i>	CWHdm	Dry Maritime Coastal Western Hemlock Subzone	0 - 650 m	warm, relatively dry summers and moist, mild winters with little snowfall
	CWHvm2	Montane Very Wet Maritime Coastal Western Hemlock Variant	650 - 1000 m	wet, humid climate with cool, short summers and cool winters; heavier snow than vm1
	MHmm1	Windward Moist Maritime Mountain Hemlock Variant	Lower (800 to 1000 m); Upper (1100 to 1350 m)	long, wet, cold winters with high snowfall and short, cool, moist summers

### 1.3.2 Climate

Much of the western half of the Bunster Landscape Unit falls within the Moist Maritime Coastal Douglas-fir Subzone (CDFmm) and the Very Dry Maritime Coastal Western Hemlock Variant (CWHxm1), two of the driest and mildest climates in the country. As the slopes increase towards the Bunster Range, the temperature decreases and precipitation increases. The biogeoclimatic sequence in these areas reflects the moister, cooler climate and consists of (from lower to higher elevation) the Dry Maritime Coastal Western Hemlock Subzone (CWHdm), the Montane Very Wet Maritime Coastal Western Hemlock Variant (CWHvm2) and the Windward Moist Maritime Mountain Hemlock Variant (MHmm1).

### 1.3.3 Hydrology

Within the mapped area, most of the water flows into Theodosia and Okeover Inlets, or directly into the Strait of Georgia, along the western edge of the landscape unit. Some of the larger lakes within the study area include Sliammon Lake, Little Sliammon Lake, Chipewa Lake (Figure 5), Isle Lake and Olsen Lake. There are many other smaller lakes, ponds and wetlands, especially upon the gentle terrain of the Bunster Range and Gwendoline Hills, on Malaspina Peninsula.



**Figure 5. View towards plot SH67 along shore of Chipewa Lake**

Larger watercourses within the Bunster LU include Theodosia River, at the northern end, and Appleton Creek, which initiates in the Bunster Range and flows into Sliammon Lake and ultimately into the Strait of Georgia via Sliammon Creek. Other notable creeks include Wilde Creek, which flows into Sliammon Creek and Browne Creek, on Malaspina Peninsula.

### 1.3.4 Topography and Soils

Much of the land base mapped within the CDFmm subzone and CWHxm1 variant, primarily along the western portions of the landscape unit, consists largely of gentle, undulating terrain, often with second-growth Fd and Hw stands. Shallow soils and rocky openings are common throughout the lower elevations, resulting in an abundance of drier ecosystems (Figure 6). Steeper, rugged terrain exists at the higher elevations (especially within the Bunster Range, and in the Theodosia River drainage).



**Figure 6. Sampling a rocky opening within the CWHdm subzone (plot SH30)**

Podzolic soils, characterized by reddish-brown B horizons dominated by accumulations of aluminum, iron and humified organic material, typically develop on coarse- to medium-textured, acidic parent materials, common to much of the Coastal Western Hemlock zone. They are likely very widespread on a variety of morainal and glaciofluvial materials throughout the Bunster study area. On the ground, the vast majority of soils were in the loam and sand categories, primarily sandy-loam and loamy-sand textures. Smaller areas of wetter (Gleysol) soils (with higher silt and/or clay components) were associated with narrow watercourses and localized receiving areas. The soils in these areas are characterized by mottled grey colours due to prolonged saturation of the soils or fluctuating water levels throughout the year. Organic deposits (Figure 7) are locally common, especially within the CWHvm2 and MHmm1 Variants, upon the gentle terrain of the Bunster Range.



**Figure 7. Carex-dominated wetland (plot SH25)**

### 1.3.5 Parks

The 8,450 hectare Desolation Sound Marine Provincial Park is located at the north end of the landscape unit, at the confluence of Malaspina Inlet and Homfray Channel. A popular destination for boaters, it has more than 60 kilometres of shoreline and the warm waters make it an ideal location for swimming and scuba diving.

## 2 METHODOLOGY: ECOSYSTEM MAPPING

A full summary of the hierarchical framework of ecosystem mapping used in BC is described in Appendix 1.

Under a previous contract funded through the Forest Investment Account (FIA) by the Sunshine Coast Licensee Group, Timberline Natural Resource Group Ltd. (Timberline) completed the following TEM phases within the Bunster LU:

- Air photo acquisition and preparation (2003-2005 colour; ~1:17,000 scale),
- Digital data acquisition and preparation,
- Ecosystem delineation (TEM delineation) below the CMA zone (where applicable),
- Placement of preliminary Biogeoclimatic (BGC) lines onto the aerial photos,
- Preliminary digital line capture (monorestitution) of the ecosystem polygons and preliminary BGC lines,
- Third party Quality-Assurance (QA) of the preliminary delineation / BGC placement, and
- Field sampling plan preparation.

The following phases were completed for this project:

- Field data collection,
- Data entry (Venus 5.0 and Microsoft Excel),
- Edits to ecosystem polygons and refinement of the preliminary BGC lines following field sampling, as required,
- Ecosystem classification (polygon attribution),
- Third party Quality-Assurance of the final classification and mapping,
- Preparation of final digital (GIS) data, and
- Final reporting and data preparation.

The following Ministry of Environment-approved variances from a standard TEM project applied to this project:

- Pre-stratification of the terrain polygons was not completed (product not a standard 'bioterrain-based' approach).
- The field program consisted of a combination of ground inspections and visual inspections in a targeted ratio of 70% visual inspections and 30% ground inspections at a sampling density within the productive forested land base of one plot per 100 hectares.
- The provincial park land base was excluded.
- Detailed FS882 (ecosystem) plots were not completed in the field.
- The structural stage attributes were not catalogued as these attributes are being described in an independent forest inventory project.

- The expanded legend does not provide a detailed vegetation list within each structural stage.

## 2.1 Polygon Delineation: non-standard approach

Although this project does not follow a standard approach to delineating the bioterrain polygons, 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 ‘bioterrain-based’ TEM polygons (i.e. an initial stratification of the landscape according to the physical conditions that influence ecosystem development and expression).

The ecosystem polygons were delineated within the Bunster Landscape Unit to capture the differences within the following criteria:

- surficial material types and texture (affecting soil drainage),
- surface expression (landform and thickness),
- slope position and gradient,
- topography,
- TEM aspect class (cool and warm), and
- geomorphologic process (i.e. gullying, avalanching, meandering river etc).

## 2.2 Field Planning

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 and a working legend of expected map units was developed. In devising a preliminary plan, aerial photographs and overview maps were examined to identify accessible areas for potential field sampling. The potential sampling sites were selected to provide a cross section of the biogeoclimatic units and topographic relief present within the landscape unit.

## 2.3 Field Sampling

The targeted plot production was largely based upon the productive forest land base. In the digital net-down process (to estimate a productive forest land base), a productive land base was estimated at approximately 22,800 hectares. Field sampling was focused largely on the productive forested land base within the Coastal Douglas-fir, Coastal Western Hemlock and Mountain Hemlock biogeoclimatic zones.

Field sampling (Figure 8) in the Bunster LU was completed over several days during the months of July and August 2009. Each two-person crew consisted of experienced ecologists, one with significant coastal ecology sampling experience. The lead ecologists on each crew have been involved with data collection during the previous fiscal years of this project.



**Figure 8. Field sampling within the Bunster LU**

The lower elevations within the southern half and western margins of the landscape unit were readily accessible due to the abundance of roads. There are two active road systems (forming a loop) that access the higher elevations (CWHvm2 and MHmm1), both in the southern half of the landscape unit. The northern portion of the landscape unit, within the Theodosia River valley, required helicopter to access.

A total of **236** field plots were completed within the Bunster LU study area, consisting of **63** ground inspections and **173** visual inspections. The location of all field plots and air calls were marked and recorded on the air photos or maps at the time of field sampling. Wherever possible, Global Positioning System (GPS) point locations were also recorded in the field. Where satellite coverage was insufficient for an accurate measurement, the field plot locations were marked directly onto air photos. 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 a detailed methodology for data collection at the ground inspections locations. Standard TEM ground inspection forms (GIF) were used for the ground inspections and for some of the visual inspections. Other visual inspections and air calls were recorded as hand-written notes on field note paper.

## 2.4 Data Entry and Analysis

The ground inspection data was entered into the Ministry of Environment's Venus 5.0 program and the visual inspections were entered into a Microsoft Excel spreadsheet. Both of the databases are submitted as deliverables with this project.

Upon completion of the field program, each of the project ecologists reviewed the field forms in the office for completeness and accuracy and to ensure that all plot locations had been accurately transferred into the final GIS spatial database. A 1:1 check was performed to ensure that all plot locations are accounted for.

## 2.5 Ecosystem Mapping

Following completion of the field sampling and subsequent review of the field data, the ecosystem polygons – and subsequent line edits – were digitized via monorestitution. In preparation for the final ecosystem classification (mapping), the final polygons were each assigned a unique number and plotted onto a base map that included contour lines and Terrain Resources Information Mapping (TRIM) hydrology features.

The landscape unit was mapped by Scott Hawker, R.P.Bio., and Jim Webb, B.I.T. Each of the ecosystems were given ecosystem attribute labels and entered into a Microsoft Excel TEM ecosystem 'polygon (.ecp)' database. The ecosystem unit labels were recorded through manual examination of the air photos using a combination of a Sokkisha MS-27 mirror stereoscope, with 3X binocular attachment for enhanced resolution. Field plots were used, wherever available, to assist with making estimates for the polygons that were not visited in the field.

- BCGS Mapsheet Number;
- Polygon number (ecp\_tag);
- Data source used for the estimation (Photo Interpreted (P), Ground Inspection (G) or Visual Inspection (V));
- Flight line and photo number (project specific);
- Ecosection code;
- Biogeoclimatic zone, subzone, and variant;
- Ecosystem attribute labels [including decile, site series, modifier(s) and structural stage: recorded up to three components per polygon];
- User-defined field: Other "point-feature" habitat elements that are <20% of the polygon area (i.e. RO, TA, OW etc. that may be of importance for future habitat or ecosystem analysis);
- Polygon area (hectares); and
- Comments: additional information on the polygon made by the interpreter during classification.

Each of the ecosystem polygons have been classified as either a single ecosystem unit (simple label) or as a complex unit, with two or three (maximum) ecosystem units per

polygon. Each polygon includes a site series number (and TEM alpha map code) and has been described with up to three site modifier(s) where the conditions differ from the assumed conditions described in the provincial database for each site series (refer to the accompanying map legend). For the complexed units, only the ecosystems estimated to cover approximately 20% of the total polygon area have been recorded.

## 2.6 Expanded Vegetation Legend

A modified expanded vegetation legend was developed in Microsoft Word and is attached as Appendix 2. Whereas a standard legend has a detailed list of vegetation species for all potential structural stages, this legend does not differentiate between structural stages. The legend provides the following information for each mapped ecosystem unit (site series):

- a description of the typical situation in which the unit has been mapped,
- the assumed modifiers and typical soil moisture regime,
- the provincial, approved, site series (2-letter) map code,
- all mapped modifiers,
- the dominant vegetation species, by layer (tree, shrub, herb and moss layers),
- the associated vegetation species by layer (tree, shrub, herb and moss), and a
- list of the field plots established within each of the units.

For the units not confirmed with field plots, the typical situations and vegetation lists were derived from a combination of the provincial TEM map code database and the current Land Management Handbook for the Vancouver Forest Region: LMH28 (Green and Klinka 1994).

### 3 RESULTS: MAPPED BGC UNITS AND ECOSYSTEMS

A summary of ecosystem units mapped in the project area is provided below. A full description of the plant associations within each ecosystem mapped in each of the BGC units is provided on separate tables found in Appendix 2.

#### 3.1 Biogeoclimatic Units

Table 3 summarizes the number of polygons mapped within each of the BGC units within the Bunster Landscape Unit. Across the landscape unit (and excluding lakes), the average TEM polygon size is **12.1 hectares**, in line with a ‘typical’ TEM polygon size range of 12 to 15 hectares.

**Table 3. Area summary of mapped polygons by BGC unit**

BGC Unit	Name	# Polygons	Area (Ha)
CDFmm	Moist Maritime Coastal Douglas-fir Subzone	54	586.6
CWHxm1	Eastern Very Dry Maritime Coastal Western Hemlock Variant	605	8,450.3
CWHdm	Dry Maritime Coastal Western Hemlock Subzone	588	7,767.8
CWHvm2	Montane Very Wet Maritime Coastal Western Hemlock Variant	469	4,876.7
MHmm1	Windward Moist Maritime Mountain Hemlock Variant	157	1,148.0

Following are descriptions of each of the biogeoclimatic (BGC) units mapped within the Bunster Landscape Unit.

##### 3.1.1 CDFmm

The Moist Maritime Coastal Douglas-fir Subzone, with the mildest climate in Canada, has been mapped along the very southern shores of the landscape unit. Much of the CDFmm area falls within private, municipality or Indian reserve lands. Within the Bunster landscape unit, this subzone extends from Powell River, at the very southern tip, to Finn Cove, approximately half way up the Malaspina Peninsula. The CDFmm subzone has been mapped from sea level to approximately 200 metres elevation, below the CWHxm1 variant. Its extent remains largely as per the existing Ministry BGC coverage.

With **54** TEM polygons mapped within the CDFmm subzone, the average polygon size (excluding lakes) is **10.9 hectares**. Table 4 summarizes the site series that have been mapped within the CDFmm subzone. Where applicable, any map units that have been borrowed from other BGC units (as listed in the user-defined deliverable), have been noted within the table.

**Table 4. Vegetated site series mapped within CDFmm**

Site Series	Map Code	Site Series Name
01	DS	Fd - Salal
02	DA	FdPl - Arbutus
04	DG	FdBg - Oregon grape
05	RK	CwFd - Kindbergia
06	RF	CwBg - Foamflower
10	LS	Pl - Sphagnum
11	RC	Cw - Skunk cabbage (Ws53 - Cw - Sword fern - Skunk cabbage)
00	HL	Hardhack - Labrador tea

### 3.1.2 CWHxm1

The Eastern Very Dry Maritime Coastal Western Hemlock Variant has been mapped at low elevations within much of the western half of the Bunster LU. It has typically been mapped from sea level (above CDFmm at the south end) to approximately 300 metres elevation, below the CWHdm variant. It has been mapped along the windward edge of the Bunster Range (on the west-facing slopes above Okeover Inlet) and extends north, along Lancelot Inlet, to the mouth of Theodosia Inlet. Throughout its range, the CWHxm1 variant has been mapped below the CWHdm subzone.

With **605** TEM polygons (excluding lakes) mapped within the CWHxm1 variant, the average polygon size (excluding lakes) is **13.7 hectares**. Table 5 summarizes the site series that have been mapped within the CWHxm1 variant. Where applicable, any map units that have been borrowed from other BGC units (as listed in the user-defined deliverable), have been noted within the table.

**Table 5. Vegetated site series mapped within CWHxm1**

Site Series	Map Code	Site Series Name
01	HK	HwFd - Kindbergia
02	DC	FdPl - Cladina
03	DS	FdHw - Salal
05	RS	Cw - Sword fern
06	HD	HwCw - Deer fern
07	RF	Cw - Foamflower

11	LS	Pl - Sphagnum
12	RC	CwSs - Skunk cabbage (Ws53 - Cw - Sword fern - Skunk cabbage)
13	RB	Cw - Salmonberry
00	HL	Hardhack - Labrador tea
00	SW	Sedge wetland
00	Wf52	Sweet gale - Sitka sedge
00	Wm05	Cattail marsh

### 3.1.3 CWHdm

The Dry Maritime Coastal Western Hemlock Subzone has been mapped above the CWHxm1 variant throughout the Bunster LU and has been mapped to approximately 650 metres, below the CWHvm2 variant. This subzone has been mapped along the windward edge of the Bunster Range and covers most of the Theodosia River valley at the north end of the landscape unit.

With **588** TEM polygons mapped within the CWHdm subzone, the average polygon size (excluding lakes) is **13.1 hectares**. Table 6 summarizes the site series that have been mapped within the CWHdm subzone. Where applicable, any map units that have been borrowed from other BGC units (as listed in the user-defined deliverable), have been noted within the table.

**Table 6. Vegetated site series mapped within CWHdm**

Site Series	Map Code	Site Series Name
01	HM	Hw - Flat moss
02	DC	FdPl - Cladina
03	DS	FdHw - Salal
05	RS	Cw - Sword fern
06	HD	HwCw - Deer fern
07	RF	Cw - Foamflower
10	CW	Act - Willow (F150 - Sitka willow - False lily-of-the-valley)
11	LS	Pl - Sphagnum
12	RC	CwSs - Skunk cabbage
13	RB	Cw - Salmonberry

00	CT	Cattail marsh
00	HL	Hardhack - Labrador tea

### 3.1.4 CWHvm2

The Montane Very Wet Maritime Coastal Western Hemlock Variant has been mapped above the CWHdm subzone throughout the Bunster LU. This variant, mapped upon much of the gentle terrain of the Bunster Range and on some cool, north-facing aspects above Theodosia River, has typically been mapped between 650 metres and 1000 metres, above which the MHmm1 variant has been mapped.

With **469** TEM polygons mapped within the CWHvm2 variant, the average polygon size is **10.4 hectares**. Table 7 summarizes the site series that have been mapped within the CWHvm2 variant. Where applicable, any map units that have been borrowed from other BGC units (as listed in the user-defined deliverable), have been noted within the table.

**Table 7. Vegetated site series mapped within CWHvm2**

Site Series	Map Code	Site Series Name
01	AB	HwBa - Blueberry
02	LC	HwPl - Cladina
03	HS	HwCw - Salal
04	RS	CwHw - Sword fern
05	AF	BaCw - Foamflower
06	HD	HwBa - Deer fern
07	AS	BaCw - Salmonberry
08	AD	BaSs - Devil's club
09	YG	CwYc - Goldthread
10	LS	Pl - Sphagnum (Wb51 - Plc - Black crowberry - Tough peat-moss)
11	RC	CwYc - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)
00	FS	Carex fen
00	HW	Shrub carr
00	MK	Mountain hemlock krummholz

### 3.1.5 MHmm1

The Windward Moist Maritime Mountain Hemlock Variant has been mapped in a small area within the Bunster LU, above the CWHvm2 variant within the higher elevations of the Bunster Range. It has been mapped in the vicinity of Pat Lake and Isle Lake.

With **157** TEM polygons mapped within the MHmm1 variant, the average polygon size is **7.3 hectares**. Table 8 summarizes the site series that have been mapped within the MHmm1 variant. Where applicable, any map units that have been borrowed from other BGC units (as listed in the user-defined deliverable), have been noted within the table.

**Table 8. Vegetated site series mapped within MHmm1**

Site Series	Map Code	Site Series Name
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
09	YC	YcHm - Skunk cabbage
00	AA	Ba - Alaskan blueberry
00	BT	Brushy talus
00	HM	Heather meadow
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	SL	Sedge - Leatherleaf saxifrage
00	YB	HmYc - Blueberry - Mountain-heather
00	YR	Yc - Racomitrium bluffs

### 3.1.6 Non-vegetated units

The following non-vegetated units (Table 9) have been mapped within the Bunster Landscape Unit:

**Table 9. Non-vegetated units mapped within the Bunster LU**

Site Series	Map Code	Site Series Name
00	CL	Cliff
00	ES	Exposed soil
00	LA	Lake
00	OW	Open shallow water
00	PD	Pond
00	RI	River
00	RO	Rock outcrop
00	TA	Talus
00	UR	Urban/ Suburban

## 4 QUALITY CONTROL

### 4.1 Internal Quality Control

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

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 less than 1ha);
2. checked the spatial vs. the non-spatial data to ensure a 1:1 link of the final polygons;
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 (and where not, that the user-defined database was updated);
6. reviewed the database to ensure that no duplicate or blank entries remain for any of the polygons;
7. 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 CWHxm1 labels within the CWHdm BGC subzone); and
8. completed a final review of the Venus and Excel databases for overall completeness.

### 4.2 External Quality Control

An independent assessment of mapping quality and consistency was completed and submitted by Helen Reid, R.P.Bio.

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## APPENDIX 1: 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 Ministry of Forests and Range (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 may be selected from the Ministry of Environment Provincial Site Series Code list.

### 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.

### 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 1 below depicts the ecoregion and biogeoclimatic unit label as they appear on typical ecosystem maps (RIC 1998).

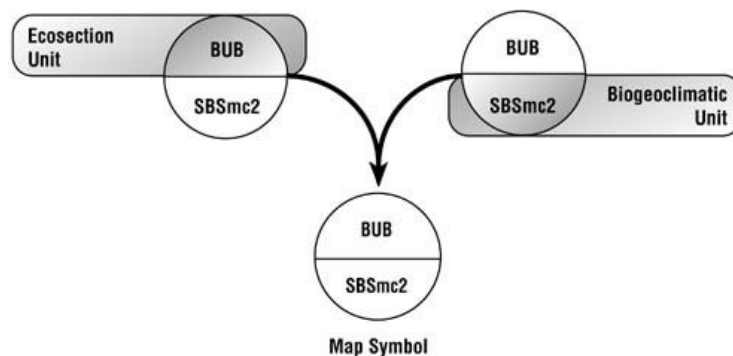


Figure 1. Symbols for Ecoregion and Biogeoclimatic Units

## Biogeoclimatic Variants

The BGC 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 2 below (RIC 1998) illustrates the symbols used for biogeoclimatic units.

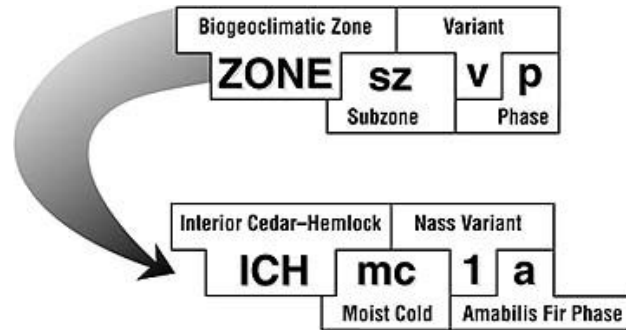


Figure 2. Symbols for biogeoclimatic units

## 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.

### 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 BGC 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 (map code) is assigned to each site series and each map code is unique to each BGC subzone and variant.

### Site Modifiers

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

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

Table 1. 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	gulying <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 gulying 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.
t	terrace <sup>1</sup> – the site series occurs on a fluvial or glaciofluvial terrace, lacustrine terrace, or rock cut terrace.
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> .
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

## APPENDIX 2: EXPANDED LEGEND – BUNSTER LU