TERRESTRIAL ECOSYSTEM MAPPING OF THE CORTES LANDSCAPE UNIT

(SUNSHINE TIMBER SUPPLY AREA)

Prepared for:
Sunshine Coast DFAM Committee
(Ian Robertson, International Forest Products)

Prepared by:
Timberline Forest Inventory Consultants Ltd.
Suite 401-958 West 8th Ave
Vancouver, BC V5Z 1E5
Contact: Scott Hawker, R.P.Bio.

March 2006

Timberline
Forest Inventory Consultants

Timberline
Forest Inventory Consultants

Date: March 31st, 2006

International Forest Products
311-1180 Ironwood St
Campbell River, BC
V9W 5P7

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_4299_mta.csv)
- TEM polygon database - (tem_4299_ecp.csv)
- Venus 5.0 (ground inspection) database - (tem_4299_eci.mdb)
- Excel (visual inspection) database – (tem_4299_eci.xls)

Reports and Legends

- Map legend – (tem_4299_ml.pdf)
- Expanded (vegetation) legend – (tem_4299_el.pdf)
- Final Report - (tem_4299_rpt.pdf)

ARC/INFO Spatial Databases

- TEM polygon information - (tem_4299_ecp.e00)
- TEM field plot data - (tem_4299_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,

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

Timberline Forest Inventory Consultants Ltd.

ACKNOWLEDGEMENTS

Terrestrial ecosystem mapping of the Cortes 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 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).

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 Sunshine Coast 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 Cortes Landscape Unit (LU) is a somewhat remote area that includes the islands of Maurelle, Read, Raza, Cortes, East Redonda and West Redonda. The study area encompasses approximately 25,079 hectares. In order to catalogue the resources of this LU, Sunshine Coast 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 Cortes 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 boundaries, private lands and Indian Reserve lands.

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

CWHvm1	Submontane Very Wet Maritime Coastal Western Hemlock Variant
CWHvm2	Montane Very Wet Maritime Coastal Western Hemlock Variant
CWHxm1	Very Dry Maritime Coastal Western Hemlock Variant
CWHxm2	Very Dry Maritime Coastal Western Hemlock Variant
CWHmm1	Submontane Moist Maritime Coastal Western Hemlock Variant
CWHdm	Dry Maritime Coastal Western Hemlock
MHmm1	Moist Maritime Mountain Hemlock Variant

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1 INTRODUCTION

1.1 Project Background

The Cortes Landscape Unit (LU) is a somewhat remote area that includes the islands of Maurelle, Read, Raza, Cortes, East Redonda and West Redonda. Approximately 17% of the total LU is private land and ecological reserves and parks make up another 16% of the total area. This project excluded parks, private lands and First Nation reserve lands. The resulting study area encompasses 25,079 hectares.

The LU is also within the traditional territories of the Klahoose, Homalco, Sliammon and Kwakiutl_Laich_Kwil_Tack First Nations. This landscape unit falls partly under the jurisdiction of the Ministry of Forests and Range's (MoFR) Sunshine Coast Forest District. The Sunshine Coast Forest District oversees timber resource extraction for this area. Four forest licensees, one woodlot licensee and BC Timber Sales are responsible for the majority of timber extraction. (Sutherland and Gill 2005).

In order for stakeholders to adequately manage the LU within the scope of the Sunshine Coast 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 Cortes 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 Cortes LU was funded through the Sunshine Coast DFAM committee's Forest Investment Account (FIA) allocation.

1.3 Study Area

The 25,079 ha Cortes LU study area is located on the southern coast of BC and covers portions of the following 1:20,000 scale BCGS mapsheets: 092K035, 092K036, 092K037, 092K024, 092K025, 092K026, 092K027, 092K015, 092K016, 092K017 and 092K006.

Figure 1 shows an overview map of the Cortes LU within the Sunshine Coast Timber Supply Area (LU boundary shown in bold black) and Figure 2 depicts the landscape unit itself.

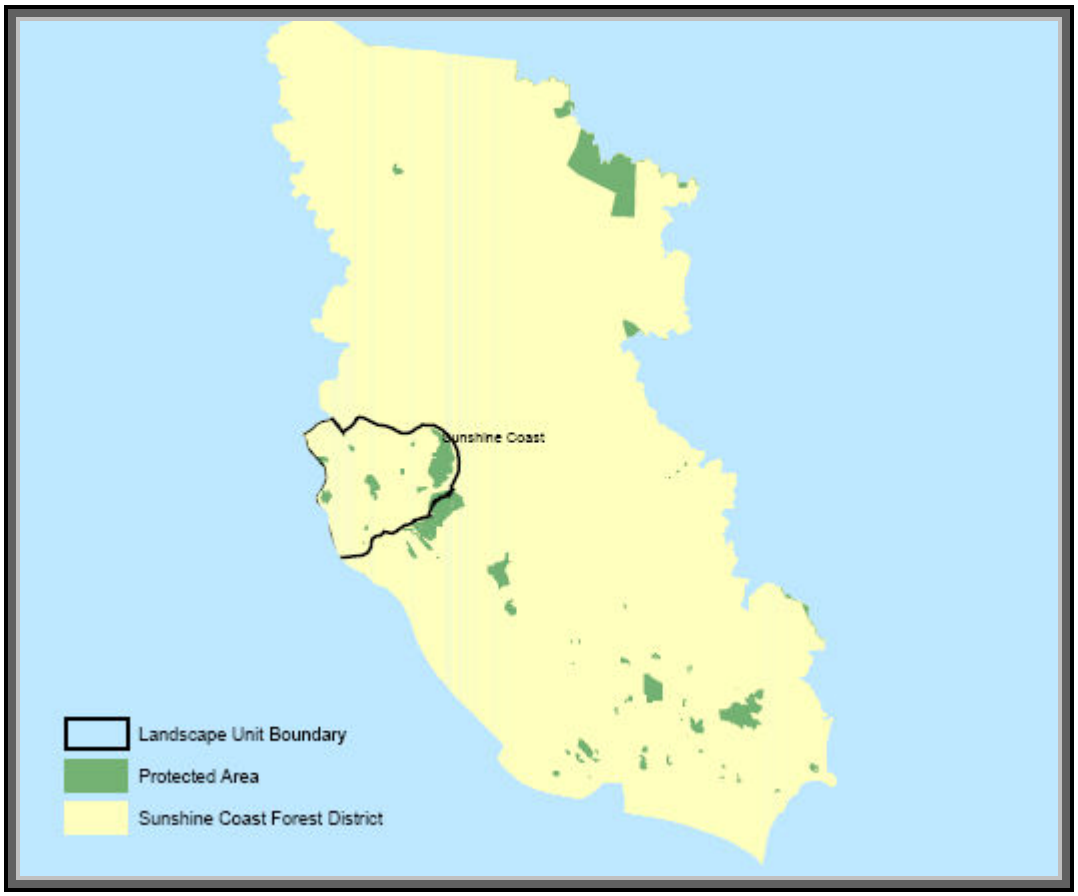

Figure 1. Location of the Cortes LU within the Sunshine Coast TSA.

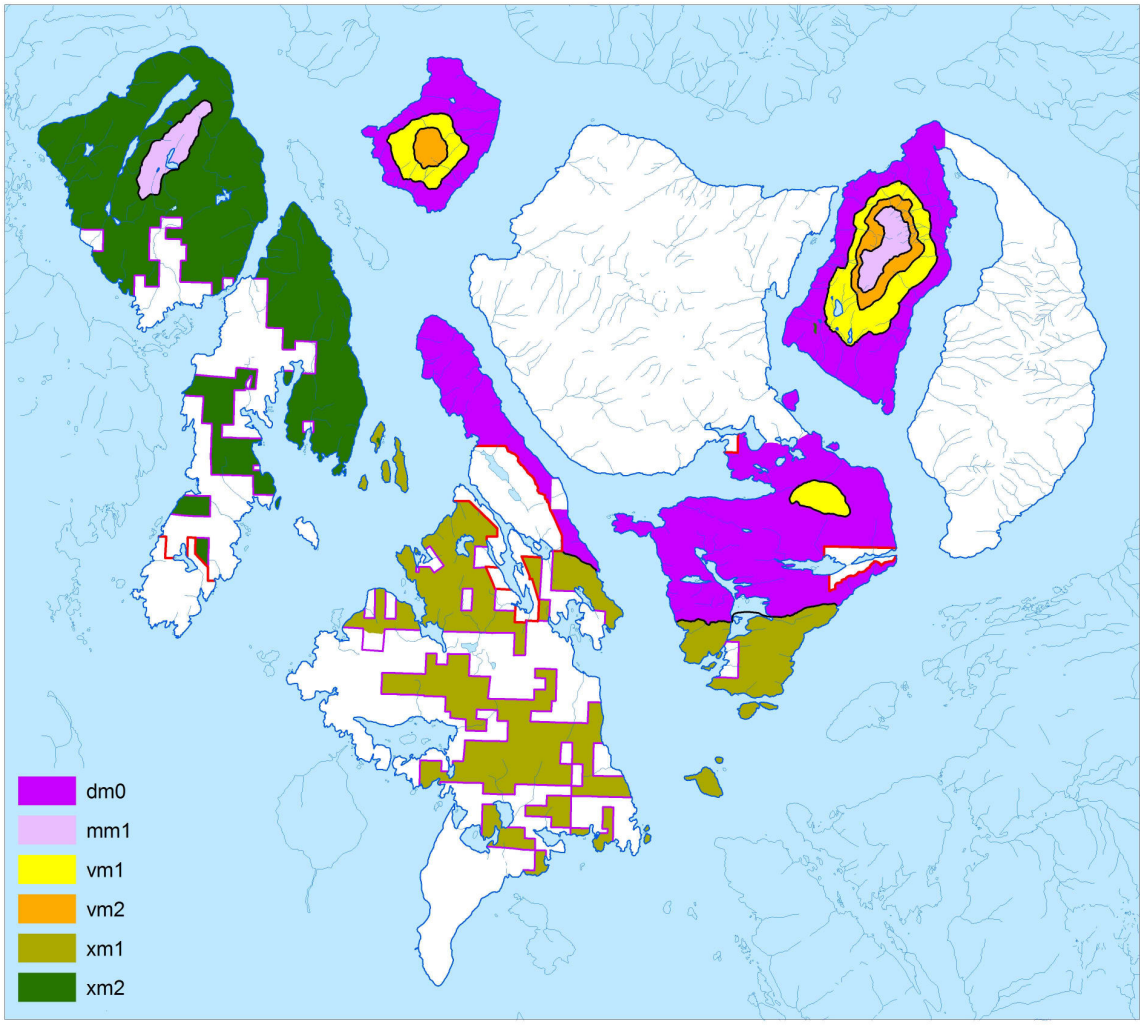

Figure 2. Cortes LU with BGC overview

This landscape unit is bounded by Pryce Channel to the north and by Desolation Sound to the south. It is subject to a maritime climate with warm and dry summers and cool, wet winters. The major islands in this landscape unit include Maurelle, Read, Raza, Cortes, East Redonda and West Redonda.

Steep, rocky terrain (common bedrock exposures) is typical of many of the shorelines within this landscape unit. Site series 02 and 03 were commonly mapped on many steep, warn aspects along the coastline. Shallow soils are common on many of the steeper slopes with surficial materials of varying thickness common in many areas of gentle or undulating topography.

The majority of the landscape unit lies within the CWH zone, with a very small area (304 ha) on East Redonda Island mapped as MHmm1. Due to the steep slopes and limited accessibility, the transition to MHmm1 on this island was not confirmed in the field.

Much of the area sampled was dominated by young forest (structural stage 5), with little mature to old forest.

Podzolic soils (characterized by B horizons dominated by accumulations of Al, Fe and humified organic matter) are the most common soils found within the study area. They typically develop in coarse to medium-textured, acidic parent materials, under coniferous forest vegetation in cool humid climates. They are widespread on till and colluvium throughout the Cortes study area. As along much of the coast, soil textures were typically medium (to coarse) in the sandy-loam to loamy-sand classes. In some of the wetter areas, gleysolic soils have developed, characterized by grey colours and/or mottling due to prolonged saturation.

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 may be selected 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). Ecosection 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 Ecosections, 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 ecosection and biogeoclimatic unit label as they appear on typical ecosystem maps (RIC 1998).

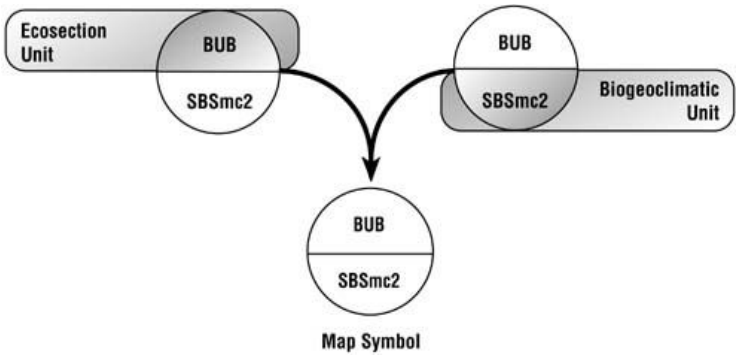

Figure 3. Symbols for Ecosection and Biogeoclimatic Units

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.

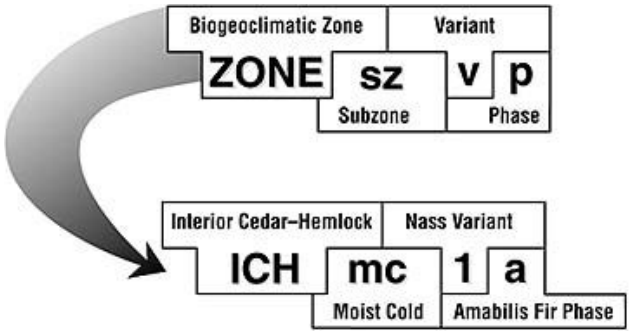

Figure 4. Symbols for biogeoclimatic units

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 mapped 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%.

Table 1. Standard TEM Site Modifiers

Code	Criteria
Topography	
a	active floodplain[1] – 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[1] 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[1] 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[1] – 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[1](optional modifier) – the site series occurs throughout an area of ridged terrain, or it occurs on a ridge crest.
t	terrace[1] – 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°).
Soil	
c	coarse-textured soils[2] – 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% **coarse fragment volume**.
p	peaty material – the site series occurs on deep organics or a peaty surface (15–60 cm)[3] 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

Code	Criteria
	bedrock (less than 20 cm).

[1] Howes and Kenk 1997
[2] Soil textures have been grouped specifically for the purposes of ecosystem mapping.
[3] Canada Soils Survey Committee, 1987

3 METHODOLOGY: ECOSYSTEM MAPPING

This project was completed as per the terms agreed to by the Sunshine Coast 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).

- 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 Cortes 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.

- The project area excluded park areas, private lands and Ecological and Indian Reserve lands. There is a large amount of private land in this landscape unit (primarily on Cortes and Read Islands).

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 Cortes 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 Plots

Field sampling was completed over 6 days between July 11th and July 16th 2005. Each two-person field crew consisted of an experienced ecologist and an assistant Forester familiar with the coastal tree and plant species and site interpretation. Much of Cortes Island was accessible via 2WD truck and the surrounding islands required the use of water taxis for access. 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.

A total of 221 field plots were completed within the Cortes LU study area. This consisted of a total of 95 Ground inspections and 126 Visual inspections. 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 a detailed methodology for data collection at the ground inspections locations. Standard TEM Ground inspection forms (GIF) were used for the Ground Inspections and some visual inspections. Many of the visual inspections were recorded 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 lead 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 conditions differ 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. Madrone Environmental Services Ltd. was retained to provide this 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
- Ecosection 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 vegetation species by layer (tree, shrub, herb and moss) – dominant species are present in approximately >50% of the field plots;
- other (associated) vegetation species by layer (tree, shrub, herb and moss); and
- list of field plots established within each unit.

For the units not confirmed through field visitation, the typical situations and vegetation lists have been 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

Due to limited availability of road networks on many of the islands (excluding Cortes, which is well roaded), several field days were completed through the use of a boat to access the remote shorelines or previously operational log dumping areas.

On the smaller islands (including Maurelle, Read, Raza), field crews used a water taxi (from Quadra and Campbell River) to access old log dumps and then walked (or mountain biked) along the existing roadways to sample. Where roads were absent from the target sampling area, the crews requested that the boat drop them along the shoreline and then completed sampling by traversing upslope from the shore. The slopes encountered on such transects were typically steep and rocky, and where salal undergrowth was thick, made for very slow movement through the brush.

The higher elevation biogeoclimatic transitions, including the very moist CWH variants and the MHmm1 variant (East Redonda) could not be sampled and confirmed in the field due to time constraints on the ground and the inability to land a helicopter at the higher elevations. However, the MHmm1 unit is very small (approx. 300 ha), covering just over one percent of the study area. This made it very difficult to assess the ecosystems for purposes of describing zonal sites and refining the elevation boundaries.

Much of the accessible, lower elevation forested areas have been harvested in the preceding decades years, making it difficult to complete ground samples in mature (to

old) mesic forest habitats. Many of the field plots land within young forests (structural stage 5).

4 RESULTS: MAPPED BGC UNITS AND ECOSYSTEMS

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

4.1 Ecosection

The northern portion of the Cortes LU falls within the Pacific Ranges Ecoregion (Figure 5).

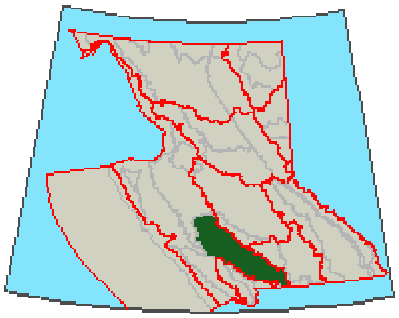

Figure 5. Pacific Ranges Ecoregion

As per Demarchi (1996), the Pacific Ranges 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." There are four ecosections within the Pacific Ranges Ecoregion. The northern portion of the Cortes study area lies within the Outer Fiordland (OUF) Ecosection. This ecosection "is an area of rugged, low relief, consisting of inlets, sounds, islands and peninsulas, east of Johnstone Strait and Seymour Narrows."

The southern portion of the Cortes LU lies within the Georgia-Puget Basin Ecoregion (Figure 6).

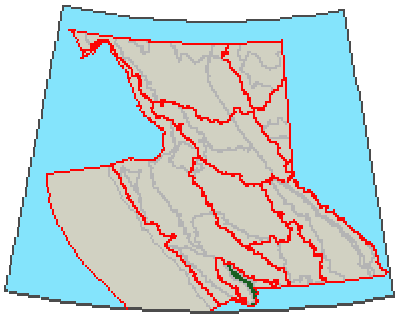

Figure 6. Georgia-Puget Basin Ecoregion

As per Demarchi (1996), the Georgia-Puget Basin Ecoregion "is a semi-enclosed estuarine basin that includes several straits, troughs and island clusters. It extends from Johnstone Strait, south across the Canada/U.S.A. boundary to Nisqually Reach."

There are three ecosections within this ecoregion. The south end of the Cortes study area falls within the Strait of Georgia (SOG) Ecosection. This ecosection "is a broad shallow marine basin that separates southern Vancouver Island from the mainland. It holds several islands that have very dry mild climates."

4.2 Biogeoclimatic Units

Tables 2 summarizes the area of each BGC unit mapped within the Cortes Landscape Unit. The Cortes LU contains 7 different BGC units.

Table 2. Area summary of mapped BGC units

BGC Unit	Name	Area (Ha)
CWHvm1	Submontane Very Wet Maritime Coastal Western Hemlock Variant	1,502
CWHvm2	Montane Very Wet Maritime Coastal Western Hemlock Variant	537
CWHxm1	Very Dry Maritime Coastal Western Hemlock Variant	5,930
CWHxm2	Very Dry Maritime Coastal Western Hemlock Variant	7,705
CWHmm1	Submontane Moist Maritime Coastal Western Hemlock Variant	390
CWHdm	Dry Maritime Coastal Western Hemlock	8,710
MHmm1	Moist Maritime Mountain Hemlock Variant	304

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 subzone occurs at lower elevations on the mainland coast and is the most extensive unit in the region. Along the lower mainland coastline, it occurs above the CWHdm subzone. Elevation limits range from sea level (or above CWHdm) to approximately 650m.

The CWHvm1 unit typically has a wet, humid climate with cool summers and mild winters with little snowfall. Forested sites within the vm1 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 be found.

At approximately 650 to 700 metres in elevation, the vm1 grades into the vm2 variant, which is differentiated from the vm1 by the presence of yellow cedar, mountain hemlock and pipecleaner moss, especially in wetter areas.

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

- 01 – AB HwBa-blueberry
- 02 – LC HwPl-cladina
- 03 – HS HwCw-salal
- 05 – AF BaCw-foamflower
- 06 – HD HwBa-deer fern
- 07 – AS BaCw-salmonberry
- 12 – YG CwYc-goldthread
- 14 – RC CwSs-skunk cabbage
- 00 – HG Hardhack-sweet gale wetland

4.2.2 CWHvm2

Within the Coast Forest Region, the CWHvm2 subzone occurs above the CWHvm1 variant. Elevation limits range from approximately 650 to 1000 metres.

The CWHvm2 unit 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.

At approximately 1000 metres, the vm2 grades into the MHmm, which has over 50% mountain hemlock tree cover.

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

- 01 – AB HwBa-blueberry
- 02 – LC HwPl-cladina
- 03 – HS HwCw-salal
- 04 – RS CwHw-swordfern
- 05 – AF BaCw-foamflower
- 07 – AS BaCw-salmonberry
- 11 – RC CwYc-skunk cabbage

4.2.3 CWHxm1

The CWHxm1 occurs from sea level to approximately 700 metres elevation along islands in southern Johnstone Strait. It is characterized by warm, dry summers and moist, mild winters with little snowfall.

Forests are dominated by Douglas fir, have a large component of western hemlock and minor amounts of western red cedar. The understory consists primarily of salal, dull Oregon grape, red huckleberry, *Hylocomium spendens* and *Kindbergia oregana*.

The CWHdm subzone occurs above this variant and is distinguished by the presence of vine maple and a stronger component of *Plagiothecium undulatum*.

The following vegetated site series have been mapped within the CWHxm1:

- 01 – HK HwFd-kindbergia
- 02 – DC FdPl-cladina
- 03 – DS FdHw – salal
- 05 – RS Cw-swordfern
- 06 – HD HwCw-deer fern
- 07 – RF Cw-foamflower
- 11 – LS P-Sphagnum
- 12 – RC CwSs-skunk cabbage
- 15 – CS Cw-slough sedge
- 00 – HL hardhack-labrador tea
- 00 – SW sedge wetland
- 00 – HG hardhack-sweet gale wetland (CWHxm2 unit)

4.2.4 CWHxm2

The CWHxm1 occurs from sea level to approximately 700 metres elevation along islands in southern Johnstone Strait. It is characterized by warm, dry summers and moist, mild winters with little snowfall.

Forests are dominated by Douglas fir, have a large component of western hemlock and minor amounts of western red cedar. The understory consists primarily of salal, dull Oregon grape, red huckleberry, *Hylocomium spendens* and *Kindbergia oregana*.

The CWHdm subzone occurs above this variant and is distinguished by the presence of vine maple and a stronger component of *Plagiothecium undulatum*.

The following vegetated site series have been mapped within the CWHxm2:

- 01 – HK HwFd-kindbergia
- 02 – DC FdPl-cladina
- 03 – DS FdHw-salal
- 04 – DF Fd-swordfern
- 05 – RS Cw-swordfern
- 06 – HD HwCw-deer fern
- 07 – RF Cw-foamflower
- 11 – LS Pl-Sphagnum
- 12 – RC CwSs-skunk cabbage
- 00 – HL hardhack-labrador tea
- 00 – SW sedge wetland

4.2.5 CWHmm1

The CWHmm1 has a discontinuous distribution and is mainly restricted to the leeward side of the Vancouver Island Ranges above the CWHxm. It ranges in elevation from approximately 450 to 700 metres.

This variant has a transitional climate between the CWHxm and CWHvm; it has moist, mild winters and cool, relatively dry summers. Forests are characterized by western hemlock, amabilis fir and Douglas fir. The understory consists of red huckleberry and Alaskan blueberry. Some salal and dull Oregon grape may be present in the shrub layer as well. This variant has a well-developed moss layer consisting of *Hylocomium splendens, Rhytidiadelphus loreus, and Rhytidiopsis robusta.*

The following vegetated site series have been mapped within the CWHmm1:

- 01 – AP HwBa-pipecleaner moss
- 02 – DS FdHw-salal
- 03 – HS HwCw-salal
- 05 – AF BaCw-foamflower
- 07 – AS BaCw-salmonberry
- 12 – RC CwSs-skunk cabbage

4.2.6 CWHdm

This subzone occurs from sea level to approximately 650 metres elevation. Along the Sunshine Coast, it occurs above and adjacent to the CWHxm. It has warm, relatively dry summers and moist, cool winters.

On zonal sites, Douglas fir, western hemlock and western red cedar are common. Understory species include salal, red huckleberry, *Hylocomium splendens, Kindbergia oregana, Rhytidiadelphus loreus, and Plagiothecium undulatum*.

The CWHvm1 occurs above the dm subzone. The vm1 variant is characterized by amabilis fir and Alaskan blueberry.

The following vegetated site series have been mapped within the CWHdm:

- 01 – HM Hw-flat moss
- 02 – DC FdPl-cladina
- 03 – DS FdHw-salal
- 05 – RS Cw-swordfern
- 06 – HD HwCw-deer fern
- 07 – RF Cw-foamflower
- 11 – LS Pl-Sphagnum
- 12 – RC CwSs-skunk cabbage
- 15 – CS Cw-slough sedge
- 00 – OS organic shrub fen
- 00 – HL hardhack-labrador tea (CWHxm1 unit)

4.2.7 Non-vegetated units

The following non-vegetated units have been mapped throughout the Cortes Landscape Unit:

- 00 – LA lake
- 00 – OC ocean
- 00 – OW shallow open water
- 00 – PD pond
- 00 – RO rock outcrop
- 00 – UR urban
- 00 – RZ road surface

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.

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