

Appendix 5

Terrestrial Ecosystem Mapping Detailed Methods

TERRESTRIAL ECOSYSTEM MAPPING DETAILED METHODS

Terrestrial Ecosystem Mapping (TEM) delineates the landscape into homogeneous map units (polygons) by taking into account the major environmental factors and features that shape the landscape and determine the distribution of plants and plant communities. Factors and features include climate, terrain (bedrock geology, surficial material, soil, physiography) and vegetation. The mapping combines aspects of Biogeoclimatic Classification (BEC) with Ecoregion Classification (Resources Inventory Committee (RIC) 1998).

The ecosystem units are mapped using a bioterrain approach, a procedure that focuses on observable site and biological features assumed to determine the function and distribution of plant communities on the landscape. Four classifications are mapped: ecoregion (ecoregion units), zonal (biogeoclimatic units), site (site series), and vegetational development (structural stages and seral community types). Map units are first delineated through aerial photograph interpretation and field sampling is then conducted to verify ecosystem boundaries. Maps produced using this method are incorporated into a Geographic Information System (GIS) such as ArcView™.

For the purposes of TEM, ecosystem units are a conceptual group of sites that have similar enough characteristics to allow them to share the same ecosystem label. In reality, each polygon is unique. Differences (such as shifts in abundance of a certain species) within ecosystem units sharing the same label are more visible at the large scale (1:5000) in which this study was conducted. From a park management perspective it is important to note these differences because management prescriptions should be site specific, and not generic.

OBJECTIVES

Ecosystem Mapping

The overall objective of the project is to develop an ecosystem based management plan (EBP) for Helliwell Provincial Park. The purpose for undertaking TEM mapping was to provide baseline information for the EBP. Mapping was to be completed at a scale of 1:5 000 using Resource Inventory Committee (RIC) survey intensity level one, following the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998). Besides the standard suite of data collected for TEM mapping, B.C. Parks requested the inclusion of several additional attributes that would assist in the development of the EBP. These were an indication of the level and type of disturbance for all polygons (naturalness ratings) and information on areas that would be sensitive or limiting to park development. Other data included the identification of exotic or invasive plant species.

METHODOLOGY

Mapping was completed according to the methodology described in *Standard for Terrestrial Ecosystem Mapping* in British Columbia (RIC 1998). Using the provincial standard of Survey Intensity Level 1, approximately 76 – 100% polygon inspections were required. As a ratio, this translates as 2 Full Plots, 15 Ground Inspections and 83 Visual Checks (walk-bys). Because Full Plots yield more useful data for EBP purposes, and for other agencies such as the Conservation Data Centre, the number of full plots was increased.

Bio-Terrain Mapping

Pre-typed terrain map units were used to guide delineation of ecological polygons onto 1:5000 scale colour aerial photographs flown in 1997 by Selkirk Remote Sensing. Delineation of ecological polygons, based on surficial geology, topography and vegetation, while also taking into account soil drainage, aspect and exposure is the first step in the TEM process. The preliminary polygons were then used to select the general areas in which detailed sampling plots would be located. Following the fieldwork, the ecological polygon lines, terrain symbols, and soil drainage classes were confirmed and adjusted based on the field data and visual inspections.

Appendix 4 contains additional information regarding terrain mapping and the terrain symbology,

Ecosystem Mapping

Development of a Working Legend

Prior to commencement of the fieldwork, a working legend was developed that lists all the ecosystems that might be encountered in the study area. The working map legend ensures that mappers are aware of all of the potential variability present in the study area. Terrain features were used to match preliminary site series to ecosystem polygons, based on known environmental conditions most likely to support their development. The working legend was then refined continuously once fieldwork commenced.

Field Sampling

TEM fieldwork was conducted in the park on three separate site visits: October 18th to October 20th and November 8th & 9th, 2000; and January 27th & 28th, 2001. Kathy Dunster collected vegetation data; Ted Trueman collected soils and terrain data at various other times; Jenny Balke collected wildlife data throughout the months of October through December 2000, and January 2001. A list of plant species encountered during the fieldwork is presented in Appendix 2.

Polygons were sampled using one of three types of plots; full plots with detailed site, soil vegetation and wildlife descriptions (FS882 forms), ground inspection plots (GIF), and visual inspections. *The Field Manual for Describing Terrestrial Ecosystems* (RIC 1998) provides a detailed methodology for data collection at detailed and ground inspection plots while the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC, 1998) provides guidelines for data collection at visual sites. A photo was taken at each of the detailed and ground inspection plots, as well as at most of the visual plots.

Colour photocopies of the original pre-typed air photos were laminated and used in the field. The location of all detailed plots, ground inspections, and visuals were pin pricked on these photocopies with the corresponding plot number written on the back of the photo. The plot locations and numbers were then transferred to the original photos after the field session.

There are a number of existing trails on the island, all of which were used to gain access to much of the park. A boat was used to gain access to Flora Islet.

Rare Elements

Some rare plant species and plant communities (CDC 1999) are known to occur in the park, and numerous rare plant inventories have been conducted by BC Park staff and others in the past. Because the time of year available for this study precluded any opportunity to add to the list of spring ephemeral flowering plants, the focus was on verifying existing rare plant communities, and identifying new rare plant communities. The locations of rare plant communities were documented with photographs and by completing a “Field Observation Form: Rare Plant Associations” provided by the CDC.

Measurements were taken of various “big” trees, and in several cases, documentation was completed for the B.C. Big Tree Register maintained by the CDC.

Conservation Evaluation Ratings

In order to appraise the ecological condition of each ecosystem map unit, plant community element occurrence (EO) ratings were applied. At each full plot location, naturalness, degree of polygon fragmentation, disturbance history and known threats to the ecosystem were recorded using a “Conservation Evaluation & Visual Inspection Form” provided by the B.C. Conservation Data Centre (CDC). Ratings were also assigned to polygons assessed by ground or visual inspection methods, based on the ecosystem unit, topography and adjacency to other ecosystem types and their known condition.

These factors are taken into consideration as part of the criteria used by the CDC when evaluating the conservation potential of ecosystems and assigning “Rare Element Occurrence” ranks.

Quality: Describes the representativeness of the ecosystem within its known range of characteristics. Characteristics such as geographic size, number of occurrences, presence of indicator species, and successional status (maturity) are all considered.

Condition: Describes how much the site and the ecosystem itself has been damaged or altered from its optimal condition or character. Land use practices, resource extraction, introduction of non-native species (plant and animal) are considered.

Viability: Assesses the long-term prospects for the continued existence of the ecosystem. Current land use of the site as well as the effects of surrounding land uses are considered.

Defensibility: Assesses the degree to which the site can be protected from extrinsic human factors that might otherwise degrade or destroy it, given the current land use practices. Effects of current land use, buffering and formal protection measures are considered.

For each polygon, the four factors were ranked according to the following scale, and are summarised in the final database:

A=	excellent
B=	good
C=	marginal
D=	poor
X=	extirpated
O=	obscure
E=	extant
I=	introduced (used only as a qualifier of the ranks above)

Legend Development

Forested ecosystem units were used directly from existing site series defined in the Ministry of Forests, Vancouver regional field guide (Green and Klinka 1994). Non-forested units such as wetlands, shoreline, riparian areas, rock outcrops and new plant communities were described based on the field data collected and were mapped accordingly. Sample plots were used to describe all of the ecosystem units found in the park during the development of the expanded legend. Species lists in the expanded legend were developed only for the structural stages of plant communities actually.

Data Analysis

Data from all plots was recorded into an Excel format spreadsheet (delivered as part of the digital data base for this project). This database was used to sort the plots into groups with similar physical attributes and ecosystem classifications. The range of environmental conditions, terrain units, and vegetation communities over which site series were distributed was obtained from these databases.

Plant Identification

Plants were identified in the field using field guides (Douglas *et al.* 1998, Hitchcock & Cronquist 1973, Pojar & MacKinnon 1994). Difficult plants were pressed and keyed out using the provincial botanical keys (Douglas *et al.* 1999).

Ecosystem Unit Mapping

Ecosystem units were mapped according to the standards set forth in the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998). Each ecosystem is assigned an uppercase two-letter code that is equivalent to one recognized biogeoclimatic ecosystem classification (BEC) site series for each forested site. Site series have been identified according to Green and Klinka (1994). Labelling for all forested ecosystems follows the updated site series coding master list available on the Ministry of Environment, Lands, and Parks web site (RIC 1997).

Where an ecosystem was not recognized as an official site series (wetlands and herbaceous meadows), new ecosystem units were proposed and two letter codes applied similarly. Sparsely vegetated, non-vegetated, and anthropogenic units follow the symbols outlined in Table 3.1 of the TEM standards (RIC 1998). One seral community type has been mapped. Seral community types represent ecosystems that are considered to be an earlier sere to the climax ecosystem unit resulting from disturbance. The seral community types are coded with a semi-colon and two lower case letters, they appear at the end of an ecosystem unit label.

Site modifiers were mapped with many of the ecosystem designations to more specifically describe the ecosystem (Table 1 and Figure 1). Up to two site modifiers may be present (in lower case letters) with each ecosystem unit. The site modifiers represent different site conditions than those of the typical environmental condition (typical situation), as defined by MELP, for each site series. Each site series has a set of assumed site modifiers under the typical situation. Hence, when a site series is mapped in its typical situation it will not need any site modifiers to be included in the map label.

The site series code and/or site modifier(s) are followed by a numerical structural stage designation, 1 through 7 (Table 2). A structural stage modifier (a single lower case letter)

further subdivides the structural stage designation. Where applicable, a stand composition modifier (a single upper case letter) (Table 4) is also applied.

Up to three ecosystem units were noted for each polygon. The percentage for each ecosystem unit present is indicated by deciles ranging from 1 to 10 (1=10%; 10=100%). Note, that 10 (100%) is not displayed in the map label, but it does appear in the database.

Jacqueline Booth and Associates completed the GIS mapping. The draft ecosystem map was submitted to Ted Lea, the provincial correlator, for review and to ensure provincial standards were followed. Revisions were then incorporated into the final products.

Site Modifiers

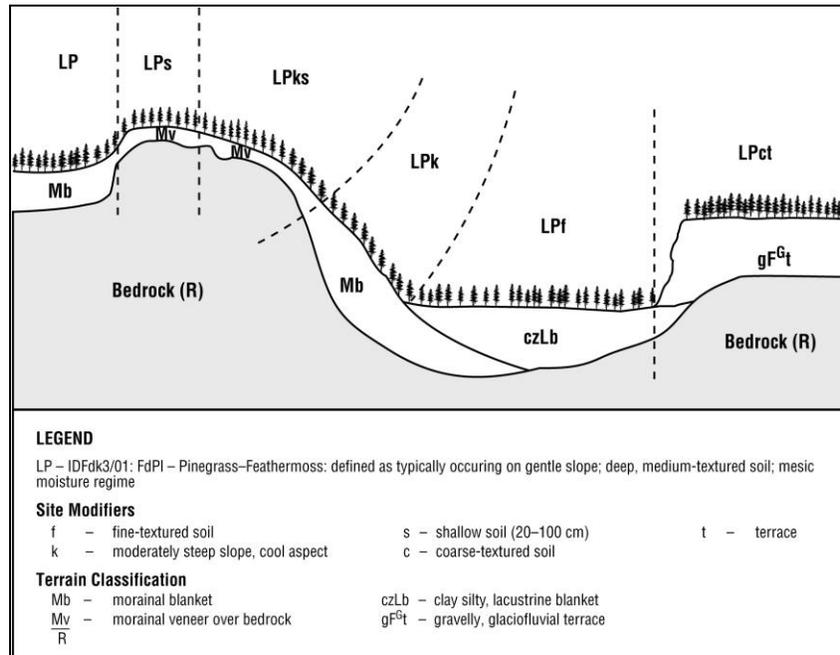


Figure 1: Use of site modifiers in mapping site series

The following is a list of TEM standard codes for site modifiers taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).

Table 1: Site modifiers for atypical conditions

Code	Criteria
<i>Topography</i>	
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.

Code	Criteria
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 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°).

Moisture

x	drier than typical (optional modifier) – describes part of the range of conditions for circummesic ecosystems with a wide range of soil moisture regimes or significantly different site conditions. For example, SBSmc2/01 (Sxw–Huckleberry) has three site phases described, and the submesic phase can be labeled with the “drier than average” modifier (e.g., SBx). This code should be applied only after consultation with the Regional Ecologist.
y	moister than typical (optional modifier) – describes part of the range of conditions for circummesic ecosystems with a wide range of soil moisture regimes or significantly different site conditions. For example, SBSmk1/06 (Sb–Huckleberry–Spiraea) is “typically” described as submesic to mesic. When this site series is found on subhygric or hygric sites, the “y” modifier is used (e.g., BHy). This code should be applied only after consultation with the Regional Ecologist.

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.
d	deep soil – the site series occurs on soils greater than 100 cm to bedrock.
f	fine-textured soils ² – the site series occurs on soils with a fine texture including silt and silt loam with less than 20% coarse fragment volume; and clay, silty clay, silty clay loam, clay loam, sandy clay and heavy clay with less than 35% coarse fragment volume.
m	medium-textured soils – the site series occurs on soils with a medium texture, including sandy loam, loam and sandy clay loam with less than 70% coarse fragment volume; silt loam and silt with more than 20% coarse fragment volume; and clay, silty clay, silty clay loam, clay loam, sandy clay and heavy clay with more than 35% 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 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

Structural Stages

The following is a list of TEM standard codes for structural stages taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).

Table 2: Structural stages and codes¹

Structural Stage	Description
<i>Post-disturbance stages or environmentally induced structural development</i>	
1 Sparse/bryoid²	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance less than 20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover less than 20%; total tree layer cover less than 10%.
Substages	
1a Sparse ²	Less than 10% vegetation cover;
1b Bryoid ²	Bryophyte- and lichen-dominated communities (greater than 1/2 of total vegetation cover).
<i>Stand initiation stages or environmentally induced structural development</i>	
2 Herb²	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover less than 10%, shrub layer cover less than or equal to 20% or less than 1/3 of total cover, herb-layer cover greater than 20%, or greater than or equal to 1/3 of total cover; time since disturbance less than 20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
Substages	
2a Forb-dominated ²	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid-dominated ²	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic ²	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d Dwarf shrub ²	Communities dominated (greater than 1/2 of the total herb cover) by dwarf woody species such as <i>Phyllodoce empetriformis</i> , <i>Cassiope mertensiana</i> , <i>Cassiope tetragona</i> , <i>Arctostaphylos arctica</i> , <i>Salix reticulata</i> , and <i>Rhododendron lapponicum</i> . (See list of dwarf shrubs assigned to the herb layer in the <i>Field Manual for Describing Terrestrial Ecosystems</i>).
3 Shrub/Herb³	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover less than 10%, shrub layer cover greater than 20% or greater than or equal to 1/3 of total cover.
Substages	
3a Low shrub ³	Communities dominated by shrub layer vegetation less than 2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 20 years for normal forest succession.
3b Tall shrub ³	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
<i>Stem exclusion stages</i>	
4 Pole/Sapling⁴	Trees greater than 10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually greater than 10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually less than 40 years for normal forest succession; up to 100+ years for dense (5000–15 000+ stems per hectare) stagnant stands.

Structural Stage	Description
5 Young Forest⁴	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions.
<i>Understory reinitiation stage</i>	
6 Mature Forest⁴	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years for biogeoclimatic group A ⁵ and 80–250 years for group B. ⁶
<i>Old-growth stage</i>	
7 Old Forest⁴	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and coarse woody debris in all stages of decomposition typical, as are patchy understories; understories may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally greater than 140 years for biogeoclimatic group A ⁵ and greater than 250 years for group B. ⁶

¹ In the assessment of structural stage, structural features and age criteria should be considered together. Broadleaf stands will generally be younger than coniferous stands belonging to the same structural stage.

² Substages 1a, 1b and 2a–d should be used if photo interpretation is possible, otherwise, stage 1 and 2 should be used.

³ Substages 3a and 3b may, for example, include very old krummholz less than 2 m tall and very old, low productivity stands (e.g., bog woodlands) less than 10 m tall, respectively. Stage 3, without additional substages, should be used for regenerating forest communities that are herb or shrub dominated, including shrub layers consisting of only 10–20% tree species, and undergoing normal succession toward climax forest (e.g., recent cut-over areas or burned areas).

⁴ Structural stages 4–7 will typically be estimated from a combination of attributes based on forest inventory maps and aerial photography. In addition to structural stage designation, actual age for forested units can be estimated and included as an attribute in the database, if required.

⁵ Biogeoclimatic Group A includes BWBSdk, BWBSmw, BWBSwk, BWBSvk, ESSFdc, ESSFdk, ESSFdv, ESSFxc, ICHdk, ICHdw, ICHmk1, ICHmk2, ICHmw3, MS (all subzones), SBPS (all subzones), SBSdh, SBSdk, SBSdw, SBSmc, SBSmh, SBSmk, SBSmm, SBSmw, SBSwk1 (on plateau), and SBSwk3.

⁶ Biogeoclimatic Group B includes all other biogeoclimatic units (see Appendix C).

Structural Stage Modifiers

The ‘t’ - two storied, structural stage modifier is used in stands where there are two distinct layers of trees. In particular, this modifier is used on ecosystem units with an abundant number of mature trees in the overstory and younger trees in the understory. Structural stage is applied to the unit according to which group of trees has the greatest percentage of cover. For example, if the site has 40% cover of mature trees and 20% of younger trees, structural stage 6 is applied.

The following is a list of TEM standard codes for structural stage modifiers taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).

Table 3: Structural stage modifiers and codes¹

Modifier	Description
s single storied	Closed forest stand dominated by the overstory crown class (dominant and co-dominant trees); intermediate and suppressed trees account for less than 20% of all crown classes combined ³ ; advance regeneration in the understory is generally sparse.
t two storied	Closed forest stand co-dominated by distinct overstory and intermediate crown classes; the suppressed crown class is lacking or accounts for less than 20% of all crown classes combined ³ ; advance regeneration is variable.
m multistoried	Closed forest stand with all crown classes well represented; each of the intermediate

Modifier	Description
	and suppressed classes account for greater than 20% of all crown classes combined ³ ; advance regeneration is variable.
i irregular	Forest stand with very open overstory and intermediate crown classes (totaling less than 30% cover), and well-developed suppressed crown class; advance regeneration is variable.
h shelterwood	Forest stand with very open overstory (less than 20% cover) and well-developed suppressed crown class and/or advance regeneration in the understory; intermediate crown class is generally absent.

¹ Structural stage modifiers should be used as in the following examples: 5s for young forest stage with single-storied structure or 7m for old forest with multistoried structure. The only structural stage modifier, other than single storied, generally applicable to structural stage 3 is “h” (for shelterwood). This can be used to describe recently regenerated stands with a very open overstory (less than 20% cover of mature trees or vets) and a (usually dense) understory of seedlings and saplings.

² Based on either basal area or percent cover estimates.

Stand Composition Modifiers

The following is a list of the TEM standard codes for stand composition modifiers taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).

Table 4: Stand composition modifiers¹ and codes

Modifier	Description
C coniferous	Greater than 3/4 of total tree layer cover ² is coniferous
B broadleaf	Greater than 3/4 of total tree layer cover ² is broadleaf
M mixed	Neither coniferous or broadleaf account for greater than 3/4 of total tree layer cover ²

¹ Stand composition modifiers should be used as in the following examples: 6C for mature forest of coniferous composition, 7mM for old forest with multistoried structure and mixed composition, 3bC for tall shrub community dominated by coniferous saplings.

² Stand composition modifiers emphasize overstory and intermediate tree layers, since these are the most visible on aerial photographs.

Conservation Evaluation of Ecosystems

“Conservation Evaluation and Visual Inspection” forms were used to record the site assessment of each full plot polygon visited at Helliwell. The CDC typically completes site evaluations to determine if an area is suitable for conservation or to compare sites being considered for protection, as well as to affirm plant community element occurrences. In this study, the conservation evaluations were used to: 1) determine if any areas or ecosystem units in the park were in an undisturbed condition; 2) determine if certain areas or ecosystem map units were more or less damaged by recreational activities; and 3) determine the extent of exotic species invasion. Additionally, it is intended that the evaluations will provide a preliminary guide to determining where restoration efforts could be most effective by evaluating the degree of naturalness for each polygon.

Discussion of Map Reliability

Survey Intensity

All sites described have been identified in the field. Some sparsely vegetated and anthropogenic units, for example, RO (rock outcrop), RP (road surface) and CL (cliff), were observed in the field and on the air photos but no plot data was collected. A total of 74 polygons were delineated. Thirty-six full plots, 66 ground inspections, and 74 visual inspections were completed. The plot location map (Included in the Map Atlas accompanying this report)

indicates where each type of inspection was completed. Numerous polygons were re-visited without formal visual plot cards being completed. In these cases notes were made on photos and in notebooks to confirm airphoto pretyping and these are not included in the plot location map. Sixty-six polygons were visited equating to a survey intensity of 89% (equivalent to level 1 under the RIC standards). All other areas were photo interpreted.

Air Photographs

Colour aerial photographs, taken on July 9th, 1997, at a scale of approximately 1:5000 were used for mapping the study area. The age of the photos made it difficult to interpret a few areas on Flora Islet that had dwellings and other buildings on the photos, but have since been removed.

Ecosystem Identification

Although the scale of the airphotos did allow for significant detail to be captured, many small micro-ecosystem types were too small to be delineated or even complexed with other units. Some of the micro-ecosystems were determined to be important for the EBP plan, and include Beach (BE), Dunegrass-Beach pea (LM) and Vernal Pool (VP). Examples of excluded micro-ecosystems include patches where water collected in bedrock basins often smaller than 2 metres square, cliff seepages and small seepage pools. In these situations, small inclusions of ecosystems were noted in the comments field of the database.

Due to the time of year and dormancy of herbaceous understory vegetation, many of the plant species normally used to support site series identification were not available for this study. This was further complicated by the presence of perennial introduced species. As a result, emphasis was placed on the tree and shrub species present and site, soil and terrain features were used to determine forested site series.

Mapping Limitations and Considerations

Few mapping limitations were encountered because the mapping was completed at a scale of 1:5 000. With the exception of the most northern polygons, the park was easily traversed by foot. No soil classification or soil maps exist for Hornby Island and detailed soils information such as soil series descriptions, locating pans or cemented soil horizons, and the distribution of variable surface or subsoil textures was beyond the scope of this study. Further soils inventory work would provide additional information that would further our understanding of the park's ecosystems, and allow refinement of both terrestrial and wetland boundaries.

RESULTS AND DISCUSSION

Site Series and Ecosystem Units

Helliwell Park is located wholly within the CDFmm Biogeoclimatic subzone. Table 5 lists the various ecosystem units mapped, the total area of each unit mapped and the percentage each represents of the total study area. Six existing site series were mapped ranging from Moist (RK/05) and mesic sites (01/DS) to the most dry and poor sites (02/DAO). Of the richer site series in the CDF, only two were mapped, the FdBg – Oregon-grape (04/DG) and the Black cottonwood – Red osier dogwood (08/CD). One site series with a fluctuating water table was mapped (CS/14). This site series forms a complex of wetland types and ages in the northern part of the park.

Several non-forested ecosystems were described for the first time at Jedediah Island Marine Park, and were also noted at Helliwell: (FC) Red fescue – Death Camas/Camas, and (OR) Oceanspray – Nootka rose.

Four previously undescribed, non-forested units were also mapped. They include the Trembling aspen – Slough sedge (AS) seral wooded wetland, Beach (BE), Dunegrass – beachpea (LM), and Vernal Pool (VP).

Two anthropogenic units: Cultivated orchard (CO) and Road surface (RP), were also mapped.

Complete accounts for each ecosystem unit are provided in the expanded legend (Appendix 5b). Each unit is described over several pages. The first includes a description of the ecosystem; the typical location, site, soil and terrain characteristics, and a photo showing the appearance of the unit. The second page provides a summary of dominant, indicator and associate plant species at each developmental stage found in the park.

Dominant species are defined as those having 5% or higher cover and occurring in the unit with 75% frequency; indicators are those species found greater than 60% of the time; and associates are all others that occur with a minimum of 40% frequency. Six potential structural stages are listed for the forested ecosystem units. Structural stages that were not sampled are extrapolated from other developmental stages, known seral community types and plot information from other studies in similar areas. For the edaphic units only the herb or shrub stages are described. Notes to further describe the unit or explain how the findings at Helliwell Park may differ from sites found in other areas of the CDFmm are provided at the bottom of the table.

Table 5: Ecosystem units mapped for Helliwell Park

Code/Number*	Ecosystem Unit	Ha ²	% of study area
	Name		
AS3	Trembling aspen / Slough sedge	0.09	0.09
AS3b	Trembling aspen / Slough sedge	0.30	0.31
AS4	Trembling aspen / Slough sedge	1.48	1.53
BE	Beach	0.67	0.69
CD5	Black cottonwood / Red osier dogwood	3.81	3.94
CD6	Black cottonwood / Red osier dogwood	3.44	3.56
CS2	Red alder /Slough sedge [Black cottonwood]	0.38	0.39
CS4	Red alder /Slough sedge [Black cottonwood]	2.13	2.20
CS5	Red alder /Slough sedge [Black cottonwood]	2.85	2.95
CS6	Red alder /Slough sedge [Black cottonwood]	1.42	1.47
DAO3a	Douglas-fir/Shore pine/Arbutus	0.08	0.08
DAO3b	Douglas-fir/Shore pine/Arbutus	1.51	1.57
DAO4	Douglas-fir/Shore pine/Arbutus	3.14	3.25
DAO5	Douglas-fir/Shore pine/Arbutus	5.69	5.89
DAO7	Douglas-fir/Shore pine/Arbutus	7.74	8.01
DO2	Douglas-fir/Garry oak/Onion grass	0.16	0.16
DO4	Douglas-fir/Garry oak/Onion grass	0.77	0.79
DO5	Douglas-fir/Garry oak/Onion grass	0.79	0.81
DO7	Douglas-fir/Garry oak/Onion grass	15.21	15.73
DS5	Douglas-fir/Salal	4.96	5.13
FC2	Fescue/Camas	1.35	1.40
OR	Oceanspray/Rose	0.18	0.18
RK4	Western redcedar/Douglas-fir/Oregon beaked moss/	1.92	1.99
RK5	Western redcedar/Douglas-fir/Oregon beaked moss/	7.01	7.25
RO	Rock outcrop	8.52	8.81
RP	Road surface	0.29	0.30
VP	Vernal pool	0.01	0.01
5CO-5DAO3b	Cultivated Orchard 50%/ Douglas-fir/Shore pine/Arbutus 50%	0.65	0.67
5CS4-5CS2	Red alder /Slough sedge [Black cottonwood] Seral stage 4 50% Seral stage 2 50%	0.53	0.54
5DO3b-5FC2	Douglas-fir/Garry oak/Onion grass 50 / Fescue/Camas 50%	0.52	0.54
5FC2-5CL	Fescue/Camas 50% Cliff 50%	0.11	0.12
5RO-5CL	Rock outcrop 50% Cliff 50%	2.21	2.29
6BE - 4LM	Beach 60% Dune Grass/Beach Pea 40%	0.09	0.09
6BE-4DAO3b-1LM	Beach 60% Douglas-fir/Shore pine/Arbutus 30% Dune Grass/Beach Pea 10%	0.37	0.39
6BE-4LM	Beach 60% Dune Grass/Beach Pea 40%	0.38	0.39
6DAO3b-4FC2	Douglas-fir/Shore pine/Arbutus 60% / Fescue/Camas 40%	0.49	0.51
7BE-3LM	Beach 70% Dune Grass/Beach Pea 30%	0.06	0.07
8CL-2RO	Cliff 80% Rock outcrop 20%	1.27	1.31
8DAO3-2FC	Douglas-fir/Shore pine/Arbutus 80% / Fescue/Camas 20%	0.50	0.52
8DAO3a-2FC2	Douglas-fir/Shore pine/Arbutus 80% / Fescue/Camas 20%	0.73	0.76
8DAO3b-2FC2	Douglas-fir/Shore pine/Arbutus 80% / Fescue/Camas 20%	1.22	1.27
8FC2 - 2DAO3a	Fescue/Camas 80% / Douglas-fir/Shore pine/Arbutus 20%	9.44	9.76
8FC2-2DAO3	Fescue/Camas 80% /Douglas-fir/Shore pine/Arbutus 20%	0.14	0.15
8RO-2BE	Rocky outcrop 80% Beach 20%	1.50	1.55
9CL-1BE	Cliff 90% Beach 10%	0.52	0.54
9LM-1DAO2	Dune Grass/Beach Pea 90% / Douglas-fir/Shore pine/Arbutus 10%	0.03	0.03

¹ Bg – grand fir, Cw – western redcedar, Fd – Douglas-fir, Pl – lodgepole pine, Qg – Garry oak.

Seventy-six polygons were mapped, 56 (74%) were mapped as pure units (i.e. only one ecosystem), the rest were complexes of two or three units. The most frequent complex was the DA/02 - FdPI - Arbutus with the CV/00 – Red fescue – Death camas. These were found on exposed gentle or hummocky slopes and crest positions. Common also were complexes of the BE/00 – Beach and LM/00 – Dunegrass - Beachpea units that occupy narrow shoreline margins that cannot be subdivided at 1: 5 000.

One seral community type was mapped. The CR seral community type persists despite disturbance to the ecosystem by recreational trampling. This seral community is sparsely interspersed (<5% total cover) within the extensive FC meadow community that dominates the south-western area of the park, and has not been mapped as a separate unit. Soils are non-existent to very thin sandy veneers that are capable of supporting mat forming carpets of reindeer lichens (*Cladina* spp.), rock moss (*Racomitrium* spp.), broom moss (*Dicranum scoparium*), and very rarely Wallace's selaginella (*Selaginella wallacei*).

CR occurs on less-disturbed outcropping sandstone and conglomerate exposed bedrock patches within the FC meadow areas, and its distribution has been reduced to a narrow margin along the extreme edges of outcropping cliffs and the less frequently used meadow areas in the southwestern part of the park, where recreational trampling disturbance is less problematic.

While trails and trampling across the open meadow areas have kept succession in check, heavy use has taken its toll on this fragile plant community. Along with the FC community, the CR community may continue to persist at the young seral stage, rather than be overtaken by the DAO/02 and DO/03 communities. Management decisions have implications for the Taylor's Checkerspot Butterfly, which requires these open meadows for habitat.

Plant Species

Observations at Helliwell indicate that the FC meadows adjacent to trails are the most heavily impacted by recreational trampling. On the one hand, it is likely that most of the exotic plant species that are now ubiquitous in the meadows were introduced from the footwear and clothing of park visitors. On the other hand, it is likely that recreational use of the meadows is playing an important role in holding back succession. Less frequently used parts of the meadows (towards the western boundary of the park) are slowly being invaded by woody plants such as Douglas-fir, shorepine and arbutus. Wind-pruning and exposure to severe weather conditions also plays a role in limiting tree growth. One polygon was struck by fire approximately six years ago and shorepine and other pioneer species are now thriving.

Elsewhere in the park, the forested communities are generally in good to excellent condition. While selective logging may have occurred in the previous two centuries, recovery and regeneration is well underway. Deer browse is minimal. Wetland communities are "off the beaten trail" and are in excellent condition. Only minor alteration of natural drainages has occurred to divert water from trails.

Flora Islet has been heavily impacted in the past by recreational cottage uses. Several years ago a major effort was made to burn outbuildings and clean-up of debris. Since then the only disturbances are by recreational visitors (kayakers, scuba divers and wild flower lovers). The islet retains much of its ecological integrity, and should respond well to restoration efforts. Some exotic species still remain from the cottage gardens (near the present lighthouse), and should be removed when flowering to avoid mis-identification.

Bryophytes appear to be the most negatively impacted suite of plants in the park, and are highly vulnerable to trampling. The very shallow soils over much of St. John's Point have become exposed and the Ah horizon is very visible in many places. To the north of St. John's Point, trail

compaction and erosion has exposed midden material on the main trail.

Rare Plant Communities

The Conservation Data Centre (CDC, 1999) tracks rare and endangered plant communities throughout the province. The list and rank of plant associations tracked by the CDC, which were mapped in the study area follows in Table 6. A full list of rare plant communities for the CDFmm is listed in Table 7 at the end of this Appendix and can be found on the CDC web site (<http://www.elp.gov.bc.ca/rib/wis/cdc/tracking.htm>) where it is continually updated. It should be noted that the CDC natural plant community tracking list is currently incomplete since there is not yet enough data available for the CDC to rank all of the rare natural plant communities in B.C. This applies especially to many wetland and non-forested plant communities.

In 2000-2001, Ministry of Forests will be classifying grassland and wetland plant communities throughout B.C., and this will enable the CDC to produce a more comprehensive natural plant community tracking list. The rarity ranks of those wetland and non-forested plant communities already on the tracking list have the "Q" modifier (e.g. S2Q) to indicate that their classification is about to change. Their names and ranks will be updated after the classification is completed. Until then, they will be retained on "interim" red and blue lists to indicate that there are conservation concerns for these plant communities which will probably also apply to the corresponding plant communities in the new classification.

The rank reflects the rarity of plant community occurrences that are relatively undisturbed by humans or domestic animals, and are in a natural or "climax" state. In this mapping project the mapped ecosystem element is the "site series" with an indication of its structural development stage and specific features of the site.

Because the site series is a member of a plant association, (the relationship may be exclusive or there may be many site series within one plant association) each site series reflects the rarity rank of its parent plant association. Hence, the site series mapped at Helliwell that have reached structural stage 6 (mature forest) or 7 (old growth) are considered to represent these rare plant associations. Some non-forested plant communities have now been recognised by the CDC as rare and have been assigned a "00" code. Edaphic climax communities and non-forested communities do not reach structural stage 7.

Two previously undescribed plant community types were mapped: five occurrences of the Trembling aspen – Slough Sedge (AS) wooded wetland; the seral bryophyte association, Cladina - Wallace's selaginella: Cladina - Racomitrium (CR) in association with the FC community, and the Dunegrass- Beach pea (LM) shoreline community. The LM is relatively common elsewhere, but is rarely mapped and frequently disturbed by recreational beach use. At Helliwell, the LM is in excellent condition.

The AS community has been placed on the Willamette-Puget-Georgia Ecoregion Vegetation Targets list by the BC Conservation Data Centre and has been given a tentative rank of S1S2 (Red) and has not yet been assigned a unit number.

Table 6: Ratings of Plant Communities and relationship to Ecosystem Units mapped at Helliwell

Plant Community	Common Name	Equivalent Site Series (map code)	CDC Ranking ¹	Prov. Listing
<i>Populus tremuloides</i> – <i>Carex obnupta</i>	Trembling aspen – Slough Sedge	CDFmm/00	S1/S2	Red
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> – <i>Cornus sericea</i>	Black cottonwood – Red Osier Dogwood	CDFmm/08 (CD)	-	-
<i>Alnus rubra</i> / <i>Carex obnupta</i> [<i>Populus balsamifera</i> Ssp. <i>trichocarpa</i>]	Red Alder / Slough Sedge [Black Cottonwood]	CDFmm/14 (CS)	S1	Red
<i>Pseudotsuga menziesii</i> - <i>Pinus contorta</i> - <i>Arbutus menziesii</i>	Douglas-Fir - Lodgepole Pine - Arbutus	CDFmm/02 (DA)	S2S3	Blue
<i>Pseudotsuga menziesii</i> / <i>Gaultheria shallon</i>	Douglas-Fir / Salal	CDFmm/01 (DS)	S1S2	Red
<i>Thuja plicata</i> - <i>Pseudotsuga menziesii</i> / <i>Kindbergia oregana</i>	Western redcedar – Douglas-fir/Oregon beaked moss	CDFmm/05 (RK)	S1S2	Red

¹CDC ranking codes are explained on the CDC website – <http://elp.gov.bc.ca/rib/wis/cdc>

Conservation Evaluation Ratings

The ratings provide an indication of site conditions, as found between October 2000 and January 2001 and should serve as a benchmark to assess ecosystem health in the future. It should be noted that these conditions are not static and can change very quickly. Viability ratings provide some indication of future conditions if the present trends continue. They are only relevant if the disturbance regime remains unchanged. At the start of sampling the conservation evaluations were based on the ecosystem mapper's knowledge of other areas of the CDFmm. After becoming more familiar with the ecosystems and the overall conditions at Helliwell, the evaluations became more relevant to the park, and earlier ratings were adjusted as required.

Analysis of the conservation ratings show that there are very few units that were rated as marginal (C) or poor (D) or good (2) for naturalness with a high likelihood of remaining in that condition (viability = 1 or 2) if the present management situation were to continue. Eighty - two percent of the mapped units fell into the range of marginal (3) to poor (4) for naturalness and viability, with the majority (approx. 51%) being rated as marginal for naturalness and poor for viability. At the extremes of the scale, approximately four percent of the ecosystems were rated as excellent in both naturalness and viability. These are mostly located on Paul Island and the surrounding islets. Approximately eight percent were rated as poor in both categories.

The red and blue listed plant associations found on Helliwell are forested ecosystems at developmental stage 6 or 7. Only two plant associations were mapped at structural stage 7: *Pseudotsuga menziesii* – *Pinus contorta* – *Arbutus menziesii* (02/DAO) was mapped once and *Pseudotsuga menziesii* – *Quercus garryana*/*Melica subulata* (03/DO) was mapped twice. Both of these communities are represented by relatively large polygons, with undisturbed forest interior, and excellent area/perimeter ratios.

Several plant associations were mapped at structural stage six. The *Alnus rubra*/*Carex obnupta* [*Populus balsamifera* ssp. *trichocarpa*] (14/CS) had one occurrence, as did the *Populus balsamifera* ssp. *trichocarpa* – *Cornus sericea* (08/CD) community.

As mentioned earlier, the CDFmm has few old growth sites remaining and development pressures are intense. With Helliwell Park's Class A Provincial Park designation, certain assurances for protection are implied. As a result, the above units are probably good recruitment sites for endangered plant associations and as such may be good areas to emphasize protection and restoration efforts. Seven polygons were mapped at structural stage 5, and are in excellent condition. Several are approaching the cusp of becoming classified as structural stage 6, and the diversity of age classes within the park again implies that there are good opportunities to allow natural processes to carry on while concentrating on reducing the human-induced pressures on the park.

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2000 Provincial Natural Plant Community Tracking List – Red (S1/S2) and Blue (S3) Listed Communities in the CDFmm Subzone

The natural plant community tracking list is incomplete since there is not yet enough data available for the CDC to rank all of the rare natural plant communities in B.C. This applies especially to many wetland, alpine, and grassland plant communities. This year, the Ministry of Forests will be classifying grassland and wetland plant communities throughout B.C., and this will enable the CDC to produce a more comprehensive natural plant community tracking list. In preparation for this, the rarity ranks of those wetland and grassland plant communities already on the tracking list have the "Q" modifier (e.g. S2Q) to indicate that their classification is about to change. Their names and ranks will be updated after the classification is completed. Until then, they will be retained on "interim" red and blue lists to indicate that there are conservation concerns for these plant communities which will probably also apply to the corresponding plant communities in the new classification.

Please note that all ranks reflect the rarity of plant community occurrences that have not been disturbed by humans or domestic animals, and are in a natural or "climax" state. Do not confuse these natural plant communities with successional plant communities (e.g. second-growth Douglas-fir and salal forests), or with degraded plant communities (e.g. a weedy bluebunch wheatgrass and junegrass grassland). However, be aware that for the purposes of conservation, disturbed occurrences of rare plant communities may be ecologically valuable if there are few or no natural, undisturbed occurrences left in the Province (e.g. Garry Oak plant communities). Please visit our Ecology page or contact the CDC for more information on rare natural plant communities and rare natural plant community conservation.

Table 7: CDC Listing of Rare Plant Communities in the CDFmm Biogeoclimatic Zone

Scientific name Common Name	Rank	List	BEC Unit	Successional Status	Structural Stage
<i>Abies grandis</i> / <i>Mahonia nervosa</i> Grand fir / dull Oregon-grape	S1	Red	CDFmm/04	CC	7
<i>Abies grandis</i> / <i>Tiarella trifoliata</i> Grand fir / three-leaved foamflower	S1	Red	CDFmm/06	CC	7
<i>Alnus rubra</i> / <i>Carex obnupta</i> [<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>] Red alder / slough sedge [black cottonwood]	S1	Red	CDFmm/14	EC	6
<i>Festuca idahoensis</i> - <i>Koeleria macrantha</i> Idaho fescue - junegrass	S1	Red	CDFmm/00	DC	2
<i>Myosurus minimus</i> - <i>Montia</i> spp. - <i>Limnanthes macounii</i>	S1	Red	CDFmm/00	EC	2
<i>Pinus contorta</i> / <i>Sphagnum girgensohnii</i> CDFmm Lodgepole pine / common green sphagnum CDFmm	S1	Red	CDFmm/10	EC	7
<i>Pseudotsuga menziesii</i> - <i>Arbutus menziesii</i> Douglas-fir - arbutus	S2Q	Interim Red	CDFmm/00	EC	7

<i>Pseudotsuga menziesii</i> - <i>Quercus garryana</i> / <i>Melica subulata</i> Douglas-fir - garry oak / alaska oniongrass	S1	Red	CDFmm/03	EC	7
<i>Pseudotsuga menziesii</i> / <i>Gaultheria shallon</i> Douglas-fir / salal	S2	Red	CDFmm/01	CC	7
<i>Quercus garryana</i> - <i>Arbutus menziesii</i> Garry oak - arbutus	S1	Red	CDFmm/00	EC	7
<i>Quercus garryana</i> / <i>Bromus carinatus</i> Garry oak / California brome	S1	Red	CDFmm/00	EC	7
<i>Quercus garryana</i> / <i>Holodiscus discolor</i> Garry oak / oceanspray	S1	Red	CDFmm/00	EC	7
<i>Thuja plicata</i> - <i>Pseudotsuga menziesii</i> / <i>Kindbergia oregana</i> Western redcedar - Douglas-fir / Oregon beaked moss	S2	Red	CDFmm/05	CC	7
<i>Thuja plicata</i> / <i>Achlys triphylla</i> Western redcedar / vanilla leaf	S2	Red	CDFmm/12	EC	7
<i>Thuja plicata</i> / <i>Oemleria cerasiformis</i> Western redcedar / indian-plum	S2	Red	CDFmm/13	EC	7
<i>Thuja plicata</i> / <i>Symphoricarpos albus</i> Western redcedar / snowberry	S1	Red	CDFmm/07	EC	7
<i>Alnus rubra</i> / <i>Lysichiton americanum</i> Red alder / skunk cabbage	S2S3	Blue	CDFmm/11	EC	7
<i>Pseudotsuga menziesii</i> - <i>Pinus contorta</i> - <i>Arbutus menziesii</i> Douglas-fir - lodgepole pine - arbutus	S2S3 Q	Interim Blue	CDFmm/02	EC	7

Ranks with a "Q" indicate that the classification is under review.

Notes:

BEC Unit: Biogeoclimatic Ecosystem **C**lassification unit (including site series) in which each natural plant community can occur. These units are described in the Ministry of Forests' "Field Guide to Site Identification and Interpretation" for the appropriate Forest Region. Units numbered "00" have not yet been assigned site series numbers by the Ministry of Forests. In some cases, the list of BEC units given is incomplete. Site series are by no means equivalent to natural plant communities as defined by the CDC; visit the Ecology page for an explanation.

Successional Status: This column indicates the successional status of each natural plant community. Natural plant communities are, almost without exception, climax plant communities. Younger successional stages are considered to be different plant communities, though they may eventually develop into climax plant communities. For more information on successional status, visit the Ecology page or the *Field Manual for Describing Terrestrial Ecosystems*.

Code	Successional Status	Definition
CC	Climatic climax	The oldest expression of an ecosystem, where succession has been unimpeded by edaphic (site) limiting factors or ecological disturbance. This state is self-perpetuating in

		the absence of disturbance.
ED	Edaphic climax	The oldest possible expression of an ecosystem given edaphic (site) limiting factors atypical for the landscape that arrest or redirect succession, so that the climatic climax is never achieved. Edaphic limiting factors include extremely dry soil, extremely wet soil, and very poor nutrient regime, relative to the landscape norms.
DC	Disclimax	The oldest possible expression of an ecosystem given a natural disturbance regime that arrests or redirects succession so that the climatic climax is never achieved. Natural disturbances include periodic surface fires and annual flooding.

Structural Stage: This column indicates the structural stage(s) of each natural plant community. Similar plant communities at younger structural stages are considered to be different plant communities, though they may eventually develop into natural plant communities. For definitions, see the *Field Manual for Describing Terrestrial Ecosystems*.

Code	Structural Stage
1	Sparse/bryoid
1a	<i>Sparse</i>
1b	<i>Bryoid</i>
2	Herb
2a	<i>Forb-dominated</i>
2b	<i>Graminoid-dominated</i>
2c	<i>Aquatic</i>
2d	<i>Dwarf shrub-dominated</i>
3	Shrub/Herb
3a	<i>Low shrub</i>
3b	<i>Tall shrub</i>
4	Pole/Sapling
5	Young Forest
6	Mature Forest
7	Old Forest

Appendix 5b: Expanded Legend

Complete accounts for each ecosystem unit are provided in the expanded legend (Appendix 5b). Each unit is described over two pages. The first includes a description of the ecosystem; the typical location, site, soil and terrain characteristics, and a photo showing the appearance of the unit. A small distribution map indicates all polygons where the unit is mapped in at least one of the three deciles, regardless of how small a component. The second page provides a summary of dominant, indicator and associate plant species at each developmental stage.

Dominant species are defined as those having 5% or higher cover and occurring in the unit with 75% frequency; indicators are those species found greater than 60% of the time; and associates are all others that occur with a minimum of 40% frequency. Six potential structural stages are listed for the forested ecosystem units. Structural stages that were not sampled are extrapolated from other developmental stages, known seral community types and plot information from other studies in similar areas. For the edaphic units only the herb or shrub stages are described. Notes to further describe the unit or explain how the findings on Helliwell Park may differ from sites found in other areas of the CDFmm are provided at the bottom of the table. Because vegetation has been highly impacted by disturbance on Helliwell Park, a species list is provided, on the right side of the table, to show the normal expected species in a mature, undisturbed, forested site series within the CDFmm. These list have been generated based upon the Ministry of Forests Environment and Vegetation tables (Inselberg 1991).