Photo Interpretation Procedures

Phase I

Vegetation Resources Inventory

May 14, 1996
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Introduction

Background

The Forest Resources Commission recommended a review of the provincial resource inventory process in its report *The Future of our Forests*. The Resources Inventory Committee (RIC) was established with the objective of achieving common standards and procedures and it, in turn, established several task forces. One of these task forces, the Terrestrial Ecosystems Task Force, set up the Vegetation Inventory Working Group and charged the members with:

"...making recommendations pertaining to the vegetation inventory...(and)...designing and recommending standards and procedures for an accurate, flexible...inventory process".

The Vegetation Inventory Working Group recommended a photo-based, two-phased vegetation inventory program:

- Phase I: Photo Interpretation;
- Phase II: Sampling.

Two tasks were identified to ensure that the desired outcomes were achieved:

1. Design a vegetation-based land classification scheme.
2. Identify vegetation inventory attributes to describe the polygons identified through the land classification scheme.

The Ministry of Forests, assisted by the Ministry of Environment, Lands and Parks, is implementing these recommendations in the Vegetation Resources Inventory.
Vegetation Resources Inventory Process

The Vegetation Resources Inventory is carried out in two phases. Phase I: Photo Interpretation involves estimating vegetation polygon characteristics from aerial photographs. Phase II: Ground Sampling provides the information necessary to determine how much of a given attribute is within the inventory area. Ground samples alone cannot be collected in sufficient numbers to provide the specific locations of the land cover characteristics being inventoried.

The relationship between polygon estimates and ground samples is used to adjust the Phase I polygon estimate and to provide an overall correct answer. The polygon location, with its adjusted characteristics, provides the location within the inventory area.

Principles of the Photo Interpretation Process

1. The vegetation inventory will cover the entire land base of British Columbia, irrespective of ownership or vegetation values.

2. The vegetated land base will be delineated into polygons based on similar vegetation characteristics visible on mid-scale aerial photography (1:15 000).

3. Areas of non-vegetated lands will be delineated into similar polygons and basic attributes will be assigned at the level achievable by photo interpreters with minimal additional training. Such polygons may be further described by experts in a separate process if desired.

4. The inventory design does not allow polygon boundaries to be changed by the sampling process.

5. The estimate for a polygon will describe land cover types according to the British Columbia Land Classification Scheme.

6. The estimation of polygon attributes may indicate that several cover types exist within a polygon boundary. Several land cover types may be described as additional information for resource users.

7. All continuous variables will be estimated to the finest level of resolution practical; class-based summaries can be compiled as desired from the detailed data.

8. Ancillary data will be used, as available, to provide accurate and consistent estimates of polygon attributes.

9. The photo interpretation process strives towards consistency of estimates:
   - by one classifier;
   - between classifiers; and,
   - over time.
Note: A primary goal of the inventory is to produce accurate polygon estimates as accurate estimates are automatically consistent. However, inaccurate estimates are also useful if they are consistently "high" or "low" (e.g., all height estimates are overestimated by three metres) as these estimates can be adjusted following the ground sampling phase. Inconsistent estimates are undesirable as they may increase the sampling intensity required and lead to greater errors after adjustment.

10. All attributes estimated as continuous variables will be adjusted by the sampling process.

11. Categorical (non-continuous) attributes will be assigned. As a minimum, these will be reported as to the proportion of times the estimate was correct by the sampling process. These attributes may also be adjusted.
How to use this manual

This manual deals with the Phase I: Photo Interpretation component of the Vegetation Resources Inventory. It describes procedures required to delineate polygons, using the new B.C. Land Classification Scheme, and to estimate vegetation inventory attributes within polygons.

A brief background is provided to explain the rationale behind the procedures. The remainder of the manual follows the process that would be required when delineating polygons and estimating attributes. Section 1 explains the new B.C. Land Classification Scheme. Section 2 describes the procedures required to delineate polygons. Section 3 explains the identification of polygons and the estimation of general and ecological attributes. Sections 4 and 5 describe estimating land cover and site indices and Sections 6, 7, 8, and 9 explain estimation of the attributes related to vegetated portions of polygons. Section 10 describes procedures required to classify the non-vegetated portions of polygons.

Section 11: Derived Polygon Attributes identifies and explains the attributes that are derived after Phase I and Phase II are complete. Although derived attributes are not the responsibility of the photo interpreter, an understanding of the attributes that will be derived should improve the consistency and quality of estimation overall.

Each of these main sections contains a definition, statement of purpose, and detailed procedures. Where applicable, examples and tips are provided.

A glossary of terms and a detailed index are included to ensure the usability of the manual as a reference tool.
B.C. Land Classification Scheme

Introduction

The Vegetation Inventory Working Group, a component of the Resource Inventory Committee (RIC), was given the task of creating a land cover classification scheme to meet the needs of British Columbia’s resource managers today and into the future. Present inventories were found lacking when used to assess integrated resource management options. It was from this perspective, along with growing worldwide demand for an accurate assessment of land cover, that the following classification was created.

The B.C. Land Classification Scheme was designed to meet present provincial and national needs, and to provide for global vegetation accounting. Numerous classifications were considered in the development of the scheme.

The B.C. land classification scheme is based on current cover. Cover can be vegetated or non-vegetated. Vegetated cover is either treed or non-treed; non-vegetated cover is either land or water. In most cases, homogeneous areas (polygons) are delineated on mid-scale aerial photographs (1:10,000 to 1:20,000). Land cover classes can exist as components within larger polygons.

The purpose of the B.C. Land Classification Scheme is twofold. First, the land classification can be derived for each polygon (or portion thereof), based on the photo interpreter’s attribute estimates. The land classification of each polygon is summarized as a seven letter code (see Levels 1 to 5 following) to facilitate broad land classification reporting, and also to provide a link for comparison of land classification accuracy with Phase II field sampling data. Second, the B.C. Land Classification.

1 Note: Section 1 is adapted from the B.C. Land Cover Classification Document, March 31, 1995. Contact the Resources Inventory Committee for a copy of this report.
Scheme provides the criteria for distinguishing cover types within the polygon. These criteria are critical for the assessment of specific tree, shrub, herbaceous, bryoid and non-vegetated communities within polygon boundaries (referred to as land cover components).

The land classification (seven letter) code for the polygon is not derived by the photo interpreter; it is derived after Phase I data has been delivered. However, it is important that photo interpreters be familiar with the derivation process to improve the consistency of photo-interpreted data. Photo interpreters will also apply the classification criteria to the description of individual communities (land cover components) within the polygon.

Figure 1-1 and Figure 1-2 illustrate a simplified land classification scheme for vegetated and non-vegetated covers.
Vegetated Polygons

Figure 1-1
Simplified Land Classification Scheme
- Vegetated Polygons
The remainder of this section explains the land classification scheme in detail. For a discussion of the derivation of land classification codes based on photo-interpreted estimates, see Section 11 Derived Polygon Attributes.
Level 1 Land Base

Definition

The first level of the B.C. Land Classification Scheme classifies the presence or absence of vegetation within the boundaries of the polygon. Presence or absence is recognized by the vertical projection of vegetation upon the land base within the polygon.

Purpose

Assessing the presence or absence of vegetation within the polygon provides the first level of classification of the B.C. Land Classification Scheme and the first level of reporting ability.

Procedure

\[ V = \text{Vegetated} \]

a polygon is vegetated when the total cover of trees, shrubs, herbs and bryoids (other than crustose lichens), covers at least 5% of the total surface area of the polygon.

\[ N = \text{Non-vegetated} \]

a polygon is non-vegetated when the total cover of trees, shrubs, herbs and bryoids (other than crustose lichens), covers less than 5% of the total surface area of the polygon.

According to the scheme, bodies of water are to be classified as non-vegetated.

Note: Bodies of water may have vegetation on or under their surface which are the responsibility of others to evaluate.
Level 2 Land Cover Type

Definition

The second level of the B.C. Land Classification Scheme classifies the polygon as to the land cover type: treed or non-treed; land or water.

Purpose

Land cover type provides the second level of delineation within the B.C. Land Classification Scheme and provides the second level of reporting ability.

Procedure for Vegetated Polygons

An interpretation is made of the coverage of tree crowns as measured by their vertical projection upon the land base; estimated to the nearest percentage crown closure.

\[
T = \text{Treed}
\]

a polygon is considered treed if at least 10%, by crown cover, of the area consists of tree species of any size.

\[
N = \text{Non-treed}
\]

a polygon is considered non-treed if less than 10%, by crown cover, of the area consists of tree species of any size.

Note: The classification scheme applies to the entire land base and equal care should be given to treed and non-treed areas. Non-treed sites are an important part of the landscape as they often contain many diverse and unique species and provide valuable habitat. Without a better appreciation for the types of non-treed sites and their distribution it will be more difficult to assemble new information. Management interpretations and decisions at the large landscape level will be enhanced with the addition of information on non-treed ecosystems.
Procedure for Non Vegetated Polygons

The polygon is interpreted as to the percentage area occupied by land or water. The area greater than 50% is the cover type to be assigned.

\[ L = \text{Land} \]

is the portion of the landscape not covered by water (as defined below) based on the percentage area coverage.

\[ W = \text{Water} \]

is a naturally occurring, static body of water, greater than two metres in depth in some portion, or a watercourse formed when water flows between continuous, definable banks. These flows may be intermittent or perennial; it does not include ephemeral flows where no channel with definable banks is present. Islands, within streams that have definable banks, are not part of the stream; gravel bars are part of the stream. Interpretation is based on the percentage area coverage.
Level 3 Landscape Position for Vegetated and Non-Vegetated Polygons

Definition

The third level of the B.C. Land Classification Scheme is the location of the polygon relative to elevation and drainage and is described as either alpine, wetland or upland. In rare cases, the polygon may be alpine wetland.

Purpose

The landscape position provides the framework for delineation of ecosystems and habitat and the third level of reporting ability.

Procedure

The polygon is interpreted to see if it has one or more cover classes. The polygon classification is determined by the class with the majority coverage by area.

A = Alpine

is dominated in the vegetated areas by shrubs, graminoids, herbs, bryophytes and lichens. Much of the alpine will be non-vegetated, covered primarily by rock and ice. The alpine is treeless by definition; however, there may be a few rare trees (≤1% crown closure).

The boundary for alpine is drawn using the upper elevation of the discontinuous treed area (typically including parkland and krummholz). Generalization of the boundary is necessary since cliffs, rock outcrops, and avalanche chutes often dissect the alpine/upland transition.

Note: Alpine is the land area above the maximum elevation for tree species.

Parkland is a landscape characterized by strong clumping of trees due to environmental factors (from Ecosystems of British Columbia, MoF, 1991).

Krummholz is the scrubby, stunted growth form of trees, often forming a characteristic zone at the limit of tree growth at high elevations (from Forest Ecology Terms in Canada, Canadian Forest Service, 1994).
W = Wetland
is land having the water table near, at, or above the soil surface or which is
saturated for a long enough period to promote wetland or aquatic processes
as indicated by poorly drained soils, specialized vegetation, and various
kinds of biological activity which are adapted to the wet environment.

In the Canadian wetland classification, wetland classes include bog, fen,
marsh, swamp, and shallow water. In British Columbia, wetlands include
forested or non-forested subhydric (SMR 7) sites, in addition to non-
forested hydric (SMR 8) ecosystems (see the B.C. Land Cover
Classification document for a detailed description).

U = Upland
is a broad class including everything from xeric, moss- and lichen-covered
rock outcrops to highly productive forest ecosystems on hygric (SMR 6)
soils.
Level 4 Vegetation Types and Non-Vegetated Cover Types

Definition
The fourth level of the B.C. Land Classification Scheme classifies the vegetation types and non-vegetated cover types (as described by the presence of distinct types upon the land base within the polygon).

Purpose
Vegetation types and non-vegetated cover types provide the fourth level of delineation within the B.C. Land Classification Scheme and the fourth level of reporting ability.

Procedure for Vegetated Polygons
The vegetated polygons delineated and described in levels 1 to 3 in the land classification scheme are further classified by the vegetation types as listed below. An interpretation is made of the coverage of vegetation crown closure as measured by their vertical projection upon the land base, estimated to the nearest percent crown closure.

Treed units are split into three groups: Coniferous, Broadleaf, Mixed (broadleaf and coniferous)

TC = Treed - Coniferous
is defined as those trees found in B.C. within the order Coniferae. These trees are generally referred to as "softwoods". The polygon is classified as coniferous when the total crown cover of coniferous trees is 75% or more of the total tree crown cover and trees cover a minimum of 10%, by crown cover, of the total area.

TB = Treed - Broadleaf
is defined as trees classified botanically as Angiospermae in the subclass Dicotyledoneae. These species are commonly referred to as "hardwoods". The polygon is classified as broadleaf when the total crown cover of broadleaf trees is 75% or more of the total tree crown cover and trees cover a minimum of 10%, by crown cover, of the total area.

TM = Treed - Mixed
the polygon is classified as mixed when neither coniferous nor broadleaf trees cover 75% or more of the total tree crown cover and trees cover a minimum of 10%, by crown cover, of the total area.
Non-treed units are broken into Shrubs, Herbs, and Bryoids (formerly referred to as non-vascular cryptogams).

**Shrubs** are defined as multi-stemmed woody perennial plants, both evergreen and deciduous. A reporting break is made between Tall (greater than two metres in height) and Low (less than or equal to two metres in height) for wildlife management purposes.

For a polygon to be classified as non-treed shrub it must have more than 5% total vegetation cover, have a minimum of 20% ground cover of shrubs; or shrubs must constitute more than one third of the total vegetation cover.

\[ \text{ST} = \text{Shrub Tall} \]
shrub polygon with average shrub height greater than two metres.

\[ \text{SL} = \text{Shrub Low} \]
shrub polygon with average shrub height less than or equal to two metres in height.

**Herbs** are defined as vascular plants without a woody stem, including ferns, their allies, some dwarf woody plants, grasses and grass-like plants. The herb class is further subdivided into:

- **forbs** which are defined as herbaceous plants other than graminoids;
- **graminoids** which are defined as herbaceous plants with long, narrow leaves with linear venation; including grasses, sedges, and rushes.

For a polygon to be classed as non-treed herb it must have more than 5% total vegetation cover; have a minimum of 20% ground cover of herbs; or herbs must constitute more than one third of the total vegetation cover and the polygon must have less than 20% shrub cover.

\[ \text{HE} = \text{Herb} \]
herb polygon with no distinction between forbs and graminoids.

\[ \text{HF} = \text{Herb - Forbs} \]
herb polygon with forbs greater than 50% of the herb cover.

\[ \text{HG} = \text{Herb - Graminoids} \]
herb polygon with graminoids greater than 50% of the herb cover.
**Bryoids** (formerly referred to as non-vascular cryptogams) are defined as bryophytes (mosses, liverworts, and hornworts) and lichens (foliose or fruticose; not crustose).

For a polygon to be classed as non-treed bryoid it must have more than 5% total vegetation cover; have greater than 50% of the vegetation cover in bryoids; and herb and shrub cover must be less than 20%.

\[
\text{BY} = \text{Bryoid}
\]

bryoid polygon with no distinction between mosses and lichens.

\[
\text{BM} = \text{Bryoid - Moss}
\]

bryoid polygon with mosses, liverworts, and hornworts greater than 50% of the bryoid cover.

\[
\text{BL} = \text{Bryoid - Lichens}
\]

bryoid polygon with lichens (foliose or fruticose; not crustose) greater than 50% of the bryoid cover.

### Procedures for Non-Vegetated Polygons

The non-vegetated polygons, delineated and described in levels 1 to 3 of the land classification scheme, are further classified by the non-vegetated cover types listed below. An estimation is made of the class which has the greatest percentage coverage by area.

Non-vegetated polygons (within the land cover type) are broken into three groups: Snow / Ice; Rock / Rubble; and Exposed Land.

\[
\text{SI} = \text{Snow / Ice}
\]

is defined as either glacier, which is considered a mass of perennial snow and ice with definite lateral limits, typically flowing in a particular direction; or other permanent snow which is ice and snow that is not part of a glacier.

\[
\text{RO} = \text{Rock / Rubble}
\]

is defined as bedrock or fragmented rock broken away from bedrock surfaces and moved into its present position by gravity or ice.

\[
\text{EL} = \text{Exposed Land}
\]

contains all other forms of exposed land identified by a range of subclasses.

**Note:** The water portion of level 2 (land cover type) does not have any classes in this level of the land classification scheme.
Level 5 Vegetated Density Classes and Subdivision of Non-Vegetated Categories

Definition

The fifth level of the B.C. Land Classification Scheme classifies the vegetation density classes and non-vegetated categories.

Purpose

Vegetated density classes and non-vegetated categories provide the fifth level of delineation within the B.C. Land Classification Scheme and the fifth level of reporting ability.

Procedure for Vegetated Polygons

The vegetated polygons delineated and described in levels 1 to 4 in the land classification scheme are further classified into density classes as listed below. An interpretation is made of the coverage and density of vegetation within the polygon. The density classes for treed, shrub and herb cover are as follows:

DE = Dense
tree, shrub or herb cover is between 61% and 100% for the polygon.

OP = Open
tree, shrub or herb cover is between 26% and 60% for the polygon.

SP = Sparse
cover is between 10% and 25% for treed polygons and cover is less than 26% for shrub and herb polygons.

The density classes for the bryoid class is as follows:

CL = Closed
cover of bryoids is greater than 50% of the polygon.

OP = Open
cover of bryoids is less than or equal to 50% of the polygon.
Procedure for Non-Vegetated Polygons

The non-vegetated polygons delineated and described in levels 1 to 3 in the land classification scheme are further classified into categories as listed below.

Snow/Ice has two subclasses: Glacier and Snow Cover

GL = Glacier
a mass of perennial snow and ice with definite lateral limits, typically flowing in a particular direction.

SC = Snow Cover
snow or ice that is not part of a glacier but is found on the landscape.

Rock/Rubble has four subclasses: Bedrock; Rubble, Talus, Blockfield; Rubbly Mine Spoils; and Lava Bed.

BR = Bedrock
unfragmented, consolidated rock, contiguous with the underlying material.

RT = Rubble, Talus, Blockfield
fragmented rock, broken away from bedrock surfaces, and moved into present position by gravity or ice.

MS = Rubbly Mine Spoils
discarded overburden or waste rock, moved to extract ore during mining.

LB = Lava Bed
an area where molten rock has flowed from a volcano or fissure and cooled to form solidified rock.

Exposed Land is a broad class that has sixteen subclasses:

RS = River Sediments
silt, gravel, and sand bars associated with former river channels and present river edges.

ES = Exposed Soil
any exposed soil not covered by the other categories. (e.g., areas of recent disturbance that include mud slides, debris torrents, avalanches, or manmade disturbances such as pipeline right-of-ways) where vegetation cover is less than 5%.

LS = Pond or Lake Sediments
exposed sediments related to dried lakes or ponds.

RM = Reservoir Margin
land exposed by a drained or fluctuating reservoir. It is found above "normal" water levels and may consist of a range of substrates including gravel, cobbles, fine sediments, or bedrock.
BE = Beach
the area that expresses sorted sediments reworked in recent time by wave action, it may be formed at the edge of fresh or salt water bodies.

LL = Landing
a compacted area adjacent to a road used for the purpose of sorting and loading logs.

BU = Burned Area
land showing evidence of recent burning, either natural or prescribed. Vegetation of less than five percent crown cover was present at the time of polygon description.

RP = Road Surface
an area cleared and compacted for the purpose of transporting goods and services by vehicles. Older roads that are used infrequently or not at all may cease to be non-vegetated.

MU = Mudflat
flat plane-like areas in association with lakes, ponds, rivers or streams - dominated by fine textured sediments, they can be associated with freshwater or estuarine sources.

CB = Cutbank
part of a road corridor created upslope of the road surface created by excavation into the hillside.

MO = Moraine
area of debris carried down and deposited by a glacier.

GP = Gravel Pit
area exposed through the removal of sand and gravel.

TS = Tailings
an area containing the solid waste material produced in the mining and milling of ore.

RR = Railway surface
a roadbed with fixed rails, may contain single or multiple rail lines.

BP = Buildings and Parking
buildings and associated developments includes areas with buildings and associated developments such as roads and parking areas.

OT = Other
non-vegetated polygon where none of the above categories can be reliably chosen.

Water Cover (Level 2) has 3 sub-classes:
LA = Lake
a naturally occurring static body of water more than two metres deep in some portion. The boundary for the lake is the natural high water mark.

RE = Reservoir
an artificial basin affected by impoundment behind a manmade structure such as a dam, berm, dyke, or wall.

RI = River/stream
a watercourse formed when water flows between continuous, definable banks, flow may be intermittent or perennial. It does not include ephemeral flow where no channel with definable banks is present. Gravel bars are part of a stream while islands within a stream that have definable banks are not.
Polygon Delineation

Introduction

Polygon delineation is based on the British Columbia Land Classification Scheme. This land classification scheme includes both vegetated and non-vegetated cover classes over the entire provincial landscape. Polygons identified by the land classification scheme are further divided into similar vegetated or non-vegetated polygons. Detailed polygon attributes are assigned to each polygon, providing an estimated base from which ground sampling locations (Phase II) are selected.

Definition

Polygon delineation is the process used to divide the landscape into similar polygons according to defined criteria. Polygon delineation is based on observable differences in vegetated or non-vegetated covers using mid-scale aerial photography.

Purpose

Delineating polygons provides boundaries for similar or "like" vegetated or non-vegetated land covers. Accurate delineation provides logical units for the estimation of attributes.

Procedure

The photo interpreter normally proceeds from the general to the specific during the delineation process. The order in which delineation is accomplished will vary from individual to individual so the following steps are provided as an example that may be modified as required. The photo interpreter will use the land classification scheme to guide the process of delineating polygons. The primary types of attributes that drive the delineation process are:
• land classification scheme criteria;
• vegetation attributes;
• mensurational attributes; and,
• ecological attributes.

The objective of delineation is to identify distinctly recognizable vegetated or non-vegetated polygons which are homogeneous or similar. In many cases, the polygon will be a complex of vegetated and/or non-vegetated areas. In these cases, it may still be necessary to delineate the cover as one polygon due to the limitations of minimum polygon size.

**Example:**

These steps may be taken to delineate a treed landscape on a mountain slope.

1. Delineate the upland versus alpine line.
2. Delineate areas of wetland.
3. Delineate vegetated versus non-vegetated.
   (A vegetated polygon must have a vegetation crown cover of ≥ 5%.)

*If polygon is vegetated, then:*

4. Delineate treed versus non-treed.
   (A treed polygon must have ≥ 10% tree crown cover.)

   Treed areas:
   • Delineate coniferous versus broadleaf composition based on crown closure.
   • Further delineation will be done as appropriate for a combination of attributes such as species, age, height, moisture regime, or a combination of others.

   Non-treed areas:
   • Delineate by shrub versus herb versus bryoid based on crown closure.
   • Further delineation will be done as appropriate for a combination of attributes for shrub height, moisture and others.

*If polygon is non-vegetated, then:*

4. Delineate by category of non-vegetated cover type.
**Guidelines**

The delineation process is very much an interpretive art. The delineation of polygons can be achieved with various differentiations which may all be appropriate. In order to achieve some consistency, by each interpreter and between interpreters, the following guidelines are suggested. These guidelines may vary depending on each user's needs and the complexity of the project area. In many cases, information will be available from silviculture on various stand conditions.

**Table 2-1**

**Delineation Guidelines for Treed Polygons**

<table>
<thead>
<tr>
<th>Polygon Attribute Classification</th>
<th>Species Composition</th>
<th>Age</th>
<th>Height</th>
<th>Crown Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silviculture Opening</td>
<td>Silviculture Records</td>
<td>Silviculture Records</td>
<td>Silviculture Records</td>
<td>Silviculture Records</td>
</tr>
<tr>
<td>Age ≤ 50 yrs or Height ≤ 20 m</td>
<td>When to delineate polygons:</td>
<td>Difference between adjacent stands should be at least 3 m.</td>
<td>Difference between adjacent stands should be at least 10 yrs.</td>
<td>Difference between adjacent stands should be at least 20%</td>
</tr>
<tr>
<td></td>
<td>1. if there is ≥20% difference in leading species composition;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>or 2. if there is a switch in the leading species;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50&lt; Age ≤ 140 or 20m&lt; Ht≤30m</td>
<td>or 3. if there is a different 2nd species present;</td>
<td>Difference between adjacent stands should be at least 5-10 m.</td>
<td>Difference between adjacent stands should be at least 20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or 4. if the species composition changes from a mixed species stand to a pure stand.</td>
<td>Difference between adjacent stands should be at least 50 yrs</td>
<td>Difference between adjacent stands should be at least 20%</td>
<td></td>
</tr>
</tbody>
</table>


For stands that have not achieved free growing status, and where silvicultural records are not available, the interpreter will delineate polygons based on observable, recognizable differences in vegetation, using the guidelines listed in Table 2-1.
Minimum polygon sizes

In many instances, the identifiable features on a photograph could result in a large number of polygons, a level of detail that is unnecessary for a provincial inventory and unmanageable for local users. The minimum polygon size should be set by the contract supervisor as local user needs are identified. The minimum sizes suggested to meet the needs of the provincial inventory are:

1. Areas with distinct boundaries - 2 hectares.
   Where polygon boundaries are readily recognizable and distinct on the air photo, a minimum polygon size of 2 hectares is appropriate.
   
   *For example:* treed versus shrub complex; herb complex versus rock talus area; 10 metre trees versus 32 metre trees.

2. Areas with indistinct boundaries - 5 hectares.
   Where polygon boundaries are not readily recognizable on the air photo, a minimum polygon size of 5 hectares is appropriate.
   
   *For example:* a treed area with a gradual height difference graduating from 30 metres to 35 metres; a repetitious complex area with ridge and swale vegetation complexes; high elevation treed areas with dispersed patches of rock outcrop.

Delineation of distinct features

In some instances, the polygon size minimums may not be appropriate. In instances where unique vegetated or non-vegetated complexes are noted, these may be delineated. This may locate high value resources for the users or significant features for field navigation by map users. See the following example:

![Diagram of delineation](image)

Treed

<2 Hectares non-treed or non vegetated
Up to three ecologically distinct components can be described within each polygon, although most polygons will contain only a single land cover type. A compromise is made between detailed delineation, with relatively simple attributes, and broader delineation with more complex descriptions. A repeating pattern of two distinct land cover types is a good candidate for broader typing.

**Tips:**

- Avoid detailed delineation in non-vegetated land.
- Avoid complicated, irregular-type lines in landscapes with indistinct polygon boundaries. In areas with distinct features these irregular polygon boundaries may be valuable aids in navigation, etc.
- The following natural boundaries are polygons on the base map and therefore do not require further delineation:
  - double line rivers;
  - lake shores; and,
  - saltwater shores.
- Strive for consistency in delineation by each photo interpreter and between interpreters. Some useful aids may be to:
  - review daily project sample photos;
  - frequently discuss estimates, issues and problems with other interpreters; and,
  - review previous days' photos before beginning current day's activities.
Section 3
General Attributes
General Attributes

Introduction

Delineated polygons are assigned descriptions that are either estimates of polygon characteristics or contain other information relating to the polygon. This section describes general attributes that include information about the polygon and descriptions of ecological characteristics.

Polygons and the accompanying attributes may have applications in areas such as determining the distribution and coverage of ecosystems, landscape patterns, wildlife habitat values, biological diversity, land sensitivities for forestry, forest and ecosystem productivity, silviculture and harvesting options, and land use planning. Government, private companies, and educational institutions will be major users of such information.

Attributes are polygon-based estimates. The polygon is uniquely identified and subsequent qualitative and quantitative measurements are made for all vegetated and non-vegetated covers observed in the polygon. Cover types within the polygon, which are too small to delineate, may be described as land cover components.

This section describes the process of identifying the polygon and estimating general attributes and includes:

- polygon number
- data source
- surface expression
- modifying processes
- site position meso
- soil nutrient regime
- alpine designation
3.1 Polygon Number

Definition

The polygon number is a unique number assigned to each vegetated or non-vegetated polygon after it is delineated. The intent is to assign a unique polygon number to each polygon in British Columbia. As the polygon boundary or attributes change, a "new" unique number will be assigned and the "old" unique number will be archived.

Purpose

The polygon number provides the link between the graphic and descriptive files.

Procedure

Assign unique polygon numbers sequentially and systematically, based on a square-edged map, throughout the project area (e.g., BCGS mapsheet).

- Administrative boundaries do not constitute polygon boundaries.
- Forest Inventory Zones (FIZ) that separate coastal from interior forest zones do not constitute polygon boundaries.

Figure 3-1 indicates one of the methods of polygon numbering for a BCGS mapsheet.

![Figure 3-1: One Method of Polygon Numbering Layout](image)
3.2 Data Source

Definition

Data source refers to the primary source of information used for the polygon description.

Purpose

The data source will provide an indication of the reliability of polygon descriptions and will be used in the pre-inventory analysis (PIA) process. The data source may also be used to assess training issues, such as the reliability of estimates with various data sources.

Procedures

Data sources provide calibration points to aid in the determination of polygon attributes. The photo interpreter may, or may not, have data sources available within a polygon to aid in the interpretation. The interpreter will use available data sources and his or her interpretive skills to make the appropriate estimation for the polygon.

The interpreter will:

- Assign one data source code to every polygon.
- If two or more data sources occur within the same polygon, derive the attribute descriptions from the most appropriate source that describes the polygon estimate.
  
  When several data sources are used, reference only the source used in the polygon estimation.
- In multi-layered stands, assign a data source code for each tree layer.
<table>
<thead>
<tr>
<th>CODES</th>
<th>DATA SOURCES</th>
<th>Possible APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Photo interpretation</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Air call (air observation without 70 mm photography)</td>
<td>species composition</td>
</tr>
<tr>
<td>2</td>
<td>Air call from low-level, fixed base (70 mm photography)</td>
<td>species comp., height</td>
</tr>
<tr>
<td>3</td>
<td>Phase 1 photo sample (pre-1990)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ground call 1 point</td>
<td>age, height</td>
</tr>
<tr>
<td>5</td>
<td>Standard fixed radius sample (pre-1979)</td>
<td>age, height</td>
</tr>
<tr>
<td>6</td>
<td>Phase 2 or phase 3 sample (pre-1990)</td>
<td>species, age, height, density, basal area</td>
</tr>
<tr>
<td>7</td>
<td>Silviculture surveys - stocking, survival, free growing, pre-stand tending</td>
<td>species composition, density, SMR, SNR</td>
</tr>
<tr>
<td>8</td>
<td>Ground observation with measurement</td>
<td>age, height</td>
</tr>
<tr>
<td>9</td>
<td>Research plots (e.g. Sx trials, ecological site description)</td>
<td>species, age, height</td>
</tr>
<tr>
<td>10</td>
<td>Valuation cruise plot(s)</td>
<td>basal area, species composition, height</td>
</tr>
<tr>
<td>11</td>
<td>Silviculture treatment record - a record that summarizes the modified stand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>structure following an activity or treatment such as planting, juvenile</td>
<td></td>
</tr>
<tr>
<td></td>
<td>spacing, brushing and weeding, conifer release, seed tree control,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sanitation spacing, rehabilitation or commercial thinning</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Disturbance - an area recently disturbed by fire, logging, windthrow, or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>insects that is classified as NSR. Has no source of information other than</td>
<td></td>
</tr>
<tr>
<td></td>
<td>type and year of disturbance</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Managed stand sample</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Ground call, 2 or more points</td>
<td>age, height, species composition</td>
</tr>
<tr>
<td>15</td>
<td>Vegetation sample</td>
<td>age, height, density, basal area, SMR, SNR</td>
</tr>
<tr>
<td>16</td>
<td>Audit sample</td>
<td>species, age, height, density, basal area</td>
</tr>
<tr>
<td>17</td>
<td>Vegetation ground call</td>
<td>age, height, density, basal area, SMR, SNR</td>
</tr>
<tr>
<td>18</td>
<td>Vegetation air call</td>
<td>species composition, shrub height, shrub %</td>
</tr>
<tr>
<td>19</td>
<td>Natural growth sample</td>
<td>species, age, height</td>
</tr>
<tr>
<td>20</td>
<td>Volume and depletion sample</td>
<td>age, height</td>
</tr>
</tbody>
</table>
3.3 Surface Expression

Definition

Surface expression refers to the form of the surficial material within the polygon (see p.26, *Terrain Classification System for British Columbia*, D. Howes and E. Kenk, MOE Manual 10, Dec. 1988)

Purpose

Given the specialized nature of comprehensive terrain classification, and the fact that the ground surface is often blanketed by a canopy of trees, a simple classification attribute was selected. Surface expression is relatively easy to photo interpret, and together with the attributes "modifying processes" and "site position meso" will provide clues to soil parent material and useful site classification data.

Procedure

Assign the appropriate letter code (from the table following) to the polygon. In polygons which have multiple components, record the prevalent surface expression of the polygon on the basis of greatest percent area coverage.
<table>
<thead>
<tr>
<th>CODES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Cone(s)</td>
</tr>
<tr>
<td></td>
<td>A cone, or segment of a cone, with a relatively smooth slope gradient, greater than 15 degrees (&gt;25%).</td>
</tr>
<tr>
<td>D</td>
<td>Depression</td>
</tr>
<tr>
<td></td>
<td>Circular or irregular area of lower elevation, lower than the surrounding terrain; depressions are greater than two metres deep.</td>
</tr>
<tr>
<td>F</td>
<td>Fan(s)</td>
</tr>
<tr>
<td></td>
<td>A smooth segment of a cone with a slope gradient of up to 15 degrees (25%).</td>
</tr>
<tr>
<td>H</td>
<td>Hummock(s)</td>
</tr>
<tr>
<td></td>
<td>Steep-sided hillocks and hollows that are rounded or irregular in plan; slopes of 15 to 35 degrees (25 to 75%) are predominant on unconsolidated materials and slopes of 15 to 90 degrees (25% to vertical) are predominant on bedrock; local relief is greater than one metre.</td>
</tr>
<tr>
<td>M</td>
<td>Rolling</td>
</tr>
<tr>
<td></td>
<td>Elongated hillock(s) with slopes dominantly between 3 and 15 degrees (5 to 25%) with local relief greater than one metre; in plan, an assemblage of parallel or sub-parallel linear forms with subdued relief.</td>
</tr>
<tr>
<td>N</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>None of these descriptions apply; no apparent surface expression features.</td>
</tr>
<tr>
<td>P</td>
<td>Plain</td>
</tr>
<tr>
<td></td>
<td>A level or gently sloping unidirectional surface with gradients of up to three degrees (up to 5%); local surface irregularities have a relief of less than one metre.</td>
</tr>
<tr>
<td>R</td>
<td>Ridge(s)</td>
</tr>
<tr>
<td></td>
<td>Elongated or linear, parallel or sub-parallel hillock(s) or ridges with slopes predominantly between 15 and 35 degrees (25 to 70%) on unconsolidated materials and between 15 and 90 degrees (25% to vertical) on bedrock; local relief is greater than one metre.</td>
</tr>
<tr>
<td>T</td>
<td>Terrace(s)</td>
</tr>
<tr>
<td></td>
<td>Step-like topography; includes both scarp face and horizontal or gently inclined surface above it.</td>
</tr>
<tr>
<td>U</td>
<td>Undulating</td>
</tr>
<tr>
<td></td>
<td>Gently sloping hillock(s) and hollow(s) with slopes of up to 15 degrees (25%); local relief is less than one metre; in plan, an assemblage of non-linear chaotic forms.</td>
</tr>
</tbody>
</table>
3.4 Modifying Processes

Definition

Modifying processes are natural mechanisms of weathering, erosion and deposition that result in the modification of surficial materials and land forms at the earth's surface (see p.39, Terrain Classification System for British Columbia, D. Howes and E. Kenk, MOE Manual 10, Dec. 1988).

Purpose

Modifying processes are used for terrain classification. These processes provide information for site classification, soil conditions, and identify potential hazards such as avalanches, slope instability, and flooding.

Procedure

When appropriate, assign a one letter code (from the table following) to the polygon. The code is recorded for the prevalent modifying processes within the polygon on the basis of percent area coverage. If no modifying processes are observed in the polygon, “N” (None) should be entered in the column for this attribute.

**TABLE 3-3**

Description of Modifying Processes

<table>
<thead>
<tr>
<th>CODES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Avalanching</td>
</tr>
<tr>
<td></td>
<td>Slopes modified by frequent snow avalanches and by the deposition of rock debris transported by snow avalanches; slopes affected by ice falling from glaciers.</td>
</tr>
<tr>
<td>B</td>
<td>River channeling</td>
</tr>
<tr>
<td></td>
<td>Erosion and channel formation by the flow of water.</td>
</tr>
<tr>
<td>F</td>
<td>Mass movements</td>
</tr>
<tr>
<td></td>
<td>Downslope movement of cohesive or non-cohesive surficial material and/or bedrock by creeping, sliding, flowing or falling.</td>
</tr>
<tr>
<td>N</td>
<td>None of the these descriptions apply; no modifying processes are observed in the polygon.</td>
</tr>
<tr>
<td>U</td>
<td>Flooding</td>
</tr>
<tr>
<td></td>
<td>Areas subject to periodic inundation with subsequent deposition of soil particles.</td>
</tr>
<tr>
<td>V</td>
<td>Gully erosion</td>
</tr>
<tr>
<td></td>
<td>Modification of unconsolidated or consolidated surfaces by various processes such as running water, mass movements and snow avalanching that results in parallel or sub-parallel ravines.</td>
</tr>
</tbody>
</table>
3.5 Site Position Meso

Definition

Site position meso is the relative position of the polygon within a catchment area which often falls within one of the major slope segments of site position macro. Site position macro applies to the scale perspective of mountain top to main valley floor, with vertical distance in excess of 300 metres in most mountain regions. The scale of vertical distance for site position meso is usually between 3 m and 300 m. Ideally, site position meso applies to the scale of topography affecting surface water flow. In some simple landscapes, site position meso and macro are the same (see p.31, Describing Ecosystems in the Field, H. Luttmerding et al, MOE Manual 11, Dec. 1990).

Purpose

Site position meso is one of the key attributes for site series identification. Identification of soil moisture regime, using environmental properties, is done with reference to categories of site position meso.

Procedure

The various descriptions of meso slope site position are illustrated in Figure 3-2. A code is recorded for the prevalent site position meso of the polygon on the basis of percent area coverage. The alphabetic codes used to identify site position are described in Table 3-4.
FIGURE 3-2
Schematic of Site Position Meso Interpretation
### Table 3-4
**Description of Site Position Meso**

<table>
<thead>
<tr>
<th>codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Crest</td>
</tr>
<tr>
<td></td>
<td>The generally convex uppermost portion of a hill (meso scale); usually convex in all directions and usually has no distinct aspect. The term &quot;crest&quot; may also be applied to a ridge.</td>
</tr>
<tr>
<td>U</td>
<td>Upper slope</td>
</tr>
<tr>
<td></td>
<td>The generally convex, upper portion of the slope of a hill (meso scale) immediately below the crest; it has a convex surface profile with a specific aspect.</td>
</tr>
<tr>
<td>M</td>
<td>Middle slope</td>
</tr>
<tr>
<td></td>
<td>The area of the slope of a hill between the upper and lower slopes, where the slope profile is not generally concave or convex; it has a straight or somewhat sigmoid surface profile with a specific aspect.</td>
</tr>
<tr>
<td>L</td>
<td>Lower slope</td>
</tr>
<tr>
<td></td>
<td>The area toward the base of the slope of the hill. It generally has a concave surface profile with a specific aspect.</td>
</tr>
<tr>
<td>T</td>
<td>Toe</td>
</tr>
<tr>
<td></td>
<td>The area differentiated from the lower slope by an abrupt decrease in slope gradient; often characterized by seepage.</td>
</tr>
<tr>
<td>D</td>
<td>Depression</td>
</tr>
<tr>
<td></td>
<td>Any area that is concave in all directions; generally at the foot of a meso scale hill or in generally level area.</td>
</tr>
<tr>
<td>F</td>
<td>Flat (Level)</td>
</tr>
<tr>
<td></td>
<td>Any level area (including toe slopes). The surface profile is generally horizontal with no significant aspect.</td>
</tr>
</tbody>
</table>
3.6 Alpine Designation

Definition

Alpine designation pertains to one category of landscape position (the third level of the B.C. Land Classification Scheme). It describes the location of the polygon relative to elevation by assigning a classification: Alpine or Not Alpine. Subsequent information on the relative soil moisture regimes (SMRs) will identify Wetlands.

Purpose

Alpine designation contributes to the framework for delineation of ecosystems and habitat and the third level of reporting ability.

Procedure

The polygon is interpreted to see if it is above or below the tree line. The boundary for alpine is drawn using the upper elevation of the discontinuous treed area (parkland including krummholz).

Note: Parkland is a landscape characterized by strong clumping of trees due to environmental factors (from Ecosystems of British Columbia, MoF, 1991).

Krummholz is the scrubby, stunted growth form of trees, often forming a characteristic zone at the limit of tree growth at high elevations (from Forest Ecology Terms in Canada, Canadian Forest Service, 1994).

Generalization of the alpine boundary is necessary since cliffs, rock outcrops, and avalanche chutes often dissect the alpine/upland transition. If the polygon is alpine, record the code "A". If the polygon is not alpine, record "N".

Table 3-5
Description of Alpine Designation

<table>
<thead>
<tr>
<th>CODES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Alpine</td>
</tr>
<tr>
<td></td>
<td>Alpine is the land area above the maximum elevation for tree species, dominated in the vegetated areas by shrubs, graminoids, forbs, bryophytes or lichens. Much of the alpine will be non-vegetated; covered primarily by rock and ice. The alpine is treeless by definition; however, there may be a few rare trees (≤1% crown closure).</td>
</tr>
<tr>
<td>N</td>
<td>Not Alpine</td>
</tr>
<tr>
<td></td>
<td>Areas not included in alpine areas, as defined above.</td>
</tr>
</tbody>
</table>
3.7 Soil Nutrient Regime

Definition

Soil Nutrient Regime (SNR) refers to the amount of essential soil nutrients, particularly nitrogen, available to vascular plants over a period of several years.

Purpose

Soil nutrient regime is an interpretive attribute which, together with soil moisture regime, is used for site series identification.

Procedure

Assign one of the SNR alphabetic codes to the polygon. The code is recorded for the dominant SNR of the polygon on the basis of percent area coverage. As outlined on Table 3-6, SNR is potentially a six point scale from A to F. However, F (saline, excess accumulations of variety of salts) is uncommon in the larger landscape. Examples of polygons with an F nutrient status include non-forested alkaline marshes around shallow ponds in the dry southern interior, and tidal marshes associated with deltaic river deposits.

\[
\text{TABLE 3-6} \\
\text{SOIL NUTRIENT REGIME CLASSES}
\]

<table>
<thead>
<tr>
<th>Codes</th>
<th>SNR classes</th>
<th>Codes</th>
<th>SNR classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Very poor</td>
<td>D</td>
<td>Rich</td>
</tr>
<tr>
<td>B</td>
<td>Poor</td>
<td>E</td>
<td>Very rich</td>
</tr>
<tr>
<td>C</td>
<td>Medium</td>
<td>F</td>
<td>Ultra rich (saline, excess accumulations of variety of salts).</td>
</tr>
</tbody>
</table>

Keys for identification of SNR are normally designed for use at ground level. SNR identification typically involves a look at the soil for information on humus form, type of A horizon, soil depth, moist colour, texture, coarse fragment content, and type of parent material. In addition, one would look for nutrient indicator plants and their coverage. Table 3-7 draws together attributes that will aid SNR identification, when as many as possible of the attributes are considered.
Tree distribution across nutrient regimes is drawn with a wide brush, as the same species can be limited to narrower SNR bands in different biogeoclimatic subzones. For instance, in the wetter subzones of the Coastal Western Hemlock zone, shore pine or lodgepole pine is essentially restricted to very poor and poor SNRs, whereas in the drier subzones of the Interior Cedar-Hemlock zone lodgepole pine ranges from very poor to rich SNRs.
### Table 3-7
**A Selection of Attributes to Assist Estimation of SNR Through Air Photo Interpretation**

<table>
<thead>
<tr>
<th>Generalized SNR</th>
<th>Poor</th>
<th>Medium</th>
<th>Rich</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil Nutrient Regime</strong></td>
<td>A very poor</td>
<td>B poor</td>
<td>C medium</td>
</tr>
<tr>
<td><strong>Site Position Meso</strong></td>
<td>upper</td>
<td>middle</td>
<td>lower</td>
</tr>
<tr>
<td><strong>Mineral Soil Matrix</strong></td>
<td>coarse</td>
<td>medium</td>
<td>fine</td>
</tr>
<tr>
<td><strong>Cover of Rock Outcrops</strong></td>
<td>high (&gt;50%)</td>
<td>medium (15-50%)</td>
<td>low (&lt;15%)</td>
</tr>
<tr>
<td><strong>Rock Type</strong></td>
<td>conglomerate quartzite sandstone</td>
<td>other rock types</td>
<td>dolomite limestone</td>
</tr>
<tr>
<td><strong>Relative Productivity</strong></td>
<td>low</td>
<td>medium</td>
<td>high</td>
</tr>
</tbody>
</table>

**Proposed SNR Relations For Selected Tree Species In Their Main Climatic Distributional Range:**

- Douglas-fir: `<-----Fd------>`
- Yellow-cedar: `<------Yc------>`
- Western red cedar: `<------Cw------>`
- Black spruce: `<------Sb------>`
- Shore and lodgepole pine: `<------Pl------>`
- Arbutus: `<------Ra------>`
- Western Hemlock: `<------Hw------>`
- Mountain hemlock: `<------Hm------>`
- Trembling aspen: `<------At------>`
- Paper birch: `<------Ep------>`
- Red alder: `<------Dr------>`
- Engelmann spruce: `<------Se------>`
- White spruce: `<------Sw------>`
- Whitebark pine: `<------Pa------>`
- Western larch: `<------Lw------>`
- Alpine larch: `<------La------>`
- Grand fir: `<------Bg------>`
- Amabilis fir: `<------Ba------>`
- Subalpine fir: `<------Bl------>`
- Yellow (ponderosa) pine: `<------Py------>`
- Garry oak: `<------Qg------>`
- Sitka spruce: `<------St------>`
- Bigleaf maple: `<------Mb------>`
- Tamarack: `<------Lt------>`
- Balsam poplar: `<------Aeb------>`
- Black Cottonwood: `<------Act------>`

**Identification:** These are guidelines only and are not intended to substitute for regular field truth checks and practical knowledge of site classification as presented in the Ministry of Forests “Field Guide for Site Identification and Interpretation ...” for the forest region in question. The tree nutritional relations interpretations have been adapted from Karjina, V.J., K. Klinka and J. Worrall. 1982. Distribution and ecological characteristics of trees and shrubs of British Columbia. UBC Faculty of Forestry. 131 pp. T. Lewis has provided valuable suggestions and ideas for this key.
Section 4
Land Cover Component Attributes
Land Cover Component Attributes

Introduction

The entire polygon will fall within a single land cover classification within the B.C. Land Classification Scheme (see Section 1). Land cover types within the polygon that contribute to the overall polygon description, but are too small to be delineated using current guidelines, may be described by land cover components. For each land cover component identified within a polygon, a percent area coverage and a soil moisture regime will be recorded. For information on derived land cover class and soil moisture regime at the polygon level, refer to Section 11 Derived Attributes.
4.1 Land Cover Components (#1, #2, #3)

**Definition**

Land cover component identifies a type of land cover under the B.C. Land Classification Scheme, to the most detailed level possible (Level 4 for vegetated; levels 4 or 5 for non-vegetated).

**Purpose**

The land cover component identifies a portion of the total polygon area that would be uniquely described if a finer delineation criteria were applied. This information will provide further spatial description of each land cover component for forest management purposes and will also be used in interpretation of wildlife habitat.

**Procedure**

Enter the appropriate two-letter code (see tables below) for any polygon component that:

- consists of continuous area(s) greater than or equal to 10% of the polygon;
- is distinct at levels 4 or 5 of the B.C. Land Classification Scheme; and,
- would otherwise be delineated and classified at approximately twice the scale.

Describe up to three land cover components (in decreasing size, by area). Enter the appropriate code under Land Cover Component #1, Land Cover Component #2 and Land Cover Component #3. If more than three components exist, the remaining percent cover is recorded under "Other Land Cover Component Percent Coverage".
<table>
<thead>
<tr>
<th>codes</th>
<th>Description</th>
</tr>
</thead>
</table>
| TB    | Treed Broadleaf  
If 75% or more of the tree crown closure consists of a broadleaf cover. |
| TC    | Treed Coniferous  
If 75% or more of the tree crown closure consists of a coniferous cover. |
| TM    | Treed Mixed  
If neither coniferous nor broadleaf cover individually constitutes at least 75% of the tree crown closure. |
| ST    | Shrub Tall  
Shrub polygon with shrub height greater than two metres. |
| SL    | Shrub Low  
Shrub polygon with shrub height less than or equal to two metres in height. |
| HE    | Herb  
Herb polygon with no distinction between forbs and graminoids. |
| HF    | Herb - Forbs  
Herb polygon with forbs greater than 50% of the herb cover. |
| HG    | Herb - Graminoids  
Herb polygon with graminoids greater than 50% of the herb cover. |
| BY    | Bryoid  
Bryoid polygon with no distinction between mosses and lichens. |
| BM    | Bryoid - Moss (bryophytes)  
Bryoid (formerly non-vascular cryptogams) polygon with bryophytes greater than 50% of the bryoid cover. |
| BL    | Bryoid - Lichens  
Bryoid (formerly non-vascular cryptogams) with lichens greater than 50% of the bryoid cover. |
<table>
<thead>
<tr>
<th>Codes</th>
<th>Description</th>
</tr>
</thead>
</table>
| SI    | Snow / Ice  
Either glacier (which is considered a mass of perennial snow and ice with definite lateral limits; typically flowing in a particular direction); or other permanent snow which is ice and snow that is not part of a glacier. |
| GL    | Glacier  
a mass of perennial snow and ice with definite lateral limits; typically flowing in a particular direction. |
| SC    | Snow Cover  
snow or ice that is not part of a glacier but is found on the landscape. |
| RO    | Rock / Rubble  
Bedrock or fragmented rock, broken away from bedrock surfaces and moved into its present position by gravity or ice. |
| BR    | Bedrock  
unfragmented, consolidated rock; contiguous with underlying material. |
| RT    | Rubble, Talus, Blockfield  
fragmented rock, broken away from bedrock surfaces and moved into present position by gravity or ice. |
| MS    | Rubbly Mine Spoils  
discarded overburden or waste rock, moved to extract ore during mining. |
| LB    | Lava Bed  
an area where molten rock has flowed from a volcano or fissure and cooled to form solidified rock. |
| EL    | Exposed Land  
All other forms of exposed land identified by a range of subclasses. |
| RS    | River Sediments  
silt, gravel and sand bars associated with former river channels and present river edges. |
| ES    | Exposed Soil  
any exposed soil not covered by other categories (e.g., areas of recent disturbance that include mud slides, debris torrents, avalanches, or manmade disturbances such as pipeline right-of-ways where vegetation cover is less than 5%). |
| LS    | Pond or Lake Sediments  
exposed sediments related to dried lakes or ponds. |
| RM    | Reservoir Margin  
land exposed by a drained or fluctuating reservoir. Found above "normal" water levels and may consist of range of substrates including gravel, cobbles, fine sediments, or bedrock. |
<table>
<thead>
<tr>
<th>Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL</td>
<td>Exposed Land continued</td>
</tr>
<tr>
<td>BE</td>
<td>Beach area that expresses sorted sediments reworked in recent time by wave action; it may be formed at the edge of fresh or salt water bodies</td>
</tr>
<tr>
<td>LL</td>
<td>Landing a compacted area adjacent to a road used for the purpose of sorting and loading logs.</td>
</tr>
<tr>
<td>BU</td>
<td>Burned Area land showing evidence of recent burning, either natural or prescribed. Vegetation of less than 5% crown cover was present at the time of polygon description.</td>
</tr>
<tr>
<td>RP</td>
<td>Road Surface an area cleared and compacted for the purpose of transporting goods and services by vehicles.</td>
</tr>
<tr>
<td>MU</td>
<td>Mudflat Sediment flat plane-like areas in association with lakes, ponds, rivers or streams; dominated by fine textured sediments. May be associated with freshwater or estuarine sources.</td>
</tr>
<tr>
<td>CB</td>
<td>Cutbank part of a road corridor created upslope of the road surface created by excavation into the hillside.</td>
</tr>
<tr>
<td>MO</td>
<td>Moraine area of debris carried down and deposited by a glacier.</td>
</tr>
<tr>
<td>GP</td>
<td>Gravel Pit area exposed through the removal of sand and gravel.</td>
</tr>
<tr>
<td>TS</td>
<td>Tailings area contains solid waste material from mining and milling of ore.</td>
</tr>
<tr>
<td>RR</td>
<td>Railway roadbed with fixed rails; may contain single or multiple rails.</td>
</tr>
<tr>
<td>BP</td>
<td>Buildings and Parking buildings and developments such as roads and parking.</td>
</tr>
<tr>
<td>OT</td>
<td>Other none of the above applies.</td>
</tr>
</tbody>
</table>
4.2 Land Cover Component Percent (LCC #1, #2, #3)

**Definition**

Land cover component percent is the estimation of the percentage of the polygon occupied by each land cover component identified by the photo interpreter.

**Purpose**

Land cover component percent quantifies the extent of each land cover component identified. It provides for reporting to a finer resolution than the polygon unit and can be used to model wildlife habitat capability.

**Procedures**

Examine the polygon to determine how many land cover components are present. Generally, individual patch sizes under 10% of the polygon should not be estimated for land cover components.

Record land cover component percent to the nearest percent. The total of all land cover component percent values must equal 100%.

Estimate percent cover for Land Cover Component #1, Land Cover Component #2 and Land Cover Component #3. If more than three components exist, the remaining percent cover is recorded under "Other Land Cover Component Percent Coverage".
4.3 Soil Moisture Regime (LCC#1, #2, #3)

Definition

Soil Moisture Regime (SMR) refers to the average amount of soil water annually available for evapotranspiration by vascular plants over several years. The "relative" SMR scale applied here has nine classes. Within a specific climatic regime, such as a biogeoclimatic variant, the soil moisture status is comparatively constant for any of the SMR classes. However, between different climatic regimes the same SMR classes can represent dramatically different soil moisture content.

Purpose

SMR is an interpretative attribute for estimation of site potential and site series classification.

Procedure

View a substantial portion of the project area to evaluate the range of conditions to be encountered within a given biogeoclimatic subzone variant. Biogeoclimatic maps and ground calibration points will aid in this interpretation. From this observation the average (zonal) soil moisture regime can be visualized. The zonal SMR is normally a value of 4. The interpretation of individual polygons can then be calibrated as to how much drier or wetter the area is in relation to the zonal SMR.

Assign the estimate of the SMR for each land cover component (LCC #1, #2, #3) identified in the polygon.

<table>
<thead>
<tr>
<th>CODES</th>
<th>SNR CLASSES</th>
<th>CODES</th>
<th>SNR CLASSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>very xeric</td>
<td>5</td>
<td>subhygic</td>
</tr>
<tr>
<td>1</td>
<td>xeric</td>
<td>6</td>
<td>hygic</td>
</tr>
<tr>
<td>2</td>
<td>subxeric</td>
<td>7</td>
<td>subhydric</td>
</tr>
<tr>
<td>3</td>
<td>submesic</td>
<td>8</td>
<td>hydric</td>
</tr>
<tr>
<td>4</td>
<td>mesic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4-3

Soil Moisture Regime Classes
It is difficult to consistently and reliably assign SMR classes from air photos. However, for most polygons it should be feasible to determine the "generalized" SMR outlined on Table 4-4 and Figure 4-1 which will in turn help you decide on the relative SMR. Although the emphasis here is largely on the physical features of the landscape, vegetation species composition and vigour obviously play an important role in the SMR decision. Furthermore, the Ministry of Forests biogeoclimatic subzone and variant maps for the different forest regions in the province, in combination with the accompanying field guides for site identification, will provide practical reference information.

**Guidelines**

The following guidelines can be used to aid estimation of SMR:

- SMR can be inferred from selected physiographic and soil features.
- SMR classes, particularly 0 to 5, do not reflect the actual amount of available water as this is a function of climate.
- SMR is based on annual water balance and water table depth.
- Dry classes represent growing season water deficits.
- Circum-mesic classes represent regimes with neither deficits nor surpluses during the growing season.
- Seepage, wet, and aqueous classes indicate growing season water surpluses, often with shallow water tables.
- Wet and aqueous classes are by definition "wetlands".
- SMR can be indirectly inferred using indicator plants.

The following table and figure will assist in the photo interpretation of SMR. Table 4-4 indicates the relationship between SMR and soil nutrient regime (SNR). It also provides assistance to the photo interpreter in determining generalized SMR.
<table>
<thead>
<tr>
<th>SOIL MOISTURE REGIME</th>
<th>PRIMARY WATER SOURCE</th>
<th>GENERALIZED SOIL NUTRIENT REGIME</th>
<th>GENERALIZED SOIL MOISTURE REGIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY XERIC</td>
<td>precipitation</td>
<td>P very poor</td>
<td>VERY DRY (V)</td>
</tr>
<tr>
<td>XERIC</td>
<td>precipitation</td>
<td>P poor</td>
<td>DRY (D)</td>
</tr>
<tr>
<td>SUBXERIC</td>
<td>precipitation</td>
<td>M medium</td>
<td>CIRCUM-MESIC (CM)</td>
</tr>
<tr>
<td>SUBMESIC</td>
<td>precipitation</td>
<td>R rich</td>
<td></td>
</tr>
<tr>
<td>MESIC</td>
<td>precipitation</td>
<td>A very poor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B poor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D rich</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>E very rich</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F ultra-rich, saline</td>
<td></td>
</tr>
<tr>
<td>SUBHYGRIC</td>
<td>precipitation and seepage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYGRIC</td>
<td>seepage</td>
<td></td>
<td>SEEPAGE (S)</td>
</tr>
<tr>
<td>SUBHYDRIC</td>
<td>seepage of permanent water table</td>
<td></td>
<td>WET (WT)</td>
</tr>
<tr>
<td>HYDRIC</td>
<td>permanent water table</td>
<td></td>
<td>AQUEOUS (AQ)</td>
</tr>
</tbody>
</table>
Generalized SMR

Site Position Meso

- ridge crests
  - upper slopes
    - soil very shallow (< 0.5m)
    - slope > 35% or southerly aspect
    - frequent bedrock
- middle slope
  - water table or seepage productive
    - slope > 35%
    - coarse soil
- lower slopes and toe
  - water table or seepage productive
    - soil < 1 m or S aspect
    - soil < 1 m or S aspect
    - soil < 1 m or S aspect
    - soil < 1 m or S aspect
- level
  - floodplain
    - water table present
    - productive
    - low productivity
    - CM or S
- depression
  - water table present
  - low productivity
  - AQ

* Generally moister if aspect is N or NE
* Generally drier if aspect is S or SW

Adapted from A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region, 1993.

**Figure 4-1**

**Key to Air Photo Interpretation of Soil Moisture Regime**
Examples of Land Cover Component Classification

Criteria for the delineation of land cover polygons is presented in Section 2 of this manual. Under ideal conditions, land cover can be delineated into homogenous or “like” land cover communities (referred to as polygons); thus, providing a means of attaching polygon descriptions (attributes) as well as the spatial data necessary for mapping operation. However, ideal conditions do not always occur and it is necessary to group areas of varying land cover together as a single polygon. Delineating small polygons is impractical so these distinct communities of land cover cannot be delineated as separate polygons. They can, however, be identified as separate land cover components within one polygon.

Figure 4-2 summarizes the varying possibilities of classification using land cover component identification.
Table 4-5 lists the criteria used to classify each polygon example.

**Table 4-5**

**LAND CLASSIFICATION SUMMARY**

<table>
<thead>
<tr>
<th>Example</th>
<th>lcc1</th>
<th>lcc1%</th>
<th>smr</th>
<th>lcc2</th>
<th>lcc2%</th>
<th>smr</th>
<th>lcc3</th>
<th>lcc3%</th>
<th>smr</th>
<th>OTHER LCCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TC</td>
<td>100%</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>TC</td>
<td>50%</td>
<td>5</td>
<td>TB</td>
<td>50%</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>TM</td>
<td>50%</td>
<td>5</td>
<td>TB</td>
<td>35%</td>
<td>6</td>
<td>LA</td>
<td>10%</td>
<td>0</td>
<td>5%</td>
</tr>
<tr>
<td>4(a)</td>
<td>TM</td>
<td>50%</td>
<td>5</td>
<td>TB</td>
<td>30%</td>
<td>6</td>
<td>LA</td>
<td>10%</td>
<td>8</td>
<td>10%</td>
</tr>
<tr>
<td>4(b)</td>
<td>TM</td>
<td>50%</td>
<td>5</td>
<td>TB</td>
<td>30%</td>
<td>6</td>
<td>GP</td>
<td>10%</td>
<td>0</td>
<td>10%</td>
</tr>
</tbody>
</table>

Figure 4-3 illustrates a homogenous polygon of both coniferous and deciduous tree cover. There may be a variety of land cover (e.g., shrubs, herbs, etc.) visible between the trees but since the tree crown closure exceeds 10% throughout all parts of the polygon, any land cover components identified must be treed. Since coniferous coverage (crown closure) is greater than 75% in all parts of the polygon (see Section 1 Land Classification Scheme), it is “Treed Coniferous (TC)” throughout. There is no portion of the polygon 10% or more that represents another land classification.

This is a simple example that is typically observed in treed areas. Remember that land cover components can be identified on the basis of distinct differences in soil moisture regime within the polygon, although tree, shrub, herb, etc. cover entirely
dominates the polygon. In this respect, it is possible to identify separate land cover components. In Figure 4-3, two or more distinct soil moisture regimes are evident. Each component would be TC, but with different soil moisture regimes. For instance, if the upper end of the polygon is dominated by upper slope FDC and the lower part of the polygon by lower slope SW, there may be two land cover components identified:

1. TC 50% SMR = 5; and,
2. TC 50% SMR = 7.

The vegetation observed in the polygon should clearly reflect the presence of multiple soil moisture regimes.

In Figure 4-4, the polygon consists of both coniferous and deciduous tree cover, as well as a small, non-vegetated area covered by roads. Two distinct communities of land cover can be identified (based on B.C. Land Classification Scheme).

Although the road is a distinct form of land cover, it is not of a sufficient size (10% of the polygon) to be required as a land cover component. However, the minimum land cover size of 10% is only a guideline and smaller sizes may be used if it is distinct land cover. The road in this example is certainly a distinct land cover and the interpreter could include “LCC3 = RP; %Cover = 4%; SMR = 0” but it is unnecessary.

All land cover is described in attributes other than land cover components and, in this case, RP would be included as a Non-Vegetated Cover Type (see Section 10.1) with a 4% Non-Vegetated Cover Percent (see Section 10.2) and a Non-Vegetated Cover Pattern (see Section 10.3) of “2”.
In Figure 4-5, three land cover components are observed.

3.

The top portion of the polygon is dominated by tree cover consisting of both coniferous and deciduous cover. Since neither of the two exceed 75% of the tree crown closure in any area 10% or more of this portion of the polygon, it is “Treed Mixed (TM)”.

In the lower portion of the polygon, deciduous cover dominates with a greater than 75% portion of the total crown closure; thus, “Treed Broadleaf (TB)” is the land cover component.

The lake is a distinct land cover and is considered to consist of 10% of the polygon total area. It is included as land cover component #3. Although the road cover is less than 10%, it is distinct and is included as “Other Land Cover Component Area”. Note that both the road and the lake will need to be included as Non-Vegetated Cover (see Section 10) in the overall polygon description.
In Figure 4-6, there are several distinct land covers present.

The treed areas are identified using the same criteria discussed in the previous examples. However, this leaves only one other land cover component to be identified. The decision of whether to include the lake or the gravel pit as the third land cover component depends on the size and distinctness of the land cover in question. In this case, both are distinct and of roughly equal size. Therefore, either may be chosen (as shown in examples 4(a) and 4(b) in Table 4-5). The road is included as Other Land Cover Component area. It is expected that polygons of this complexity will be infrequent and all land cover is subsequently described in the full polygon description. The land classification is a separate exercise for broad reporting capabilities; not for a single detailed polygon description.
Section 5

Site Index Attributes
Introduction

All polygons with trees, and polygons which are potentially capable of producing trees, are to be assigned site index values. Values are entered for the following attributes.

**Estimated Site Index Species**: species upon which the site index is based.

**Estimated Site Index**: site index in metres at base age 50 at DBH.

**Estimated Site Index Source**: source of information for site index determination.

Photo interpreters will **NOT** be responsible for estimating values in the following situations:

- polygons with trees 30 years old or greater (the site index for these stands will be derived from the tree attributes);
- regenerated stands located in silviculture openings, as the information used to generate the site index attributes will be obtained from silviculture field surveys.

Photo interpreters will be responsible for estimating values in the following situations:

- polygons with trees less than 30 years old;
- polygons (not in silviculture openings), with no tree cover at present, but estimated to be potentially capable of producing trees if converted to a tree crop; and,
- polygons which are occupied by trees that have been planted outside their normal ecological range or by suppressed trees which do not reflect the potential site for the polygon.
- The following sections describe the process of estimating site index. For more information on site index derivation, see Section 11 *Derived Attributes.*
5.1 Estimated Site Index Species

Definition

Estimated site index species is the tree species from which the site index for the polygon is derived.

Purpose

The estimate of site index species provides a link between the site index and a particular tree species site productivity (i.e., age/height curve).

Procedure

The interpreter will enter the species for areas as previously described:

- trees less than 30 years;
- non-treed areas capable of producing trees; and,
- areas occupied by trees that have been planted outside their normal ecological range or by suppressed trees which do not reflect the potential site productivity of the polygon.

The interpreter will view the polygon and select the tree species that provides the best description of site productivity:

- from the existing tree species;
- from adjacent, similar stands;
- from an assessment of ecological factors; and,
- from ground information calibration points.
5.2 Estimated Site Index

Definition

Estimated site index is an estimate of site productivity for tree growth (height in metres at breast height age of 50 years).

Purpose

The estimated site index provides an estimate of the site productivity for tree species growth.

Procedure

Estimated site index may be based on the direct application of conventional site index curves, or it may be estimated from other data sources. The direct site index value may be determined from the dominant and codominant trees.

Note: Dominant trees have crowns receiving full light from above and full to partial light from the side. Codominant trees have crowns receiving full light from above and comparatively little direct light from the sides.

Alternate data sources may be used when assigning an estimated site index to the following:

- young stands less than 30 years (total age);
- polygons which are occupied by trees that have been planted outside of their normal ecological range or by suppressed stands that have been released; and,
- disturbed areas with or without shrub or tree covers upon which it is estimated that a tree crop could be produced.

For each category listed above, determine the most appropriate method for deriving site index.

Estimated site index is recorded to the nearest one metre.
Example:

Burned P1 (lodgepole pine) area with no tree coverage (interior stand).

- Delineate denuded area (e.g., burn) into areas of similar productivity.
- The estimated site index source code (for this example) is "E" Ecological Correlations (see following Estimated Site Index Source).

Using Figure 5-1, establish the polygon's relevant slope position from which the site index can be interpreted. If the polygon is in the receiving zone, the site index value is interpreted as 15 m.

Figure 5-1
SITE PRODUCTIVITY FOR PINE STANDS IN THE UPPER ELK VALLEY NEAR FERNIE
5.3 Estimated Site Index Source

Definition

Estimated site index source indicates the method used for obtaining an estimated site index.

Purpose

The estimated site index source identifies the method by which the site index is estimated, indicates the reliability of the estimate, and classifies the sources for further analysis.

Procedure

Assign the appropriate one-letter code to identify the site index source:

<table>
<thead>
<tr>
<th>Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td><strong>Adjacent stand</strong>&lt;br&gt;If no silvicultural prescription is available, the site index is assigned using adjacent stands with similar site series classification</td>
</tr>
<tr>
<td>E</td>
<td><strong>Ecological correlation</strong>&lt;br&gt;Using an assessment of ecological site factors and indicator plant species prior to harvest, a determination is made of an ecological classification. The classification and associated site index for various species is attained from tabular values.</td>
</tr>
<tr>
<td>H</td>
<td><strong>Historic</strong>&lt;br&gt;Derived from the site index value of the previous stand with no change to the site index value</td>
</tr>
<tr>
<td>I</td>
<td><strong>Growth intercept</strong>&lt;br&gt;This is a field procedure carried out on stands that have at least five years growth above breast height, but are less than 30 years old. It is determined during a silvicultural survey.</td>
</tr>
<tr>
<td>S</td>
<td><strong>Silviculture section</strong>&lt;br&gt;Assigned by the District Silviculture section; when the method of determination is unknown (potential methods can be the growth intercept, ecological correlations, historic, or adjacent stands)</td>
</tr>
</tbody>
</table>
Section 6
Tree Attributes
Introduction

Tree attributes are polygon-based estimates. The polygon is uniquely identified and subsequent qualitative and quantitative measurements are made for the tree cover in the polygon.

This section describes the process for developing estimates for polygon attributes related to tree cover. These attributes are:

- tree cover pattern
- tree crown closure
- tree layer
- vertical complexity
- species composition
- age (leading and second species)
- age confidence index (leading species)
- height (leading and second species)
- height confidence index (leading species)
- basal area
- basal area confidence index
- density
- snag frequency
6.1 Tree Cover Pattern

Definition

Tree cover pattern describes the spatial distribution of the tree cover within the polygon.

Purpose

Tree cover pattern is used to describe the tree layer (e.g., treed islands in the subalpine parkland; clumps of trees on rocky outcrops; scattered groves or individual trees in an otherwise shrubby flood plain). Tree cover pattern provides information on the amount of "edge" and "interior" habitat within the polygon.

Procedure

Enter the cover pattern code (1-9), from the table below, for the tree cover observed within the polygon. Cover pattern is based on the majority area coverage.

Cover pattern is estimated for each tree layer in the polygon. It may help to visualize all the trees without the aid of a stereo and interpret the cover pattern in this manner.
1. Single to very few (<4) occurrences of limited extent, circular to irregular shape.

2. Single to very few (<4) occurrences of limited extent, linear or elongated shape.

3. Several (<3) sporadic occurrences of limited extent, circular to irregular shape.

4. Several (<3) sporadic occurrences of limited extent, linear or elongated shape.

5. Intimately intermixed units, often with gradational transitions from one to the other.

6. Discontinuous but extensive occurrences, parallel to sub-parallel elongated in shape.

7. Limited continuous occurrence with few inclusions.

8. Continuous occurrence with several inclusions.

9. Continuous occurrence with very few inclusions.

FIGURE 6-1
TREE COVER PATTERNS
6.2 Tree Crown Closure

Definition

Tree crown closure is the percentage of ground area covered by the vertically projected crowns of the tree cover within the polygon.

Purpose

Tree crown closure provides an essential estimate of the vertical projection of tree crowns upon the ground. Since tree crown closure cannot be measured on the ground, this estimation by the interpreter is important.

Procedure

Record crown closure to the nearest percent for the polygon. Where vegetation is overlapping (e.g., a two layer stand) only the visible portion of each layer is estimated for crown closure.

Crown closure is estimated for each tree layer in the polygon.

Crown closure estimation can be aided by:

- **Cover comparison charts**
  
  Using a stereoscope to view the photograph, select a representative part of the polygon. Compare the relative crown densities of the comparison chart (see Figure 6-2) against the representative crown closure of the polygon. Select a relative crown density that most closely matches the polygon; read and enter the crown closure percent from the comparison chart.

- **Black and white stereogram handbook**
  
  This handbook has photo examples with measured crown closure values. It includes 70 mm photo samples and measured photo samples that can be used as calibration values.
Comparison charts for Visual Estimation of Foliage Cover.

Figure 6-2
Cover Comparison Chart

6.3 Tree Layer

Definition

Tree layer is a number that identifies the tree layer being described in a multi-layered stand.

Purpose

The tree layer identification creates a link between each polygon attribute and the corresponding tree layer.

Procedure

Tree layers are distinguished according to recognized height differences which are, in many cases, associated with distinct age differences. Identification guidelines may vary, depending on each user's needs and the complexity of the project area. An example of this is a regenerated lodgepole pine stand growing under an older Douglas-fir layer after a fire.

Enter a number to identify the tree layer being described. The layer of greatest height is indicated by "1", and each subsequent height layer will be identified with a larger number (e.g., the next greatest height would be "2", the next greatest would be "3", etc.).

To be classified as multi-layered, a stand should meet the following criteria:

- Each layer must be distinct and relatively homogenous throughout the type.
- Each layer should consist of different species except when the separation is distinct such as a layer of seedlings or saplings under a volume component.
- Differences in age and height between layers should be identifiable on the aerial photograph and on the ground.
- The bottom layer is usually established following a major disturbance such as fire or logging.
- The age of the younger of the two layers must always be 120 years or less. If both layers are 121 years or older, treat as one layer.
6.4 Vertical Complexity

Definition

Vertical complexity indicates the distribution and representation of different stand ages and stand size classes within a polygon. Vertical complexity is an ocular classification that reflects the form of the stand rather than its actual composition by age groups.

Purpose

Vertical complexity is used to identify and describe uneven-aged stands for further analysis in forest stand management and wildlife habitat assessment.

Procedure

Select the most appropriate code from the table below to best describe the polygon's vertical complexity.
### Table 6-2

#### Coding for Vertical Complexity

<table>
<thead>
<tr>
<th>Codes</th>
<th>Description</th>
</tr>
</thead>
</table>
| E     | **Even-aged**  
An even-aged stand or tree layer has a relatively simple structure that is typically characterized by a short period of regeneration after a major disturbance. These stands or tree layers generally have a crown canopy that is relatively even due to the intimate competition between trees of approximately the same size. Smaller trees are usually spindly members of the stand that have fallen behind their associates. The greatest number of stems are in a diameter class represented by the average of the stand or tree layer; there are fewer trees in the classes above and below this mean. |
| U     | **Uneven-aged**  
Theoretically, uneven-aged stands contain trees of every age on a continuum from seedlings to mature canopy trees. However, these stands may also be characterized by a broken or uneven canopy layer. Usually the largest number of trees is in the smaller diameter classes. As trees increase in diameter, their numbers diminish throughout the stand. Often, instead of producing a negative exponential distribution of diminishing diameters, uneven-aged stands behave irregularly with waves of reproduction and mortality. Recurring logging disturbances (due to selection, diameter limit and salvage cutting) will show an uneven-aged structure. |
| M     | **Mosaic**  
Mosaic stands show more than two distinct size classes and uneven distribution. Size classes are grouped in small, repeating aggregations or occur as stringers less than 40 metres wide throughout the stand. Each size class aggregation is too small to be recognized and mapped as an individual stand or identified as an individual tree layer. Aggregations may or may not be even-aged. |

*Adapted from Lorimer, Can. J. For. Res. 15: 200-213, 1985*
6.5 Species Composition

Definition

Species composition describes the species present and provides an estimate of the percentage of each species within the polygon. Species percent is an estimate of the percentage of live tree species occupying the polygon, based on the proportion of basal area or density.

Purpose

Species composition describes the various species of live trees that may be present in the polygon and provides an estimate of percentage of each species to the nearest percent. Species composition is used for volume derivation.

Procedure

Identify the tree species present in the polygon and list them in descending order. You may identify up to six different species. Estimate species composition for each tree layer in the polygon.

Then, for each species identified, estimate the species composition to the nearest one percent for all living trees of that species in the polygon based on density or basal area occupancy.

- If the height of the dominant and codominant species is greater than or equal to two metres, the estimate is based on basal area occupancy (B.A. per hectare).
- If the height of the dominant and codominant species is less than two metres, the estimate is based on density (stems per hectare).

Note: Dominant trees have crowns that receive full light from above and full to partial light from the side. Codominant trees have crowns that receive full light from above and comparatively little direct light from the sides.

The interpreter normally estimates the overall stand basal area first. Then this value is split into individual estimates for each species. Species composition based on basal area is strongly correlated with species composition based on volume. Studies have shown that volume and basal area correspond quite well, except for some species. Cedar has a larger basal area in proportion to its volume and spruce has a smaller basal area in proportion to its volume.

The tools used to make these interpretations are stereograms, ground calibration points, ecological site descriptions, and local knowledge. These interpretations are tempered by knowledge of species heights, crown shapes and other factors.
Species composition must add up to 100%.

It is important to establish the correct percentages for the leading species, as the stand age, height, and site index are usually determined from the leading species.

In some instances the interpreter will be able to identify the genera (e.g., Abies) but not be able to identify the specific species (e.g., Abies amabilis or Abies grandis). In these instances only the genera should be identified. The level of identification may vary depending on the user's needs and the complexity of the project area. The objective of the inventory is to identify the species accurately, wherever possible.

**Table 6-3**

**ACCEPTABLE TREE GENUS AND SPECIES CODES AND COMMON NAMES**

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Genus Symbol</th>
<th>Species Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONIFEROUS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balsam</td>
<td>Abies</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Amabilis fir</td>
<td>A. amabilis</td>
<td>Ba</td>
<td></td>
</tr>
<tr>
<td>Grand fir</td>
<td>A. grandis</td>
<td>Bg</td>
<td></td>
</tr>
<tr>
<td>Subalpine fir</td>
<td>A. lasiocarpa</td>
<td>Bl</td>
<td></td>
</tr>
<tr>
<td>Shasta red fir</td>
<td>A. magnifica var. shantensis</td>
<td>Bs</td>
<td></td>
</tr>
<tr>
<td>Noble fir</td>
<td>A. procera</td>
<td>Bn</td>
<td></td>
</tr>
<tr>
<td>White fir</td>
<td>A. concolor</td>
<td>Bw</td>
<td></td>
</tr>
<tr>
<td>Cedar</td>
<td>Thuja, Chamaecyparis, etc.</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Western red-cedar</td>
<td>T. plicata</td>
<td>Cw</td>
<td></td>
</tr>
<tr>
<td>Alaska yellow-cedar</td>
<td>Cham. nootkatensis</td>
<td>Yc</td>
<td></td>
</tr>
<tr>
<td>Incense cedar</td>
<td>Libocedrus decurrens</td>
<td>Ci</td>
<td></td>
</tr>
<tr>
<td>Port-Orford cedar</td>
<td>Cham. Lawsoniana</td>
<td>Yp</td>
<td></td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>Pseudo tsuga</td>
<td>Fd</td>
<td></td>
</tr>
<tr>
<td>Coastal Douglas-fir</td>
<td>P. menziesii var. menziesii</td>
<td>Fdc</td>
<td></td>
</tr>
<tr>
<td>Interior Douglas-fir</td>
<td>P. menziesii var. glauca</td>
<td>Fdi</td>
<td></td>
</tr>
<tr>
<td>Hemlock</td>
<td>Tsuga</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Western hemlock</td>
<td>T. heterophylla</td>
<td>Hw</td>
<td></td>
</tr>
<tr>
<td>Mountain hemlock</td>
<td>T. mertensiana</td>
<td>Hm</td>
<td></td>
</tr>
<tr>
<td>Juniper</td>
<td>Juniperus</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Rocky Mountain juniper</td>
<td>J. scopulorum</td>
<td>Jr</td>
<td></td>
</tr>
<tr>
<td>Larch</td>
<td>Larix</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Western larch</td>
<td>L. occidentalis</td>
<td>Lw</td>
<td></td>
</tr>
<tr>
<td>Tamarack</td>
<td>L. laricina</td>
<td>Lt</td>
<td></td>
</tr>
<tr>
<td>Subalpine larch</td>
<td>L. lyallii</td>
<td>La</td>
<td></td>
</tr>
<tr>
<td>Pine</td>
<td>Pinus</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Lodgepole pine</td>
<td>P. contorta</td>
<td>Pl</td>
<td></td>
</tr>
<tr>
<td>Lodgepole pine</td>
<td>P. contorta var. latifolia</td>
<td>Pli</td>
<td></td>
</tr>
<tr>
<td>Shore pine</td>
<td>P. contorta var. contorta</td>
<td>Plc</td>
<td></td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Genus Symbol</td>
<td>Species Symbol</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
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<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Pine continued</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western white pine</td>
<td><em>P. monticola</em></td>
<td>Pw</td>
<td></td>
</tr>
<tr>
<td>Monterey pine</td>
<td><em>P. radiata</em></td>
<td>Pr</td>
<td></td>
</tr>
<tr>
<td>Ponderosa pine</td>
<td><em>P. ponderosa</em></td>
<td>Py</td>
<td></td>
</tr>
<tr>
<td>Jack pine</td>
<td><em>P. banksiana</em></td>
<td>Pj</td>
<td></td>
</tr>
<tr>
<td>Red pine</td>
<td><em>P. resinosa</em></td>
<td>Pr</td>
<td></td>
</tr>
<tr>
<td>Sugar pine</td>
<td><em>P. lambertiana</em></td>
<td>Ps</td>
<td></td>
</tr>
<tr>
<td>Limber pine</td>
<td><em>P. flexilis</em></td>
<td>Pf</td>
<td></td>
</tr>
<tr>
<td>Whitebark pine</td>
<td><em>P. albicaulis</em></td>
<td>Pa</td>
<td></td>
</tr>
<tr>
<td>Lodgepole and jack pine</td>
<td><em>P. x murraybanksiana</em></td>
<td>Pxj</td>
<td></td>
</tr>
<tr>
<td>Spruce</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engelmann spruce</td>
<td><em>P. engelmannii</em></td>
<td>Se</td>
<td></td>
</tr>
<tr>
<td>Sitka spruce</td>
<td><em>P. stichensis</em></td>
<td>Ss</td>
<td></td>
</tr>
<tr>
<td>White spruce</td>
<td><em>P. glauca</em></td>
<td>Sw</td>
<td></td>
</tr>
<tr>
<td>Black spruce</td>
<td><em>P. mariana</em></td>
<td>Sb</td>
<td></td>
</tr>
<tr>
<td>Norway spruce</td>
<td><em>P. abies</em></td>
<td>Sn</td>
<td></td>
</tr>
<tr>
<td>Intermediate cross</td>
<td>unknown designation</td>
<td>Sx</td>
<td></td>
</tr>
<tr>
<td>Sitka and white spruce</td>
<td><em>P. x lutii</em></td>
<td>Sxs</td>
<td></td>
</tr>
<tr>
<td>White and Engelmann spruce</td>
<td><em>P. x lutii</em></td>
<td>Sxs</td>
<td></td>
</tr>
<tr>
<td>Sequoia type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coast redwood</td>
<td><em>Sequoia sempervirens</em></td>
<td>Is</td>
<td></td>
</tr>
<tr>
<td>Giant sequoia</td>
<td><em>Sequoia gigantea</em></td>
<td>Ig</td>
<td></td>
</tr>
<tr>
<td>Yew</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western yew</td>
<td><em>T. brevifolia</em></td>
<td>Tw</td>
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<td>unknown</td>
<td>Xx</td>
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<tr>
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<td>unknown genus, species</td>
<td>Xc</td>
<td></td>
</tr>
<tr>
<td>Other conifer species</td>
<td>not in this list</td>
<td>Ze</td>
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</tr>
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<td>DECIDUOUS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alder</td>
<td><em>Alnus</em></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Green alder</td>
<td><em>A. crispa ssp. crispa</em></td>
<td>Dg</td>
<td></td>
</tr>
<tr>
<td>Red alder</td>
<td><em>A. rubra</em></td>
<td>Dr</td>
<td></td>
</tr>
<tr>
<td>Sitka alder</td>
<td><em>A. crispa ssp. sinuata</em></td>
<td>Ds</td>
<td></td>
</tr>
<tr>
<td>Mountain alder</td>
<td><em>A. tenufolia</em></td>
<td>Dm</td>
<td></td>
</tr>
<tr>
<td>Birch</td>
<td></td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Paper birch</td>
<td><em>Betula papyrifera</em></td>
<td>Ep</td>
<td></td>
</tr>
<tr>
<td>Alaska paper birch</td>
<td><em>B. neodakaska</em></td>
<td>Ea</td>
<td></td>
</tr>
<tr>
<td>Water birch</td>
<td><em>B. occidentalis</em></td>
<td>Ew</td>
<td></td>
</tr>
<tr>
<td>Scrub birch</td>
<td><em>B. glandulosa</em></td>
<td>Eb</td>
<td></td>
</tr>
<tr>
<td>Swamp birch</td>
<td><em>B. pumila var. glandulifera</em></td>
<td>Es</td>
<td></td>
</tr>
<tr>
<td>Water and paper birch</td>
<td><em>B. x piperi</em></td>
<td>Exw</td>
<td></td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Genus Symbol</td>
<td>Species Symbol</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------------</td>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Cascara</td>
<td>Rhamnus purshiana</td>
<td></td>
<td>Kc</td>
</tr>
<tr>
<td>Cherry</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Bitter cherry</td>
<td>Prunus</td>
<td></td>
<td>Vb</td>
</tr>
<tr>
<td>Choke cherry</td>
<td>P. emarginata</td>
<td></td>
<td>Vc</td>
</tr>
<tr>
<td>Pin cherry</td>
<td>P. virginiana</td>
<td></td>
<td>Vp</td>
</tr>
<tr>
<td>Cottonwood or Poplar</td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Trembling aspen</td>
<td>Populus</td>
<td></td>
<td>At</td>
</tr>
<tr>
<td>Black cottonwood</td>
<td>P. tremuloides</td>
<td></td>
<td>Act</td>
</tr>
<tr>
<td>Hybrid poplars</td>
<td>P. balsamifera ssp. trichocarpa hybrid poplars</td>
<td></td>
<td>Ah</td>
</tr>
<tr>
<td>Balsam popular</td>
<td>P. balsamifera ssp. balsamifera</td>
<td></td>
<td>Aeb</td>
</tr>
<tr>
<td>Dogwood</td>
<td>Cornus</td>
<td></td>
<td>G</td>
</tr>
<tr>
<td>Red-osier dogwood</td>
<td>C. stolonifera</td>
<td></td>
<td>Gr</td>
</tr>
<tr>
<td>Western dogwood</td>
<td>C. nuttalii</td>
<td></td>
<td>Gw</td>
</tr>
<tr>
<td>Maple</td>
<td>Acer</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Bigleaf maple</td>
<td>A. macrophyllum</td>
<td></td>
<td>Mb</td>
</tr>
<tr>
<td>Vine maple</td>
<td>A. cinnatum</td>
<td></td>
<td>Mv</td>
</tr>
<tr>
<td>Douglas maple</td>
<td>A. glabrum var. douglasii</td>
<td></td>
<td>Mr</td>
</tr>
<tr>
<td>Oak</td>
<td>Quercus</td>
<td></td>
<td>Q</td>
</tr>
<tr>
<td>Garry oak</td>
<td>Q. garryana</td>
<td></td>
<td>Qg</td>
</tr>
<tr>
<td>Arbutus</td>
<td>Arbutus menziesii</td>
<td></td>
<td>Ra</td>
</tr>
<tr>
<td>Pacific crab apple</td>
<td>Malus fusca</td>
<td></td>
<td>Mf</td>
</tr>
<tr>
<td>Willow</td>
<td>Salix</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>Pacific willow</td>
<td>S. lucida</td>
<td></td>
<td>Wp</td>
</tr>
<tr>
<td>Bebb's willow</td>
<td>S. bebbiana</td>
<td></td>
<td>Wb</td>
</tr>
<tr>
<td>Scouler's willow</td>
<td>S. scoulerianna</td>
<td></td>
<td>Ws</td>
</tr>
<tr>
<td>Grey-leaved willow</td>
<td>S. glauca</td>
<td></td>
<td>Wd</td>
</tr>
<tr>
<td>Unknown</td>
<td>unknown</td>
<td></td>
<td>Xx</td>
</tr>
<tr>
<td>Unknown hardwood</td>
<td>unknown genus species</td>
<td></td>
<td>Xh</td>
</tr>
<tr>
<td>Other hardwood species</td>
<td>not in list</td>
<td></td>
<td>Zh</td>
</tr>
</tbody>
</table>
6.6 Age of Leading Species
Age of Second Species

Definition

Age is an average age, weighted by basal area, of the dominant and codominant trees for the leading and second species of each tree layer identified.

**Note:** Dominant trees have crowns that receive full light from above and full to partial light from the side. Codominant trees have crowns that receive full light from above and comparatively little direct light from the sides.

Purpose

The age attributes describe the age of the leading and second tree species to the nearest year.

Procedure

Procedures for age estimation are for average age of dominant and codominant trees. A relationship between these estimates and top height may be derived, however, a photo estimation process to directly estimate top height is not practical.

Begin age estimation by estimating the species composition for the polygon to determine the leading and second species.

Then, estimate the average age, to the nearest year, of dominant and codominant trees:

- for the leading species, in each tree layer identified; and,
- for the second species in each tree layer identified.

Recall that species composition is determined on the basis of basal area or density (see Section 6.5).
The following data can be collected and used to aid in the photographic interpretation of tree age within a polygon:

- history of origin (previous surveys, silviculture);
- field measurements (for calibration, verification);
- age-height-site relationships; and,
- age patterns.
Other aids are shown in Table 6-4 below.

TABLE 6-4
AIDS TO PHOTO INTERPRETATION OF AGE

<table>
<thead>
<tr>
<th>Photo characteristics</th>
<th>immature</th>
<th>mature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand texture</td>
<td>Even</td>
<td>Coarse (often crown openings are present)</td>
</tr>
<tr>
<td>Crown size on species</td>
<td>Narrow</td>
<td>Wide (varies dependent on species)</td>
</tr>
<tr>
<td>Height (height variation)</td>
<td>Minor</td>
<td>Variable</td>
</tr>
<tr>
<td>Height (size)</td>
<td>less than maximum</td>
<td>equals Maximum per Site</td>
</tr>
<tr>
<td>Snag frequency</td>
<td>Few</td>
<td>Increasing</td>
</tr>
<tr>
<td>Presence and height of successional species</td>
<td>None</td>
<td>e.g., spruce under aspen</td>
</tr>
<tr>
<td>Presence of short-lived pioneer species</td>
<td>Present</td>
<td>Reduced occurrence around 120 years.</td>
</tr>
</tbody>
</table>

**Examples:**

History of origin:

- Large wildfire in 1938. The ages of successional stands should be consistent throughout the burn.
6.7 Height of Leading Species
Height of Second Species

Definition

Height is an average height, weighted by basal area, of the dominant and codominant trees for the leading and second species of each tree layer identified.

Note: Dominant trees have crowns that receive full light from above and full to partial light from the side. Codominant trees have crowns that receive full light from above and comparatively little direct light from the sides.

Purpose

An estimate of height is used to describe the height of the leading and second tree species to the nearest tenth of a metre.

Procedure

Procedures for height estimation are for average height of dominant and codominant trees. A relationship between these estimates and top height may be derived; a photo estimation process to directly estimate top height is not practical.

First, estimate species composition for the tree component.

Then, estimate average height, to the nearest tenth of a metre, of the dominant and codominant trees:

- for the leading species, for each tree layer identified; and,
- for the second species, for each tree layer identified.

Recall that species composition is determined on the basis of basal area or density (see Section 6.5).

Height adjustments

Consider making height adjustments for the following situations.
1. For species with narrow crowns whose tops do not resolve above a point where the crown width is less than one metre, (e.g., narrow crowned alpine fir or rapidly growing coniferous). Adjust height upwards by 1 to 6 metres.

![Diagram of tree crowns with height adjustments](image)

**FIGURE 6-5**

**RESOLUTION OF TREE CROWNS**

2. For high elevation stands, heights appear taller than they actually are, e.g., for a tree of the same height, differential parallax increases with elevation at the rate of 7m/1000m.

![Diagram of height adjustment for elevation difference](image)

**FIGURE 6-6**

**HEIGHT ADJUSTMENT FOR ELEVATION DIFFERENCE**
6.8 Basal Area

Definition

Basal area is the total cross-sectional area, at breast height, of all living trees two centimetres (DBH) or greater in the polygon. Basal area is expressed as square metres per hectare.

Purpose

Basal area provides an estimate of polygon basal area per hectare and is used for the determination of species composition.

Procedure

The polygon is visually conceived as a whole. This impression is converted to basal area (square metres per hectare) by estimating stand structure, species composition, form factors, height by species, stems per hectare, site and uniformity. The following is a suggested approach to estimating these factors:

1. Classify the polygon for the basic stand attributes: stand structure, species composition, age, height and crown closure.

2. Select representative areas of the polygon.

3. Estimate the basal area for all living trees in the polygon, for each tree layer, to the nearest square metre per hectare.

   For stands with an average height of less than two metres, the basal area will likely be zero square metres per hectare.

In most stand situations there will be a proportion of the stand that is obscured by the dominant and codominant layers which will make interpretation of the understorey vegetation difficult. To maintain consistency it is suggested that individuals concentrate their interpretation on the visible portion of the stand.
**Example:**

The following is an example of a low density polygon with 1,000 trees per hectare with the average DBH of two centimetres. Calculate the basal area:

$$\text{Basal area} = \frac{\text{Average DBH area}}{\text{1 stem}} \times \text{number of stems per hectare}$$

$$= \frac{\pi r^2}{\text{1 stem}} \times \text{density (stems per hectare)}$$

$$= \frac{(3.14) (0.01 \text{ m}^2)}{\text{1 stem}} \times 1000 \text{ stems per hectare}$$

$$= 0.314 \text{ m}^2 \text{ per hectare}$$

Some suggested methods for estimation are:

- **Direct estimate:** based on local knowledge and calibration points. Care must be taken in using calibration points as many of these have used various diameter limits in calculating the basal area; factor this into the interpretation.

- **Indirect estimate:** based on a comparison of the target area against a field verified stereogram that represents similar stand characteristics. (adjust the stereogram basal area to account for local variations).

**Tips:**

- Basal area, combined with height, is highly correlated with stand volume and varies by site and stand density.

- The number of trees per hectare and diameter contribute most to basal area variation.

- Basal area increases with age and levels off or may even drop as the stand matures.
6.9 Confidence Indices

Definition

Confidence indices are a subjective value that reflects the photo interpreter's confidence in the estimation of age, height and basal area.

Purpose

A confidence index provides a mechanism for the photo interpreter to influence the amount of adjustment applied.

The assignment of the confidence index for age, height and basal area will allow polygons to be stratified into classes which may impact the sampling intensity and/or influence the degree of adjustment following ground sampling. Polygons with high confidence indices should have a high correlation between the photo interpreter's estimates and the ground sampled measurements and therefore the adjustments will be minimal.

The confidence indices do not reflect upon the individual interpreter's abilities; they are an estimate of the difficulty of making the interpretation due to polygon complexity and availability of data sources.

Procedure

Using a scale of 1-9, with 9 indicating the most confidence, indicate the level of confidence in the overall polygon estimate for:

- tree age (leading species);
- tree height (leading species); and,
- basal area for all trees.

In multi-layered stands, provide the above estimates for each layer identified.

If there are variable conditions within the polygon, the level of confidence will likely be lower and the polygon attributes may be adjusted more. Land cover variability will usually influence the interpreter's confidence in age, height and basal area estimates.

Each index value should reflect the level of confidence the interpreter places on the estimate, regardless of the source of information.
Examples:

- An existing recent cutting permit cruise within a polygon would likely provide a high confidence index for basal area with the index assigned towards the upper end of the scale from 1 to 9.

- A uniform burned Pl area with supporting ancillary ground measurements for age and height would have a similar high confidence index assigned.

- An interior Douglas-fir, selectively cut, area would likely have a lower confidence index for age and height assigned.

- Polygons with shadows on an aerial photo would likely have a lower confidence index assigned for all attributes.

A higher index would indicate that estimates are more constrained in the amount they are adjusted. Lower index values would suggest greater latitude for adjustment.
6.10 Density

Definition

Density is the average number of living trees within the polygon greater than two centimetres DBH, expressed as a per hectare value.

Purpose

Density provides a direct estimate of tree stems per hectare.

Procedure

The following is a suggested approach to estimating density:

1. Classify the polygon for the basic stand attributes:  stand structure, species composition, age, height and crown closure.
2. Select representative areas of the polygon.
3. Estimate the density of trees in the polygon for all tree layers to the nearest stem per hectare when practical.

Some suggested methods of estimation are:

- **Direct estimate**: based on local field experience and photo calibration points. Care must be taken in using calibration points as many of these have used various diameter limits in calculating tree density; factor this into the interpretation.

- **Indirect estimate**: based on a comparison of the target area against a field verified stereogram that represents similar stand characteristics. (Adjust the stereogram density to account for local variations).

- **Variable Density Yield Prediction (VDYP)**: for baseline estimates compare the target area against a VDYP predicted density for the species composition, age, site and crown closure. (Adjust the VDYP predicted density to account for local variations).

Note: Variable Density Yield Prediction is a method, based on empirical data, of calculating mensurational data (primarily stand volume and tree diameter) from photo-interpreted data (such as species composition, age, height, crown closure).
6.11 Snag Frequency

Definition

Snag frequency is defined as the number of standing dead trees greater than or equal to two centimetres at DBH, expressed as a per hectare value for the polygon.

Purpose

The snag frequency provides a direct estimate of snags per hectare which can be used for wildlife and fire management and provides information for danger tree assessment.

Procedure

The following is a suggested approach to estimating snag frequency:

1. Select representative areas of the polygon.
2. Estimate the number of snags per hectare in the polygon for each tree layer.

Some suggested methods of estimation are:

- **Direct estimate**: direct count of visible snags with the usage of calibrated overlay grids.
- **Indirect estimate**: compare target area against a field verified stereogram that represent similar stand characteristics.

**Note**: Old growth stands, particularly with cedar or cypress stems, may show numerous dead (whitish) tops which will appear as snags but are actually living trees.
Section 7
Shrub Attributes
Shrub Attributes

Introduction

This set of attributes describes the portion of shrub cover within the polygon that is not obscured under the vertical projection of tree crown cover. Shrubs are generally multi-stemmed or non-erect woody plant species. Shrubs do not include species previously identified as trees, or those low woody plants and intermediate life forms referred to in Table 4.1 of *Describing Ecosystems in the Field*, H. Luttmerning et al, MOE Manual 11, Dec. 1990.
7.1 Shrub Height

Definition

Shrub height is the average height, in tenths of a metre, of all shrubs within the polygon.

Purpose

Shrub height describes the average height of shrub species, to the nearest one-tenth of a metre. Multiplied by shrub cover, this gives an index of shrub volume that indicates available browse.

Procedure:

Estimate the average height in metres (weighted by crown closure) of all shrubs within the polygon that are not obscured by tree crown cover.

Example:

Where you have two distinct shrub species, of two distinct heights, within one polygon:

<table>
<thead>
<tr>
<th>Shrub Species</th>
<th>Height</th>
<th>Crown Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.0 m</td>
<td>30 %</td>
</tr>
<tr>
<td>B</td>
<td>5.0 m</td>
<td>20%</td>
</tr>
</tbody>
</table>

A, B weighted average = 2.6 m 50%

Note: The height of shrubs less than or equal to two metres is particularly important to wildlife and range managers as this represents the critical threshold for availability of browse.
7.2 Shrub Crown Closure

Definition

Shrub crown closure is the percentage of ground area covered by the vertically projected crowns of the shrub cover (visible to the photo interpreter). Shrub crown closure is expressed as a percentage of the entire polygon.

Purpose

Shrub crown closure provides a direct estimate of crown closure which is not adjusted by the sampling phase (Phase II).

Procedure

Estimate crown closure for all shrub species based on the percentage of ground area covered by the vertically projected crowns of shrubs. Record crown closure to the nearest percent. No overlap of vegetation is considered for crown closure estimation.

Where different cover types occur the following procedures may be used:

- Weight the crown closure estimate by the specific cover types. For example:
  - shrub land cover component (60% of area) has crown closure of 80% for shrubs;
  - herb land cover component (40% of area) has crown closure (CC) of 10% for shrubs.

  Therefore:

  \[ (60\% \times 80\% \text{ CC}) + (40\% \times 10\% \text{ CC}) \]

  \[ = 52\% \text{ shrub crown closure for the polygon.} \]

The following methodology will assist in the estimation of shrub crown closure:

- Under stereoscopic viewing, select a representative part of the polygon.
- Compare the relative crown densities of the cover comparison chart (see Figure 7-1) against the representative crown closure of the polygon.
- Select a relative crown density that most closely matches the polygon; enter the crown closure percent from the comparison chart.
Comparison charts for Visual Estimation of Foliage Cover.

**FIGURE 7-1**

**COVER COMPARISON CHART**
7.3 Shrub Cover Pattern

Definition

Shrub cover pattern is a code which describes the spatial distribution of the shrubs within a polygon.

Purpose

Shrub cover pattern is used to describe the shrub layer (e.g., clumps of shrubs on rocky outcrops, scattered patches or individual shrubs).

Procedure

Enter the cover pattern code (1-9), for shrub cover within the polygon, from the figure below. Shrub cover pattern is based on the majority area coverage.
1. Single to very few (<4) occurrences of limited extent, circular to irregular shape.

2. Single to very few (<4) occurrences of limited extent, linear or elongated shape.

3. Several (<3) sporadic occurrences of limited extent, circular to irregular shape.

4. Sever (<3) sporadic occurrences of limited extent, linear or elongated shape.

5. Intimately intermixed units, often with gradational transitions from one to the other.

6. Discontinuous but extensive occurrences, parallel to sub-parallel elongated in shape.

7. Limited continuous occurrence with few inclusions.

8. Continuous occurrence with several inclusions.

9. Continuous occurrence with very few inclusions.

**Figure 7-2**

*Shrub Cover Patterns*
Section 8
Herb Attributes
Herb Attributes

Introduction

This set of attributes describes the portion of herb cover that is not obscured by the vertical projection of the crowns of either trees or shrubs.

Herbs are defined as non-woody plants, including graminoids (sedges, rushes, grasses), vascular cryptogams (ferns, club mosses and horsetails) and some low, woody species and intermediate life forms identified in Table 4.1 of Describing Ecosystems in the Field, H. Luttmerding et al, MOE Manual 11, Dec. 1990.
8.1 Herb Cover Type

Definition

Herb cover types are the designations for herb-dominated areas as listed in the B.C. Land Classification Scheme.

Purpose

Herb cover types will provide detailed reporting for herbaceous land cover.

Procedure

Enter the appropriate code from Table 8-1, to the level of resolution that can be photo interpreted for all herbaceous cover types observable in the polygon.

<table>
<thead>
<tr>
<th>CODES</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HE</td>
<td>Herbs</td>
</tr>
<tr>
<td></td>
<td>indistinguishable herbaceous cover; no distinction between forbs and graminoids</td>
</tr>
<tr>
<td>HF</td>
<td>Herbs - Forbs</td>
</tr>
<tr>
<td></td>
<td>forbs; herb polygon with forbs greater than 50% of herb cover.</td>
</tr>
<tr>
<td>HG</td>
<td>Herbs - Graminoids</td>
</tr>
<tr>
<td></td>
<td>graminoids; herb polygon with graminoids greater than 50% of herb cover.</td>
</tr>
</tbody>
</table>
8.2 Herb Cover Percent

Definition

Herb cover percent is the percentage of ground area covered by herbaceous cover visible to the photo interpreter. Herb cover percent is analogous to tree and shrub crown closures and is expressed as a percentage of the entire polygon.

Purpose

Herb cover percent provides a direct estimate of herbaceous cover.

Procedure

Estimate herbaceous cover based on the percentage of ground area covered by the herbs (see Figure 8-1). Record herbaceous cover to the nearest percent.

FIGURE 8-1

Comparison charts for Visual Estimation of Folage Cover.

COVER COMPARISON CHART
8.3 Herb Cover Pattern

**Definition**

Herb cover pattern is a code which describes the spatial distribution of the herbaceous cover within a polygon.

**Purpose**

Cover pattern is used to describe the herb layer (e.g., herbaceous cover on rocky outcrops, patches of herbaceous cover).

**Procedure**

Enter the cover pattern code (1-9), for herbaceous cover within the polygon, from Figure 8-2. Herb cover pattern is based on the majority area coverage.
1. Single to very few (<4) occurrences of limited extent, circular to irregular shape.

2. Single to very few (<4) occurrences of limited extent, linear or elongated shape.

3. Several (<3) sporadic occurrences of limited extent, circular to irregular shape.

4. Several (<3) sporadic occurrences of limited extent, linear or elongated shape.

5. Intimately intermixed units, often with gradational transitions from one to the other.

6. Discontinuous but extensive occurrences, parallel to sub-parallel elongated in shape.

7. Limited continuous occurrence with few inclusions.

8. Continuous occurrence with several inclusions.

9. Continuous occurrence with very few inclusions.

**Figure 8-2**

*Herb Cover Pattern*
Section 9
Bryoid Attributes
Bryoid Attributes

Introduction

This set of attributes describes the portion of bryoid cover (formerly referred to as non-vascular cryptogams) that is not obscured by the vertical projection of the crowns of either trees, shrubs or herbs.

Bryoids include mosses, liverworts and non-crustose lichens.
9.1 Bryoid Cover Percent

**Definition**

Bryoid cover percent is the percentage of ground area covered by bryoids visible to the photo interpreter. Bryoid cover percent is expressed as a percentage of the entire polygon.

**Purpose**

Bryoid cover percent provides a direct estimate of bryoid cover.

**Procedure**

Estimate bryoid cover based on the percentage of ground area covered by bryoids that are not obscured by taller life forms (see Figure 9-1). Record bryoid cover to the nearest percent.

*Figure 9-1*

*Cover Comparison Chart*

---

Comparison charts for Visual Estimation of Folage Cover.

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Section 10
Non-Vegetated Attributes
Non-Vegetated Attributes

Introduction

This set of attributes describes the portion of the polygon that is non-vegetated (not obscured by vegetation or shadows).
10.1 **Non-vegetated Cover Type(s)**

**Definition**

Non-vegetated cover types are the designations (from levels 4 and 5 of the B.C. Land Classification Scheme) for all observable non-vegetated land cover within the polygon.

**Purpose**

Non-vegetated cover types provide detailed reporting for non-vegetated land cover.

**Procedure**

Enter the appropriate code (see Table 10-1) to the level of resolution that can be photo interpreted for all non-vegetated cover types observable within the polygon. If more than one non-vegetated cover type is identified, use additional rows, as required, on the attribute form.

<table>
<thead>
<tr>
<th>Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>Snow / Ice</td>
</tr>
<tr>
<td></td>
<td>Either glacier (which is considered a mass of perennial snow and ice with definite lateral limits; typically flowing in a particular direction); or other permanent snow which is ice and snow that is not part of a glacier.</td>
</tr>
<tr>
<td>GL</td>
<td>Glacier</td>
</tr>
<tr>
<td></td>
<td>a mass of perennial snow and ice with definite lateral limits; typically flowing in a particular direction.</td>
</tr>
<tr>
<td>SC</td>
<td>Snow Cover</td>
</tr>
<tr>
<td></td>
<td>snow or ice that is not part of a glacier but is found on the landscape.</td>
</tr>
<tr>
<td>RO</td>
<td>Rock / Rubble</td>
</tr>
<tr>
<td></td>
<td>Bedrock or fragmented rock, broken away from bedrock surfaces and moved into its present position by gravity or ice.</td>
</tr>
<tr>
<td>BR</td>
<td>Bedrock</td>
</tr>
<tr>
<td></td>
<td>unfragmented, consolidated rock; contiguous with underlying material.</td>
</tr>
<tr>
<td>RT</td>
<td>Rubble, Talus, Blockfield</td>
</tr>
<tr>
<td></td>
<td>fragmented rock, broken away from bedrock surfaces and moved into present position by gravity or ice.</td>
</tr>
<tr>
<td>MS</td>
<td>Rubbly Mine Spoils</td>
</tr>
<tr>
<td></td>
<td>discarded overburden or waste rock, moved to extract ore during mining.</td>
</tr>
<tr>
<td>Codes</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>RO</td>
<td>Rock / Rubble</td>
</tr>
<tr>
<td>LB</td>
<td>Lava Bed</td>
</tr>
<tr>
<td></td>
<td>an area where molten rock has flowed from a volcano or fissure and cooled to form solidified rock.</td>
</tr>
<tr>
<td>EL</td>
<td>Exposed Land</td>
</tr>
<tr>
<td>RS</td>
<td>River Sediments</td>
</tr>
<tr>
<td></td>
<td>silt, gravel and sand bars associated with former river channels and present river edges.</td>
</tr>
<tr>
<td>ES</td>
<td>Exposed Soil</td>
</tr>
<tr>
<td></td>
<td>any exposed soil not covered by other categories (e.g., areas of recent disturbance that include mud slides, debris torrents, avalanches, or manmade disturbances such as pipeline right-of-ways where vegetation cover is less than 5%).</td>
</tr>
<tr>
<td>LS</td>
<td>Pond or Lake Sediments</td>
</tr>
<tr>
<td></td>
<td>exposed sediments related to dried lakes or ponds.</td>
</tr>
<tr>
<td>RM</td>
<td>Reservoir Margin</td>
</tr>
<tr>
<td></td>
<td>land exposed by a drained or fluctuating reservoir. Found above &quot;normal&quot; water levels and may consist of range of substrates including gravel, cobbles, fine sediments, or bedrock.</td>
</tr>
<tr>
<td>BE</td>
<td>Beach</td>
</tr>
<tr>
<td></td>
<td>area that expresses sorted sediments reworked in recent time by wave action; it may be formed at the edge of fresh or salt water bodies</td>
</tr>
<tr>
<td>LL</td>
<td>Landing</td>
</tr>
<tr>
<td></td>
<td>a compacted area adjacent to a road used for the purpose of sorting and loading logs.</td>
</tr>
<tr>
<td>BU</td>
<td>Burned Area</td>
</tr>
<tr>
<td></td>
<td>land showing evidence of recent burning, either natural or prescribed. Vegetation of less than 5% crown cover was present at the time of polygon description.</td>
</tr>
<tr>
<td>RP</td>
<td>Road Surface</td>
</tr>
<tr>
<td></td>
<td>an area cleared and compacted for the purpose of transporting goods and services by vehicles.</td>
</tr>
<tr>
<td>MU</td>
<td>Mudflat Sediment</td>
</tr>
<tr>
<td></td>
<td>flat plane-like areas in association with lakes, ponds, rivers or streams; dominated by fine textured sediments. May be associated with freshwater or estuarine sources.</td>
</tr>
<tr>
<td>CB</td>
<td>Cutbank</td>
</tr>
<tr>
<td></td>
<td>part of a road corridor created upslope of the road surface created by excavation into the hillside.</td>
</tr>
<tr>
<td>Codes</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>EL</td>
<td>Exposed Land continued</td>
</tr>
<tr>
<td>MO</td>
<td>Moraine area of debris carried down and deposited by a glacier.</td>
</tr>
<tr>
<td>GP</td>
<td>Gravel Pit area exposed through the removal of sand and gravel.</td>
</tr>
<tr>
<td>TS</td>
<td>Tailings area contains solid waste material from mining and milling of ore.</td>
</tr>
<tr>
<td>RR</td>
<td>Railway roadbed with fixed rails; may contain single or multiple rails.</td>
</tr>
<tr>
<td>BP</td>
<td>Buildings and Parking buildings and developments such as roads and parking.</td>
</tr>
<tr>
<td>OT</td>
<td>Other none of the above applies.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA</td>
</tr>
<tr>
<td>RE</td>
</tr>
<tr>
<td>RI</td>
</tr>
</tbody>
</table>
10.2 Non-vegetated Cover Percent

Definition

Non-vegetated cover percent indicates the percentage of the polygon that a non-vegetated cover type occupies.

Purpose

Non-vegetated cover percent provides a direct estimate of non-vegetated cover which is not adjusted.

Procedure

Estimate non-vegetated cover percent, based on the percentage of ground area of the polygon covered by the non-vegetated cover type. Enter the cover percent estimate on the same line of the attribute form as the cover type (see Figure 10-1).

Enter non-vegetated cover percent for each non-vegetated cover type identified in the polygon. There are no constraints to the number of non-vegetated cover types to be identified.

Example:

The polygon being estimated is entirely treed.

Land cover component #1 = TC.

Land cover component #1 percent coverage = 100%

All existing non-vegetated cover is still recorded (cover type and cover percent) even though there is no land cover component (see Section 4.1) identified for the polygon.

For example, a scattered cover of river sediments would be described as:

Non-vegetated Cover = RS
Non-vegetated Cover Percent = 4%
Example of Non-vegetated Cover Percent
The following example shows a polygon with coniferous tree cover (TC 100%) with 4% non-vegetated (river sediment) cover.
Comparison charts for Visual Estimation of Foliage Cover.

**FIGURE 10-2**

*COVER COMPARISON CHART*
10.3 Non-vegetated Cover Pattern

Definition

Non vegetated cover pattern describes the spatial distribution of the non vegetated cover type(s) within the polygon.

Purpose

Non-vegetated cover pattern is used to describe non-vegetated cover (e.g., roads within vegetated polygons, lakes within non-vegetated polygons).

Procedure

Enter the cover pattern code (1-9), for each non-vegetated cover type identified in the polygon, from the Figure 10-2 below.
There are no constraints on the number of non-vegetated cover types to be identified.

1. Single to very few (<4) occurrences of limited extent, circular to irregular shape.

2. Single to very few (<4) occurrences of limited extent, linear or elongated shape.

3. Several (<3) sporadic occurrences of limited extent, circular to irregular shape.

4. Several (<3) sporadic occurrences of limited extent, linear or elongated shape.

5. Intimately intermixed units, often with gradational transitions from one to the other.

6. Discontinuous but extensive occurrences, parallel to sub-parallel elongated in shape.

7. Limited continuous occurrence with few inclusions.

8. Continuous occurrence with several inclusions.

9. Continuous occurrence with very few inclusions.
Section 11
Derived Polygon Attributes
Derived Polygon Attributes

Introduction

Photo interpreters delineate and assign many attributes to polygons on mid-scale aerial photographs which describe the land base and vegetation characteristics. A number of additional attributes can be derived, in a consistent manner, from the estimated attributes. For example, the tree cover site index can be derived from the estimates for species, age and height. Similarly, the land cover class code can be derived from the position, vegetation type and crown closure estimates.

This section presents a discussion on the additional attributes, referred to as "derived attributes", that have been identified as a product of Phase I of the Vegetation Resources Inventory. While the provision of these estimates is not the immediate task of the photo interpreter, it is important that their derivations and the associations with the photo interpreted attributes are understood.

In this respect, photo interpreters are encouraged to consider the extension of the Phase I information being provided.
The following list presents the attributes identified for derivation from the photo interpreted attributes which may be subsequently adjusted with Phase II data.

- land cover class code
- dominant polygon soil moisture regime (SMR)
- diameter at breast height (DBH)
- volume
- site index
- polygon descriptions for multi-layered stands
- slope, aspect and elevation
Land Cover Class Code

Definition

The land cover class code is the land cover designation of the polygon, consistent with the B.C. Land Classification Scheme.

Purpose

The land cover class code provides a categorization of the polygon to the most detailed land cover description level of the B.C. Land Classification Scheme. This information can be used for the classification of individual polygons and can be summarized for national and international reporting.

Derivation Procedure

The five levels of the B.C. Land Classification Scheme can be derived from the photo interpreters' estimates as follows. (See Section 1: B.C. Land Classification Scheme for a detailed description of the levels.)

Vegetated

Level 1  Land base - Vegetated versus Non-vegetated
          Level 1 is derived from the sum of the vegetation crown closures.

Level 2  Land cover type (treed versus non-treed)
          Level 2 is derived from the tree crown closure estimate.

Level 3  Landscape Position (wetland, upland or alpine)

The alpine designation indicates polygons that fall in the alpine regions of the landscape. For all other polygons, land cover component #1 soil moisture regime will determine whether that polygon is considered to be upland or wetland. The B.C. Land Classification Scheme presents the designations "wetland, upland and alpine" as being mutually exclusive; however, it is possible in some rare cases to have a wetland polygon in an alpine setting. The current format of the scheme is maintained due to the infrequency of this occurrence.
Level 4  Vegetation Type

Land cover component #1 provides this information directly since the photo interpreter must describe the type of vegetated cover (i.e., broadleaf, coniferous or mixed tree component; low or tall shrub; herbaceous; or bryoid) observed.

Level 5  Density

Level 5 is derived from vegetation crown closures.

Non - Vegetated

Level 1  Land base - Vegetated versus Non-vegetated

Level 1 is derived from the sum of the vegetation crown closures.

Level 2  Land Cover Type

Level 2 is derived from land cover component #1.

Level 3  Landscape Position

The alpine designation indicates polygons that fall in the alpine regions of the landscape. For all other polygons, land cover component #1 soil moisture regime will determine whether that polygon is considered to be upland or wetland. The B.C. Land Classification Scheme presents the designations "wetland, upland and alpine" as being mutually exclusive; however, it is possible in some rare cases to have a wetland polygon in an alpine setting. The current format of the scheme is maintained due to the infrequency of this occurrence.

Level 4  Non Vegetated Cover Types

Land cover component #1 provides this information directly since the photo interpreter must describe the type of non-vegetated cover observed. The codes from either levels 4 or 5 may be entered as land cover components for non-vegetated land. No level 4 codes exist for non-vegetated codes water bodies.

Level 5  Subdivision of Non-Vegetated Categories

Usually, and exclusively for water bodies, the codes from level 5 will be described for the land cover components. There will be some instances where complex non-vegetated land cover may be described to level 4 of the B.C. Land Classification Scheme and not level 5. This shortcoming is due to the limitations of photo interpretation using mid-scale aerial photography.
**Example:**

A typical derivation of a vegetated Land Cover Class Code:

<table>
<thead>
<tr>
<th>Level</th>
<th>Estimated attribute criteria</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vegetated crown closure &gt;5%</td>
<td>V</td>
</tr>
<tr>
<td>2</td>
<td>Tree crown closure &gt;10%</td>
<td>T</td>
</tr>
<tr>
<td>3</td>
<td>Not Alpine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCC #1 SMR = 6</td>
<td>U</td>
</tr>
<tr>
<td>4</td>
<td>LCC #1 = TC</td>
<td>TC</td>
</tr>
<tr>
<td>5</td>
<td>Tree crown closure = 80</td>
<td>DE</td>
</tr>
</tbody>
</table>

The Land Class Code for this polygon would be "VTUTCDE".
Dominant Polygon Soil Moisture Regime

Definition

The dominant polygon SMR is an estimate of soil moisture for the polygon.

Purpose

Dominant polygon SMR provides soil moisture information at the polygon level, thus facilitating broad reporting capabilities.

Derivation Procedure

Dominant polygon SMR is assigned directly as the largest land cover component by area.
**Diameter at Breast Height (DBH)**

**Definition**

DBH is the average tree diameter at breast height for all live trees that are two centimetres in diameter (DBH) or greater in the polygon.

**Purpose**

DBH provides an additional dimension of tree stand information that is useful for broad silviculture planning (particularly for lower productivity, interior Pl stands) as well as change management of some forest stands.

**Derivation Procedure**

DBH of the visible trees can be derived from the estimates provided for basal area per hectare, and density, using the following method:

\[
DBH = 2 \sqrt{\frac{\text{Basal Area}}{(\text{Density} \times \pi)}}
\]

**Example:**

Basal Area = 100 m² per hectare

Density = 400 stems per hectare

\[
DBH = 2 \times \sqrt{\frac{100 \text{ m}^2 \text{ per ha}}{400 \text{ stems per ha} \times 3.14}}
\]

\[
= 2 \times \sqrt{0.0796 \text{ m}^2}
\]

\[
= 0.564 \text{ m}
\]

\[
= 56.4 \text{ centimetres DBH}
\]
Volume

Definition

Volume is the average gross stem volume of all living trees visible to the photo interpreter for the polygon (expressed in cubic metres per hectare).

Purpose

The derivation of volume estimates for each polygon provides another method of assessing timber yields and can be useful for long term resource planning.

Derivation Procedure

Volume can be derived from estimates provided for basal area per hectare, species composition and height. Leading species and the vegetation inventory project location (e.g., Forest Inventory Zone) determines which taper equations and which decay, loss and breakage factors are appropriate for volume derivation. Basal area and height then provide the essential input parameters from which volume estimates can be derived.
Site Index

Definition

Site index is an estimate of site productivity for tree growth expressed as a height (metres) at breast height age of 50 years of a particular tree species.

Purpose

Site index provides an estimate of the site productivity for tree species growth.

Derivation Procedure

Site index estimates are required on all treed polygons as well as polygons which are potentially capable of producing trees. Stands which are 30 years or older will have the site index derived from species, age and height. The photo interpreter can still override the process if they:

- have field data to provide site specific values; or,
- have evidence to indicate abnormal site suppression exists.

Leading species indicates which species height/age curves should be used. Age and height estimates then indicate which of the available curves should be used for extrapolation (age < 50) or interpolation (age > 50) of site index.
Polygon Description for Multi-layered Stands

Definition

The polygon description for multi-layered stands is a summary of the attribute estimates for each observable tree layer into one set of attribute estimates for the polygon.

Purpose

Phase II sampling data does not differentiate trees from different layers within a stand. Therefore, attributes from individual tree layers are amalgamated into a single polygon description to facilitate Phase II adjustments.

Phase II adjustment is followed by a redistribution of the adjusted attribute values into the original individual tree layer estimates.

Derivation Procedure

Example:

The following is an example of an adjustment and redistribution into layers of a two-layered stand. Assume an adjustment ratio of 1.1 for all attribute adjustments. This indicates that all attribute values are 10% higher as a result of Phase II field sampling.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Redistribution procedure into individual tree layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species comp.</td>
<td>pro-rated on the basis of basal area</td>
</tr>
<tr>
<td>Crown closure</td>
<td>crown closure(layer 1) + crown closure(layer 2) + ... + crown closure(layer n) = polygon crown closure</td>
</tr>
<tr>
<td>Age</td>
<td>pro-rated on the basis of basal area</td>
</tr>
<tr>
<td>Height</td>
<td>pro-rated on the basis of basal area</td>
</tr>
<tr>
<td>Basal area</td>
<td>basal area(1) + basal area(2) + ... + basal area(n)</td>
</tr>
<tr>
<td>Density</td>
<td>density(1) + density(2) + ... + density(n)</td>
</tr>
<tr>
<td>Snags</td>
<td>snags(1) + snags(2) + ... + snags(n)</td>
</tr>
</tbody>
</table>

Adjustment of the total polygon estimates takes place with computed adjustment ratios from Phase II samples.

Table 11-1 shows the adjustment of a two layer stand. Assume an adjustment ratio of 1.1 for all attributes.
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Estimate Layer 1 (visible)</th>
<th>Estimate Layer 2 (visible)</th>
<th>Estimate Total for Polygon</th>
<th>Phase 2 Adjusted Polygon Value</th>
<th>Adjusted Layer 1</th>
<th>Adjusted Layer 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>250 (x $\frac{24}{32}$)</td>
<td>50 (x $\frac{8}{32}$)</td>
<td>200 (x 1.1) =</td>
<td>220</td>
<td>265</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$250 + (\frac{24}{32})20$</td>
<td>$50 + (\frac{8}{32})2.8$</td>
</tr>
<tr>
<td>Height (m)</td>
<td>33.0 (x $\frac{24}{32}$)</td>
<td>12 (x $\frac{8}{32}$)</td>
<td>27.9 (x 1.1) =</td>
<td>30.7</td>
<td>35.1</td>
<td>12.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$33 + (\frac{24}{32})2.8$</td>
<td>$12 + (\frac{8}{32})5.5$</td>
</tr>
<tr>
<td>Basal Area (m²/ha)</td>
<td>24</td>
<td>8</td>
<td>32 (x 1.1) =</td>
<td>35</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$35(\frac{24}{32})$</td>
<td>$35(\frac{8}{32})$</td>
</tr>
<tr>
<td>Density (SPH)</td>
<td>100</td>
<td>350</td>
<td>450 (x 1.1) =</td>
<td>495</td>
<td>110</td>
<td>385</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$495(\frac{100}{450})$</td>
<td>$495(\frac{350}{450})$</td>
</tr>
<tr>
<td>Snags</td>
<td>10</td>
<td>0</td>
<td>10 (x 1.1) =</td>
<td>11</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$11(\frac{10}{10})$</td>
<td>$11(\frac{0}{10})$</td>
</tr>
</tbody>
</table>
Slope, Aspect and Elevation

Definition

Slope is the average gradient of the polygon measured in percent. Aspect is the average oriented direction of the polygon measured in degrees azimuth. Elevation is the average height above mean sea level of the polygon measured in metres.

Purpose

Slope, aspect and elevation contribute to a more complete description of the polygon and provide information useful for ecological interpretations.

Derivation Procedure

A Digital Elevation Model (DEM) provides the necessary information for GIS derivation of each slope, aspect and elevation.
Glossary

Age of leading and second species: a weighted basal area average age of dominant and codominant trees within the polygon.

Alpine: Alpine is the land area above the maximum elevation for tree species, dominated in the vegetated areas by shrubs, graminoids, forbs, bryophytes or lichens. Much of the alpine will be non-vegetated; covered primarily by rock and ice. The alpine is treeless by definition; however, there may be a few rare trees (≤1% crown closure).

Alpine designation: one category of landscape position and the third level of the B.C. Land Classification Scheme. It is dominated in the vegetated areas by shrubs, graminoids, herbs, bryoids and lichens. Much of the alpine will be non-vegetated, covered primarily by rock and ice. The alpine is treeless by definition; however, there may be a few rare trees (≤1% crown closure).

Attributes: are polygon-based estimates described by photo-interpreters.

Basal area: the cross-sectional area (in square metres) of all living trees 2 cm (DBH) or greater in the polygon; expressed as a per hectare value for the entire polygon.

Bryoids: formerly referred to as "non-vascular cryptogams"; includes mosses, liverworts, hornworts and non-crustose lichens.

Codominant trees: trees having crowns receiving full light from above and comparatively little direct light from the sides.

Confidence index: an index of the photo interpreter's confidence in the estimation of age, height and basal area.

Data source: identifies the primary source of information used to determine the attributes describing the polygon.
Density: the average number of living trees in the polygon, greater than 2 cm DBH; expressed as a per hectare value.

Derived attributes: land cover descriptions that are generated from the estimates of other land cover values.

Dominant trees: trees having crowns receiving full light from above and full to partial light from the side.

Estimated site index: site index in metres at base age 50 at DBH; site index is an estimate of site productivity for tree growth.

Estimated site index source: source of information or method used for site index determination.

Estimated site index species: tree species upon which the site index is based.

General polygon attributes: includes assigned attributes and estimated attributes (polygon number, data source, surface expression, modifying processes, site position meso, Alpine Designation, Soil Nutrient Regime).

Generalized SMR/SNR: a grouping of SMRs/SNRs into broader classes. The differentiation of SMRs/SNRs between these classes is more critical than the differentiation of SMRs/SNRs within each class.

Height of Leading and Second Species: tree height of the leading and second species is the average height of the dominant and codominant trees, weighted by basal area.

Herbs: non-woody plants, including graminoids (sedges, rushes, grasses), vascular cryptogams (ferns, club mosses and horsetails) and some low woody species and intermediate life forms listed in Table 4-1 of Describing Ecosystems in the Field, MOE Manual 11.

Herb Cover Pattern: describes the spatial distribution of herbaceous cover within the polygon.

Krummholz: is the scrubby, stunted growth form of trees, often forming a characteristic zone at the limit of tree growth at high elevations (from Forest Ecology Terms in Canada, Canadian Forest Service, 1994).

Land Classification Scheme: refers to the B.C. Land Classification Scheme; forms Section 1 of this manual and is derived from the original document B.C. Land Cover Classification, Mar. 31, 1995.
**Land cover component**: identifies a type of land cover, under the B.C. Land Classification Scheme, to the most detailed level possible.

**Land cover component percent**: the area, as a percentage of the polygon, occupied by each land cover component.

**Land cover type**: second level from B.C. Land Classification Scheme; classifies the polygon as treed or non-treed; land or water.

**Landscape position**: third level of the B.C. Land Classification Scheme; classifies the polygon as alpine or not alpine; wetland or upland.

**Minimum polygon size**: to be set by contract supervisor as local user needs are identified; suggested minimum sizes are:
- 2 hectares for areas with distinct boundaries
- 5 hectares for area with indistinct boundaries

**Modifying processes**: natural mechanism of weathering, erosion and deposition that result in the modification of surficial materials and land forms at the earth's surface. Described by alphabetic code that includes description of avalanching, river channeling, mass movements, flooding, gully erosion.

**Multi-layered stand**: a site that has more than one distinctly recognizable height layer and may be considered the same as a site occupied by more than one distinct single-layered stand.

**Non-treed polygon**: a polygon is considered non-treed if less than 10% by crown closure of the area consists of tree species of any size.

**Non-vascular cryptogams**: now referred to as "bryoids"; includes mosses, liverworts, hornworts and non-crustose lichens.

**Non-vegetated cover types**: fourth level of the B.C. Land Classification Scheme; classifies the polygon as snow / ice (SI), rock / rubble (RO), exposed land (EL) if non-vegetated.

**Non-vegetated polygon**: a polygon is non-vegetated when the total cover of trees, shrubs, herbs and bryoids (other than crustose lichens), covers less than 5% of the total surface area of the polygon. Includes bodies of water.

**Parkland**: a landscape characterized by strong clumping of trees due to environmental factors (*from Ecosystems of British Columbia, MoF, 1991*).

**Phase I**: refers to the first phase of the Provincial Vegetation Resources Inventory process; involves photo estimation of detailed land cover attributes.
**Phase II:** refer to the second phase of the Provincial Vegetation Resources Inventory process; involves ground sampling of polygon attributes. Data gathered is used to adjust phase I estimates.

**Polygon:** a portion of land area delineated on mid-scale aerial photography of "like" or uniform land cover appropriate for applying land cover descriptions.

**Polygon delineation:** the process of dividing the landscape into similarly vegetated polygons according to defined criteria.

**Polygon number:** a unique number assigned to each polygon as it is delineated.

**Shrubs:** generally multi-stemmed or non-erect woody plant species that do not include species previously defined as trees or those low woody plants and intermediate life forms listed in Table 4-1 of *Describing Ecosystems in the Field*, MOE Manual 11.

**Shrub cover pattern:** describes the spatial distribution of shrubs within the polygon.

**Shrub crown closure:** the percentage of ground area covered by the vertically projected crowns of shrubs; expressed as a percentage of the entire polygon.

**Shrub height:** the average height, in tenths of a metre, of all shrubs within a polygon.

**Site position meso:** indicates the relative position of the polygon within a catchment area. An alphabetic code indicates crest, upper slope, middle slope, lower slope, toe, depression, flat.

**Snag frequency:** the number of standing dead trees greater than 2 cm DBH; expressed as a per hectare value for the polygon.

**Soil nutrient regime (SNR):** refers to the amount of essential soil nutrients, particularly nitrogen, available to vascular plans over a period of several years. SNR classes include A (very poor), B (poor), C (medium), D (rich), E (very rich), F (ultra rich, saline).

**Soil moisture regime (SMR):** refers to the average amount of soil water annually available for evapotranspiration by vascular plants over several years. SMR classes include 0 (very xeric), 1 (xeric), 2 (subxeric), 3 (submesic), 4 (mesic), 5 (subhygric), 6 (hygric), 7 (subhydric), 8 (hydric).

**Species composition:** identifies species in the polygon and estimates percentage of each present.
Stand structure: indicates the distribution and representation of different stand ages and stand size classes within a polygon.

Surface expression: describes the form of surficial material within the polygon; described by letter codes that indicate the following forms: cone, depression, fan, hummock, rolling, plain, ridge, terrace, undulating or none of the above.

Top height: the height of a stand of trees as measured or estimated using "top height" procedures. Currently this is the height of the tree with the largest DBH within a 5.64 metre fixed radius plot.

Tree cover pattern: describes the spatial distribution of the tree cover within the polygon.

Tree crown closure: the percentage of ground area covered by the vertically projected crowns of the tree cover within the polygon.

Tree layer: a number that identifies the tree layer being described in a multi-layered stand.

Treed polygon: a vegetated polygon with tree crown cover greater than or equal to 10% by area.

Upland designation: is a broad class including everything from xeric, moss- and lichen-covered rock outcrops to highly productive forest ecosystems on hygric (SMR 6) soils.

Variable Density Yield Prediction (VDYP): is a method, based on empirical data, of calculating mensurational data (primarily stand volume and tree diameter) from photo-interpreted data (such as species composition, age, height, crown closure).

Vegetated polygon: a polygon is vegetated when the total cover of trees, shrubs, herbs and bryoids (other than crustose lichens), covers at least 5% of the total surface area of the polygon.

Vegetation cover types: fourth level of the B.C. Land Classification Scheme; classifies the polygon as coniferous (TC), broadleaf (TB) or mixed (TM) if treed; as tall shrubs (ST) or low shrubs (SL) if shrub cover; undifferentiated herbs (HE), forbs (HF) or graminoids (HG) if herb cover; and undifferentiated bryoids (BY), bryoid -moss (BM) or - lichens (BL) if cover is bryoids.

Vegetated density classes: fifth level of the B.C. Land Classification Scheme; classifies the polygon as dense (DE), open (OP) or sparse (SP) for tree, shrub and herb covers; and classes the polygon as closed (CL) or open (OP) for bryoid cover.
**Vertical complexity**: indicates the distribution and representation of different stand ages and stand size classes within a polygon.

**Volume**: average gross stem volume of all living trees expressed in cubic metres per hectare.

**Wetland designation**: is the third level of the B.C. Land Classification Scheme. Wetland is land having the water table near, at, or above the soil surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by poorly drained soils, specialized vegetation, and various kinds of biological activity which are adapted to the wet environment.
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