Vegetation Resources Inventory

Photo Interpretation Procedures

Prepared by

Ministry of Forests

Forest Analysis and Inventory Branch

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Major Changes to Photo Interpretation Procedures

1. Clarified **Alpine** definition (from <1%) to reflect that no trees should be described when an A- Alpine designation has been assigned, as the alpine is treeless by definition. (Multiple Sections where Alpine is defined Section 2.4.3, pg. 10 and Section 4.9.3, pg 46 for instance)
2. Corrected the visual example of multi layer stands, dead vs lyr 2. (Section Appendix A, pg. 128)

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1 Introduction

1.1 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:

- Photo Interpretation
- Ground 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 (VRI).

1.1.1 Vegetation Resources Inventory Process

The VRI is carried out in two phases. The Photo Interpretation phase involves estimating vegetation polygon characteristics from aerial imagery. The Ground Sampling phase provides the information necessary to determine how much of a given attribute is within the inventory area and to verify the accuracy of the photo estimates.

1.1.2 Principles of the Photo Interpretation Process

The VRI photo interpretation process is guided by several principles:

- The VRI will cover the entire land base of British Columbia, irrespective of ownership or vegetation values.
- The vegetated land base will be delineated into polygons based on similar vegetation characteristics visible in aerial imagery. Imagery specifications may

differ between projects. Interpreters are encouraged to use similar imagery settings within a project for consistency.

- 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.
- Vegetated and non-vegetated attributes that are not visible on the project aerial imagery, at the attribution scale given for the project, due to the overtopping vegetation and shadows of the surrounding vegetation are not to be incorporated into the description of the delineated polygon. This principle does not apply to the RESULTS non-free growing blocks. Any other deviation from this photo interpretation principle must be endorsed in the inventory project plan.
- The inventory design does not allow polygon boundaries to be changed by the sampling process.
- The estimate for a polygon will describe land cover types according to the British Columbia Land Cover Classification Scheme.
- 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.
- 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.
- Ancillary data will be used, as available, to provide accurate and consistent estimates of polygon attributes.
- The photo interpretation process strives towards consistency of estimates by one interpreter, between interpreters, and over time.

1.2 How to Use this Procedures Document

This document deals with the Photo Interpretation component of the Vegetation Resources Inventory. It describes procedures required to delineate polygons using the BC Land Cover 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 this procedure document follows the process that is required when delineating polygons and estimating attributes. Section 2 explains the BC Land Cover Classification Scheme. Section 3 describes the procedures required to delineate polygons. Section 4 explains the identification of polygons and the estimation of general and ecological attributes. Sections 5 and 6 describe estimating land cover and site indices, and Sections 7, 8, 9, and 10 explain the estimation of the attributes related to vegetated portions of polygons. Section 11 describes procedures required to classify the non-vegetated portions of polygons. Section 12 outlines procedures for describing human-caused and natural disturbance events that have impacted the land base and are represented within polygons.

Appendix D: *Derived Polygon Attributes* identifies and explains the attributes that are derived after the Photo Interpretation and Ground Sampling 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 it's applicable, examples and tips are provided.

A glossary of terms and a detailed index are included to ensure the usability of this document as a reference tool.

2 Land Cover Classification Scheme[1]

2.1 Introduction

The Vegetation Inventory Working Group, a component of the Resources 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 in the future. Present inventory systems were found to be inadequate when used to assess integrated resource management options. It was from this perspective, along with the growing worldwide demand for an accurate assessment of land cover, that this classification was created.

The BC Land Cover Classification Scheme was designed to meet present provincial and national needs and to be capable of providing data for global vegetation accounting. Numerous classifications were considered in the development of the scheme.

The BC Land Cover Classification Scheme is based on the current cover. Cover can be Vegetated, Non-Vegetated or Unreported. Vegetated cover is either Treed or Non-Treed; Non-Vegetated cover is either Land or Water. In most cases, uniform areas (polygons) are delineated on aerial imagery. Vegetation types and non-vegetated cover categories can exist as components within larger polygons. Unreported areas may be Vegetated or Non-Vegetated, but their attributes are unknown (as in the case of parks), or they are outside of the area being reported (as in the case of Tree Farm Licenses or Tree Farms).

The purpose of the BC Land Cover 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 comparing land classification accuracy with Ground Sampling data. Second, the BC Land Cover Classification Scheme provides the criteria for distinguishing cover types within the polygon. These criteria are critical for assessing 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 directly assigned by the photo interpreter; it is derived after the photo-interpreted data has been delivered. It is important that photo interpreters be familiar with the derivation process to improve the consistency of photo-interpreted data. Figure 2.1 and Figure 2.2 illustrate the structure of the land classification scheme for Vegetated and Non-Vegetated polygons.

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[1] **Note**: Section 2 is adapted from the Vegetation Resources Inventory *BC Land Cover Classification Scheme* Document, March, 1999. Contact the Resources Inventory Committee for this document.

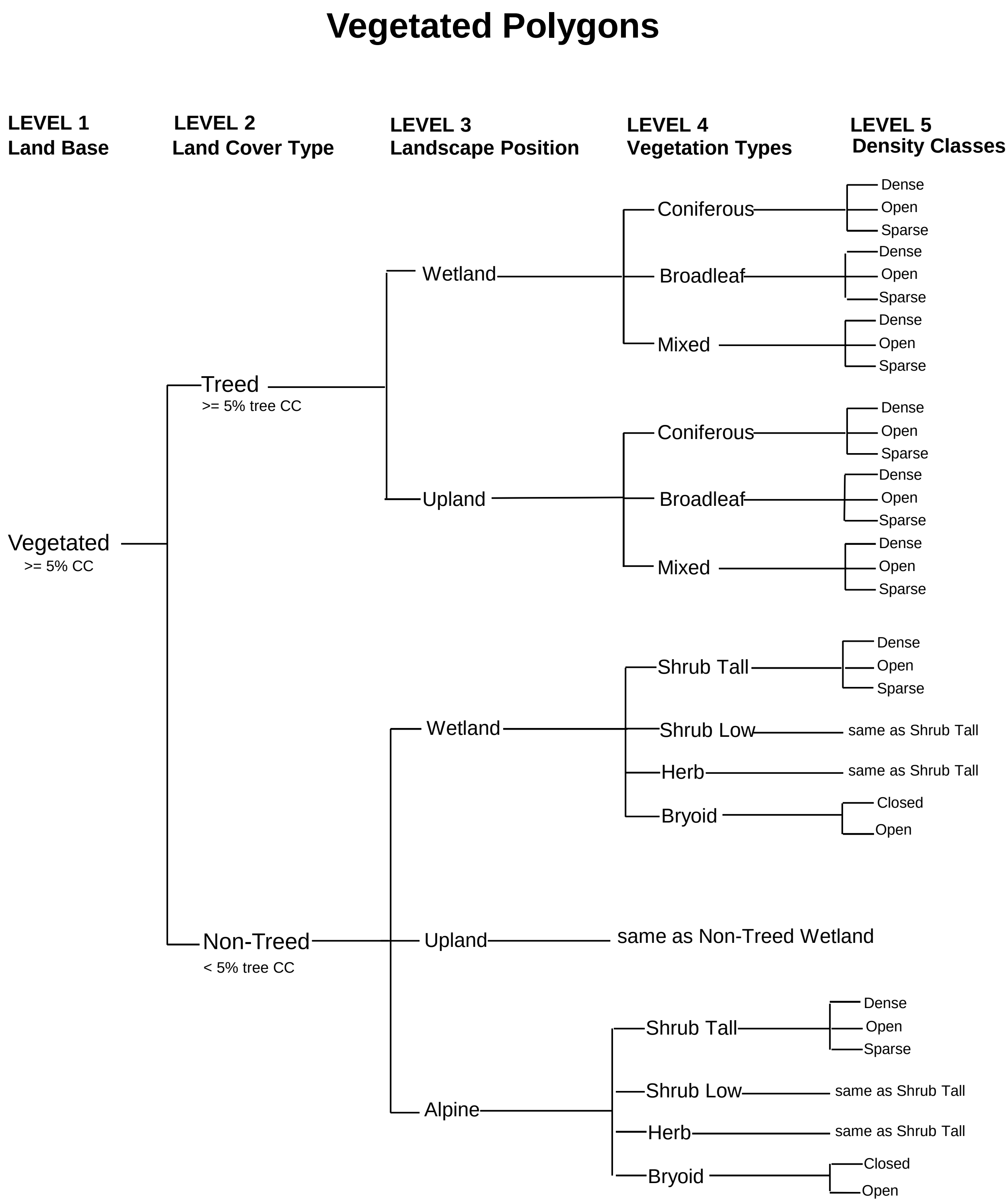


Figure 2-1 Structure of the BC Land Cover Classification Scheme - Vegetated polygons

Non-Vegetated Polygons

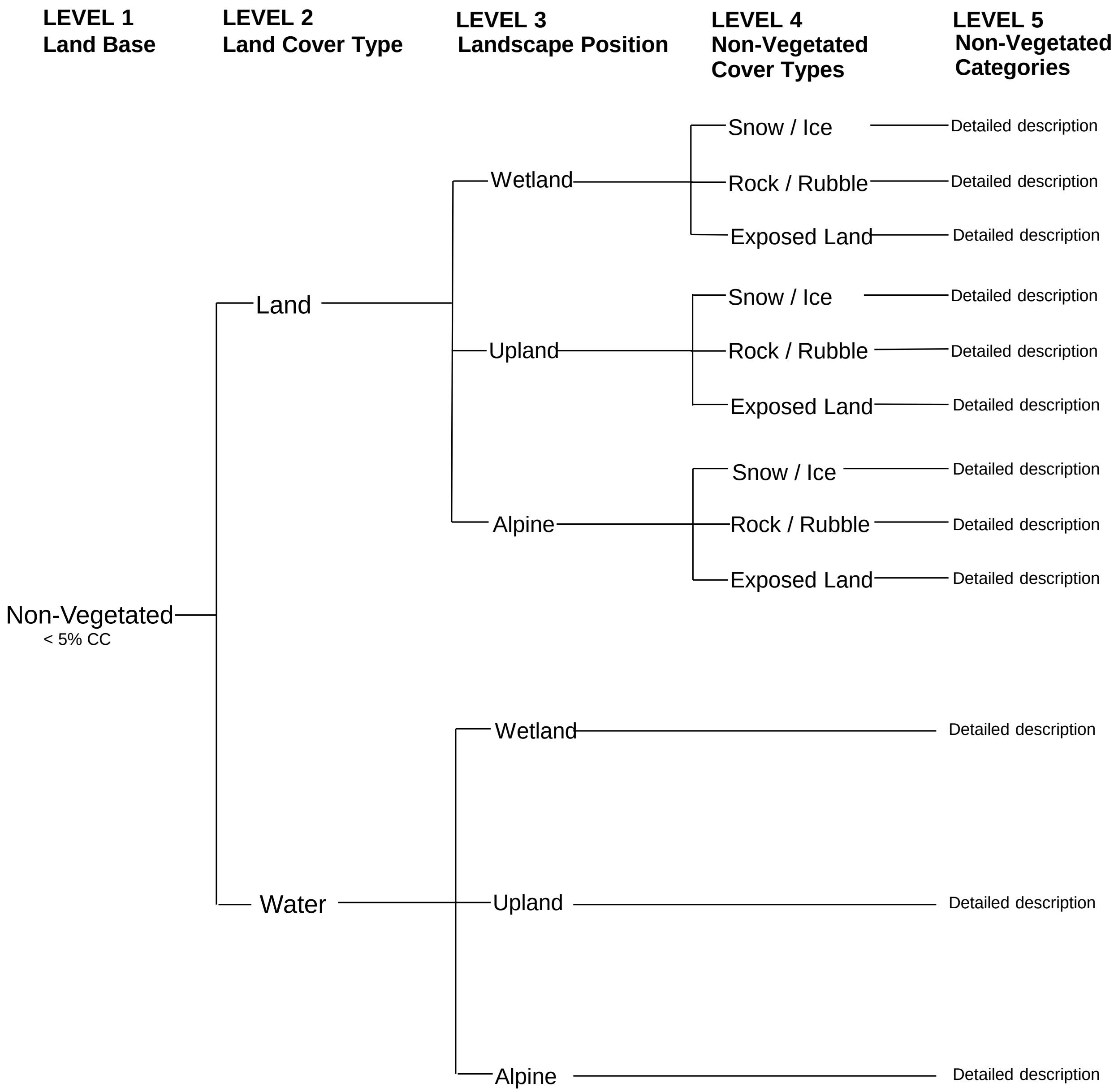


Figure 2-2 Structure of the BC Land Cover Classification Scheme- Non-Vegetated polygons

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 13 *Derived Polygon Attributes*.

2.2 Level 1 Land Base

2.2.1 Definition

The first level of the BC Land Cover 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.

2.2.2 Purpose

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

2.2.3 Procedure

V = Vegetated
A polygon is considered 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 = Non-Vegetated
A polygon is considered 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. Bodies of water are to be classified as Non-Vegetated.

U = Unreported
A polygon is classified as Unreported if it is within the mapsheet being reported on but is outside the inventory unit of interest. The Unreported designation is restricted to areas where inventory information is not currently available. Examples include National Parks, Provincial Parks (where information is not available), Tree Farm Licenses and Tree Farms that are not in the existing vegetation cover databases, and areas outside of the Province of British Columbia.

Note: Bodies of water may have vegetation on or under their surface; they are the responsibility of others to evaluate.

2.3 Level 2 Land Cover Type

2.3.1 Definition

The second level of the BC Land Cover Classification Scheme classifies the polygon as to the land cover type: treed or non-treed for vegetated polygons; land or water for non-vegetated polygons.

2.3.2 Purpose

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

2.3.3 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 = **Treed**
A polygon is considered Treed if at least 5% of the polygon area, by live crown cover, consists of tree species of any size.

N = **Non-treed**
A polygon is considered Non-Treed if less than 5% of the polygon area, by live crown cover, 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 habitats. 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.

2.3.4 Procedure for Non-Vegetated Polygons

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

L = **Land**
The portion of the landscape not covered by water (as defined below), based on the percentage area coverage.

W = **Water**
A naturally occurring, static body of water or a watercourse formed when water flows between continuous, definable banks. These flows may be intermittent or perennial but do not include ephemeral flows where a channel with no 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.

2.4 Level 3 Landscape Position for Vegetated and Non-Vegetated Polygons

2.4.1 Definition

The third level of the BC Land Cover 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 an alpine wetland.

2.4.2 Purpose

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

2.4.3 Procedure

The polygon is interpreted to see if it has one or more landscape positions. The polygon classification is determined by the landscape position with the majority coverage by area.

W = Wetland
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 bogs, fens, marshes, swamps, hot springs, hot pools, and shallow water. In British Columbia, Wetlands include forested or non-forested sub-hydric (SMR 7) sites in addition to non-forested hydric (SMR 8) ecosystems (see the BC Land Cover Classification document for a detailed description).

U = Upland
A broad class that includes all non-wetland ecosystems below Alpine that range from very xeric, moss- and lichen-covered rock outcrops to highly productive forest ecosystems on hygric (SMR 6) soils.

A = Alpine
The land area above the maximum elevation for tree species. It is dominated in the vegetated areas by shrubs, graminoids, forbs, bryoids or lichens. Much of the alpine is non-vegetated, covered primarily by rock, ice, and snow. The Alpine is treeless by definition. Do not describe trees in the Alpine.

The boundary between Alpine and Upland is drawn using the upper elevation of the discontinuous treed area. The Alpine area will not typically include parkland

and krummholz forest types. Generalization of the boundary at a consistent elevation (varying with aspect) is necessary as cliffs, rock outcrops, and avalanche chutes often dissect the Alpine/Upland transition. Alpine is a classification level of Non-Treed areas above the tree line only.

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*).

2.5 Level 4 Vegetation Types and Non-Vegetated Cover Types

2.5.1 Definition

The fourth level of the BC Land Cover 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).

2.5.2 Purpose

Vegetation types and Non-Vegetated cover types provide the fourth level of delineation within the BC Land Cover Classification Scheme and the fourth level of reporting ability.

2.5.3 Procedure for Vegetated Polygons

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 percentage crown closure.

Treed Units

Treed units are split into three groups: Coniferous, Broadleaf, and Mixed.

TC = Treed - Coniferous
Defined as those trees found in BC within the order Coniferae. These trees are commonly referred to as conifer or softwoods. The polygon is classified as Coniferous when the total basal area (expressed as percentage species composition) of coniferous trees is 75% or more of the total polygon tree basal area, and trees cover a minimum of 5% of the total polygon area by crown cover.

TB = Treed - Broadleaf
Defined as those trees classified botanically as Angiospermae in the subclass Dicotyledoneae. These species are commonly referred to as deciduous or hardwoods. The polygon is classified as Broadleaf when the total basal area (expressed as percentage species composition) of broadleaf trees is 75% or more of the total polygon tree basal area, and trees cover a minimum of 5% of the total polygon area by crown cover.

TM = Treed - Mixed
The polygon is classified as Mixed when neither coniferous nor broadleaf trees account for 75% or more of the total polygon tree basal area, and trees cover a minimum of 5% of the total polygon area by crown cover.

Non-Treed Units

Non-Treed units are broken into Shrubs, Herbs, and Bryoids.

Shrubs are defined as multi-stemmed woody perennial plants, both evergreen and deciduous. A reporting break is made between Tall (i.e. ≥ 2.0 m in height) and Low (i.e. < 2.0 m in height) for wildlife management interpretation purposes. Other breaks may be reported by the user as height data are estimated and stored as a continuous variable.

For a polygon to be classified as Non-Treed Shrub, it must have more than 5% total vegetation cover, have less than 5% crown cover of trees, and have a minimum of 20% ground cover of shrubs, or shrubs must constitute more than 1/3 of the total vegetation cover.

ST = Shrub Tall
A Shrub polygon with an average shrub height greater than or equal to 2.0 m. Shrub tall includes species that are known to achieve heights of greater than 10 m but are specifically excluded from the "tree" category in BC VRI Photo interpretation. These include willow (*Salix spp.*) and alder species other than Red Alder (*Alnus rubra*).

SL = Shrub Low
A Shrub polygon with an average shrub height of less than 2.0 m.

Herbs are defined, for this system, as vascular plants without a woody stem, including ferns, fern allies, some dwarf woody plants, grasses, and grass-like plants. The Herb class has two further subdivisions based on the proportion of graminoids and forbs present:

Graminoids are defined as herbaceous plants with long, narrow leaves characterized by linear venation, including grasses, sedges, rushes, and other related species.

Forbs are defined as herbaceous plants other than graminoids.

For a polygon to be classed as Non-Treed Herb, it must have more than 5% total vegetation cover, have less than 5% crown cover of trees, and have 20% or more ground cover of herbs, or herbs must constitute more than 1/3 of the total vegetation cover, and the polygon must have less than 20% shrub cover.

HE = **Herb**
A Herb polygon with no distinction between forbs and graminoids.

HF = **Herb - Forbs**
A Herb polygon with forbs greater than 50% of the herb cover.

HG = **Herb - Graminoids**
A Herb polygon with graminoids greater than 50% of the herb cover.

Bryoids 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 less than 5% crown cover of trees, and have greater than 50% of the vegetation cover in bryoids, and herb and shrub cover must each be less than 20% crown cover.

BY = **Bryoid**
A Bryoid polygon with no distinction between mosses and lichens.

BM = **Bryoid - Moss**
A Bryoid polygon with mosses, liverworts, and hornworts greater than 50% of the bryoid cover.

BL = **Bryoid - Lichens**
A Bryoid polygon with lichens (foliose or fruticose; not crustose) greater than 50% of the bryoid cover.

2.5.4 Procedures for Non-Vegetated Polygons

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 that has the greatest percentage coverage by area.

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

SI = **Snow / Ice**
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 ice and snow cover that is not part of a glacier.

RO = **Rock / Rubble**
Defined as bedrock or fragmented rock broken away from bedrock surfaces and moved into its present position by gravity or ice. Extensive deposits are found in and adjacent to alpine areas and are associated with steep rock walls and exposed ridges; canyons and cliff areas also contain these deposits.

EL = Exposed Land
Contains all other forms of exposed land identified by a range of subclasses.

Note: The Water cover type (level 2) does not have any classes at this level of the land classification scheme.

2.6 Level 5 Vegetated Density Classes and Non-Vegetated Categories

2.6.1 Definition

The fifth level of the BC Land Cover Classification Scheme classifies the vegetation density classes and Non-Vegetated categories.

2.6.2 Purpose

Vegetated density classes and Non-Vegetated categories provide the fifth level of delineation within the BC Land Cover Classification Scheme and the fifth level of reporting ability.

2.6.3 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. Note that these are reporting breaks only, and interpreters estimate density as a continuous variable.

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 5% and 25% for treed polygons, or cover is between 20% and 25% for shrub or herb polygons.

The density classes for Bryoids are 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.

2.6.4 Procedure for Non-Vegetated Polygons

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 (Level 4) Subclasses:

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

PN = **Snow Cover**
Snow or ice that is not part of a glacier but is found during the summer months on the landscape. (Care should be taken to determine if the snow on the imagery is a result of the photo acquisition date. In such cases, the delineation or attribution procedure should be discussed with the Ministry).

Rock/Rubble (Level 4) Subclasses:

BI = **Blockfield**
Blocks of rock derived from the underlying bedrock by weathering and/or frost heaving. These have not undergone any significant downslope movement as they occur on level or gently sloping areas.

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

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

MZ = **Rubbly Mine Spoils**
Discarded overburden or waste rock, moved to extract ore during mining.

TA = **Talus**
Rock fragments of any size accumulated on or at the foot of slopes as a result of successive rock falls. This is a type of colluvium.

Exposed Land (Level 4) Subclasses:

AP = **Airport**
A permanent, paved or gravel area, and associated buildings and parking used by airplanes.

BE = **Beach**
An area with sorted sediments reworked in recent time by wave action, which may be formed at the edge of freshwater or saltwater bodies.

BU = **Burned Area**
Land showing evidence of recent burning, either natural or prescribed. Vegetation with less than 5% crown cover is present at the time of polygon description.

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

CL = **Cultivated Land**
Land that is worked by plowing and sowing and raising crops, including orchards and vineyards.

DW = **Downed wood**
Consolidated coarse woody debris, blowdown, log deck, burn pile, or area of downed trees.

ES = **Exposed Soil**
Any exposed soil not covered by the other categories, such as areas of recent disturbance that include mud slides, debris torrents, avalanches, or disturbances such as pipeline rights-of-way where vegetation cover is less than 5%. Exposed soil resulting from harvesting operations is recognized in this category; however, harvested polygons must maintain a vegetated status.

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

LL = **Landing**
A compacted area adjacent to a road used for sorting and loading logs.

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

MI = **Open Pit Mine**
An exposed area used to extract ore during a mining operation. This may contain associated buildings and any tailing produced by the mining and milling process.

MN = **Moraine**
An area of debris transported and deposited by a glacier.

MU = **Mudflat**
Flat plane-like areas that are associated with lakes, ponds, rivers, or streams and dominated by fine-textured sediments. They can be associated with freshwater or estuarine sources.

OT = **Other**
A Non-Vegetated polygon where none of the above categories can be reliably chosen.

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.

RN = Railway Surface
A roadbed with fixed rails, which may contain single or multiple rail lines.

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

RZ = Road Surface
An area cleared and compacted for transporting goods and services by vehicles. Older roads that are used infrequently or not at all may cease to be classed as Non-Vegetated.

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

UC = Utility Corridor
Land that is perpetually cleared and occupied by pipelines or transmission lines.

UR = Urban
Buildings and associated developments such as roads and parking areas which form an almost continuous coverage of the landscape.

Water Cover (Level 2) Subclasses:

LA = Lake
A naturally occurring static body of water. The boundary for the lake is the natural high-water mark taken from Fresh Water Atlas if the feature is present. A dried-out lake bed should be described as observed during photo interpretation and attributed according to the VRI standard.

OC = Ocean
A naturally occurring body of water containing salt or generally considered to be salty.

RE = Reservoir
An artificial basin affected by impoundment behind a man-made 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 but does not include ephemeral flow where a channel with no definable banks is present. Gravel bars are part of a stream, while islands within a stream that has definable banks are not.

3 Polygon Delineation

3.1 Introduction

Polygon delineation is based on the BC Land Cover 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 future Phase II Ground Sampling locations are selected.

3.1.1 Definition

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

3.1.2 Purpose

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

3.1.3 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
- Mensuration attribute
- Ecological attributes (where appropriate)

The objective of delineation is to identify distinctly recognizable vegetated or non-vegetated polygons which are uniform 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.

<u>Example:</u>

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

1. Delineate the alpine from the upland
2. Delineate areas of wetland
3. Delineate vegetated from non-vegetated
   (A Vegetated polygon must have vegetation crown cover of 5% or greater.)

When the polygon is Vegetated, then:

1. Delineate Treed versus Non-Treed.
   (A Treed polygon must have 5% or greater 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, crown closure, or a combination of others

   Non-Treed areas:

   - Delineate by Shrub versus Herb versus Bryoid
   - Further delineation will be done as appropriate for a combination of attributes such as shrub height, herb cover type, vegetation density, and others

When a polygon is Non-Vegetated, then:

2. Delineate by category of Non-Vegetated cover type.

Guidelines

The delineation of polygons can be achieved with various differentiation that may 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 is available from silviculture on various stand conditions.

For normal aerial imagery, it is expected that delineation quality assurance will be performed at an approximate starting ground scale of 1:3,000 to maintain consistency between interpreters and for Quality Assurance purposes. This may be modified on a project-specific basis. In general:

- Polygon delineation must appear "smooth" and follow natural polygon boundaries and not have sharp non-natural edges.
- All polygons must close.
- Polygon size must be consistent with the delineation guidelines set in the Photo Interpretation Procedures.

- The interpreter should try to avoid significant areas where the delineation is within 40 m of other delineation, with exceptions as noted elsewhere in the Photo Interpretation Procedures.
- General specifications for silviculture blocks are outlined in Section 13: RESULTS.
- Projects that are not using "puzzle" boundaries (see "Puzzle Boundaries" in section 3.1.3.4) for project deliverables must be checked by the interpreter to ensure that polygons edge tie to adjacent maps inside the project and outside the project as determined in the VPIP or contract specifications.
- It is acceptable to use the project boundary as a polygon boundary.
- The interpreter is expected to review and correct any items identified in the random sample of work evaluated by the quality assurance personnel, as requested by the Ministry.

Table 3-1 Delineation guidelines for Treed polygons

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

Adapted from Forest Inventory Manual, Forest Classification/Sampling and Environmentally Sensitive Areas, Vol.2, MoF, 1992.

For stands that have not achieved free-growing status and where silviculture records are not available, the interpreter will delineate polygons based on observable, recognizable differences in vegetation, using the guidelines listed in Table 3-1.

3.1.3.1 Minimum Delineated Polygon Size

In some instances, the identifiable features on an aerial image could potentially 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 following guidelines address the minimum sizes used to meet the needs of the provincial inventory:

Table 3-2 Summary of Minimum Delineated Polygon Guidelines

Polygon Type	Minimum Size
Ministry-Provided Delineation	
RESULTS Non-Free Growing Silviculture Openings, including reserve polygons within an opening	As Ministry-supplied in accordance with Section 13.2.2
RESULTS Free Growing Silviculture Openings, including reserve polygons within an opening	≥ 2 ha minimum
Fresh Water Atlas polygon water features (i.e. lakes and rivers)	≥ 0.5 ha minimum
Interpreter Delineated Polygons	
Polygons with distinct attribute differences that create obvious boundaries in the imagery (e.g. trees versus shrub complex)	≥ 2 ha minimum
Polygons with indistinct attributes/boundaries as seen on the imagery (e.g. tree heights change from 30 m to 25 m)	≥ 5 ha minimum
Polygons with an Alpine Designation of ‘A’	Delineate individual cover types ≥ 5 ha into separate polygons where possible. Otherwise, combine adjacent cover types < 5 ha into polygons with multiple land cover components.

The minimum sizes to meet the needs of the provincial inventory are:

1. Areas with distinct boundaries - minimum 2 ha.

Where polygon boundaries are readily recognizable and distinct in the imagery, a minimum polygon size of 2 hectares is appropriate.

For example: Treed versus Shrub complex; Herb complex versus Rock Talus area; abrupt change from 10 m trees to 32 m trees.

2. Areas with indistinct boundaries - minimum 5 ha.

Where polygon boundaries are not readily recognizable on the imagery, a minimum polygon size of 5 hectares is appropriate.

For example: a Treed area with a gradual height difference graduating from 30 m to 35 m; a repetitious complex area with ridge and swale vegetation complexes; high-elevation Treed areas with dispersed patches of rock outcrops.

3. Ministry-Supplied Water features

Modification to the imported Fresh Water Atlas (FWA) map features is generally not desired. Minor defects are normally ignored, and delineation should be directly copied from the FWA. Major defects discovered in the FWA dataset should be discussed with Ministry Inventory staff prior to re-delineation or incorporation into the inventory. Revised waterbody delineation may also be submitted to GeoBC.

Areas where major inaccuracies occur typically include flat lands with meandering rivers or reservoirs. The high-water marks (usually considered the vegetation line) along rivers and lake edges should be captured due to seasonal water fluctuations. See examples below of FWA Lakes and FWA Rivers.

Figure 3-1 FWA Lake delineation needing modification

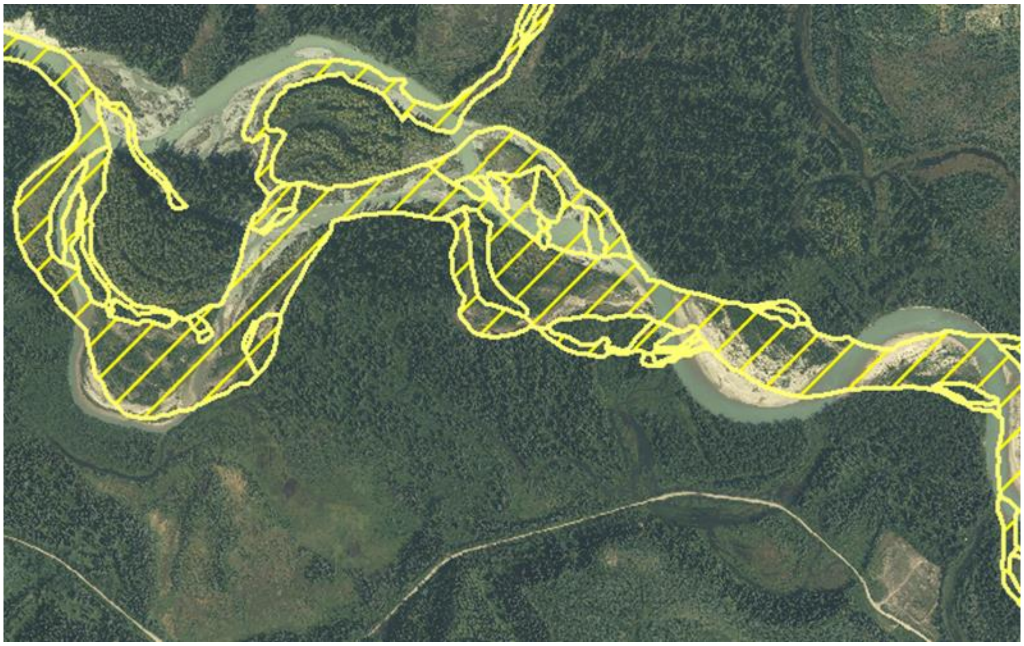


Figure 3-2 FWA River delineation needing modification

Figure 3-3 Reservoir lake boundary

3.1.3.2 Delineation of Dead Polygons

The remaining live trees normally drive polygon delineation in Treed polygons. However, additional delineation is required when the estimated mortality exceeds a snag frequency of 100 stems/ha.

In polygons with dead trees and the combined crown closure of all live trees is ≥ 5% (i.e. the polygon is Vegetated Treed (VTU or VTW)), use normal VRI delineation principles to establish boundaries between polygons and record the snag frequency for the polygon.

In polygons with dead trees and the combined crown closure of all trees is <5% (i.e. the polygon is now Vegetated Non-Treed (VNU or VNW) and was Vegetated Treed (VTU or VTW)) prior to disturbance (e.g. wildfire, mountain pine beetle (MPB) attack), delineate polygons based on BCLCCS Level 5 and snag frequency.

For example, delineate an MPB-killed now classified as VNU, but previously VTU, to BCLCCS Level 5 (i.e. HE. BY, ST, SL), with further delineation based on the snag frequency.

3.1.3.3 Delineation of Linear Features

Avoid continuous areas where the delineation is parallel to and within 40 m of other delineation.

This rule is to be applied as a guideline, and smaller distances are acceptable in exceptional circumstances to an absolute minimum distance of 15 m for non-Fresh Water Atlas, Digital Road Atlas or National Railway Network features.

Linear features may sometimes require other exemptions to the minimum width criteria of 40 m between polygons. As linear features may cross many map sheets and interpreters, consistency is of importance.

- All double line rivers are copied from the Fresh Water Atlas, and they will form polygons regardless of width.
- Delineate roads, railways, and other man-made features only when the majority of the width of the polygon to be created is greater than 40 m. The polygon will consist of the actual feature itself and the associated right of way. The interpreter should review the entire length of the polygon before delineating to make the determination. When a linear feature appears to become less than 40 m in width for greater than 2 km, then the interpreter should close off the polygon and include the linear feature in the surrounding polygons.

Roads that travel through settlements (i.e. cities and towns) will not generally be delineated separately from those features.

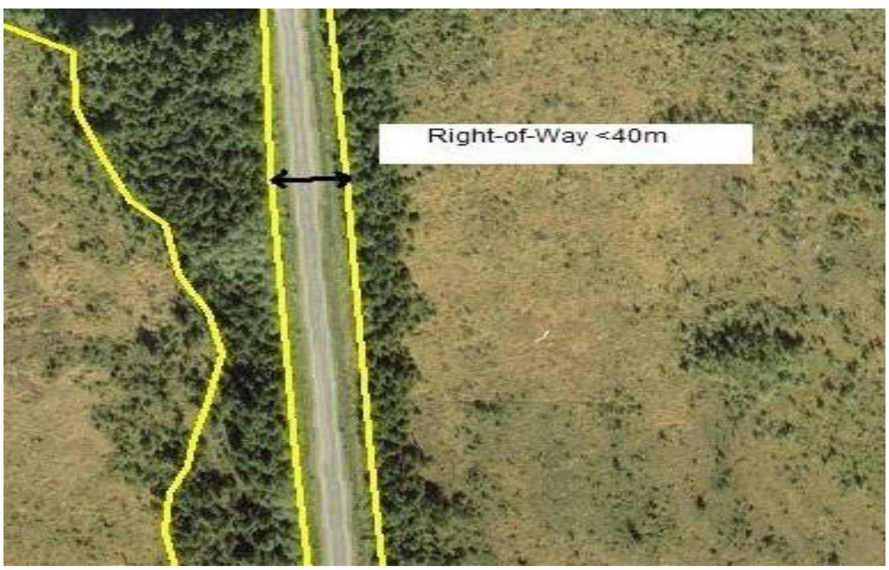


Figure 3-4 Example of unacceptable delineation of a linear feature – road right-of-way with continuous width under 40 m for more than 2 km.

When necessary, the use of the "bridging" technique is acceptable where the delineation is within 40 m of other delineation to connect similar undersize types to a polygon with similar attributes.

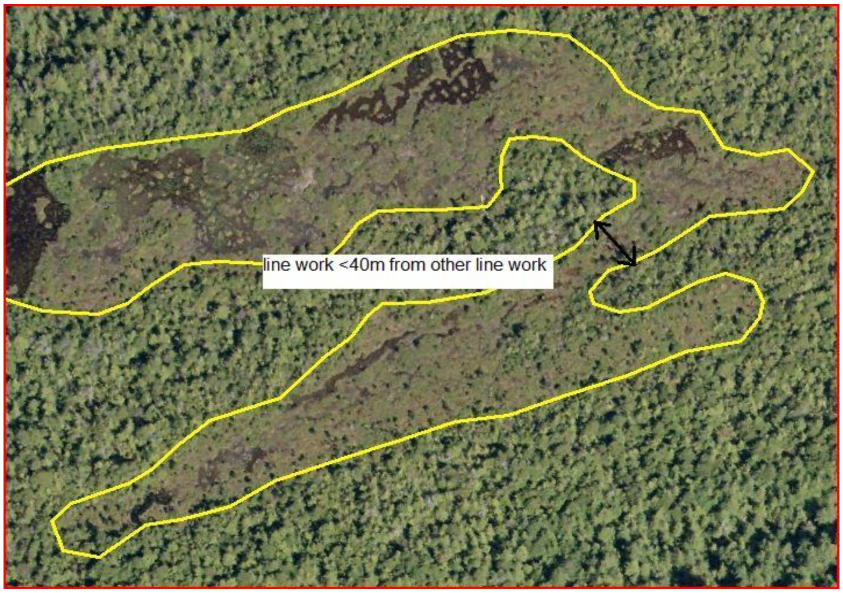


Figure 3-5 Example of acceptable delineation within 40 m of other delineation

These are guidelines, but consistency must be maintained throughout a project and, where tied to other projects, maintained between projects as much as possible.

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
  - 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
  - review the previous day’s photos before beginning the current day's activities.

3.1.3.4 Polygon Boundaries Along Project Area Edge and Between Internal Project Deliverables

Two methods may be employed to ensure continuity of delineation along the edge of a project or between deliverables within a project. The methods to employ for a project will be determined in contract specifications and may include a combination of the following techniques.

Puzzle Boundary Method

"Puzzle" boundaries are the preferred method of project and within deliverable polygon boundaries.

External project boundary

The project boundary has been set to follow the exact boundaries of the existing delineation of a previous inventory project. The interpreter, therefore, will be responsible for delineation and attribution *exactly* up to the boundary of the Project (vertices delineated <u>must</u> be identical to the project boundary).

Below is an example of a project boundary that matches the existing VRI delineation in an adjacent project. The area to be interpreted in the Project is shown hatched in yellow, and a BCGS map boundary is shown in red.

Figure 3-6 Puzzle Boundary example

Internal project deliverable boundaries

Individual deliverable submissions also follow the puzzle boundary concept; artificial boundaries such as BCGS map sheets are NOT included in the deliverable. A polygon is delineated in its entirety, and an area roughly equivalent to a BCGS map sheet is provided as a deliverable to the Ministry.

Below is an example of a deliverable that approximates a BCGS map sheet in size. Polygons are delineated completely and not cut by artificial lines such as BCGS map sheets. The only exception to this rule is for extremely long features such as highways, lakes or rivers that may cross several map sheets. In this case, it is acceptable to cut the polygon at a BCGS map boundary (neat line), as is shown in the top left of the example.

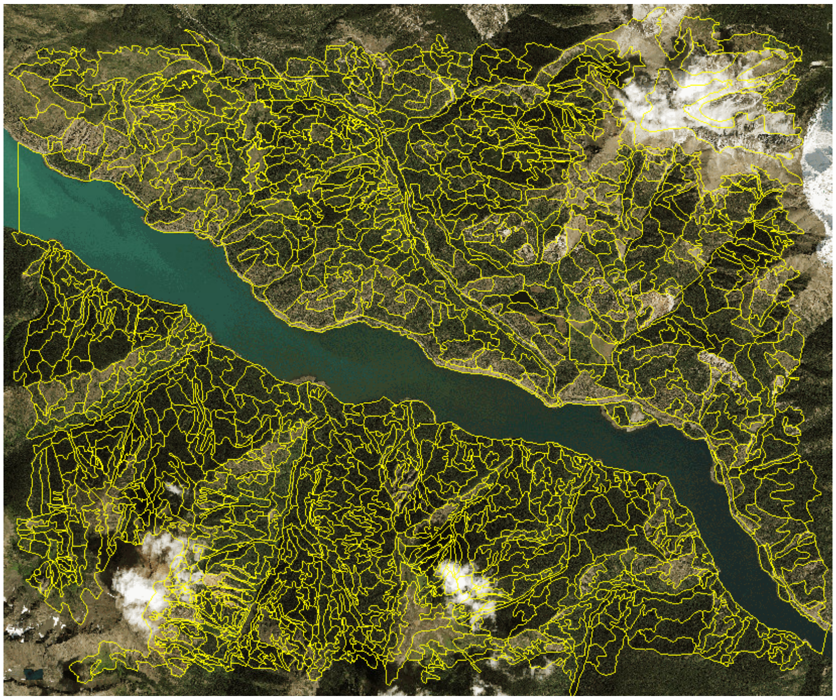


Figure 3-7 Internal Project Deliverable boundary example

Final deliverables for surrounding map sheets inside a project must match *exactly* (to the vertex) to surrounding map sheet deliverables, as illustrated below.

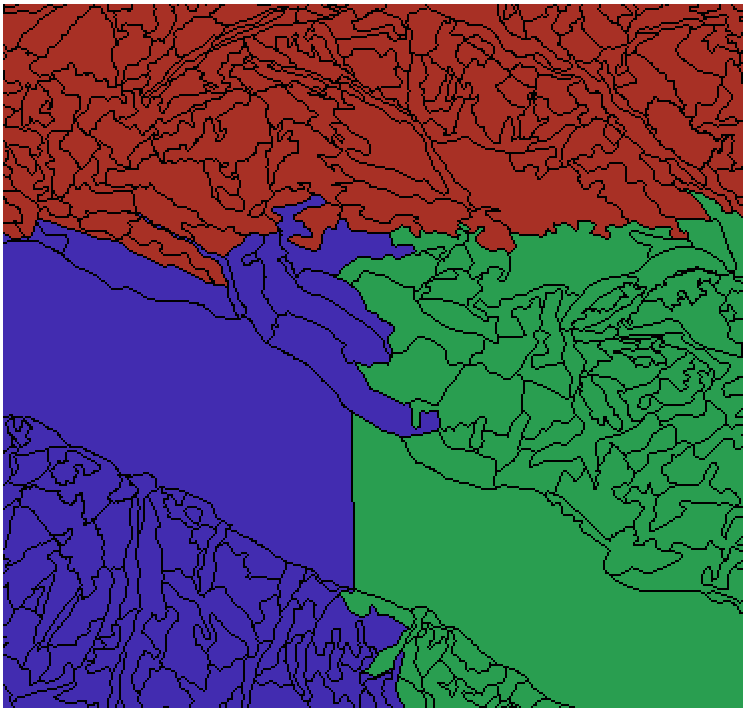


Figure 3-8 Deliverable matching example

Edge Tie Method

The interpreter may be instructed to join delineated lines between currently ongoing projects or older projects completed in previous years (edge ties). Typically, interpreters will only tie to inventories completed to the current VRI standard, but decisions on whether to tie to adjacent projects will be determined by the Ministry on a contract-specific basis.

When an interpreter is to edge tie delineation to another project, lines on both sides of the project must join exactly (0 m tolerance), with a number of exceptions:

- The types stop at the project boundary – this may occur at cut block edges that end at a TSA or TFL boundary, where the line separating two adjacent polygons will stop at a cut block boundary that happens to be on the edge of the project.
- A boundary that follows along a project boundary within 20 m. When the polygon boundary follows along the edge of the project, it is not necessary to create a separate polygon along the boundary or offset the polygon boundary if it is within 20 m of the project boundary. The interpreter does not need to jump back and forth between using a project boundary and using the visual boundary if it varies inside and outside of 20 m along the polygon boundary. The intent is to minimize very small sliver polygons along the edge of the project. The interpreter should send screen captures to the project manager when in doubt.

- A significant change has occurred between the two projects. Examples include insect outbreaks or wildfires that occurred after the adjacent inventory was completed and prior to the imagery being taken in the current inventory.
- The delineation on the adjacent inventory is clearly incorrect. Minor differences will be tied to exactly, but there may be cases where an obvious error was made in the adjacent inventory.
- New Silviculture opening information is available. The delineation will be updated to reflect new RESULTS data even if it creates an edge tie mismatch.

Edge ties between individual submissions in a project should follow the same guidelines. Usually, the edge of files delivered as a final product will follow map sheet neatlines.

It is the interpreter's responsibility to ensure that edge ties make sense as per the existing photos.

4 General Attributes

4.1 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
- Surface expression
- Site position meso
- Soil nutrient regime
- Data source
- Modifying processes
- Alpine designation

4.2 Polygon Number

4.2.1 Definition

A polygon number is a unique number (i.e. Forest Cover Object ID) 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.

4.2.2 Purpose

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

4.2.3 Procedure

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

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

Figure 4.1 indicates one of the methods of polygon numbering for a BCGS map sheet.

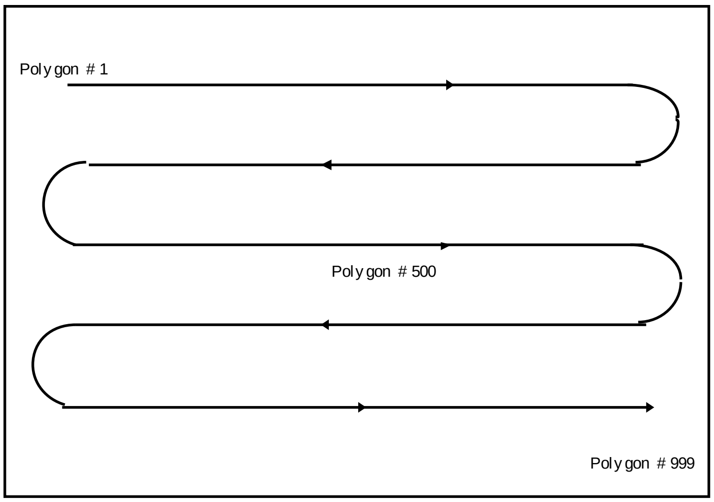


Figure 4-1 One method of polygon numbering layout

4.3 Reference Year

4.3.1 Definition

The reference year is the year of the aerial imagery used in the inventory project.

4.3.2 Purpose

A reference year serves as a base for continually projecting and updating forest type attributes in the database.

4.3.3 Interpretation Procedure

The year of the aerial imagery is entered for each polygon in the inventory project. The interpreter is responsible for projecting previous data sources to the year of imagery for all inventory projects.

The Ministry uses Variable Density Yield Prediction (VDYP) software to "grow" or "project" the age, height, volume and other attributes of polygons over time. The "reference year" for each polygon that data is related to must be recorded appropriately for old data sources to enable the prediction software to provide the correct projected attributes in current and future years.

Old data sources are a valuable source of information for interpreters, but not all of the data may be present. For example, an old call may have age and height information but not basal area and density. VDYP will only project data from one date, so all data that is provided must be related to the same year. A polygon cannot have attributes that are correct for 1979 (e.g. age and height), as well as attributes that are correct in 2010 (basal area and density). The attributes below must ALL relate to the same year. This year is recorded as the "Reference Year" regardless of the year of imagery.

- Age (leading and second species)
- Height (leading and second species)
- Basal Area
- Density

When all of the above data is available for a data source, then the data will be entered as-is from the original data source, and the "Reference Year" will be the date of collection of the original data source. As this data represents a single calibration point within the polygon, slight modifications to the attributes are allowed to accommodate the polygon variability. VDYP will perform the "projection" of age, height, etc., to the current and future years.

When any of the above items are not present in the old data source, portions of the data source attributes are not going to be used by the interpreter, or large modifications are made to the data source attributes, then the data source information must be revised (projected) by the interpreter so that all data is provided relative to the date of imagery. The date of imagery will be used as the "Reference Year." For example, the interpreter must increase the age and height in the ground call to represent what is visible in the imagery, which will now match the density and basal area that is visible in the photo.

Similarly, if a data source is NEWER than the year of imagery, all of the attributes must be referenced to the same year. In most cases, a newer call will be to the VRI standard, so the reference year will be recorded as the date of the calibration point (more recent) rather than the date of imagery (older).

4.4 Data Source Code

4.4.1 Definition

Data source refers to the primary source of information used for the attribute or attributes being described.

4.4.2 Purpose

The data source will provide an indication of the reliability of attribute descriptions. The data source may also be used to assess training issues, such as the reliability of estimates with various data sources.

4.4.3 Procedures

Data sources provide calibration points to aid in the determination of polygon attributes. The interpreter may (not) have data sources available within a polygon to aid in the interpretation. The interpreter will use available data sources (Table 4-1) and interpretive skills to make appropriate attribute estimations.

The interpreter will:

- Assign one data source code to each of the following attributes or set of attributes:
    - Ecological information (primarily SMR and SNR)
    - Species composition
    - Age of the leading species
    - Height of the leading species
    - Tree basal area
    - Tree density
- When two or more data sources occur within the same polygon for a specific attribute or set of attributes, use the attribute descriptions from the most appropriate source that describes the polygon estimate.
- When several data sources are available, reference only the source used in the polygon attribute estimate.
- In multi-layered stands, assign a data source code for each tree layer.

Table 4-1 Data source codes

Codes	Data Sources	Best Used to Describe
0	Photo interpretation	
1	Air call (air observation without 70 mm photography)	species composition
2	Air call from low-level, fixed base (70 mm photography)	species comp., height
3	Phase 1 photo sample (pre-1990)	
4	Ground call (pre-VRI)	age, height
5	Standard fixed radius sample (pre-1979)	age, height
6	Phase 2 or phase 3 sample (pre-1990)	species, age, height, density, basal area

Codes	Data Sources	Best Used to Describe
7	**Retired – Do Not Use** Silviculture surveys - stocking, survival, free growing, pre-stand tending	species composition, density, SMR, SNR
8	Ground observation with measurement	age, height
9	Research plots (e.g. Sx trials, ecological site description)	species, age, height
10	Valuation cruise plot(s)	basal area, species composition, height
11	Silviculture record – data from RESULTS. A record that summarizes stocking, regeneration, free growing, etc.	RESULTS data import
12	Disturbance - an area recently disturbed by fire, logging, windthrow, or insects that is classified as NSR. Has no source of information other than type and date of disturbance	
13	Managed stand sample	
14	Ground call with two or more points	age, height, species composition
16	Vegetation sample	age, height, density, basal area, SMR, SNR
17	Vegetation ground call	age, height, density, basal area, SMR, SNR
18	Vegetation air call	species composition, shrub height, shrub %
19	Natural growth sample	species, age, height
20	Volume and depletion sample	age, height
22	Photogrammetrically captured information that is determined or captured using photogrammetric means. An example of this is the determination of photo-measured heights using softcopy technology or parallax bars.	height
25	Pandemic or Catastrophic Event Modelling Adjustment (i.e. MPB, Spruce Budworm, etc.)	
26	Fire Modelling Adjustment	
27	Other Model Adjustments (e.g. Basal Area)	
28 and 29	Not Allocated	
30	LiDAR Model (i.e. derived) Values are modelled from the LiDAR/ground model	
31	LiDAR Canopy (calculated) Values are directly measured from LiDAR canopy data	
32 to 39	Not Allocated	

Codes	Data Sources	Best Used to Describe
40	LVI derived values are calculated from the LVI models	
41	LVI measured values are from photo interpretation and/or measured directly from a photo	
42 to 49	Not Allocated	
50	Medium Resolution interpreted satellite imagery (greater than 10 m resolution)	
51	High Resolution interpreted satellite imagery (less than 1o m Resolution)	
52 to 59	Not Allocated	
60	Low Level, high-res digital imagery ***interpreted*** (e.g. Digital Camera System, DCS) values from high-resolution photo interpretation	
61	Low Level, high-res digital imagery ***measured*** (i.e. Digital Camera System, DCS) measured directly from high-resolution photography	

4.4.4 Historical Data Sources

Historical Data Sources refer to data collected in previous inventory projects. These data sources could include ground or air calls from previous VRI projects or older data collected to various standards in place at the time of the project.

Interpreters must not use inventory classifications from the former forest cover inventory as a data source unless data source points are not available. For example, a previous inventory polygon may have data source code 4 (Ground Call 1 point). This label should NOT be used as a direct data source since the previous interpreter may have modified the label for the polygon to account for differences between the sample point and the rest of the polygon. New delineation will not match the historical polygon boundaries, so the interpreted data from the previous inventory may not relate to the existing polygon. The old interpretation could also be *in error*, and therefore ground or air measurements are preferable.

In Figure 4.2, a data source is shown in blue, old delineation from a previous inventory is shown in yellow and new delineation from a current project is shown in red. The data source POINT is still usable as a reference for red polygon A, but the polygon LABEL for the old forest cover, as shown in yellow, is not appropriate as a direct label to use for polygons A or B, as the label reflects the old delineation which covers portions of both new polygons.

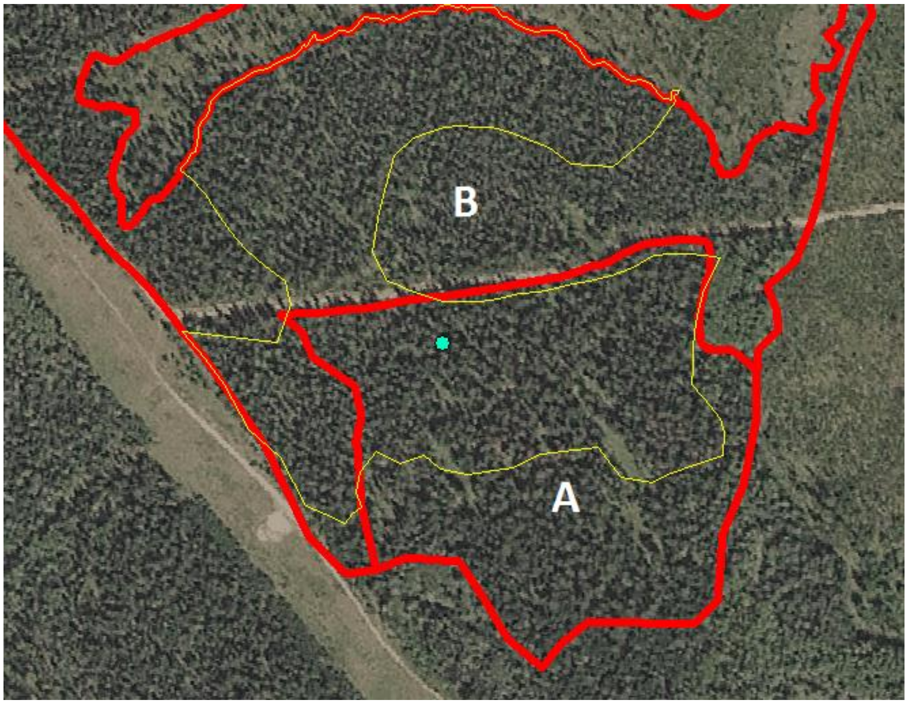


Figure 4-2: **Historical data source within old and new delineation**

A data source code that represents the data source type (e.g. old ground or air call, etc.) will be recorded for the polygon where the given attribute is used directly or is "grown" from the old data source, and the old data source falls within the polygon being interpreted. Extents of calls are not always available for old air calls, and only a call centre point may be present. Air call labels should be used with caution when applying to a new inventory. The call may have covered the entire polygon and, therefore, may not directly relate to the new delineation, similar to using the polygon label from the above example.

Not all data sources are of equal accuracy and reliability. Table 4-1 describes the relative reliability associated with various data source types.

Table 4-2 Reliability of various VRI and pre-VRI data source types by attribute

Data Source (Approximate Hierarchy of Reliability)	Attribute Variation					
	Age		Height		Species Composition	
	Even	Multi-Aged	Even	Multi-Height	Single Species	Mixed Species
VRI Data Sources						
VRI Ground Call	G	G	G	G	G	G

VRI Air Call	A	A	A	A	G	G
Pre-VRI/ Historical Data Sources						
Phase 2 or phase 3 samples (Pre-VRI volume ground sampling)	G	G	G	G	G	G
Regeneration Survey	G	G	G	G	G	G
Valuation Cruise Plots	G	G	G	G	G	G
Standard Fixed Radius Samples (pre-1979)	G	A	G	A	G	P
Pre VRI-Ground Call	G	A-G	G	G	G	G
Phase 1 Photo Sample	A-P	A-P	G	G	G	G
70mm Air Call	A	A	G	G	G	G
Standard Air Call (Without 70mm)	A	A	A	A	G	A-G
Historical Photo Interpretation	P-G	A	P-G	A	P-G	P-A

Historical data sources must also be recorded in the spreadsheet formats required by the Ministry. This data should be recorded in its original, un-projected state. Future interpreters will assess and provide additional data as required.

Transfer the start, middle and end point coordinates for historical air calls installed in 1990 or later. Only the midpoint coordinates are required from air calls installed before 1990.

Older inventories may have collected ages and heights in "classes, " which should not be transferred directly into the age and height fields on the calibration spreadsheet. The mid-pointed age and height for that class will be entered into the comments field, with the suffix "Age/height from mid-pointed classes."

All data sources should be transferred except when a justifiable case can be made to remove them (such as a major disturbance, large stand structure changes, calls obviously placed in the wrong location on a photo, or as defined in the contract document). Data sources that fit these criteria should not be transferred to the calibration tile.

4.5 Data Capture Method Code

The Data Capture Method Code describes the method that is used to capture all polygon boundaries. Most polygons being delineated by a photo interpreter will be recorded as "4" – photogrammetric, but other codes can be used. When a polygon boundary is taken directly from RESULTS, it will be coded with an "11", but if the line has been re-drawn because it was incorrect in RESULTS, a photogrammetric code of "4" should be used.

When a combination of sources is used for a polygon boundary, then record the code that corresponds to the source for the largest proportion of the polygon.

Other codes should only be used with the permission of the project manager and are not typically used during a photo interpretation project.

Table 4-3 Data capture method codes

Codes	Description	Possible Applications
4	Photogrammetric	Most photo interpreted polygons and imported water features lines from (TRIM/FWA)
7	Digitizing	Digitized directly from hard-copy sources
8	Scanning	
11	RESULTS	Lines incorporated directly from RESULTS
12	Other	
14	Medium Resolution Satellite Imagery (> 10 m resolution)	
15	Low-Resolution Satellite Imagery (< 10 m resolution)	
16	LiDAR Imagery (Light Detection and Ranging)	

4.6 Surface Expression

4.6.1 Definition

Surface expression refers to the form and patterns of form of the surficial material within the polygon. For more detailed definitions and diagrams, refer to *Terrain Classification System for British Columbia*, D. Howes and E. Kenk, MOE Manual 10, Version 2, 1997).

4.6.2 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.

4.6.3 Procedure

Assign the appropriate letter code (from Table 4-4) to each polygon. In polygons that have multiple components, record the prevalent surface expression of the polygon on the basis of the greatest percent area coverage.

Table 4-4 Description of surface expression

Codes	Description
C	**Cone** A cone, or segment of a cone, with a relatively smooth slope gradient greater than 15 degrees (>25%).
D	**Depression** Circular or irregular area of lower elevation (such as a hollow) than the surrounding terrain; depressions are greater than two metres deep. Examples are kettle holes and karst depressions
F	**Fan** A smooth segment of a cone with a slope gradient of up to 15 degrees (25%). Typically applied to fluvial or alluvial fans.
H	**Hummock(s)** Steep-sided hillocks and hollows with slopes of 15 to 35 degrees (25 to 70%) predominantly on unconsolidated materials and slopes of 15 to 90 degrees (25% to vertical) predominantly on bedrock. Slopes are non-linear (not parallel) but, generally, chaotic or dissected and rounded or irregular in profile. Local relief is greater than one metre. Differentiated from undulating on the basis of slope angle.
M	**Rolling** Elongated hillock(s) with slopes dominantly between 3 and 15 degrees (5 to 25%) with local relief greater than one metre. Slopes are an assemblage of parallel or sub-parallel linear forms with subdued relief and may occur in level or sloping meso slope positions.
N	**None** of these descriptions apply as no apparent surface expression features are present.

Codes	Description
P	**Plain** A level or gently sloping unidirectional surface with gradients of up to three degrees (5%). Local surface irregularities generally have a relief of less than one metre. Commonly applied to floodplains, organic deposits, lacustrine and marine plains, and the level portions of terraces and deltas.
R	**Ridge(s)** 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. Differentiated from rolling on the basis of slope angle. Possible locations include drumlinized till plains, eskers and ridged bedrock. These may be created through the erosional effects of water.
T	**Terrace(s)** Step-like topography where each step-like form consists of both a scarp face and a horizontal or gently inclined surface above it. The terrace description is applied to both the scarp and the flat surface.
U	**Undulating** Gently sloping hillock(s) and hollow(s) with slopes of up to 15 degrees (25%). Local relief is greater than one metre. Slopes are non-linear (not parallel), chaotic forms that are rounded or irregular in profile.

4.7 Modifying Processes

4.7.1 Definition

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

4.7.2 Purpose

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

4.7.3 Procedure

Assign the appropriate code (from Table 4-5) to each polygon. The code is recorded for the most predominant modifying process within the polygon on the basis of percent area coverage. When a modifying process is not observed in the polygon, "N" (i.e., None) should be entered in the column for this attribute. A process is considered active if there is evidence of a current or recent occurrence or likely future occurrence. This is not defined in quantitative terms (such as every 25 years) as the quantitative assessment of frequency is often very difficult.

Table 4-5 Description of modifying processes

Codes	Description
A	**Avalanching** Slopes modified by the rapid downslope movement of snow and ice and by the deposition of rock debris, surficial material and vegetation debris transported by snow avalanches. Sites usually contain avalanche chutes and run-out zones but may also be affected by ice falling from glaciers.
B	**River channelling** Erosion and channel formation by the flow of water within clearly defined banks.
F	**Mass movements** Downslope movement of cohesive or non-cohesive surficial material and/or bedrock by creeping, sliding, flowing or falling. This includes rock and debris slides, soil slumps and talus slopes.
N	**None** of these descriptions apply; no modifying processes are observed in the polygon.
U	**Flooding** Areas subject to periodic (possibly seasonal) inundation with subsequent deposition of soil particles. Commonly applied to ephemeral lakes.
V	**Gully erosion** Modification of unconsolidated or consolidated surfaces by processes such as running water and snow avalanching that result in the formation of parallel or sub-parallel long, narrow ravines. Singular gullies are not generally included in this class.

4.8 Site Position Meso

4.8.1 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 from 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).

4.8.2 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.

4.8.3 Procedure

The various descriptions of meso slope by site position are illustrated in Figure 4.3. A code is recorded for each polygon 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 4-6.

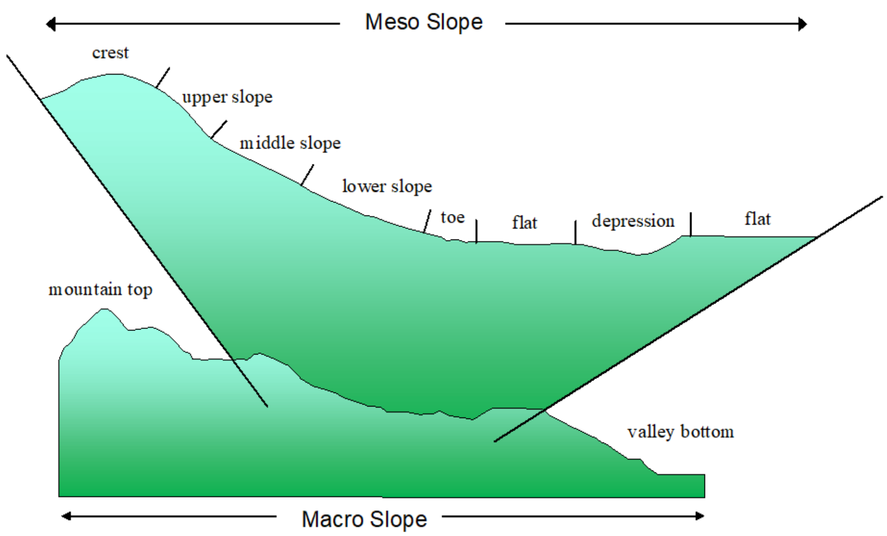


Figure 4-3 Schematic of site position meso interpretation

Table 4-6 Description of site position meso

Codes	Description
C	**Crest** The generally convex uppermost portion of a hill (meso scale). It is usually convex in all directions and generally has no distinct aspect. The term "crest" may also be applied to a ridge.
U	**Upper slope** 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.
M	**Middle slope** The area of the slope of a hill between the upper and lower slope, where the slope profile is not generally concave or convex. It has a straight or somewhat sigmoid surface profile with a specific aspect.

Codes	Description
L	**Lower slope** The area toward the base of the slope of the hill. It generally has a concave surface profile with a specific aspect.
T	**Toe** The area differentiated from the lower slope by an abrupt decrease in slope gradient. It is often characterized by seepage.
D	**Depression** Any area that is concave in all directions. It is generally at the foot of a meso scale hill or in a generally level area.
F	**Flat (Level)** Any level area not immediately adjacent to a meso scale hill (or toe). The surface profile is generally horizontal with no significant aspect.

4.9 Alpine Designation

4.9.1 Definition

Alpine designation pertains to one category of landscape position (the third level of the BC Land Cover 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 regime (SMR) will identify Wetlands.

4.9.2 Purpose

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

4.9.3 Procedure

The polygon is interpreted to see if it is above or below the tree line. The boundary between Upland and Alpine is drawn using the upper elevation of the discontinuous treed area. The alpine areas will not typically include parkland and krummholz forest types.

Note: **Alpine** is the land area above the maximum elevation for trees.

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 at a consistent elevation (varying with aspect) is necessary as cliffs, rock outcrops, and avalanche chutes often dissect the Alpine/Upland transition.

Assign the appropriate code to each polygon (see Table 4-7).

Table 4-7 Description of alpine designation

Codes	Description
A	**Alpine** The land area above the maximum elevation for tree species. It is dominated in the vegetated areas by shrubs, graminoids, forbs, bryoids or lichens. Much of the alpine is non-vegetated, covered primarily by rock, ice, and snow. The Alpine is treeless by definition. Do not describe trees in the Alpine.
N	**Not Alpine** Areas not included in Alpine areas, as defined above.

4.10 Soil Nutrient Regime

4.10.1 Definition

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

4.10.2 Purpose

Soil nutrient regime is an interpretive attribute that, together with soil moisture regime, is used to assist in site series identification.

4.10.3 Procedure

Assign one of the SNR alphabetic codes to the polygon. The code is recorded for the dominant SNR of the polygon based on percent area coverage. As outlined on Table 4-8, SNR is potentially a six-point scale from A to F. However, F (saline, excess accumulations of a 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.

Table 4-8 Soil Nutrient Regime classes

Codes	SNR Classes	Codes	SNR Classes
A	Very poor	**D**	Rich
B	Poor	**E**	Very rich

C	Medium	**F**	Ultra-rich (saline, excess accumulations of a variety of salts).

Keys for the 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 4-9 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.

In polygons where soil is not available for vascular plants to grow in, record the soil nutrient regime as A. Polygons that have the following dominant strata types have an SNR default value of A:

> Lakes, rivers, reservoirs, saltwater, glaciers, road surface (paved, not gravel), buildings and parking and airports (paved, not gravel).

Note that this does not apply to polygons where the above features are not the dominant type. Normal procedures apply to polygons that are vegetated or non-vegetated, and they have one of the listed cover types as a non-dominant portion of that polygon.

For water bodies, note that the standard code for the ecology features is:

Surface expression = D (depression)
Modifying processes = N (none)
Site position meso = D (depression)
Alpine designation = A or N, dependent on landscape location
Soil nutrient regime = A (very poor)

Table 4-9 A selection of attributes to assist estimation of SNR through photo interpretation

Generalized SNR	Poor		Medium	Rich	
Soil Nutrient Regime	A very poor	B poor	C medium	D rich	E very rich
Site Position Meso	upper		middle	lower	
Mineral Soil Matrix	coarse		medium	fine	
Cover Of Rock Outcrops	high (>50%)		medium (15-50%)	low (<15%)	

Rock Type	conglomerate quartzite sandstone	other rock types	dolomite limestone
Relative Productivity	Low	Medium	High
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	<-----------------------Ss------------------->		
Bigleaf maple	<---------------Mb------------------->		
Tamarack	<----------------Lt-------------------->		
Balsam poplar	<---------Acb------------------>		
Black cottonwood	<---Act------------------->		

Note: These are only guidelines and are not intended to substitute 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.

5 Land Cover Component Attributes

5.1 Introduction

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. The intent is to determine the *ecological function* of the polygon. For each land cover component identified within a polygon, percent area coverage and a soil moisture regime will be recorded. For information on deriving land cover class and soil moisture regime at the polygon level, refer to Section 13 *Derived Attributes*.

The process of determining Land Cover Components is independent of the derived BC Land Cover Classification Scheme. For example, 8% vegetated cover on a talus slope; the Land Cover Component for this polygon would still be TA100.

5.2 Land Cover Components (LCC #1, #2, #3)

5.2.1 Definition

Land cover component identifies the ecological function of the polygon or portions of the polygon.

5.2.2 Purpose

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

5.2.3 Procedure

Enter the appropriate two-letter code (see Table 5-1) for any polygon component that:

- Consists of continuous area(s) that are individually greater than or equal to 10% of the polygon area
- Would otherwise be delineated and classified at approximately twice the map 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.

When more than three components exist, the remaining percent cover is recorded under "Other Land Cover Component Percent Coverage."

Table 5-1 Land cover component codes

Codes	Description
TB	**Treed Broadleaf** A Treed polygon where 75% or more of the live tree basal area, expressed as percentage species composition, consists of broadleaf cover.
TC	**Treed Coniferous** A Treed polygon where 75% or more of the live tree basal area, expressed as percentage species composition, consists of coniferous cover.
TM	**Treed Mixed** A Treed polygon where neither coniferous nor broadleaf cover individually constitutes at least 75% of the live tree basal area, expressed as percentage species composition.
ST	**Shrub Tall** A Shrub polygon with shrub height of two metres or more.
SL	**Shrub Low** A Shrub polygon with shrub height of less than two metres.
HE	**Herb** A Herb polygon with no distinction between forbs and graminoids.
HF	**Herb - Forbs** A Herb polygon with forbs greater than 50% of the herb cover.
HG	**Herb - Graminoids** A Herb polygon with graminoids greater than 50% of the herb cover.
BY	**Bryoid** A Bryoid polygon with no distinction between mosses and lichens.
BM	**Bryoid - Moss** (bryophytes) A Bryoid polygon with bryophytes greater than 50% of the bryoid cover.
BL	**Bryoid - Lichens** A Bryoid polygon with lichens greater than 50% of the bryoid cover.
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 ice and snow cover 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.
PN	**Snow Cover** Snow or ice that is not part of a glacier but is found during the summer months on the landscape. (Care should be taken to determine if the snow on the imagery is a result of the photo acquisition date. In such cases, the delineation or attribution procedure should be discussed with the Ministry).

Codes	Description
RO	**Rock / Rubble** Bedrock or fragmented rock broken away from bedrock surfaces and moved into its present position by gravity or ice. Extensive deposits are found in and adjacent to alpine areas and are associated with steep rock walls and exposed ridges; canyons and cliff areas also contain these deposits.
BR	**Bedrock** Unfragmented, consolidated rock contiguous with underlying material.
TA	**Talus** Rock fragments of any size accumulated on or at the foot of slopes as a result of successive rock falls. This is a type of colluvium.
BI	**Blockfield** Blocks of rock derived from the underlying bedrock by weathering and/or frost heaving. These have not undergone any significant downslope movement as they occur on level or gently sloping areas.
MZ	**Rubbly Mine Spoils** Discarded overburden or waste rock, moved to extract ore during a mining operation.
LB	**Lava Bed** An area where molten rock has flowed from a volcano or fissure and cooled and solidified to form 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, such as areas of recent disturbance that include mudslides, debris torrents, avalanches, or disturbances such as pipeline rights-of-way where vegetation cover is less than 5%. Exposed soil resulting from harvesting operations is recognized in this category; however, harvested polygons must maintain vegetated status.
CL	**Cultivated Land** Land that is worked by plowing and sowing and raising crops, including orchards and vineyards.
DW	**Downed Wood** Consolidated coarse woody debris, blowdown, log deck, burn pile, or area of downed trees.
UC	**Utility Corridor** Land that is perpetually cleared and occupied by pipelines or transmission lines.

Codes	Description
LS	**Pond or Lake Sediments** Exposed sediments related to dried-up 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** An area with sorted sediments reworked in recent time by wave action. It may be formed at the edge of freshwater or saltwater 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 5% crown cover is present at the time of polygon description.
RZ	**Road Surface** An area cleared and compacted for transporting goods and services by vehicles. Older roads that are used infrequently or not at all may cease to be classed as Non-Vegetated.
MU	**Mudflat Sediment** Flat plain-like areas associated 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 by excavation into the hillside.
MN	**Moraine** An area of debris transported and deposited by a glacier.
GP	**Gravel Pit** An area exposed through the removal of sand and gravel.
TZ	**Tailings** An area containing the solid waste material produced in the mining and milling of ore.
RN	**Railway** A roadbed with fixed rails that may contain single or multiple rail lines.
UR	**Urban** Buildings and associated developments such as roads and parking areas which form an almost continuous covering of the landscape.
AP	**Airport** A permanent, paved or gravel area, and associated buildings and parking used by airplanes.

Codes	Description
MI	**Open Pit Mine** An exposed area used to extract ore during a mining operation. This may contain associated buildings and any tailing produced by the mining and milling process.
OT	**Other** A Non-Vegetated polygon where none of the above categories can be reliably chosen.
	Water Cover
LA	**Lake** A naturally occurring static body of water. The boundary for the lake is the natural high-water mark.
RE	**Reservoir** An artificial basin affected by impoundment behind a 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 but does not include ephemeral flow where a channel with no definable banks is present. Gravel bars are part of a stream, while islands within a stream that has definable banks are not.
OC	**Ocean** A naturally occurring body of water containing salt or generally considered to be salty.

5.3 Land Cover Component Percent (LCC #1, #2, #3)

5.3.1 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.

5.3.2 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.

5.3.3 Procedures

Examine the polygon to determine how many land cover components are present. Individual component pieces that make up less than 10% of the polygon area should not be estimated for land cover components. Each land cover component should have a minimum of one contiguous piece that makes up at least 10% of the polygon area. Individual pieces or patches that are individually at least 10% of the polygon may be combined such that the amalgamation of those individual pieces could constitute 20% of the polygon area or greater.

Record land cover component percent in descending order 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. When more than three components exist, the remaining percent cover is added to the largest Land Cover Component.

5.4 Soil Moisture Regime (LCC#1, #2, #3)

5.4.1 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.

5.4.2 Purpose

SMR is an interpretative attribute to aid in the estimation of site potential and site series classification.

5.4.3 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 (see Table 5-2) for each land cover component (LCC #1, #2, #3) identified in the polygon.

Table 5-2 Soil moisture regime classes

Codes	SMR Classes	Codes	SMR Classes
0	very xeric	5	subhygric
1	xeric	6	hygric
2	subxeric	7	subhydric
3	submesic	8	hydric
4	mesic		

It is difficult to consistently and reliably assign SMR classes from stereo imagery. However, for most polygons, it should be feasible to determine the "generalized" SMR outlined in

Table 5-3 and Figure 5.1, 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.

For land cover components where soil is not available for vascular plants to establish and grow in, the soil moisture regime field should be recorded as zero (0).

As each land cover component is given a unique SMR value, it is possible that a particular polygon may have both an LCC with an SMR value and an LCC without an SMR value.

The following cover types should have a zero (0) attribute in the SMR field:

- Road surfaces
- Buildings
- Parking lots
- Airports

Soil moisture attribute should be recorded as a blank for lakes, rivers, reservoirs, saltwater and glaciers.

Guidelines

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

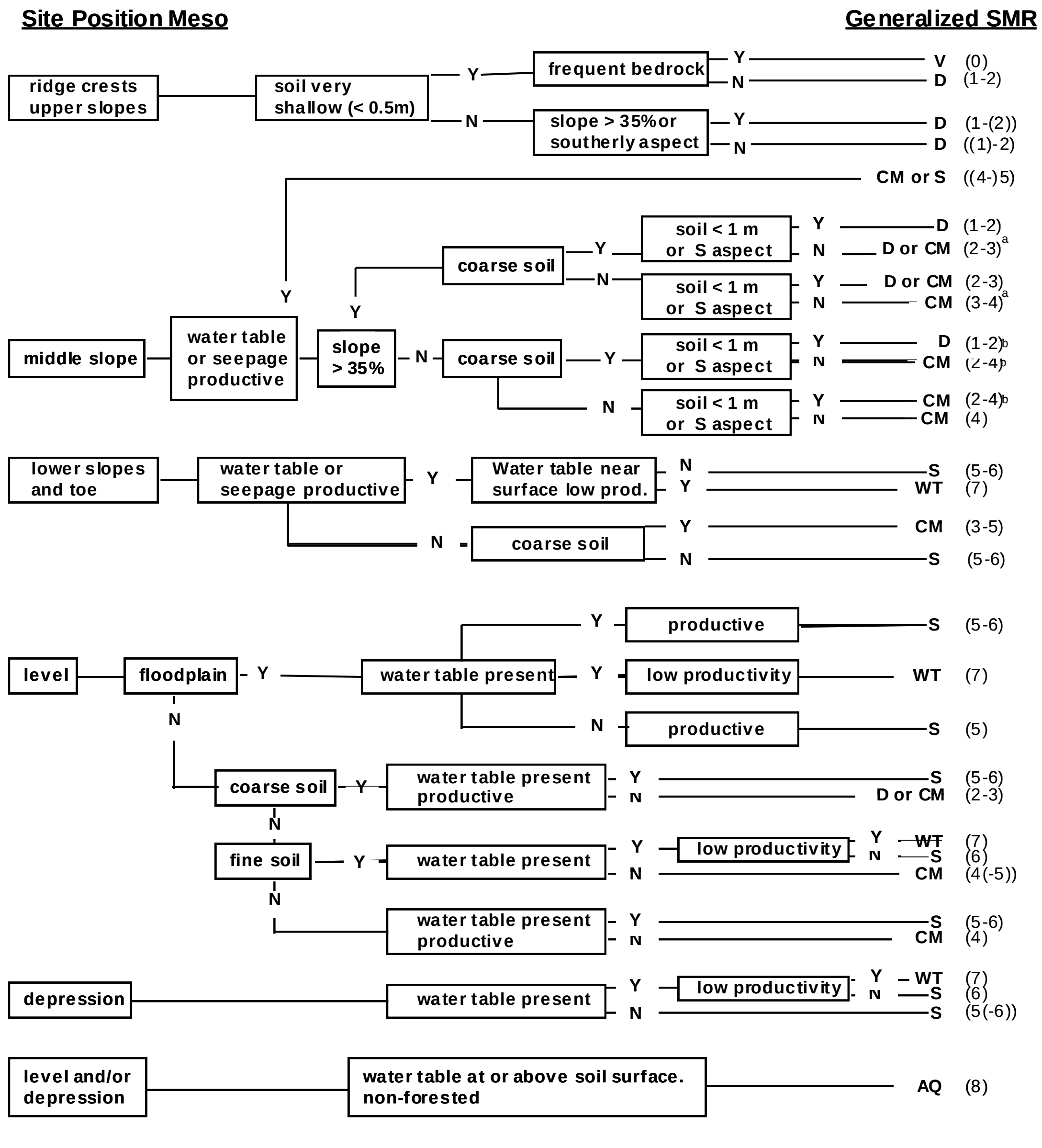
- SMR can be inferred from selected physiographic and soil features
- SMR classes, particularly 0 to 5, do not reflect the actual amount of available water as this is a function of climate
- SMR is based on annual water balance and water table depth
- Very dry and dry classes represent growing season 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

Table 5-3 and Figure 5.1 will assist in the photo interpretation of SMR. Table 5-3 indicates the relationship between SMR and soil nutrient regime (SNR). It also provides assistance to the photo interpreter in determining generalized SMR.

Table 5-3 Relative and generalized SMR and SNR Guide

		GENERALIZED SOIL NUTRIENT REGIME						
		P		M		R		GENERALIZED
SOIL	PRIMARY	poor		medium		rich		SOIL
MOISTURE	WATER	RELATIVE SOIL NUTRIENT REGIME						MOISTURE
REGIME	SOURCE	A very poor	B poor	C mediu m	D rich	E very rich	F ultra-rich, saline	REGIME
VERY XERIC 0	precipitation							VERY DRY (V)
XERIC 1	precipitation							
SUBXERIC 2	precipitation							DRY (D)
SUBMESIC 3	precipitation							
MESIC 4	precipitation in moderately fine-textured soils & limited seepage in coarse-textured soils							CIRCUM-MESIC (CM)
SUBHYGRIC 5	precipitation and seepage							
HYGRIC 6	seepage							SEEPAGE (S)
SUBHYDRIC 7	seepage of permanent water table							WET (WT)
HYDRIC 8	permanent water table							AQUEOUS (AQ)

Adapted from A Field Guide for Site Identification and Interpretation for the Vancouver Forest Region, LMH 28, 1994



[a] **Generally moister if aspect is N or NE**

[b] **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 5-1 Key to photo-interpretation of soil moisture regime

Examples of Land Cover Components

Criteria for the delineation of land cover polygons are presented in Section 3 of this manual. Under ideal conditions, land cover can be delineated into uniform or "like" land cover communities (referred to as polygons), 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 sometimes 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 5.2 summarizes the various possibilities of classification using land cover component identification.

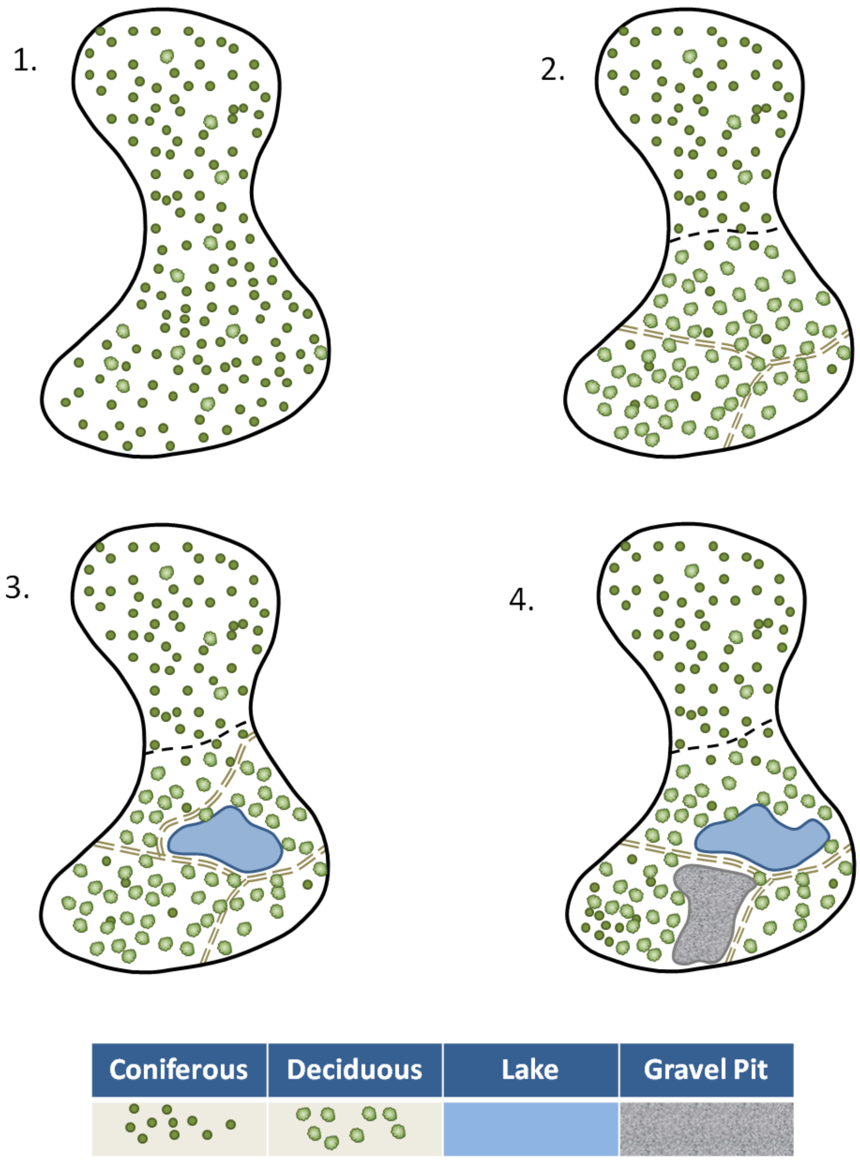


Figure 5-2 Examples of land cover components

Table 5-4 lists the criteria used to classify each polygon example.

Table 5-4 Land cover components summary

Example	LCC1 Code	LCC1 %	LCC1 SMR	LCC2 Code	LCC2 %	LCC2 SMR	LCC3 Code	LCC3 %	LCC3 SMR	Other LCCs
1	TC	100%	5	-	-	-	-	-	-	-
2	TC	50%	5	TB	50%	6	-	-	-	-
3	TC	50%	5	TB	40%	6	LA	10%	-	-
4(a)	TC	50%	5	TB	30%	6	LA	10%	-	10%
4(b)	TC	50%	5	TB	30%	6	GP	10%	0	10%

Figure 5.3 illustrates a uniform polygon of both coniferous and broadleaf tree cover. There may be a variety of land cover, such as shrubs, herbs, etc., visible between the trees, but since the primary ecological function of the polygon is treed base, any land cover components identified must be treed. Since coniferous coverage (by basal area) is greater than 75% in all parts of the polygon (see Section 1 Land Cover Classification Scheme), it is "Treed Coniferous - TC" throughout. There is no portion of the polygon that is 10% or more by area that represents another land cover type.

1.

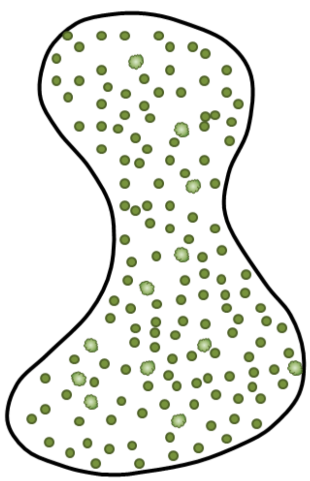


Figure 5-3 Land cover components - Example #1

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. As an example, assume that in Figure 5.3, 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 Douglas-fir and the lower part of the polygon by lower slope white spruce, there may be two land cover components identified:

1. TC 50% SMR = 5
2. TC 50% SMR = 7

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

In Figure 5.4, the polygon consists of both coniferous and broadleaf tree cover, as well as short road surface sections. Two distinct communities of land cover can be identified.

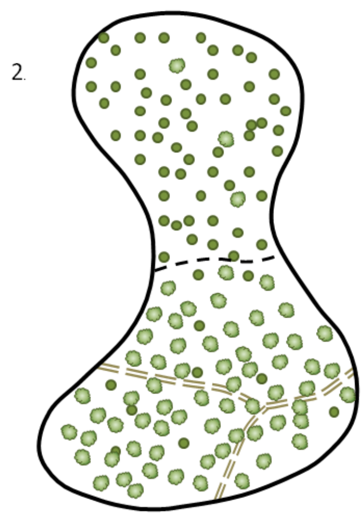


Figure 5-4 Land cover components - Example #2

Although the road is a distinct form of land cover, it is not of sufficient size (at least 10% of the polygon area) to be indicated as a land cover component. The description of it as a distinct land cover component is unnecessary.

All land cover visible to the photo interpreter is fully described in attributes other than land cover components, and, in this example, "RZ" would be included as a Non-Vegetated Cover Type (see Section 11.2) with a Non-Vegetated Cover Percent (see Section 11.3) of 4% and a Non-Vegetated Cover Pattern (see Section 11.4) of "2."

In Figure 5.5, three land cover components are observed.

3.

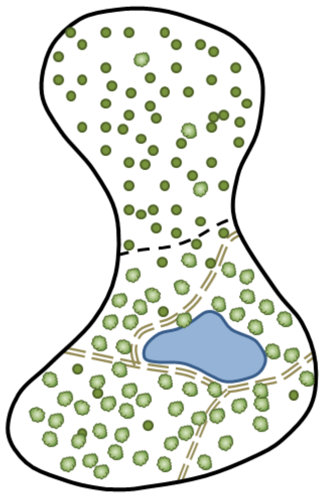


Figure 5-5 Land cover components - Example #3

The top portion of the polygon is dominated by greater than 75% coniferous cover (by basal area) and is considered to be a "Treed Coniferous - TC" cover component.

In the lower portion of the polygon, broadleaf cover dominates with a greater than 75% portion of the total basal expressed as species composition. 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 total polygon area. It is included as land cover component #3. The road cover is less than 10% and, although it is distinct, it is not included as an "Other Land Cover Component." Note that both the road and the lake will need to be included as a Non-Vegetated Cover (see Section 11) in the overall polygon description.

In Figure 5.6, there are several distinct land covers present.

4.

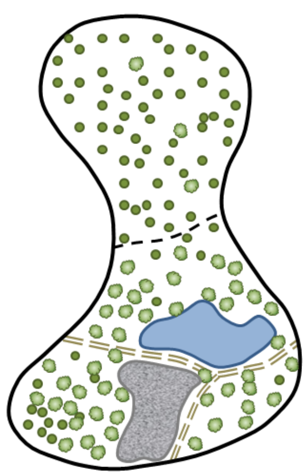


Figure 5-6 Land cover components - Example #4

The two 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 5-4). The road is included within the "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.

6 Site Index Attributes

6.1 Introduction

All polygons with trees and polygons that 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: the 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, where the site index is present, attributes will be obtained from silviculture field surveys unless declared free growing, and the interpreter determines that the trees are suppressed and do not reflect the potential site productivity.

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

- Polygons with trees less than 30 years old (total age). Layers consisting of live or dead trees less than 30 years require an estimated site index
- 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
- Polygons occupied by trees planted outside their normal ecological range or are occupied by suppressed trees that do not reflect the potential site productivity of the polygon

The following sections describe the process of estimating site index values. For more information on site index derivation, see Section 12 *Derived Attribute*s.

6.2 Estimated Site Index Species

6.2.1 Definition

The estimated site index species are the tree species from which the site index for the polygon is derived.

6.2.2 Purpose

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

6.2.3 Procedure

The interpreter will enter the site index species for:

- Polygons with trees less than 30 years (total age)
- Polygons currently non-treed but capable of producing trees (including completely dead stands)
- Polygons occupied by trees that have been planted outside their normal ecological range or occupied by suppressed trees that do not reflect the potential site productivity of the polygon

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

- From the existing tree species
- From adjacent, similar stands
- From an assessment of ecological factors
- From ground information calibration points

6.3 Estimated Site Index

6.3.1 Definition

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

6.3.2 Purpose

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

6.3.3 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.

Alternative data sources may be used when assigning an estimated site index to:

- All layers with trees (live or dead) less than 30 years (total age)
- Polygons that are occupied by trees that have been planted outside of their normal ecological range or occupied by suppressed stands that do not reflect their potential site productivity
- Non-treed areas with or without shrub or tree cover 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 lodgepole pine area with no current 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 6.1, establish the polygon's relevant slope position from which the site index can be interpreted. When the polygon is in the receiving zone, the site index value is interpreted as 15 m.

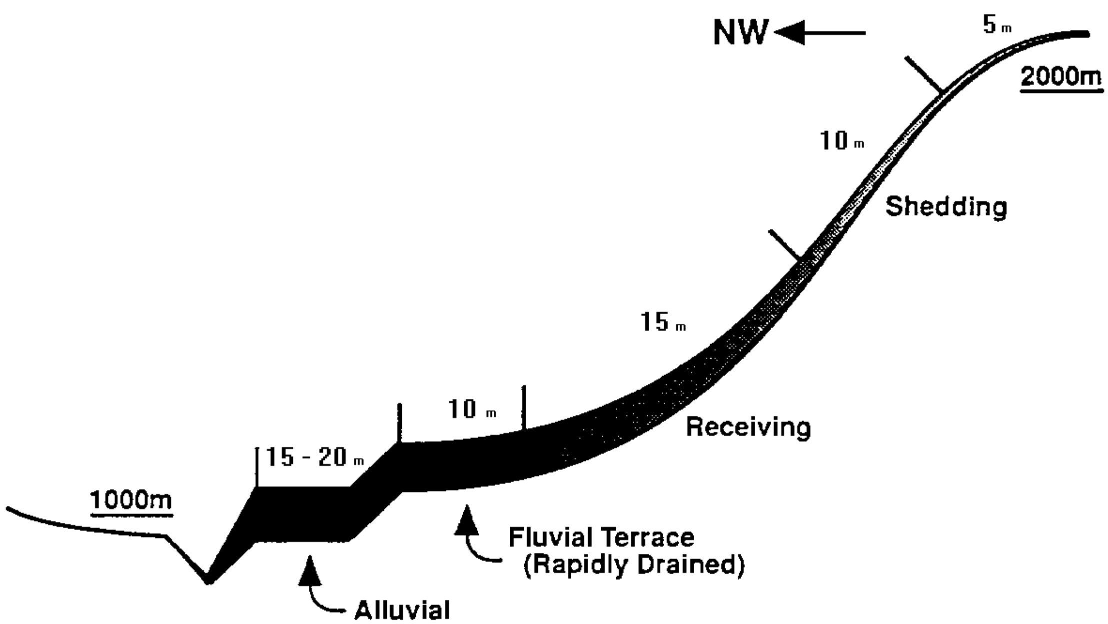


Figure 6-1 Site productivity for pine stands in the Upper Elk Valley near Fernie

6.4 Estimated Site Index Source

6.4.1 Definition

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

6.4.2 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.

6.4.3 Procedure

Assign the appropriate letter code to identify the site index source (see Table 6-1).

Table 6-1 Estimated site index source codes

Codes	Description
A	**Adjacent stand** The site index is assigned using information from adjacent stands with similar species, age and height.
C	**Site Index curve** The site index assigned using Site Index curves based on age and height inputs
E	**Ecological correlation** 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 are attained from tabular values.
H	**Historical** Derived from the site index value of the previous stand with no change to the site index value.
I	**Growth intercept** This is a field procedure carried out on stands that have at least five years of growth above breast height but are less than 30 years old. It is determined during a silviculture survey.
S	**Silviculture section** Assigned by the District Silviculture section when the method of determination is unknown (potential methods can be the growth intercept, ecological correlations, historical, or adjacent stands).
P	**Site Productivity Layer** Assigned from the provincial site productivity layer.

7 Tree Attributes

7.1 Introduction

Tree attributes are layer-specific polygon estimates. The polygon is uniquely identified, and subsequent qualitative and quantitative measurements are made for the tree cover in each layer of the polygon.

For normal aerial imagery, it is expected that estimation quality assurance of tree attributes would be performed at the largest ground scale of approximately 1:3,000 in order to maintain consistency between interpreters and for Quality Assurance purposes. This may be modified on a project-specific basis.

In cases where there is a discrepancy in photo estimation between the photo interpreter and Quality Assurance personnel, the Quality Assurance personnel will adjust the viewing to a larger scale in order to better assess the original estimate.

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)
- Height (leading and second species)
- Update year
- Basal area
- Density
- Snag frequency

Attribution procedures for edge tying attributes

The interpreter may be instructed to join attributes between currently ongoing projects or older projects completed in previous years (edge ties). Typically, interpreters will only tie to inventories completed to the current VRI standard, but decisions on whether to tie to adjacent projects will be determined by the Ministry on a contract-specific basis.

Attributes from adjacent projects should be carried over unless otherwise stated in the contract; however, it is the interpreter’s responsibility to ensure attributes meet VRI standards.

When an interpreter is to edge tie attributes to another project, all attributes must match exactly, with a number of exceptions:

- The types stop at the project boundary – this may occur at cutblock edges that end at a TSA or TFL boundary, where the line separating two adjacent polygons will stop at a cutblock boundary that happens to be on the edge of the project.
- A significant change has occurred between the two projects. Examples include insect outbreaks or wildfires that occurred after the adjacent inventory was completed and prior to the imagery being taken in the current inventory.
- The attributes on the adjacent inventory are clearly incorrect. Minor differences should still be tied as is.
- New Silviculture opening information is available. The attributes will be updated to reflect new RESULTS data even if it creates an edge tie mismatch.

Edge ties between individual submissions in a project should follow the same guidelines, but where the difference is because one side is "clearly incorrect" polygons must be corrected on both sides of the edge tie.

Usually, the edge of files delivered as a final product will follow mapsheet neatlines.

It is the interpreter’s responsibility to ensure that edge ties make sense as per the existing photos and data supplied to support the contract.

7.2 Tree Cover Pattern

7.2.1 Definition

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

7.2.2 Purpose

Tree cover pattern is used to describe the tree layer spatial distribution. Examples include treed islands in the subalpine parkland, clumps of trees on rocky outcrops, scattered groves or individual trees in an otherwise shrubby flood plain or solid, continuous tree cover. A tree cover pattern provides information on the amount of "edge" and "interior" habitat within the polygon.

7.2.3 Procedure

Enter the cover pattern code (1-9) from Appendix B 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 stereoscope and interpret the cover pattern in this manner.

7.3 Tree Crown Closure

7.3.1 Definition

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

7.3.2 Purpose

Tree crown closure provides an essential estimate of the vertical projection of tree crowns upon the ground. Since tree crown closure is very difficult to measure on the ground, this estimation by the interpreter is important.

7.3.3 Procedure

Crown closure can be estimated to the nearest percent for the polygon. Where vegetation is overlapping (such as a two-layer stand), only the visible portion of each layer is estimated for crown closure. Crown closures greater than 10% are typically estimated in 5% increments.

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 imagery, select a representative part of the polygon. Compare the relative crown densities of the comparison chart (see Appendix C) 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 and Colour Stereogram Handbook**

  These handbooks have photo examples with measured crown closure values. They include 70 mm photo samples and measured photo samples that can be used as calibration values.

7.4 Tree Layer

7.4.1 Definition

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

7.4.2 Purpose

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

7.4.3 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. For example, trees from the former stand may be identified as a layer with less than 5% crown closure. 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 is 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 throughout the type
- Each layer should consist of different tree species except when the layer separation is distinct
- Differences in age and height between layers should be identifiable on the imagery and on the ground
- Layers should differ by 40 years in age and 10 m in height. (Note: Silviculture layers that are provided from RESULTS may not follow this convention. This is acceptable.)
- The bottom layer is usually established following a major disturbance such as fire or logging

Examples of multi-layered stands are shown in Appendix A.

Any stand that has more than an estimated 100 sph mortality would have a dead layer interpreted and is identified with the layer code of "D." Only one dead layer (D layer) is to be collected for each stand, incorporating the dead even if they would have been collected as separate layers if they were alive. A tree is considered "dead" for the purposes of the VRI if it has no foliage (seasonally dependent for deciduous and Larch) or if all the foliage has the visible colour that is appropriate for a dead tree of that species.

The only attributes to be collected for a dead layer include the species composition, age of the leading species, the height of the leading species, basal area, stems/ha and a data source code for each. Requirements for the recording of each attribute are located in the sections below. An appropriate disturbance code should also be collected where observed.

Site index attributes must be entered for all polygons with only a dead layer. Since these polygons are non-treed but capable of producing trees, estimated site index is required as per Section 6.2.3 – Site Index Attributes. (This may need a layer 1 for site index accessibility)

7.5 Vertical Complexity

7.5.1 Definition

Vertical complexity is a subjective classification that describes the form of each tree layer as indicated by the relative uniformity of the forest canopy as it appears in aerial imagery. Vertical complexity is influenced by stand age, species (succession as it relates to shade tolerance), and degree and age of past disturbance. The tree height range is calculated as the total difference in height between the tallest and shortest visible dominant, codominant, and high intermediate trees. To most adequately represent the tree layer of interest, occasional occurrences of either very tall or very short trees should be ignored so that the vertical complexity indicated is for the majority of stems in the dominant, codominant, and high intermediate portion of each tree layer.

7.5.2 Purpose

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

7.5.3 Procedure

Select the most appropriate code from Table 7-1 to best describe the vertical complexity for each tree layer in the polygon.

Example Calculation:

The following is an example of the calculation to determine the percent difference in tree height for the assignment of the Tree Vertical Complexity code. The Leading Species Height (dominant, codominant, and high intermediate trees) is 23 m, and the tree heights range from 20 m to 26 m (all species in the dominant, codominant, and high intermediate crown positions) for a total tree height range of 6 m:

> Percent difference = Tree height range ÷ Height of leading species × 100 = 6 ÷ 23 × 100 = 26%

A difference of 26% correlates to a vertical complexity code 3 for the tree layer.

Notwithstanding the calculations above, plantations and young, immature stands less than 30 years of age must be recorded with a vertical complexity code of 1.

Table 7-1 Coding for vertical complexity

Codes	Description
1	**Very uniform** A very uniform canopy with less than 11% difference between the height of the leading species and the average tree layer height. Holes (or canopy gaps) are generally not visible in the canopy, and there is usually no evidence in the imagery of recent disturbances affecting the form of the stand. Examples include plantations and young, immature stands of shade-intolerant species.
2	**Uniform** A uniform canopy with 11% - 20% difference between the height of the leading species and the average tree layer height. A few holes (or canopy gaps) may be visible in the canopy, and there is usually little or no evidence on the imagery of recent disturbance affecting the form of the stand.
3	**Moderately uniform** A moderately uniform canopy with 21% - 30% difference between the height of the leading species and the average tree layer height. Some holes (or canopy gaps) may be visible in the canopy, and there may be evidence of past disturbance affecting the form of the stand. Stocking may be somewhat patchy or irregular. Examples include older spruce-balsam stands.
4	**Non-uniform** A relatively non-uniform canopy with 31% - 40% difference between the height of the leading species and the average tree layer height. Holes (or canopy gaps) are often visible in the canopy (due to past disturbance), and stocking is typically patchy or irregular.
5	**Very non-uniform** A very non-uniform canopy with more than a 40% difference between the height of the leading species and the average tree layer height. Stocking is typically very patchy or irregular. Examples include disturbed dry belt Douglas-fir stands and decadent, coastal over-mature stands.

<u>Example:</u>

Average Tree	**Tree Height Range (m) by Vertical Complexity Code**				
Layer Height (m)	1	2	3	4	5
10	0 - 1.0	1.1 - 2.0	2.1 - 3.0	3.1 - 4.0	> 4.0
20	0 - 2.0	2.1 - 4.0	4.1 - 6.0	6.1 - 8.0	> 8.0
30	0 - 3.0	3.1 - 6.0	6.1 - 9.0	9.1 - 12.0	> 12.0
40	0 - 4.0	4.1 - 8.0	8.1 - 12.0	12.1 - 16.0	> 16.0
50	0 - 5.0	5.1 - 10.0	10.1 - 15.0	15.1 - 20.0	> 20.0

7.6 Species Composition

7.6.1 Definition

Species composition describes the tree 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 (stands less than 2 metres).

7.6.2 Purpose

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

7.6.3 Procedure

Identify the tree species present in the polygon and list them in descending order. Up to six different species may be identified. Estimate species composition for each tree layer in the polygon.

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.

- When the height of the dominant, codominant and high intermediate trees is greater than or equal to two metres, the estimate is based on basal area occupancy (square metres per hectare).
- When the height of the dominant, codominant and high intermediate trees is less than two metres, the estimate is based on density (stems per hectare).

Note: Dominant trees have well-developed crowns that extend above the general level of the trees around them. Codominant trees have crowns forming the general level of trees around them. High intermediate trees have smaller crowns slightly below but extending into the general level of trees around them.

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 the knowledge of species heights, crown shapes, and other factors.

Species composition must add up to 100%.

Species composition for dead layers may be difficult to estimate. The interpreter will use clues such as existing known outbreaks of insects (species-specific), surrounding stands, BEC zones, historical inventory data and other information to help determine the species of dead stands.

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 amabalis* 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. Acceptable genus and species codes are listed in Table 7-2 as summarized in version 4.5 of the 2009 BC Ministry of Forests and Range Tree Code List.

Table 7-2 Acceptable tree genus and species codes and common names

Common Name	Scientific Name	Codes	
NATIVE CONIFERS			
Cedar	***Thuja***	**C**	
western redcedar	*Thuja plicata*		Cw
Cypress	***Chamaecyparis***	**Y**	
yellow-cedar	*C. nootkatensis*		Yc
Douglas-fir	***Pseudotsuga***	**F**	
Douglas-fir	*P. menziesii*		Fd
coastal Douglas-fir	*P. menziesii* var. *menziesii*		Fdc
interior Douglas-fir	*P. menziesii* var. *glauca*		Fdi
Fir (Balsam)	***Abies***	**B**	
amabilis fir	*A. amabilis*		Ba
grand fir	*A. grandis*		Bg
subalpine fir	*A. lasiocarpa*		Bl
Hemlock	***Tsuga***	**H**	
mountain hemlock	*T. mertensiana*		Hm
western hemlock	*T. heterophylla*		Hw
mountain x western hemlock hybrid	*T. mertensiana* x *heterophylla*		Hxm
Juniper	***Juniperus***	**J**	
Rocky Mtn. juniper	*J. scopulorum*		Jr
Seaside juniper	*J. maritima*		Js
Larch	***Larix***	**L**	
alpine larch	*L. lyallii*		La
tamarack	*L. laricina*		Lt
western larch	*L. occidentalis*		Lw
Pine	***Pinus***	**P**	
jack pine	*P. banksiana*		Pj
limber pine	*P. flexilis*		Pf
lodgepole pine	*P. contorta*		Pl
lodgepole pine	*P. contorta* var. *latifolia*		Pli
lodgepole x jack pine hybrid	*P.* x *murraybanksiana*		Pxj

Common Name	**Scientific Name**	**Codes**	
ponderosa pine	*P. ponderosa*		Py
shore pine	*P. contorta* var. *contorta*		Plc
western white pine	*P. monticola*		Pw
whitebark pine	*P. albicaulis*		Pa
Spruce	***Picea***	**S**	
black spruce	*P. mariana*		Sb
Engelmann spruce	*P. engelmannii*		Se
Sitka spruce	*P. sitchensis*		Ss
white spruce	*P. glauca*		Sw
spruce hybrid	*Picea* cross		Sx
Engelmann x white	*P. engelmannii* x *glauca*		Sxw
Sitka x white	*P.* x *lutzii*		Sxl
Sitka x unknown hybrid	*P. sitchensis* x*?*		Sxs
Yew	***Taxus***	**T**	
western yew	*Taxus brevifolia*		Tw
NATIVE HARDWOODS			
Alder	***Alnus***	**D**	
red alder	*A. rubra*		Dr
Apple	***Malus***	**U**	
Pacific crab apple	*Malus fusca*		Up
Aspen, Cottonwood or Poplar	***Populus***	**A**	
poplar	*P. balsamifera*		Ac
balsam poplar	*P. b.* ssp. *balsamifera*		Acb
black cottonwood	*P. b.* ssp. *trichocarpa*		Act
hybrid poplars	*P. sp.* x *P.* sp.		Ax
trembling aspen	*P. tremuloides*		At
Arbutus	***Arbutus***	**R**	
Arbutus	*Arbutus menziesii*		Ra
Birch	***Betula***	**E**	
Alaska paper birch	*B. neoalaskana*		Ea
Alaska x paper birch hybrid	*B.* x *winteri*		Exp
paper birch	*B. papyrifera*		Ep
water birch	*B. occidentalis*		Ew

Common Name	Scientific Name	Codes	
Cascara	***Rhamnus***	**K**	
cascara	*R. purshiana*		Kc
Cherry	***Prunus***	**V**	
bitter cherry	*P. emarginata*		Vb
choke cherry	*P. virginiana*		Vw
pin cherry	*P. pensylvanica*		Vp
Dogwood	***Cornus***	**G**	
Pacific dogwood	*Cornus nuttallii*		Gp
Maple	***Acer***	**M**	
bigleaf maple	*A. macrophyllum*		Mb
vine maple	*A. circinatum*		Mv
Oak	***Quercus***	**Q**	
Garry oak	*Q. garryana*		Qg
UNKNOWNS			
Unknown		**X**	
Unknown conifer			Xc
Unknown hardwood			Xh
EXOTICS			
Apple	*Malus*	**U**	
apple	*Malus pumila*		Ua
Aspen, Cottonwood or Poplar	***Populus***	**A**	
*southern cottonwood	*P. deltoides*		Ad
Birch	***Betula***	**E**	
European birch	*B. pendula*		Ee
silver birch	*B. pubescens*		Es
*yellow birch	*B. alleghaniensis*		Ey
Cherry	***Prunus***	**V**	
sweet cherry	*P. avium*		Vs
Cypress	***Chamaecyparis***	**Y**	

Common Name	Scientific Name	Codes	
*Port Orford-cedar	*C. lawsoniana*		Yp
Fir (Balsam)	***Abies***	**B**	
*balsam fir	*A. balsamea*		Bb
noble fir	*A. procera*		Bp
*Shasta red fir	*A. magnifica* var. *shastensis*		Bm
*white fir	*A. concolor*		Bc
Larch	***Larix***	**L**	
*Dahurian larch	*L. gmelinii*		Ld
*Siberian larch	*L. siberica*		Ls
Maple	***Acer***	**M**	
box elder	*A. negundo*		Me
*Norway maple	*A. platanoides*		Mn
*Sycamore maple	*A. pseudoplatanus*		Ms
Oak	***Quercus***	**Q**	
*English oak	*Q. robur*		Qe
*white oak	*Q. alba*		Qw
Other exotics			
*incense-cedar	*Calocedrus decurrens*		Oa
*giant sequoia	*Sequoiadendron giganteum*		Ob
*coast redwood	*Sequoia sempervirens*		Oc
European mountain-ash	*Sorbus aucuparia*		Od
Siberian elm	*Ulmus pumila*		Oe
common pear	*Pyrus communis*		Of
Oregon ash	*Fraxinus latifolia*		Og
*white ash	*Fraxinus americana*		Oh
*shagbark hickory	*Carya ovata*		Oi
tree-of-heaven	*Ailanthus altissima*		Oj
Japanese walnut	*Juglans ailanthifolia*		Ok
Pine	***Pinus***	**P**	
*Monterey pine	*P. radiata*		Pm
*red pine	*P. resinosa*		Pr
*sugar pine	*P. lambertiana*		Ps
Spruce	***Picea***	**S**	

Common Name	Scientific Name	Codes	
*Norway spruce	*P. abies*		Sn
(*) Introduced species not known to occur on Crown Land, but requiring a code for database purposes, are indicated with an asterisk.			

7.7 Age of Leading Species - Age of Second Species

7.7.1 Definition

Age is representative of the main canopy, typically the co-dominant trees, for the leading and second species of each tree layer identified.

Note: Co-dominant trees have crowns forming the general level of trees around them.

7.7.2 Purpose

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

7.7.3 Procedure

Begin age estimation by estimating the species composition for the layer to determine the leading and second species. Estimate the representative age of the main canopy trees:

- For the leading species, in each tree layer identified
- 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 7.6). Figure 7.1 illustrates the selection of appropriate sample trees for age and height estimations.

Table 7-3 Crown class codes

Codes	Description
D	**Dominant** Trees with crowns that extend above the general level of the trees immediately around the measured trees. They are somewhat taller than the co-dominant trees and have well-developed crowns, which may be somewhat crowded on the sides, receiving full light from above and partly from the side.
C	**Co-dominant** Trees with crowns forming the general level of the trees immediately around the measured trees. The crown is generally smaller than those of the dominant trees and is usually more crowded on the sides, receiving full light from above and little from

	the sides.
I	**Intermediate** Trees with crowns below but extending into the general level of the trees immediately around the measured trees. The crowns are usually small and quite crowded on the sides, receiving little direct light from above but none from the sides.
S	**Suppressed** Trees with crowns entirely below the general level of the trees around the measured trees receiving no direct light either from above or from the sides.

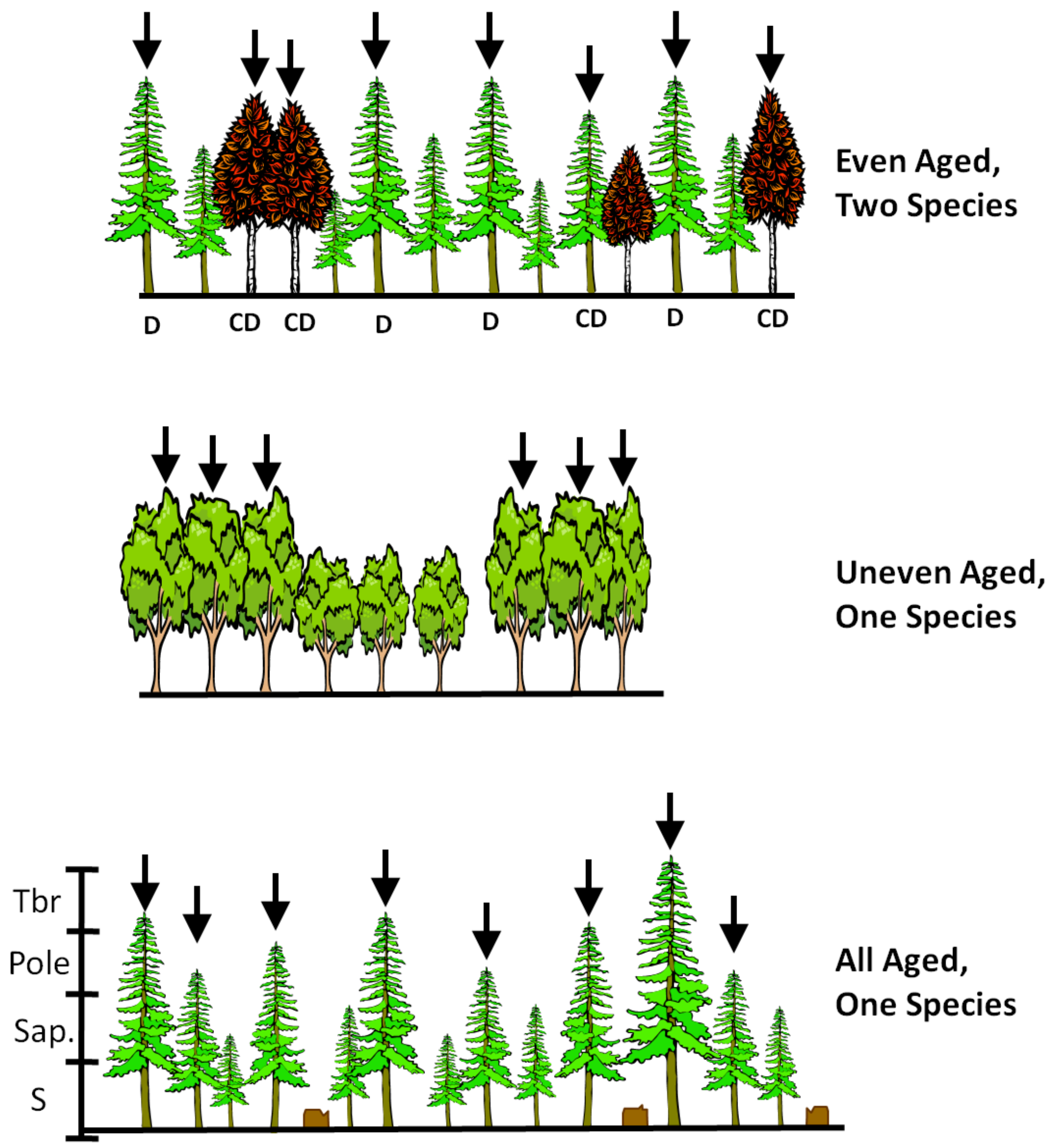


Figure 7-1 Selection of appropriate sample trees for age and height estimations

Note: Third figure is a selectively logged interior dry belt stand. Arrows indicate trees included for age (and height) estimation.

The following data can be collected and used to aid in the photo-interpretation of tree age within a polygon:

- History of origin (previous surveys, silviculture)
- Field measurements (for calibration, verification)
- Age-height-site relationships
- Age patterns

Any dead layer contained in the polygon will only require the age of the *leading* species to be recorded. This age will be the representative age of ALL dead trees visible in the stand. As the aids listed in table 7.3 may not all be visible to the interpreter for a dead layer, the interpreter may need to use the surrounding or remnant stand as a surrogate for age for the dead layer, keeping in mind obvious differences in heights for much older "veterans." Other aids are shown in Table 7-3 below.

Table 7-3 Aids to photo interpretation of age

Photo Characteristics	Immature	Mature
Stand texture	Even	Coarse (often crown openings are present)
Crown size on species	Narrow	Wide (varies dependent on species)
Height (height variation)	Minor	Variable
Height (size)	Less than maximum	Equals maximum per site
Snag frequency	Few	Increasing
Presence and height of successional species	None	Common, one example is spruce under aspen
Presence of short-lived pioneer species	Present	Reduced occurrence around 120 years.

<u>Examples:</u>

History of origin: A large wildfire in 1938. The ages of successional stands should be consistent throughout the burn.

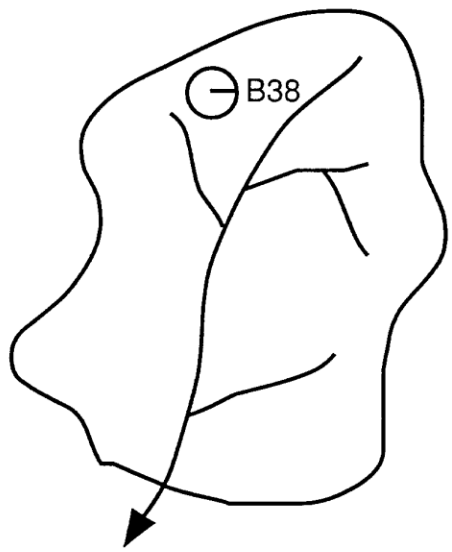


Figure 7-2 The use of historical information for age determination

7.8 Height of Leading Species - Height of Second Species

7.8.1 Definition

Height is representative of the main canopy, typically the co-dominant trees, for the leading and second species of each tree layer identified.

Note: Codominant trees have crowns forming the general level of trees around them.

7.8.2 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.

7.8.3 Procedure

Begin by estimating species composition for the tree layer to determine the leading and second species. Estimate the representative height, to the nearest tenth of a metre, of the main canopy trees:

- For the leading species, in each tree layer identified
- 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 7.6).

Height adjustments

Consider making height adjustments for the following situations:

For species with narrow crowns as the crowns do not resolve on the imagery where the crown width is less than one metre (e.g., narrow crowned alpine fir or rapidly growing coniferous). Heights may need to be adjusted upward by 1 to 4 metres, depending on species and imagery resolution.

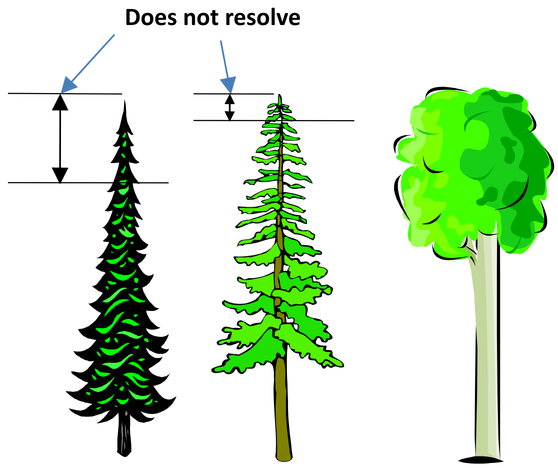


Figure 7-3 Resolution of tree crowns

For high-elevation stands, trees appear taller in imagery than they actually are because they are closer to the aircraft camera. This may result in photo-interpreted heights being overestimated. When estimating height, it is important to consider the effect of elevation changes and ecological factors on stand growth. For example, trees growing in colder, drier conditions in the subalpine are generally shorter than trees growing in a richer, wetter site in a valley bottom.

Any dead layer contained in the polygon will only require the height of the *leading* species to be recorded. This height will be the average dominant, co-dominant and high intermediate height of ALL dead trees visible in the stand. Resolution of the tops of dead trees will be especially difficult due to the lack of foliage. The interpreter will usually need to adjust the dead tree height upwards to account for this lack of resolution and use surrounding live trees/stands as an additional aid to interpretation.

7.9 Basal Area

7.9.1 Definition

Basal area is the total cross-sectional area, at breast height, of all living trees visible to the photo interpreter in the dominant, co-dominant and high intermediate canopy for each tree layer in the polygon. Basal area is expressed as square metres per hectare.

7.9.2 Purpose

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

7.9.3 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. Estimate the basic stand attributes for the polygon: vertical complexity, layer, 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 2 m, the basal area will likely be 0 m^2/ha.

To maintain consistency, interpreters are to concentrate their interpretation on the portion of the stand visible in aerial imagery.

Care should be taken to ensure that dead and live basal areas combined are reasonable for the site, species and size of the trees in all layers.

Example:

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

Basal area = Average DBH area ÷ 1 stem × number of stems per hectare

= πr^2 ÷ 1 stem × density (stems per hectare)

= (3.142) $(0.02\ m)^2$ ÷ 1 stem × 1000 stems per hectare

= 1.256 m^2 per hectare

Some suggested estimation method involves a 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.

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 drops as the stand matures.

7.10 Density

7.10.1 Definition

Density is the average number of living trees visible to the photo interpreter in the dominant, co-dominant and high intermediate canopy for each tree layer in the polygon. Density is expressed as stems per hectare.

7.10.2 Purpose

Density provides a direct estimate of tree stems per hectare.

7.10.3 Procedure

The following is a suggested approach to estimating density:

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

The dead layer density must equal the VRI Snags Frequency for the entire polygon where a dead layer has been recorded.

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 Ministry-verified stereogram from the Black and White Stereogram Handbook or Colour Stereogram Handbook 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, basal area, age, height, crown closure).

7.11 Snag Frequency

7.11.1 Definition

Snag frequency is defined as the number of standing dead trees visible to the photo interpreter in the dominant, co-dominant and high intermediate canopy for each tree layer. Snag frequency is expressed as stems per hectare for each tree layer.

7.11.2 Purpose

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

7.11.3 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 for each tree layer in the polygon.

The Snag Frequency must equal the dead layer density for the entire polygon where a dead layer has been recorded.

Note: Old-growth stands, particularly with cedar or cypress stems, may show numerous dead (whitish) tops that will appear as snags but are actually living trees.

8 Shrub Attributes

8.1 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. Luttmerding et al., MOE Manual 11, Dec. 1990.

8.2 Shrub Height

8.2.1 Definition

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

8.2.2 Purpose

Shrub height describes the average height of shrub species to the nearest tenth of a metre. When multiplied by shrub cover, an index of shrub volume is obtained that indicates available browse.

8.2.3 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:

Shrub Species	Height	Crown Closure
A	1.0 m	30%
B	5.0 m	20%
A, B weighted average =	2.6 m	50%

Note: The height of shrubs less than 2.0 m is particularly important to wildlife and range managers as this represents the critical threshold for the availability of browse.

8.3 Shrub Crown Closure

8.3.1 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.

8.3.2 Purpose

Shrub crown closure provides a direct photo estimate of crown cover.

8.3.3 Procedure

Estimate crown closure for all shrub species based on the percentage of ground area covered by the vertically projected crowns of shrubs. Only those shrubs not otherwise obscured by tree crown cover are recorded. Record the 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 (CC) of 80% for shrubs
    - Herb land cover component (40% of area) has crown closure of 10% for shrubs
- Therefore: (60% × 80% CC) + (40% × 10% CC) = 52% 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 Appendix C) 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

8.4 Shrub Cover Pattern

8.4.1 Definition

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

8.4.2 Purpose

Shrub cover pattern is used to describe the shrub layer spatial distribution. Examples include clumps of shrubs on rocky outcrops, scattered patches or individual shrubs or solid, continuous shrub cover.

8.4.3 Procedure

Enter the cover pattern code (1-9) for shrub cover within the polygon from Appendix B. Shrub cover pattern is based on the majority area coverage.

9 Herb Attributes

9.1 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 (vascular) plants, including graminoids (sedges, rushes, grasses), forbs (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.

9.2 Herb Cover Type

9.2.1 Definition

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

9.2.2 Purpose

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

9.2.3 Procedure

Enter the appropriate code from Table 9-1 to the level of resolution that can be photo interpreted for all herbaceous cover types observable in the polygon.

Table 9-1 Coding for herb cover type

Codes	Description
HE	**Herb** A Herb polygon with no distinction between forbs and graminoids
HF	**Herb - Forbs** A Herb polygon with forbs greater than 50% of the herb cover.
HG	**Herb - Graminoids** A Herb polygon with graminoids greater than 50% of the herb cover.

9.3 Herb Cover Percent

9.3.1 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.

9.3.2 Purpose

Herb cover percent provides a direct estimate of herbaceous cover.

9.3.3 Procedure

Estimate herbaceous cover based on the percentage of ground area covered by the herbs (see Appendix C). Record herbaceous cover to the nearest percent.

9.4 Herb Cover Pattern

9.4.1 Definition

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

9.4.2 Purpose

Herb cover pattern is used to describe the herb layer spatial distribution. Examples include herbaceous cover on rocky outcrops or patches of herbaceous cover within shrub-dominated polygons.

9.4.3 Procedure

Enter the cover pattern code (1-9) for herbaceous cover within the polygon from Appendix B. Herb cover pattern is based on the majority area coverage.

10 Bryoid Attributes

10.1 Introduction

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

Bryoids include mosses, liverworts, hornworts, and non-crustose lichens.

10.2 Bryoid Cover Percent

10.2.1 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.

10.2.2 Purpose

Bryoid cover percent provides a direct estimate of bryoid cover.

10.2.3 Procedure

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

Bryoids are typically found in abundance and/or dominating certain broad ecosystem units – i.e. high elevation, rockier alpine areas, and wetlands with water-saturated soils. As such, bryoids will be more abundant and identifiable in imagery for sparsely vegetated sites that tend to be drier or wetter – i.e. sites with a soil moisture regime of 0, 1, 2, 7 or 8.

Interpreters are expected to identify bryoids only if they can be viewed and identified in the imagery.

11 Non-Vegetated Attributes

11.1 Introduction

This set of attributes describes the portion of the polygon that is non-vegetated (vegetation cover is less than 5% of the total surface area of the polygon) and is not obscured by vegetation or shadows.

11.2 Non-Vegetated Cover Type(s)

11.2.1 Definition

Non-vegetated cover types are the designations (from level 5 of the BC Land Cover Classification Scheme) for all observable non-vegetated land cover within the polygon.

11.2.2 Purpose

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

11.2.3 Procedure

Enter the appropriate code (see Table 11-1) to the level of resolution that can be photo interpreted for all non-vegetated cover types observable within the polygon. When more than one non-vegetated cover type is identified, use additional rows on the attribute form or in the database, as required.

A maximum of five (5) non-vegetated attributes is acceptable per polygon.

BCLCCS Level 4 non-vegetated cover type codes SI (Snow/Ice), RO (Rock/Rubble), CL (Cultivated Land), UC (Utility Corridor), and EL (Exposed Land) are non-available descriptions for this attribute.

Table 11-1 Codes for non-vegetated cover

Codes	Description
Land Cover	
AP	**Airport** A permanent, paved or gravel area, and associated buildings and parking used by airplanes.
BE	**Beach** An area with sorted sediments reworked in recent time by wave action which may be formed at the edge of fresh or saltwater bodies

Codes	Description
BI	**Blockfield** Blocks of rock derived from the underlying bedrock by weathering and/or frost heaving. These have not undergone any significant downslope movement as they occur on level or gently sloping areas.
BR	**Bedrock** Unfragmented consolidated rock, contiguous with underlying material.
BU	**Burned Area** Land showing evidence of recent burning, either natural or prescribed. Vegetation of less than 5% crown cover is present at the time of polygon description.
CB	**Cutbank** Part of a road corridor created upslope of the road surface created by excavation into the hillside.
DW	**Downed Wood** Consolidated Coarse Woody Debris, Blowdown, Log Decks, Burn pile, or any area of downed trees.
ES	**Exposed Soil** Any exposed soil not covered by other categories such as areas of recent disturbance that include mud slides, debris torrents, avalanches, or disturbances such as pipeline rights-of-way where vegetation cover is less than five percent. Exposed soil resulting from harvesting operations is recognized in this category; however, harvested polygons must maintain vegetated status.
GL	**Glacier** A mass of perennial snow and ice with definite lateral limits, typically flowing in a particular direction.
GP	**Gravel Pit** An area exposed through the removal of sand and gravel.
LB	**Lava Bed** An area where molten rock has flowed from a volcano or fissure and cooled and solidified to form rock.
LL	**Landing** A compacted area adjacent to a road used for the purpose of sorting and loading logs.
LS	**Pond or Lake Sediments** Exposed sediments related to dried lakes or ponds.
MI	**Open Pit Mine** An exposed area used to extract ore during a mining operation. This may contain associated buildings and any tailing produced by the mining and milling process.
MN	**Moraine** An area of debris transported and deposited by a glacier.

Codes	Description
MU	**Mudflat Sediment** Flat plain-like areas associated with lakes, ponds, rivers or streams - dominated by fine-textured sediments. They can be associated with freshwater or estuarine sources.
MZ	**Rubbly Mine Spoils** Discarded overburden or waste rock, moved to extract ore during mining.
OT	**Other** A non-vegetated polygon where none of the above categories can be reliably chosen. This code is used very rarely.
PN	**Snow Cover** Snow or ice that is not part of a glacier but is found during the summer months on the landscape. (Care should be taken to determine if the snow on the imagery is a result of the photo acquisition date. In such cases, the delineation or attribution procedure should be discussed with the Ministry).
RM	**Reservoir Margin** Land exposed by a drained or fluctuating reservoir. This is found above "normal" water levels and may consist of a range of substrates, including gravel, cobbles, fine sediments, or bedrock.
RN	**Railway** A roadbed with fixed rails that may contain single or multiple rail lines.
RS	**River Sediments** Silt, gravel and sand bars associated with former river channels and present river edges.
RZ	**Road Surface** An area cleared and compacted for transporting goods and services by vehicles. Older roads that appear vegetated and are used infrequently or not at all may cease to be considered a road surface.
TA	**Talus** Rock fragments of any size accumulated on or at the foot of slopes as a result of successive rock falls. This is a type of colluvium.
TZ	**Tailings** An area containing the solid waste material produced in the mining and milling of ore.
UR	**Urban** Buildings and associated developments such as roads and parking areas which form an almost continuous covering of the landscape.
Water Cover	
LA	**Lake** A naturally occurring static body of water. The boundary for the lake is the natural high-water mark.

Codes	Description
OC	**Ocean** A naturally occurring body of water containing salt or generally considered to be salty.
RE	**Reservoir** An artificial basin affected by impoundment behind a man-made 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 but does not include ephemeral flow where a channel with no definable banks is present. Gravel bars are part of a stream, while islands within a stream that has definable banks are not.

11.3 Non-Vegetated Cover Percent

11.3.1 Definition

The non-vegetated cover percent indicates the percentage of polygon area occupied by a non-vegetated cover.

11.3.2 Purpose

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

11.3.3 Procedure

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

Enter the 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 that can be identified.

Example of Non-Vegetated Cover Percent

The following example (see Figure 11.1) shows a polygon with deciduous tree cover (the land cover component is indicated as being entirely treed), and there is a non-vegetated (river sediment) cover of 4%.

Land Cover Component #1 = TB 100%

Non-Vegetated Cover = RS

Non-Vegetated Cover Percent = 4%

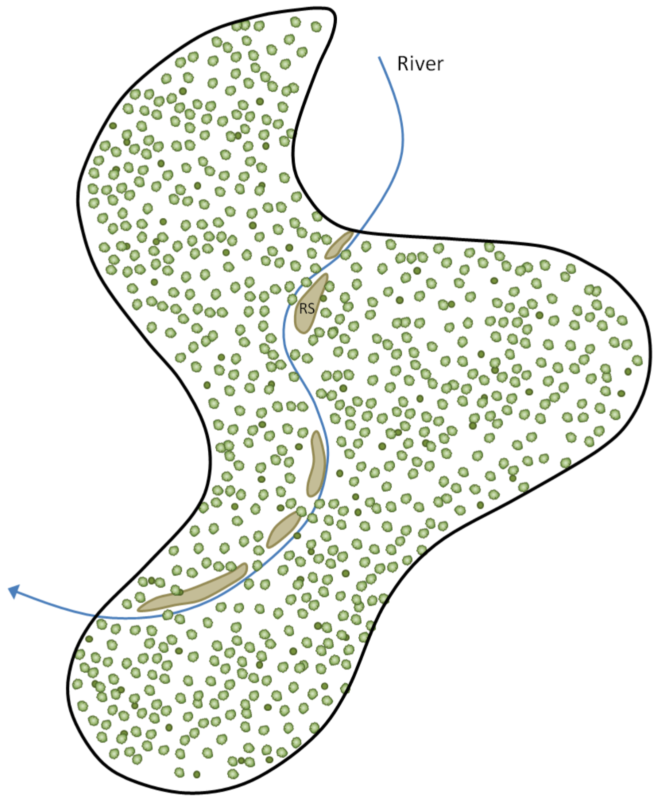


Figure 11-1 Example of Non-Vegetated Cover Percent

11.4 Non-Vegetated Cover Pattern

11.4.1 Definition

The non-vegetated cover pattern describes the spatial distribution of the non-vegetated cover types within the polygon. Each non-vegetated cover type indicated must have a non-vegetated cover pattern assigned.

11.4.2 Purpose

Non-vegetated cover pattern is used to describe the non-vegetated cover spatial distribution. Examples include roads within vegetated polygons or lakes within non-vegetated polygons.

11.4.3 Procedure

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

12 Disturbance Events Information

12.1 Definition

The Disturbance Events Information section describes any natural or human-caused event that has impacted the land base and is represented in the polygon.

12.2 Purpose

Disturbance Event codes provide a detailed description of any event that has impacted the land base. Some events can impact forests at the landscape level, such as a bark beetle epidemic and wildfires, while other events are limited in extent, such as logging or flooding.

12.3 Procedure

A disturbance code must be assigned where an event is present on the land base. The most common human-caused disturbance likely to be encountered within a VRI project area is logging. Disturbance information may be found in the RESULTS data, the previous inventory and other data sources. The interpreter will identify the disturbance code as Logging (L) but will also be expected to enter any Disturbance Start and Disturbance End date provided in RESULTS. Start and End dates must consist of Month/Day/Year. Refer also to Section 13 for further information on RESULTS coding.

Disturbance codes consist of a dichotomous hierarchy. When the interpreter has been provided supplemental information or has conducted any ground-truthing, they must use a more descriptive sub-category code to identify the specific forest damage agent. The first letter of each code is a general description of a disturbance type, and subsequent letters in the code further describe the damage agent. For example, the code for mountain pine beetle is IBM.

All disturbance types on the land base and their assigned codes can be found in the VRIMS Personal Geodatabase Structure and Use manual.

In the case of natural disturbances, it may not be possible to determine a Start and End date, and those fields should be left blank. Any supplemental information provided by the Ministry that has a start year must be recorded, for example, Burn Years.

An interpreter may have to interpret polygons that have multiple types of disturbances. In these cases, it will be up to the interpreter to determine which disturbance had the greater stand volume impact on the land base and record the appropriate code.

13 RESULTS

13.1 Definition

The Reporting Silviculture Updates and Land Status Tracking System (RESULTS) tracks silviculture information by managing the submission of openings, disturbances, silviculture activities and obligation declarations as required by the *Forest and Range Practices Act*.

RESULTS data is collected by Resource Practices Branch and contains spatial and attribute data used for tracking depletion (harvest), regeneration, silviculture reserves and free growing (FG). This and other data sources are summarized by Forest Analysis and Inventory Branch for incorporation into new VRIs and provided to interpreters in the ArcMap Personal Geodatabase (PGDB) format. In this document, the term "RESULTS" refers to the Forest Analysis and Inventory Branch summarized version of this silviculture data and other data sources.

The Ministry will supply a prepared RESULTS data package. This package consists of a single spatial and attribute data file in a Vegetation Resources Inventory Management System (VRIMS) format, as well as a point file containing the same attributes for integration into new inventories. The package reduces the need for the interpreter to adjust opening boundaries and determine attributes from multiple sources.

The Ministry recommends the use of automated transfer techniques to import RESULTS spatial and attribute data into the Contractor’s data set, followed by a thorough review of the transferred data.

13.2 RESULTS Openings and Polygon Delineation

The interpreter must consider a few guiding principles when integrating RESULTS data into a new VRI photo interpretation project.

1. Provide reliable polygon forest cover descriptions based on the photo estimated vegetation attributes and the supporting RESULTS information. The intent is not to make minor changes in attributes from RESULTS; the intent is to correct for apparent errors that exist in the RESULTS data when compared to what is observed on the imagery.
2. Review every opening to ensure that the final VRI polygon description is consistent with the principles described in the VRI Photo Interpretation Procedures. The interpreter will discuss proposed modifications of RESULTS data with the Ministry Representative before incorporation.
3. The Ministry has supplied the "SPATIAL_SOURCE" field in the RESULTS database, which identifies the source of the spatial data for a particular opening. In general,

openings with spatial data identified as "FTEN_POLY" and "RESULTS_OPENING" will have lower qualities of delineation and attribution data. These openings will likely require additional review and editing than openings with a "RESULTS_FOREST_COVER" spatial data source.

4. Re-delineate RESULTS boundaries only when the Ministry-supplied delineation is greater than 20 m of the correct location viewed in the image. Thus, do not re-delineate if the interpreted delineation based on what is observed on the imagery is less than 20 m of the Ministry-supplied RESULTS delineation.
5. Maintain the opening boundaries and Opening IDs as supplied for openings created by single-tree selection, salvage logging, multiple entry harvesting, or similar.

13.2.1 External Opening Boundaries

There are two types of boundaries of concern when incorporating RESULTS boundaries: external boundaries, which form the outside edge of a cut block as determined by a unique Opening ID, and internal boundaries, which differentiate between the different stand types.

The Ministry-supplied RESULTS layers have been reviewed for the spatial correctness of each opening and include the removal of road tubes, overlaps and slivers. There will be situations where openings are visible on the imagery, but the associated opening delineation and data may not be present in the Ministry-supplied RESULTS dataset. Standard delineation procedures will apply for these openings. Furthermore, there will be situations where harvesting occurs after imagery acquisition; that is, the opening is not visible on the imagery. Where delineation and data exist in the Ministry-supplied RESULTS dataset for an opening harvested after imagery acquisition (i.e. RESULTS Reference Year ≥ imagery acquisition date), use the RESULTS delineation and data for the opening as supplied with no alteration.

There will be situations where what appears to be a single large opening is comprised of several unique openings directly adjacent to each other, each with its disturbance or silviculture history. Figure 13-1 is an example of this situation. Each opening is identified by a unique Opening ID number in the Ministry-supplied RESULTS data. Ensure that each opening is assigned the correct RESULTS data.

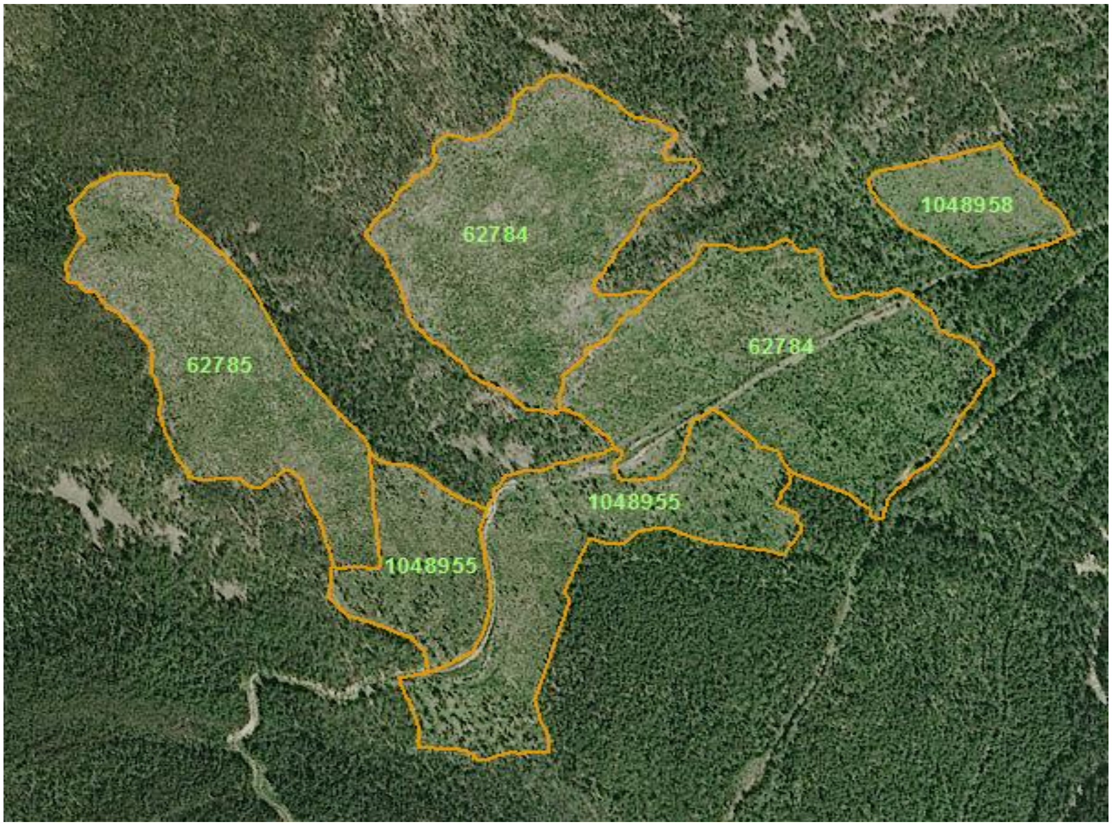


Figure 13-1 Example of a Ministry-prepared RESULTS spatial layer with multiple openings

13.2.2 Internal Opening Boundaries

Internal polygon delineation requirements differ between openings that are declared Free Growing and openings that are not declared Free Growing.

13.2.2.1 Internal Delineation for Openings Declared Free Growing

When an opening has been declared Free Growing, the FREE_TO_GROW_IND field has a value of "Y" in the Ministry-supplied RESULTS data. Review all internal delineation supplied in the RESULTS data to determine if it meets the VRI delineation standards for the opening as it appears on the imagery. When the internal opening delineation no longer meets VRI polygons delineation standards, re-delineate the internal opening boundaries.

As a guideline, use the Ministry-supplied RESULTS Free Growing survey internal delineation if the survey was completed approximately ten years or less from the date of imagery. The only exception will be when there are apparent and dramatic differences from the RESULTS survey observed in the imagery.

When the survey is more than ten years old, use the survey information as a reference and change the internal delineation as required to meet VRI delineation standards.

13.2.2.2 Internal Opening Delineation for Openings NOT Declared Free Growing

The Ministry-supplied RESULTS data also includes openings that are not declared Free Growing. These openings have an "N" value in the FREE_TO_GROW_IND field of the Ministry-supplied RESULTS data. Maintain the internal boundaries present in the Ministry-supplied RESULTS non-Free Growing polygons.

The exception to this rule applies to openings created before 2003 that display significant Free Growing characteristics on the imagery but were never declared Free Growing. These older, non-Free Growing openings require review and re-delineation to ensure that they meet VRI delineation standards. Figure 13-2 illustrates examples of older, non-Free Growing openings with characteristics of Free Growing stands.

Figure 13-2 Example of Non-Free Growing openings displaying Free Growing characteristics

13.3 RESULTS Openings and Polygon Attribution

The procedures for integrating RESULTS attribute data into a VRI photo interpretation project are:

1. Ministry-supplied RESULTS data has two layers of information for each opening polygon:

   a. A point (centroid) layer set to an "I" (Incomplete) standard in the VRIMS "INVENTORY_STANDARD_CODE" field; and
   b. A polygon layer called the "FOREST_COVER_OBJECT" and associated VRIMS attribute tables also set to the "I" standard for each RESULTS polygon

2. Each RESULTS opening is supplied with an attribute set that may or may not have a complete set of RESULTS survey data. In general, openings identified as "FTEN_POLY" and "RESULTS_OPENING" in the "SPATIAL_SOURCE" field of the Ministry-supplied RESULTS data typically contain minimal attribute data and are often limited to an opening ID and logging history date. More recent Free Growing openings typically have all the tree layer attributes from the Free Growing survey, including species composition, age, height, density, site index, etc. Review each opening to determine, using the VRI RESULTS standards and criteria, if the opening requires attribution to the "I" or "V" standard. Details about the criteria used to determine the attribution standard required are provided in the sections below.
3. Non-Free Growing openings may contain multiple layers in the Ministry-supplied RESULTS data (i.e. RESULTS layers 1, 2, 3, 4, etc.). Incorporate all Ministry-supplied RESULTS layers into any polygon identified as non-Free Growing. It is not acceptable to amalgamate multi-layer RESULTS data into a reduced number of layers or exclude one or more RESULTS layers to simplify the attribution. These layers may not meet the VRI layer definition as there may be only slight differences between the age and height of the separate layers.
4. Free Growing openings may also contain multiple layers in the Ministry-supplied RESULTS data. Using the RESULTS silviculture survey data as a guide, describe what is visible on the imagery. This may modify the number of layers provided in the RESULTS data.
5. When trees are present in a polygon, describe each tree layer to VRI standards. Describe non-Free Growing openings to the "I" standard and Free Growing openings to the "V" standard. Openings identified as non-Free Growing in the Ministry-supplied RESULTS data that have significant Free Growing characteristics (as with example Figure 13-2) are attributed to the "V" standard but still retain an "N" value in the "FREE_TO_GROW_IND" field. Further details describing the attribution requirements for "I" and "V" standards are provided in section 13.3.1.
6. For all openings where a tree layer is visible in the imagery or provided by RESULTS, assign a crown closure to each layer in the polygon that will sum to a total of at least 11% for all the tree layers combined, even when the opening appears in the imagery to have a crown closure less than 11%. Attribute openings with more than 11% crown closure, according to the crown closure visible in the imagery.
7. The reference year is typically the year of the RESULTS data (i.e. survey year) when attributing polygons with the Ministry-supplied RESULTS data. Use the year of

imagery as the reference year when a RESULTS opening is attributed to the "V" standard.

8. Use the site indices in the Ministry-supplied RESULTS data if they are a reasonable reflection of what is observed on the imagery. When no site index is available, it is crucial to carefully use the year of disturbance and reference year to derive the correct age together with a height measurement or estimate to provide a true age/height relationship. Site index is an important determinant of site productivity and informs future management options for that site or stand of trees. Since predicting growth rates of young planted trees can be very difficult and site index curves unreliable in the early stages of a stand, it is imperative that the age/height ratio is estimated as accurately as possible to provide end-users with the best opportunity to predict site potential. This is particularly true of stands between 20 and 35 years that have been declared Free Growing as they will have no further surveys completed.
9. Review each opening to ensure a correct Opening ID has been applied and review the corresponding attributes for accuracy and completeness.
10. The existing forest cover inventory provided by the Ministry must be reviewed to obtain any logging history or Opening IDs that are not present in the RESULTS data set provided. The interpreter will delineate the boundary using VRI delineation standards and is responsible for interpreting these openings to a "V" standard.

13.3.1 Polygon Attribution

Attribute estimation requirements differ between openings declared Free Growing and openings not declared Free Growing.

13.3.1.1 Attribute Estimation for Openings Declared Free Growing

All Free Growing openings require attribution to the full "V" record standard as per the VRI Photo Interpretation Procedures.

For a Free Growing opening with RESULTS data and a reference (survey) year that is ten years or less from the year of the imagery, the interpreter will use the RESULTS free growing attributes supplied. When the RESULTS data is used as supplied, maintain the reference year of the survey data.

An exception to using RESULTS data as supplied applies to openings where there are obvious and dramatic differences between the tree characteristics observed in the image and the Ministry-supplied RESULTS data for that opening. An example of this situation:

A 2008 Free Growing survey data indicates the stand has a species composition of PLI SX BL with 5,250 stems/ha. The stems/ha value accounts for all trees in silviculture layers. However, the interpreter can only see the PLI as the main canopy on the 2018 image. The interpreter is expected to only interpret what can be observed on the imagery (e.g. 2,200 stems/ha) and will adjust the attributes to reflect the visible stand characteristics, including species composition, age, height, basal area, and density. The reference year is changed to the year of the imagery (e.g. 2018) to reflect the adjusted attributes

For a Free Growing opening with RESULTS data and a reference (survey) year that is more than ten years from the year of the imagery, the interpreter must review the data to determine if it is still relevant and update the attribution to reflect the tree characteristics observed in the imagery. The interpreter may still use the survey information as a reference to assist with attribution. The attribution must reflect the guidelines described in Table 3-1 *Delineation Guidelines for Treed Polygons* and describe any differences in species composition, age, height, or crown closure. When the RESULTS data includes internal delineation of separate standard units, the interpreter must review this delineation to determine if the internal delineation requires updating or if differences between the units are insignificant and can be amalgamated.

Figure 13-3 is provided to assist the interpreter with determining how to use Ministry-supplied RESULTS data for Free Growing openings.

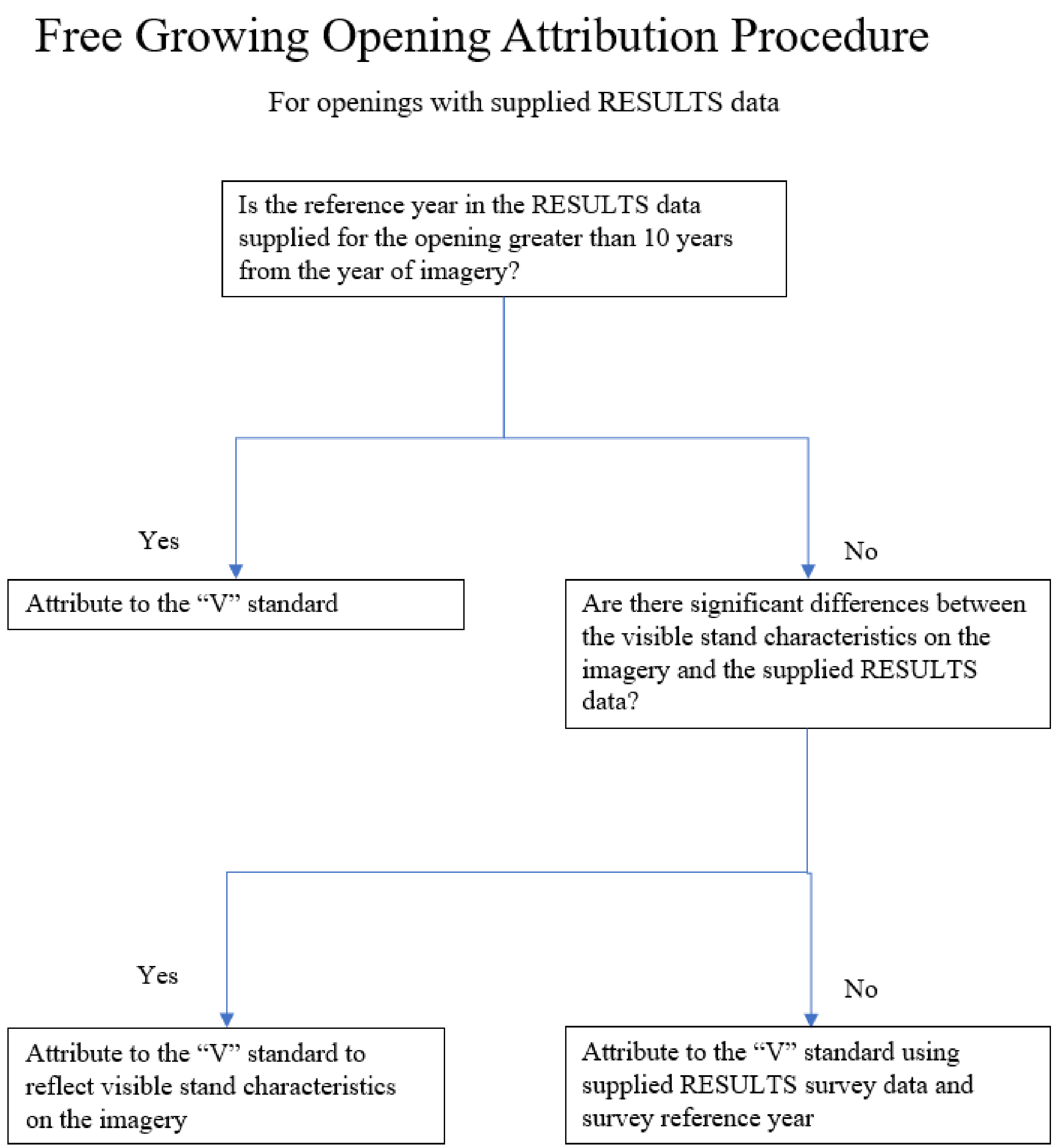


Figure 13-3 Free Growing opening attribute estimation procedure

The Ministry projects (i.e. age, volume and other attributes are grown) each polygon in the VRI on an annual basis and the reference year assigned to each polygon is used to "grow" the tree attributes to the current year. The survey date from RESULTS will generally be used as the reference year to apply to RESULTS openings where survey data is maintained. The interpreter must ensure that any interpreted attributes that are added to the survey information are reflected by the reference year used for that opening.

For example, the basal area is missing from the survey for an opening. The year of imagery is 2010, and the survey was completed in 2000. The basal area as viewed on the 2010 image will need to be adjusted to reflect the year of the survey (2000, the reference year) so that all attributes reflect the same year.

Alternatively, all attributes can be interpreted and date referenced to the year of the image. This is only desirable if the polygon is completely re-interpreted to ensure that the attributes reflect the reference year of the imagery. All attributes provided for a polygon must be consistent with the reference year provided by the interpreter.

13.3.1.2 Attribute Estimation for Openings NOT Declared Free Growing

The "I" standard attribution applies to RESULTS polygons with the following criteria:

1. The opening is not free growing (i.e. FREE_TO_GROW_IND = "N")
2. The opening has a reference year that is more recent than ten years from the year of imagery
3. The opening is NOT displaying significant free growing characteristics
4. The Ministry-supplied RESULTS data includes some tree information

Figure 13-4 is provided to assist the interpreter with determining whether a non-Free Growing opening is to be attributed to an "I" standard or to a "V" standard.

Non-Free Growing Opening Attribution Procedure

For openings with supplied RESULTS data

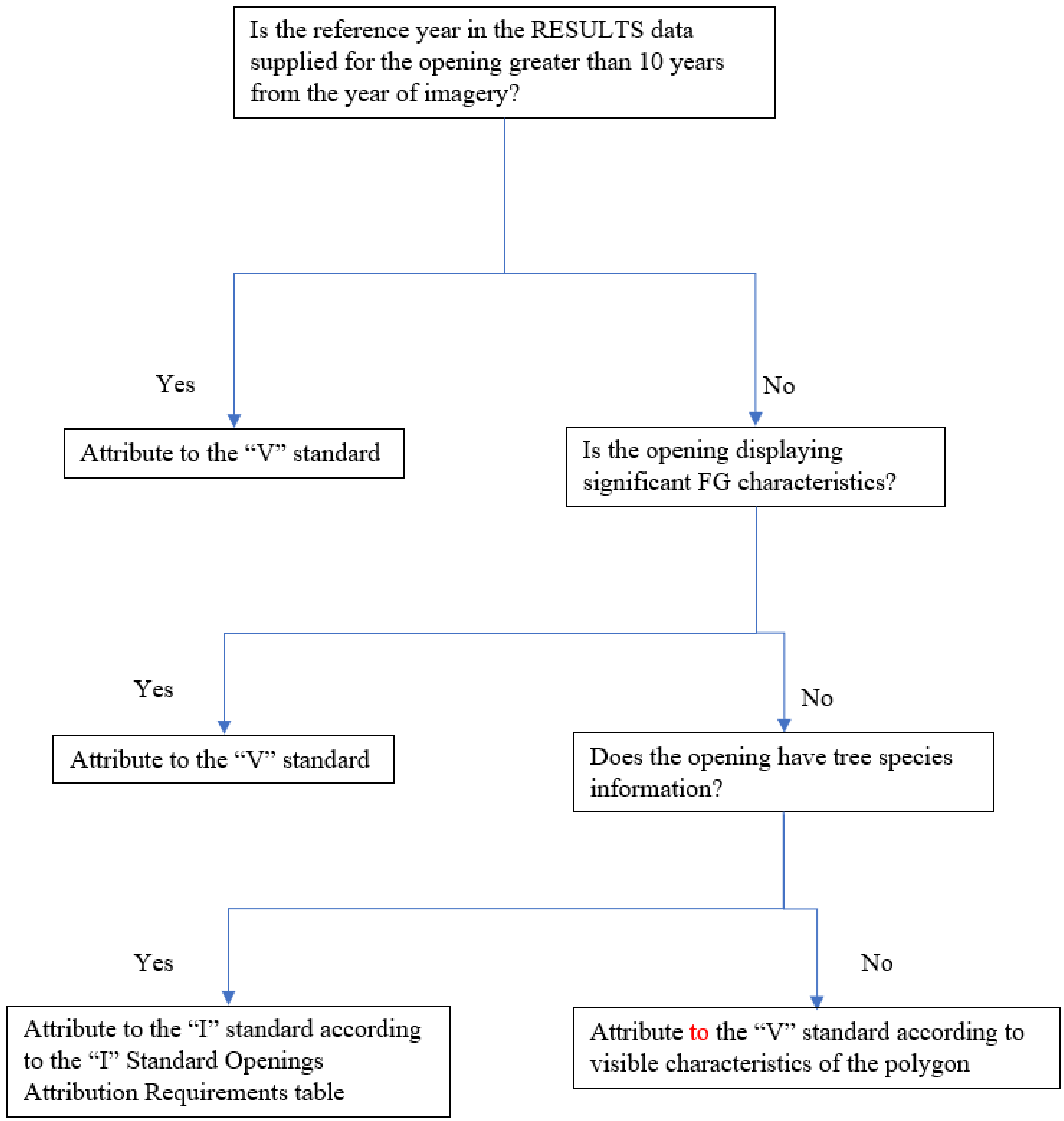


Figure 13-4 Non-Free Growing opening attribute estimation procedure

Table 13-1 describes the attribute estimation requirements for an "I" standard opening in more detail.

Table 13-1 Attribute estimation requirements for "I" standard opening polygons

Attribute	Requirements
Forest Cover Object ID	Mandatory, provided by the Interpreter
Opening ID	Mandatory
Free Growing Indicator	Mandatory
Project Name	Mandatory, provided by the Interpreter
Interpreter Name	Mandatory, provided by the Interpreter
Interpretation Date	Mandatory, provided by the Interpreter
Reference Year	Mandatory
Layer ID	Mandatory
Crown Closure	Mandatory, must be a minimum of 11% where tree attributes are provided or interpreted
Estimated Site Index	Mandatory if provided in RESULTS. Otherwise, interpret it when: 1. Openings have trees < 30 years old (as per Section 6); or 2. Openings have visible or supplied tree data but have the potential to produce a stand of trees
Estimated Site Index Species	Mandatory if an Estimated Site Index has been provided or interpreted
Estimated Site Index Source Code	Mandatory if an Estimated Site Index has been provided or interpreted
Species Composition	Mandatory where provided in Ministry-supplied RESULTS data. Adjustments to labels to ensure composition adds up to 100, address duplicate species or typos are required
Leading Species Age	Mandatory. Interpreted adjustments to allow for validation are permitted
Leading Species Age Data Source Code	Mandatory where age is supplied or interpreted
Leading Species Height	Mandatory. Interpreted adjustments to allow for validation are permitted
Leading Species Height Data Source Code	Mandatory where height is supplied or interpreted

Attribute	Requirements
Second Species Age	Mandatory where available in the Ministry-supplied RESULTS data. However, when a second species height has been supplied or interpreted, a second species age must be provided/interpreted as well
Second Species Height	Mandatory where provided in the Ministry-supplied RESULTS data. However, when a second species age has been supplied/interpreted, a second species height must be provided/interpreted
Density	Mandatory as supplied in RESULTS data or interpreted when absent
Data Source Density	Mandatory as supplied in RESULTS data or interpreted when absent
Disturbance Type	Mandatory as supplied in RESULTS data or interpreted when absent
Disturbance Start Date	Mandatory where provided in the Ministry-supplied RESULTS data
Disturbance End Date	Mandatory where provided in the Ministry-supplied RESULTS data

Figure 13-5 shows an example of how an opening with minimal Ministry-supplied RESULTS data is attributed to the "I" standard. Fields bounded by red boxes are mandatory for all "I" standard polygons. Fields bounded by blue boxes are mandatory when RESULTS tree layer and disturbance history are supplied or to complete the attribute set as described in the chart above.

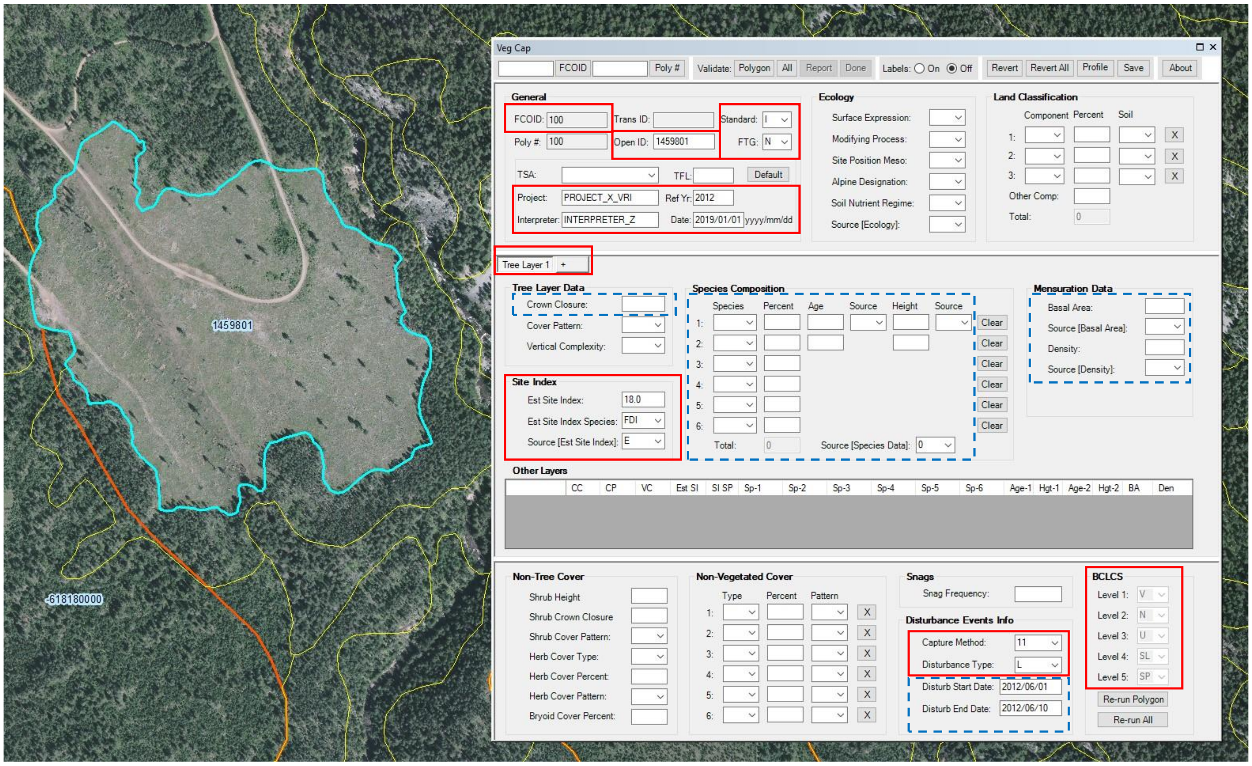


Figure 13-5 Example of "I" standard polygon attributes

For "I" standard RESULTS openings with supplied tree data, the interpreter is responsible for ensuring that the polygon is attributed with a minimum crown closure of 11% to ensure that they meet the BCLCCS definition of a treed polygon. A minimum of 11% crown closure is required where tree data is supplied regardless of whether the tree layer is visible or not or if it appears that cover is less than 11% crown closure.

An exception occurs when tree attributes are not supplied for a non-free growing opening in the RESULTS data. In these instances, interpret what is visible in the opening. For example, an opening with visible trees must have tree attributes interpreted. A non-treed opening would be attributed to describe herb, shrub, etc., as per normal VRI ("V" standard) interpretation standards and coded as a "V" standard.

Figure 13-6 is an example where two openings are identified with an "N" for FREE_TO_GROW_IND and no tree attributes have been provided in the RESULTS data. However, it is clear from the image that there is significant tree cover – these two openings must be interpreted to the "V" standard using VRI photo interpretation standards; however, the opening must retain non-free growing opening status ("N") as provided in the FOREST_COVER_OBJECT table.

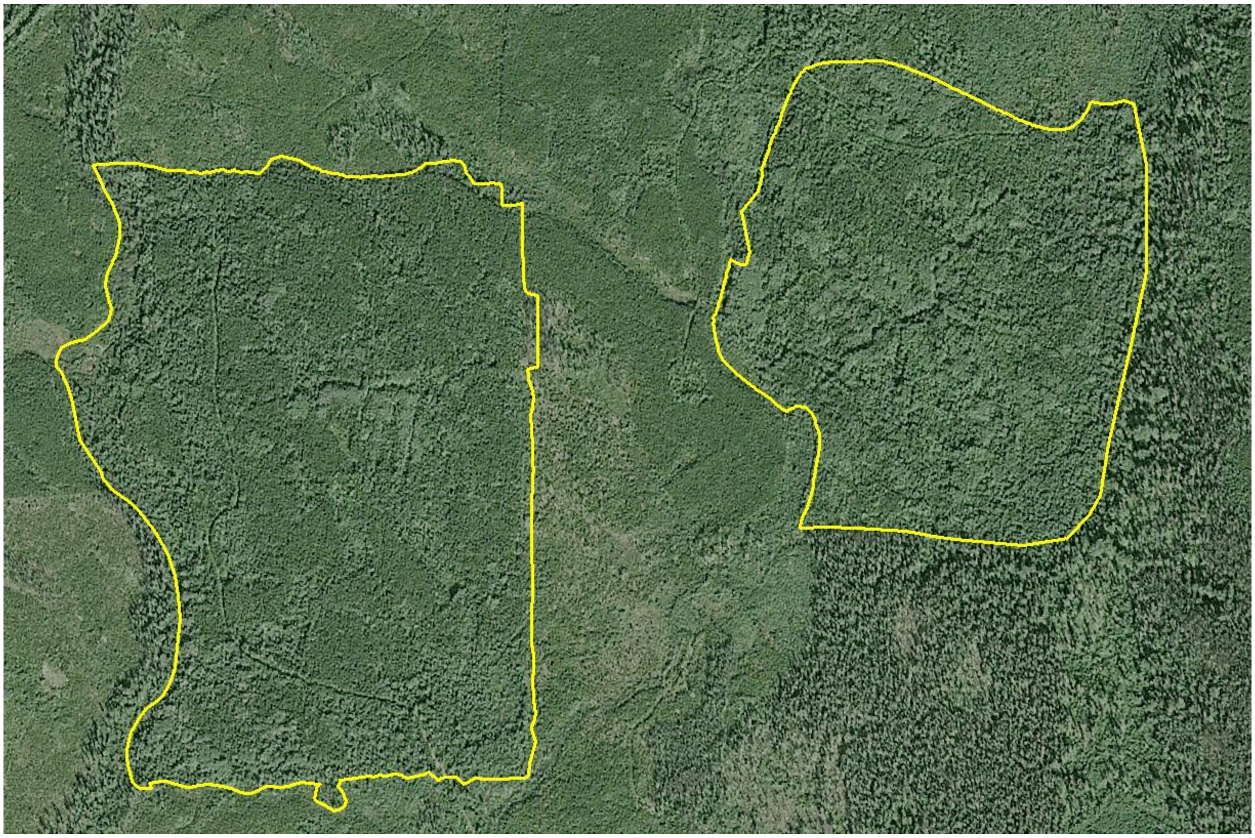


Figure 13-6 Example of openings with Free Growing characteristics and no supplied attributes

There will be occurrences where residual timber is present and distributed with sufficient cover to create a separate layer in newer openings (i.e. openings with disturbance date approximately ten years or less from the year of the imagery). The interpreter will be expected to use any Ministry-supplied RESULTS layer information to describe the residual layer and the regenerated layer. Figure 13-7below is an example of harvesting less than ten years from the year of imagery, with an overstory layer of residual mature timber.

Figure 13-7 Example of a newer opening with a residual layer of mature timber

When attributes for the observed layer are not described in the RESULTS data set, the interpreter may choose to interpret these residuals as a separate layer. When the layer is less than 5% crown closure, the attributes for that layer will not be subject to attribution Quality Assurance, other than identifying systematic issues. When the layer is more than 5% crown closure, the layer attributes will be subject to normal attribution Quality Assurance.

13.3.1.3 Attribute Estimation for Harvested Openings Not Captured in the RESULTS Data

When an opening is present in the imagery but is not included in the Ministry-supplied RESULTS data, the boundary and attributes will be photo interpreted. The RESULTS database was created in 2003, and the interpreter is to determine whether an opening was created prior to or after that date.

All polygons interpreted with a harvest disturbance must be assigned an Opening ID of 0 or -99, regardless of land ownership.

Harvesting disturbance not found in RESULTS and believed to be created after January 1, 2003, will be given an Opening ID (OP_ID) of 0 (zero). Harvesting disturbance not found in RESULTS and believed to be created on or before January 1, 2003, will be given an OPENING_ID of -99. This determination can be made based on reviewing any historical information present in the current forest cover inventory or based on the age of the stand as interpreted from the imagery. Differentiating between pre and post-2003 will help the

Ministry determine whether these are harvested polygons that should be included in RESULTS or if they are pre-RESULTS legacy logging.

Prior to assigning a 0 or -99 Opening ID, the current forest cover inventory data provided by the Ministry must be reviewed to determine if there is a logging history or an Opening ID that is not captured in the Ministry-supplied RESULTS data. The interpreter will delineate the boundary using VRI delineation standards and is responsible for attributing these openings to a "V"- standard.

Figure 13-8 is provided to assist the interpreter with determining the Opening ID for attributing harvested area with no RESULTS data.

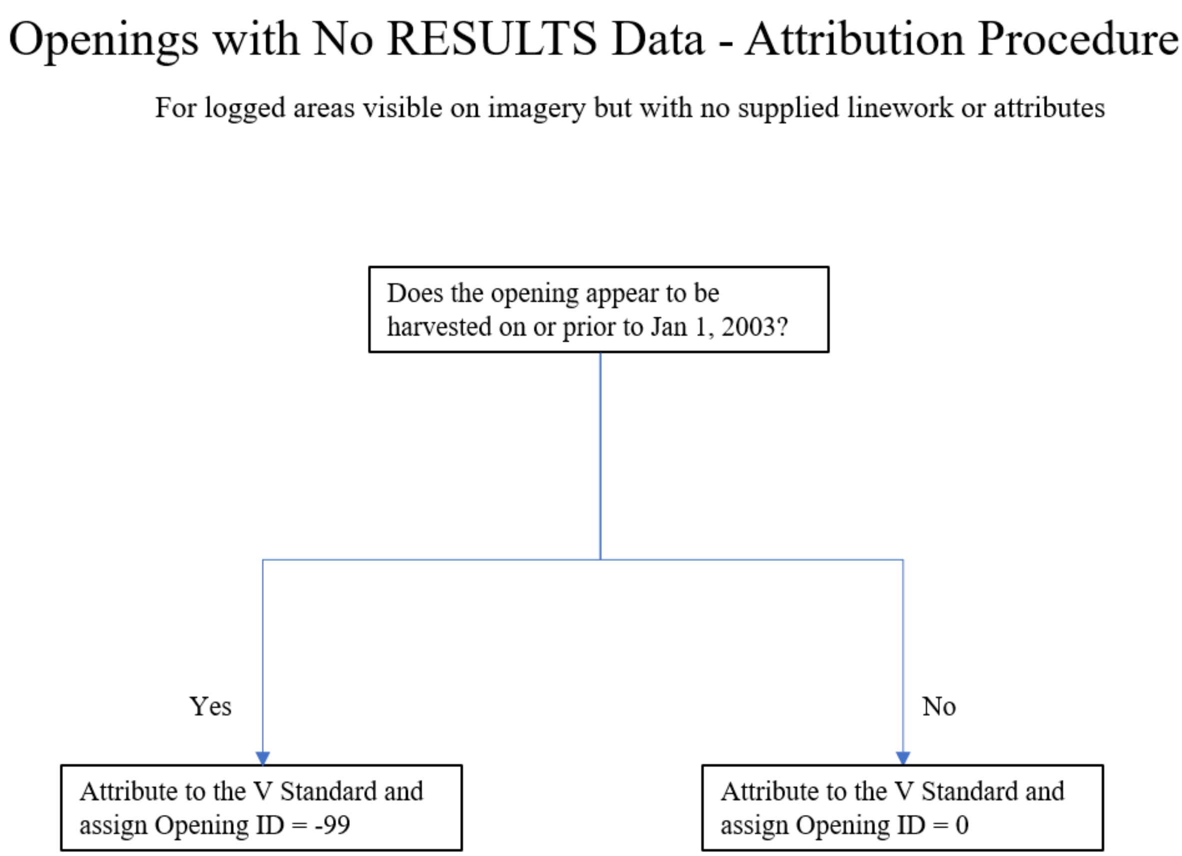


Figure 13-8 Procedure for attribution of harvested openings with no RESULTS data

13.4 Data Capture Method Codes

All opening boundaries must have a data capture method code. With the prepared RESULTS spatial layers, the data source capture code will be populated with Code 11. However, if the interpreter has added any openings from the imagery or has moved any opening boundaries to better fit the imagery, they will then use Code 4.

- Code 11 for Ministry-supplied RESULTS data

- Code 4 for a photo interpreted opening boundary

13.5 Attributes Entry Clarification for RESULTS Polygons

Interpreters must follow these data entry conventions to facilitate accurate data searches and analysis after the VRI is incorporated into the provincial database. The order of preference for data sources is listed in brackets.

Table 13-2 Attribute entry clarification for RESULTS polygons

Minimum Attributes	Data Source	Convention
Opening ID	RESULTS Data	When no Opening ID is available, enter 0 (zero) or -99 as appropriate
Interpreter	Contractor supplied	Interpreter's first and last name in ALL Capital letters (i.e. FIRST_LASTNAME)
Interpretation Date	Contractor supplied	
Reference Year	(1) RESULTS data (2) Contractor supplied	Care must be taken to ensure that all attributes apply to the same reference year
Project Name	Contractor supplied	Same as Contract Project Description Name (i.e. HORSEFLY_VRI)
Disturbance Code	RESULTS data	
Disturbance Start Year	RESULTS data	Year/Month/Day
Disturbance End Year	RESULTS data	Year/Month/Day Leave blank if the disturbance end year is blank in RESULTS.
Disturbance Type Code	RESULTS data	Most significant impact for the opening. See Section 12.
Estimated Site Index Species *	RESULTS data or interpreted if not in RESULTS	Mandatory for polygons under 30 years old
Estimated Site Index *	RESULTS data or interpreted if not in RESULTS	Mandatory for polygons under 30 years old
Estimated SI Source Code *	RESULTS data or interpreted if not in RESULTS	Mandatory for polygons under 30 years old
Free To Grow Ind	RESULTS data	"Y" for RESULTS Free Growing blocks, "N" for all other openings

Glossary

Age of leading and second species: a weighted (by basal area) average age of the dominant, codominant, and high intermediate trees within each layer of the polygon for the leading and second tree species identified.

Alpine: The land area above the maximum elevation for tree species. It is dominated in the vegetated areas by shrubs, graminoids, forbs, bryoids or lichens. Much of the alpine is non-vegetated, covered primarily by rock, ice, and snow. The Alpine is treeless by definition. Do not describe trees in the Alpine.

Alpine designation: one category of landscape position in the third level of the BC Land Cover Classification Scheme. It is dominated in the vegetated areas by shrubs, graminoids, herbs, bryoids and lichens. Much of the alpine is non-vegetated, covered primarily by rock, ice and snow. The alpine is treeless by definition. Do not describe trees in the Alpine.

Aspect: the average oriented direction of the polygon measured in degrees azimuth.

Attributes: polygon-based estimates described by photo interpreters.

Basal area: the cross-sectional area (in square metres per hectare) of all living trees visible to the photo interpreter in the dominant, codominant and high intermediate crown positions in each tree layer in the polygon.

Bryoids: includes bryophytes (mosses, liverworts, hornworts) and non-crustose lichens.

Codominant trees: trees having crowns forming the general level of the trees around them.

Crown Closure/Crown Cover: the percentage of ground area covered by the vertically projected crowns of the tree layer or vegetation cover in the polygon. Crown closure and crown cover are used interchangeably throughout the VRI.

Data source: identifies the primary source of information used to determine the attribute or attributes being described.

Dead (D) layer: a layer describing the dead tree component for any stand that has greater than or equal to an estimated 100 stems per hectare mortality. The dead layer is identified with the layer code of "D."

Density: the average number of living trees in the polygon visible to the photo interpreter in the dominant, codominant and high intermediate crown positions in each tree layer in the polygon. It is 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 well-developed crowns that extend above the general level of the trees around them.

Elevation: the average height above mean sea level of the polygon, measured in metres.

Estimated site index: an estimate of site productivity for tree growth indicated as the height, in metres, at breast height age 50 years.

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.

Forbs: herbaceous plants other than graminoids, including ferns, clubmosses and horsetails.

General polygon attributes: includes assigned attributes and estimated attributes (polygon number, data source, surface expression, modifying processes, site position meso, alpine designation and soil nutrient regime).

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

Graminoids: herbaceous plants with long, narrow leaves characterized by linear venation, including grasses, sedges, rushes and other related plants.

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

Herbs: non-woody plants, including graminoids (sedges, rushes, grasses, and grass-like plants), vascular cryptogams (ferns, fern allies, club mosses and horsetails) and some dwarf woody species and intermediate life forms listed in Table 4-1 of *Describing Ecosystems in the Field,* MOE Manual 11 (Luttmerding et al. 1990).

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

High intermediate trees: trees having smaller crowns, slightly below but extending into the general level of the trees around them.

Inventory Standard Code: a code indicating under which inventory standard the data was collected:
"F" for Forest Inventory Planning (FIP), "I" for Incomplete (a full set of VRI attributes is not collected), "L" for Landscape Vegetation Inventory (LVI), and "V" for Vegetation Resources Inventory (VRI).

Krummholz: 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 Base: the first level of the BC Land Cover Classification Scheme. This classifies the polygon as Vegetated, Non-Vegetated or Unreported. The presence or absence of vegetation is recognized by the vertical projection of vegetation upon the land base within the polygon.

Land Cover Classification Scheme: refers to the BC Land Cover Classification Scheme, which forms Section 1 of this procedures document. It is derived from the original VRI document *BC Land Cover Classification Scheme*, March 1999.

Land cover component: identifies a type of land cover under the BC Land Cover Classification Scheme to the most detailed level possible. They consist of continuous areas within the polygon that are individually 10% or more of the polygon area and would otherwise be delineated and classified at approximately twice the map scale.

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

Land cover type: the second level of the BC Land Cover Classification Scheme. This classifies the polygon as Treed or Non-Treed, or as Land or Water.

Landscape position: the third level of the BC Land Cover Classification Scheme. This classifies the polygon as 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 and 5 ha for an area with indistinct boundaries. Refer to Section 3.1.3 for more information on minimum polygon sizes.

Modifying processes: natural mechanisms of weathering, erosion and deposition that result in the modification of surficial materials and landforms at the earth's surface. It is described by letter codes that include descriptions of avalanching, river channelling, mass movements, flooding, and gully erosion.

Multi-layered stand: a polygon 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 5% of the crown cover of the polygon area consists of tree species of any size.

Non-vegetated categories: the fifth level of the BC Land Cover Classification Scheme. This classifies the polygon into one of a number of specific categories of Non-Vegetated cover.

Non-Vegetated cover types: the fourth level of the BC Land Cover Classification Scheme. This classifies the polygon as Snow / Ice, Rock / Rubble or Exposed Land if Non-Vegetated. The Non-Vegetated cover type is left blank for water features.

Non-Vegetated polygon: a polygon is considered Non-Vegetated when the total cover of trees, shrubs, herbs, and bryoids (other than crustose lichens) covers less than 5% of the surface area of the polygon. Bodies of water are included in this class.

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 Provincial VRI process involving photo estimation of detailed land cover attributes. It is also referred to as Photo Interpretation.

Phase II: refers to the Provincial VRI process involving ground sampling of polygon attributes. Also referred to as Ground Sampling.

Polygon: a portion of land area delineated on aerial imagery of "like" or uniform land cover appropriate for applying land cover descriptions.

Polygon delineation: the process of dividing the landscape into uniform polygons according to defined criteria.

Polygon number: a unique number assigned to each polygon after it has been delineated.

Shrubs: multi-stemmed or non-erect woody plant species that do not include species previously defined as trees or those dwarf 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 the 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 or flat site position.

Slope: the average gradient of the polygon expressed as a percentage.

Snag frequency: the number of standing dead trees visible to the photo interpreter in the dominant, codominant and high intermediate crown positions. It is expressed as a per hectare value for each tree layer in the polygon.

Soil nutrient regime (SNR): refers to the number of essential soil nutrients, particularly nitrogen, available to vascular plants over a period of several years. SNR classes include A (very poor), B (poor), C (medium), D (rich), E (very rich) and 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) and 8 (hydric).

Species composition: identifies the tree species in the polygon and provides an estimate of the percentage of each species present.

Stand structure: indicates the distribution and representation of different stand ages and stand size classes within a polygon.

Surface expression: describes the form and patterns of form of the surficial material within the polygon. It is 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 diameter at breast height within a 5.64 m fixed-radius plot.

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

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

Treed polygon: a vegetated polygon is considered Treed if 5% or more of the polygon by crown cover consists of tree species of any size.

Update year: the year after the year of imagery that an update or revision has occurred to the age or height of the leading tree species layer in the polygon.

Upland designation: a broad class that includes all non-wetland ecosystems below the Alpine that range from very xeric, moss- and lichen-covered rock outcrops to highly productive forest ecosystems on hygric (SMR 6) soils.

Variable Density Yield Prediction (VDYP): 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 considered 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: the fourth level of the BC Land Cover Classification Scheme. This classifies the polygon as Coniferous, Broadleaf or Mixed if treed; as Tall Shrub or Low Shrub if shrub cover; undifferentiated Herbs, Forbs, or Graminoids if herb cover; and undifferentiated Bryoids, Moss or Lichens if the cover is bryoids.

Vegetated density classes: the fifth level of the BC Land Cover Classification Scheme. This classifies the polygon as Dense, Open or Sparse for tree, shrub and herb covers; and classes the polygon as Closed or Open for bryoid cover.

Vertical complexity: a subjective classification that describes the form of each tree layer as indicated by the relative uniformity of the forest canopy as it appears on aerial imagery.

Volume: average gross stem volume of all living trees in the dominant, codominant and high intermediate crown positions. It is expressed in cubic metres per hectare.

Wetland designation: 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. These processes are indicated by poorly drained soils, specialized vegetation, and various kinds of biological activity, which are adapted to the wet environment.

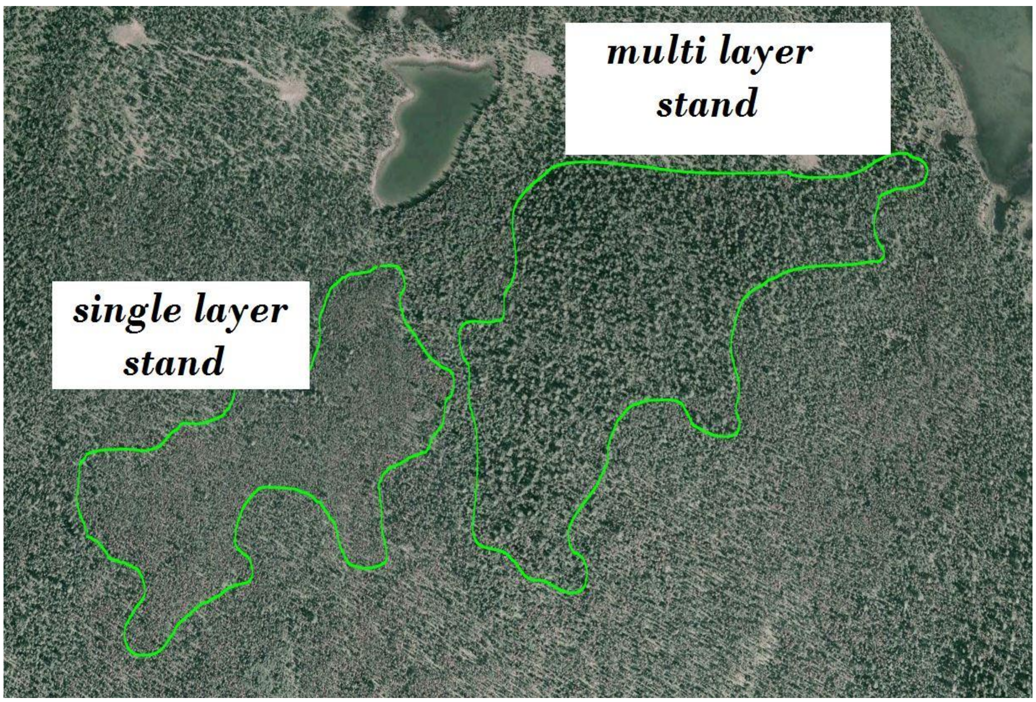
Appendix A

Examples of multi-layered stands

<u>Non-silviculture polygons</u>

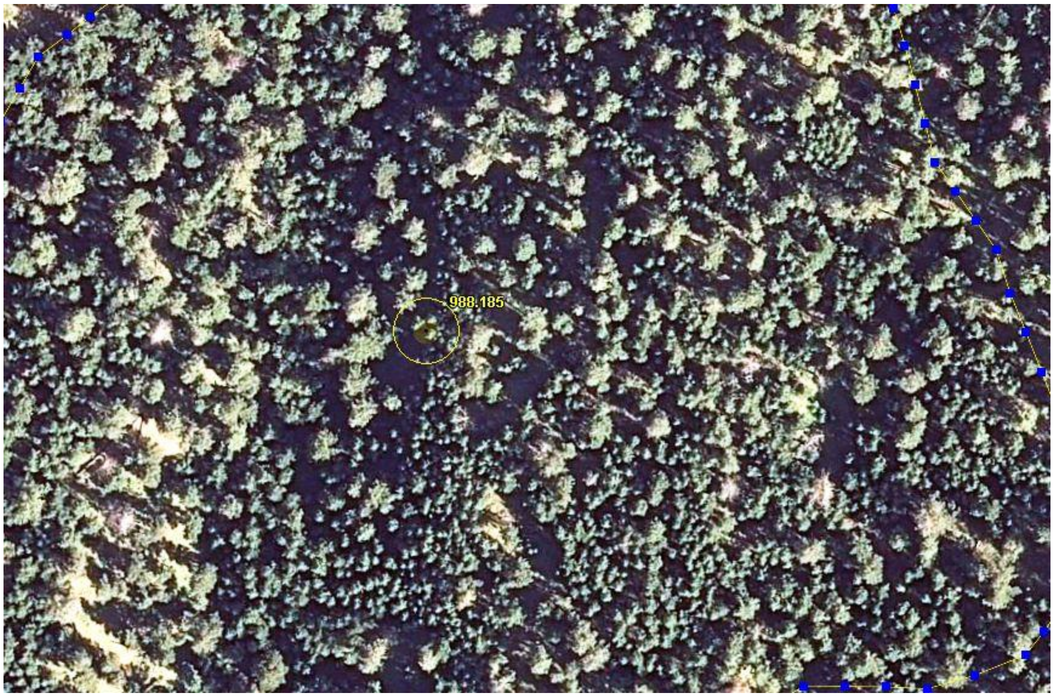
Example 1: Lodgepole pine after fire disturbance growing under residual old-growth Douglas-fir.

Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Fdc100	180	26				
2	Pli100	50	13				



Example 2: Interior Douglas-fir with a Douglas-fir understory.

Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Fdc100	270	26				
2	Fdi100	90	15				

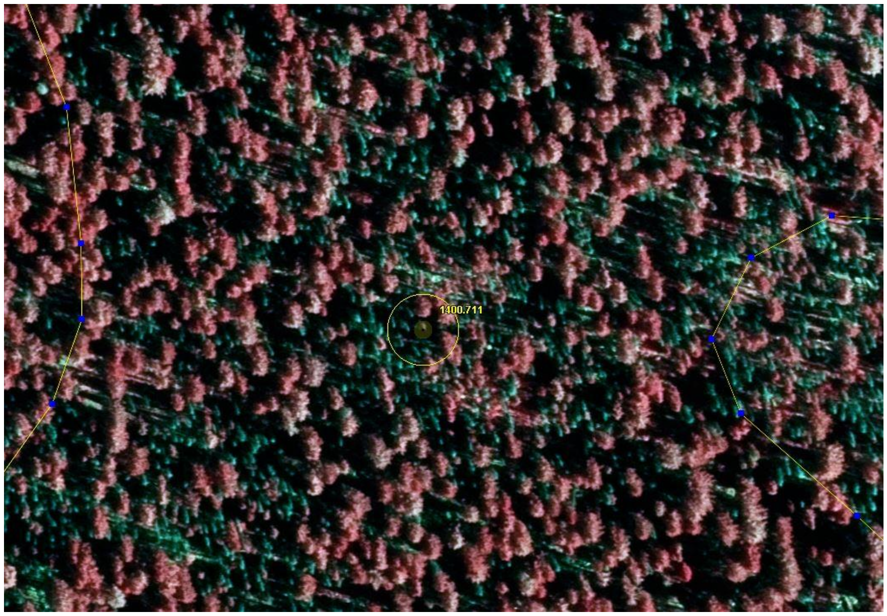


Example 3: Coastal old-growth Douglas-fir stand with hemlock understory.

Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Fdc90Cw10	350	47	32	35		
2	Hw70 (Cw,Mb,Dr,Fdc)	70	22	30	700		

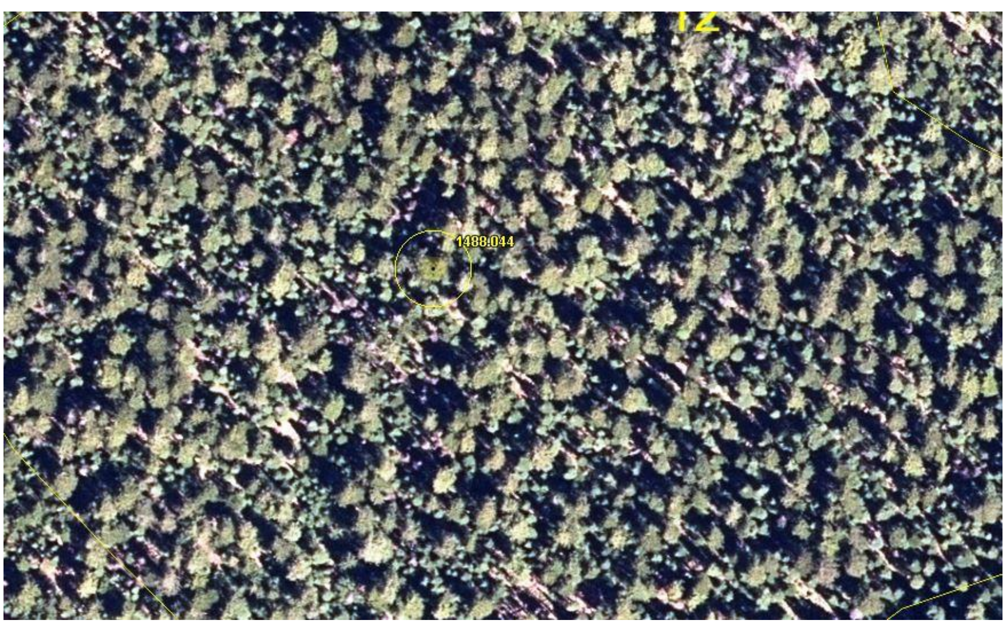
Example 4: Interior old-growth Douglas-fir with lodgepole pine dead layer (near infra-red).

Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Fdi90Pli10	184	30	28	229		
D	Pli90Sx10	125	9	30	189		



Example 5: Interior old growth fir with balsam understory.

Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Fdi70Pli10 Bl10Sx10	185	30	28	229		
2	Bl85Sx15	90	9	6	161		



Silviculture polygons (RESULTS openings)

Example 1: Opening with retention of dispersed individual trees.

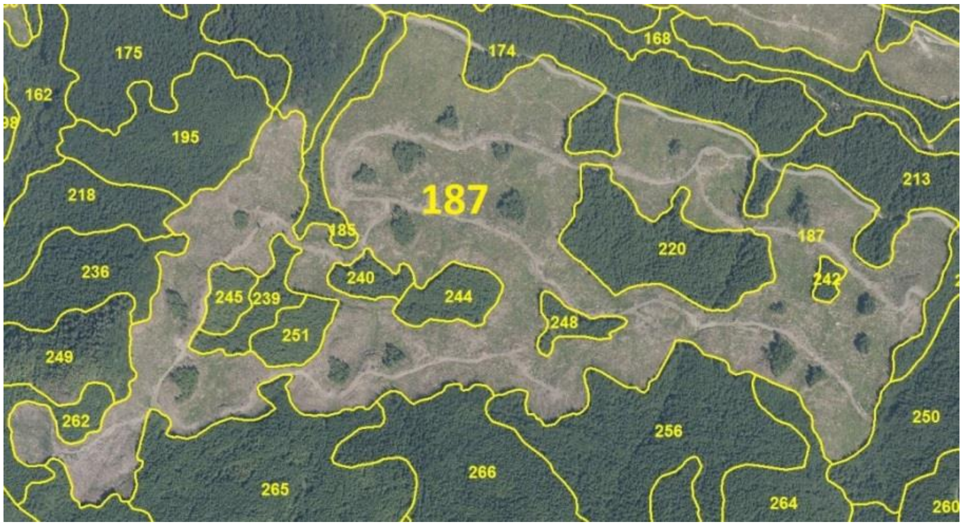
Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Fdc100	95	23	4	40	5	8
2	Fdc100	2	0.3	0	1200	6	

All residual tree patches and individual trees from the former stand are described as a separate VRI layer.

Example 2: Opening polygon 187 with evenly distributed reserves.

Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Hw70Fdc30	225	39	4	15	5	8
2	Herb 55% Shrub Low 20%						

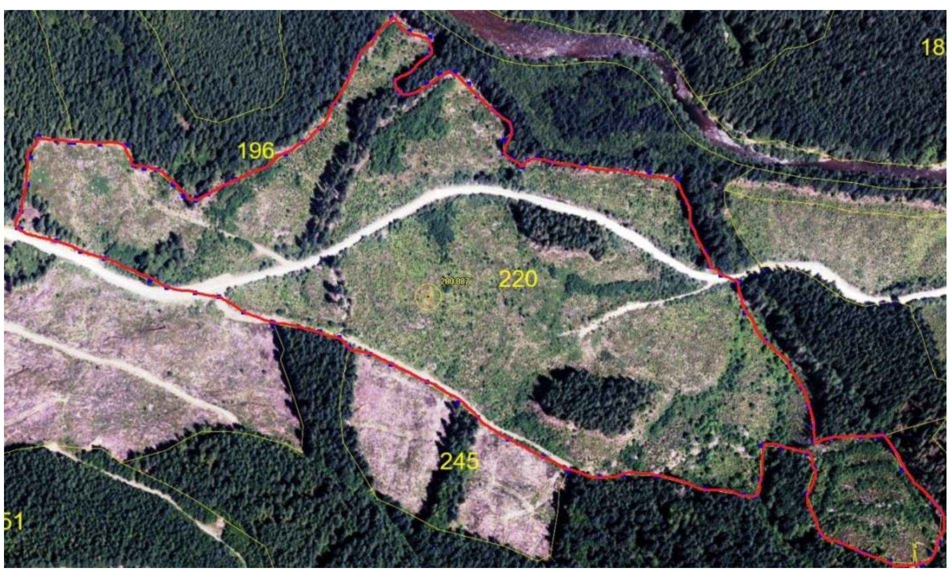
Any reserve equal to or greater than one hectare in size that is completely contained within the opening is delineated into separate polygons (polygons 220, 240, 244), and reserves adjacent to existing standing timber outside the block are included with the adjacent standing timber (polygons 174, 213).



Example 3: Opening polygon 220 with unevenly distributed reserves each reserve below 1 ha.

Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Fdc100	55	33	4	35	5	3
2	Fdc90Dr10	8	3	0	435	10	8

Attribute as a two-layer stand with no further delineation.

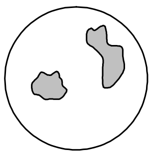


Example 4: Opening polygon with two distinct layers and the same leading species.

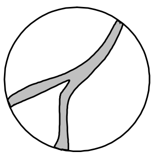
Layer	Species	Age (yrs)	Height (m)	BA (m^2)	SPH	CC (%)	CP
1	Bl100	101	20	6	35	5	8
2	Bl100	35	7	1	1600	30	9

Appendix B

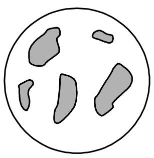
Cover Patterns



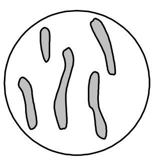
1. Single to very few (<4) occurrences of limited extent, circular to irregular shape.



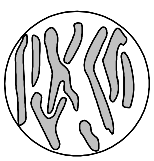
2. Single to very few (<4) occurrences of limited extent, linear or elongated shape.



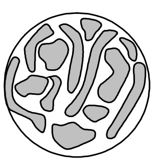
3. Several (>3) sporadic occurrences of limited extent, circular to irregular shape.



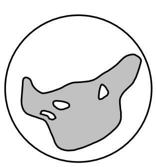
4. Several (>3) sporadic occurrences of limited extent, linear or elongated shape.



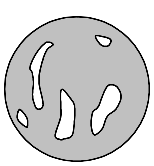
5. Discontinuous but extensive occurrences, parallel to sub-parallel, elongated in shape.



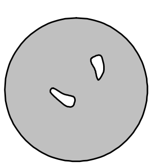
6. Intimately intermixed units, often with gradational transitions from one to the other.



7. Limited continuous occurrence with few inclusions.



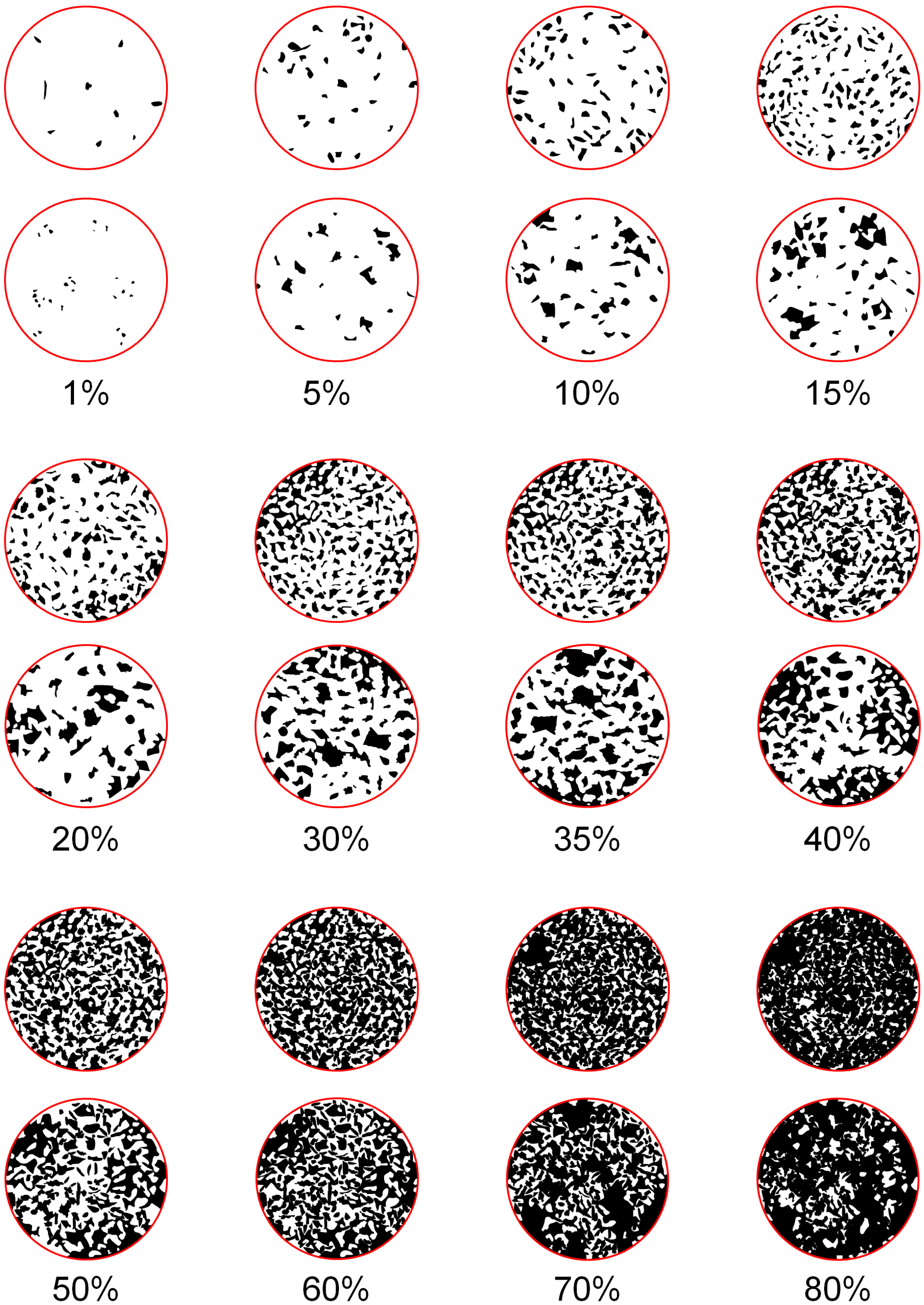
8. Continuous occurrence with several inclusions.



9. Continuous occurrence with very few inclusions.

Appendix C

Comparison Chart for Estimating Cover Percent



Adapted from: Terry, R.D.; Chillinger, G.V. 1955, Sept. Journal of Sedimentary Petrology 25(3): 229 – 234.

Appendix D

Derived Polygon Attributes

1.0 Introduction

Photo interpreters delineate and assign many attributes to polygons on aerial imagery that 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 landscape position, vegetation type, and crown closure estimates.

This section presents a discussion of the additional attributes, referred to as "derived attributes,” that have been identified as a product of the Photo Interpretation phase 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 Photo-interpreted information being provided.

The following list presents the attributes identified for derivation from the photo-interpreted attributes that may be subsequently adjusted with Ground Sampling data:

- Land cover class code
- Dominant polygon soil moisture regime (SMR)
- Tree diameter at breast height (DBH)
- Tree volume
- Tree site index
- Polygon descriptions for multi-layered stands

2.0 Land Cover Class Code

2.1 Definition

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

2.2 Purpose

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

2.3 Derivation Procedure

The BC Land Cover Classification Scheme's five levels are derived from the photo interpreter's estimates as follows. (See Section 2: *BC Land Cover 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 BC Land Cover 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

An iterative process following the rules of the BC Land Cover Classification Scheme is followed using the hierarchy of the Scheme. When the polygon is Treed, the basal area of each species (expressed as percent composition) is reviewed and amalgamated to determine which vegetation type the polygon should be classified as. When the polygon is Non-Treed, the hierarchy of the Scheme is implemented to determine which vegetation type should be derived.

Level 5 Density

Level 5 is derived from specific vegetation type crown closure (or cover percent for Herb and Bryoid cover types).

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 using the Level 5 information and working in reverse order. Each non-vegetated category can be directly correlated with a specific land cover type.

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 BC Land Cover 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 Type

Level 4 is derived using the level 5 information and working in reverse order. There is a direct correlation between each Non-Vegetated category and a specific Non-Vegetated cover type. No level 4 codes exist for water bodies; therefore, these fields are left blank for Water cover types.

Level 5 Non-Vegetated Categories

The codes from level 5 will be assigned directly by the photo interpreter as part of the attribute estimation process.

Examples:

A typical derivation of a Vegetated Land Cover Class Code:

Level	Estimated attribute criteria	Code
1	Vegetated crown closure ≥ 5%	V
2	Tree crown closure ≥ 5%	T
3	Not Alpine and LCC #1 SMR = 4	U
4	Species composition = $Pl_{80}At_{20}$	TC
5	Tree crown closure = 80%	DE

The Land Class Code for this polygon would be "VTUTCDE."

An example of a derivation of a Non-Vegetated Land Cover Class Code:

Level	Estimated attribute criteria	Code
1	Vegetated crown closure < 5%	N
2	Level 5 = Rubble, Talus, Blockfield	L
3	Alpine	A

4	Level 5 = Rubble, Talus, Blockfield	RO
5	Photo interpreted as Talus	TA

The Land Class Code for this polygon would be "NLARORT."

3.0 Dominant Polygon Soil Moisture Regime

3.1 Definition

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

3.2 Purpose

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

3.3 Derivation Procedure

Dominant polygon SMR is derived from the largest land cover component by area. When the first two or more land cover components are equal in percent area, the first land cover component indicated will be used to derive the dominant SMR.

4.0 Tree Diameter at Breast Height (DBH)

4.1 Definition

Diameter at breast height (DBH) is the average tree diameter at breast height for all live trees in the dominant, co-dominant, and high intermediate crown positions in each tree layer in the polygon.

Note: Dominant trees have well-developed crowns that extend above the general level of the trees around them. Co-dominant trees have crowns forming the general level of trees around them. High intermediate trees have smaller crowns slightly below but extending into the general level of trees around them.

4.2 Purpose

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

4.3 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:

$$DBH = 2 * \sqrt{\frac{\text{Basal Area}}{(\text{Density x } \pi)}}$$

For example, if basal Area = 100 m^2per ha and density = 400 stems per ha

$$DBH = 2 * \sqrt{\frac{100m^2 \ per ha}{400 stems \ per ha \ x 3.14}} = 2 * \sqrt{0.0796m^2} = 0.564 \text{ m}$$

DBH = 56.4 cm

5.0 Tree Volume

5.1 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.

5.2 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.

5.3 Derivation Procedure

Volume can be derived from estimates provided for basal area, species composition, and height. Leading species and the vegetation inventory project location (e.g., Forest Inventory Zone) determine 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.

A very simplified formula to calculate tree volume is:

Gross volume = 1/3 × height × basal area

For example, if basal area = 57 m^2 per ha and height = 42 m

Gross volume = 1/3 × 42 m × 57 m^2 per ha

Gross volume = 798 m^3 per ha

This is a simplified approach for demonstration purposes only. The actual process and formula used to derive the volume that will be stored in the database will incorporate many more factors than the formula indicated above.

6.0 Tree Site Index

6.1 Definition

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

6.2 Purpose

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

6.3 Derivation Procedure

Site index estimates are required on all treed polygons as well as polygons that are potentially capable of producing trees. Stands that 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
- 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 less than 50 years) or interpolation (age greater than 50 years) of site index.

7.0 Polygon Description for Multi-layered Stands

7.1 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.

7.2 Purpose

Ground sampling data does not differentiate trees from different layers within a stand. Therefore, attributes from individual tree layers need to be amalgamated into a single polygon description to facilitate inventory adjustments.

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

7.3 Derivation Procedure

<u>Example:</u>

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 should be 10% higher because of the ground sampling phase.

Attribute layers	**Redistribution procedure into individual tree**
Species composition	Prorated on the basis of basal area
Crown closure	crown closure$_{(\text{layer 1})}$ + crown closure$_{(\text{layer 2})}$ + … + crown closure$_{(\text{layer n})}$

Attribute layers	**Redistribution procedure into individual tree**
Age	Prorated on the basis of basal area
Height	Prorated on the basis of basal area
Basal area	basal area$_{(\text{layer 1})}$ + basal area$_{(\text{layer 2})}$ + … + basal area$_{(\text{layer n})}$
Density	density$_{(\text{layer 1})}$ + density$_{(\text{layer 2})}$ + … + density$_{(\text{layer n})}$
Snags	snags$_{(\text{layer 1})}$ + snags$_{(\text{layer 2})}$ + … + snags$_{(\text{layer n})}$

Adjustment of the total polygon estimates uses computed adjustment ratios from the ground samples. Table 7-1 shows the adjustment of a two-layer stand.

Table 7-1 - Adjustment of a two-layer stand

Attribute	**Estimate Layer 1** (visible)	**Estimate Layer 2** (visible)	**Estimate Total for Polygon**	**Ground Sampling Adjusted Polygon Value**	**Adjusted Layer 1**	**Adjusted Layer 2**
Age (years)	250 (x $\frac{24}{32}$)	50 (x $\frac{8}{32}$)	200 (x 1.1) =	220	265 (250 + ($\frac{24}{32}$)*20)	55 (50 + ($\frac{8}{32}$) * 20)
Height (m)	33.0 (x $\frac{24}{32}$)	12 (x $\frac{8}{32}$)	27.9 (x 1.1) =	30.7	35.1 (33 + ($\frac{24}{32}$)*2.8)	12.7 (12 + ($\frac{8}{32}$)*2.8)
Basal area (m^2/ha)	24 sum	8	32 (x 1.1) =	35	26 (24 + ($\frac{24}{32}$) * 3)	9 (8 + ($\frac{8}{32}$) * 3)
Density (stems /ha)	100 sum	350	450 (x 1.1) =	495	110 (100 + ($\frac{100}{450}$)*45)	385 (350 + ($\frac{350}{450}$)*45)
Snags (stems/ha)	10 sum	0	10 (x 1.1) =	11	11 (10 + ($\frac{10}{10}$) * 1)	0 (0 + ($\frac{0}{10}$) * 1)

This is a simplified approach for demonstration purposes only.