Yukon Vegetation Inventory Manual

Version 3.0

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Forest Management Branch

Energy, Mines and Resources

Yukon Government

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1.0 INTRODUCTION

1.1 Background on Yukon Forest Inventories

The first forest inventories in the Yukon began in the 1950's and 1960's. These inventories were undertaken by the federal Department of Fisheries and Forestry. A total of 58,000 km2 were mapped at a variety of scales for the purpose of providing forest maps and volume data for the planning and control of industrial activity. Additional studies, centred in the Teslin and Watson Lake areas were undertaken during the fiscal year of 1968-69. These studies updated earlier estimates and provided more detail for operations.

The Gairns report of 1968 provided the first reconnaissance inventory of the Territory south of 66 degrees latitude. This inventory was based on previous reports and reconnaissance flights. The derived area and volume figures were adjusted for use in the national inventory in 1976 and 1981.

In 1982, the Northern Affairs Program, Forest Resources Section completed a small scale reconnaissance inventory of the Yukon. In response to this, 1:250,000 forest cover maps were produced from medium scale photography (1:50,000-1:70,000) and satellite imagery. This inventory covered the entire Yukon and was completed by the Canadian Forest Service and Forest Resources, Department of Indian and Northern Development with funding from the Energy from the Forest (ENFOR) program. The objectives of this inventory were to provide broad area, volume and biomass estimates for developing plans and policies; to identify areas for more intensive inventories; and to provide information for national inventory reporting. This inventory was completed between 1983 and 1986.

The 1982 program evaluation also identified more detailed management type inventories as a second priority. Between 1986 and 1995 Forest Resources completed the first management inventory at a scale of 1:50,000 covering Forest Management Units 1 to 7. The southeast Yukon saw a boom in the logging industry in 1994 as prices in British Columbia reached new highs. Rising prices for forest products coupled with the crisis in the Yukon mining industry, put new pressures on the forests of the Yukon. In improved forest inventory was therefore required to provide the basis for forest use decisions and sound forest management.

Beginning in 1999, Yukon began the first vegetation inventory for southeast Yukon and areas with no forest inventory for the Boreal Cordillera ecozone and 17 map sheets along the Porcupine River. This inventory was completed in 2003.

This inventory manual represents the current version of vegetation inventory for Yukon to provide foundational information for various land use and economic activities.

1.2 Vegetation Classification

Forest Resources' original forest classification methodology was developed in 1986 to guide the forest cover mapping program. This methodology was based on British Columbia's Ministry of Forests' Inventory Manual modified to suit the needs of the Yukon. Over the past few years the

needs of forest inventory users have changed. In order to meet these changing needs, Forest Management Branch has revised its forest classification to become a broader based vegetation classification. The new classes described in this classification are intended to increase the utility of the inventory.

1.3 Overview of Yukon Vegetation Inventory Structure

The purpose of classification is to divide the land into recognizable homogeneous units based on well-defined criteria. In Yukon, aerial photo interpretation for vegetation mapping has utilized 1:40,000 scale black and white aerial photography. Past inventories have used a minimum polygon size of 25 hectares (ha). This equates to an area of 1 square centimeter on a 1:50,000 National Topographic System base map. Since 1:40,000 aerial photographs are used for vegetation interpretation, measurements are to a large extent obtained or estimated from several secondary sources including:

- Ground samples
- Air calls
- Ground calls
- Regeneration surveys
- Permanent Sample Plots (PSPs)
- Previous mapping or other mapping projects

The inventory manual version 3 uses a smaller polygon size for forested and non-forested polygons. Softcopy technology will be used for interpretation. The advantage of using softcopy technology is the ability to interpret at a finer scale and capture more detail than hardcopy. Softcopy is explained further in section 1.4.

1.4 Softcopy

Softcopy is digital photogrammetry. The hard copy aerial photos are replaced with digital imagery and photo interpretation is done with a 3-D computer system. The inventory that was completed in parts of Yukon between 1999 and 2004 used both manual and softcopy procedures. Inventories that will be completed under this manual (version 3) will use softcopy technology.

2.0 LAND BASE DELINEATION

2.1 Basis for Delineation

Polygon delineation is based on observable differences in vegetated or non-vegetated cover following the classification scheme, standards and guidelines outlined this document. Delineation starts from broad categories and proceeds to more detailed and specific categories as described in the classification scheme. The criteria for when to differentiate polygons are described below.

2.1.1 Forested Polygons

Forested polygons will have >= 10% tree cover and >= 5% vegetation cover to be classified as forested and meet the minimum polygon size.

Interpreters will differentiate between forested polygons when one of the following conditions applies:

- The crown closure differs by more than 20%;
- The species composition differs by 20% or more;
- The age differs by 20 years or more;
- The height differs by 3m or more;
- The moisture regime differs by major class (dry, fresh, moist, wet);
- The stand structure differs;
- The disturbance on the land base requires delineation. Two disturbances next to each other on the land base may require differentiation based on available data. For example, two logged areas that are next to each other that were logged in different years would require 2 polygons;

Interpreters will differentiate between forested polygons when two of the following conditions apply:

- The crown closure differs by more than 10%;
- The species composition differs by 10% or more;
- The age differs by 10 years or more;
- The disturbance of the land base requires delineation

2.1.2 Non-Forested

Non-forested polygons are vegetated land with >=5% plant cover and < 10% tree cover and meet the minimum polygon size criteria for non-forested polygons. Delineation for non-forested polygons will be differentiated when:

- Crown closure differs by more than 30% from tall shrubs, short shrubs, herbs, and bryoids.

Non-forested polygons will be differentiated when two of the following applies:

- The crown closure differentiates by more than 20%;
- The composition of tall shrubs, short shrubs, herbs or bryoids differs by 20% or more.
- Polygons that are intersected by urban corridors. If urban corridors are abandoned then the vegetation needs to be described.

2.1.2 Non-Vegetated Polygons

Non-vegetated polygons have <5% of the total ground area of the polygon covered by trees, shrubs, herbs and/or bryoids. Water bodies are classified as non-vegetated.

2.2 Working Scale

A working scale refers to the map scale at which delineation of photo features are captured. A working scale is required for softcopy systems to help standardize delineation so that delineation occurs in a consistent manner between photo interpreters. Softcopy systems allow users to view stereo images at a variety of scales limited by the image pixel size. There is a chance that features are delineated with either too much or too little detail.

Forested and non-forested vegetated polygons should be delineated between a scale of 1:5,000 and 1:3,000. Zooming out to small scales should be used to visualize the polygon and its relationship to adjacent polygons while delineation is progressing.

Working with hard lines like watercourses and road right-of-ways should be delineated at a scale of 1:2,000.

The interpreter should be aware that the working scale will be influenced by elevation change over the landscape.

These guidelines for working scale will be used for auditing purposes.

2.3 Minimum Polygon Size and Range of Polygon Sizes

Minimum polygon size is provided to assist with producing hard copy map products and to help avoid an inventory that is too detailed. However, there is a risk of over simplifying the inventory and still meet the minimum polygon size criteria. This should be avoided. The forests of Yukon are generally a result of large fire events. Therefore, the forest composition and age

class is often consistent over large landscapes. Geographic features that influence the difference between stands can include landscape position, aspect, elevation, fire history, moisture and surficial geology. The intent of delineation is to represent the range of various cover types across the landscapes as influenced by landscape features, water and disturbances based on the minimum polygon sizes and classification criteria described in this manual. Table 1 provides the criteria for minimum polygon size for each land cover class.

Alpine and subalpine polygons delineation will be broader with a minimum polygon size of 25 ha.

There are allowances where the minimum sizes or widths may be exceeded by the interpreter. These circumstances allow the interpreter to identify unique features, non-forest or non-vegetated cover types that would add value to the inventory but not add frivolous delineation. These could include but not be limited to harvest areas, minimum widths for corridors and water features. Allowances will also be permitted for when corridors split polygons.

Table 1. Minimum Polygon Size for Each Land Cover Class

Land Cover Class	Minimum Polygon Size (ha)
Vegetated, Forested	8
Vegetated, non-forested	4
Lakes	As per base maps (may consider a minimum value for delineation on mapsheets that have many small lakes and ponds less than 1 ha)
Alpine	25
Subalpine	25
Islands	2
Roads and Right-of-Ways	2
Land Use	4
Harvest Areas	2 If smaller polygons are identified in the harvest areas information then delineate the smaller polygon.

2.4 Linear Features

Linear features are features such as roads, cut-lines and power line right-of-ways. To delineate a linear feature the minimum width should be greater than 20 m. A water course should be delineated where the minimum average width is greater than 20 m.

2.5 Relationship with Base Mapping

The base maps that will be used are CanVec. CanVec is a digital cartographical reference product produced by Natural Resources Canada. CanVec originates from the best available data sources covering Yukon and offers topographical information in vector format that comply with international geomatics standards.

CanVec information will be used to help identify water bodies and road features. Waterbody features may not match. The interpreter will delineate the feature as per the inventory classification scheme. CanVec should be used as a guide. All spatial features will be redrawn as part of the vegetation cover feature. Water bodies may have changed over time and may not exist today or have become some other wetland feature.

Linear streams will be left as they are. They will not be redrawn or connected to water features that have been revised.

Please visit www.Geogratis.gc.ca for more information on CanVec data product specifications.

3. LAND COVER CLASSIFICATION

3.1 Cover Type

Cover type describes the dominant land cover within the interpreted polygons. The land cover classification or cover type is the first differentiation or highest level of the classification scheme. The cover type is a roll up of the detailed vegetation attributes into broad-level classification. The first stratification of the land base is to differentiate vegetated and non-vegetated polygons.

Polygons with greater than or equal to 5% plant cover are considered vegetated. Non-vegetated polygons have less than 5% plant cover.

Cover type is derived for all polygons based on attributes in Cover Type Class for non-forest polygons and non-vegetated polygons and the presence of forest attribute values for forested polygons.

Table 2. Cover Type Attribute Descriptions and Codes.

Cover Type	Description	Code
Vegetated	Polygons with greater than or equal to 5% plant cover.	V
Non-Vegetated	Polygons with less than 5% plant cover	N

3.2 Cover Type Class

Cover Type Class is used to describe Cover Type in more detail. Vegetated classes are either Forested or Non-Forested. Polygons that are labeled Forested are derived from forest attributes. Polygons that are non-forested are derived from the Non-Forest attributes. Forested polygons have greater than or equal to 10% tree cover. Non-forested polygons have less than 10% tree cover but greater than 5% vegetation cover.

Non-Vegetated polygon Cover Type Classes includes water, exposed land and urban/industrial lands.

Table 3. Cover Type Class Description and Codes.

Cover Type	Cover Type Class	Description	Code
Vegetated (V)	Forested	Polygons with greater than or equal to 10% tree cover.	VF
	Non-Forested	Polygons with less than 10% tree cover	VN
Non-Vegetated (N)	Water	Lakes and Rivers	NW
	Urban/Industrial	Developed land such as municipalities, power lines, roads, mines, gravel pits, clearings, residential and rural residential.	NU
	Exposed Land	Lands where the surficial materials have been exposed by natural erosional and depositional processes.	NE
	Snow/Ice	Lands covered year round by snow or ice	NS

3.3 Landscape Position

Landscape Position is used to describe the relative location of a polygon in the landscape into four categories (lowland, upland, subalpine, alpine).

All polygons will have a landscape position code except for corridor features. Corridors may intersect a number of landscape positions.

Table 4. Landscape Position Descriptions and Codes.

Attribute	Description	Code
Alpine	The land area above a maximum elevation for tree species, dominated in the vegetated areas by shrubs, graminoids, forbs, bryophytes or lichens. Much of the alpine maybe non-vegetation; covered primarily by rock and ice. The alpine is treeless by definition; however, there may be scattered trees (<10% crown closure).	A
Subalpine	Those higher elevation areas adjacent to alpine areas or cover higher elevation treed mountains or knolls. Tree cover is usually open in nature (10 to 40%). Influences include aspect and latitude. Other indicators are the presence of Subalpine Fir.	S
Upland	Those areas at mid elevations where vegetation and processes are not affected by water table or surface water or else affected only for short periods so that riparian (hydrophyllic) vegetation or processes do not persist.	U
Lowland	Those areas at lower elevation where the vegetation and ecological processes are significantly impacted by the presence and availability of water. The delineation of lowlands should be guided by visible indicators such as proximity to water, obvious slope breaks, river meander scars and vegetation patterns.	L

Since much of the criteria for landscape position are determined by vegetation characteristics, the position of non-vegetated polygons should be determined by their position relative to other classified, vegetated polygons.

4.0 ATTRIBUTES

Attributes are used to describe the polygons. Attributes are placed in the following categories:

- General Attributes
- Site Attributes
- Non-Vegetated Attributes
- Non-Forested Attributes
- Forest Attributes
- Wetland Attributes
- Derived Attributes

Each attribute category is described below.

4.1 General Attributes

General attributes are used to describe reference information or requirements for data storage.

4.1.1 Map Number

The Map Number refers to the National Topographic System 1:50,000 map sheet for a polygon. The project area will be seamless, i.e., the delineation will not be split across the map sheets.

When a polygon is completely within a map sheet, the NTS map sheet number will be placed in the field. If the polygon intersects more than 1 NTS map sheet, then the map sheet that has the majority of the polygon will be listed.

4.1.2 Polygon Number

Polygon number is a unique identifier for each polygon. It is used for labeling.

4.1.3 Photo Year

The year the aerial photography was acquired. Photo year is assigned to each polygon.

Example: Photo Year = 2007

4.1.4 Inventory Year

The inventory project may expand over several years. Inventory year is the year the polygon was classified.

Example: Inventory Year = 2012

4.1.5 Photo Interpreter

The name or initials of the photo interpreter who completed or has finalized the interpretation.

Example: Photo Interpreter = Poncho Intrepid

4.2 Site Attributes

Site attributes are used to describe the physical features of a polygon. Site attributes include:

- Soil Moisture Regime
- Soil Nutrient Regime
- Slope Position

4.2.1 Soil Moisture Regime

Soil moisture regime describes the available moisture supply for plant growth over a period of several years. Within a particular ecoregion the soil moisture will be relatively constant for any moisture regime class. However, between ecoregions with different climatic regimes the same moisture regime is influenced by precipitation, evapotranspiration, insolation and soil particle size.

Soil moisture regime is interpreted for all vegetated polygons, burned areas and exposed soil using the classes in Table 5.

Table 5. Description of Soil Moisture Regime and Codes.

Class	Description	Effective Soil Texture	Code
Dry	Majority of soil is coarse fragments. Water removed extremely rapidly in relation to supply. Soil is moist for a negligible period following precipitation.	Gravel, cobbles, stones, boulders	D
Moderately Dry	Water removed very rapidly in relation to supply. Soil is moist for brief periods following precipitation.	Very coarse sands, coarse sand, loamy coarse sand, and silty coarse sand	MD
Moderately Fresh	Water removed rapidly in relation to supply. Soil is moist for short periods following precipitation.	Medium sand, loamy sand to sandy loam	MF
Fresh	Water removed readily in relation to supply. Water available for moderately short periods following precipitation.	Sandy loam to very fine sands	F
Very Fresh	Water removed somewhat slowly in relation to supply. Soil may remain moist for significant but sometimes short periods of the year.	Silty loams to sandy clayey loams and clays	VF
Moderately Moist	Water removed slowly enough to keep the soil wet for a significant part of the growing season. Some temporary seepage. Must have mottling above 50 cm.	Variable depending on seepage	MM
Moist	Water removed slowly enough to keep the soil wet for substantial parts of the growing season; seepage common.	Must have mottling variable depending on seepage	M
Very Moist	Water removed slowly enough to keep the soil wet for most of the growing season. Permanent seepage and mottling present possibly weak gleying.	Variable depending on seepage	VM
Moderately Wet	Water removed slowly enough to keep the soil wet for most of the growing season. Permanent seepage and mottling present gleying in mineral soils.	Variable depending on seepage	MW
Wet	Water removed slowly enough to keep the water table at or near the surface for most of the year, gleying mineral and permanent seepage near the surface. Permanent seepage less than 30 cm below the surface.	Organic and gleyed mineral soils	W
Very Wet	Water removed so slowly that the water table is at or above the soil surface all year. Saturated to surface all year.	Organic and gleyed mineral soils	VW

4.2.2 Soil Nutrient Regime

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

Table 6. Soil Nutrient Regime Description and Codes.

Soil Nutrient Regime	Code
Very Poor	VP
Poor	P
Medium	M
Moderately Rich	MR
Rich	R
Very Rich	VR

4.2.3 Slope Position

Slope position describes the relative position of a polygon within the landscape. Figure 1 illustrates the relative slope position.

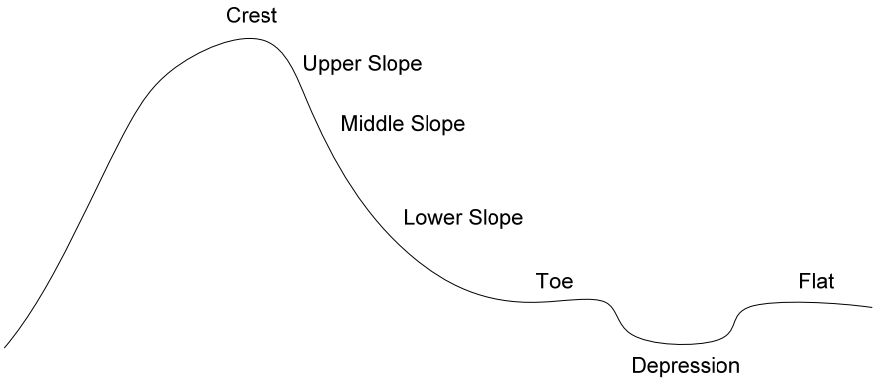

Figure 1. Relative Slope Position Diagram.

Table 7. Slope Position Description and Codes.

Slope Position	Description	Code
Crest	Generally, convex in all directions with no distinct aspect.	C
Upper	The generally convex, upper portion of the slope of a hill immediately below the crest. It has a convex surface profile with a specific aspect.	U
Middle	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.	M
Lower	The area toward the base of the slope of the hill. It generally has a concave surface profile with a specific aspect.	L
Toe	The area differentiated from the lower slope by an abrupt decrease in slope gradient. It is often characterized by seepage.	T
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.	D
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.	F
All	This category is used to describe alpine or subalpine areas or small islands. These broader polygons may include multiple positions.	A

4.3 Non-Vegetated Attributes

There are two types of non-vegetated attributes: natural and anthropogenic. Natural non-vegetated attributes include features such as lakes, rivers and rock. Non-vegetated anthropogenic attributes include features such as gravel pits, mines and roads. It is recognized that some anthropogenic features may be vegetated like seismic lines, transmission lines and old road corridors. The vegetation does not need to be recorded for these anthropogenic features.

Landscape position is required for non-vegetated attributes. It is plausible to have non-vegetated attributes in all four landscape positions.

Table 8**.** Non-Vegetated Attribute Descriptions and Codes.

Non-Vegetated Cover Type	Non-Vegetated Attributes	Description	Code
Water	Lake	A body of water. The boundary of a lake is the natural high water mark.	LK
	River/Stream	A watercourse formed when water flows between continuous, definable banks. Flow may be intermittent or perennial, but does not include ephermeral flow where a channel with no definable banks is present. Gravel bars are part of a stream, while islands (>2 ha)within a stream that have definable banks are not. The CANVEC base map should be used as a guide to help delineate islands and other features within a river/stream.	RV
Exposed Land	Bedrock	Unfragmented, consolidated rock contiguous with underlying material.	BR
	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, cliff areas and rock from glaciers.	RU
	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.	TA
	Exposed Soil	Any exposed soil not covered by other categories such as areas of recent disturbance that include mud slides, debris torrents, avalanches where vegetation cover is less than 5%.	ES
	Sand	Dunes or sandy outwash.	SA
	Beach	An area with sorted sediments reworked in recent time by wave action. It is formed at the edge of waterbodies.	BE
	Cut bank	These are natural features along water courses or slumps or slides. Note, the cut bank with a road corridor is included and labeled as part of the road.	CB
	Pond or Lake Sediments	Exposed sediments related to dried-up lakes or ponds.	LS
	River Sediment	Silt, gravel and sand bars associated with former river channels and present river edges. This is not be confused with gravel and sand bars that are part of the river.	RS
	Exposed Land	Exposed land that is not described in any other category.	EO
Anthropogenic	Mine Site	An area that has been cleared for mining activity.	MS

Non-Vegetated Cover Type	Non-Vegetated Attributes	Description	Code
	Mine Tailings	Discarded overburden or waste rock moved to extract ore during a mining operation.	MT
	Airport	Area cleared for the purposed of landing an aircraft.	AP
	Urban / Settlement / Rural Residential	Areas that are occupied by people and infrastructure. Forest and non-forest attributes will be interpreted for these areas as per specifications.	US
	Gravel Pit	Area exposed for removal of sand and/or gravel.	GP
	Railway	A roadbed with fixed rails which may contain single or multiple rail lines. These maybe abandoned lines.	RW
	Seismic	Area cleared for seismic activity greater than 20 m in width.	SL
	Road	Includes all weather and seasonal roads where the vegetation cover has been removed for the construction of the road.	RD
	Industrial Site	An area cleared for industrial activity. It may include various types of industrial activity.	IS
	Cultivated	Cleared areas that are used to grow crops in agriculture.	CU
	Tower Site	Cleared area that is used for a tower.	TS
	Anthropogenic Other	None of the above applies.	AO
	Generic Clearing	Cleared area where the land use cannot be determined.	GC

4.4 Percent Cover of Non-Vegetated Attributes

The non-vegetated attribute cover percent is the estimation of the percentage of the polygon occupied by each non-vegetated attribute.

The percent cover is estimated in 10 percent classes.

4.5 Non-Forested Attributes

Non-forested attributes include all vegetated non-treed areas (less than 5% tree cover) and describe the non-forest component of a forested area if applicable. This includes woody vegetation (shrubs) and non-woody vegetation (grasses, mosses, herbs, lichens).

All forested polygons with less than 55% tree cover must also identify the understory non-treed component. Percent cover will be estimated in 10% classes and is required for all non-forested categories. Only one shrub category and one (most dominant) non shrub category can be described per polygon.

Canopy pattern is required for all non-forested attributes.

Table 9. Non-Forest Attributes Description and Codes

Non-Forest Attributes	Description	Code
Tall Shrub	Shrub types dominated by shrubs greater than or equal to 2 m in height.	TS
Low Shrub	Shrub types dominated by shrubs less than 2 m in height.	LS
Herb (undifferentiated)	Polygons which are dominated by herbs but not clearly differentiated between graminoid or forbs and shrubs less that 30%.	HE
Herb (graminoid)	Lands where graminoids are the dominant cover and shrub cover is <30%.	HG
Herb – Forb	Lands where herbs / forbs are the dominant cover and shrub cover is <30%.	HF
Bryoid (undifferentiated)	Polygons which are dominated by bryoids but not clearly differentiated between moss or lichens and shrubs less than 30%.	BY
Bryoid – Moss	Lands where bryoids / moss are the dominant cover and shrub cover is <30%.	BM
Bryoid – Lichen	Lands where bryoid / lichen are the dominant cover and shrub cover is <30%.	BL

4.6 Percent Cover of Non-Forest Attributes

The non-forest attribute cover percent is the estimation of the percentage of the polygon occupied by each non-forest attributes.

The percent cover will be estimated in 10 percent classes.

4.6 Forest Attributes

All of the attributes in this section are recorded for polygons classified as vegetated, forested. Non-forested vegetation can also be described independently for a polygon if applicable. If a forested polygon has a combined (for multiple layered) crown closure of less than 55% then non-forested attributes must also be described.

4.6.1 Stand Structure

Structure is the physical arrangement or vertical pattern of organization of the treed layer within a polygon. Structure is applied to tree layers only. Non-forested vegetation can also be described independently for the polygon if applicable. A forested polygon can be identified as a single layered, multiple layered or complex layered polygon.

Only two tree layers can be described for multiple layered polygons.

Table 10. Stand Structure Description and Codes

Stand Structure	Description	Code
Single Layered	Vegetation within a polygon where the heights do not vary more than +- 3 m.	S
Multiple Layered	Two distinct tree layers occur. Each layer is significant, clearly observable and evenly distributed. A 3 m height difference must exist between each layer. Each layer is assigned an independent description	M
Complex	There is no distinct layer between trees and heights are variable. Complex polygons are limited to subalpine and wetland areas in order to ensure that this attribute is not over used.	C

4.5.2 Vertical Complexity

Vertical complexity is used to identify and describe even-age and uneven-aged tree layers for further analysis in forest stand management.

Vertical complexity describes the relative uniformity of each layer of the forest canopy. Vertical complexity is influenced by stand age, species and time since the last major disturbance (e.g. fire, insects, windthrow). Vertical complexity is the difference between the height range (minimum height and maximum height) divided by the average stand height.

Example:

Average height = 19 m

Maximum height = 22 m

Minimum height = 20 m

$$\text{Vertical Complexity} = \frac{(\text{Maximum Height} - \text{Minimum Height})}{\text{Average Height}} * 100$$

$$= \frac{(22 - 20)}{19} * 100$$

$$= (2/19) * 100$$

$$= 10.5$$

Therefore, the vertical complexity of the stand would be Very Uniform.

Table 11. Vertical Complexity Coding

Vertical Complexity	Description	Code
Very Uniform	A very uniform canopy with less than 11% difference between the height range and average height. These stands have no evidence of recent disturbance affecting the stand structure (no holes or gaps in stand). Examples may include: young lodgepole pine stands, plantations, immature stands.	1
Uniform	A uniform canopy with 11 to 20% difference between the height range and average height. A few holes or gaps maybe visible in the canopy. Typically, there is little evidence that disturbance is affecting the stand structure.	2
Moderately Uniform	A moderately uniform canopy with 21 to 30% difference between the height range and average height. Some holes or gaps maybe visible in the canopy. There maybe evidence of past disturbance affecting the form of the stand. An example is an older spruce stand where larger intermediate trees exist through the stand.	3
Non-Uniform	A relatively non-uniform canopy with 31 to 40% difference between the height range and average tree height. Holes or gaps are often visible in the canopy from past disturbance and stocking is patchy or irregular.	4
Very Non-Uniform	A very non-uniform canopy with more than a 40% difference between the height range and average height. Stocking is typically very patchy or irregular.	5

4.5.3 Canopy Pattern for Forested Areas and Non-Forested Areas

Canopy pattern describes the spatial arrangement of tree cover within a polygon. Canopy pattern will be described for each tree layer.

Canopy pattern is used to describe the spatial distribution of vegetation. Examples include treed islands in the subalpine landscape position, clumps of trees on rocky outcrops, scattered patches of trees in shrub lands, or continuous forest cover. Tree canopy provides information on the relative amount “edge” or “interior” stand conditions within the polygon. Polygons with anthropogenic disturbance or created as a result of anthropogenic activities area assigned a code of P9.

Table 12. Canopy Pattern Description and Codes.

Pattern Type	Description	Code
A single patch	Relates to an over story layer in multi-layer or trees over non-forested stands.	P1
Few patches of stems	There is greater than one patch and less than four patches of stems without single occurrences of stems.	P2
Few patches of stems plus several sporadic occurrences	There is greater than one patch and less than four patches of stems with occurrences of single stems throughout polygon.	P3
Several patches of stems, evenly spaced	There is greater than one patch of stems per two hectares evenly distributed throughout the polygon. This may include sporadic and single trees.	P4
Several patches of stems, unevenly spaced	There is greater than one patch of stems per two hectares unevenly spaced throughout the polygon. This may include sporadic and single trees.	P5
Continuous single stems, evenly spaced	Crowns rarely interlock and spacing is uniform. Crown closure is $\leq$ 70%.	P6
Continuous canopy, openings common	Crowns interlock and crown closure is > 50%. Several openings occur throughout polygon	P7
Continuous canopy, openings uncommon	Crowns interlock, spacing is uniform and crown closure is > 50%. Very few openings occur in polygon	P8
Anthropogenic pattern, any occurrence	Signs of planting or treatment that indicate rows or other human-caused pattern	P9

4.5.4 Species Composition

Species composition is the percentage of each tree species within a forested polygon. Species are listed in descending order according to their contribution to crown canopy. A total of 4 species can be used to describe each polygon for single layer, multiple layer or complex layer stands.

Delineation of polygons will be separated if species compositions differ by 10% or more. The species composition for each layer within a polygon must sum to 100%.

There are eight tree species found in Yukon. Not all species may be found in one location or region. It is a good idea to check via local knowledge or field work to determine which species are missing or in low or restricted occurrence based on latitude, elevation or other regional factors.

Table 13. Yukon Tree Species and Codes.

Tree Species	Code
Tremblin Aspen – *Populus tremloides*	A
Balsam Poplar – *Populus balsamifera*	B
Subalpine Fir – *Abies lasiocarpa*	F
Larch – *Larix laricina*	L
Lodgepole Pine – *Pinus contorta*	P
Black Spruce – *Picea mariana*	SB
White Spruce – *Picea glauca*	SW
Birch – *Betula spp.*	W

4.5.5 Percent Composition

The percent composition is estimated to the nearest 10% from the photo. Field checks or air calls are used whenever possible via a field program to help calibrate the photo interpreter. Delineation of polygons will be separated if species compositions differ by 10% or more. The species composition for each layer within a polygon must sum to 100%.

Table 14. Percent Composition Description and Codes.

Percent Composition	Codes
Contribution to the Crown Canopy	10% = 1; 100% = 10

4.5.6 Crown Closure

Crown closure is the percentage of ground area covered by the vertically projected tree crowns. This percentage is estimated from photos and where possible checked during the field program through air calls or field data. Stands are separated if the difference in crown closure is greater than 20%. Crown closure is recorded to the nearest 5%.

Crown closure is estimated for all tree layers independent of each other.

4.5.7 Height

Tree height is estimated for leading tree species in the canopy based upon an average of dominant and codominant tree heights. Height is recorded to the nearest metre (+/- 1 metre). A stand will be separated into two or more types where the range of heights are 3 m or more (unless such a separation violates the minimum type size limitation).

In multiple layered stands, the stand height attributes will be described for each layer.

Height range will only be used for complex stands. There are 3 attributes describing the average height and height range described in Table 14.

Table 15. Stand Height Description.

Attribute Name	Description
Average Height	Average height, in metres, of the dominant and co-dominant trees of the leading species.
Minimum Height	Minimum height, in metres, of the dominant and co-dominant trees of the leading species
Maximum Height	Maximum height, in metres, of the dominant and co-dominant trees of the leading species.

There should be a minimum of 20 height measured using the digital photogrammetric system.

4.5.8 Stand Age

Stand age is the average age of the stand from origin to the nearest 10 year class. Stand age is interpreted for the dominant and codominant trees for the leading species in 10 year classes for single layered stands. For multiple layered stands, age is interpreted for each layer. Complex stands, age is interpreted according to the leading species. Field ages for complex stands will come from the upper third of the canopy.

Age will also be collected at breast height for most plots during the field program. For young stands age should be collected as close to the ground as possible. Fire history maps should be used to age regenerating forests. Age correction factors for each species are provided below as a guide. At the time of this manual, Yukon has little data to support these relationships. Through the field program, the table can be updated with more data and perhaps include species by site class relationship.

To assist in interpreting age, Fire History data and silviculture records are provided to the photo interpreters to assist in determining stand age. Also, Yukon site index curves and other sources can be used to help determine age.

Table 16. Age to Breast Height Relationship Guide.

Species	Years to DBH Guideline by Site Class			
	Good (Site Index >= 20)	**Medium (Site Index 15 – 19)**	**Poor (Site Index 10 – 14)**	**Low (Site Index <= 9)**
White Spruce	5	8	12	15
Black Spruce	8	12	15	18
Lodgepole Pine	5	8	12	15
Subalpine Fir	5	8	12	15
Larch	5	8	12	15
Trembling Aspen	5	8	10	12
Balsam Poplar	5	8	10	12
Birch	5	8	10	12

4.5.9 Stand Density

Stand density describes the number of stems per hectare based on classes for the major species, i.e. those species described by the species composition. Stand density will be guided based on relationships developed during field sampling. Species or species groups by height and crown closure relationship with stems per hectare will help guide the interpreters to estimate stand density.

Stand density will be described for each layer in multi-layered stands.

Stand density classes should be refined as more data and relationship confidence increases.

Table 17. Stand Density Classes.

Stand Density Class	Code
Non-forest	0
0 to 100	100
101-200	200
201 – 300	300
301 – 400	400
401 – 500	500
501 – 600	600
601 – 700	700
701 – 800	800
801 – 900	900
901 – 1,000	1,000
1001 – 1,200	1,200
1201 – 1,500	1,500
1501 – 2,000	2,000
2001 – 2,500	2,500
2501 – 3,000	3,000
3000 – 5,000	5,000
5000 – 10,000	10,000
10,001+	15,000

4.5.10 Disturbance

Disturbance codes are used to identify types of disturbance that has affected an area. There can be a maximum of two disturbance codes for a polygon. The disturbance code and year (if known) is recorded in the database in the appropriate fields.

Table 18. Disturbance Descriptions and Codes.

Disturbance	Description	Code
Burn / Fire	The forest vegetation has been destroyed or noticeably altered by fire.	DB
Wind	The forest vegetation has been damaged or destroyed by wind	DW
Disease	The forest vegetation has been damaged or destroyed by disease, such as root rot.	DD
Insect	The forest vegetation has been damaged or destroyed by insects, such spruce bark beetle.	DI
Flooding	The forest vegetation has been damaged or destroyed by flooding.	DF
Harvesting	The forest vegetation has been removed by harvesting	DL
Silviculture	The forest vegetation has been altered by silviculture activity	SI
Mining	Disturbance by surface mining or dredging.	DM
Seismic	Disturbance by seismic activity	DS
Slide or Slump	The vegetation has been disturbed or removed by a slide or slump.	SL
Weather	The vegetation has been disturbed by a weather event.	WE
Unclassified Clearing	The forest vegetation has been disturbed by unknown anthropogenic causes.	UC

Other disturbance may be added based on observed features. Before adding features or codes, Forest Management Branch needs to approve the new disturbance.

The extent of the disturbance is also interpreted. The extent will be applied to each disturbance code for a polygon. Disturbance extent is the amount of vegetation cover removed or affected by the disturbance.

The extent of the disturbance must coincide with the crown closure of any residual trees that were not affected by the disturbance. For example, if the stand has had a fire that affected 30 percent of the area it would be impossible to have a remnant crown closure of 75 percent for that stand.

Table 19. Extent Class Descriptions and Codes.

Class	Description	Code
Light	1 to 25% loss of crown closure or land area affected	1
Moderate	26 to 50% loss of crown closure or land area affected	2
Heavy	51 to 75% loss of crown closure or land area affected	3
Severe	76 to 94% loss of crown closure or land area affected	4
Entire	95 to 100% of loss of crown closure or land area affected	5

Disturbance and extent class will be described for each layer.

4.6 Wetland Attributes

The wetland classification scheme follows the classes developed by the National Wetlands Working Group[1] and modified by Vitt and Halsey[2,3]. The wetland attribute is composed of four parts: wetland class, wetland vegetation modifier, wetland landform modifier, and wetland local modifier.

Five major wetland classes are recognized based on wetland development from hydrologic, chemical, and biotic gradients that commonly have strong cross-correlations. Two of the classes; fen and bog, are peat-forming with greater than 40 cm of accumulated organics. The three non-peat forming wetland types are shallow open water, marsh (fresh or salt water), and swamp. A non-wetland class is also included. The Vegetation Modifier is assigned to a wetland class to describe the amount of vegetation cover. The Landform Modifier is a modifier label used when permafrost, patterning, or salinity are present. The Local Landform Modifier is a modifier label used to define the presence or absence of permafrost features or if vegetation cover is shrub or graminoid dominated.

Table 20. Wetland Class

	Attribute Value
Bog - > 40 cm peat, receive water from precipitation only, low in nutrients and acid, open or wooded with sphagnum moss	B
Fen - > 40 cm of peat, groundwater and runoff flow, mineral rich with mostly brown mosses, open, wooded or treed	F
Swamp - woody vegetation with ≥ 30 shrub cover or 6% tree cover. Mineral rich with periodic flooding and near permanent subsurface water. Various mixtures of mineral sediments and peat.	S
Marsh - emergent vegetation with < 30% shrub cover, permanent or seasonally inundated with nutrient rich water	M
Shallow Open Water - freshwater lakes < 2 m depth	O
Wetland - no distinction of class	W
Not Wetland - upland areas	Z

[1] National Wetlands Working Group 1988. Wetlands of Canada. Ecological Land Classification Series No. 24.

[2] Alberta Wetland Inventory Standards. Version 1.0. June 1977. L. Halsey and D. Vitt.

[3] Alberta Wetland Inventory Classification System. Version 2.0. April 2004. Halsey, et. al.

Table 21. Wetland Vegetation Modifier.

	Attribute Value
Forested - closed canopy > 70% tree cover	F
Wooded - open canopy > 5% to 70% tree cover	T
Open Non-Treed Freshwater - < 5% tree cover with shrubs	O
Open Non-Treed Coastal - < 5% tree cover, with shrubs	C
Mud - no vegetation cover	M

Table 22. Wetland Landform Modifier.

	Attribute Value
Permafrost Present	X
Patterning Present	P
No Permafrost or Patterning Present	N
Saline or Alkaline Present	A

Table 23. Wetland Local Modifier.

	Attribute Value
Collapse Scar Present in permafrost area	C
Internal Lawn With Islands of Forested Peat Plateau	R
Internal Lawns Present (permafrost was once present)	I
Internal Lawns Not Present	N
Shrub Cover $\geq$ 25%	S
Graminoids With Shrub Cover < 25%	G

4.7 Data Source and Plot Number

Data source and plot number field is used when other information sources like field data is used to interpret the polygon. If a plot is used the plot number is added to the data field.

Table 24. Data Source Description and Codes.

Data Source	Description	Code
Ground Plot	Information source supplied an inventory ground plot.	G(plot no.)
Air Call	Information source supplied an inventory air call.	A(plot no.)
Permanent Sample Plot	Information source supplied by a Permanent Sample Plot	P
Temporary Sample Plot	Information supplied by a temporary sample plot	T
Observation	Information supplied by a field Observation (ground or air)	O
Interpreted	The polygon is entirely interpreted based on surrounding data sources and local knowledge.	I

4.8 Derived Attributes

Derived attributes are values calculated or summed together based on photo interpreted attributes. These include site index, site class, stratum, polygon area

4.8.1 Site Index

Site index is an estimate of site productivity for tree growth. This attribute provides a common base for comparing the productivity of different sites.

Site index is derived for all forested polygons based on leading species, average height and stand age. For multiple layered stands, site index will be for the dominant layer. The reference age for site index is 100 years.

Site index base age 100 using the following equations:

$$H = b_1 S(1-e^{b2A})^{b3}$$

$$S = H / b_1(1-e^{b2})^{Ab3}$$

Where:

H = Height (total metres)

S = Site Index (metres) at reference age 100 years

A = Age in years

Regression coefficients at age 100 are b_1, b_2, b_3

Table 25. Regression Coefficients for Tree Species.

Species	Coefficients		
	b_1	**b_2**	**b_3**
Subalpine Fir	1.3832	-0.0155	1.3597
Birch spp.	1.1580	-0.0175	0.7687
Larch	1.1637	-0.0215	1.2243
Spruce spp.	1.2883	-0.0181	1.4177
Lodgepole Pine	1.0236	-0.0465	2.4269
Balsam Poplar	1.1318	-0.0226	1.1233
Trembling Aspen	1.2025	-0.0158	0.7994

4.8.2 Site Class

Site classes are grouping of site index values for forested polygons.

Table 26. Site Class Groupings and Codes

Site Class	Site Index Range	Code
Good	20+	G
Medium	15 to 19.9	M
Poor	10 to 14.9	P
Low	1 to 9.9	L

4.8.3 Stratum

Stratum code is a derived code which summarizes the species composition. At the time this manual was completed, strata are currently used for timber supply analysis to characterize the forest into species group for growth and yield modeling. There are 9 strata based on the tree species in Yukon.

Table 27. Strata Description and Codes.

Strata Name	Description	Code
Spruce	Spruce and fir stands where the combined spruce and fir component exceeds 80% based on crown closure.	1
Pine	Lodgepole pine stands where the pine component exceeds 80%.	2
Deciduous	Aspen, balsam poplar and white birch stands where these exceed 80%.	3
Spruce/Pine	Spruce leading stands where the secondary species is lodgepole pine.	4
Spruce/Deciduous	Spruce leading stands where the secondary species is aspen, balsam poplar or birch.	5
Pine/Spruce	Lodgepole pine leading stands where the secondary species is spruce or fir.	6
Pine/Deciduous	Lodgepole pine leading stands where the secondary species is aspen, balsam poplar or white birch.	7
Deciduous/Spruce	Aspen, balsam poplar or birch leading stands where the secondary species is spruce or fir.	8
Deciduous/Pine	Aspen, balsam poplar or birch leading stands where the secondary species is lodgepole pine.	9

5.0 Field Sample Guidelines and Standards

The field program is to assist the photo interpreters in linking what is observed in the field to what is observed on the photography. It is used to "calibrate" the photo interpreter in making their judgements in describing the polygons according to the classification scheme. Table 27 provides a guideline for minimum field samples for air calls and field plots. These numbers may change or be distributed differently once a project begins. For budget purposes, these numbers will be used.

Table 28. Guideline for Minimum Plots per 1:50,000 Map Sheet.

Plot Type	Guideline for Minimum Number of Plots
Field Air Calls	30
Ground plots	15

5.1 Field Sampling

Field sampling will be done using a combination of air calls, ground plots and observations. The emphasis is accessing a polygon and quickly collecting required measured and estimated values for each tree layer and non-treed vegetation. The number of each type of plots will be determined on a map sheet by map sheet basis after consideration of access, potential helicopter landing sites and homogeneity of forest cover types. Air calls and ground calls will be organized into both logical flight plans and ground plans to maximize the effort spent in the field. Ideally, an even distribution of field sampling would occur of all cover types, but this subject to access, production and economic constraints. The photo interpreters will work with the project manager to ensure the field program meets the need of the inventory for that region.

5.1.2 Air Calls

Air calls are visual estimates of attributes defined in the Yukon Inventory Classification Scheme. Air calls are typically completed at a polygon level. The field personnel performing the air calls need to be at a low-level flying height or heights to observe and accurately estimate the polygon attributes.

Field personnel should also record observations along flight lines to assist in calibration whenever possible. The field personnel should also calibrate themselves by landing periodically throughout the day to confirm air calls and/or establish ground plots or additional data. Appendix 1 provides a recommended air call sheet. The air photo interpreter contractors can devise their own sheet pending approval from the Yukon Government project manager.

5.1.3 Ground Plots

Ground plots provide actual measurements for photo interpreters at a site level to assist in interpretation. The primary purpose for ground calls is to gather data on age, height and density for each tree layer.

Access to ground plots is a major consideration due to the remoteness of Yukon. Economic constraints in most cases will limit where and how many ground will be measured. Ground plot measurements and estimates should emphasize obtaining the information quickly for the treed layers and non-treed vegetation. The minimum specifications are described or determined based on the objectives of the inventory project. The photo interpreters can ask for more information to be gathered pending the approval of the project manager from Yukon Government.

Ground plots should be placed within the polygon, i.e. the plot area should be representative of the polygon. Ground plot locations will avoid stand boundaries or non-representative areas or disturbances within the polygon.

5.1.4 Observations

Observations are gathered along flight lines for air calls or traverse lines for ground plots. These are quick notes and estimates for stand attributes. These are very helpful for the photo interpreters as it provides linkages across the landscape that note changes or homogeneity across the landscape. When observational data and information is used to help interpret a polygon, it must be recorded in the database for the vegetation inventory.

5.2 Ground Plot Specifications

Ground plot specifications are provided to ensure that ground plot data are gathered in a consistent manner so that it can be used for interpretation. Plots do not require the set up or flagging of tie points of flagging to a plot location. A GPS location indicating where the sample trees were recorded is required.

5.2.1 Ground Plot Records (Field Tally)

The following information is required to be collected at each ground plot location.

- Plot number
- Date
- Coordinates (GPS location)
- Fixed Area Plot Radius (m) (for stem density estimates)
- Overstory Field Call (Species Composition)
- Understory Field Call (Species Compostion)

- Crown Closure by layer (to the nearest 5%)
- Ground Layer Field Call (Percent cover of shrub, non-shrub)
- Stand Structure (single layer, multi-layer, complex layer)
- Slope Position
- Stand Disturbance and Disturbance Extent
- Stems / ha (as per classes)
- Age at Breast Height (1.3m) or other height if necessary
- Total age (based on counted age plus age correction factor)
- Soil Moisture Regime
- Soil Nutrient Regime
- Height of Trees in each Layer when applicable to the nearest metre.
- Wetland identifiers (when in wetland)
- Notes

A sample tally card/sheet is provided in Appendix 1. The contractor can add or change the tally card/sheet pending approval from the project manager from Yukon Government.

5.2.1.1 Age

Age will most often be taken by an increment bore at breast height for trees greater than 15 cm at Diameter at Breast Height (DBH). A different core position can be used and recorded if there is an incidence of rot at DBH. Trees smaller than 15 cm DBH can be sampled by either coring close to the bottom of the tree or cutting the tree to obtain a cookie.

Most trees have relatively slow growth in Yukon. It is difficult to count rings in the field and be accurate with counting. The age cores or cookies will be collected and brought back from the field to count. This will ensure accurate ages are obtained. Cores can be stored in either properly labeled straws or core holders.

A minimum of two ages per tree layer are required from co-dominant and dominant trees of the leading species of the stand layer. Complex stands may require more than two age counts. Ages will be counted to the nearest 1 year.

5.2.1.2 Sample Tree Selection for Heights and Ages

Height samples will be measured to the nearest 0.1 m. Trees that are measured for height will not have forks or broken tops. Height sample trees will also be the trees used for age sampling (see Section 5.2.1.1). A minimum two trees per layer should be measured.

Trees measured in single-layered stands should be dominant and co-dominant trees. Trees measured in multiple-layered stands will have trees measured in the top layer and lower layer that are representative of the stand. Complex stands should have a height measured for a variety of trees that are representative of the complex stand to obtain an average height, minimum height and maximum height.

5.2.1.3 Stand Density Estimates

Stand density is an estimate of the total stems per hectare represented by the dominant, co-dominant and upper intermediates of each tree layer. To assist with determining an estimate, a minimum of three fixed area plots must be established. More plots will be required for variable stands. Fixed area plot size must be the same for all plots used in the estimate for the stand. Plot size should be selected to reflect the openness or denseness of a stand; i.e. a larger plot radius should be chosen for an open stand and a smaller plot can be used for a dense stand. Selection of plot locations should be random in nature and reasonably separated from each other. Only include trees for the layer they represent.

Plots do not require a GPS locations or require ribboning.

6.0 Database Specifications

The database structure and requirements will meet Yukon Government corporate guidelines or specifications. A geodatabase has been developed by Forest Management Branch for the inventory. Forest Management Branch is responsible for meeting these requirements.

A database validation program will not be provided by Yukon Government for this project. Quality assistance and quality control will rely on the contractor, Yukon Government and possible 3 party auditors.

6.1 Metadata File

The table describes the metadata required for Yukon Vegetation Inventory.

Table 29. Metadata file.

Field Name	Type	Width	Dec	Allowable Entries
Map	C	7		Vegetation Inventory Cover Name
Projection	C	7		Projection Name
Ellipsoid	C	7		Ellipsoid of vegetation cover name
Datum	C	5		Datum of vegetation cover name
Scale	C	6		Scale number
Accuracy	C	6		Accuracy of vector number is metres
Base map	C	10		Base used to create vegetation inventory
Base scale	C	6		Scale of base map
Base ellipsoid	C	7		Ellipsoid of base
Base datum	C	5		Datum of base maps
Date	Date	10		MM/DD/YYYY – date of contract end
Company	C	20		Primary contractor
Interpreter	C	20		Name of lead interpreter
Photo year	I	4		Year of aerial photography
Photo scale	I	6		Scale of aerial photography
Film type	C	7		Type of film
Photo company	C	20		Aerial Photo Company
Comments	C	50		Additional comments about map

References

Forest Management Branch would like to thank and acknowledge the following publications and their authors and contributors. These publications were highly valuable for developing the *Yukon Vegetation Inventory Manual Version 3*.

Alberta Environmental Protection, 1997. Alberta Vegetation Inventory Standards Manual Version 2.2. Resource Information Branch, AB.

Department of Renewable Resources, Forest Resources, Forest Management Division, 2006. Northwest Territories Forest Vegetation Inventory Standards with Softcopy Supplements. Version 3.0.

Forest Management Branch, Energy, Mines and Resources, Yukon Government, 2003. Yukon Vegetation Inventory Manual Version 2.1.

Resources Inventory Branch, 2001. Vegetation Resources Inventory, Photo Interpretation Procedures, Version 2.3. British Columbia Ministry of Forests.

Saskatchewan Environment, Forest Service, 2004. Saskatchewan Forest Vegetation Inventory.

Yukon Vegetation Inventory Classification Scheme Diagram