PROVINCIAL GROWTH & YIELD INITIATIVE (PGYI)

Minimum Standards and Suggested Protocol and Priorities for Establishing and Measuring Permanent Sample Plots in Alberta

(**Draft**)

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Government of Alberta ■

Executive Summary

As a part of an integrated provincial forest growth and yield program, this document describes the minimum standards for accepting existing permanent sample plots (PSPs) and measuring new PSPs in Alberta. Variables required to be measured at plot and tree levels are described, along with relevant reporting formats to a proposed centralized provincial database. Priorities for establishing and measuring new PSPs in Alberta where significant data gaps exist are identified. The primary goal of this document is to ensure the quality, usefulness and compatibility of collected PSP datasets from different agencies, for the purpose of modeling the growth and yield of natural and post-harvest stands under existing and emerging conditions in a collaborative, efficient, consistent, compatible and scientifically defensible manner.

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1. Background and Main Objectives

Alberta has been collecting forest growth and mortality data from permanent sample plots (PSPs) for five decades. Large amounts of valuable data have been collected across Forest Management Agreement (FMA) areas. The historical focus of the PSP data collections was on fire-origin natural stands in older age classes (>50 years). The data have been used for various purposes, chief among them, modeling and yield curve development to estimate growth rates for determining sustainable harvest level.

However, due to the absence of a common minimum standard and the associated quality assurance problems, some of the FMA-specific data sets lack scientific rigor and consistency, and are less useful than they could be. Variable standards and procedures in data collection among FMAs also hampered the use and exchange of data from different FMAs located within similar biological/ecological subregions. This has led to redundant and inefficient data collection programs that are more expensive than required. In addition, some forest types and age classes have been over-sampled, while there are significant data gaps in other areas, especially in younger stands.

More importantly, with Alberta moving more towards post-harvest stand management, additional data collection and new priorities, which shall take into account the changing environment, management practices and the dynamics of post-harvest stands, as well as the province's long-term stewardship responsibilities in sustainable management, must be weighed in to cope with the existing and emerging situations in a collaborative, efficient, consistent, compatible and scientifically defensible manner.

The main objectives of this document are to:

1). Present the minimum standards for accepting existing and measuring new PSPs;

2). Describe a standardized data reporting format for the proposed centralized PSP database;

3). Enhance collaboration and standardization of PSP programs to ensure data quality, consistency and compatibility among stakeholders;

4). Identify priorities for establishing and measuring new PSPs in areas where significant data gaps exist; and

5). Provide a standard and a reference for upgrading and modifying existing PSP programs (where applicable), and for establishing new PSP programs.

The ultimate goal of this document is to provide a standard and a template for establishing a centralized provincial PSP database with the same core minimum standards, to partially fulfill the requirements of forest management planning needs, to improve model development and model calibration, and to address other growth and yield issues under existing and changing forest and management conditions.

A unique characteristic of the proposed centralized provincial PSP database is that, within this database, companies can retain and/or upgrade existing PSP programs. They will contribute the existing data that meet the minimum standards to the database, and/or collect new data allocated to their land-bases following the same core minimum standards recommended for all PSPs. The provincial database will primarily be used for model development, model enhancement and model calibration. Companies can access the common database to fill in the data gaps in their areas, or to use the database for model calibration and localization in their areas in combination with other available data sources, e.g., from temporary sample plots (TSPs) and LiDAR (Light Detection And Ranging).

2. Minimum PSP Standards

Table 1 summarizes the minimum standards required for accepting existing and measuring new PSPs. More detailed definitions for the variables listed in Table 1 are provided in **Section 3**.

Table 1. Minimum standards for accepting existing and measuring new PSPs.

Variable category	Existing PSPs	New PSPs
Minimum plot sizes		
Tree	400 m^2	400 m^2
Sapling	62.5 m^2	100 m^2
Regeneration	10 m^2	40 m^2
Tagging limits		
Regular trees	9.1 cm DBH or smaller	5.1 cm DBH or smaller
Sapling trees	≥1.30 m HT or ≥1.1 or 2.0 cm DBH	≥1.30 m HT
Regeneration trees	If available	≥0.30 m HT, for coniferous only
Ages		
Pure species stands	At least 1 age tree	2 largest DBH trees per species
Mixed-species stands	At least 2 age trees, for 2 species	For up to 5 leading species
Regular and sapling tree measurements		
Tree number	All trees	All trees
Species	All trees	All trees
DBH	All trees	All trees
Height	All or a sample of trees	All or a sample of trees
Crown class	All or a sample of trees	All or a sample of trees
Height to live crown	If available	All trees or all height trees
Origin	If available	All trees
Tree condition code	Yes	All trees
Regeneration tree measurements (up to 10 trees per up to 3 coniferous species)		
Tree number	If available	Yes
Species	If available	Yes
Height	If available	Yes
Origin	If available	Yes
Tree condition code	If available	Yes
Regeneration density count by species	If available	Yes, for coniferous only
Plot measurements		
Plot number	Yes	Yes
Stand type (natural or regenerated)	Yes (can do at next measure)	Yes
GPS of plot centre	Yes (can do at next measure)	Yes
Natural subregion	Yes (can do at next measure)	Yes
Plot establishment year	Yes	Yes
Measurement year/month/day	Yes	Yes
Slope	Yes (can do at next measure)	Yes
Aspect	Yes (can do at next measure)	Yes
Elevation	Yes (can do at next measure)	Yes
Topographic position	Yes (can do at next measure)	Yes
Ecosite phase	Yes (can do at next measure)	Yes
% cover (shrub/herb/grass/moss)	If available	Yes
Stem-mapping (additional measurements apply to 10% of PSPs)		
Azimuth from plot centre	If available	All numbered stems ≥1.30 m
Distance from plot centre	If available	All numbered stems ≥1.30 m
Crown widths	If available	All or a sample of height trees

Note: details on height, crown class, height to live crown and stem-mapping measurements are provided in **Section 3**.

3. Reporting Format and Variable Definitions

The PSP data are to be inputted into a proposed, centralized PSP database (CPD). This CPD is to be established following the same core minimum standards and requirements. The standard data reporting format detailing the plot and tree level variables is defined in Table 2. Some variables in Table 2 apply to post-harvest (regenerated) stands only while others apply to all stand types. Whenever possible or available, additional variables listed in Table 2 beyond those required for the minimum standards defined in Table 1 shall also be inputted into the CPD.

The CPD is designed to accommodate all accepted data in a single flat file. The accepted data shall also be stored in a formatted relational database (e.g., Microsoft Access or Oracle), with standardized information coded in separate but easily linkable tables (e.g., for plot header, measurement header, tree/sapling data, regeneration data, age data, etc.), and with the overall database structure designed to address redundancy, integrity, efficiency, accuracy, reliability, accessibility and security issues.

The CPD will allow (as much as possible) for the seamless linkage and usage of data from multiple FMAs. It would also serve as a "one-stop shop" for accessing all PSP data. In addition, the CPD could potentially lead to standardized compilation processes and reduced analysis times by making pre-compiled data available. It may also foster improved knowledge sharing among FMAs, growth and yield analysts and forest planners. Specific details about this proposed relational database will be worked out at a later stage, using Table 2 as the basis and template.

It is recommended that all numeric variables (i.e., those with "I" and "F" formats in Table 2) shall be right-justified and all character variables (i.e., those with "A" format in Table 2) shall be left-justified.

The data reporting format presented in Table 2 is designed to encompass a wide range of situations, chief among them:

1). Existing and new PSP data sets;
2). High density stands;
3). Unique measurements on regeneration;
4). Age measurements within or outside the plot;
5). With or without stem-mapping; and
6). With or without AVI labels.

Definitions, examples and brief descriptions of the variables listed in Table 2 are provided next, many of which are included in the "Examples and notes" column of Table 2 itself.

3. Reporting Format and Variable Definitions

Table 2. Data reporting format for the centralized provincial PSP database (part 1 of 3).

Variable	Format	Examples and notes
General plot information		
1. Agency/company	A4	Table 3
2. Centralized plot number	I5	1 to 99999, to be assigned by ESRD
3. Company plot number	A15	Unique to each company. If I15, convert to A15
4. Company stand number	A15	If applicable
5. Stand type	I1	1=natural; 2=1st rotation post-harvest; 3=2nd rotation post-harvest
6. Stand origin	A1	C=Coppice/sucker; R=Residual stand; L=Layering; N=Natural (fire-origin); F=Fill-planted; S=Naturally seeded; P=Planted; A=Artificially seeded
7. UTM Zone	A5	UTM11, UTM12
8. Datum	A7	NAD83, NAD27
9. GPS – easting (x-coordinate)	F14.5	GPS of plot centre (recommended)
10. GPS – northing (y-coordinate)	F14.5	GPS of plot centre (recommended)
11. GPS – latitude	F15.10	GPS of plot centre (if available)
12. GPS – longitude	F15.10	GPS of plot centre (If available)
13. Township	I3	1 (south) to 126 (north)
14. Range	I2	1 to 26
15. Meridian	I1	4, 5, or 6
16. Section	I2	1 to 36 within a given township (if available)
17. FMU	A4	Forest management unit at survey time. E.g., C5, W13L
18. Topographic position	I1	1=Hollow or depression; 2=Flat; 3=Toe; 4=Lower slope; 5=Middle slope; 6=Upper slope; 7=Hilltop or crest
19. Slope	I2	Average percent (%) slope of the plot
20. Aspect	A2	N=North; E=East; S=South; W=West; NE=Northeast; SE=Southeast; SW=Southwest; NW=Northwest; NA=No aspect (slope = 0)
21. Elevation	I4	Height above mean sea level
Natural subregion and ecosite		
22. Natural subregion	A3	Table 4 and Figure 1
23. Ecosite and ecosite phase	A2	E.g., e3=low-bush cranberry Aw-Sw-Pl, in lower foothills
Linkage to reforestation standard (applies to post-harvest stands only)		
24. Opening number	A11	Opening number consistent with ARIS records. E.g. 4230755229A
25. Polygon/sampling unit number	A3	E.g., 001, 002 within an opening
Plot size and tagging limit		
26. Tree plot size	F7.1	E.g., 400.0 m^2, 1000.0 m^2
27. Minimum tree tagging limit	F3.1	E.g., 9.1 cm, 5.1 cm
28. Sapling plot size	F5.1	100.0 m^2
29. Sapling tagging limit – DBH	F3.1	0.1 cm
30. Sapling tagging limit – height	F4.2	1.30 m
31. Regeneration plot size	F5.1	E.g., 10.0 m^2, 40.0 m^2, 100.0 m^2

3. Reporting Format and Variable Definitions

Table 2. Data reporting format for the centralized provincial PSP database (part 2 of 3).

Variable	Format	Examples and notes
Plot size and tagging limit (continued)		
32. Regeneration tagging limit	F4.2	E.g., 0.30 m
33. Regeneration plot number	I1	1, 2, 3, 4 (if applicable)
Time of measurement		
34. Plot establishment year	I4	E.g., 1960, 2012
35. Year of measurement	I4	E.g., 2000, 2012
36. Month of measurement	I2	01 to 12
37. Day of measurement	I2	01 to 31
38. Measurement number	I2	1 (establishment), 2, 3 and up sequentially
Plot type, treatment and condition		
39. Plot type	I2	1=Regular; 2=Detailed; 3=Stem-mapped
40. Plot treatment 1	A1	Coded in the sequence in which the treatments occurred:
41. Plot treatment 2	A1	N=Not treated, not site prepared F=Fertilized
42. Plot treatment 3	A1	M=Site prepared, mechanical P=Pre-commercial
43. Plot treatment 4	A1	C=Site prepared, chemical thinning
44. Plot treatment 5	A1	B=Site prepared, burning T=Commercial thinning
		H=Tended, chemical U=Understory protection
		W=Tended, manual/mechanical A=Understory avoidance
		S=Shelterwood/selection harvest D=Drainage
45. Plot status and condition	I2	General status and condition of the plot (Table 5)
Plot surface vegetation		
46. Ground cover % - shrubs	I3	Percent ground cover by shrubs
47. Ground cover % - herbs/forbs	I3	Percent ground cover by herbs/forbs
48. Ground cover % - grass	I3	Percent ground cover by grasses/sedges
49. Ground cover % - moss/lichen	I3	Percent ground cover by moss/lichen
Tree measurement		
50. Tree number	I4	E.g., 1 to 6999 (inside the plot); 7000 and up (outside the plot)
51. Sector or quarter	A1	E.g., A, B, C, D, E, or 1, 2, 3, 4 (numbers treated as characters)
52. Tree type identifier	A1	T=Regular; S=Sapling; R=Regeneration;
		B=Tree in buffer or outside the main plot
53. Species	A2	Table 6
54. DBH	F5.1	E.g., 18.8 cm
55. Height of DBH	F4.2	E.g., 1.30 m or 1.37 m
56. Root collar diameter	F5.1	E.g., 3.8 cm
57. Height of root collar diameter	F4.2	E.g., 0.0 m or 0.30 m
58. Tree location	I1	0=Do not know
		1=tree within the sapling plot
		2=tree outside the sapling plot
59. Tree origin	I2	0=Unknown 5=Artificially seeded
		1=Naturally seeded 6=Planted, regular stock
		2=Coppice/sucker 7=Planted, genetically improved
		3=Layering 8=Planted, stock unknown
		4=Natural unknown 9=Advanced
60. Height	F5.2	2.88 m, 18.92 m
61. Crown class	A1	D=Dominant; C=Co-dominant; I=Intermediate; S=Suppressed
		V=Veteran/residual/remnant/super-dominant

3. Reporting Format and Variable Definitions

Table 2. Data reporting format for the centralized provincial PSP database (part 3 of 3).

Variable	Format	Examples and notes
Tree measurement (continued)		
62. Height to live crown	F5.2	Height from the ground to the base of continuous live crown
63. Condition code 1 (condition)	I2	Table 7
64. Condition code 1 (cause)	I2	Table 7
65. Condition code 1 (severity)	I1	Table 7
66. Condition code 2 (condition)	I2	Table 7
67. Condition code 2 (cause)	I2	Table 7
68. Condition code 2 (severity)	I1	Table 7
69. Condition code 3 (condition)	I2	Table 7
70. Condition code 3 (cause)	I2	Table 7
71. Condition code 3 (severity)	I1	Table 7
Regeneration density count by species		
72. Regeneration density count	I3	Density count (0 to 999) for coniferous regeneration species
Tree age		
73. Total age	I3	Total age (years) of the tree, from the point of germination
74. Stump age	I3	Age (ring count) at the stump height of 0.30 m above ground
75. Breast height age	I3	Age (ring count) at the breast height of 1.30 m above ground
Stem-mapped plot		
76. Crown width - north	F5.2	Stem centre to the widest crown to the north
77. Crown width - east	F5.2	Stem centre to the widest crown to the east
78. Crown width - south	F5.2	Stem centre to the widest crown to the south
79. Crown width - west	F5.2	Stem centre to the widest crown to the west
80. Azimuth from plot centre	F5.1	A tree due north has an azimuth of 0^{o} (or 360.0^{o}), one due east has 90.0^{o}, south 180.0^{o} and west 270.0^{o}.
81. Distance from plot centre	F5.2	The distance (m) from the stem centre to the main plot centre
Others		
82. AVI photo variables	Table 8	AVI photo-interpreted variables (up to 37 variables, Table 8)
83. AVI field variables	Table 8	AVI field-call variables (up to 33 variables, Table 8)
84. Crew member 1	A12	First initial plus the last name of field crew number 1
85. Crew member 2	A12	First initial plus the last name of field crew number 2
86. Comment	A80	Notes or comments for unusual or unique information

Note that:

1). The format (Table 2) is developed for standardizing data reporting. Not all variables are required but whenever available, they are inputted into the database. Only those listed in Table 1 (minimum standards) are required.

2). For some variables (such as height, crown class, height to live crown, crown width, and stem-mapping), either all or part of the sample trees are measured, as detailed later.

3). When the precision (i.e., decimal places) of a variable or a measurement instrument does not meet the requirement specified in Table 2, retain the maximum precision and zero-fill the other decimal places.

Specific definitions for the variables listed in Table 2 are provided as follows.

3. Reporting Format and Variable Definitions

1. Agency/company (up to 4-digit character)

This variable is used to identify a company or an agency (Table 3) that is currently responsible for the plot at the time of measurement. They are consistent with ARIS records. New, re-named, or additional companies and agencies can be added to the list whenever necessary.

Table 3. List of agency/company code.

Character code	Agency
AINS	Ainsworth Lumber C. Ltd.
GOA	Alberta Environment and Sustainable Resource Development
APLY	Alberta Plywood Ltd.
ALPC	Alberta Pacific Forest Products Incorporated
ANC	ANC Timber Ltd.
BLUE	Blue Ridge Lumber Inc.
CFPL	Canadian Forest Products Ltd.
CFS	Canadian Forest Service (Alberta)
DAIS	Daishowa-Marubeni International Ltd.
FOFP	Footner Forest Products Ltd.
BUCH	Gordon Buchanan Enterprises Ltd.
MDFP	Manning Diversified Forest Products Ltd.
MWWC	Millar Western Forest Products Ltd.
SLPC	Slave Lake Pulp Corporation
SPRA	Spray Lake Sawmills (1980) Ltd.
SUND	Sundance Forest Industries Ltd.
SFPI	Sundre Forest Products Inc.
HLFP	Tolko Industries Ltd. (High Level)
TOLK	Tolko Industries Ltd. (High Prairie)
TOSL	Tolko Industries Ltd. (Slave Lake)
UOA	University of Alberta
VAND	Vanderwell Contractors (1971) Ltd.
WFML	West Fraser Mills Ltd. (Hinton Wood Products Ltd.)
WEYR	Weyerhaeuser Company Ltd. (Grande Prairie)
WEYR	Weyerhaeuser Company Ltd. (Pembina Timberland)
UNKN	Unknown

2. Centralized Plot Number (up to 5-digit numeric)

Centralized plot number is used to identify a plot within the centralized PSP database. It is to be assigned by ESRD or the database manager to each PSP submitted by different organizations. Centralized plot number starts from 1 and up sequentially to a maximum of 99999.

3. Company Plot Number (up to 15-digit character)

A unique character or number (treated as character) retained from each company for each plot submitted to the centralized PSP database.

3. Reporting Format and Variable Definitions

4. Company Stand Number (up to 15-digit character)

A unique character or number (treated as character) retained from each company for each plot submitted to the centralized PSP database. Company stand number may be AVI version specific.

5. Stand Type (1-digit numeric)

Used to indicate if the plot is located in fire-origin natural or regenerated (post-harvest) stands:

1 — Fire-origin natural 2 — 1st rotation post-harvest 3 — 2nd rotation post-harvest

6. Stand Origin (1-digit character)

Stand origin is used to denote the primary origin of the stand at the time of plot establishment:

C — Coppice (from downed logs, stumps/snags) or sucker (from the roots or base of a tree)
L — Layering (from the rooting of un-detached branches)
F — Fill-planted (in areas of inadequate stocking to achieve the desired level of stocking)
P — Planted
R — Residual stand
N — Natural (fire-origin)
S — Naturally seeded (i.e., a conifer block that was left for natural)
A — Artificially seeded

7. UTM Zone (5-digit character)

Refers to the Universal Transverse Mercator zones. E.g., UTM11 and UTM12.

8. Datum (up to 7-digit character)

The official datum used for the primary geodetic network in North America. E.g., NAD83, NAD27.

9. GPS (plot centre) – easting (up to 14-digit numeric with five decimal places)

GPS reading of the plot centre – easting, i.e., eastward-measured distance (or the *x*-coordinate).

10. GPS (plot centre) – northing (up to 14-digit numeric with five decimal places)

GPS reading of the plot centre – northing, i.e., northward-measured distance (or the *y*-coordinate).

11. GPS (plot centre) - latitude (up to 15-digit numeric with 10 decimal places)

GPS reading of the plot centre – latitude recorded in degrees, minutes and seconds.

12. GPS (plot centre) – longitude (up to 15-digit numeric with 10 decimal places)

GPS reading of the plot centre – longitude recorded in degrees, minutes and seconds. Note: when used with a GIS tool, a MINUS sign must be put in front of the longitude value.

3. Reporting Format and Variable Definitions

13. Township (up to 3-digit numeric)

A unique number from 1 to 126, starting from the Alberta-US border and increasing towards the north. The vast majority of Alberta townships are 6 mile × 6 mile (9.6558 km × 9.6558 km).

14. Range (up to 2-digit numeric)

A number starting from 1 and up sequentially to a maximum of 26 to the west of a given meridian.

15. Meridian (1-digit numeric)

A number of 4, 5, or 6 starting from the Saskatchewan-Alberta border and increasing to the west.

16. Section (up to 2-digit numeric)

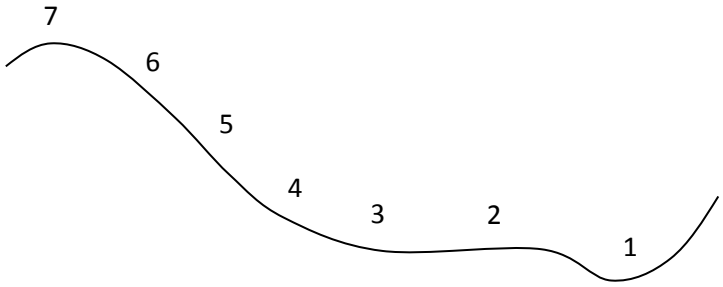
A number from 1 to 36, each represents one square mile (1.6093 km × 1.6093 km, or 2.5898 square km) within a given township.

17. FMU (up to 4-digit character)

Forest management unit, such as C5 and W13L, at the time of measurement.

18. Topographic Position of the Plot (1-digit numeric)

A number from 1 to 7 used to indicate the relative topographic position of the plot, in a hydrological sense, when compared to the general immediate area surrounding the plot (see illustration below). It is related to soil drainage class.



1 — Hollow or depression, for plots located in local topographic depressions (collecting water)
2 — Flat or level, for plots located on flat terrain (receiving water)
3 — Toe, for plots at the bottom of the slope
4 — Lower slope, for plots on low slope (shedding water)
5 — Middle slope, for plots on mid slopes (shedding water)
6 — Upper slope, for plots on upper slopes (shedding water)
7 — Hilltop or crest, for plots located on ridge crests (shedding water)

19. Slope (up to 2-digit numeric)

A number representing the average percent slope for the plot, recorded to the nearest ±1%. If there is no slope, zero is recorded. Note: make sure the slope measurement is in %, not in degrees.

3. Reporting Format and Variable Definitions

20. Aspect (up to 2-digit character)

The predominant aspect, i.e., the direction when facing away from the slope, of the plot:

N — North	E — East	S — South	W — West
NE — Northeast	SE — Southeast	SW — Southwest	NW — Northwest

NA — No aspect or not applicable (i.e., when slope = 0)

21. Elevation (up to 4-digit numeric)

Elevation is the height above mean sea level, taken at the plot centre and recorded to the nearest ± 1 m (e.g., 1368 m).

22. Natural Subregion (up to 3-digit character)

Natural regions and subregions of Alberta are listed in Table 4 and shown in Figure 1, with the older names still in use included in parentheses.

Natural regions and subregions of Alberta are taken from Natural Regions Committee (2006). Character codes are recommended for use in the centralized PSP database.

Table 4. Natural regions and subregions of Alberta.

Natural region	Natural subregion	Numeric	Character
Boreal Forest	Central Mixedwood	1	CM
	Dry Mixedwood	2	DM
	Northern Mixedwood (Wetland Mixedwood)	3	NM
	Boreal Subarctic	4	BSA
	Peace-Athabasca Delta (Peace River Lowlands)	5	PAD
	Lower Boreal Highlands (Boreal Highlands)	6	LBH
	Upper Boreal Highlands (Boreal Highlands)	21	UBH
	Athabasca Plain	12	AP
Rocky Mountains	Alpine	7	ALP
	Subalpine	8	SA
	Montane	9	MT
Foothills	Upper Foothills	10	UF
	Lower Foothills	11	LF
Canadian Shield	Kazan Upland	13	KU
Parkland	Foothills Parkland	14	FP
	Peace River Parkland	15	PRP
	Central Parkland	16	CP
Grassland	Dry Mixedgrass	17	DMG
	Foothills Fescue	18	FF
	Northern Fescue	19	NF
	Mixedgrass	20	MG

3. Reporting Format and Variable Definitions

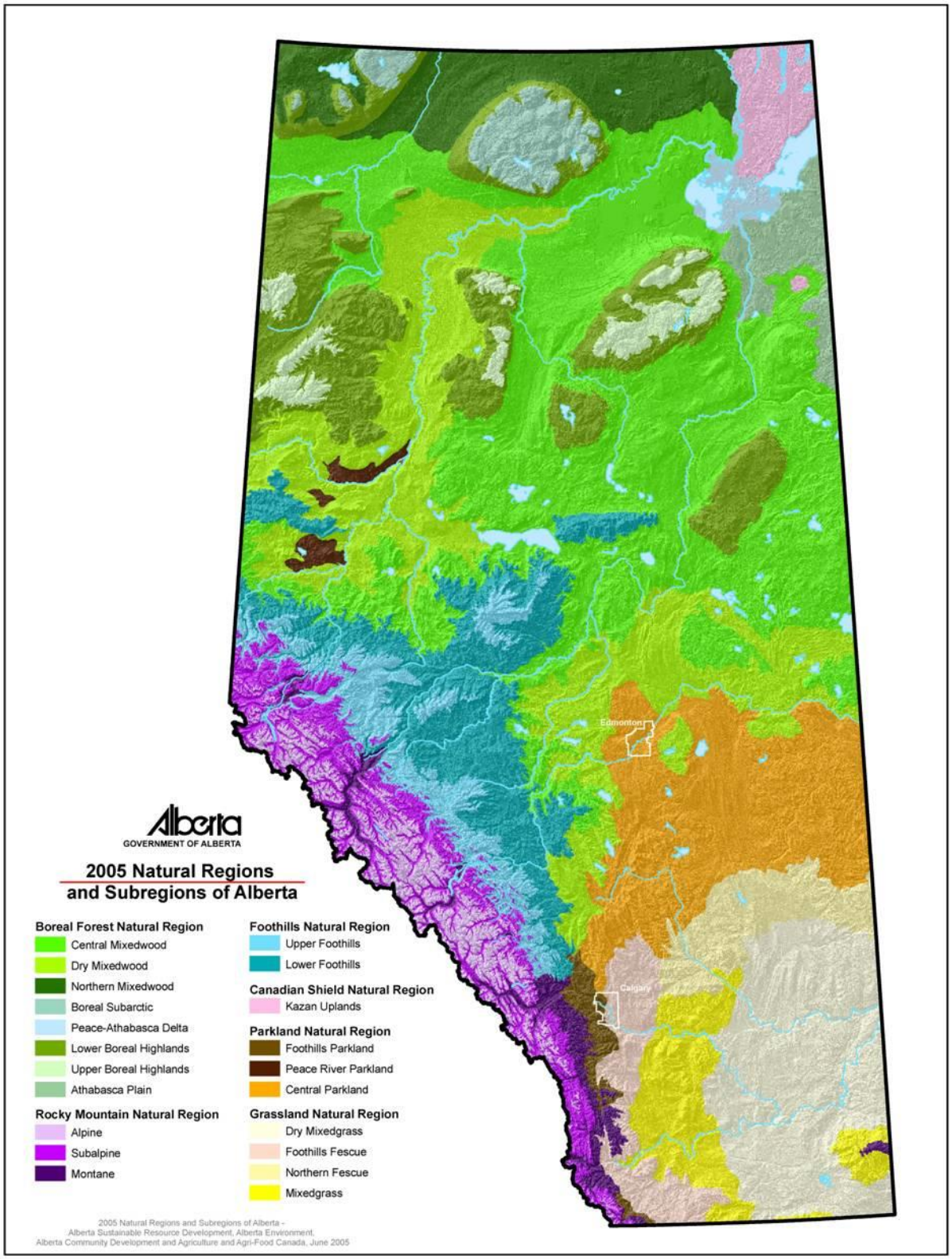


Figure 1. Natural regions and subregions of Alberta. Designated numeric and character codes for each natural subregion are listed in Table 4.

23. Ecosite and Ecosite Phase (2-digit character)

Ecosites are ecological functional units that develop under similar environmental influences. An "ecosite phase" is a subdivision of an ecosite based on the dominant species in the canopy layer. Ecosites and ecosite phases are natural subregion-specific. **Appendix 1** lists the ecosites and ecosite phases within each natural subregion in Alberta.

24. Opening Number (up to 11-digit character)

Opening number applies to post-harvest stands only. It is a unique number assigned based on the legal location of the centroid of the harvest area. Opening number represents the centre of an "opening" on the ground, where "opening" is an area (or unit) created by timber harvest for reforestation management (i.e., regeneration surveys) and tracking of reforestation activities in the Alberta Regeneration Information System (ARIS). Each opening number consists of the following:

Meridian + range + township + section + grid coordinate + alpha character or blank

Where meridian = 1 digit, 4, 5 or 6; range = 2 digits, 01 to 30; township = 3 digits, 001 to 126; section = 2 digits, 01 to 36; grid coordinate = 2 digits, 00 to 99, and the grid is an X (horizontal) and Y (vertical) grid; and alpha character or blank = 1 character, A to Z or blank.

25. Polygon Number (or Sampling Unit Number) (3-digit number coded as character)

Polygon number or sampling unit number applies to post-harvest stands where a Reforestation Standard of Alberta (RSA) performance survey has been conducted. It refers to the unique number (e.g., 001, 002, 003) assigned within an opening. It could be blank if no survey has been done.

26. Tree Plot Size (up to 7-digit numeric with one decimal place)

Main plot size (e.g., 400.0 m^2, 800.0 m^2, 1000.0 m^2) for measuring trees to the defined tree tagging limit. Different plot shapes (circular or square) are acceptable and will not be differentiated.

27. Minimum Tree Tagging Limit (up to 3-digit numeric with one decimal place)

Minimum tree tagging limit in DBH (e.g., 9.1 cm, 5.1 cm). Note: minimum tree tagging limits greater than 9.1 cm are not acceptable to the centralized PSP database.

28. Sapling Plot Size (up to 5-digit numeric with one decimal place)

Sub-plot size (e.g., 100.0 m^2) for measuring saplings to the defined sapling tagging limit.

29. Sapling Tagging Limit - DBH (3-digit numeric with one decimal place)

Minimum DBH for measuring saplings. New PSPs will be assigned a value of 0.1 cm.

30. Sapling Tagging Limit - Height (4-digit numeric with two decimal places)

Minimum height for measuring saplings. New PSPs will have a value of 1.30 m.

3. Reporting Format and Variable Definitions

31. Regeneration Plot Size (up to 5-digit numeric with one decimal place)

Sub-plot size (e.g., 10.0 m^2, 40.0 m^2) for measuring regeneration to the defined regeneration tagging limit. New PSPs will only measure coniferous regeneration.

32. Regeneration Tagging Limit (up to 4-digit numeric with two decimal places)

Refers to the minimum height for measuring regeneration (e.g., 0.30 m).

33. Regeneration Plot Number (1-digit numeric)

A number of 1, 2, 3, or 4 indicating the regeneration plot number used for measuring regeneration. It applies to PSPs where multiple regeneration plots are used. For new PSPs with one regeneration plot, a number of "1" is used.

34. Plot Establishment Year (4-digit numeric)

A four-digit number representing the year when the plot is first established.

35. Year of Measurement (4-digit numeric)

A four-digit number representing the year when the plot is measured.

36. Month of Measurement (2-digit numeric)

A two-digit number of 01 to 12 representing the month of measurement.

37. Day of Measurement (2-digit numeric)

A two-digit number of 01 to 31 representing the day of measurement.

38. Measurement Number (up to 2-digit numeric)

A number of 1 (establishment), 2, 3 and up representing the measurement number.

39. Plot Type (up to 2-digit numeric, currently 1-digit numeric)

1 — Regular PSP
2 — Detailed PSP (i.e., all planted stems are measured in the 400 m^2 main plot regardless of their height or diameter)
3 — Stem-mapped PSP
4 — Detailed stem-mapped PSP

40. Plot Treatment 1 (1-digit character)
41. Plot Treatment 2 (1-digit character)
42. Plot Treatment 3 (1-digit character)
43. Plot Treatment 4 (1-digit character)
44. Plot Treatment 5 (1-digit character)

3. Reporting Format and Variable Definitions

The five plot treatment variables are used to denote up to five types of plot treatment applied. Codes should be employed in the sequence in which the treatments occurred.

N — No treatment or not site prepared
M — Site prepared, mechanical (includes various scarification and mechanized site preparation methods using blades, disks, drags, mixers, mounders, plows, etc.)
C — Site prepared, chemical (using herbicide)
B — Site prepared, burning (using a prescribed burn)
H — Tended, chemical (using herbicide, following planting)
W — Tended, manual/mechanical (using manual of mechanical means, i.e., cleaning or weeding)
F — Fertilized (any treatment where fertilizer is applied)
P — Pre-commercial thinning
T — Commercial thinning
S — Shelterwood, or selection harvest
U — Understory protection (strip harvesting while protecting desirable under-storey)
A — Understory avoidance
D — Drainage (treatment used to channel excess water off site)

45. Plot Status and Condition (up to 2-digit numeric)

Refers to the most obvious general status and condition of the plot at the time of measurement.

Table 5. Plot status and condition codes.

1	Active and no obvious damage	11	Destroyed (fire)
2	Natural damage (severe wind)	12	Destroyed (climate/weather)
3	Natural damage (flood and water)	13	Plot closed and reopened
4	Natural damage (defoliation)	14	Burned
5	Man-made damage (road, seismic, pipeline)	15	Missing or lost
6	Man-made damage (herbicide and treatment)	16	Mistletoe
7	Natural and man-made damage (cause unknown)	17	Mountain pine beetle
8	Harvested or cut down	18	Spruce bud worm
9	Horse logged	19	Plot harvested & re-established
10	Inactive, closed or abandoned	20	Retired by other reason(s)

46. Ground cover % – Shrubs (up to 3-digit numeric)

Percent of the ground that is covered by the crown closure of all shrubs (including tall, low and ground level), estimated from the regeneration plot(s), recorded to ±5%. Shrub stems may be inside or outside the regeneration plot(s). The maximum value is 100 (percent).

47. Ground cover % – Herbs/Forbs (up to 3-digit numeric)

Percent of the ground that is covered by the combined crown closure all herbs and forbs, estimated from the regeneration plot(s), recorded to ±5%.

48. Ground cover % – Grass (up to 3-digit numeric)

Percent of the ground that is covered by grasses and sedges, estimated from the regeneration plot(s), recorded to ±5%.

49. Ground cover % – Moss/Lichen (up to 3-digit numeric)

Percent of the ground that is covered by all moss/lichen species, estimated from the regeneration plot(s), recorded to ±5%. Moss coverage on logs or debris suspended over the ground should not be included in the estimation.

50. Tree Number (up to 4-digit numeric, applies to new plots only)

Tree numbers are unique numbers assigned to:

- All live and standing dead trees in the main tree plot;
- All live saplings in the sapling plot; and
- Live regeneration in the regeneration plot(s), for up to 10 regeneration per up to three leading coniferous species in each regeneration plot.

It is the "best" practice to assign unique numbers to all planted stems in the main plot (400 m^2) and measure them regardless of their height or size (diameter).

For new PSPs, tree numbers start from 1, 2, 3 and up sequentially to a maximum of 6999 regardless of whether the stem is a tree, sapling or regeneration. Once a stem is assigned a unique number, that number retains to the stem throughout re-measurements. All trees measured outside the plot can be numbered from 7000 and up to a maximum of 7999, or by some other unique numbers that distinguish them from the stems measured within the plot.

51. Sector or Quarter (1-digit character)

Sector or quarter applies only to some existing PSPs where the main plot is divided into sectors or quarters (e.g., A, B, C, D, E, or 1, 2, 3, 4) for the purpose of locating and numbering trees. Numerical sector or quarter numbers will be treated as characters.

52. Tree Type Identifier (1-digit character)

T — Regular tree measured in the main tree plot to the specified tree tagging limit
S — Sapling tree measured in the sapling plot to the specified sapling tagging limit
P — Planted tree measured in the sapling plot
R — Regeneration tree measured in the regeneration plot(s) to the regeneration tagging limit
B — Tree(s) measured in the plot buffer or outside the plot

53. Species (2-digit character)

Tree species are coded using the two-digit characters defined in Table 6. In cases where the separation of species is not possible (e.g., sometimes between lodgepole pine and jack pine, Engelmann spruce and white spruce, and various poplar species), a "hybrid pine" (Px), a "hybrid spruce" (Sx), or a "hybrid poplar" (Ax), is assigned. Dead deciduous and dead coniferous are assigned as "DD" and "DC", respectively. Minor species not listed in Table 6 can be assigned as "Ms". Shrub species are not identified, nor need to be measured or recorded.

3. Reporting Format and Variable Definitions

Table 6. Major Alberta tree species and species code.

Species	Species	Scientific name	Code
	Aspen	*Populus tremuloides* Michx.	Aw
	Balsam poplar	*Populus balsamifera* L.	Pb
	White birch	*Betula papyrifera* Marsh.	Bw
	Hybrid poplar	*Populus*	Ax
	Dead deciduous		DD
	Dead coniferous		DC
Pine	Lodgepole pine	*Pinus contorta* var. *latifolia* Engelm.	Pl
	Whitebark pine	*Pinus albicaulis* Engelm.	Pw or Pa
	Limber pine	*Pinus flexilis* E. James	Pf
	Jack pine	*Pinus banksiana* Lamb.	Pj
	Hybrid pine	*Pinus*	Px
Spruce	White spruce	*Picea glauca* (Moench) Voss	Sw
	Engelmann spruce	*Picea engelmannii* Parry ex Engelm.	Se
	Black spruce	*Picea mariana* (Mill.) B.S.P.	Sb
	Hybrid spruce	*Picea*	Sx
Fir	Balsam fir	*Abies balsamea* (L.) Mill.	Fb
	Subalpine fir	*Abies lasiocarpa* (Hook.) Nutt.	Fa
	Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco	Fd
Larch	Tamarack larch	*Larix laricina* (Du Roi) K. Koch	Lt
	Western larch	*Larix occidentalis* Nutt.	Lw
	Subalpine larch	*Larix lyallii* Parlatore	La
	Siberian Larch	*Larix sibirica* Ledeb.	Ls

54. DBH (up to 5-digit numeric with one decimal place)

Unless specified otherwise, DBH always refers to the tree diameter (cm) at the breast height of 1.30 m above ground from the point of germination. DBH is measured for all numbered stems in the main tree plot and sapling plot. It is recorded to the nearest ±0.1 cm. Pay special attention to trees that are leaning, swelling at breast height, forked, and on slope.

55. Height of DBH (up to 4-digit numeric with two decimal places)

Refers to the height at which the DBH is measured. The default is always 1.30 m. If the DBH is not measured at 1.30 m above the point of germination, the height at which the DBH is measured must be recorded to the nearest ±0.01 m (or nearest ±1 cm). This applies to some special cases (e.g., leaning, swelling, and forked trees).

56. Root Collar Diameter (up to 5-digit numeric with one decimal place)

Root collar diameter (RCD) typically refers to the tree diameter (recorded to ±0.1 cm) measured at 0.0 m above ground. RCD is not a requirement for minimum standards. But it is recommended for numbered regeneration stems, and for all planted stems <2.0 cm DBH in the main plot.

57. Height of Root Collar Diameter (up to 4-digit numeric with two decimal places)

Height of root collar diameter refers to the height at which the RCD is measured (default = 0.0 m). If the RCD is not measured at 0.0 m above ground, the height at which the RCD is measured must be recorded to ±0.01 m.

58. Tree Location (1-digit numeric)

Tree location is used to indicate if a regular tree (defined to the main tree tagging limit, e.g., ≥5.1 cm DBH), is located within the sapling plot. It allows for more specific stand density calculations for sapling plots. Previously, except for stem-mapped plots, it was unknown if a regular tree is located within or outside the sapling plot.

0 – Do not know or did not record (applies to existing PSPs)
1 – The tree is located within the sapling plot
2 – The tree is located outside the sapling plot

59. Tree Origin (up to 2-digit numeric)

Each tagged stem is assigned an origin. Origin "7" and "8" are for future reference only. Currently genetically improved stock does not meet base PGYI requirement.

0 — Unknown
1 — Naturally seeded
2 — Coppice (from downed logs, stumps/snags) or sucker (from the roots or base of a tree)
3 — Layering (from the rooting of un-detached branches)
4 — Natural but unknown or not sure
5 — Artificially seeded
6 — Planted, regular stock
7 — Planted, genetically improved stock
8 — Planted but stock unknown or mixed
9 — Advanced prior to the date of harvest (or remnant/veteran from a previous generation)

60. Height (up to 5-digit numeric with two decimal places)

Height refers to the total tree height (m), taken from the ground to the tip of the tree, regardless if the tip is alive or dead. Height must be measured to the nearest 1 cm if a tree is shorter than 2 m. Taller trees can be measured to the nearest 10 cm.

Below are some **important notes on height measurement**:

1. For all new 400 m^2 PSPs to be established starting in 2013:
   - Heights must be measured on all trees ≥5.1 cm in DBH, regardless of the tree density;
   - Heights must be measured on a minimum of 1/5 (20%) of the saplings (i.e., stems ≥ 1.30 m in HT but <5.1 cm in DBH) in the sapling plot, regardless of the sapling density.
   - It is the "best" practice to measure heights on all planted stems in the sapling plot.

2. For PSPs established before 2013 (many of them are 800 m^2 or larger):

- If the density of trees (≥5.1 cm DBH) is <10,000 trees/ha, heights are required on a minimum of 1/5 (20%) of the trees; If the density of trees is ≥10,000 trees/ha, heights are required on a minimum of 1/10 (10%) of the trees.
- If the density of saplings (i.e., stems ≥ 1.30 m in HT but <5.1 cm in DBH) is <20,000 stems/ha, heights are required on a minimum of 1/5 (20%) of the saplings in the sapling plot; If the density of saplings is ≥20,000 stems/ha, heights are required on a minimum of 1/10 (10%) of the saplings in the sapling plot.
- Excluding regeneration, a minimum of 5 heights per species (if available) are required for each plot.

3. Heights for up to 10 regeneration per up to 3 coniferous species are measured in each regeneration plot, regardless of the regeneration density.

4. Height trees died at re-measurements must be replaced by the equivalent number (if available) of new height trees.

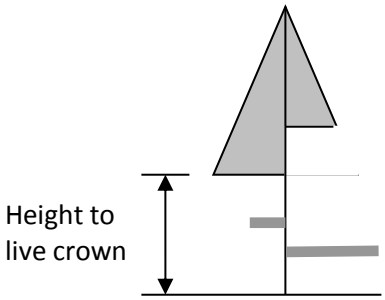
61. Crown Class (1-digit character)

Crown class refers to the relative position of the tree crown within the canopy of a stand. It is often defined by the height of the tree crown in relation to its neighbours or competitors. Crown class is measured only on trees and saplings with height measurements.

D — Dominant, crowns extend above the general level of the canopy
C — Co-dominant, crowns form the general level of the canopy
I — Intermediate, crowns below but extending into the bottom of the general level
S — Suppressed, crowns entirely below the general level of the canopy
V — Veteran, residual, remnant or super-dominant (e.g., from a previous generation)
N — No crown class (e.g., trees with severe lean, broken top, broken stem, dead, standing dead)

62. Height to Live Crown (up to 5-digit numeric with two decimal places)

Refers to the height (m) from the ground to the base of the continuous live crown. Recorded to the nearest ±10 cm (or ±1 cm if a tree is <2 m). The base of the continuous live crown refers to where live branches begin a continuous progression to the top of the tree. It is not necessarily the first live branch above ground, nor a full or near-full live crown base circling the stem, as the live crown could be asymmetric due to inter- and intra-specific competition (see illustration below).



Shaded areas indicate live crown and branches

Height to live crown is measured only on numbered trees and saplings with height measurements.

3. Reporting Format and Variable Definitions

63. Tree Condition Code 1 (condition) (up to 2-digit numeric)
64. Tree Condition Code 1 (cause) (up to 2-digit numeric)
65. Tree Condition Code 1 (severity) (1-digit numeric)

66. Tree Condition Code 2 (condition) (up to 2-digit numeric)
67. Tree Condition Code 2 (cause) (up to 2-digit numeric)
68. Tree Condition Code 2 (severity) (1-digit numeric)

69. Tree Condition Code 3 (condition) (up to 2-digit numeric)
70. Tree Condition Code 3 (cause) (up to 2-digit numeric)
71. Tree Condition Code 3 (severity) (1-digit numeric)

Three sets of tree condition codes are used to denote up to three observed (most obvious) tree conditions and their associated causes and severities. They are defined in Table 7.

Table 7. Tree condition code look-up table.

Condition		Cause		Severity	
0	Live and healthy	1	Spruce budworm	1	Minor
1	Dead but standing	2	Defoliator	2	Medium
2	Dead and down (at re-measurements)	3	Mountain pine beetle	3	Severe
3	Broken or dead top	4	Root Collar weevil	9	Unknown
4	Bole damage	5	Terminal weevil		
5	Crown damage	6	Armillaria root disease		
6	Root damage	7	Shepard's crook		
7	Crook	8	Dwarf Mistletoe		
8	Sweep	9	Stem disease		
9	Fork	10	Western gall rust (WGR)		
10	Lean	11	Animal damage		
11	Poor form	12	Wind damage		
12	Same stump	13	Snow/ice/frost damage		
13	Harvested tree	14	Hail damage		
14	Missing tree	15	Fire damage		
15	Disqualified tree	16	Mechanical damage		
16	Newly qualified tree	17	Improper planting		
		18	Poor ground conditions		
		19	Competition		
		20	Insect (other)		
		21	Disease (other)		
		22	Climate/weather/flood damage		
		23	Anthropogenic damage		
		99	Unknown		

Additional definitions and descriptions about the tree condition codes, causal agents and severity of the conditions are provided in Appendix 2.

The tree condition codes apply only to new measurements. The approach used to develop tree condition codes is to focus on cause and effect and to limit data collected to what is needed for growth and yield modeling. Companies can continue to use their existing codes, which must be converted to the new codes when submitting data to the centralized provincial database.

Each set of tree condition codes consists of a condition, a cause and a severity. Condition is the effect—the resulting condition seen on the tree. Cause is a description of what happened to put the tree in that condition. Severity is how much the condition is expected to impact a tree's long-term growth and survival. The causes are limited to the ones that are important and reasonable for field crews to differentiate. General categories (insect, disease, climate, anthropogenic and unknown) would be used for ones not on the list or that field crews cannot identify.

When multiple causes are suspected, only the "most obvious cause" for the observed condition is usually recorded. If multiple causes are deemed important to record, one could record the same condition more than once at the expense of other conditions, using a second and a third set of tree condition codes to record multiple causes. For instance:

Condition 1: bole damage; Cause 1: MPB; Severity 1: 2
Condition 2: bole damage; Cause 2: WGR; Severity 2: 1
Condition 3: bole damage; Cause 3: Conk; Severity 3: 1

The severity codes listed in Table 7 are defined as follows:

1 – Minor (obvious condition but expected to have no long-lasting damage)
2 – Medium (long-lasting damage but not severe, e.g., broken or dead top <1/3 of the tree)
3 – Severe (long-lasting damage, possible mortality, e.g., gull rust circling ≥50% of main stem, leaning $\geq 20^0$ off the vertical axis)

No cause or severity code is needed for "live and healthy" trees. No severity code is needed for live and healthy, dead, missing, disqualified, newly qualified, felled or cut down trees.

Note that:
– Conks/cankers, burls, scars, cracks and stem decay can be assigned as "bole damage";
– Dying, "poor vigor", "half-dead" and "unhealthy looking" can be assigned as "crown damage";
– Snags at plot establishment are not measured;
– Snags from a previously numbered stem at re-measurements are assigned as "dead and down".

72. Regeneration Density Count (up to 3-digit numeric)

Refers to the total density count (0 to 999) by species for coniferous regeneration species in the regeneration plot.

The total density count by species applies only to all coniferous regeneration species ≥0.30 m but <1.30 m in height.

73. Total Age (up to 3-digit numeric)

Total age (years) of the tree, from the point of germination.

74. Stump Age (up to 3-digit numeric)

Stump age refers to the age (ring count) at the stump height of 0.30 m above ground, from the point of germination.

75. Breast Height Age (up to 3-digit numeric)

Breast height age refers to the age (ring count) at the breast height of 1.30 m above ground, from the point of germination.

Variables 76 to 81 Apply to Stem-Mapped Plots:

1). 10% of the PSPs will be selected randomly or systematically across the strata for stem-mapping;

2). For any selected plot, whenever the density of trees (≥5.1 cm DBH) is ≥10,000 stems/ha, no stem-mapping is done for trees in the main tree plot;

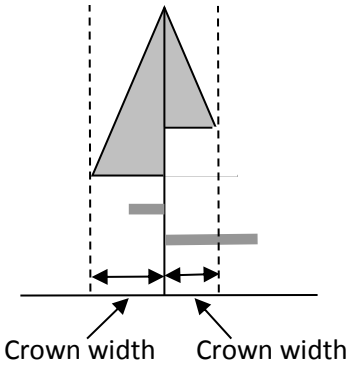
3). For any selected plot, whenever the density of saplings (stems ≥ 1.30 m in HT but < 5.1 cm in DBH) is ≥20,000 stems/ha, no stem-mapping is done for saplings in the sapling plot;

4). In young stands of high densities, the "best" practice is to wait until the stands are older enough (e.g., >20 years total age), or the sapling densities are lower enough (i.e., <20,000 stems/ha) before considering stem-mapping;

5). The key reason for not stem-mapping in dense stands is that dense stands are typically more uniform and homogeneous. It is both unnecessary and impractical to stem-map an excessive number of stems in high density stands;

6). Stem-mapping is done for trees in the main tree plot and saplings in the sapling plot. No stem-mapping will be done for regeneration regardless of the regeneration density and plot size.

76. Crown Width – North (up to 5-digit numeric with two decimal places)
77. Crown Width – East (up to 5-digit numeric with two decimal places)
78. Crown Width – South (up to 5-digit numeric with two decimal places)
79. Crown Width – West (up to 5-digit numeric with two decimal places)



Shaded areas indicate live crown and branches

Crown widths refer to the crown widths (m) to the four cardinal directions (north, east, south and

west), from the centre of the tree to the widest portion of the continuous live crown base continued from the top of the tree. Crown widths are measured only on numbered trees and saplings with both height and height to live crown measurements. They apply to coniferous as well as deciduous species.

80. Azimuth from Plot Centre (up to 5-digit numeric with one decimal place)

Azimuth describes the direction of the base of a tree, in degrees, measured clockwise from the north from the main plot centre. A tree due north has an azimuth of 0^{o} (or 360.0^{o}), one due east has 90.0^{o}, south 180.0^{o} and west 270.0^{o}. Azimuth is recorded to the nearest ± 1 or ± 0.5 degree.

81. Distance from Plot Centre (up to 5-digit numeric with two decimal places)

Refers to the distance (m) from the centre of a tree to the centre of the main plot.

82. AVI Photo Variables

AVI photo-interpreted variables are defined in Table 8. They are made by photo-interpreters. More detailed descriptions about the variables are provided in *Chapter 3 – Vegetation Inventory Standards and Data Model Documents*, *Alberta Vegetation Inventory Interpretation Standards* (version 2.1.1).

83. AVI Field Variables

AVI field-call variables are defined in Table 8. They are made by a trained field crew member. More detailed descriptions about the variables are provided in *Chapter 3 – Vegetation Inventory Standards and Data Model Documents*, *Alberta Vegetation Inventory Interpretation Standards* (version 2.1.1).

84. Crew Member 1 (up to 12-digit character)

Record the first initial plus the last name of field crew number 1.

85. Crew Member 2 (blank or up to 12-digit character)

Record the first initial plus the last name of field crew number 2.

86. Comment (blank or up to 80-digit character)

The “Comment” field records notes and comments for any unusual or unique information observed in the field by field crew.

3. Reporting Format and Variable Definitions

Table 8. Alberta vegetation inventory (AVI) photo-interpreted and field-call variables.

AVI variables	Photo	Field	Format	Notes
1. Version	Yes	Yes	A6	AVI21 = AVI version 2.1 AVI211 = AVI version 2.1.1 (recommended) AVI22 = AVI version 2.2 AVI10 = AVI version 1.0
2. Year	Yes	Yes	I4	Year of photography or year of field-call
3. Polygon number	Yes	Yes	I10	Unique AVI polygon identifier
4. Moisture regime	Yes	Yes	A1	d = dry; m = mesic; w = wet; a = aquatic
5. Density (crown closure class)	Yes	Yes	A1	A = 6 to 30% B = 31 to 50% C = 51 to 70% D = 71 to 100%
6. Stand height	Yes	Yes	I2	Average height (m) of dominant/co-dominant trees
7. SP1	Yes	Yes	A2	Over-storey tree species 1 (coded in Table 6)
8. SP1_per	Yes	Yes	I2	SP1 crown closure to nearest 10%
9. SP2	Yes	Yes	A2	Over-storey tree species 2 (coded in Table 6)
10. SP2_per	Yes	Yes	I1	SP2 crown closure to nearest 10%
11. SP3	Yes	Yes	A2	Over-storey tree species 3 (coded in Table 6)
12. SP3_per	Yes	Yes	I1	SP3 crown closure to nearest 10%
13. SP4	Yes	Yes	A2	Over-storey tree species 4 (coded in Table 6)
14. SP4_per	Yes	Yes	I1	SP4 crown closure to nearest 10%
15. SP5	Yes	Yes	A2	Over-storey tree species 5 (coded in Table 6)
16. SP5_per	Yes	Yes	I1	SP5 crown closure to nearest 10%
17. Stand structure	Yes	Yes	A1	Blank or S = single storey M = multi-layer canopy (2 storey) C = complex (more than 2 or uneven stories) H = horizontal (homogeneous w/ scattered pockets)
18. Stand structure value	Yes	Yes	I1	Percentage (to nearest 10%) for stand structure = 'H'
19. Origin	Yes	No	I4	Actual year of stand origin
20. Timber productivity rating	Yes	No	A1	U = unproductive F = fair M = medium G = good
21. U_moisture regime	Yes	Yes	A1	Under-storey moisture regime
22. U_density	Yes	Yes	A1	Under-storey density (crown closure class)
23. U_stand height	Yes	Yes	I2	Under-storey stand height
24. U_SP1	Yes	Yes	A2	Under-storey SP1
25. U_SP1_per	Yes	Yes	I2	Under-storey SP1_per
26. U_SP2	Yes	Yes	A2	Under-storey SP2
27. U_SP2_per	Yes	Yes	I1	Under-storey SP2_per
28. U_SP3	Yes	Yes	A2	Under-storey SP3
29. U_SP3_per	Yes	Yes	I1	Under-storey SP3_per
30. U_SP4	Yes	Yes	A2	Under-storey SP4
31. U_SP4_per	Yes	Yes	I1	Under-storey SP4_per
32. U_SP5	Yes	Yes	A2	Under-storey SP5
33. U_SP5_per	Yes	Yes	I1	Under-storey SP5_per
34. U_stand structure	Yes	Yes	A1	Under-storey stand structure
35. U_stand structure value	Yes	Yes	I1	Under-storey stand structure value
36. U_origin	Yes	No	I4	Under-storey origin year
37. U_TPR	Yes	No	A1	Under-storey timber productivity rating

Notes: two sets of variables are listed. “Photo” and “Field” refer to photo-interpreted and field-call variables, respectively. Year of photography and year of field-call shall be clearly recorded. Standards for under-storey variables follow those for over-storey.

4. Additional Notes

4.1 Plot Installation

The PSPs can be located on a pre-determined, fixed grid to eliminate bias or perceived bias. If the density of the grid is high enough, the data collected from this type of plot allocation can be used not only for growth modeling, but also for estimating average stand conditions on the land-base.

Primarily for growth modeling purposes, each new PSP stand is selected from the provincial PSP sampling matrix designed to cover stand types (strata), natural subregions, age classes and some other factors. The approximate location of each new PSP shall be chosen randomly or systematically and marked on a stand cover map. The selected stand must be large enough (i.e., ≥2 ha or 141.42 m × 141.42 m) to ensure that the entire plot and the buffers around the plot are within the same type of a targeted stratum. At a minimum, a 30 m buffer is required on all four sides of the main plot.

Figure 2 shows the recommended plot sizes and configuration. Both circular and square plot shapes are acceptable. To increase PSP coverage, individual PSPs shall be established in separate stands. Multiple PSPs (i.e., in a group of three or four plots) in the same stand are not recommended for any future layout.

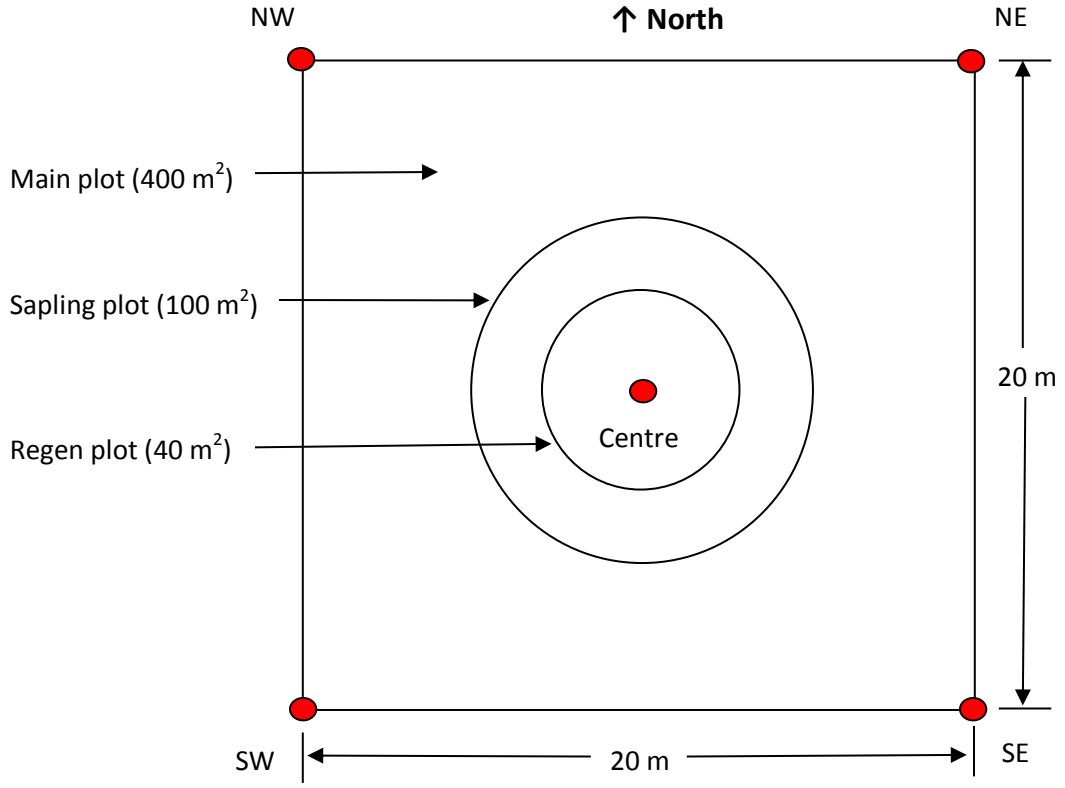


Figure 2. The recommended plot sizes and layout, consisting of a 400 m^2 main plot (20 m × 20 m), a 100 m^2 sapling plot (5.64 m radius), and a 40 m^2 regeneration plot (3.57 m radius).

Preliminary office analysis of the stand cover map shall greatly facilitate the field installation of a plot. The goal is to make the plot installation as consistent as possible, and as representative of the general stand condition as possible. Only in rare cases a plot should be moved to avoid uncharacteristic and unrepresentative stand features such as:

a). Large openings, drastic density shifts and site differences;
b). Unmapped stand type changes or drastic species composition changes;
c). Roads, pipelines, transmission lines and seismic lines;
d). Well sites, archaeological and historic sites;
e). Riparian areas, or large water features and boulders in the plot.

Plot movement is allowed only if the sequence described below is followed:

1). From the original centre, move plot centre north 30 m – check location
2). From the original centre, move plot centre northeast 30 m – check location
3). From the original centre, move plot centre east 30 m – check location
4). From the original centre, move plot centre southeast 30 m – check location
5). From the original centre, move plot centre south 30 m – check location
6). From the original centre, move plot centre southwest 30 m – check location
7). From the original centre, move plot centre west 30 m – check location
8). From the original centre, move plot centre northwest 30 m – check location

If no suitable location is found it should be evaluated if the stand should be abandoned. If not it is permissible to keep adding another 30 m sequentially to the north, northeast, east, southeast, south, southwest, west and northwest and repeat this progress as necessary until a suitable location is found. Reasons for re-locating the plot must be clearly described and consistently applied when the same situations arise.

In addition, once a plot location is decided, it is important to check the availability of "suitable" age trees in the buffer before the final plot installation is laid out. At a minimum, each plot in pure species stands must have at least one suitable age tree. Each plot in mixed-species stands must have at least two suitable age trees for two species. The entire plot installation is abandoned (for modeling purposes only but not necessarily for other purposes such as "averaging") if less than one tree (pure species stands) or two trees (mixed-species stands) are suitable for aging.

New Plot Installation for Regenerated Stands

1. In cases of laying out a PSP from a reforestation survey grid in a stand, a detailed plot is randomly selected from the reforestation survey grid and expanded to become a full PSP, provided that it allows for the layout of a 20 m $\times$ 20 m plot surrounded by a 30 m buffer on all four sides of the plot. In rare cases if the selected location of the plot happens to be in an unsuitable area, apply the same plot movement rules described above to move the plot until a full PSP is successfully installed.

2. For companies (FMAs) with an already established grid, new plots will be established on the pre-determined, fixed grid regardless of the circumstances with regard to stand type (natural or regenerated) and age trees. Companies are allowed to pick their preferred plot configuration (circular or square) so long as the minimum sizes of the plots are met.

Alternative Plot Layouts

Other plot configurations and different plot shapes (circular and square) can also be used. Figure 3 shows three alternative plot layouts that some companies may prefer over Figure 2. Each consists of a 400 m^2 main tree plot, a 100 m^2 sapling plot, and a 40 m^2 regeneration plot for measuring coniferous regeneration.

4. Additional Notes

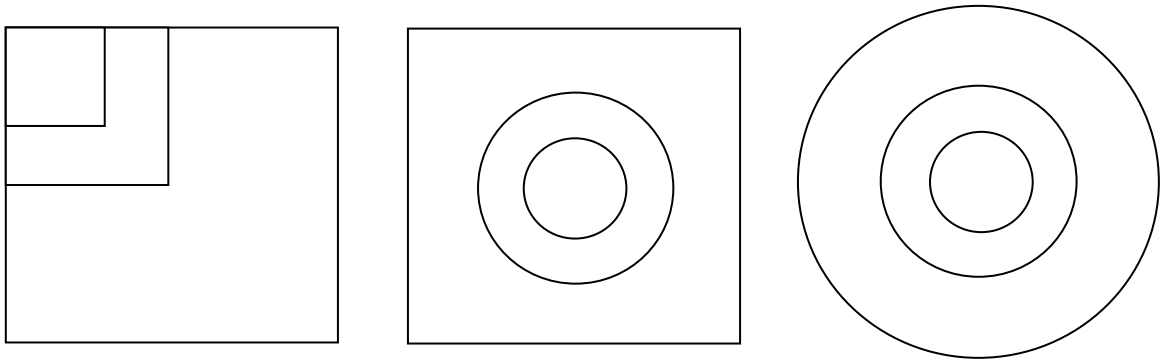


Figure 3. Alternative plot layouts, consisting of a 400 m^2 main plot, a 100 m^2 sapling plot, and a 40 m^2 regeneration plot for measuring coniferous regeneration.

Four additional plot layouts each with four 10 m^2 regeneration plots are shown in Figure 4.

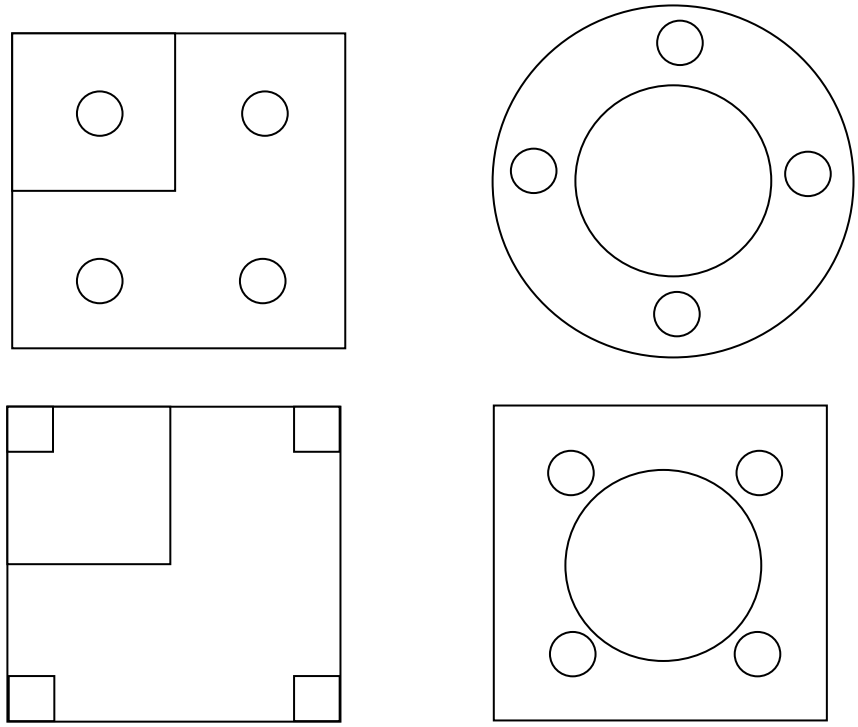


Figure 4. Alternative plot layouts, consisting of a 400 m^2 main plot, a 100 m^2 sapling plot, and four 10 m^2 regeneration plots for measuring coniferous regeneration.

Some companies have proposed to measure all coniferous regeneration taller than 0.30 m in the 100 m^2 sapling plot and drop the regeneration plot all together. This is feasible when the density of coniferous regeneration taller than 0.30 m is low. However, when the density of coniferous regeneration is high, measuring all coniferous taller than 0.30 m in the 100 m^2 sapling plot can be onerous.

In cases where a company chooses to measure all coniferous regeneration taller than 0.30 m in the 100 m^2 sapling plot, the regeneration plot is dropped. All trees (≥ 5.1 cm in DBH) are measured in the main tree plot (400 m^2). All deciduous (≥ 1.30 m in HT) and coniferous (≥ 0.30 m in HT) saplings are measured in the sapling plot (100 m^2). Figure 5 shows some possible plot layouts with the regeneration plot dropped.

4. Additional Notes

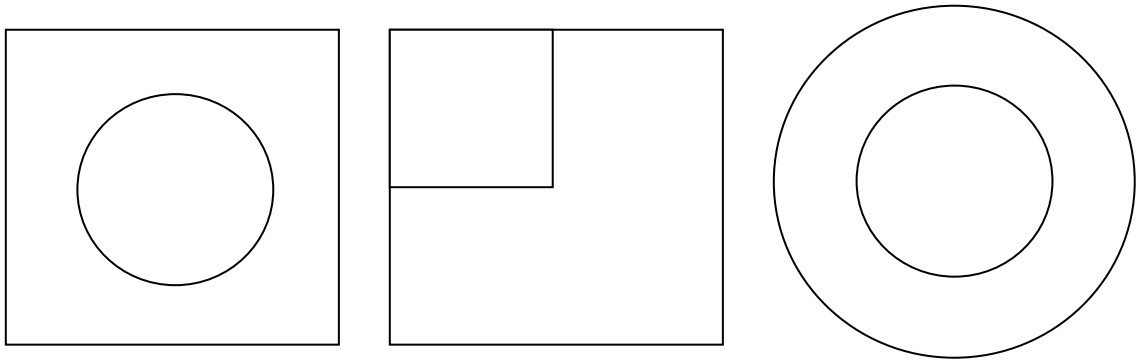


Figure 5. Alternative plot layouts, consisting of a 400 m^2 main plot for measuring trees and a 100 m^2 sub-plot for measuring deciduous (≥ 1.30 m in HT) and coniferous (≥ 0.30 m in HT) saplings.

Figure 5 is different from Figures 2-4 in that coniferous regeneration is measured in a 40 m^2 area (Figures 2-4) rather than a 100 m^2 area (Figure 5). Since Figure 2 is recommended, the descriptions presented in this document are tied to Figure 2 but they can be easily modified to fit Figures 3-5.

4.2 Plot and Tree Measurements

Plot Measurements

Plot level measurements are summarized in Table 2 (variables 1 to 49). Most are fairly straightforward. Some additional notes about plot treatment variables 40 to 44 are provided here.

Most plots to be installed in post-harvest stands will have silviculture treatments done before installation. The plot treatment variables refer to the broad silvicultural treatment types applied to a stand. They describe site preparation methods and stand tending activities, but not anything related to planting (e.g., stock type, density, extent or leave for natural, etc.). The plot treatment variables are to be coded in the sequence in which the treatments occurred. They can be linked to the relevant ARIS codes.

In general, silvicultural treatments of already established PSPs are not recommended, unless for treatment response studies in which separate control plots must be established adjacent to the treated plots.

Tree Measurements

Tree level measurements are also summarized in Table 2 (variables 50 to 81). Some additional clarifications about tree numbering and tree/sapling/regeneration measurements are provided here.

A unique tree number is assigned to each stem in the plot, starting from 1, 2, 3 and up sequentially to a maximum of 6999 regardless of whether the stem is a tree (≥ 5.1 cm in DBH), a sapling (≥ 1.30 m in HT and < 5.1 cm in DBH) or a regeneration (coniferous ≥ 0.30 m and < 1.30 m in HT). The assigned number remains with the stem "forever". It must not be changed during re-measurements. All stems measured outside the plot are numbered from 7000 and up, or by some other unique numbers that distinguish them from the stems measured within the plot.

1. All standing trees (live and dead) in the main tree plot and all standing saplings (live only) in the sapling plot are assigned a unique number (note: standing dead trees are measured once only);

4. Additional Notes

2. It is the "best" practice to assign tree numbers to all planted stems in the main plot (400 m^2) and measure them regardless of their height or size (diameter).

3. In the regeneration plot(s), average regeneration trees per species (live only) are selected, tagged and measured as follows, for up to 3 leading coniferous regeneration species per plot:
   —If ≤10 regeneration stems, select all stems for that species
   —If >10 but ≤30 stems, select every third stem (3, 6, 9,…, 30) to a maximum of 10 stems
   —If >30 stems, select every tenth stem to a maximum of 10 stems per species

4. For any plot layout without a regeneration plot, all deciduous (live, ≥1.3 m in HT) and all coniferous (live, ≥0.3 m in HT) saplings are assigned a unique number.

The tree numbering system applies only to new plots. Previous tree numbers/tags remain for existing plots. Similarly, previous plot re-measurement number and other specifications remain for existing plots. But they should be able to be converted to the new codes and standards when submitting data to the centralized provincial database.

Previous practice of using different series of numbers (e.g., 8000's, 9000's, etc.) to separate trees, saplings and regeneration at plot establishment are not recommended for new plots. The specified tagging limits alone can separate them. Only for data recording purposes the trees measured outside the plot (e.g., age trees, felled trees for site index studies, etc.) are numbered from 7000 and up, or by some other unique numbers that distinguish them from the stems measured within the plot.

Criterion for Identifying Borderline Trees

For both square and circular plots, borderline trees must be checked carefully. The "in" and "out" of any borderline tree is determined from the centre of the tree at its base on the ground. Borderline trees must be clearly marked (e.g., painted or flagged) to facilitate re-measurement, especially in dense circular plots. This will assist future crews in determining plot boundary and "in" and "out" trees. Be careful of any tree that grows into or outside a plot at re-measurements.

4.3 Age Determination

Age is one of the most critical variables in data collection and model development. Each established plot must have one or more tree ages measured depending on the species composition of the stand. It is very important to check the availability of suitable age trees before a plot is installed.

General Rules for Aging

1. The two largest diameter trees per species are aged, for up to five most abundant tree species with 10% or more species composition in the stand, where species composition could be by any one of the four quantities: a) percent crown cover; b) basal area proportion; c) volume proportion; and d) stand density (stems/ha) proportion.

2. If aging is difficult due to rot etc., a minimum of one tree age is required in pure species stands, and a minimum of two tree ages for two species are required in mixed-species stands. No effort will be made to find smaller trees to replace the suitable age trees.

4. Additional Notes

3. To avoid damaging trees, affecting tree growth, and/or introducing insects and diseases, aging must be done outside the main plot. It is recommended that aging be done in a 200 m^2 (7.98 m radius) circular age plot placed in the northwest corner of the main plot buffer. The nearest edge of this 200 m^2 age plot should be about 20 m away from the edge of the main plot to avoid any potential edge effect. In some cases, the age plot may be extended to outside the plot buffer if the area is representative of the main plot.

4. If the minimum requirement of one tree age for pure species stands and two tree ages for two species in mixed-species stands is not met, the original location of the 200 m^2 age plot is abandoned, and a new age plot is attempted, sequentially, to the north, northeast, east, southeast, south, southwest, and west of the plot, until the minimum requirement is met. The entire plot installation is abandoned if the minimum requirement is not met.

5. Whenever possible, both total age and breast height age are obtained. If not, total age for deciduous, and total and breast height ages for coniferous are obtained in post-harvest stands and young fire-origin stands; and breast height ages are obtained in mature fire-origin stands. Additional age data for complex stands of multi-layers or multi-cohorts, if needed, can be collected at subsequent measurement(s).

6. In addition to age(s), all age trees must also record DBH (variable 53), origin (variable 58), height (variable 59) and crown class (variable 60).

Suitable Age Trees

To be considered suitable age trees, the two largest diameter trees per species must satisfy:

a). Live and healthy looking
b). No broken or dead top
c). Not an advanced/remnant/veteran or a super-dominant from a previous generation
d). No severe leaning $\geq 20^0$, not a wolf tree or of obvious poor form (e.g., crook, sweep, fork)
e). No severe damage to more than 1/3 of bole, crown and/or root

Note that crown class is not used as a criterion in selecting suitable age trees, as the largest diameter trees for a species may be in different layers/cohorts during different stand development stages.

4.4 High Density Stands

Since in Alberta it is very rare for the density of trees (≥ 5.1 cm in DBH) to exceed 10,000 stems/ha, the 400 m^2 main plot is always retained for measuring trees. If the density of trees reaches 10,000 stems/ha or more, or if the density of saplings (≥1.30 m in HT) reaches 20,000 stems/ha or more, height measurements can be reduced and no stem-mapping will be done:

1. If the density of trees (≥5.1 cm DBH) is ≥10,000 stems/ha, height measurements are required on a minimum of 10% of the trees in the main tree plot.

2. If the density of saplings (≥1.30 m in HT but <5.1 cm in DBH) is ≥20,000 stems/ha, height measurements are required on a minimum of 10% of the saplings in the sapling plot.

3. Excluding regeneration, a minimum of 5 heights per species (if available) are required for each plot regardless of density.

4. The above height measurement rules apply to existing PSPs, many of them are 800 m^2 or larger. As stated before (variable 59), for all new 400 m^2 PSPs to be established starting in 2013:

   — Heights must be measured on all trees ≥5.1 cm in DBH, regardless of the density of trees;
   — Heights must be measured on a minimum of 1/5 (20%) of the saplings (i.e., stems ≥ 1.30 m in HT but < 5.1 cm in DBH) in the sapling plot, regardless of the density of saplings.
   — It is the "best" practice to measure heights on all planted stems in the sapling plot.

5. For new 400 m^2 PSPs to be established starting in 2013, whenever the density of trees is ≥10,000 stems/ha, no stem-mapping is done for trees in the main tree plot; whenever the density of saplings is ≥20,000 stems/ha, no stem-mapping is done for saplings in the sapling plot.

6. For existing PSPs, many of them are 800 m^2 or larger, whenever the number of trees exceeds 200 in the main tree plot, no stem-mapping is done for trees; whenever the number of saplings exceeds 200 in the sapling plot, no stem-mapping is done for saplings.

4.5 Plot Measurement Schedule

The recommended plot measurement schedules are:

1. Before 40 years (total age): every 5 years preferred.

2. After 40 years (total age): every 10 years preferred.

3. Whenever possible, established plots shall also be measured at certain required or desirable ages to coincide with, for instance: a) the mandated reforestation survey schedules (e.g., 8 and 14 years total age); b) the traditional site index ages (i.e., 50 years total age and 50 years breast height age); c) the expected rotation age; and d) the before and after suspected stand breakup ages.

4. Access and weather may determine the time of measurement. For stands younger than 20 years, only under extenuating circumstances should these stands be measured during the growing season. For stands older than 20 years, re-measurements during the growing season are preferred to be taken as close to the month of the first measurement as possible. But this is not a requirement. During the dormant season (i.e., the season of no or minimal tree growth, generally from August 16 to May 15), the exact measurement dates become unimportant regardless of stand age.

Determination of plot re-measurement schedule shall be based on the current age of the stand and not the time of plot establishment. In mixed-species stands the age of the leading species will be used.

4.6 Data Collection Priorities

The most immediate PSP data collection priorities in Alberta are identified below based on the current and potential modeling needs in the near future (5 to 10 years). The priorities also reflect the current data gaps in existing Alberta PSPs from various sources.

4. Additional Notes

1. Fire-origin natural stands younger than 40 years total age, for lodgepole pine, white spruce, aspen, and black spruce.

2. Fire-origin natural mixed lodgepole pine-aspen stands in young and immature age classes (0 to 60 years total age).

3. Post-harvest managed stands from 8 to 30 years total age, especially around 10 to 14 years and 25 to 30 years, in all stand types.

For research and forest management purposes, data from the following categories are also of great interest and importance:

a). The oldest post-harvest stands (some are at or around 50 years total age)
b). Age measurements for more than one leading species in existing mixed-species stands
c). Stands under potential risks from MPB or other biological, environmental and climatic factors
d). Stands that cover wide ecological/bio-geo-climatic gradients, not just along main access routes
e). Stands that cover the fringes of their current species range
f). Stands associated with common operational silvicultural practices and treatments
g). Stands associated with genetic improvement
h). Stands on reclaimed sites like oil sands sites, and restored sites like well sites

Whenever possible, data collection in the identified categories shall cover a wide range of density, age, site and natural subregion gradients. In some cases specific research installations through target sampling or experimental design may be necessary.

4.7 Plot Removal

Each established PSP is protected until it is discontinued for various reasons, or destroyed by different natural and/or man-made disturbances. PSPs may be discontinued (i.e., released from protection or closed) for a variety of reasons, chief amongst them:

- Land use issues (e.g., area deemed to be more important for mineral extraction, oil and gas use)
- Harvesting (e.g., area contributing to the harvested volume)
- Unplanned natural and anthropogenic disturbances (e.g., pests, fire, climate and unauthorized harvesting render the future value of the PSP dubious)

Existing PSPs may be harvested or removed from further re-measurements provided:

1). They fall outside the provincial PSP sampling matrix;
2). They have been measured at least three times (excluding the before-harvesting-measurement);
3). They cover more than 30 years of time-frame;
4). They are not wind-firm or they are isolated; and
5). Final measurements are taken before harvesting if five years or more have passed since the previous measurement.

The provincial PSP sampling matrix designed to cover different stand types (strata), natural subregions and age classes shall be used as the primary template for strategic management of the PSP program, including

the targeting of new plot establishment and re-measurement priorities, as well as the selective harvesting of existing PSPs.

It is important to recognize that land use issues (e.g., mineral extraction, oil and gas use) cannot simply trump PSPs. This is especially true for PSPs located on a pre-determined, fixed grid. Removal of established PSPs on an established grid due to land use issues shall not be taken lightly. The PSPs are very important and cannot be destroyed without proper justification. The value of the information obtained from PSPs is irreplaceable. It is fully expected that the PSPs harvested at established grid points must be replaced by the land user at other established grid points. Ideally, whenever possible, a new PSP shall be established at the same location of a harvested or destroyed PSP.

It is recommended that 600 fire-origin PSPs, covering the base strata, natural subregion and age gradients across the province, shall be retained and measured until they break up. The criteria used to distribute these 600 retaining PSPs among the companies shall follow those developed for allocating the PGYI required PSPs among the companies based on their AACs or LRSYAs.

The plot removal (retirement) rules apply to the plots in the database over and above the 600 PSPs that will be measured “forever” (i.e., until they break up). Companies are allowed when they wish to retire plots that are not part of the PGYI database requirement.

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Appendix 1. Subregion-Specific Ecosites and Ecosite Phases

Ecosites are ecological functional units that develop under similar environmental influences (e.g., climate, moisture and nutrient regimes). Up to fourteen ecosites have been defined for each natural subregion. Each ecosite is designated by a lowercase letter from 'a' to 'n', ordered by increasing moisture regime. Letter 'a' represents the driest ecosite and the last letter represents the wettest ecosite. Note that the same letter from different natural subregions may indicate different ecosites.

An 'ecosite phase' is a subdivision of an ecosite based on the dominant species in the canopy layer. For example, in subregion 11 (Lower Foothills), 'e' indicates low-bush cranberry ecosite. 'e3' indicates low-bush cranberry Aw-Sw-Pl. On lowland sites where a tree canopy is not present (e.g., some bogs and fens), the tallest vegetation layer with greater than 5% cover is used to determine the ecosite phase. Up to 6 ecosite phases have been identified within a given ecosite.

Ecosites and ecosite phases are natural subregion-specific. They are usually determined during the pre-harvest survey. Ecosites are embedded in ecosite phases.

Tables A1 to A6 list the subregion-specific ecosites and ecosite phases. Sources and more detailed descriptions for Tables A1 and A2 are provided in *Field guide to ecosites of northern Alberta* (Beckingham and Archibald 1996), for Tables A3 and A4 in *Field guide to ecosites of west-central Alberta* (Beckingham et al. 1996), and for Tables A5 and A6 in *Field guide to ecosites of southwestern Alberta* (Archibald et al. 1996). Natural subregions are defined in Table 4 and shown in Figure 1 of the main text of this document.

Appendix 1. Subregion-Specific Ecosites and Ecosite Phases

Table A1. Ecosites and ecosite phases of Alberta – Boreal Forest (excludes Boreal Subarctic).

Subregion	Ecosite		Ecosite phase	
1, 2, 3, 5, 12	a	Lichen (subxeric/poor)	a1	lichen Pj
	b	Blueberry (submesic/medium)	b1	blueberry Pj-Aw
			b2	blueberry Aw(Bw)
			b3	blueberry Aw-Sw
			b4	blueberry Sw-Pj
	c	Labrador tea-mesic (mesic/poor)	c1	labrador tea-mesic Pj-Sb
	d	Low-bush cranberry (mesic/medium)	d1	low-bush cranberry Aw
			d2	low-bush cranberry Aw-Sw
			d3	low-bush cranberry Sw
	e	Dogwood (subhygric/rich)	e1	dogwood Pb-Aw
			e2	dogwood Pb-Sw
			e3	dogwood Sw
	f	Horsetail (hygric/rich)	f1	horsetail Pb-Aw
			f2	horsetail Pb-Sw
			f3	horsetail Sw
	g	Labrador tea-subhygric (subhygric/poor)	g1	labrador tea-subhygric Sb-Pj
	h	Labrador tea/ horsetail (hygric/medium)	h1	labrador tea/ horsetail Sw-Sb
	i	Bog (subhydric/very poor)	i1	treed bog
			i2	shrubby bog
	j	Poor fen (subhydric/medium)	j1	treed poor fen
			j2	shrubby poor fen
	k	Rich fen (subhydric/rich)	k1	treed rich fen
			k2	shrubby rich fen
			k3	graminoid rich fen
	l	Marsh (hydric/rich)	l1	marsh
6, 21	a	Bearberry (subxeric/poor)	a1	bearberry Pj
	b	Blueberry (submesic/medium)	b1	blueberry Pj-Aw(Bw)
			b2	blueberry Aw
			b3	blueberry Sw-Pj
	c	Labrador tea-mesic (mesic/poor)	c1	labrador tea-mesic Pj-Sb
	d	Low-bush cranberry (mesic/medium)	d1	low-bush cranberry Aw
			d2	low-bush cranberry Aw-Sw-Sb
			d3	low-bush cranberry Sw
	e	Fern (subhygric/rich)	e1	fern Sw
	f	Horsetail (hygric/rich)	f1	horsetail Sw
	g	Labrador tea-hygric (hygric/poor)	g1	labrador tea-hygric Sb-Pj
	h	Bog (subhydric/very poor)	h1	treed bog
			h2	shrubby bog
	i	Poor fen (subhydric/medium)	i1	treed poor fen
			i2	shrubby poor fen
	j	Rich fen (subhydric/rich)	j1	treed rich fen
			j2	shrubby rich fen
			j3	graminoid rich fen

Notes: natural subregions are defined in Table 4 and shown in Figure 1 (1– Central Mixedwood; 2 – Dry Mixedwood; 3 – Northern Mixedwood; 5 – Peace-Athabasca Delta; 6 – Lower Boreal Highlands; 12 – Athabasca Plain; 21 – Upper Boreal Highlands).

Appendix 1. Subregion-Specific Ecosites and Ecosite Phases

Table A2. Ecosites and ecosite phases of Alberta – Boreal Subarctic and Kazan Upland/Canadian Shield.

Subregion	Ecosite		Ecosite phase	
4	a	Bearberry (subxeric/poor)	a1	bearberry Pl
			a2	bearberry Pl-Aw
			a3	bearberry Aw
	b	Canada buffalo-berry (mesic/medium)	b1	Canada buffalo-berry Pl-Aw
			b2	Canada buffalo-berry Aw
			b3	Canada buffalo-berry Aw-Sw-sb
			b4	Canada buffalo-berry Sw
	c	Labrador tea-mesic (mesic/poor)	c1	labrador tea-mesic Pl-Sb
	d	Horsetail (subhygric/rich)	d1	horsetail Pb-Bw
			d2	horsetail Aw-Sw
			d3	horsetail Sw
	e	Labrador tea-hygric (hydric/poor)	e1	labrador tea-hygric Sb-Pl
	f	Bog (subhydric/very poor)	f1	treed bog
			f2	shrubby bog
	g	Poor fen (subhydric/medium)	g1	treed poor fen
			g2	shrubby poor fen
	h	Rich fen (subhydric/rich)	h1	treed rich fen
			h2	shrubby rich fen
			h3	graminoid rich fen
13	a	Bearberry (subxeric/poor)	a1	bearberry Pj
	b	Canada buffalo-berry-green alder (mesic/medium)	b1	Canada buffalo-berry-ga Pj-Aw-Bw
			b2	Canada buffalo-berry-ga Aw
			b3	Canada buffalo-berry-ga Aw-Sw-Sb
	c	Labrador tea-mesic (mesic/poor)	c1	labrador tea-mesic Pj-Sb
	d	Labrador tea-subhygric (subhygric/poor)	d1	labrador tea-subhygric Sb-Pj
	e	Willow/horsetail (subhygric/rich)	e1	willow/horsetail Aw-Bw-Pb
			e2	willow/horsetail Aw-Sw-Sb
	f	Bog (subhydric/very poor)	f1	treed bog
			f2	shrubby bog
	g	Poor fen (subhydric/medium)	g1	treed poor fen
			g2	shrubby poor fen
	h	Rich fen (subhydric/rich)	h1	treed rich fen
			h2	shrubby rich fen
			h3	graminoid rich fen

Notes: natural subregions are defined in Table 4 and shown in Figure 1 (4 – Boreal Subarctic; 13 – Kazan Upland/Canadian Shield).

Appendix 1. Subregion-Specific Ecosites and Ecosite Phases

Table A3. Ecosites and ecosite phases of Alberta – Lower Foothills and Montane (**west-central**).

Subregion	Ecosite		Ecosite phase	
11	a	Grassland (xeric/poor)	a1	shrubby grassland
	b	Bearberry/lichen (subxeric/poor)	b1	bearberry/lichen Pl
	c	Hairy wild rye (submesic/medium)	c1	hairy wild rye Pl
			c2	hairy wild rye Aw
			c3	hairy wild rye Aw-Sw-Pl
			c4	hairy wild rye Sw
	d	Labrador tea-mesic (mesic/poor)	d1	labrador tea-mesic Pl-Sb
	e	Low-bush cranberry (mesic/medium)	e1	low-bush cranberry Pl
			e2	low-bush cranberry Aw
			e3	low-bush cranberry Aw-Sw-Pl
			e4	low-bush cranberry Sw
	f	Bracted honeysuckle (subhygric/rich)	f1	bracted honeysuckle Pl
			f2	bracted honeysuckle Aw-Pb
			f3	bracted honeysuckle Aw-Sw-Pl
			f4	bracted honeysuckle Sw
	g	Meadow (subhygric/very rich)	g1	shrubby meadow
			g2	forb meadow
	h	Labrador tea-subhygric (subhygric/poor)	h1	labrador tea-subhygric Sb-Pl
	i	Horsetail (hygric/rich)	i1	horsetail Pb-Aw
			i2	horsetail Pb-Sw
			i3	horsetail Sw
	j	Labrador tea/horsetail (hygric/medium)	j1	labrador tea/horsetail Sb-Sw
	k	Bog (subhydric/poor)	k1	treed bog
			k2	shrubby bog
	l	Poor fen (subhydric/medium)	l1	treed poor fen
			l2	shrubby poor fen
	m	Rich fen (subhydric/rich)	m1	treed rich fen
			m2	shrubby rich fen
			m3	graminoid rich fen
	n	Marsh (hydric/rich)	n1	marsh
9	a	Grassland (subxeric/medium)	a1	shrubby grassland
			a2	graminoid grassland
	b	Bearberry (submesic/medium)	b1	bearberry Fd
			b2	bearberry Pl
			b3	bearberry Aw
			b4	bearberry Aw-Sw-Pl
			b5	bearberry Sw
	c	Hairy wild rye (mesic/medium)	c1	hairy wild rye Fd
			c2	hairy wild rye Pl
			c3	hairy wild rye Aw
			c4	hairy wild rye Aw-Sw-Pl
			c5	hairy wild rye Sw
	d	Dogwood (subhygric/rich)	d1	dogwood Pb-Aw
			d2	dogwood Pb-Sw
	e	Meadow (subhygric/very rich)	e1	shrubby meadow
			e2	forb meadow
	f	Horsetail (hygric/rich)	f1	horsetail Pb-Aw
			f2	horsetail Sw
	g	Fen (subhydric/rich)	g1	treed fen
			g2	shrubby fen
			g3	graminoid fen
	h	Marsh (hydric/rich)	h1	marsh

Notes: natural subregions are defined in Table 4 and shown in Figure 1 (11 – Lower Foothills; 9 – Montane).

Appendix 1. Subregion-Specific Ecosites and Ecosite Phases

Table A4. Ecosites and ecosite phases of Alberta – Upper Foothills and Subalpine (**west-central**).

Subregion	Ecosite		Ecosite phase	
10	a	Grassland (xeric/poor)	a1	shrubby grassland
	b	Bearberry/lichen (subxeric/poor)	b1	bearberry/lichen Pl
	c	Hairy wild rye (submesic/medium)	c1	hairy wild rye Pl
			c2	hairy wild rye Aw
			c3	hairy wild rye Aw-Sw-Pl
			c4	hairy wild rye Sw
	d	Labrador tea-mesic (mesic/poor)	d1	Labrador tea-mesic Pl-Sb
	e	Tall bilberry/arnica (mesic/medium)	e1	tall bilberry/arnica Pl
			e2	tall bilberry/arnica Aw-Sw-Pl
			e3	tall bilberry/arnica Sw
			e4	tall bilberry/arnica Fa
	f	Bracted honeysuckle (subhygric/rich)	f1	bracted honeysuckle Pl
			f2	bracted honeysuckle Pb
			f3	bracted honeysuckle Pb-Sw-Pl
			f4	bracted honeysuckle Sw
			f5	bracted honeysuckle Fa
			f6	bracted honeysuckle willow
	g	Meadow (subhygric/very rich)	g1	shrubby meadow
			g2	forb meadow
	h	Labrador tea-subhygric (subhygric/poor)	h1	labrador tea-subhygric Sb-Pl
	i	Labrador tea/horsetail (hygric/medium)	i1	labrador tea/horsetail Sb-Sw
	j	Horsetail (hygric/rich)	j1	horsetail Sw
	k	Bog (subhydric/poor)	k1	treed bog
			k2	shrubby bog
	l	Poor fen (subhydric/medium)	l1	treed poor fen
			l2	shrubby poor fen
			l3	graminoid poor fen
	m	Rich fen (subhydric/rich)	m1	treed rich fen
			m2	shrubby rich fen
			m3	graminoid rich fen
8	a	Grassland (subxeric/medium)	a1	shrubby grassland
			a2	graminoid grassland
	b	Bearberry/lichen (subxeric/poor)	b1	bearberry/lichen Pl
	c	Hairy wild rye (submesic/medium)	c1	hairy wild rye Pl
			c2	hairy wild rye Pl-Aw
			c3	hairy wild rye Se
	d	Rhododendron-mesic (mesic/medium)	d1	rhododendron-mesic Pl
			d2	rhododendron-mesic Se
			d3	rhododendron-mesic Fa
	e	Meadow (subhygric/very rich)	e1	shrubby meadow
			e2	forb meadow
	f	Rhododendron- subhygric (subhygric/medium)	f1	rhododendron- subhygric Pl
			f2	rhododendron- subhygric Se-Fa
	g	Horsetail (hygric/rich)	g1	horsetail Se
	h	Bog (subhydric/poor)	h1	treed bog
			h2	shrubby bog
	i	Fen (subhydric/rich)	i1	treed fen
			i2	shrubby fen
			i3	graminoid fen

Notes: natural subregions are defined in Table 4 and shown in Figure 1 (10 – Upper Foothills; 8 – Subalpine).

Appendix 1. Subregion-Specific Ecosites and Ecosite Phases

Table A5. Ecosites and ecosite phases of Alberta – Lower Foothills and Montane (**southwestern**).

Subregion	Ecosite		Ecosite phase	
11	a	Bearberry (subxeric/poor)	a1	bearberry Pl
	b	Bearberry/hairy wild rye (submesic/medium)	b1	bearberry/hwr Pl
			b2	bearberry/hwr Aw
			b3	bearberry/hwr Aw-Sw-Pl
	c	Labrador tea-mesic (mesic/poor)	c1	Labrador tea-mesic Pl
			c2	Labrador tea-mesic Aw-Sw-Pl
	d	Low-bush cranberry/wild sarsaparilla (mesic/medium)	d1	low-bush cranberry/ws Pl
			d2	low-bush cranberry/ws Aw
			d3	low-bush cranberry/ws Aw-Sw-Pl
			d4	low-bush cranberry/ws Sw
	e	Bracted honeysuckle/fern (subhygric/rich)	e1	bracted honeysuckle/f Pl
			e2	bracted honeysuckle/f Aw-Pb
			e3	bracted honeysuckle/f Aw-Sw-Pl
			e4	bracted honeysuckle/f Sw
	f	Labrador tea-hygric (hygric/poor)	f1	labrador tea-hygric Pl
	g	Black spruce/horsetail (hygric/medium)	g1	black spruce/horsetail Sw-Sb
			g2	black spruce/horsetail Sb
	h	White spruce/horsetail (hygric/rich)	h1	white spruce/horsetail Sw
	i	Bog (subhydric/poor)	i1	treed bog
	j	Poor fen (subhydric/medium)	j1	treed poor fen
	k	Rich fen (hydric/rich)	k1	treed rich fen
			k2	shrubby rich fen
			k3	graminoid rich fen
9	a	Limber pine/juniper (subxeric/poor)	a1	limber pine/juniper Fd-Pf
	b	Bearberry (submesic/poor)	b1	bearberry Pl
			b2	bearberry Aw
			b3	b3 bearberry Aw-Sw-Pl
	c	Canada buffalo-berry/hairy wild rye (submesic/medium)	c1	Canada buffalo-berry/hwr Fd
			c2	Canada buffalo-berry/hwr Pl
			c3	Canada buffalo-berry/hwr Aw
			c4	Canada buffalo-berry/hwr Aw-Sw-Pl-Fd
	d	Creeping mahonia-white meadowsweet (mesic/medium)	d1	creeping mahonia-wm Fd
			d2	creeping mahonia-wm Pl
			d3	creeping mahonia-wm Sw
	e	Thimbleberry/pine grass (mesic/rich)	e1	thimbleberry/pine grass Pl
			e2	thimbleberry/pine grass Aw
			e3	thimbleberry/pine grass Sw
	f	Balsam poplar (subhygric/rich)	f1	balsam poplar Pb
	g	Horsetail (hygric/rich)	g1	horsetail Sw-Pb
			g2	horsetail Sw

Notes: natural subregions are defined in Table 4 and shown in Figure 1 (11 – Lower Foothills; 9 – Montane).

Appendix 1. Subregion-Specific Ecosites and Ecosite Phases

Table A6. Ecosites and ecosite phases of Alberta – Upper Foothills and Subalpine (**southwestern**).

Subregion	Ecosite		Ecosite phase	
10	a	Bearberry (subxeric/poor)	a1	bearberry Pl
	b	Bearberry/hairy wild rye (submesic/medium)	b1	bearberry/hwr Pl
			b2	bearberry/hwr Aw
			b3	bearberry/hwr Aw-Sw-Pl
	c	Tall bilberry-Labrador tea (mesic/medium)	c1	Labrador tea-mesic Pl
			c2	Labrador tea-mesic Aw-Sw-Pl
	d	Silver-berry (subhygric/medium)	d1	low-bush cranberry/ws Pl
			d2	low-bush cranberry/ws Aw
			d3	low-bush cranberry/ws Aw-Sw-Pl
			d4	low-bush cranberry/ws Sw
	e	Green alder/fern (subhygric/rich)	e1	bracted honeysuckle/f Pl
			e2	bracted honeysuckle/f Aw-Pb
			e3	bracted honeysuckle/f Aw-Sw-Pl
			e4	bracted honeysuckle/f Sw
	f	Black spruce/Labrador tea (hygric/poor)	f1	labrador tea-hygric Pl
	g	Black spruce/horsetail (hygric/medium)	g1	black spruce/horsetail Sw-Sb
			g2	black spruce/horsetail Sb
	h	white spruce/horsetail (hygric/rich)	h1	white spruce/horsetail Sw
	i	Bog (hydric/poor)	i1	treed bog
	j	Poor fen (hydric/medium)	j1	treed poor fen
	k	Rich fen (hydric/rich)	k1	treed rich fen
			k2	shrubby rich fen
			k3	graminoid rich fen
8	a	Lichen (xeric/poor)	a1	lichen Pl
	b	Bearberry//hairy wild rye (subxeric/medium)	b1	bearberry/ hairy wild rye Pl
	c	Subalpine larch/heather (submesic/poor)	c1	subalpine larch/heather La-Fa
	d	Spruce/heather (mesic/poor)	d1	spruce/heather Se
	e	False azalea-grouse-berry (mesic/medium)	e1	false azalea-grouse-berry Pl
			e2	false azalea-grouse-berry Pw
			e3	false azalea-grouse-berry Se
			e4	false azalea-grouse-berry Fa
	f	Thimbleberry (subhygric/rich)	f1	thimbleberry Pl
			f2	thimbleberry Fa-Se
	g	Dwarf birch/tufted hair grass (hygric/rich)	g1	dwarf birch/tufted hair grass
	h	Horsetail (subhydric/rich)	h1	horsetail Se
			h2	horsetail fen

Notes: natural subregions are defined in Table 4 and shown in Figure 1 (10 – Upper Foothills; 8 – Subalpine).

Appendix 2. Tree Condition Codes

Table A7. Descriptions of general tree condition codes, causal agents and severity of condition (part 1 of 3).

General Tree Condition Codes		
Code	**Condition**	**Description of Use**
0	Live and Healthy	A tree is live and has no noticeable defect or damage.
1	Dead But Standing	A tree is completely dead (i.e., no live buds or foliage) but remains standing.
2	Dead and Down	Used in plot re-measurements when a tree is dead and no longer supported by its root system. The tree must be located in order to use this code.
3	Broken or Dead Top	The upper portion of the tree has died or broken off.
4	Bole Damage	The main stem of a tree is damaged as a result of mechanical or abiotic factors or from animal, insect, disease or anthropogenic activity.
5	Crown Damage	A tree's crown is damaged as a result of mechanical or abiotic factors or from animal, insect, disease or anthropogenic activity.
6	Root Damage	The root system of a tree is damaged as a result of mechanical or abiotic factors or from animal, insect, disease or anthropogenic activity.
7	Crook	The bole of a tree exhibits an abrupt curvature.
8	Sweep	The bole of a tree exhibits a gradual curvature. This includes "pistol grip" trees which have a large horizontal displacement at their base.
9	Fork	Used for all prominent forks above DBH. Forks occur where there has been damage to the main leader, and must not be confused with the natural branching patterns on hardwoods. Stems which have multiple leaders originating above DBH will also be given this code.
10	Lean	A tree that is leaning a minimum of 10 degrees from vertical.
11	Poor Form	This applies to trees which have form defects other than crooks, sweeps and forks. This includes excessively limby trees (wolf trees), trees with multiple leaders (where no distinct fork is present) and various other tree form anomalies.
12	Same Stump	Used when two or more trees share the same stump (i.e., forked below DBH). Note that all trees originating from the same stump receive the 12 code.
13	Harvested Tree	Used in plot re-measurements when a tree has clearly been harvested. The location of the stump will have to be verified with the previous data before a 10 code can be assigned.
14	Missing Tree	Used in plot re-measurements to represent a tree that can no longer be located.
15	Disqualified Tree	Used in plot re-measurements when a tagged tree no longer satisfies the necessary criteria under current PSP protocols to be tallied as a tree.
16	Newly Qualified Tree	Used in plot re-measurements, when a tree was clearly missed during a previous measurement.

Appendix 2. Tree Condition Codes

Table A7. Descriptions of general tree condition codes, causal agents and severity of condition (part 2 of 3).

Causal Agents		
Code	**Cause**	**Description of Use**
1	Spruce Budworm	Tree shows evidence of Eastern Spruce Budworm (*Choristoneura fumiferana (Clemens))* attack. Symptoms include: webbing, frass and rust colouring on the tree crown. Primary hosts are white spruce, black spruce and balsam fir.
2	Defoliator	Tree shows evidence of attack from any defoliating insect other than spruce budworm.
3	Mountain Pine Beetle	Tree shows evidence of mountain pine beetle attack (*Dendroctonus ponderosae (Hopkins*)). Symptoms include: evidence of entrance or exit holes and accumulations of pitch and sawdust. Primary hosts are lodgepole pine and jack pine.
4	Root Collar Weevil	Tree shows evidence of attack from any species of root collar weevil. Identified by presence of resin flow and tunnels in the bark and cambium at or below the duff layer. Most conifer species are susceptible to root collar weevil attack.
5	Terminal Weevil	Tree shows evidence of attack from any species of terminal weevil. Identified by presence of bent-over leaders with obvious exit holes. Most conifer species are susceptible to terminal weevil attack.
6	Armillaria Root Disease	Tree shows evidence of attack from Armillaria root disease (*Armillaria spp*.). Identified by the presence of mycelial fans around the root collar.
7	Shepherd's Crook	Tree shows evidence of aspen leaf and twig blight (*Venturia spp*.) which causes terminal shoots and leaves to wilt and turn black, ultimately forming a shepherd's crook.
8	Dwarf Mistletoe	Tree shows evidence of dwarf mistletoe (*Arceuthobium spp*.), notably the characteristic witches broom associated with this parasitic plant. Most species of conifer are susceptible.
9	Stem Disease	Tree shows evidence of a stem pathogen typically caused by canker, heart rot and sap rot diseases. Evidence is usually in the form of a canker (sunken or swollen lesion), conk or other fruiting body on the stem.
10	Western Gall Rust	Tree shows evidence of western gall rust (*Endocronartium harknessii (J.P. Moore) Y. Hairatsuka,)* most notably woody swellings (galls) on the main stem and/or branches. Primary hosts are lodgepole pine and jack pine.
11	Animal Damage	Tree has been damaged by any type of mammal or bird. This includes small mammal feeding, ungulate rubs, ungulate browsing, beaver damage, woodpecker and sapsucker damage, etc.
12	Wind Damage	Tree exhibits signs of wind damage.
13	Snow/Ice/Frost Damage	Tree has been damaged by snow, ice or frost. This may result from ice build-up, heavy snow loads and early or late frosts which damage trees that are not properly hardened off. This includes: snow press, frost cracks and frost heave.

Appendix 2. Tree Condition Codes

14	Hail Damage	Tree has been damaged by hail. Signs of hail damage may include stripped branches and extensive scarring on stems and branches. Damage is greatest on younger shoots, making younger trees more susceptible.
15	Fire Damage	Tree has been damaged as a result of burning or scorching
16	Mechanical Damage	Tree has been damage by the natural mechanical action of trees contacting each other, resulting in scarring or crown damage.
17	Improper Planting	Tree has been planted in a manner that is adversely affecting growth. This includes J-rooted trees, shallow or deeply planted trees, trees that are planted loosely or trees planted at an acute angle.
18	Poor Ground Conditions	Tree has been planted in an inappropriate location (i.e., poor microsite selection) or where the seedbed is unsuitable for growing trees (I.e., hardpan, rotten logs, deep organic soil, etc.).
19	Competition	Tree is suffering from excessive competition from herbaceous or woody vegetation. It applies only to seedlings shorter than 1.30 m.
20	Insect (Other)	Tree shows evidence of attack from an insect other than those listed in 1 through 5 or from an unidentified insect.
21	Disease (Other)	Tree shows evidence of attack from an insect other than those listed in 6 through 10 or from an unidentified disease.
22	Climate, Weather or Flood Damage	Tree exhibits damage resulting from climate, weather or flooding. This includes damage caused by lightning, drought, sunscald and desiccation
23	Anthropogenic Damage	Tree exhibits damage resulting from some type of human activity. This includes damage from harvesting, land clearing, herbicide and other human caused activities.
24	Unknown	Tree has been damaged by some sort of unknown cause.

Appendix 2. Tree Condition Codes

Table A7. Descriptions of general tree condition codes, causal agents and severity of condition (part 3 of 3).

Severity of Condition		
Code	**Severity**	**Description of Use**
1	Minor	Condition is **noticeable** but is **unlikely** to have an adverse impact the long-term survival, growth or form of the tree. Impacts on fibre quality and yield at the time of harvest are expected to be negligible.
2	Moderate	Condition is **obvious** and **could potentially** have an adverse impact the long-term survival, growth or form of the tree. If the tree survives, some minor to moderate impacts on fibre quality and yield at the time of harvested can be expected.
3	Severe	Condition is **prominent** and is **almost certain** to affect the long-term survival, growth or form of the tree. If the tree survives, major impacts on fibre quality and yield at the time of harvest can be expected.
9	Unknown/Not Applicable	The severity of the condition is not known or unquantifiable.

Appendix 3. Metric Conversion Chart

1 cm	=	0.39370 in.
1 m	=	3.28083 ft.
1 m	=	1.09361 yards
1 ha	=	2.47105 acres
1 m^2	=	10.76385 ft^2
1 m^3	=	35.31435 ft^3
1 m^2/ha	=	4.3560 ft^2/acre
1 m^3/ha	=	14.2913 ft^3/acre
1 ha	=	10000 m^2
1 km	=	1000 m
1 km	=	0.62137 miles
1 km^2	=	100 ha
1 km^2	=	0.3861 $miles^2$
1 in.	=	2.5400 cm
1 ft.	=	0.3048 m
1 acre	=	0.4047 ha
1 ft^2	=	0.09290 m^2
1 ft^3	=	0.02832 m^3
1 ft^2/acre	=	0.2296 m^2/ha
1 ft^3/acre	=	0.06997 m^3/ha
1 mile	=	1.6093 km
1 $mile^2$	=	2.5898 km^2
1 $mile^2$	=	258.9846 ha
1 fbm	=	1 ft. $\times$ 1 ft. $\times$ 1 in.
1 fbm	=	0.0023597 m^3
1 Mfbm	=	1000 foot board measure (fbm)
1 Mfbm	=	2.3597 m^3
1 township	=	6 miles $\times$ 6 miles = 36 $mile^2$
1 township	=	9.6558 km $\times$ 9.6558 km = 93.2345 km^2
1 township	=	9323.45 ha
1 m^3 log	$\approx$	233 board feet lumber (provincial average conversion factor)
1 Mfbm	$\approx$	4.3 m^3 log (provincial average conversion factor)


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