FOREST SCIENCE, PLANNING, AND PRACTICES BRANCH

Silviculture Survey Procedures Manual



April 1, 2023

BRITISH COLUMBIA

This version of the Silviculture Surveys Procedures Manual was edited and produced by:

Ministry of Forests (FOR) – Forest Science, Planning and Practices Branch (FSPPB)

Surveyors will need to adopt the new methodologies outlined in the *2023 Silviculture Survey Procedures Manual* on April 1, 2023.

Reporting completed between April 1 and May 31, 2023, for surveys completed prior to March 31, 2023, can follow the earlier editions of the *RESULTS Information Submission Specifications* documents.

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1 Introduction

This *Silviculture Survey Procedures Manual* covers the collection and compilation of silviculture survey data from regeneration delay, stocking and free growing surveys. It also reviews alternative survey methodologies and sub-surveys such as plantability, brushing, and forest health surveys. There are no explicit legislated survey requirements to use the procedures outlined in this manual, but there are reporting requirements for licensee obligations. These survey procedures will provide the necessary guidance to meet the legislated reporting requirements.

Concepts believed to be "best practices" but not necessarily required by legislation have been highlighted using purple text in a box like this.

Commonly misunderstood issues have been highlighted using blue text in a box like this.

The 2022 and 2023 updates were too extensive to use text boxes. The 2022 updates are identified with red text and the 2023 updates are identified with green text.

Variations from this procedures manual are acceptable if the outcomes resulting from the alternative methods are the same as those that would be found using the guidance in this document.

While there is no requirement to follow the procedures described in this manual, the results reported by a licensee must be consistent with the results that would be reached by the procedures described here. This concept also applies to the use of electronic data collectors. The method of capturing survey data may vary, but the calculated and reported results must be consistent with the results of having used the methods in this manual.

Survey methods and stocking standards contained within an approved Forest Stewardship Plan (FSP) take precedence over the methodologies provided herein.

1.1 Manual Organization

Sections 1 to 6 Fundamentals of Silviculture Surveying - Common to all survey designs and methodologies.

Sections 7 to 8 Standard Clearcut Even-aged Stand Structure - Data collection and data compilation using standard FOR field cards.

Section 9.0 Alternative Survey Methodologies

Section 9.2 Complex Vertical Stand Structure – Multi-Storey Survey; Layered; Deviation from Potential (DFP); Single-Entry Dispersed Retention Stocking Standard Survey (SEDRSS); Boreal Mixedwood Survey.

Section 9.3 Complex Horizontal Stand Structure – Even-aged Clustered Stands; Intermediate Cut – Commercial Thinning; Small-Scale Harvested Openings; Coastal & Interior Mixedwood – Patch Mixtures.

Efforts have been made to write the first 8 Sections of the manual to correspond with the chronological sequence in which surveys are conducted, from the office preparation to the final survey summary report that is submitted to the Ministry of Forests (FOR).

This document contains numerous links to online references and to other places within this document. To return to your original place within the manual, hold ALT and the left arrow key.

For additional information and general survey reference materials, please visit the FOR silviculture surveys website.

The *Silviculture Survey Procedures Manual* will be subject to ongoing review by ministry and non-ministry survey experts. Your suggestions for improvements to this manual can be sent to the provincial Silviculture Performance Assessment Specialist.

1.2 Background

Each year, silviculture surveys are conducted on approximately one million hectares of provincial land. In terms of hectares treated, silviculture surveys exceed the hectares of all other silviculture activities combined.

On a per-hectare basis, silviculture surveys are one of the lowest-cost silviculture activities. This, however, does not mean that they are of little value or that surveyors require minimal experience and training. Surveys costing relatively little per hectare provide the information necessary to accurately prescribe silviculture investments costing hundreds or thousands of dollars per hectare.

Silviculture surveys assemble the baseline information required to develop and implement effective silviculture programs. They are an essential element in the confirmation of completed silviculture obligations and may also be used to assess due diligence with respect to achievement of free growing obligations. The silviculture survey is the tool used to measure the achievement of stated objectives.

Survey information may be used for planning treatments, conducting resource analyses, preparing annual reports, conducting audits, or monitoring compliance with silviculture plans or prescriptions.

Silviculture survey data is used to update the Vegetation Resource Inventory and to meet the data needs of various internal government programs, such as carbon, wildlife, wildfire, forest health, and forest investments.

The inventory species composition, inventory density, and planting data are used to develop yield curves for timber supply review and carbon modelling.

Accuracy and consistency in conducting surveys are vitally important given their many uses. Consistency is required to allow comparisons to be made between blocks, licensees, and districts.

Standardized concepts ensure that the survey system remains consistent and predictable. They also allow comparison between agreed-upon standards and current conditions. Deviation from standardized concepts may be discussed in individual plans or contracts. Where no specifics are discussed, standardized concepts should be used.

1.2.1 History

Silviculture surveys are based on standards that may have been created many years in the past. The silviculture plan or prescription covering an opening is legally binding until the requirements contained within it are met or amended by mutual agreement.

This means that even a Pre-Harvest Silviculture Prescription created in 1987 is still in effect until its standards are met, amended, or replaced with an approved FSP. Note: The standards in a woodlot Pre-Harvest Silviculture Prescription can be amended, but not replaced with woodlot licence plan standards, as per Section 202 of the Forest and Range Practices Act.

Stocking standards (regardless of the containing document) state the reforestation requirements.

For simplicity, **silviculture plans and prescriptions** will refer to the collective set of documents that provide stocking standards and reforestation objectives.

Forest legislation in British Columbia has evolved across the last three decades. Surveyors have operated over seven broad eras and are currently in a transition into the eighth. With the addition of each era, the role of a silviculture surveyor becomes more complex.

The relevant eras include:

Pre-January 1, 1982

With a few exceptions, before 1982, persons who harvested on provincial forest land had no obligation to reforest. The Ministry of Forests managed the reforestation activities.

January 1, 1982, to October 1, 1987

With a few exceptions, before October 1, 1987, persons who harvested on provincial forest land had no obligation to reforest. This era is complicated in that there was an expectation for the licensees to manage the reforestation activities, but for the Ministry of Forests to fund the activities.

October 1, 1987, to April 1, 1994

Licence holders were obligated to create a Pre-Harvest Silviculture Prescription (PHSP) stating the harvesting and reforestation objectives. All reforestation activities were managed and funded by the licensee.

April 1, 1994, to June 15, 1995

The Silviculture Regulations were reformulated and renamed the Silviculture Practices Regulation. The PHSP became the Silviculture Prescription (SP).

June 15, 1995, to December 17, 2002

Forest management activities were directed by The Forest Practices Code (FPC), and its more than a dozen regulations and many guidebooks.

November 30, 1998, to present

For woodlot licensees only: silviculture prescriptions were replaced by woodlot site plans and default standards in accordance with the new Woodlot Licence Forest Management Regulation.

The transition period from the Forest Practices Code to the Forest and Range Practices Act depended on the expiration date of an individual woodlot license's Forest Development Plan.

December 17, 2002, to January 31, 2004

The Silviculture Prescription changed to the Site Plan within this period but operations continued under the Forest Practices Code. In this era stocking standards may have migrated into the Forest Development Plan in the form of Silviculture Regimes.

January 31, 2004, to present

The current era falls under the Forest and Range Practices Act (FRPA) and its regulations. There were transitional periods that led to full implementation as of January 1, 2006. Stocking standards for this era on non-woodlot areas are found in the Site Plan (SP) and associated Forest Stewardship Plan (FSP). For woodlot licences only, site plans are not a legal requirement as stocking standards are described in the Woodlot Licence Plan. Full implementation to the Forest and Range Practices Act depends on the expiration date of an individual woodlot licence's Forest Development Plan.

1.3 Legislation

The discussion that follows should be considered as general guidance and discussion. This should not be construed to be legal interpretation. The linkages between silviculture surveys and the Forest and Range Practices Act, and its associated regulations, are discussed in more detail in Appendix 10.

1.3.1 FPC versus FRPA to a surveyor

Openings being held by a licensee can still be under two types of legislative umbrella: either still under the Forest Practices Code (FPC**)** or they can be under Forest and Range Practices Act (FRPA) and the corresponding regulations - Forest Planning and Practices Legislation (FPPR) or Woodlot Licence Planning and Practices Regulation (WLPPR).

1.3.1.1 Openings under FPC:

These openings are still linked with a Forest Development Plan (FDP) and Silviculture Prescription (SP) or woodlot site plan under the FPC. A non-woodlot licensee can opt to retain their obligations under these approved plans, up to relief of their obligations. A woodlot licensee **must** retain their obligations under these approved plans, up to relief of their obligation. These openings must be surveyed to the stocking standards as outlined in these documents. However, the methodology does not need conform to procedures outlined in this manual, as that aspect of the FPC was removed when FRPA was passed. The content required to be submitted with a declaration of an FPC opening now must correspond with the data requirements as expected from FRPA openings.

1.3.1.2 Openings under FRPA:

These are openings established under the umbrella of an approved Forest Stewardship Plan (FSP) or Woodlot Licence Plan (WLP), **and/or** old FPC openings where the FSP specified either the specific blocks FRPA standards would be applied to, or a process for FRPA standards to be applied to blocks with an FPC obligation. Therefore, these openings will be surveyed to the stocking standards outlined in the FSP or WLP. In addition, there is no requirement that the field procedures and methodologies in this manual be adhered to by the surveyor. The only requirement (as previously stated) is that the data submitted by the licensee conforms to the content required.

1.3.2 Forest Cover Reporting Requirements

The survey data submission requirements outlined in this manual are consistent with the requirements under the *RESULTS Information Submission Specifications* (RISS). Refer to the RESULTS website for a detailed discussion on the requirements of these submissions.

This direction is empowered in FPPR by section 97 (7) - *"a written declaration ...for the regeneration date or free growing date include a forest cover inventory" "* and in WLPPR by section 75 (3) – *"... must carry out a survey ... on or before free growing date, identifying ... the forest cover inventory".* The precision standards for reported forest cover attributes are empowered by FPPR section 86(6) - *"must be reported in a form and manner that is satisfactory to the minister"* and refers to Table 16: Minimum precision standards for data submissions in the RISS documentation. The definition of forest cover and authority to define the content of these labels is in FPPR section 1-" *includes information required by the minister".* This definition also applies to the WLPPR in accordance with WLPPR section 1 (1). This authority has been delegated to the Chief Forester's signature.

2 Survey Principles

The survey methods in this manual have been carefully developed to promote a balance between the costs of performing surveys and the level of risk of making a wrong decision due to inconclusive data collected. In Section 7, the relative importance of each data item found on the survey plot cards is discussed.

The basic survey principles are based on an understanding of:

- a licensee's freedom to manage the forest resource (within the context of their licence agreement and the legal framework);
- a licensee's responsibility to meet stated reforestation objectives.
- reporting requirements (RESULTS).
- the role of the Professional Forester and Registered Forest Technologist; and
- the role of compliance and enforcement activities regarding milestone obligations of licensees.

The process of conducting most silviculture surveys has five steps:

1. **Office review:** Preparing for the survey; reviewing currently available information, especially the silviculture plan or prescriptions and associated approved amendments; completing preliminary stratification; analyzing imagery, and reviewing block history.
2. **Walk-through of each stratum:** Identifying the location of standards units (SUs)from the silviculture plans and prescriptions; stratifying these SUs according to silviculture survey stratification requirements; determining the survey objectives, methods and sampling intensity; determining the site index method; identifying the leading and second species in the inventory label; and listing preliminary treatment recommendations.
3. **Data gathering for each stratum:** Finalizing the survey design, sampling methodology and intensity; collecting the data within each standards unit and stratum.
4. **Summary of each stratum:** Summarizing the data, by calculating statistics where applicable; preparing inventory label and silviculture labels; and preparing treatment recommendations.
5. **Reporting of each stratum:** Submitting a forest cover, label, and map data into RESULTS.

This manual allows flexibility within the bounds of standard principles that make up the silviculture survey procedures. Alternate survey methods that can produce significantly similar results are acceptable.

Consistent and accurate data collection, summarization, data analysis and treatment recommendations are essential.

Forest professionals who submit reports based on poor survey data are held professionally accountable for their actions.

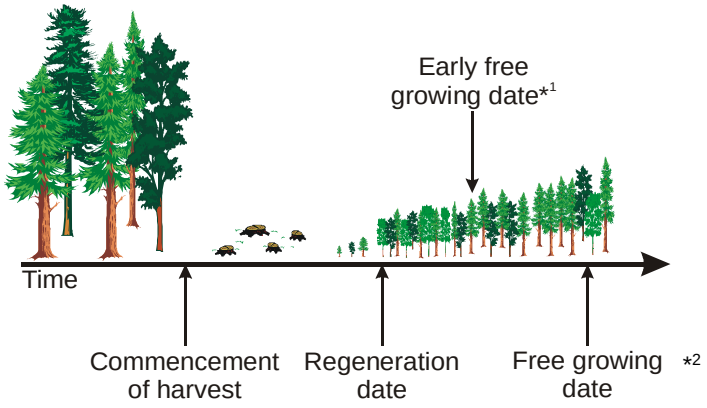
2.1 Survey Timing

Survey timing is an issue usually left to the licensee's silviculture manager. It is also important for surveyors to understand the issue as they will be asked to supply recommendations that include survey timing. Silviculture plans or prescriptions usually specify the regeneration date, may have an early free growing date, and will always have a late free growing date. Usually, these are expressed in terms of the number of years following the commencement of harvest to attain a stocked or free growing stand.

The accuracy of the regeneration date and free growing date requirements is assumed to be to the month where a specific date is not available or accurate. This is relevant since there are known errors within the various corporate databases. Often the 1st or 15th or 30th day has been entered as a default value.

It is also necessary to redefine the terms used to describe the various survey types or names to ensure consistency.

- The survey used to prove that the regeneration requirements have been met will be referred to as the **Regeneration Delay Survey**. This distinction is important since the definition of a well-spaced tree is strictly applied. This definition is dramatically different from what was used in previous years.
- An intermediate survey, conducted after the regeneration obligation has been met and before the free growing survey proves the stratum to be free growing will be called the **Stocking Survey**. Its objective is to reassess the stocking status, need for treatments (replant, brushing, spacing), and monitor the progress of the young stand toward meeting the free growing requirements.
- The **Free Growing survey** is undertaken when it is likely that the survey will find that the stand meets the free growing requirements.



*1 Not all silviculture plans and prescriptions have an early free growing date.

*2 For openings managed under FRPA, free growing heights are used to replace the need for the Early Free Growing Date.

Figure1: Reforestation timeline.

2.1.1 Regeneration Delay Survey Timing

The Regeneration Delay survey is used to prove that the regeneration requirements have been met. Previous terms used included stocking surveys and regen surveys. This clarification is necessary because of the redefinition of a well-spaced tree.

Regeneration delay surveys must be completed on or before the regeneration date. Woodlot licensees are the exception; they must establish a stand that conforms to the applicable stocking standards by the regeneration date but are not required to complete a survey. The regeneration delay survey can be effectively completed at any snow-free time of year. Where the presence of vegetation makes small trees difficult to locate, it will be advantageous to schedule regeneration delay surveys for early spring, or late fall, after leaf fall but before snowfall. This will reduce the likelihood of missing trees during data collection. However, on some sites it may be desirable to do the survey during leaf out to prove regeneration requirements have been met, and properly evaluate vegetation competition.

It is generally advantageous for a licensee to complete a regeneration delay survey as soon as possible. It may be done in conjunction with planting quality checks (see Using the Planting Quality Inspection FS 704 to report regeneration obligation met). This allows economic efficiencies while ensuring the legal responsibility is completed well within the legal period. It also provides the licensee with more flexibility to deal with potential unsuitable weather or unsatisfactory stocking.

If survival is expected to be poor, licensees should avoid declaring regeneration delay met at the time of planting. This is important to capture and report the forest health factors and the surviving forest cover.

Alternatively, if the regeneration obligation is reported at the time of planting and the forest cover inventory significantly changes, it is a best management practice to submit an additional forest cover submission.

2.1.2 Stocking Survey Timing

The stocking survey is any non-reportable intermediate survey that is intended to assess the progress of an opening toward meeting the free growing requirements. Historically there have been a few terms to describe these surveys: regen survey, stocking/free growing surveys, regen performance surveys etc. Although these are not mandatory surveys, they represent the greatest number of surveys conducted. As a result, it is prudent that we provide guidance. They are necessary for forest managers to confirm continued sufficient stocking, and to project treatment needs necessary to achieve free growing status before the late free growing date.

2.1.3 Free Growing Survey Timing

Licensees who are required to establish a free growing stand must report an inventory on the harvested area before the late free growing date. Many older silviculture plans or prescriptions have both early and late free growing assessment dates. More current openings managed under the Forest and Range Practices Act (FRPA) will have free growing heights, but no early free

growing date. As with regeneration delay surveys, pre-planning of the free growing survey is beneficial.

In areas where herbaceous vegetation competition may be a factor in the free growing determination, free growing surveys should be done between the time of maximum leaf out and before leaf fall.

On sites where vegetation competition is a smaller factor in determining free growing status, the survey can be done any time of the year, subject to the limitations of snow depth, and forest health best management practices.

Section 107 (4) and (5) of the FRPA indicates the District Manager has the option to reject a free growing declaration if the stand is under threat from competing vegetation or forest health, or is unlikely to remain free growing without a further treatment.

To limit risk of rejection:

1. Complete a free growing survey after the recommended number of complete (full summer months) growing seasons post-vegetation management treatment

Biogeoclimatic zone	Number of years[1]
ICH, IDF, MS, PP, BG, SBPS, CWH, CDF, MH, and ESSF	2
SBS and BWBS • following herbicide treatment • manually or otherwise treated	 2 3

2. A free growing declaration under FRPA section 107 should only be made when the stand is currently free growing and likely to remain so in the future.

According to FPPR 97(6), a stand must conform to the stocking standards 20 years after the commencement date or 5 years after completion of the last of the brushing or spacing treatments on the stand that were carried out more than 15 years after the applicable commencement date. The stand must not be impeded in its growth by competition from plants, shrubs, or trees or by forest health factors at this time.

3. It is advisable to schedule stocking surveys early in the stand development. This allows for early identification of issues and the opportunity to manage the issues prior to free growing.

4. Free growing surveys should be timed to maximize identification of forest health factors. For example, if rust incidence or hazard is high, the survey should be conducted during the rust sporulation season and when rust expression is at its peak.

Contact your regional forest pathologist or entomologist for clarification on the rust sporulation season and peak rust expression in your area, or for any other questions you may have regarding the timing of surveys to maximize identification of forest health factors.

For their contact information, email taisa.brown@gov.bc.ca

3 Preparing for a Survey

3.1 File Review

The objective of a file review is to prepare the surveyor for undertaking a survey, make a preliminary assessment of the site and stand conditions, identify the survey standards from the silviculture plans and prescriptions, and determine the history of previous activities. In general, the surveyor should gain as much knowledge of an area from the existing information as possible and be prepared to gather the correct data during the upcoming survey.

The following is a list of information that a surveyor should consider before conducting any silviculture survey:

- silviculture plan or prescription and any amendments (Note: woodlot licensees have different requirements and standards in their WLP or defaulted in the WLPPR).
- silviculture treatment regime.
- forest cover map.
- Biogeoclimatic map.
- imagery of opening, including orthomosaics, captured digitally by UAV, Lidar, or remote sensing techniques.
- corporate database describing history (including RESULTS database).
- previously prepared silviculture treatment prescriptions and post-treatment reports.
- previous surveys.
- previous methods of site index determination.

Note: Woodlot licensees may have different requirements and standards outlined in their WLP, defaulted in the WLPPR, or set in a PHSP, Silviculture Prescription, or Site Plan. Defaults are not always used, so you must review the approved plan or prescription.

Note: Surveyors should be aware of block overlaps with spatially explicit Government Action Regulation (GAR) orders. Some orders (e.g., Cariboo Region's GAR) address factors that stocking standards do not, and these orders supersede approved stocking standards.

Once the reference materials and information have been gathered and reviewed for each opening, some of the fields on the Silviculture Survey General Site Info Card (FS 657) card can be completed. A few examples of these include the opening number, licence number, licensee, stocking standards, forest region and district.

Even though many of the data fields of the site description portion of the FS 657 field card can be found within the opening file, these items should be left blank until the walk-through is completed. For example, soil texture, elevation, aspect, slope percent, survey date and ecological classification.

3.1.1 Silviculture Plans and Prescriptions

Before a survey is carried out on an opening, surveyors must familiarize themselves with the opening and the associated silviculture plans and prescriptions. The silviculture plans and prescriptions is the collective term for pre-harvest silviculture prescriptions, silviculture prescriptions, site plans, woodlot pre-harvest map or other site specific documents that contain management objectives and stocking standards that will be used during surveys to measure the success of re-establishing a free growing stand. These site-specific plans describe the nature and extent of timber harvesting and silviculture activities proposed for an opening.

The silviculture plan and prescription is the source of the stocking standards and parameters used to conduct the survey. Surveyors do not usually create any other standards, when ones already exist, but may make recommendations for different standards where ecologically suitable and defensible.

On October 31, 1987, the requirement to create a site-specific harvesting and reforestation plan became required. The document was called a pre-harvest silviculture prescription (PHSP). Generally, areas harvested before this point will not have a standards document. On April 1, 1994, the pre-harvest silviculture prescription form evolved to become silviculture prescription (SP). On June 15, 1995, the Forest Practices Code came into force and provided for the creation of silviculture prescriptions on backlog areas (those areas disturbed before October 31, 1987), where treatments were proposed. On November 30, 1998, for woodlot licenses only, the silviculture prescription was replaced by the woodlot site plan. On December 17, 2002, the silviculture prescription evolved to the Site Plan, in association with the Forest Development Plan. The latest evolution occurred with The Forest and Range Practices Act (FRPA). For woodlot licenses under FRPA, site plans were replaced by a pre-harvest map showing stocking standards for a specified area.

NOTE: Post-wildfire stands or pre-1987 backlog areas may not have a Silviculture Plan or Prescription. In these situations, surveyors use the stocking standards outlined in the Reference Guide for Forest Development Stocking Standards, based on the ecology for the site. Surveyors use the Free Growing Damage Criteria outlined in the FS660.

3.1.1.1 Standards Unit versus Treatment Unit

Throughout the years of silviculture plan and prescription development, there has been an evolution of many of their components. One of the changes has been the use of the terms ‘treatment unit’ and ‘standards unit.’ The current definitions are as follows:

Standards Unit (SU): An area within a cutblock that is subject to uniform soil disturbance limits and stocking standards.

Treatment Unit (TU): An area of land upon which a silviculture activity is planned and carried out.

There may be more than one Treatment Unit (TU) within a Standards Unit (SU). If more than one treatment unit has identical stocking standards, these treatment units can be surveyed as a single stratum, all other parameters being similar. Since the requirement for silviculture plans or prescriptions was first established, there has been periodic evolution of the document. Content

requirements have changed. The size of these documents ranges from one page to dozens of pages. One constant is their inclusion of stocking standards. These are the various specifications for the regenerating crop trees. Surveyors must know where stocking standards are found and how to use them. If they can be provided electronically by the licensee, the surveyor should confirm that the licensee is taking responsibility for their accuracy.

3.1.1.1.1 MSS versus MSSp versus MSSpa

With the creation of the *Silviculture Practices Regulation*, in April of 1994, one of the requirements for silviculture prescriptions was the addition of the minimum number of preferred species. The goal of this requirement was to ensure that reforestation activities be targeted to produce species that are ecologically suited to the site and with the greatest commercial viability.

For example, a silviculture plan or prescription indicates:

- Douglas-fir and spruce are preferred, and western hemlock is acceptable
- the minimum stocking is 700 trees per hectare
- the minimum preferred stocking is 600 trees per hectare

This sample opening must have at least 700 free growing trees per hectare in any proportion of Douglas-fir, spruce, and western hemlock. However, there must be at least 600 free growing trees per hectare in any combination of Douglas-fir and/or spruce for the area to be considered free growing.

The minimum stocking standard is often abbreviated as MSS or MSSpa, while the minimum preferred stocking standard is abbreviated as MSSp.

Most silviculture prescriptions or site plans make reference to both preferred and acceptable species in their stocking standards or stocking requirements section. Generally, silviculture prescriptions approved prior to April 1, 1994, will not have minimum preferred stocking standards unless it was amended for some other reason since it was originally created. The minimum preferred stocking standard concept is only a requirement if it is explicitly stated in the silviculture plan or prescription.

3.1.1.1.2 Order of Species

While there is great significance in the designation of preferred and acceptable species, there is no significance in the order (or relative position), in which they are recorded in the stocking standards section of the silviculture plan or prescription.

3.1.1.1.3 Species in Parentheses

Some older pre harvest silviculture prescriptions, or silviculture prescriptions, used a method of placing parentheses around those species that would be restricted to a certain percentage of the minimum-stocking standard.

For example, upon review of an older silviculture prescription, Douglas-fir, spruce, and (western hemlock) are listed as the acceptable species in the stocking standards section. This would suggest that, when determining stocking status, only a small percentage of the minimum stocking standard could be comprised of western hemlock. The actual percentage must be specified in the

silviculture prescription. It is recommended to contact the local Natural Resource District office to identify the correct percentage for the era of the silviculture prescription. The maximum percentage of 'bracketed species ranged from 10 to a maximum of 30%.

3.1.1.1.4 "Double Standards"

Some older pre harvest silviculture prescriptions or silviculture prescriptions (found in the former Kamloops Forest Region in particular) contain two sets of stocking standard values. The most common format indicates one set of stocking standards for pure lodgepole pine stands and a second set for "other" species. The "Pli" standards are used where the silviculture label has 80% or more lodgepole pine; otherwise, the "other" standards are used.

3.1.1.1.5 Minimum Inter-Tree Distance (MITD)

The silviculture plan or prescription specifies a minimum horizontal inter-tree distance. All trees considered well-spaced and free growing must be at least this specified distance from other well-spaced or free growing trees. MITD is always measured horizontally between well-spaced stems. On steep slopes, attention to maintain a horizontal measuring distance is required.

If a minimum horizontal inter-tree distance is not specified, discussions may be required between the licensee and the Ministry of Natural Resource Operations. From 1994 to 1998 the default inter-tree distance was assumed to be 2.0m if it was not specified in the pre harvest silviculture prescription or silviculture prescription.

Some silviculture plans and prescriptions and Forest Stewardship Plans provide for the minimum inter-tree distance to be changed when certain conditions exist, (e.g. colluvial slopes, site preparation, planting).

3.1.1.1.6 Target Leader Growth

Through the late 1980's and early 1990's, silviculture prescriptions and pre-harvest silviculture prescriptions included a target leader growth or target leader length in the stocking standards. The intent was to ensure that not only enough trees were present on the site but that they were also growing at a minimum rate. A species-specific growth rate per year or per three-year period was common. The concept of minimum growth rates was replaced by the minimum free growing height in later silviculture plan or prescriptions.

Target leader growth is not a legally binding component of the stocking standards and compliance is not required.

3.1.1.1.7 Minimum Free Growing Height

Another change in the post 1994 era was the requirement for trees to be at least a minimum height before they could be considered free growing. If these values are not found or defaults referenced in the silviculture plan or prescription, then there are no legal requirements for a tree to meet this height specification. The only exception to this is if the surveyor is using the revised free growing guidelines found in Appendix 8 of this manual or Appendix 9 of the Establishment to Free Growing Guidebook, in which case, a minimum height is required.

The addition of minimum free growing heights and the application of relaxed definitions of "competing vegetation" are the only adjustments to be made to the standards if the Free Growing Guidelines are applied.

3.1.1.1.8 Adjustment of the Early Free Growing Dates

The subject of changing the early free growing date, also known as the "sliding rule" is discussed in the Establishment to Free Growing Guidebook page 35. This concept is applicable where an early free growing date is specified in the silviculture plan or prescription. It encourages licensees to conduct prompt reforestation activities by allowing the early free growing date to be moved earlier. It may be moved back an amount equal to the amount of time the regeneration requirements were met before regeneration date. For example, if the regeneration plan provides a 4-year regeneration date and the licensee shows the standards unit is SR in year 3, the early free growing date can be moved one year earlier. This has no effect on the late free growing date. Woodlot site plans were not required to include an early free growing date, but some did. For blocks under Silviculture prescriptions or woodlot site plans, an amendment requiring approval is necessary to adjust the early free growing date. For blocks under a Forest Development Plan (FDP) site plan, an amendment requiring approval to an FDP stocking standard may also be required to adjust the early free growing date.

The District Manager has the option to decline the application of this concept such as, where forest health issues risk the continued free growing status.

3.1.1.1.9 Minimum Age of a Free Growing Tree

There is no legally required minimum age of a free growing tree unless it is specifically stated in the silviculture plans and prescriptions.

One exception is for surveys on single tree selection systems, generally drybelt Douglas fir. The Establishment to Free Growing Guidebook indicates that free growing trees must be on site for 5 years and be 40 cm tall.

3.2 Preliminary Stratification

The office review uses the information found in the opening file, in the silviculture plan or prescription and in the corporate database or RESULTS as the basis for the preliminary stratification. The data found on file, including imagery, previous surveys, previous treatments, and other maps provides the background for an opening and can help give an initial impression of what can be expected. This is a critical first step in the survey process.

The first step in preliminary stratification for any regeneration delay, stocking or free growing survey is to identify the standards unit(s) (SU) described in the silviculture plan or prescription. Each SU has distinct survey parameters and must be surveyed independently of the others to ensure legal stocking and free growing requirements have been achieved. SUs are then subdivided, or stratified based on silviculture survey stratification criteria such as forest cover, stocking status, forest health factors, treatment reasons, etc. Additional stratification may be required based on a re-evaluation of the biogeoclimatic ecosystem classification where the classification impacts stocking standards or site index determination. This must be done with

special care since it may result in the need for an amendment to the silviculture plan or prescription.

In a few exceedingly rare cases, it is possible to survey two standards units as one stratum. This is only possible if all the factors of the stocking standards in the silviculture plan or prescription are identical and the two areas are significantly similar (not different enough to be stratified).

Scenario Example: An example map has been provided in Figure 2 to assist with the description of preliminary stratification.

The crosshatched area is Standards Unit 1; the dotted area is Standards Unit 2. These two halves of the opening have different stocking standards.

Regardless of any other subsequent stratification, the boundary between stratum A and stratum B must be maintained.

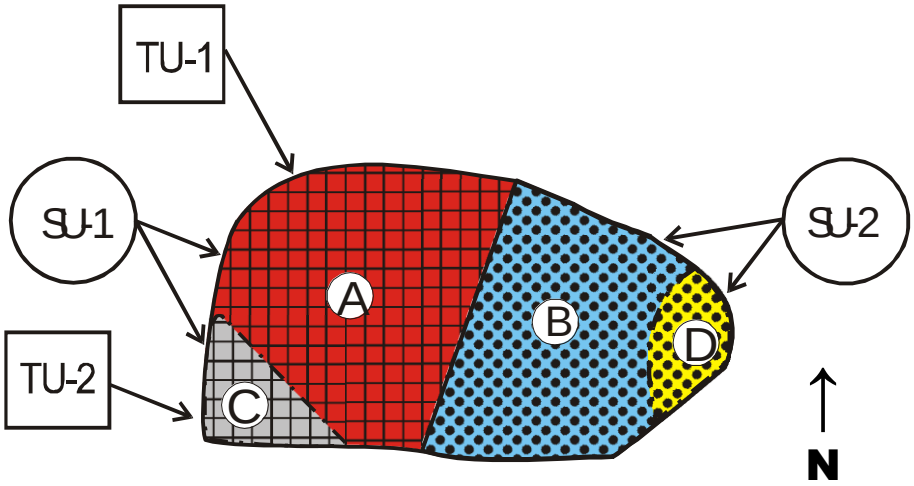


Figure 2: Preliminary Stratification

In this silviculture prescription, SU 1 has two Treatment Units (TUs). The stocking standards for TU 2 are the same as TU1, but TU2 has a restriction for no ground-based machinery to be used. We can suspect there may be something different about this area. Therefore standards unit 1 is tentatively split into 2 strata, A and C. Once the walk-through has been completed, this stratification will be either confirmed or eliminated.

Upon further review of the information on file, the satellite imagery indicates a lighter color in the eastern edge of SU 2. The cause is currently unknown. This portion of stratum B appears to be different than the remainder of the stratum. Stratum D is therefore noted and will be investigated during the walk-through.

This and other preliminary stratification will be reconsidered during the walk-through. The standards unit boundary is not reconsidered; it remains fixed unless an amendment to the silviculture plan or prescription is prepared.

Figure 3 provides the final stratification for our fictional opening. During the walk-through it was confirmed that stratum A and C are significantly different. As a result of the machine free

restriction, the understorey of previously suppressed balsam was not damaged during harvesting or mechanical site preparation. There is a higher component of balsam, in the southwest corner and as a result the inventory label will be different. Stratum C is retained and surveyed separately from stratum A.

Stratum D turned out to have a higher percentage cover of grass than the remainder of the east half of the opening. While it appeared as a different color, the satellite imagery used was not recent. The free growing trees have grown since the imagery and are now unaffected by the difference in herb species or grass species on this stratum. The stratification, prior to establishing plots has been finalized as seen in the figure below.

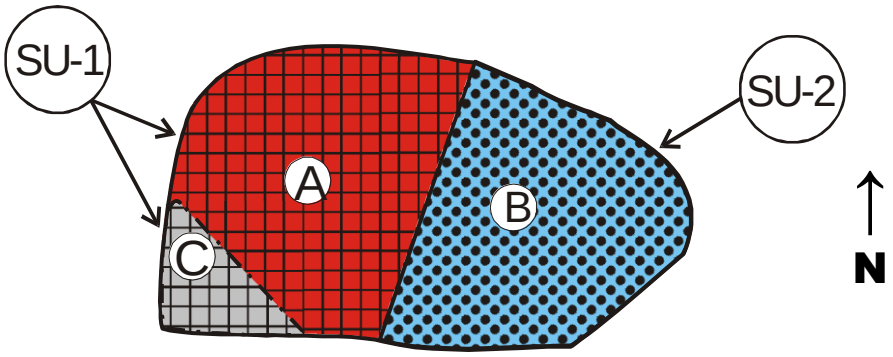


Figure 3: Stratification Following the Walk-through

Take note that even if the current characteristics of stratum A and B are identical, these are two separate standards units and therefore must be surveyed as separate strata.

Stratification based on an assessment completed while walking the block to establish plots is not the most recommended practice but is the usual practice if a walk-through is not completed prior to plot establishment.

3.3 Regeneration Delay Surveys

Tally Method: Tally the number of trees within the plot by species that meet all of the acceptability criteria and the minimum inter-tree distance requirements, **including those that exceed the M-value,** and record these in the appropriate species columns of the FS 658 (field number 96).

In the TOTAL W column (field number 99), record the sum of preferred and acceptable well-spaced trees in the plot, up to the maximum per plot indicated on the FS 657 (M-value). If the maximum is reached, or exceeded, record the letter “M” rather than the numeric value.

Follow the arithmetic procedure on the FS 659 .

Surveyors are expected to produce silviculture labels as part of the survey report. The details of silviculture labels are described later in this document.

This method is also recommended for use in stocking surveys.

3.3.1 Well-spaced Trees Definition

Trees that contribute to stocking are defined as well-spaced and represent the crop tree subset of all the trees in a plot. These are the trees most likely to form the managed portion of the new crop and will likely need additional time to meet the requirements of a free growing tree. Over the years, as legislation has evolved, so has the definition of the well-spaced tree. The current legislation has no definition of a well-spaced tree. There are two well-spaced tree characteristics to consider that will be mandatory once this well-spaced tree grows to free growing status. These mandatory factors are:

- the preferred or acceptable species listed in the silviculture plan or prescription
- at least the minimum inter-tree distance as specified in the silviculture plan or prescription from any other tree that is recorded as a well-spaced tree

Local Natural Resource District specific criteria may be applicable to well-spaced tree criteria and if authorized by the District Manager, the surveyor must consider them. The intent is to apply criteria that increase the likelihood for the trees selected as well-spaced to survive and thrive to a free growing status. These may be developed cooperatively by local silviculture practitioner steering committees, including joint stocking standards working groups. Guidance provided may specifically include:

- minimum age and/or heights.
- suitable growing microsites.
- forest health criteria.

The Free Growing Damage Criteria, outlined in the FS660, do not apply to well-spaced trees. However, many damage agents that affect well-spaced trees at the regeneration stage will likely affect the same trees at the free growing stage. For example, if mistletoe is found on a young tree, it will persist through to the free growing stage and beyond.

As a result, it is highly recommended to consider the criteria when selecting well-spaced trees during all surveys. Do not take trees as well-spaced if they will not survive or meet the damage criteria at the free growing stage. This is important to avoid misleading the licensee regarding the health of the stand and to ensure a free growing stand can be achieved.

3.3.2 Advance Regeneration Definition

Advance regeneration is defined as trees that are present on an opening that were established prior to the disturbance that created the opening. They may make up all, part, or none of the reforestation obligation. They may also be present on the opening as part of a strategy to increase biodiversity or to maintain visual quality objectives.

These trees may only be tallied as well-spaced and/or free growing trees if they meet the criteria specified in the silviculture plan or prescription.

Where acceptability criteria have not been included in the silviculture plan or prescription or where there are no regional guidelines, the best management practice is to consult the acceptability criteria found in the current FS 660.

3.3.3 Combined Stocking and Free Growing Surveys

A stocking survey often collects free growing data as well. This is done to provide useful information to the silviculture manager regarding the progress of the opening. In some cases, the block may turn out to be free growing. When this occurs, the free growing data is used in the silviculture label and a free growing declaration may be made.

The reciprocal is also the case when stocking information is also collected during a free growing survey. If the survey finds that the opening is not free growing, the stocking data is used in the silviculture label.

As the objective of the stocking survey is to maximize the number of preferred and acceptable well-spaced stems, while the objective of the free growing survey is to maximize the number of free growing stems, the free growing trees selected in a plot will not always be a subset of the well-spaced trees selected during a stocking survey.

3.4 Free Growing Surveys

Tally Method: Tally the number of free growing trees within the plot by species that meet the free growing height, quality, health, minimum inter-tree distance and vegetation free requirements, **including those that exceed the M-value** and record in the appropriate species columns of the FS 658 (field number 97).

In the TOTAL FG column (field 100), record the sum of preferred and acceptable free growing trees in the plot, up to the maximum per plot indicated on the FS 657 (M-value). If the maximum is reached, or exceeded, record the letter “M” rather than the numeric value.

Surveyors are expected to produce silviculture labels as part of the survey report. The details of silviculture labels are described later in this document.

Free growing trees are described when the stratum is found to be free growing. If it is not free growing, then the well-spaced trees are described.

Even with a thorough walk-through, the stocking status of many strata will remain undetermined thus it is generally preferable to record two separate rows of data on plot cards: one row to describe well-spaced trees and a second row for free growing tree data. Once the data collection has been completed and statistics calculations completed, the most appropriate data can be summarized.

Follow the arithmetic procedure on the FS 659 .

3.4.1 Free Growing Definition

Free growing trees are the subset of well-spaced trees that not only meet the minimum free growing height criteria, but are healthy, with growth not impeded by competition from plants, shrubs, and other trees. It is the stand of trees that we can expect to produce a commercially valuable crop tree. The assessment process is conducted at two levels: at the tree level and at the stratum level.

3.4.1.1 Tree Level

A free growing tree meets the criteria of a well-spaced tree and the following additional criteria:

- Is it free of unacceptable levels of forest health damage?
- Is it free of unacceptable levels of vegetative competition (herb, shrub, or broadleaf tree)?
- Has it achieved the minimum Free Growing Height?
- Does it meet any additional criteria explicitly stated in the silviculture plan or prescription for the area?

3.4.1.2 Stratum Level

At the stratum level surveyors consider the following questions:

- Are there sufficient free growing preferred plus acceptable tree species per hectare?
- If specified in the silviculture plan or prescription, are there sufficient free growing preferred tree species per hectare?
- If specified in the silviculture plan or prescription, are there less than the maximum density value of countable conifers present?
- Has a brushing treatment recently been completed? This is not a mandatory requirement under FRPA, but it is a recommended "best practice" to leave a post-brushing treatment waiting period (section 2.1.3) given the significant risk of re-sprouting in certain ecosystems.

3.4.1.3 Recording Unacceptable Species as Well-spaced or Free Growing

It is suggested, but not required, to record well-spaced or free growing species that are performing well on the opening but are considered unacceptable according to the silviculture prescription or site.

The surveyor must always maximize the plot with the preferred and acceptable species before tallying any unacceptable species. Unacceptable species must be recorded and compiled separately to avoid any potential confusion with the preferred and acceptable species.

The intent of tallying unacceptable species is primarily for treatment recommendations. Tallying unacceptable species will also provide justification when recommending an amendment to allow the unacceptable species to be considered as an acceptable species on the opening.

3.4.2 Procedures for the Assessment of Vegetation Competition

3.4.2.1 Background

A "free growing stand", as defined in the *Forest and Range Practices Act* (FRPA), is:
"a stand of healthy trees of a commercially valuable species, the growth of which is not impeded by competition from plants, shrubs, or other trees."

The intent of the free growing concept is to identify the point at which a managed stand is not being impeded by brush and can reasonably be expected to continue development to maturity without significant additional intervention. At this stage, liability and responsibility for free growing stands reverts from the obligation holder to the Crown.

In this section and the subsequent Appendix 8, guidance has been provided for regionally specific competition threshold criteria of acceptable vegetation competition in conifer stands.

These free growing criteria are not a competition index or a decision tool for treating stands. Rather, they identify a desired state of the free growing crop within the free growing assessment period, which represents an "acceptable" level of risk to the Crown.

3.4.2.1 Vegetation Categories

The risk that future treatments will be required will vary depending on the type of vegetation and the maturity of the crop tree. The following illustration shows the relative risk as a function of potential height growth over time for each vegetation type.

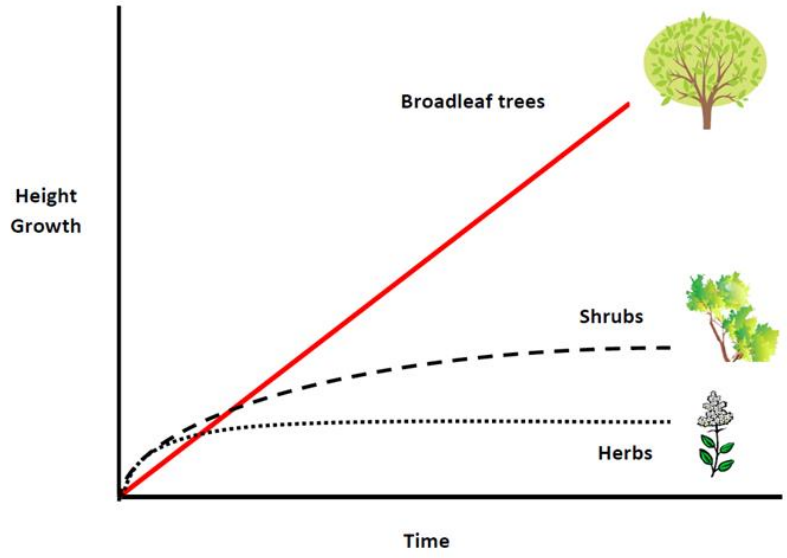


Figure 4a: Relative height growth over time per Vegetation Category

For this reason, acceptable levels of vegetation within the effective growing space of a crop tree should be evaluated, in each free growing plot, under the following three broad categories:

1st

Shrubs and Herbs Vegetation communities ***without broadleaf*** tree competition (e.g., willow, fireweed)	
2nd	2nd
Interior Broadleaf vegetation communities that include ***aspen, birch, and upland cottonwood***	**Coast Broadleaf** vegetation communities with ***red alder, big leaf maple, and cottonwood*** (coastal form)

This conceptual approach to evaluating vegetation types separately is incorporated into the competition guidance contained in the Appendix 8 section of this manual.

3.4.2.2 Competing Vegetation Evaluation Methods

Licensees with free growing obligations have two options available for evaluating competing vegetation:

- Use the competition criteria and procedures in an **approved Forest Stewardship Plan or Site Plan;**
- Use the **Local Geographic Competition Assessment Criteria** described below and in Appendix 8 for the appropriate region.

For standards units without established stocking standards or competition criteria, the default Crop/Brush Ratios in the Reference Guide for FDP Stocking Standards may be used.

3.4.2.1 Local Geographic Competition Assessment Criteria – Appendix 8

Appendix 8 provides an opportunity to count some crop trees as free growing when the crop tree is less than the required height above the broadleaf tree or other vegetation.

The competition keys are separated in 3 broad geographic regions. These rough separations are based on:

1) Different Broadleaf species (i.e., red alder on the Coast and aspen in the Interior); and
2) Different Broadleaf species competitiveness relative to the local ecologies (i.e., aspen is more competitive in the North Area than in the South Area)

Within these regions, the competition criteria also vary by BEC variant, site series, and species.

3.4.2.1.1 How to Assess Free Growing Trees

To determine whether a crop tree is free growing using Appendix 8, surveyors must understand:

- the quadrant method
- countable broadleaf trees
- allowable number of countable broadleaf trees

3.4.2.1.1.1 The Quadrant Method

The quadrant method is used to determine whether a crop tree in the immediate vicinity of non-broadleaf tree vegetation is free growing. It is also used to determine whether a crop tree in the immediate vicinity of broadleaf tree vegetation is potentially free growing. The following three steps describe the quadrant method.

1. Divide the 1 m radius cylinder around the crop tree into four equal quadrants. Note: The cylinder extends upwards, beyond the height of the crop tree being assessed.

2. Rotate the cylinder to minimize the number of quadrants that contain vegetation taller than the crop tree (including broadleaf trees, shrubs, or herbs originating inside and outside the cylinder).

3. Determine the number of quadrants containing vegetation taller than the crop. Quadrants cannot be split or divided.

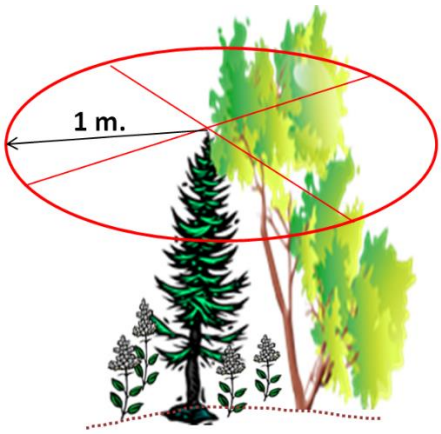


Figure 4b: North Region- The FG crop tree is taller than the shrubs/herbs in 3 of 4 quadrants.

3.4.2.1.1.2 Countable Broadleaf Trees

Countable broadleaf trees are assessed in the $50m^2$ (3.99m radius) survey plot.

Broadleaf trees that originate from below the ground level are considered countable if they exceed the median height of the potentially free growing trees.

3.4.2.1.1.2.1 Broadleaf tree clumps

The crown area of multiple stemmed broadleaf trees is larger than that of single-stemmed individuals. However, the total crown area and competitive effects of a multiple stemmed tree are often not as large as those of the same number of single-stemmed trees.

As a result, Table 1a should be used for broadleaf trees originating from a cut stump or stem to determine the number of countable broadleaf trees.

Note: This principle applies only to the determination of a free growing tree. It is not used in the assessment of total trees.

Number of Stems	Number of Countable Broadleaf Stems (for FG assessment)
1	1
2-5	2
6+	3

Table 1. A comparison of multi-stemmed birch, aspen, cottonwood, or red alder originating from above-ground stems/stumps to the number of countable broadleaf stems.

Figure 4c. Numerous broadleaf stems originating from a stump and from below ground root suckers.
Left: Three stems originating from a birch stump would be counted as two countable broadleaf trees. For the inventory tree tally by species, they would be tallied as three birch.
Right: Three aspen stems originating from below ground aspen root suckers are counted as three countable trees (if taller than the median height of the potentially free growing crop trees). For the inventory tree tally by species, they would be tallied as three aspen.

3.4.2.1.1.3 Allowable Number of Countable Broadleaf Trees

Certain biogeoclimatic subzones, variants, and site series allow a small quantity of countable broadleaf trees within the 3.99m radius plot without impacting the status of potentially free growing trees.

If the number of countable broadleaf trees (section 3.4.2.1.1.2) is less than the number of allowable broadleaf trees for the given species and biogeoclimatic subzone/site series, then the

potentially free growing trees are free growing. If the number of countable broadleaf trees exceeds the allowable level, then the potentially free growing trees will be not free growing.

The number of countable broadleaf trees does not affect the status of free growing trees that meet the required site plan's crop to brush ratio (and all other free growing criteria).

3.4.2.2 Miscellaneous

3.4.2.2.1 Mature broadleaf trees (Layer 1)

Layer 1 (≥ 12.5 dbh) broadleaf trees are considered **non-competitive** when using the quadrant method for assessing free growing conifers if their collective basal area is <8m2.

3.4.2.2.2 Vegetation Management

A free growing survey should not be completed immediately following a vegetation management treatment. The vegetation must be given time to recover before a realistic assessment of free growing can be made. The recommended periods vary based on perceived differences in conifer growth rates and brush re-invasion rates in each zone.

Biogeoclimatic zone	Number of years[1]
ICH, IDF, MS, PP, BG, SBPS, CWH, CDF, MH, and ESSF	2
SBS and BWBS • following herbicide treatment • manually or otherwise treated	 2 3

3.4.2.2.3 Mixedwood or Broadleaf Stocking Standards

The concepts of "potentially free growing" and "allowable countable broadleaf trees" do not apply to standards units with acceptable or preferred broadleaf species in their stocking standards. In such units, the "crop to brush ratio" simply applies to conifers.

To be free growing, the preferred or acceptable broadleaf trees must be well-spaced and meet the broadleaf damage criteria. The requirement of being free from brush does not apply to broadleaf trees in this situation.

3.4.2.2.4 Conifer to Brush Ratios

The two most common conifer-to-brush ratios are 125% and 150%, although others may be present in silviculture plans or prescriptions.

For example, if a Sx crop tree is 1m and the ratio is 150%, the vegetation must be less than 0.66m tall within the 1m radius cylinder.

The conifer-to-brush ratios are used in the Appendix 8 keys.

They can also be used alone to assess free growing status. This was the only method available from 1994 to 2000 (Post 1994- Silviculture Practices Regulation Era).

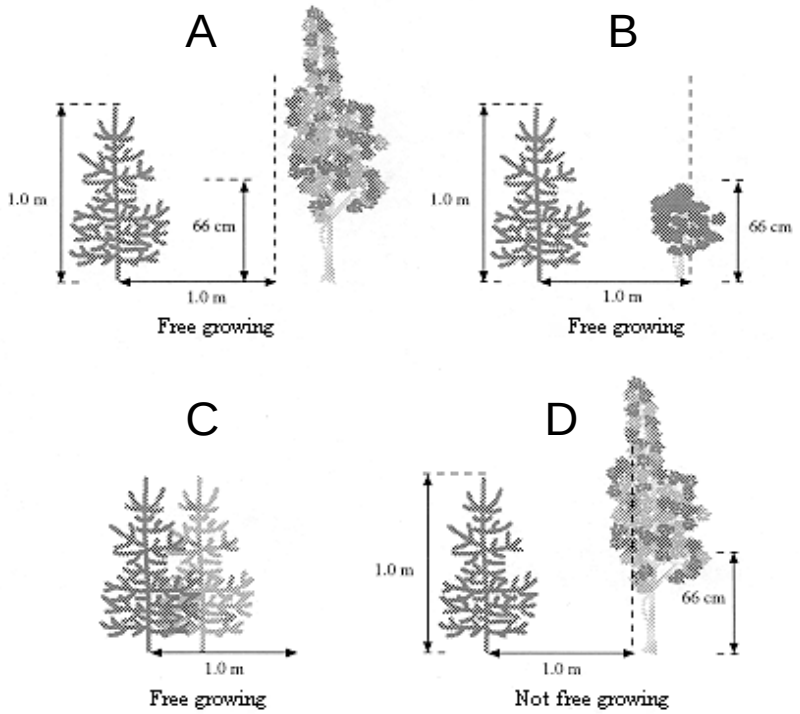


Figure 4d: Examples of free growing determination with a Conifer to Brush ratio.

Example A: The crop tree is free growing because there is no vegetation within a 1m radius.

Example B: The crop tree is free growing because the crop tree is 150% or more the height of the tallest competing vegetation within a 1m radius of the crop tree.

Example C: The crop tree is free growing because there is no competing vegetation taller than 66cm (150% the height of the conifer) within a 1m radius. Other conifers are not considered as competition at this stage. They are considered at the stratum level with maximum density.

Example D: The crop tree is not free growing because the crop tree is not 150% or more the height of the tallest competing vegetation within a 1m radius of the crop tree. Any encroachment of vegetation within the 1m radius cylinder makes the crop tree not free growing. This may be as little as a single leaf or other relatively minimal vegetation.

3.4.2.2.5 Establishment to Free Growing Guidebooks

The current "Two Free Growing Methods" period started in 1999. It was formalized in 2000 and incorporated into the Establishment to Free Growing Guidebooks.

For more information on assessing vegetation, please refer to Appendix 9 of the Establishment to Free Growing Guidebook.

The Guidebook provides more background information, examples, and graphics.

3.4.3 Maximum Density

The term maximum density is used to describe a tree density threshold, above which the licensee responsible for an opening is obligated to conduct a juvenile spacing treatment prior to declaring a stand free growing.

The term repression level, as used in early silviculture prescriptions, has the same meaning as our current definition of maximum density.

3.4.3.1 Forest and Range Practices Act (FRPA) era Opening

For those areas managed under a FSP or WLP, maximum density levels approved within the plan will apply. If a FSP or WLP does not have a stated maximum density, then there is no default maximum density that applies.

The responsibility to conduct juvenile spacing treatments depends on the content of the Forest Stewardship Plan for areas:

- Harvested after January 31, 2004
- Under an FSP
- Areas where the FSP has specified that FRPA FSP stocking standards apply.

In June 2022, the Chief Forester released a memo containing maximum density guidance. The memo has been posted on the Silviculture Survey Reference Documents webpage.

The primary recommendation was, *"When considering maximum density in the context of even-aged stocking standards, Delegated Decision Makers should discourage the inclusion of maximum density thresholds in forest stewardship planning."*

In response to this updated guidance, many licensees are expected to amend their FSPs to remove any reference to maximum density thresholds.

3.4.3.2 Forest Practices Code (FPC) era Opening:

Density levels must be controlled as per the densities prescribed in the approved SP or PHSP. If the SP or PHSP does not state a maximum density or repression level, default densities would apply, as described below. For Woodlot Licensees, the maximum density thresholds are outlined in WLFMR sec 78(7) – which parallel the approach listed below.

If the silviculture prescription was approved on or after April 1, 1994, and the number of countable conifers per hectare exceeds 10 000 or a number specified by the regional manager, prior to the free growing date, the number of conifers must be reduced to within the range specified in the silviculture plan or prescription.

For silviculture prescriptions or site plans approved before April 1, 1994, that state a maximum density or repression level, spacing is required if the density of lodgepole pine or drybelt Douglas-fir exceeds 10 000 per hectare or a number specified by the District Manager.

Maximum density thresholds have been changed by the Regional Executive Directors of the northern and southern interior:

- The Northern Interior Forest Region, in August of 2007, redefined the thresholds for the maximum density juvenile spacing obligation by a licence to:
  - 20,000 countable conifers per hectare where lodgepole pine is >80 in the inventory label,
  - 10,000 countable conifers per hectare all others

- The Southern Interior Forest Region, in February 2006, redefined the thresholds for the maximum density juvenile spacing obligation by a licence to:
  - 25,000 countable conifers per hectare where lodgepole pine is >80 in the inventory label,
  - 10,000 countable conifers per hectare all others.

3.4.3.3 Forests for Tomorrow (FFT) and the use of the Repression Density Decision Key (RDDK)

Forests for Tomorrow (FFT) and industry stakeholders have invested considerable efforts in reviewing the funding criteria for juvenile spacing activities proposed on areas under the FFT program's responsibility. Decision-making tools have since been developed by experts and specialists in collaboration with the government and industry to help guide economically sound decisions about when and where to conduct juvenile spacing treatments.

Stand-level repression is influenced by high initial densities, low site quality, and initial disturbance type. Post-wildfire regenerated stands are more likely to experience repression at lower densities than post-harvest regenerated stands, due to swift and abundant germination after a wildfire event. Although trees continue to grow, they do so at a slower rate, as if the site quality or productivity has been reduced.

To identify the most suitable stands for spacing, the Repression Density Decision Key was developed to interpret the loss of site index and consider the costs of treatments and the probability of those stands recovering from growth losses if juvenile spacing treatments were conducted

> The Pre-stand Tending Survey and Prescription Development Standard for Repressed Stands Eligible for FFT Funding document guides the survey procedures and prescription development expectations for repressed stands eligible for FFT funding. This survey standard highlights specific changes to survey plot sizes, estimates of site index, and definitions of 'countable conifers' to include dominant and co-dominant tree counts. This survey standard specifically links to the Repression Density Decision Key to develop treatment recommendations.

Additional silviculture survey activity standards, specific to the Forests for Tomorrow program, including post wildfire assessments, can be found on the FFT website.

3.4.3.4 Countable conifers

When determining if the total number of conifer trees (TC) exceeds maximum density, an understanding of countable conifers is required.

> It is irrelevant to collect countable conifer data in the following cases:
> - If a maximum density is not listed in the stocking standards or
> - For areas where the number of countable conifers is well below the maximum density.

The following methodology steps are used for determining the number of countable conifers:

For even aged silviculture systems:

1. Determine the median height of the **well-spaced** trees in the plot. The surveyor should tally the tallest well-spaced trees. It is not required and can be detrimental to tally more well-spaced trees than the M value .
2. Where the median height is:

- ≤2 m, the countable height is 30% times the median height as determined in step 1.
- >2 m., the countable height is 50% times the median height as determined in step 1.

3. Countable conifers are either:

I. All the lodgepole pine or drybelt Douglas-fir above the countable size calculated in step 2 for all those silviculture prescriptions or site plans approved before April 1, 1994, **or**

II. All conifers taller than the countable size calculated in step 2, for all those silviculture prescriptions or site plans approved after April 1, 1994, but not under a Forest Stewardship Plan, **or**

III. Other maximum density and or countable conifer definitions that may be specified in Forest Development Plans or Forest Stewardship Plans.

For stands managed on a single tree selection basis:

1. All conifers in layer three (>1.3m tall but <7.49 cm dbh) contribute toward the maximum density determination and are considered countable conifers.

3.4.3.4.1 Median Height Determination Procedure

Median height, as it is used for countable height is defined as the “middle” height.

Procedural Steps:

1. Identify up to the M-value number of well-spaced trees in the plot (best to select the tallest well-spaced trees).
2. Determine the median height of the well-spaced tree. This involves measuring all the well-spaced trees; arrange their values in order from smallest to tallest. Select the height of the middle tree, or the average height of the two middle trees.

Example: In the example below, figure 5, the countable height is equal to the measured height of tree number four, times 50%. 2.1 x 50% = 1.05m, or 105 cm. The trees taller than 105 cm are countable. Tree number 4 may or may not be a free growing tree, but it is one of the five well-spaced trees.

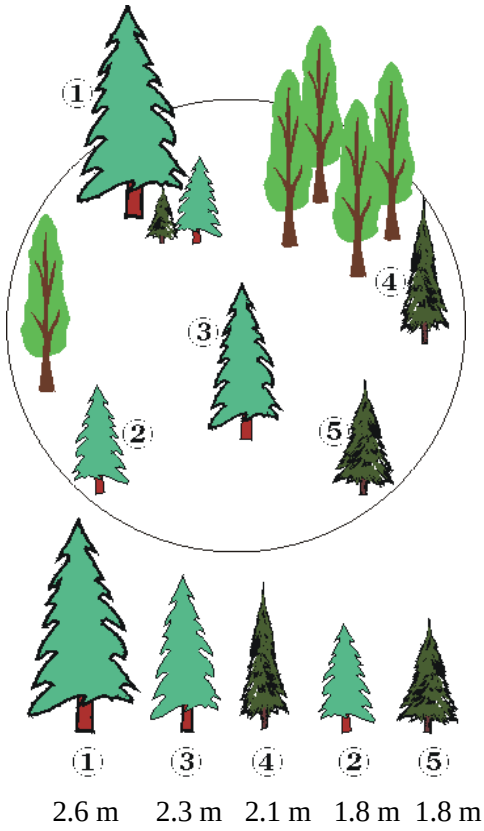


Figure 5: An example of median height determination with an odd number of free growing trees on an even-aged stand.

In the example below (Figure 6), the countable height is determined by the average of the measured heights of trees two and four, times 30 %. (2.1 + 1.8)/2 x 30% = 0.58 m or 58 cm.

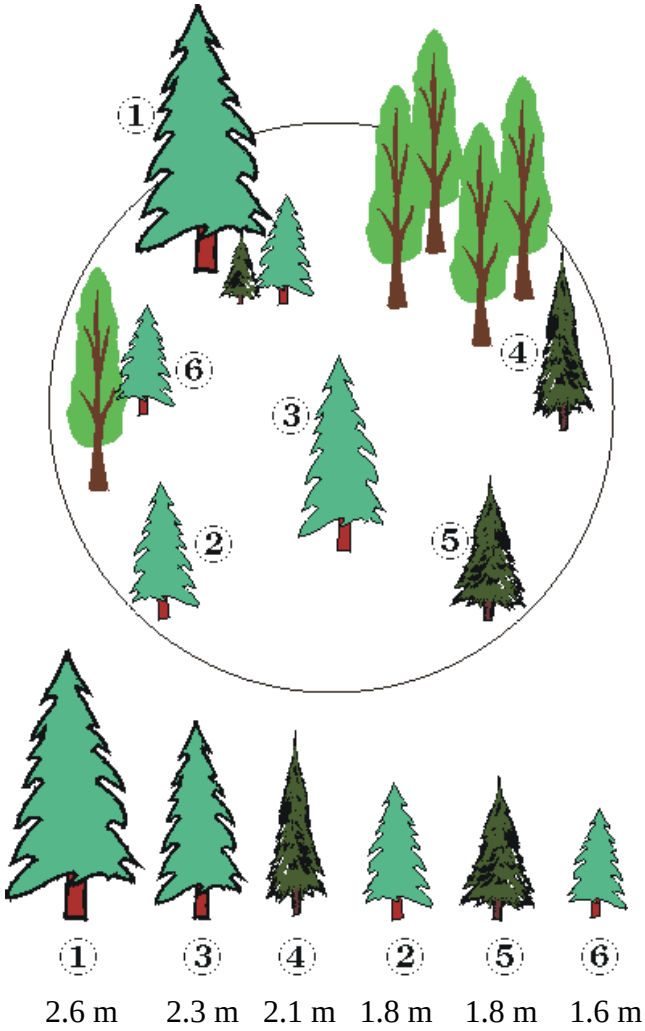


Figure 6: An example of median height determination with an even number of free growing trees on an even-aged stand.

3.5 Site Index

Site index (SI) is a measure of the growing potential of a site. Site index is defined as the average top height of trees, of a certain species, at fifty years breast height age.

Accurate site index values are required for inventory, timber supply analysis and silviculture decision making. In silviculture, site index is often used to select or rank sites for treatment, to prescribe appropriate treatments and to schedule these treatments. The reporting of site index is an integral part of an inventory label.

3.5.1 Methods to Determine Site Index

During the walk-through, a surveyor must decide which method will be used to determine the site index for each stratum.

There are five methods used to determine site index: growth intercept, SIBEC (site index by biogeoclimatic classification), site index curves, site class conversion and professional interpretation. These methods differ in their accuracy, availability, and data requirements. It is strongly encouraged to select the most reliable method for estimating site index. The two most common methods for silviculture surveys are SIBEC and growth intercept.

For help determining the most appropriate site index method, refer to section 31a of the FS660. 31b lists the approved site index source codes.

3.5.1.1 SIBEC

The BEC method is best suited to stands that have less than three-years growth above breast height and older stands not suitable for the growth intercept and site index curve methods.

With the BEC method, the SI for a stratum is predicted from its subzone and site series. If a standards unit or strata contains more than one site series, the SI estimate needs to be an area weighted average of the site series.

For example, you are surveying a Fdc leading stand in the CWH xm. During your walk-through, you confirmed the ecology from the site plan. The stratum is a mosaic: 60% 01 site series, 30% 03 site series, and 10% 05 site series.

You pull up the SIBEC table for the CWH xm:

Vancouver CWHxm

Site Series(*)	Name	Cw			Fd	
		#	SI	SE	#	SI
01	HwFd - Kindbergia		24.0		51	34.1
02	FdPl - Cladina					20.0
03	FdHw - Salal		20.0			24.0
04	Fd - Sword fern		28.0			28.0
05	Cw - Sword fern		24.0			36.0

Fdc's estimated site index varies across these site series. As a result, a proportional average based on percent area is necessary.

Fdc's SI = (34.1 * 0.6) + (24 * 0.3) + (36*0.1)
= 20.46 + 7.2 + 3.6
= 31.26
For this stratum, Fdc's site index is 31.26m

The BEC method produces SI estimates of moderate accuracy. The right site index estimate cannot be obtained without a correct site identification.

The SIBEC tables do not provide site index estimates for all species or all sites. If the leading inventory species is unavailable in the SIBEC tables and unsuitable for growth-intercept, then its site index should be predicted using site class conversion or by converting from another species (section 32 of FS660). A site class conversion table is included in Appendix A.

3.5.1.2 Growth Intercept Method

For detailed instructions, refer to *How to Determine Site Index in Silviculture* and *Growth Intercept Method for Silviculture Surveys*.

The Growth Intercept (GI) method is suitable for many stands aged 3 to 30 years breast height age. When correctly used, the GI method provides an accurate estimate of SI. However, the required input data (species, total height, and breast height age) are costly to collect and determining ages may damage crop trees.

The GI method should not be used in stands where sample trees have been:
- Overtopped by trees or brush.
- Seriously damaged or diseased.
- Cut out by spacing.
- Affected in height growth by a treatment (e.g., fertilization).

A tree species is suitable as a SI species for GI if:
- The dominant and co-dominant trees have at least 3-years growth above breast height.
- The growth intercept table is available.
- More than 500 stems/ha (total trees) are evenly distributed over the entire stratum.
- Sample tree height growth above DBH reflects site productivity.

If the stand or leading inventory species is unsuitable for growth intercept, the BEC method should be used to estimate site index of the leading inventory species.

3.5.1.3 Site Tools

The SiteTools 4.2 software is a user-friendly site index calculator for Windows that produces custom site index tables and graphs. It provides access to many site index related functions for 24 tree species in British Columbia. Some of the equations it handles include:

- Site index (height-age) equations
- Years to breast height equations
- Growth intercept equations
- Site index conversion equations

3.6 Basal Area Forest Cover Requirements – for all Milestones

Basal area (BA) is the cumulative cross-sectional area, represented in m^2, of the live trees, that are greater than or equal to 12.5 centimeters in diameter (Layer 1 trees), measured at breast height.

Best practice procedures for measuring basal area are contained in Appendix 4.

Basal area must be collected and reported (as a legal requirement) into RESULTS for Layer 1 stems, where the following situations and circumstances are present in a surveyed standards unit:

1) If the stocking standards in the silviculture plan or prescription require that a specific basal area per hectare be retained after harvest; or
2) For all SUs, regardless of the stocking standards, if the retained overstorey of Layer 1 stems are > 5 m^2/ha.

3.6.1 Layer 1 Inventory Component

If basal area is a required reporting attribute (in the situations mentioned above), a complete inventory for the Layer 1 overstorey is necessary.
The standards unit must be reported to RESULTS as a multi-layer stand. The understorey layers must be reported as Layers 2, 3, and 4, or as a combined understorey layer. The SU cannot be reported under Layers "I" and "S".

The forest cover attributes for the Layer 1 Inventory Component include:

- Species composition of Layer 1 trees (based on basal area)
- Age and height of Layer 1 trees (leading and secondary Layer 1 species)
- Crown closure of Layer 1 trees
- Density of Layer 1 trees (if status is IMM)
- Incidence Percent by Damage Agent for Layer 1 trees

To learn how to report a forest cover inventory for Layer 1 trees, please refer to *Submitting Forest Cover to RESULTS For Openings with Treed Retention.*

3.6.2 Layer 1 Silviculture Component

The mature Layer 1S represents residual stems that meet the leave tree criteria and specifications identified in the applicable stocking standard for the silviculture component.

The Layer 1 silviculture component needs to be submitted if:

- The Layer 1 trees contribute to the stocking obligation; and
- There is a difference between the silviculture and inventory components.

3.7 Dispersed Types

In some cases, strata in an opening may be better described by their characteristics rather than by their geographic location. When the walk-through identifies strata that are so distinctly different, but so intimately mixed that it is impractical to map the location of each portion of the strata, these can be surveyed as dispersed types. During the walk-through, the characteristics of each of the strata must be clearly and distinctively defined for application during the field data collection.

Dispersed types are considered at the time of a stocking survey when dispersed areas <1.0 hectare in size add up to a significant total area (approximately 2 or more hectares) and the survey demonstrates that the free growing status may be compromised. Examples would include numerous NSR holes or brush accumulations that are individually < 1.0 hectare in size each, but all together add up to a significant area over the entire SU.

Dispersed types are generally not recognized at the time of free growing. To do so would require accurate spatial data. The variability that may be present at the time of free growing due to dispersed types is addressed by increased plot intensity if required.

It is preferable that these dispersed strata are identified in the silviculture plan or prescription; if not an amendment to the silviculture plan or prescription may be required, if a change of the stocking standards for one or more of the strata is required.

Identifying an area as a dispersed type is not a replacement for proper stratification.

Dispersed strata must:

- have distinctively different characteristics that can be clearly described, and
- have occurrences of each stratum that are impractical to map (too small and numerous and/or too inter-mixed)

The following methodology is used to sample dispersed strata:

- clearly define the characteristics of each stratum.
- establish the number of plots in each stratum that are required to meet the desired statistical precision. Plots may have to be moved to ensure that they are fully located within a stratum. If a grid pattern sampling design is used, plots should be moved along the strip line in increments of 10m until the plot falls fully within one of the strata.
- estimate the proportion of the opening that is representative of each stratum.
- summarize the data for each stratum separately.
- record stratum labels on the map.

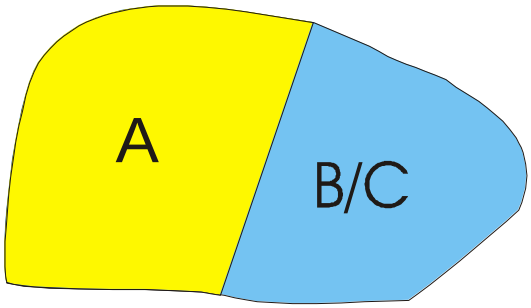


Figure 7: An example of dispersed strata map label

The determination of the area represented by each stratum is relatively complex. Further detail on how to determine the area of a Dispersed Strata is contained in Appendix 2. Area is expressed as a percentage of the combined total area of the dispersed strata. Area can be determined by either:

- visual estimate;
- photo interpretation;
- line intersect; or
- high intensity point sampling.

Visual estimates or photo interpretation are the simplest but are typically the least accurate.

Stratum		Proportion of Area Represented by Each Stratum	Area (ha)
A		n/a	8
B	} Combined Area 10ha	60%	6
C		40%	4
		Net Area to be Reforested	18

Table 2: An example of a dispersed strata area calculation

3.8 Walk-through

A walk-through is an initial reconnaissance of the opening. As the name walk-through implies, one of the most effective ways of conducting the walk-through is to physically walk-through the opening, visually noting the characteristics found on the opening. The procedure can often be completed by other methods such as all-terrain vehicles, UAVs, and aircraft.

This step in the survey process is often not performed to the formal level as outlined in this manual. This step is at the discretion of the surveyor and can often depend on the strength of the initial stratification, the surveyor's local knowledge of the opening being surveyed, and the time allotted to this step in the survey contract. It is recommended that all surveyors perform a walk-through or initial reconnaissance of each opening, but this is not a required step.

The walk-through is used to confirm a variety of site and survey decision information, including but not limited to the following:

- ecological classification
- stratification
- definition of dispersed strata
- survey objectives
- sampling method
- sampling intensity
- identification of the leading and second inventory species
- method of determining site index
- forest health factors present
- limiting factors
- potential treatments
- stand structure (even-aged, even-aged layered, DFP, SEDRSS, or multi-storey uneven-aged - as related to the stocking standards for the opening)
- dispersed retention with basal area exceeding 5 m^2/ha
- prism size used to capture basal area

3.8.1 Field Stratification

Stratification is the **most critical** step in the survey process. Stratification is the process of defining and identifying populations with similar characteristics within an opening. The objective of stratification is to increase sampling precision by delineating homogenous strata within an opening, so that there is less variation within each stratum than within the entire opening. Stratification is used to increase the efficiency of the survey by reducing the number of plots required per stratum to reach a desired sampling precision. Stratification can also improve the reliability of the treatment recommendations.

Stratification is required to meet the legal requirements specified in the silviculture plan or prescription. Silviculture prescriptions or site plans contain one or more standards units that are developed according to biogeoclimatic classification, site attributes and stand management objectives. If more than one standard unit is defined in the silviculture plan or prescription, these standard units must be stratified and surveyed separately.

These standards units (SUs are the first initial stratification criteria) are further sub-divided based on the following stratification criteria:

• stocking	NSR, SR, FG
• leading inventory label species for example, $Fd_{80}Ss_{20}$ vs. $Ss_{70}Cw_{30}$	Change of leading species,
• inventory species composition for example, $Fd_{90}Ss_{10}$ vs. $Fd_{60}Ss_{40}$	>20% difference,
• age class	>20 years difference between leading species*
• height class	>10 m difference between leading species*
• crown closure	>20% difference between strata
• site index	>3 m difference in SI 50
• treatment recommendations	
• stand structure	

*** Note**: These are the minimum requirements set by the Forest Analysis and Inventory Branch.

Forest health is a key component of stratification. Areas with treatable incidence levels of forest health factors should be stratified as a separate stratum, as should areas that are NSR or not free growing because of a high incidence of forest health factors.

The following two examples provide a comparison of the significantly different survey findings that correct stratification will result in. Figure 8 depicts the results of an un-stratified survey for a fictional opening. Figure 9 demonstrates the results of correct stratification for the same opening.

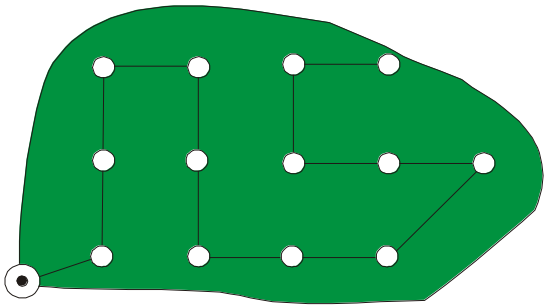


Figure 8: Systematically positioned plots without stratification

Well-spaced	750 ws/ha
Minimum stocking standard	700 ws/ha
Confidence interval	200 ws/ha
Recommendation	Establish more plots or Fill plant

The results of this survey without stratification are inconclusive.

After a thorough file review, preliminary stratification and walk-through, two strata were identified and sampled separately. The data from the thirteen plots indicate the following results:

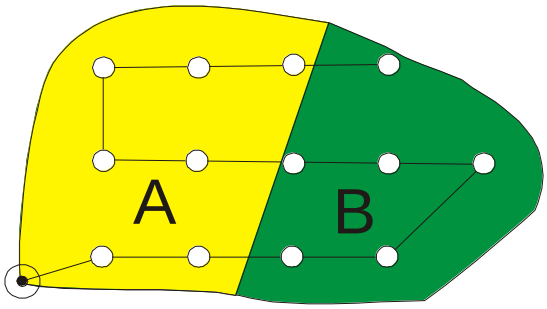


Figure 9: Systematically positioned plots after pre-stratification

Stratum A		Stratum B	
Well-spaced	1000 ws/ha	Well-spaced	500 ws/ha
Minimum stocking standard	700 ws/ha	Minimum stocking standard	700 ws/ha
Confidence interval	75 ws/ha	Confidence interval	70 ws/ha
Recommendation	**Satisfactorily restocked**	Recommendation	Fill plant

The results of the correctly stratified survey are more likely to provide definitive results and describe the condition of the current opening.

3.8.2 Ecological Classification

The ecological classification should be confirmed during the walk through. The classification completed during the preparation of the silviculture plan or prescription can be used as a likely reliable starting point for field verification. If there is a variation in the ecological classification from that of the silviculture plan or prescription, that will change the stocking standards, then an amendment should be recommended. Correct classification is also important where SIBEC is being used to assess site index.

3.8.3 SU Mapping Variation

During a walk-through it may become apparent that the standards unit boundaries as mapped in the silviculture plan and prescription do not match the location of the characteristics as they are found on the site.

The ability to see and accurately map terrain features and ecological classification is generally enhanced once the mature forest is removed during harvest operations. As a result, it is common to see more accurately the actual location of the intended standards unit boundaries after the opening has been harvested.

Standards unit mapping as found in the silviculture plan and prescription

Actual location of the standards units as found during the survey

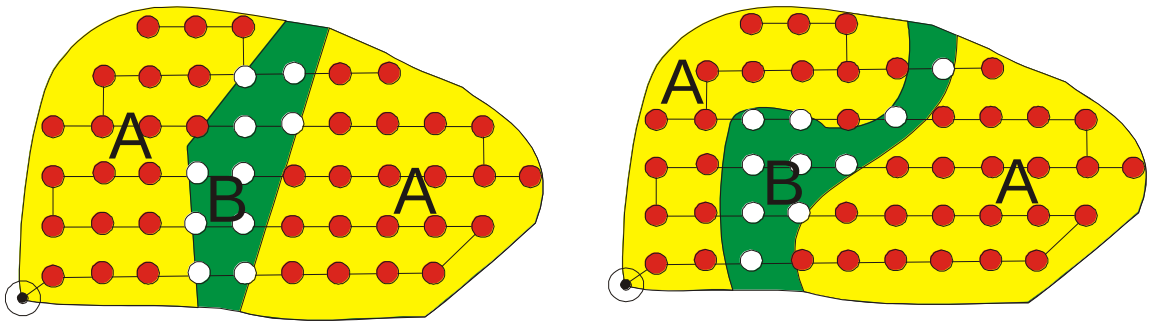


Figure 10: Standards unit mapping variation

The sample diagrams above show that the intent of the prescription was to recognize the presence of, for example, a wetter, low lying standards unit B. A portion of the block that meets the characteristics of standards unit B is identified and mapped during the walk-through. It is approximately the same size and position, yet noticeably different. If one were to follow only the standards unit map, many of the plots and their data would be summarized as representing the wrong stratum.

When the intent of the prescription is clear, surveyors are directed to update the standards unit mapping. The variation must be pointed out and consideration be given to the need for an amendment.

The magnitude of the difference will dictate the relative necessity to recommend an amendment. In the above example, the area represented by B is similar and therefore an amendment may be

of little value. In both, there are approximately 10 ha of the standards unit B. Generally, when a change in standards unit boundaries occurs, an amendment is required.

3.8.4 Preliminary Assessment of Forest Health Factors

During the walk-through, a preliminary assessment of forest health factors should be noted and recorded. The walk-through is done with less rigidity than the typical systematic survey grid pattern, allowing the surveyor to assess trees that have unusual color, vigour, or form. The forest health factors noted are recorded on the back of the FS 657 field card. A blank field card or tablet may also be used.

3.8.5 Site Index Determination Method

During the walk-through surveyors are expected to ascertain the most appropriate method for the determination of site index. The site index training materials describe the process in detail. In brief, the characteristics of the survey site are compared to the site index determination methods and the site index method is then selected.

3.8.6 Potential Treatments

While completing the walk-through it often becomes apparent to the experienced silviculture surveyor that a specific treatment, or treatments, will be required. As a result, additional data can be collected during the survey that will provide a more precise prescription for the subsequent treatment. For example, if few trees are identified during the walk-through, a planting project may be required, therefore the surveyor should take the extra time required to collect the additional data required to complete a planting prescription. The same can be said for anticipated site preparation, brushing and spacing treatments.

3.8.7 Minimum Stratum Size

The minimum stratum size is a complex composite of:

- legislative and contractual obligations
- operational feasibility
- biological practicality
- cost, benefit, and risk

In the Spring of 2007, strata size and distribution became specified in regulation:

- 0.25ha (mappable) for reserves and non-productive areas
- the entire standards unit for SUs less than 1ha
- 1 ha for post-harvest, regeneration, and free growing polygons

- 1-2 ha (max of 5% of the SU NAR) for mappable non-free growing polygons

  (except for woodlots)

The *Forest Cover Stratification and Milestone Declarations* document states:

- "Minimum stratum size is 1ha.
- The intent is to not consider long tendrils or amorphous thin amoeba-like units as being separate polygons; therefore:
- An understocked area is defined as an area where stocking levels, of well-spaced and/or free growing trees, are less than the minimum specified and is a minimum of 1ha in size.
- An understocked area must be at least 20m wide throughout its length and at least 20m from the nearest understocked area. If it is less than 20m from the nearest understocked area, they are considered contiguous."

The *Forest Cover Stratification and Milestone Declaration* document provides guidance and examples on the application of FPPR 46.11. It explains the critical difference between meeting obligations at regeneration delay and free growing. It demonstrates how 1-2ha non-free growing polygons can be maintained at free growing if less than 5% of the SU NAR.

NOTE: This document and FPPR 46.11 do not apply to woodlots since they are managed under the Woodlot License Planning and Practices Regulation.

A follow-up document to the *Forest Cover Stratification and Milestone Declaration* was posted on the Silviculture Surveys Reference Documents webpage in 2022. The new document, *Using Stratification to Achieve Non-Timber Values*, intends to:

-show how FPPR 46.11(2) can be used proactively to achieve non-timber objectives

-demonstrate how to strategically prescribe vegetation management

-provide guidance on silviculture surveying and RESULTS reporting

An accompanying presentation was posted on the BC Silviculture Surveys YouTube channel. The video sets the context, covers survey basics, explains FPPR 46.11, outlines strategies for retaining more broadleaf trees, and provides examples.

4 Sampling Principles

The current silviculture survey procedures have two survey principles at its foundation:

1. Identify strata
2. Gather data within each stratum

The data gathering principle has three sub-components

- Survey Objective
- Survey Method
- Survey Intensity

There are many sampling objectives, methods and intensities that can produce valid results, but they will only withstand an intensive review if stratification has been done correctly.

Forest management legislation requires a "forest cover inventory" to be produced through a survey but the survey methodology or intensity is not defined. The emphasis is put on the expectation for the survey to accurately represent the stand as opposed to the methods and intensity of the survey conducted. The results reported are expected to be significantly similar to those resulting from using the methods described in this manual.

4.1 Survey Objective

It is recommended that the survey objective be determined by the surveyor during the walk-through. The selection of the survey objective or objectives is based on a combination of the office and field observations.

Example: A licensee survey contract may indicate you are to conduct a free growing survey. During your walk-through you find significant mortality from a forest health factor. Not only is the stand not free growing, but in fact it is NSR. The licensee would likely not want a free growing survey completed, instead they would prefer stocking and plantability data collected.

4.2 Sampling Intensity

Sampling is performed where it is too time consuming to complete a full inventory. In the case of silviculture surveys, the time required to count every tree in a stratum is excessively costly compared to the relative accuracy required. As a result, we collect data from a relatively small number of small sample plots, and then average the data and project the information over the entire stratum.

The intensity of the survey should be adjusted to match the variability of the population. The surveyor must consider the variability of the inventory characteristics (i.e., total density, inventory species composition, basal area) and how close the silviculture characteristics are to an important threshold. If they are variable or close to a threshold, then a more intensive sample is required.

Example A: You conduct a walk-through of Stratum A of Opening 1234. You can see rows of 3m tall, planted trees. Survival was nearly 100% and forest health factors are very few. Natural regeneration and the competing vegetation are minimal. This stratum is very clearly free growing, and there is minimal variability in the inventory attributes. A light intensity survey would be acceptable.

Example B: You conduct a walk-through of Stratum B of Opening 1234. Stocking is patchy resulting from years of frost damage. Survival is better on the ridges, but poor in the depressions. Heights of the well-spaced trees range from 30 to 200cm. A more intensive and more structured survey methodology will be required to adequately sample this diverse stratum.

Example C: You conduct a walk-through of Stratum C of Opening 1234. You can see rows of 3m tall, planted trees. Survival was nearly 100%, competing vegetation is minimal, and there is no maximum density threshold. The stratum is clearly free growing. However, there are highly clumped, dense, non-stratifiable patches of natural infill of multiple conifer species. The inventory species composition and density are highly variable. A more intensive and structured survey methodology will be required than Stratum A to adequately sample this diverse stratum.

The better the stratification, the less plots will be required to achieve acceptable survey results. More plots will result in a tighter survey confidence interval; however, establishing large volumes of plots is not a substitute for inadequate stratification.

The minimum number of plots per stratum or polygon is 5. With a stratum ≥ 5 ha, initial layout should not exceed 1 plot/ha. There is no expectation to establish more than 1.5 plots/ha unless the stratum size is < 3.0 ha.

4.3 Plot Radius and Plot Multiplier

Circular plots with a known radius are integral to the sampling procedure. The most common plot radius for the collection of silviculture data is 3.99 meters. There is no mandatory requirement to use any specific plot size, but the 3.99m plot radius has become a commonly used sample size. A “rule of thumb” is to select a plot radius that will ensure four or more well-spaced crop trees will be found in the plot at target stocking.

A plot with a 3.99-meter radius has an area of 50 m^2. This is determined using the formula for calculating the area of a circle. A hectare is 10 000 m^2. This means that a 3.99-meter plot represents 1/200 of a hectare. The plot multiplier is determined by dividing 10 000 m^2 by 50 m^2. Therefore, the plot multiplier is 200. The same mathematical principles can be applied to a plot radius of 5.64 meters. The plot multiplier is 100. For a 1.26 m plot radius, the multiplier is 2000.

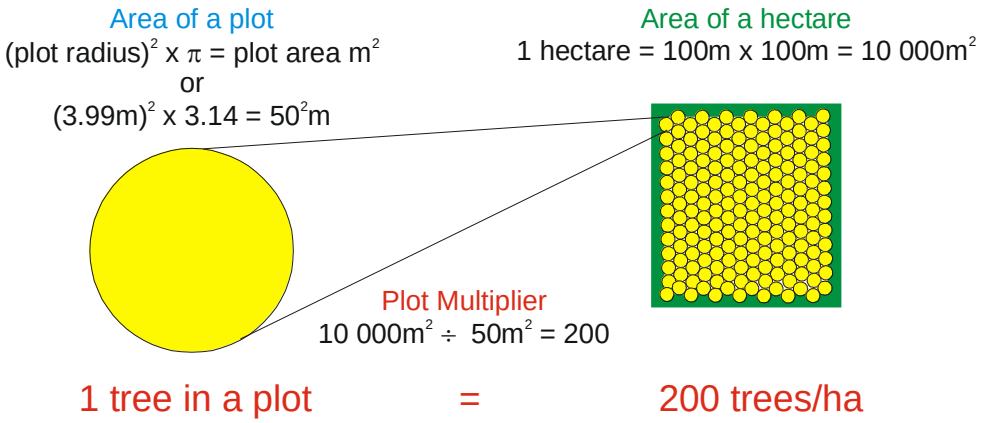


Figure 11: Plot multiplier concept

For a complete range of possible plot radii and their associated areas and plot multipliers, refer to Section 5 of the FS 660 card.

4.3.1 M-value

The 'M' in M-value represents maximum. That is, the maximum allowable number of well-spaced or free growing trees that may be recorded in a single plot.

- The M value is derived from the Target Stocking Standard (TSS) divided by the plot multiplier – it is not a value set or predetermined – and is solely a function of this equation.
- **Example:** If the TSS is 1200 and the plot multiplier is 200, the **M value is 6.**

The M-value is one of the principal factors considered within the formulation of stocking standards. The M-value acts as a cap on the number of trees in a single plot that can compensate for low stocking in other plots. Without the M-value, over stocked plots would overcompensate for under stocked plots. The result would be an unacceptable level of variation in stocking, or a 'patchy' stand. When stands of equal densities are compared, we find that the stand with an even distribution produces more volume over a rotation than the stand with a patchy distribution.

The subject of "M" value, its necessity in our survey system, and the effects of changing it are discussed in Land Management Handbook number 50.

The M-value is an integral part of the silviculture survey process and is essential to the determination of stocking, (NSR, SR or FG). The M-value, along with the minimum inter-tree distance and stratification criteria provide the District Manager with some measure of assurance that the regenerated stand is sufficiently consistent in its stocking distribution.

Example: Consider the following extreme data set:

Plot Number	**Number of Well-spaced Trees in Each Plot**	
	Without M	**With M**
1	11	6
2	11	6
3	11	6
4	1	1
5	0	0
6	1	1
Total	35	20
Average	5.8	3.3
Trees per hectare assuming 3.99m plots	**1167 tr/ha**	**667 tr/ha**
	Target Stocking Standard	**Minimum stocking Standard**
	1200	**700**

The example above depicts a situation where ignoring the M-value would produce a result of 1167 well-spaced trees per hectare. This would suggest a near fully stocked stratum. Utilizing the M-value suggests a stocked stratum is below minimum. In reality, this describes a stratum with patchy stocking levels and a great deal of variability in the stratum that may not have been stratified correctly.

4.3.2 Tallying in Excess of the M-value

Tallying trees in excess of the M-value was optional for many years. Some forest managers have expressed an interest in knowing the number of well-spaced and/or free growing trees without the limitations of the M-value. At the request of many licensee representatives this additional data was added to the mandatory reporting requirements for surveys submitted after December 31, 2004.

The stocking of a stratum is still determined based on the survey results which apply the M-value. The reporting of well-spaced or free growing **trees per hectare** in silviculture labels is also still based on survey results which apply the M-value. The process for calculating the **species composition** in the silviculture label includes all those trees in excess of the M-value.

4.4 Sampling Methods

A survey is reliant on:

1. Completion of stratification
2. Sampling of the resulting strata
3. Analysis of the statistical reliability of the data collected

The provincial survey system provides flexibility in selecting the sampling intensity and survey design. **The surveyor must complete correct stratification and consider the homogeneity of the silviculture and inventory attributes of each stratum.**

The establishment of plots is the basis for the statistical methods used in the survey. The requirement for a systematic pattern has often been stressed as important to the integrity of the sampling method.

The basis for statistics requires that all potential plots in the survey area **have an equal chance of being selected**. **The purpose of systematic locations for the plots is to ensure that there is no 'bias' in the collected data**. For instance, plots on rocky outcrops or in thick brush will be as likely to be chosen as plots in 'farm-field' spots. It has the added benefit of ensuring appropriate coverage and simplifying the mapping of the stratum.

The survey results should be similar between sampling methods and patterns. If they are not, then the selected method may not have been appropriate. The credibility of the survey results is only as good as the appropriateness of the sampling method and intensity chosen by the surveyor.

The key is selecting a sampling method and sampling intensity suitable for the complexity of the stratum being surveyed.

Considerations:

- Homogeneous populations can be adequately sampled with few plots and with less structured sampling designs.
- The less structured survey methods are more likely to have satisfactory results when completed by experienced surveyors.

The sampling method used is recorded on the bottom right corner of the FS 657 card, field 56.

The four methods, in order of decreasing structure, are: Grid Sampling, Vector Sampling, Representative Sampling and Visual Assessments.

Surveyors should be cautious using representative sampling or visual assessments for free growing surveys.

Licensees have an obligation to update the forest cover inventory at free growing. The information must be reported in a form and manner that is satisfactorily to the minister (FPPR 86(6)). District and provincial audits have indicated that precision standards are not being consistently met with ocular assessments or representative sampling. This is a compliance issue, and it has impacts on the program areas that rely on accurate inventory information.

4.4.1 Grid Sampling

The grid pattern method of plot positioning has historically been the most used method. It is the most structured of the methods and as such is often the most expensive. It has the advantage of being a systematic method which will provide accurate, reproducible results. It also provides proof that surveyor has walked over the strata being reported on. The grid system may be used with a low or high plot intensity, which should depend on the variability within the stratum.

The grid pattern method is effective where a larger number of plots are required in a stratum. The grid pattern results in a more predictable plot location.

Although one plot per hectare on a grid pattern was most used in past years, it is not a provincial standard.

The grid pattern can also be very effectively applied when few plots are required, by simply widening the distance between plots and or strip lines, in examples A and B below. Plots are positioned at equal intervals along pre-determined strip lines. The example D shows an offset grid pattern that is also acceptable. The key to maintaining the randomness of this sampling method is the arbitrary selection of the starting point and maintaining the systematic positioning of the plots. Bearings and distances are predefined at the beginning of the survey.

Pre-determined plot locations may land in non-productive (NP) areas. It is recommended to include a version of the following clauses in survey contracts, to give guidance to surveyors to adjust survey grid designs and to standardize field offset standards for plot locations:

- If established plots in the field are in un-mappable or mappable NP, then the plot should be offset a predetermined distance and bearing only ONCE (after this initial offset, if an issue of placement is still occurring, the plot will be dropped).
- The survey should continue the original grid design and NOT from the offset plot (to remain on the original survey design pattern).

NOTE: Do not move plots for any reason other than safety.

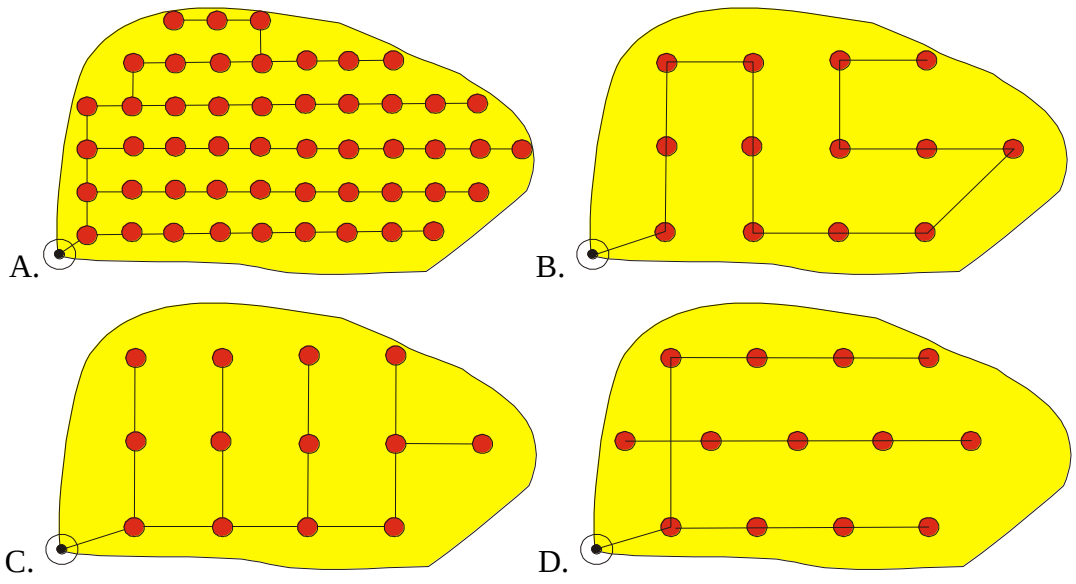


Figure 12: Examples of locating plots on a grid pattern

4.4.2 Vector Sampling

Vector sampling is less structured than the grid system and can be used when few plots are required. It is also useful for small, narrow, and irregularly shaped strata.

Procedural Steps:

1. The walk-through and stratification is completed as normal.
2. Based on the variability of the strata, as found during the walk-through, estimate the number of plots to adequately sample the stratum. This is often difficult for new surveyors.
3. Draw a desired sample strip line pattern on the stratum map. Measure the total length and bearing for each line segment. A single line should be limited to very small strata. If more than two bearing changes are required, vector sampling should be reconsidered in favor of grid sampling - unless mitigating factors preclude the use of grid sampling and a vector line with more than two compass bearings changes are required.

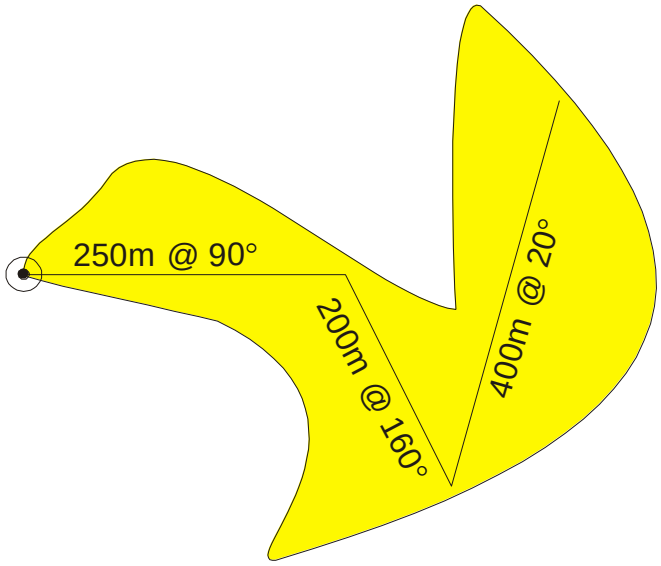


Figure 13: Example of bearing and distance for plots along vectors.

4. To calculate the distance between plots along the line, divide the total length of the lines by the number of plots. Rounding this value will make the field application of the method easier without affecting the results. In this example 850m ÷ 6 plots = 141.6m, or 142m.

5. In openings that are < 10 ha in size and of irregular shapes, it is suggested as a best management practice for surveyors to switch to non-cardinal bearings and the vector sampling design.

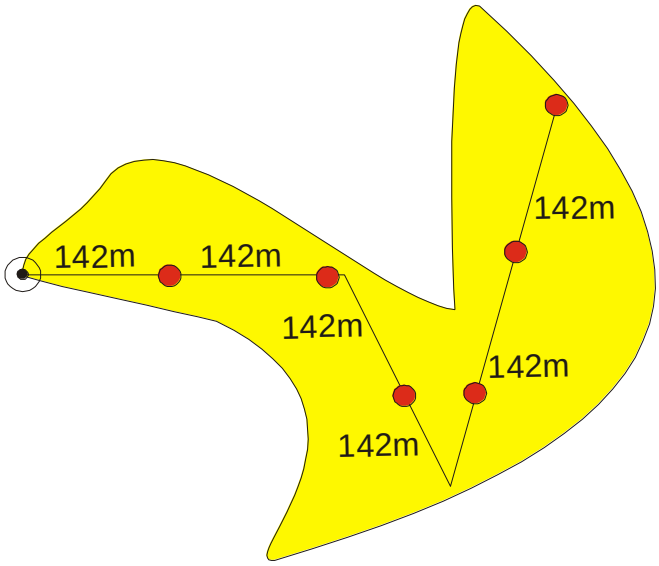


Figure 14: Example of locating plots along vectors.

4.4.3 Representative Sampling

Representative sampling should not be confused with the walk-through done before silviculture surveys. It is a **subjective** assessment of an opening when compared with the more formal methods described in this manual.

When conducted by a skilled surveyor on low-risk strata, the survey results can be sufficiently reliable to meet the required objectives and precision level of the survey.

4.4.3.1 Conditions

If there is any chance a knowledgeable forest practitioner would **find a different result, then this method is not appropriate.**

The results of the representative sampling should be **comparable to the results from a formal survey (grid or vector).**

To be **compliant with FPPR 86(6),** the survey must meet the **RESULTS Information Submission Specifications':**

-reporting requirements

-stratification criteria

-precision standards.

4.4.3.2 Suitability

Representative sampling is most suitable when:

- Used by skilled and knowledgeable silviculture surveyors with many years of directly related experience.
- Used for non-declaration (i.e., stocking) surveys:
  - E.g., To map brushing or juvenile spacing treatment areas
  - E.g., To check the efficacy of brushing or juvenile spacing treatments
  - E.g., To confirm that an opening is on track and to schedule a final free growing survey
- Used on low-risk strata that are clearly free growing with:
  - A recent plot survey
  - Low forest health incidence and hazard
  - Low basal area (<5m2)
  - Low species diversity
  - Consistent stocking

4.4.3.3 Procedural Steps

1. The walk-through and stratification is completed as normal.
2. The surveyor walks the stratum, stopping periodically to assess whether if a plot were established at that point, the data collected would represent the stratum. If the answer is yes, a plot is established at this point. If the answer is no, the surveyor continues and repeats the process. If the answer is repeatedly no, or inconclusive, then this stand is not suitable for the representative sampling method. Grid or vector sampling would be more appropriate.
3. Upon collecting 5 or more plots, the survey summary compilation is completed as normal.

4.4.4 Visual Assessments

A "visual assessment" or "ocular assessment" should not be confused with the walk-through done before silviculture surveys.

This sampling method may involve walking through, riding through, using a drone (UAV), or flying over the opening in a helicopter.

It is a **subjective** assessment of an opening when compared with the more structured sampling methods described in this manual.

The data gathering procedures are less formal. The information collected will generally involve ocular estimates with few, if any, plots established and a limited amount of quantitative data. Statistical validation is not applicable.

When conducted by a skilled surveyor on low-risk strata, the survey results can be sufficiently reliable to meet the required objectives and precision level of the survey.

4.4.4.1 Conditions

If there is **any chance** a knowledgeable forest practitioner would **find a different result, then this method is not appropriate.**

The results of the visual assessment should be **comparable to the results from a formal survey (grid or vector).**

To be **compliant with FPPR 86(6),** the survey must meet the **RESULTS Information Submission Specifications':**

-reporting requirements

-stratification criteria

-precision standards.

4.4.4.2 Suitability

This sampling method is most suitable when:

- Used by skilled and knowledgeable silviculture surveyors with many years of directly related experience.
- Used for non-legal (i.e., stocking) surveys. For example:
  - To map brushing or juvenile spacing treatment areas
  - To check the efficacy of brushing or juvenile spacing treatments.
  - To confirm that an opening is on track and to schedule a final free growing survey.

- There are significant access or safety issues (e.g., unsafe helipads and no walk-in route, unstable terrain, dangerous wildlife, etc.).
- Used on low-risk strata:
  - Obviously free growing with
    - A recent plot survey
    - Low forest health incidence and hazard
    - Low basal area (<5m2)
    - Low species diversity
    - Consistent stocking

A Sampling Suitability Matrix is under development. Surveyors can use the matrix to assess whether these conditions have been met. The matrix will help professionals demonstrate their due diligence.

To test the draft matrix and provide feedback, email taisa.brown@gov.bc.ca

4.4.4.3 Examples

Example 1 (suitable):

A forester completes an office review of Opening ABC to determine if it would be suitable for a visual assessment at free growing. The opening was surveyed four years prior at 1 plot per hectare. All trees were Layer 4, and only two tree species were present. No forest health damage was noted. The well-spaced stocking was high, with a 900 well-spaced stem per hectare LCL. Competing vegetation was limited to low herbs and shrubs.

The forester checks the SEDA Hazard Ratings excel sheet for the two tree species present. The hazard ratings are low for all relevant pests within this subzone variant.

The forester schedules Opening ABC for a drone survey.

An experienced surveyor (10+ years) flies a drone over the opening at a low altitude. The surveyor can easily detect the two tree species present. The tree heights appear 1.5m taller than the previous survey, but the forest cover inventory appears otherwise unchanged. The competing vegetation remains low.

The surveyor ground verifies the heights and uses visual observations and the last survey to produce the silviculture and inventory label.

Example 2 (unsuitable):

Opening DEF is remote, with no other survey work nearby. To reduce costs, the forester would like to fly the opening in a helicopter and complete a visual assessment. The forester completes an office review to determine the opening's suitability for a visual assessment.

The opening has not been surveyed since the 2-year survival survey. While this area regenerates well and is likely to be obviously free growing, the forester deems it too risky for a visual

assessment given the time since the last survey. The forester recognizes the importance in accurately determining the inventory attributes to ensure the RISS precision standards can be met. The forester plans a grid sample.

4.4.5 Multiple Sample Designs in an Opening

The methods for plot positioning and or sampling intensity are often different in each of the strata within a single opening. The example below depicts stratum A using a grid plot location method starting from a selected starting tie point. The high level of sampling intensity may have been selected because of the patchy nature of the stocking identified during the walk-through. Stratum B uses a random method of plot location as well as a low level of sampling intensity. This method and intensity may have been selected to reflect the very consistent level of stocking on stratum B. The statistical analysis would subsequently have a small confidence interval.

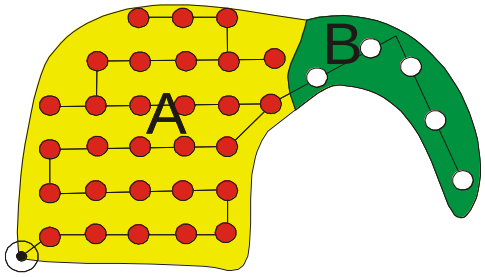


Figure 15: An example of sampling methods that vary by stratum.

Guidance for minimum stratum size is provided in the Forest Cover Stratification and Milestone Declarations document.

Confirm the minimum stratum size expectations prior to completing any survey. The District Manager or Forest Stewardship Plan may establish specific minimum stratum sizes for particular types of surveys, e.g., stocking versus free growing.

5 Field Marking Procedures

The following basic field procedures are recommended for all silviculture surveys.

5.1 Point of Commencements

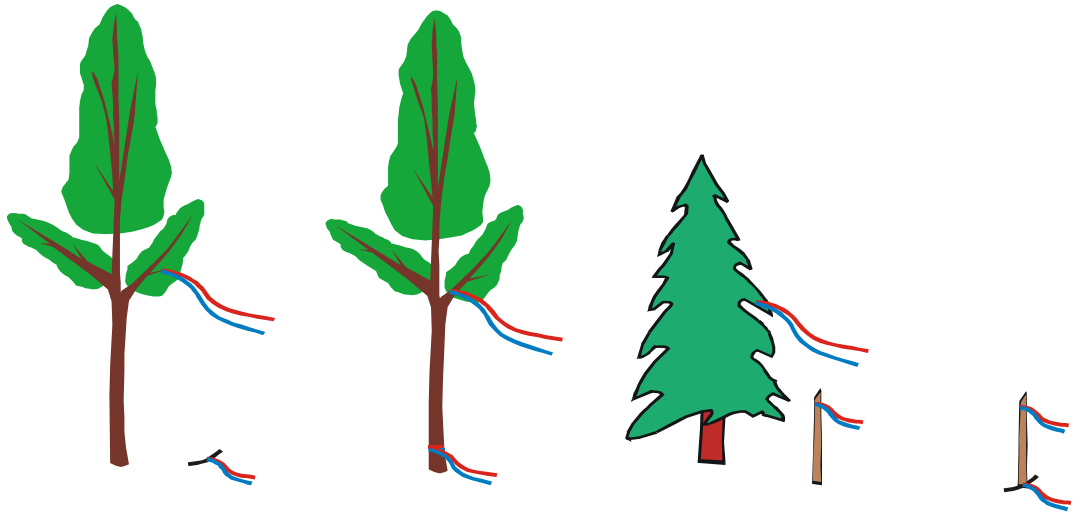
The point of commencement (POC) is the beginning or starting point of the survey.

A point of commencement may not be necessary for representative sampling, visual assessments, or GPS-positioned plot surveys.

All tie points and points of commencement should be tied into easily identifiable features indicated on a map or image (i.e., road junctions, creek crossings, creek junctions or block boundaries).

5.2 Marking Plots

Plot centers must be marked on the ground in such a way that they may be re-located for monitoring or auditing purposes. If the ground is frozen or very rocky ground and a shovel or stick cannot be used for a plot center, a comment should be made on the back of the FS 657 card indicating what was used for the plot center.



A	B	C	D
Tied to a branch and in a shovel slit at plot center	Tied to a branch and tied loosely at the base of the tree used for plot center	Tied to a branch and tied to a stick pushed into the ground at plot center	Tied to a stick and in the shovel slit at plot center

Figure 16: Examples of plot marking methods.

Method B should only be used if it will not bias the results of the survey plot. Method D should be limited to areas with low slash and vegetation.

In all cases, the plot is marked in two places with flagging tape/ribbon:

1. as high as possible, to allow for easy identification of the location of the plot; and
2. at the exact location of the center used to measure the plot radius.

5.3 Strip Lines

Strip lines are often used in association with the grid pattern method. They are typically oriented to run up and down hills, thus crossing contour lines and the ecological strata that are often associated with changes in elevation and often strata boundaries. This allows the surveyor to verify eco-stratification boundaries and identify strata boundaries. Strip lines should ensure that each stratum is evenly sampled and that the plots are well distributed. Strip lines should be marked in the field.

Where the sampling intensity varies across strata, strip lines and or inter-plot distances may also have to be varied.

6 Amendments

Periodically, the content of a silviculture plan or prescription requires changes. This may be a result of the reconsideration of the biological characteristics of the site, or to remedy a previously unrecognized data entry error, or for many other reasons. Since the silviculture plan or prescription is essentially a contract between a licensee and the government, both parties must agree to any changes.

If an amendment has been approved, it replaces specific components of the silviculture plan or prescription. This must be reflected in subsequent surveys.

A more complex issue occurs when an amendment has been applied for but not yet approved, there may be a cover letter or copy of an unsanctioned amendment found on the opening file. A licensee may propose an amendment, but it only becomes a legal amendment to the silviculture plan or prescription once the District Manager has approved it. This should trigger further investigation by the surveyor with the project administrator or supervisor.

Unless a prior understanding has been reached between the surveyor(s), the District Manager, and the licensee, the proposed amendments should not be incorporated into the survey methodology until the District Manager has approved the silviculture plan or prescription amendment.

A licensee must prepare an amendment to the silviculture plan or prescription if it becomes evident that the desired results of the silviculture plan or prescription are not achievable. Surveyors should be aware of this scenario when conducting a walk-through, and when preparing treatment recommendations. A recommendation to prepare an amendment for a biologically necessary reason is expected of a silviculture surveyor.

In addition, there are other reasons that may also require amendments. While these can be district-specific, surveyors should also consider recommending an amendment when:

- the area has changed by more than an amount set by the policy of Ministry of Forests or local FOR Regional or District policy;
- the biogeoclimatic description and subsequent stocking standards are not representative of the current site conditions found on the opening.

In selected situations where licensees employ surveyors skilled in the process of developing stocking standards for silviculture prescriptions or site plans, it may be suitable to collect data using both the specifications in the approved silviculture plans and prescriptions as well as the proposed amendment specifications. This additional information can be used to justify an amendment and will eliminate an additional survey from having to be performed.

7 Field Data Collection

The following Sections 7 and 8 describe the standard methodology for survey data collection for clearcut even-aged stand structure openings (as depicted by the following illustration).

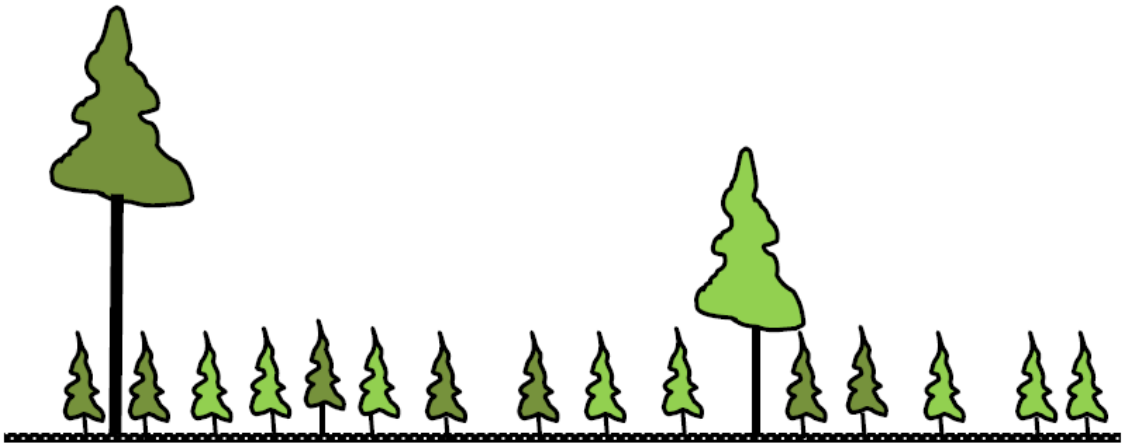


Figure 17: Standard Clearcut Even-aged Stand Structure

While the use of the standard Ministry of Forest's survey field cards and forms is not mandatory, they do allow for the following:

- organized collection of data required to meet the reforestation obligations of the silviculture plan or prescription
- data recording
- standard data compilation
- standard data summaries
- easy comparison of results

For government clients, printed waterproof field cards can be ordered from the Distribution Centre Victoria website. For non-government clients, the cards can be ordered by emailing dcvcustomerser@gov.bc.ca or calling 1 800 282 7955.

If forms and electronic data software other than those provided by the Ministry of Forests are used, it is prudent to consider the data needs for reporting declarations into RESULTS.

Note: Where a field is not applicable to a particular stratum, it is a common convention to mark the field with a "–" dash to signify the field was considered and not forgotten.

The following pages provide a comprehensive and detailed description of the information to be recorded on the field cards. Each field has a number that corresponds with the following headings.

Next to the field name you will find two letters separated by "/." This is provided as an indication of the relative importance of the field. Separate ratings are provided for regeneration delay and free growing surveys. The letter to the left of the "/" represents the data importance for regeneration delay surveys and the letter to the right of the "/" represents the data importance for free growing surveys. In a few instances additional clarification is provided where a number is found in superscript.

Example: H/L – means the data item is required or very important to collect, and do so accurately, during regeneration delay surveys, but is not important and may be omitted during a free growing survey.

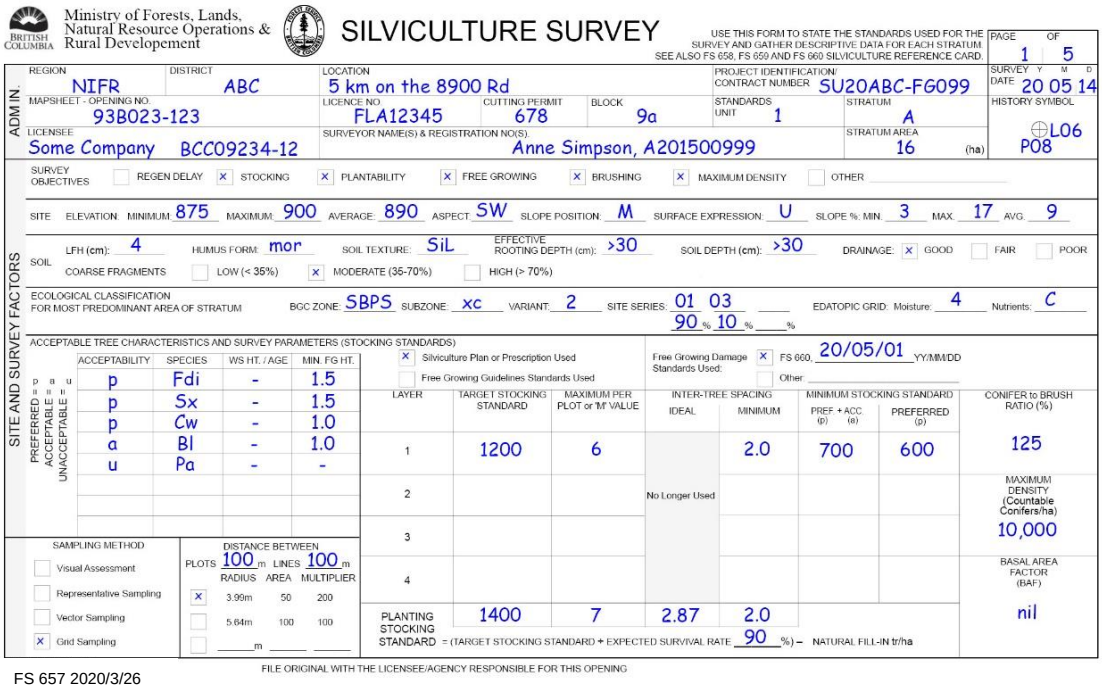
The letters are abbreviations for the descriptions listed below.

Abbreviation	Description of Importance	Examples
H	required to meet legislated requirements, essential component, accuracy is critical	survey date, stocking standards, licence, cutting permit, block, licensee
T	desired where it influences treatments being prescribed	% coarse fragments where site preparation is being recommended
L	useful for a complete description of a stratum	project identification, access km
O	optional data, field provided for your convenience	growth intercept sample data
N	not required	BAF for single layered survey, soil depth during a free growing survey

7.1 Data Field Descriptions for the Front of the FS 657 Card

Stocking standards and administrative information to complete the front of the *Silviculture Survey FS 657* card is obtained by reviewing the silviculture plan or prescription, corporate database, opening files and RESULTS data summary for the opening.

Survey objectives and all site information, including soils and biogeoclimatic classification, should be confirmed in the field. The surveyor is responsible to ensure that all input information is correct. Where corporate data base uploads are used, responsibility for the accuracy of data uploaded should be clarified between the licensee and the surveyor.


Ministry of Forests, Lands, Natural Resource Operations & Rural Developement

SILVICULTURE SURVEY

USE THIS FORM TO STATE THE STANDARDS USED FOR THE SURVEY AND GATHER DESCRIPTIVE DATA FOR EACH STRATUM. SEE ALSO FS 658, FS 659 AND FS 660 SILVICULTURE REFERENCE CARD.

PAGE 1 OF 5

ADMIN.

REGION: NIFR | DISTRICT: ABC | LOCATION: 5 km on the 8900 Rd | PROJECT IDENTIFICATION/ CONTRACT NUMBER: SU20ABC-FG099 | SURVEY DATE: 20 05 14

MAPSHEET - OPENING NO.: 93B023-123 | LICENCE NO.: FLA12345 | CUTTING PERMIT: 678 | BLOCK: 9a | STANDARDS UNIT: 1 | STRATUM: A | HISTORY SYMBOL: L06 P08

LICENSEE: Some Company BCC09234-12 | SURVEYOR NAME(S) & REGISTRATION NO(S).: Anne Simpson, A201500999 | STRATUM AREA: 16 (ha)

SURVEY OBJECTIVES: REGEN DELAY [ ] STOCKING [x] PLANTABILITY [x] FREE GROWING [x] BRUSHING [x] MAXIMUM DENSITY [x] OTHER [ ]

SITE AND SURVEY FACTORS

SITE ELEVATION: MINIMUM: 875 MAXIMUM: 900 AVERAGE: 890 ASPECT: SW SLOPE POSITION: M SURFACE EXPRESSION: U SLOPE %: MIN. 3 MAX. 17 AVG. 9

SOIL: LFH (cm): 4 HUMUS FORM: mor SOIL TEXTURE: SiL EFFECTIVE ROOTING DEPTH (cm): >30 SOIL DEPTH (cm): >30 DRAINAGE: [x] GOOD [ ] FAIR [ ] POOR

COARSE FRAGMENTS: [ ] LOW (< 35%) [x] MODERATE (35-70%) [ ] HIGH (> 70%)

ECOLOGICAL CLASSIFICATION FOR MOST PREDOMINANT AREA OF STRATUM: BGC ZONE: SBPS SUBZONE: xc VARIANT: 2 SITE SERIES: 01 03 90 % 10 % % EDATOPIC GRID: Moisture: 4 Nutrients: C

ACCEPTABLE TREE CHARACTERISTICS AND SURVEY PARAMETERS (STOCKING STANDARDS)

PREFERRED / ACCEPTABLE / UNACCEPTABLE	ACCEPTABILITY	SPECIES	WS HT. / AGE	MIN. FG HT.
p	p	Fdi	-	1.5
p	p	Sx	-	1.5
p	p	Cw	-	1.0
a	a	Bl	-	1.0
u	u	Pa	-	-

[x] Silviculture Plan or Prescription Used [ ] Free Growing Guidelines Standards Used

Free Growing Damage Standards Used: [x] FS 660, 20/05/01 YY/MM/DD [ ] Other:

LAYER	TARGET STOCKING STANDARD	MAXIMUM PER PLOT or 'M' VALUE	INTER-TREE SPACING IDEAL	INTER-TREE SPACING MINIMUM	MINIMUM STOCKING STANDARD PREF. + ACC. (p) (a)	MINIMUM STOCKING STANDARD PREFERRED (p)	CONIFER to BRUSH RATIO (%)
1	1200	6	No Longer Used	2.0	700	600	125
2							MAXIMUM DENSITY (Countable Conifers/ha)
3							10,000
4							BASAL AREA FACTOR (BAF)
PLANTING STOCKING STANDARD	1400	7	2.87	2.0			nil

= (TARGET STOCKING STANDARD + EXPECTED SURVIVAL RATE 90 %) – NATURAL FILL-IN tr/ha

SAMPLING METHOD: [ ] Visual Assessment [ ] Representative Sampling [ ] Vector Sampling [x] Grid Sampling

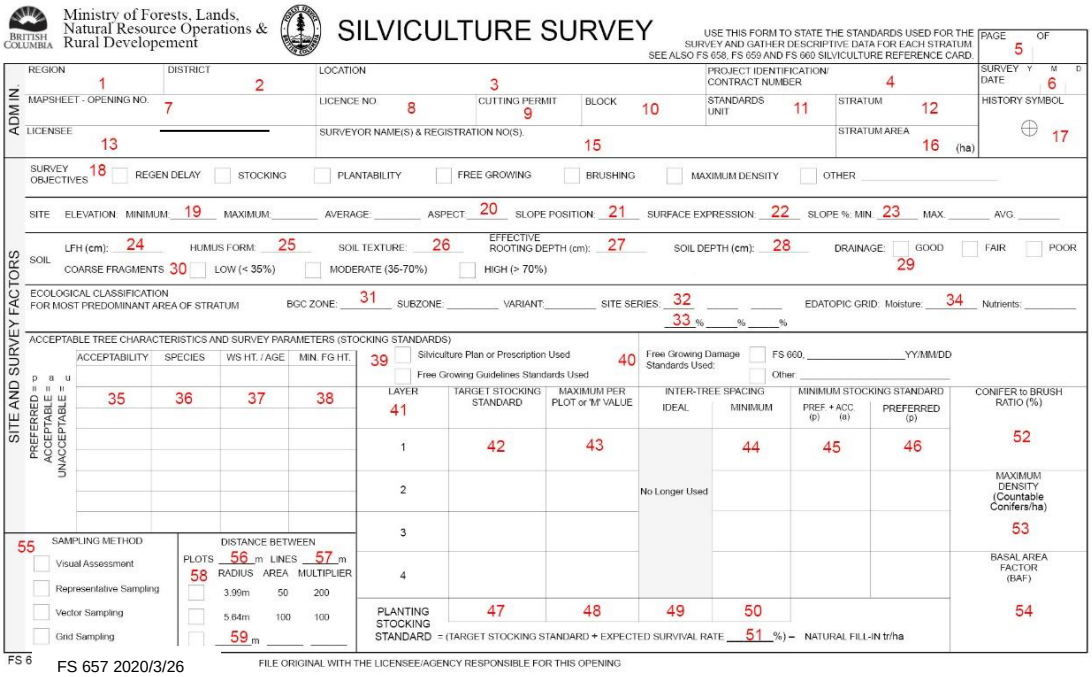
DISTANCE BETWEEN PLOTS 100 m LINES 100 m

	RADIUS	AREA	MULTIPLIER
[x]	3.99m	50	200
[ ]	5.64m	100	100
[ ]	____m	____	____

FILE ORIGINAL WITH THE LICENSEE/AGENCY RESPONSIBLE FOR THIS OPENING

FS 657 2020/3/26

Figure 18: [FS 657 Silviculture Survey card](), front side, with sample data.


Ministry of Forests, Lands, Natural Resource Operations & Rural Developement

SILVICULTURE SURVEY

USE THIS FORM TO STATE THE STANDARDS USED FOR THE SURVEY AND GATHER DESCRIPTIVE DATA FOR EACH STRATUM. SEE ALSO FS 658, FS 659 AND FS 660 SILVICULTURE REFERENCE CARD.

PAGE 5 OF

ADMIN.

REGION 1 | DISTRICT 2 | LOCATION 3 | PROJECT IDENTIFICATION/ CONTRACT NUMBER 4 | SURVEY DATE 6

MAPSHEET - OPENING NO. 7 | LICENCE NO. 8 | CUTTING PERMIT 9 | BLOCK 10 | STANDARDS UNIT 11 | STRATUM 12 | HISTORY SYMBOL 17

LICENSEE 13 | SURVEYOR NAME(S) & REGISTRATION NO(S). 15 | STRATUM AREA 16 (ha)

SURVEY OBJECTIVES 18 REGEN DELAY [ ] STOCKING [ ] PLANTABILITY [ ] FREE GROWING [ ] BRUSHING [ ] MAXIMUM DENSITY [ ] OTHER

SITE AND SURVEY FACTORS

SITE ELEVATION: MINIMUM: 19 MAXIMUM: AVERAGE: ASPECT: 20 SLOPE POSITION: 21 SURFACE EXPRESSION: 22 SLOPE %: MIN. 23 MAX. AVG.

SOIL: LFH (cm): 24 HUMUS FORM: 25 SOIL TEXTURE: 26 EFFECTIVE ROOTING DEPTH (cm): 27 SOIL DEPTH (cm): 28 DRAINAGE: [ ] GOOD [ ] FAIR [ ] POOR 29

COARSE FRAGMENTS 30 [ ] LOW (< 35%) [ ] MODERATE (35-70%) [ ] HIGH (> 70%)

ECOLOGICAL CLASSIFICATION FOR MOST PREDOMINANT AREA OF STRATUM: BGC ZONE: 31 SUBZONE: VARIANT: SITE SERIES: 32 33 % % % EDATOPIC GRID: Moisture: 34 Nutrients:

ACCEPTABLE TREE CHARACTERISTICS AND SURVEY PARAMETERS (STOCKING STANDARDS)

PREFERRED / ACCEPTABLE / UNACCEPTABLE	ACCEPTABILITY	SPECIES	WS HT. / AGE	MIN. FG HT.
	35	36	37	38

39 [ ] Silviculture Plan or Prescription Used [ ] Free Growing Guidelines Standards Used 40

Free Growing Damage Standards Used: [ ] FS 660, YY/MM/DD [ ] Other:

LAYER 41	TARGET STOCKING STANDARD	MAXIMUM PER PLOT or 'M' VALUE	INTER-TREE SPACING IDEAL	INTER-TREE SPACING MINIMUM	MINIMUM STOCKING STANDARD PREF. + ACC. (p) (a)	MINIMUM STOCKING STANDARD PREFERRED (p)	CONIFER to BRUSH RATIO (%)
1	42	43	No Longer Used	44	45	46	52
2							MAXIMUM DENSITY (Countable Conifers/ha)
3							53
4							BASAL AREA FACTOR (BAF)
PLANTING STOCKING STANDARD	47	48	49	50			54

= (TARGET STOCKING STANDARD + EXPECTED SURVIVAL RATE 51 %) – NATURAL FILL-IN tr/ha

55 SAMPLING METHOD: [ ] Visual Assessment [ ] Representative Sampling [ ] Vector Sampling [ ] Grid Sampling

DISTANCE BETWEEN PLOTS 56 m LINES 57 m

58

	RADIUS	AREA	MULTIPLIER
[ ]	3.99m	50	200
[ ]	5.64m	100	100
[ ]	59 m	____	____

FILE ORIGINAL WITH THE LICENSEE/AGENCY RESPONSIBLE FOR THIS OPENING

FS 6 FS 657 2020/3/26

Figure 19: [FS 657 Silviculture Survey card](), front side, with field numbers.

1. Region: L/L Record the name or abbreviation for the region. This information may be in the silviculture plan or prescription, opening file, corporate database, contract or from local knowledge. A map of the Forest Regions and Natural Resource Districts may be consulted.

2. District: L/L Record the name or abbreviation for the district. This information may be in the silviculture plan or prescription, opening file, corporate database, contract or from local knowledge. A map of the Forest Regions and Natural Resource Districts may be consulted.

3. Location: L/L Record the geographic location of the opening. This information may be located in the silviculture plan or prescription, forest cover map, opening file, corporate database or from local knowledge. It should match any existing description or be corrected if the currently recorded location is misleading.

4. Project Identification/Contract Number: L/L If the survey is being completed under a contract, record the specified project identification number or contract number.

5. Page: L/L Record the page number. Include all silviculture survey cards in a logical numbering sequence. The goal is to provide a logically organized package of survey cards to include in the finished report.

6. Survey date: H/H Record the date in which the survey data was collected in the field.

7. Mapsheet -Opening No.: H/H The complete opening number is made up of both the mapsheet number and the opening number. Record the map sheet and opening number of the area being surveyed. This information may be located in the silviculture plan or prescription, opening file, corporate database or on the forest cover map.

8. Licence No.: H/H Record the licence number of the licensee responsible for the reforestation activities on the opening. This information may be located in the silviculture plan or prescription, corporate database or in the opening file.

9. Cutting permit: H/H Record the cutting permit number assigned to the opening. This information may be in the silviculture plan or prescription, corporate database or in the opening file. Not every area has a cutting permit number.

10. Block: H/H Record the cut block number assigned to the opening. This information may be in the silviculture plan or prescription or in the opening file.

11. Standards Unit: H/H Each opening has one or more standards units as defined in the silviculture plan or prescription. Enter the same number or letter as found in the silviculture plan or prescription.

12. Stratum: H/H Capital letters, numbers, or a combination of both are acceptable. For an opening with strata that correspond to the standards units, the two fields will be the same to limit possible confusion.

13. Licensee: H/H Record the name of the major tenure holder responsible for the reforestation activities on the opening. This information may be located in the silviculture plan or prescription, corporate database or in the opening file.

15. Surveyor Name(s) & Registration No(s): H^1/H^1 Record the name(s) of the person who completed the survey. The Ministry of Forests assigns surveyor accreditation numbers to surveyors who have passed the silviculture survey accreditation exam. Record the silviculture surveyor accreditation number of the surveyor(s) who completed the survey.

[1] – If the survey is being completed without the use of an accredited surveyor enter “none”.

16. Stratum Area (ha): H/H Record the net area of the stratum.

17. History symbol: L/L Record the history of the opening by using the symbols described in the following table. The last 2 digits of the year of the treatment are to be recorded beside the code letter. This information may be located on the forest cover map, in corporate database or in the opening file.

CLASS SYMBOL	CODE	HISTORY OR TREATMENT
Disturbance 	B	Wildfire/Burn
	D	Disease
	F	Flooding
	I	Insect
	K	Fume Kill
	L	Logging
	L%	Logged (10% increments)
	R	Site Rehabilitation
	S	Slide
	W	Windthrow
Regeneration 	P	Planted
	PL	Plant
	FP	Fill Plant
	RP	Replant
	N	Natural
Stand Tending 	F	Fertilization
	H	Hack and Squirt
	J	Juvenile Spacing
	M	Mistletoe control
	P	Pruning
	R	Conifer Release
	S	Sanitation Spacing
	T	Commercial Thinning
	W	Brushing and Weeding
Site Preparation 	B	Broadcast burn
	C	Chemical
	G	Grass Seeded
	H	Hand Preparation
	RB	Range Management Burn
	S	Spot Burn
	M	Mechanical
	MS	Mechanical and Spot Burn
	W	Windrow

Table 4: History symbols

18. Survey Objectives: H/H Check the box next to the applicable survey objective(s) for the survey being completed. Frequently more than one survey objective may be checked as surveyors regularly do a combination of surveys at the same time. Multiple objectives should be selected with care since the survey standards and methods vary as the primary objective of the survey changes.

With a plantability survey being done in conjunction with a stocking survey, there is no conflicting objectives. Both objectives may be checked.

One will often choose to record the number of free growing trees during a stocking survey. However, if the primary objective is the collection of well-spaced tree and silviculture label data, then stocking survey should be checked.

The collection of well-spaced data is generally an integral component of a free growing survey but the primary objective is the collection of free growing tree and free growing silviculture label data. The objective to be checked is the free growing survey. However, if both stocking and free growing data is collected, it is recommended both survey objectives should be checked off.

19. Elevation: T/L Record the minimum, maximum and average elevation of the stratum in meters above sea level. This information may be located in the silviculture plan or prescription, in corporate database or on topographical maps. Elevation should be confirmed by contour map, recently calibrated altimeter, TRIM digital elevation database or high quality GPS during the walk-through.

The elevation calculated by the commonly available inexpensive GPS units is not sufficiently accurate to determine elevation used subsequently for Seedlot selection.

20. Aspect: T/L Record the direction toward which a slope faces for the stratum. This information may be in the silviculture plan or prescription or in a corporate database. Aspect should be confirmed during the walk-through. This information is recorded as found in the table below.

All three of the columns are acceptable methods.

DESCRIPTION	ABBREVIATION	APPROXIMATE RANGE OF BEARINGS
North	N	337.5 to 22.5 degrees
Northeast	NE	22.5 to 67.5 degrees
East	E	67.5 to 112.5 degrees
Southeast	SE	112.5 to 157.5 degrees
South	S	157.5 to 202.5 degrees
Southwest	SW	202.5 to 247.5 degrees
West	W	247.5 to 292.5 degrees
Northwest	NW	292.5 to 337.5 degrees
Flat	F	No identifiable aspect, associated with 0% slope
Variable	V	No consistent aspect, associated with rolling and broken topography

Table 5: Aspect and associated abbreviations

21. Slope Pos.: T/L Record the position for the slope of the stratum. This information is recorded as crest, upper slope, middle slope, lower slope, toe, depression and level, as described on the FS 660 card. This information may be located in the silviculture plan or prescription. Slope position should be confirmed during the walk-through.

Either name or abbreviation are acceptable.

C	Crest
U	Upper slope
M	Middle slope
L	Lower slope
T	Toe
D	Depression
F	Flat or Level

Table 6: Slope position abbreviations

22. Surface Expression: T/T Record the surface expression of the stratum. This information may be in the silviculture plan or prescription. Surface expression should be confirmed during the walk-through. For more information on surface expression, refer to the FS 660 card.

Either name or abbreviation are acceptable.

P	Plain
U	Undulating
R	Ridges
T	Terraces
C	Cone
D	Depression
F	Fan
H	Hummock
M	Rolling

Table 7: Surface expression abbreviations

23. Slope %: T/T Record the minimum, maximum and average slope percentage of the stratum. This information may be in the silviculture plan or prescription. Slope percent should be confirmed during the walk-through using a clinometer.

24. LFH (cm): T/L Record the average depth, in centimeters, of the Litter-Fermented-Humus (LFH) layer of the forest floor. Measure from the top of the mineral soil to the top of the litter layer. This information may be in the silviculture plan or prescription. LFH depth should be confirmed during the walk-through.

25. Humus Form: T/L Record the humus form of the organic layer of the stratum. Three types of humus form are recognized: Mor, Moder and Mull. The humus form classification can be located in the silviculture plan or prescription, but it can change following harvest. Humus form should be confirmed during the walk-through. For more information on humus form, consult the regional ecological classification field guide, (a link to the one for the Prince Rupert Region is provided since it is the same for all regions) or Field Manual for Describing Terrestrial Ecosystems.

26. Soil Texture: T/L Record the soil texture of the stratum. This is generally inferred to be the upper 10 to 30 cm. This information may be located in the silviculture plan or prescription or corporate database. Regardless, the soil texture should be confirmed during the walk-through. For more information on soils classification consult the regional ecological classification field guide.

27. Effective Rooting Depth (cm): T/L Record the depth in centimeters of the soil that is available for root development. This should involve digging a soil pit, observing root mats of wind thrown trees or looking at road cuts. This information may be in the silviculture plan or prescription. Effective rooting depth should be confirmed during the walk-through.

28. Soil Depth (cm): T/N Record the depth in centimeters of the soil to bedrock or parent material. This is generally inferred to be the upper 10 to 30 cm. This should involve digging a soil pit, observing root mats of wind thrown trees or looking at road cuts. This information may be located in the silviculture plan or prescription. Soil depth should be confirmed during the walk-through.

29. Drainage: T/L Check the appropriate box to indicate the drainage of water through the soil. Drainage is often related to the soil texture. This information may be in the silviculture plan or prescription. Drainage should be confirmed during the walk-through. The three selections can be defined by:

Good	• water freely drains into the soil profile • generally associated with coarse textured soils
Fair	• intermediate
Poor	• water is likely to accumulate on the surface and/or result in surface flow • generally associated with fine textured soils, high soil bulk density

Table 8: Drainage definitions

30. Coarse Fragments: T/L Check the appropriate box to indicate the estimated percent of coarse fragment content. Coarse fragments are greater than 2 millimeters in diameter. This information may be in the silviculture plan or prescription. Coarse fragment percent should be confirmed during the walk-through.

31. BGC Zone, Subzone and Variant: H/H Record the biogeoclimatic zone, subzone, and variant of the stratum. This information can be located in the silviculture plan or prescription, in a corporate database and on biogeoclimatic subzone maps and handbooks. However, biogeoclimatic information should be confirmed during the walk-through.

Regional ecological classification zone and subzone maps and field guides should be used to confirm the biogeoclimatic zone, subzone, variant, and site series.

When the ecological classification determined by the surveyor differs from the silviculture plan or prescription, an amendment is not necessarily required. The agency responsible for the silviculture plan or prescription may wish to consider an amendment if the re-evaluated and confirmed classification gives rise to a possible change in the stocking standards or site productivity.

32. Site Series: H/H The regional field guides for identification and interpretation of ecosystems are used to determine the site series of the stratum. Record the 1°(primary) site series that covers the majority of the stratum. Record the 2°(secondary) site series that is the next predominant site series that covers the stratum. Record the 3°(tertiary) site series, or third most predominant site series that covers the stratum.

33. Site Series %: H/H If there is more than one site series present within the stratum, a percentage should be assigned to each of the different site series. The site series should be rounded to the nearest 10 percent and the combined site series percentages should equal 100 percent.

34. Edatopic grid: L/L The moisture and nutrient co-ordinates of the site can be determined by using the edatopic grid of the corresponding biogeoclimatic zone site series. This information may be in the silviculture plan or prescription, on biogeoclimatic maps and in handbooks. However, the edatopic grid should be confirmed during the walk-through.

35. Acceptability: H/H Enter **P**, **A** or **U** corresponding to the level of acceptability (preferred, acceptable or unacceptable) as is found in the silviculture plan or prescription.

The use of the unacceptable is intended to clearly identify tree species that are present on the stratum but are neither preferred nor acceptable. This does not mean that all unacceptable tree species must be listed, rather only those which appear to have potential as an acceptable species but are not currently listed as such in the silviculture plan or prescription.

If there is no silviculture plan or prescription, the preferred and acceptable species are defined in the stocking standards provided by the District Manager. This may be in the form of a district species selection guideline or by consultation with a Professional Forester.

36. Species: H/H Record the species that corresponds to the preferred, acceptable, and unacceptable fields of the FS 657 card. This information may be located in the silviculture plan or prescription. If there are no silviculture plans and prescriptions, the preferred and acceptable species are defined in the stocking standards provided by the District Manager. Unacceptable species need only be included where unacceptable commercial tree species are present.

37. Ws Ht./Age: H^2/H^2 Record the minimum height and/or minimum age of the corresponding well-spaced trees that will contribute to stocking at the regeneration date. This information is not located in the silviculture plan or prescription, but is often established by the District Manager or licensee.

[2] – These values may not be specified for all Districts.

38. Min. FG Ht: L/H[3] Record the minimum height that a healthy, vegetation competition free well-spaced tree must attain in order to be considered free growing. This information will be specified in the silviculture plan or prescription or stocking standards in a forest stewardship plan (FSP) or forest development plan (FDP). If there is no free growing height stipulated on the silviculture plan or prescription, the free growing trees have no minimum free growing height requirement unless the surveyor, in consultation with the licensee, has selected to use the free growing guidelines found in Appendix 9 of the Establishment to Free Growing Guidebook.

[3] – Free growing minimum heights are only required if they are specified in the silviculture plan or prescription or as described in Appendix 9 of the Establishment to Free Growing Guidebook.

39. Silviculture Plan or Prescription Used / Free Growing Guidelines Standards Used: N/H Check the appropriate box as to which standards are being used for the survey. More information on this subject is found in Appendix 9 of the Establishment to Free Growing Guidebook

40. Free Growing Damage Standards Used: L/H Record the date or version number of the Provincial Free Growing Damage Criteria or standards used to determine acceptable free growing trees.

41. Layer: H/H For as single layered stand, enter the stocking standards into the row for layer 4. For layered surveys additional rows would be completed to match the stocking standards as found in the silviculture plan or prescription.

42. Target Stocking Standard/ha: H/H Record the target stocking standard (TSS) for the stratum being surveyed. The target stocking standard is the target number of preferred and acceptable healthy, well-spaced or free growing trees per hectare. This information may be located in the silviculture plan or prescription.

43. Target Maximum/Plot: H/H Record the maximum number of well-spaced or free growing trees to be tallied in a plot for the stratum. Maximum per plot is also called the "M" value. This is calculated by dividing the target stocking standard per hectare by the Plot Multiplier (fields 59 or 60).

The "M" value places a ceiling on the number of well-spaced trees and free growing trees in any one plot. This prevents over-stocking in one plot compensating for under-stocking in other plots. This is a key concept in the survey system. Thus, a relatively uniform distribution of stems must be attained before the opening can achieve regeneration delay or free growing status.

44. Minimum Inter-Tree Spacing: H/H Record the minimum inter-tree distance between well-spaced or free growing trees. Minimum inter-tree distance specifies the minimum allowable horizontal distance between preferred and/or acceptable trees which are well-spaced or free growing. This information may be in the silviculture prescription, site plan or FSP. For information regarding accepting trees at the distance allowed at the time of planting, refer to the Minimum inter-tree distance section.

45. Minimum Stocking Standard Preferred + Acceptable: H/H Record the minimum number of healthy, preferred and acceptable, well-spaced or free growing trees per hectare (MSSpa). This number of trees must be on an opening in order to consider the area satisfactorily restocked or free growing. This information may be located in the silviculture plan or prescription. In older silviculture plans or prescriptions, prior to the requirement to specify a MSSp (see next field), MSSpa is referred to as MSS.

46. Minimum Stocking Standard Preferred: H[6]/H[6] Record the minimum number of healthy, preferred well-spaced or free growing trees per hectare (MSSp). This is the minimum number of trees that must be on the opening in order to consider the area satisfactorily restocked or free growing. This information may be located in the silviculture plan or prescription.

[6] – If the silviculture plan or prescription was approved prior to April 1, 1994, there will be no minimum stocking standard for preferred species. This field will then be recorded as "-" or N/A. (see section on MSS vs. MSSp vs. MSSpa).

47. Planting Stocking Standard/ha: T/N Record the target number of planted trees per hectare desired in the stratum. This planting stocking standard is calculated using the formula on either

side of field 51 of the FS 657 card then rounded up to the next hundred (e.g., 1333 becomes 1400), or set by district or licensee policy.

48. Planting Maximum/Plot: T/N Record the maximum number of plantable spots to be recorded in a plot for the stratum. This is calculated by dividing the planting stocking standard per hectare by the plot multiplier (field 59).

49. Planting Ideal Inter-Tree Spacing: T/N This field is recorded in plantability surveys. This distance will be specified in the planting contract, Schedule B. It should be set in consideration of the instructions that will be given to the planting crews.

50. Planting minimum inter-tree spacing: T/N Record the minimum inter-tree distance between planted and/or well-spaced trees. This distance will be specified in the planting contract, Schedule B. It should be set in consideration of the instructions that will be given to the planting crews. Generally, for surveyors who are considering fill plants or replants, the planting MITD will be the same as the MITD used for the stocking or free growing assessment. This should be confirmed by the contract administrator.

51. Expected Survival %: T/N Record the estimated expected survival of the species that will be planted on the site. This information comes from the contract or the District Manager or can be based on local knowledge or on practical experience. If more than one species is recommended to be planted on the site, the expected survival rate is a combined or pro-rated estimate of each species. The contract should provide the number for the expected natural fill-in rate.

> The planting stocking standard is always rounded **up** to the nearest 200. For example, if the planting stocking standard calculation resulted in 1233, this number would be rounded to 1400.
>
> The planting stocking standards calculation can be overridden by the planting contract.

> If a fill-plant is being considered, the relative importance of planting standards including spacing, is high – or "T".

52. Conifer to Brush Ratio (%): N/H[1] Record the height of the crop tree relative to competing vegetation for free growing trees. This is usually recorded as a percentage. This information may be located in the silviculture plan or prescription.

If there is no conifer/brush ratio stipulated on the silviculture plan or prescription, there is no legal requirement for the free growing trees to meet a conifer/brush ratio. However, the crop trees must still be free growing, and the current method may be appropriate. Consult with the holder of the silviculture plan or prescription on how to assess areas with no conifer/brush ratio specified in the silviculture plan or prescription.

[1] *May not be present on stocking standards approved as part of an FSP as it is not a legal content requirement under FRPA.*

53. Maximum Density (countable conifers/ha): T/H Record the maximum allowable density of the total countable conifers. For more information on this subject refer to the Maximum Density Section.

54. Basal Area Factor (BAF): H/H Record the prism size used in completing the prism sweeps. This would be required when completing a multi-storey, layered, DFP, or SEDRSS survey, and on any other occasion where retention of layer 1 is greater than 5m² or where basal area is part of the stocking standard. It is also a best management practice when Layer 1 is <5m^2. See section 3.6 of this manual.

55. Sampling Method: H/H Check the box corresponding to the sampling method being used on this stratum. Descriptions and recommendations for selecting a sampling method are provided in the Sampling Principles section of this document.

56. Distance between plots (m): H[7]/H[7] Record the average distance, in meters, between plots that was used during the survey. If a random sampling design was used, note random in this field, or leave it blank.

[7] – Only required for grid sampling and vector sampling

57. Distance between lines (m): H[8]/H[8] Record the average distance, in meters, between strip lines that was used during the survey. If a random sampling design was used, note random in this field, or leave it blank.

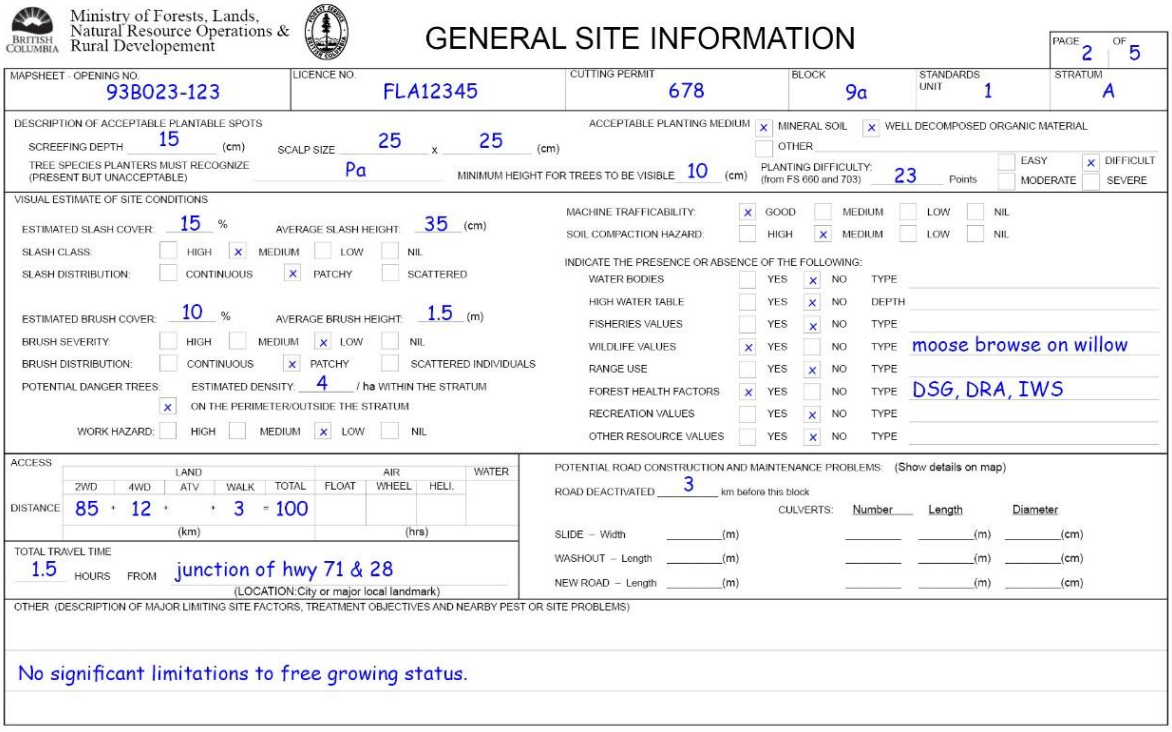
[8] – Only required for Grid Sampling

58. Radius 3.99 or 5.64 m: H/H Check one of these boxes if a plot radius of 3.99m or 5.64 m is being used or enter a different specific plot radius in the blank provided.

59. Plot Radius (m), Area, Multiplier: H/H Record the plot radius, in meters, used for the survey. Record the plot area, in m^2, associated with the plot radius used for the survey. This number can be found on Table 5 of the FS 660 card. Record the number used to multiply the tree counts in the survey plot to yield equivalent trees per hectare. Refer to the Plot Radius and Plot Multiplier section for more information.

7.2 Data Field Descriptions for the Back of FS 657 card

Information gathering to complete the back of the FS 657 is initiated during the walk-through of the stratum and should be completed before leaving the opening. It is important that the information collected in this section is accurate so that it can be incorporated into the development of treatment recommendations and contract requirements.



Ministry of Forests, Lands, Natural Resource Operations & Rural Developement

GENERAL SITE INFORMATION

PAGE 2 OF 5

MAPSHEET - OPENING NO.	LICENCE NO.	CUTTING PERMIT	BLOCK	STANDARDS UNIT	STRATUM
93B023-123	FLA12345	678	9a	1	A

DESCRIPTION OF ACCEPTABLE PLANTABLE SPOTS
SCREEFING DEPTH 15 (cm) SCALP SIZE 25 x 25 (cm)
TREE SPECIES PLANTERS MUST RECOGNIZE (PRESENT BUT UNACCEPTABLE) Pa
MINIMUM HEIGHT FOR TREES TO BE VISIBLE 10 (cm)

ACCEPTABLE PLANTING MEDIUM [x] MINERAL SOIL [x] WELL DECOMPOSED ORGANIC MATERIAL [ ] OTHER
PLANTING DIFFICULTY: (from FS 660 and 703) 23 Points [ ] EASY [x] DIFFICULT [ ] MODERATE [ ] SEVERE

VISUAL ESTIMATE OF SITE CONDITIONS
ESTIMATED SLASH COVER: 15 % AVERAGE SLASH HEIGHT: 35 (cm)
SLASH CLASS: [ ] HIGH [x] MEDIUM [ ] LOW [ ] NIL
SLASH DISTRIBUTION: [ ] CONTINUOUS [x] PATCHY [ ] SCATTERED

ESTIMATED BRUSH COVER: 10 % AVERAGE BRUSH HEIGHT: 1.5 (m)
BRUSH SEVERITY: [ ] HIGH [ ] MEDIUM [x] LOW [ ] NIL
BRUSH DISTRIBUTION: [ ] CONTINUOUS [x] PATCHY [ ] SCATTERED INDIVIDUALS
POTENTIAL DANGER TREES: ESTIMATED DENSITY: 4 / ha WITHIN THE STRATUM
[x] ON THE PERIMETER/OUTSIDE THE STRATUM
WORK HAZARD: [ ] HIGH [ ] MEDIUM [x] LOW [ ] NIL

MACHINE TRAFFICABILITY: [x] GOOD [ ] MEDIUM [ ] LOW [ ] NIL
SOIL COMPACTION HAZARD: [ ] HIGH [x] MEDIUM [ ] LOW [ ] NIL

INDICATE THE PRESENCE OR ABSENCE OF THE FOLLOWING:

WATER BODIES	[ ] YES	[x] NO	TYPE
HIGH WATER TABLE	[ ] YES	[x] NO	DEPTH
FISHERIES VALUES	[ ] YES	[x] NO	TYPE
WILDLIFE VALUES	[x] YES	[ ] NO	TYPE moose browse on willow
RANGE USE	[ ] YES	[x] NO	TYPE
FOREST HEALTH FACTORS	[x] YES	[ ] NO	TYPE DSG, DRA, IWS
RECREATION VALUES	[ ] YES	[x] NO	TYPE
OTHER RESOURCE VALUES	[ ] YES	[x] NO	TYPE

ACCESS

	LAND 2WD	4WD	ATV	WALK	TOTAL	AIR FLOAT	WHEEL	HELI.	WATER
DISTANCE	85	12		3	= 100				
	(km)					(hrs)			

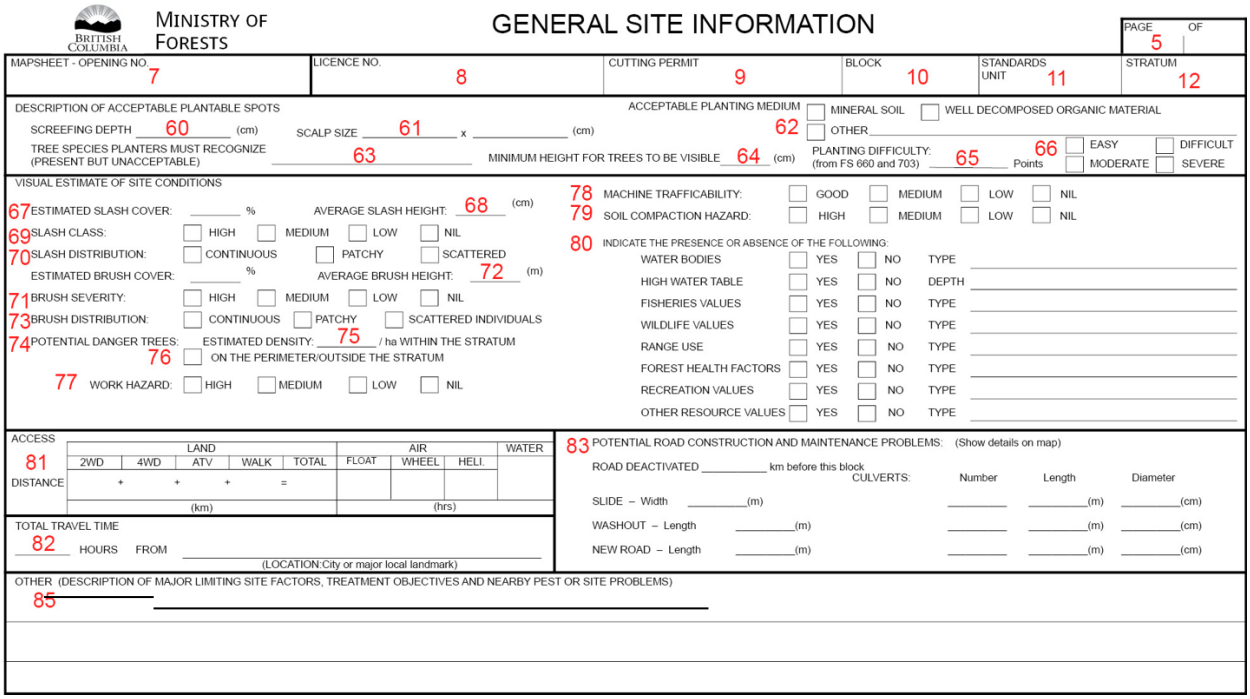
TOTAL TRAVEL TIME 1.5 HOURS FROM junction of hwy 71 & 28 (LOCATION:City or major local landmark)

POTENTIAL ROAD CONSTRUCTION AND MAINTENANCE PROBLEMS: (Show details on map)
ROAD DEACTIVATED 3 km before this block

		CULVERTS: Number	Length	Diameter
SLIDE – Width	(m)		(m)	(cm)
WASHOUT – Length	(m)		(m)	(cm)
NEW ROAD – Length	(m)		(m)	(cm)

OTHER (DESCRIPTION OF MAJOR LIMITING SITE FACTORS, TREATMENT OBJECTIVES AND NEARBY PEST OR SITE PROBLEMS)
No significant limitations to free growing status.

Figure 20: FS 657 Silviculture Survey card, back side, with sample data.



MINISTRY OF FORESTS

GENERAL SITE INFORMATION

PAGE 5 OF

7 MAPSHEET - OPENING NO.	8 LICENCE NO.	9 CUTTING PERMIT	10 BLOCK	11 STANDARDS UNIT	12 STRATUM

DESCRIPTION OF ACCEPTABLE PLANTABLE SPOTS
SCREEFING DEPTH 60 (cm) SCALP SIZE 61 x (cm)
TREE SPECIES PLANTERS MUST RECOGNIZE (PRESENT BUT UNACCEPTABLE) 63
MINIMUM HEIGHT FOR TREES TO BE VISIBLE 64 (cm)

ACCEPTABLE PLANTING MEDIUM 62 [ ] MINERAL SOIL [ ] WELL DECOMPOSED ORGANIC MATERIAL [ ] OTHER
PLANTING DIFFICULTY: (from FS 660 and 703) 65 Points 66 [ ] EASY [ ] DIFFICULT [ ] MODERATE [ ] SEVERE

VISUAL ESTIMATE OF SITE CONDITIONS
67 ESTIMATED SLASH COVER: % AVERAGE SLASH HEIGHT: 68 (cm)
69 SLASH CLASS: [ ] HIGH [ ] MEDIUM [ ] LOW [ ] NIL
70 SLASH DISTRIBUTION: [ ] CONTINUOUS [ ] PATCHY [ ] SCATTERED
ESTIMATED BRUSH COVER: % AVERAGE BRUSH HEIGHT: 72 (m)
71 BRUSH SEVERITY: [ ] HIGH [ ] MEDIUM [ ] LOW [ ] NIL
73 BRUSH DISTRIBUTION: [ ] CONTINUOUS [ ] PATCHY [ ] SCATTERED INDIVIDUALS
74 POTENTIAL DANGER TREES: ESTIMATED DENSITY: 75 / ha WITHIN THE STRATUM
76 [ ] ON THE PERIMETER/OUTSIDE THE STRATUM
77 WORK HAZARD: [ ] HIGH [ ] MEDIUM [ ] LOW [ ] NIL

78 MACHINE TRAFFICABILITY: [ ] GOOD [ ] MEDIUM [ ] LOW [ ] NIL
79 SOIL COMPACTION HAZARD: [ ] HIGH [ ] MEDIUM [ ] LOW [ ] NIL

80 INDICATE THE PRESENCE OR ABSENCE OF THE FOLLOWING:

WATER BODIES	[ ] YES	[ ] NO	TYPE
HIGH WATER TABLE	[ ] YES	[ ] NO	DEPTH
FISHERIES VALUES	[ ] YES	[ ] NO	TYPE
WILDLIFE VALUES	[ ] YES	[ ] NO	TYPE
RANGE USE	[ ] YES	[ ] NO	TYPE
FOREST HEALTH FACTORS	[ ] YES	[ ] NO	TYPE
RECREATION VALUES	[ ] YES	[ ] NO	TYPE
OTHER RESOURCE VALUES	[ ] YES	[ ] NO	TYPE

ACCESS

81	LAND 2WD	4WD	ATV	WALK	TOTAL	AIR FLOAT	WHEEL	HELI.	WATER
DISTANCE	+	+	+	=					
	(km)					(hrs)			

TOTAL TRAVEL TIME
82 HOURS FROM (LOCATION:City or major local landmark)

83 POTENTIAL ROAD CONSTRUCTION AND MAINTENANCE PROBLEMS: (Show details on map)
ROAD DEACTIVATED km before this block

		CULVERTS: Number	Length	Diameter
SLIDE – Width	(m)		(m)	(cm)
WASHOUT – Length	(m)		(m)	(cm)
NEW ROAD – Length	(m)		(m)	(cm)

OTHER (DESCRIPTION OF MAJOR LIMITING SITE FACTORS, TREATMENT OBJECTIVES AND NEARBY PEST OR SITE PROBLEMS)
85

Figure 21: FS 657 Silviculture Survey card, back side, with field numbers.

Previously described field numbers will not be repeated in the descriptions to follow. Refer to a previous section for their description.

60. Screefing Depth: T/N Record the maximum depth, in centimeters, that is required by the planter to remove the organic matter from a spot to prepare it for planting. This information is district specific and often site specific.

61. Scalp Size: T/N Record the maximum scalp size, in centimeters, that is required by the planter to remove the organic matter from a spot to prepare it for planting. When recommending the maximum scalp size, one must consider vegetative competition and soil nutrient status. This information is district specific and more often site specific.

62. Acceptable Planting Medium: T/N Record the acceptable planting medium for the site.

63. Tree Species Planters Must Recognize: T/N Record the tree species that a planter must recognize and space off during planting that are considered unacceptable according to the site plan or prescription. It can also be used if the licensee wants the planter to recognize an unacceptable species that should be planted next to. This must be considered during the plantability assessment.

64. Minimum Height for Trees to be Visible: T/N Record the minimum height of a tree, in centimeters, that a planter is expected to see during planting and will influence the number of plantable spots. This value may be different than that shown in the acceptable tree characteristics under height/age on the front of the FS 657 card. This information will be site specific. When establishing this value, consider the height of surrounding vegetation. Guidance here should be provided by the contract or contract administrator.

65. Planting Difficulty Points: T/N Record the number of points for the planting difficulty for the stratum. This information is site specific and can be determined by using Table 10 on the FS 660 card.

66. Planting Difficulty: T/N Check the box that represents the average planting difficulty for the stratum. This information is site specific and can be determined by using Table 10, and particularly the bottom right (Difficulty Class) on the FS 660 card.

> If a fill plant or replant is being considered, the relative importance of fields 60-66 (above) is high – or "T".

67. Estimated Slash Cover %: T/T Record the estimated percent of the ground that is covered by slash and debris. This is a visual observation that should be averaged throughout the entire stratum. Slash cover percent should be estimated during the walk-through.

68. Average Slash Height (cm): T/T Record the estimated height, in centimeters, of the slash and debris on the ground. This is a visual observation that should be averaged throughout the entire stratum. Average slash height should be estimated during the walk-through.

69. Slash Class: T/T Check the box next to the appropriate estimated slash class. This is a visual observation that should be averaged throughout the entire stratum. Slash class should be estimated during the walk-through.

70. Slash Distribution: T/T Record the estimate of slash continuity. This is a visual observation that should be averaged throughout the entire stratum. Slash distribution should be estimated during the walk-through.

Continuous — slash is spread evenly over the stratum.

Patchy — slash-free areas cover approximately the same percentage of ground as slash-covered areas.

Scattered — slash-free areas are larger than slash-covered areas.

71. Estimated Brush Cover %: T/H Record the estimated percent of competing vegetation within the stratum. This is a visual observation that should be averaged throughout the entire stratum. It is also collected as part of a stocking or free growing survey. Brush cover should be estimated during the walk-through.

72. Average Brush Height (m): T/H Record the estimated height, in meters, of the competing vegetation within the stratum. This is a visual observation that should be averaged throughout the entire stratum. It is also collected as part of a stocking or free growing survey. Average brush height should be estimated during the walk-through.

73. Brush Severity: T/H Check the box next to the appropriate estimate of brush severity. This is a visual observation that should be averaged throughout the entire stratum. It is also collected as part of a stocking or free growing survey. Brush severity should be estimated during the walk-through.

74. Brush Distribution: T/H Record the spatial arrangement or distribution estimate of brush continuity. This is a visual observation that should be averaged throughout the entire stratum. Brush distribution should be estimated during the walk-through.

Continuous — brush is spread evenly over the stratum.

Patchy — brush-free areas cover roughly the same percentage of ground as brush-covered areas.

Scattered — brush-free areas are larger than brush-covered areas.

75. Potential Danger Trees: T/T Record the estimated number of danger trees per hectare that are greater than 5 meters in height. This is a visual observation that should be averaged throughout the entire stratum. The number of danger trees should be estimated during the walk-through.

76. Danger Trees on Perimeter / Outside of the Stratum: T/T Check this box if there are danger trees on the perimeter or outside of the stratum.

77. Work Hazard: T/T Record the estimated potential work hazard that the danger trees may pose to workers on the site. Check the appropriate box. This is a visual observation that should be averaged throughout the entire stratum. Work hazard should be estimated during the walk-through. It is often valuable to describe the snag distribution. For example, “found in south corner only” or “none in block, or many on perimeter”.

78. Machine Trafficability: T/T Record the ability of a machine to travel through the stratum. Check the appropriate box next to machine trafficability. This is a visual observation that should be averaged throughout the entire stratum. Machine trafficability should be estimated during the

walk-through and will be impacted by slope, slash, soil moisture, residuals and drainage patterns (i.e., creeks).

79. Soil Compaction Hazard: T/T Record the soil compaction hazard rating of a machine traveling through the stratum. Soil compaction hazard can be estimated during the walk-through as an average throughout the stratum. This information may be determined by using Table 13 on the FS 660 card.

80. Resource Values: T/T Record the presence or absence of the specified resource values in the area by checking the appropriate boxes, using visual observations. Resource values can be estimated during the walk-through. They can also be found in the silviculture plans and prescriptions.

81. Access: T/T Record the distance, in kilometers or hours, to the opening from a known location. The kilometers or hours should be listed by each of the individual modes of transportation.

82. Total Travel Time: T/T Record the estimated time required to travel to the opening from a known location. The time is to be recorded in hours and should be rounded off to the nearest ¼ hour.

Record the nearest readily identifiable geographic location, such as a city, a town, a village, or a camp.

83. Potential Road Construction and Maintenance Problems: T/T Record on the card and note on the survey map any road construction and maintenance problems which could be encountered during any upgrading, construction, or reconstruction of the access to the opening.

Where a road into an opening has been deactivated, add a check to indicate so and estimate the length of road from the start of the deactivation to the opening. It is not necessary to describe the extent of repairs necessary to re-construct a deactivated road.

85. Other: L/L This field is left open for general comments about the stratum. The following are examples of what could be recorded:

- success of treatments to date;
- defining characteristics of the stratum;
- the major limiting factors to achieving free growing;
- the average snow depth during the time of survey;
- ribbon color used;
- the preliminary treatment recommendation(s) for the stratum.

7.3 Precision Standards & Allowable Errors

Precision standards identify the maximum differences allowed between licensee and ministry estimates of a forest inventory/forest cover attribute or stratification. The precision standards are measured by determining the difference between the data reported by the licensee and data collected from a ministry survey of the same area.

The ministry may consider differences between estimates of an attribute that exceeds the required precision standard as being in **non-compliance with form and manner specifications of FPPR 86(6).**

Table 9 outlines the minimum precision standards for data submissions from the *RESULTS Information Submission Specifications* documents. It also includes common contract tolerances for other attributes. These non-legal thresholds are *italicized*.

Attribute	**Allowable Error**
Species Composition	±20%
Total trees/ha	± 20%
Well-spaced or free growing per hectare	± 10%
Age	± 20%
Heights	± 20%
Site index	± 3 meters
Pest infection	>10% absolute difference (e.g., 2% vs. 13% of incidence of host species)
Crown closure	*± 10%*
All plot centers and tie points	*± 2% of horizontal distance*
Countable conifers per hectare	*± 20%*
Plantable spots/ha	*20%*
Stratum area (ha)	*± 10%*

Table 9: Allowable errors in measurement

Note: The percent allowable error applies to the reported totals and averages. It is not for individual measurements.

7.4 Inventory Label Background

In 2021, the provincial Free Growing Working Group (FGWG) completed a Data Needs Assessment. The group consulted with program areas (e.g., growth and yield, carbon, forest health, wildlife, wildfire, etc.) to understand the current use of data, necessary changes, and meaningful additional data elements.

All program areas expressed a strong reliance on inventory data, particularly the species composition, density, heights, and ages. However, they also shared concerns about the precision of the species composition due to current standards (20%) and the use of ocular estimates and rounding (nearest 10%). Respondents cited observer bias, lack of repeatability, disconnect between species composition and density, and overestimation of minor species and underestimation of smaller trees as issues.

To address the rounding concerns, species composition will now be reported to the nearest 1%. If there are greater than 10 species, the smallest contributing species will be lumped with the leading species. For example:

Fdi21Sx20Cw13Bl10Pa9At7Pli6Act4Ep4Hw3Lw2Py1 will become Fdi24Sx20Cw13Bl10Pa9At7Pli6Act4Ep4Hw3 for reporting.

The program areas, in consultation with the Office of the Chief Forester's Senior Biometrician, recommended that tree counts by species at each plot would produce a preferable inventory species composition, provided sampling intensity is adequate. They also noted that tree counts by species could capture the spatial distribution of total stems and species with a measure of dispersion. This would be valuable for growth and yield, predicting carbon capture and wildlife habitat, and for understanding wildfire resilience.

In addition, FAIB indicated that tree species percentages are based on relative basal area for older stands in the VRI, not volume. To create consistency, species composition will now be based on basal area for Layer 1 and density for Layers 2, 3, and 4 for multi-layered stands.

The program areas viewed germinants as inconsequential and expressed concerns with mortality. As a results, germinants will not be tallied by species or included in the inventory label (species composition or density). There are new fields in the FS 658 and FS 659 to track germinants separately.

Starting in 2023, inventory heights and ages will be based on plot measurements. The tallest, living tree of the leading and second species will be measured. This change removes all references of dominant/co-dominant trees with respect to the inventory label. This is important since the inventory label reflects all trees (excluding germinants), not just dominant/co-dominant trees. It also addresses the confusion surveyors faced when the leading or second species was in an intermediate or suppressed position.

Inventory heights will also include partial growth, during the active growing season. Measuring to the top of the tree is faster and easier, especially for indeterminate species, and will align with remote sensing height determinations.

7.5 Silviculture Survey Plot Card of the Ministry of Forests - FS 658

The *FS 658 Silviculture Survey Plot Card* is commonly used to collect data from individual plots during a silviculture survey. Data from the FS 658 card(s) are then summarized on the *FS 659 Silviculture Survey Summary Cards* or entered into a survey summary program.

Details on the following pages provide a comprehensive discussion regarding the information that needs to be recorded on the FS 658 form. The sample FS 658 below shows a number in each of the fields that correspond with the following headings.

7.5.1 Plot Types

There are two types of plots: count plots and full measure plots.

Count plots are simpler and happen more frequently. E.g., Plots 2, 3, 4, 6, 7, 8, 10.

The following data attributes are collected at count plots:

- Total stems by species
- WS by species
- FG by species
- Forest health (if applicable)
- Number "In" (if applicable)
- Countable height/conifers (if applicable)
- Germinants (if applicable)
- Plantable spots (if applicable)
- Preparable spots (if applicable)

Full measure plots capture the attributes of a count plot, **plus**:

- Inventory heights
- Inventory ages
- Crown closure
- Silviculture height(s)
- Silviculture age(s)
- Ground vegetation
- Swiss needle cast data (Coast region, if applicable)
    - Leader growth
    - Needle retention by year

Full measure plots happen at the first plot and every fourth plot thereafter. E.g., Plots 1, 5, 9, 13.

Height and age measurements will sometimes happen at count plots when the target species is not present at the full measure plot.

7.5.2 FS 658 Data Entry

MINISTRY OF FORESTS — SILVICULTURE SURVEY PLOT CARD

SURVEYOR NAME(S) & REGISTRATION NO(S): Anne Simpson, A201500999 | SURVEY DATE Y 23 M 02 D 16 | PAGE 3 OF 5

MAPSHEET-OPENING NO.: 93B023-123 | LICENCE NO.: FLA12345 | CUTTING PERMIT: 678 | BLOCK: 9a | STANDARDS UNIT: 1 | STRATUM: A

PLOT NO.	STRA-TUM	DATA TYPE OR LAYER	COUNT CON.	COUNT HEIGHT (m)	Fdi p	Sx p	Cw p	Bl a	Pa u	At u	TOTALS	STRATUM/S INV/SILV SPP #1	INV / SILV SPP #1 HT	INV/ SILV SPP #1 AGE	STRATUM/S INV SPP #2	INV/ SPP #2 HT	INV/ SPP #2 AGE	INV CRWN CLSR	PLANTABLE	PREPARABLE	GERMINANTS "IN" NUMBER	GROUND VEGETATION SPECIES	% COVER	HT (m)	FOREST HEALTH PEST CODE	TREE SPECIES AND # AFFECTED LIVE TREES	DEAD TREES
1	A	T	36	1.3	29	2	15	9	-	26	81	Fdi	1.7	12	At	1.6	11	21	1	-	6	At	23	2.0	DRA	1Fdi, 1Bl	1Fdi
		W			3	1	-	1	-	-	5	-	-	-	-	-	-	-	-	-	-	Rubu par	10	1.5	AD	1Fdi	-
		F			3	1	-	Br	-	-	4	Fdi	1.6	12	-	-	-	-	-	-	-						
2	A	T	29	0.8	21	12	2	6	-	17	58	-	-	-	-	-	-	-	1	1	0	At	50	2.2	IWW	1Sx	-
		W			1	1	2	-	-	-	4	-	-	-	-	-	-	-	-	-	-				DRA	-	1Sx
		F			1	1	2	-	-	-	4	-	-	-	-	-	-	-	-	-	-						
3	A	T	41	1.1	21	12	12	1	-	15	61	Fdi	1.6	12	At	1.6	11	20	1	-	0	Sali spp.	15	2.0	DRA	1Fdi, 1Sx	1Fdi
		W			3	1	2	1	-	-	M	-	-	-	-	-	-	-	-	-	-						
		F			2 & 1Ht	1	1 & 1Ht	-	-	-	4	Fdi	1.5	12	-	-	-	-	-	-	-						
4	A	T	38	1.5	22	11	1	5	-	16	55	-	-	-	-	-	-	-	1	-	3	At	40	2.1	DRA	1Fdi, 1Sx	-
		W			3	2	1	-	-	-	M	-	-	-	-	-	-	-	-	-	-				AD	1Fdi	-
		F			3	1 & 1Ht	1	-	-	-	5	-	-	-	-	-	-	-	-	-	-						
5	A	T	32	1.3	27	1	5	6	1	19	59	Fdi	1.7	14	At	1.7	13	15	1	-	2	Sali spp.	20	2.4	DRA	1Fdi, 1Bl	1Fdi
		W			4	1	1	1	1	- <- 1 nice looking Pa is u	M	-	-	-	-	-	-	-	-	-	-	Rubu par	20	1.4			
		F			4	1	Br	1	-	-	M	Fdi	1.5	12	-	-	-	-	-	-	-						

Notes: Plot 1-The well spaced are clusted to one side so there is still one plantable spot. Plot 2-no signs of repression in the conifers.
Plot 5-Willow is being browsed. The remaining well spaced Fdi and Sx will outgrow the minor willow competition in 2 or 3 years. Pa looks good but is unacceptable species.
A brushing treatment is not required. Moose browse on the willow.

FS 658 2023/04/01

Figure 22: FS 658 Silviculture Survey Plot card, with sample data

MINISTRY OF FORESTS — SILVICULTURE SURVEY PLOT CARD

SURVEYOR NAME(S) & REGISTRATION NO(S): 15 | SURVEY DATE Y M 6 D | PAGE 5 OF

MAPSHEET-OPENING NO.: 7 | LICENCE NO.: 8 | CUTTING PERMIT: 9 | BLOCK: 10 | 109 | STANDARDS UNIT: 11 | STRATUM: 12

PLOT NO.	STRA-TUM	DATA TYPE OR LAYER	COUNT CON.	COUNT HEIGHT (m)	93	94	95	96	97	TOTALS	STRATUM/S INV/SILV SPP #1	INV / SILV SPP #1 HT	INV/ SILV SPP #1 AGE	STRATUM/S INV SPP #2	INV/ SPP #2 HT	INV/ SPP #2 AGE	INV CRWN CLSR	PLANTABLE	PREPARABLE	GERMINANTS "IN" NUMBER	GROUND VEGETATION SPECIES	% COVER	HT (m)	FOREST HEALTH PEST CODE	TREE SPECIES AND # AFFECTED LIVE TREES	DEAD TREES
86	87	88	91	92			95			98		102a	103a	101b	102b	103b	106	107	108	110	111	112	113	114	115	116
		89					96			99	101a															
		90					97			100		104a	105a													

Notes: 117

FS 658 2023/04/01

Figure 23: FS 658 Silviculture Survey Plot Card, with Field Numbers

Previously described field numbers will not be repeated in the descriptions to follow. Refer to the previous section for their description.

86. Plot No.: H/H Record the plot number assigned to the plot.

87. Stratum: H/H Identify the stratum the plot is in.

88. Data Type or Layer- "T": H/H Enter "T" to represent total trees.

If there are multiple layers (e.g., multi-storied, layered, DFP, or SEDRSS stands), the total tree (T) row will need to be replicated for each applicable layer. E.g., T1, T2, T3, T4.

89. Data Type or Layer- "W": H/H Enter "W" to represent well spaced trees.

If there are multiple layers (e.g., multi-storied, layered), the well-spaced tree (W) row will need to be replicated for each applicable layer. E.g., W1, W2, W3, W4.

90. Data Type or Layer- "F": L/H Enter "F" to represent free growing trees.

If there are multiple layers (e.g., multi-storied, layered), the free-growing tree (F) row will need to be replicated for each applicable layer. E.g., F1, F2, F3, F4.

91. Count. Conifers: T/H[11] Record the total number of live coniferous trees in the plot, regardless of species and quality, which are greater than or equal to the minimum countable height (field 92).

This data does not need to be collected during stocking surveys or for standards units that do not have a maximum density indicated in the silviculture plan or prescription. If it is clear during a stocking survey that a spacing treatment may be required, surveyors will typically collect this information. It is not required for strata that are obviously less than maximum density.

11 – Only used for strata with a maximum density requirement in the stocking standards.

92. Count. Height: T/H[11] Record the countable height. For guidance on determining countable height, refer to the maximum density section of this document.

For openings managed on an uneven-aged basis, the calculation of countable height is not applicable, since all conifers in layer 3 contribute towards the maximum density calculations.

11 – Only required for strata with a maximum density requirement in the stocking standards.

93. Blank (no title): H/H List all the 'commercial' tree species present within the stratum (p, a, and u). All tree species listed in Table 6 of the FS660 or the RESULTS tree list can be considered 'commercial.'

All cards used to collect data for a given stratum should be prepared with column labels in the same sequence. This helps minimize data summary errors.

94. Blank (no title): H/H For each species, enter P, A, or U (preferred, acceptable, or unacceptable), corresponding to the level of acceptability, as found in the silviculture plan or prescription. Acceptability is listed in Field 35 of the FS657.

95. Total trees: H/H Tally the total number of living trees **by species** in the plot. Tally all tree species listed in the FS660 or the RESULTS tree list, including broadleaf species. Include both acceptable and unacceptable quality trees. All trees are to be tallied, **except germinants.**

A germinant is a ≤5cm natural A germinant is a ≤5cm natural (disregarding the loss of height by a forest health factor).

Note: Planted seedlings under 5cm (e.g., due to browse) or well-spaced trees of any size are counted under total trees (Field 95), not germinants (Field 110).

If there are more than 50 trees in the 3.99m plot (all species combined, excluding germinants), then it is reasonable to estimate tree counts by species. However, surveyors should exercise caution because the precision standards must still be met at the stratum level.

96. Well-spaced trees: H/H Tally the well-spaced trees by species in the plot.

The preference in selecting preferred or acceptable tree species is only important if the stratum has a minimum preferred stocking standard found in field 46. If field 46 is blank, preferred or acceptable species may be selected equally.

When conducting a regeneration delay or stocking survey, the surveyor is expected to maximize the number of well-spaced trees in each plot. Record all well-spaced trees in excess of the M-value, where they exist in the plot.

Maximizing the well-spaced tree count may mean a reduction in the number that are of the preferred species, within the limits of the M-value.

For example, Figure 24 assumes field 46 has a minimum preferred stocking standard value. All the conifers in the example are preferred or acceptable species and meet the well-spaced criteria.

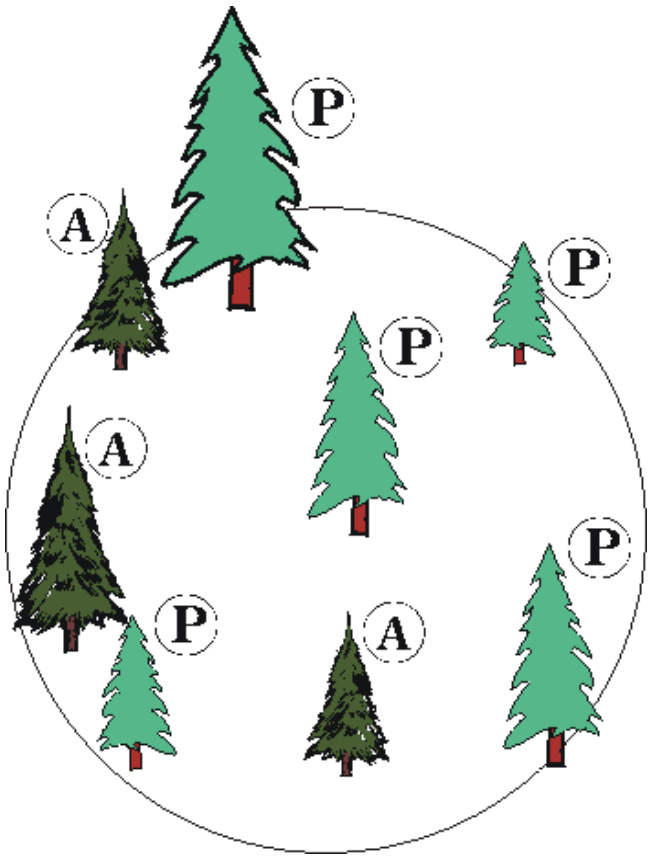


Figure 24. An example of tallying well-spaced trees.

By selecting only preferred species (marked P in the figure above), only 5 trees would be identified as well-spaced. By selecting a mix of both preferred and acceptable species, more will be identified. If the M-value were 6, it would be simple to select 4 preferred plus 2 acceptable, thereby maximizing well-spaced to the M-value.

Unacceptable species can also be tallied as well-spaced. The surveyor must first maximize the plot with the preferred and acceptable species before tallying any unacceptable species. The intent of tallying unacceptable species is primarily for treatment recommendations. Tallying unacceptable species will also provide justification when recommending an amendment to allow the unacceptable species to be considered as an acceptable species on the opening.

97. Free growing trees: L/H Tally the free growing trees by species in the plot. Maximize the number of preferred and acceptable trees that meet the criteria for an acceptable free growing tree, using the free growing damage criteria.

Unacceptable species can also be tallied as free growing. The surveyor must first maximize the plot with the preferred and acceptable species before tallying any unacceptable species. The intent of tallying unacceptable species is primarily for treatment recommendations. Tallying unacceptable species will also provide justification when recommending an amendment to allow the unacceptable species to be considered as an acceptable species on the standards unit.

98. Totals (Total Trees): H/H Record the sum of the total tree tallies by species (field 95).

99. Totals (WS): H/H Record the sum of the preferred and acceptable well-spaced trees in the plot, up to a maximum of the M-value. If the maximum value is reached or exceeded, record the letter 'M' rather than the numeric value. The number of Ms will be used in calculations on the FS 659 card. Do not include unacceptable species in this field.

100. Totals (FG): N/H Record the sum of the preferred and acceptable free growing trees in the plot up to a maximum of the M-value. If the maximum value is reached or exceeded, record the letter 'M' rather than the numeric value. The number of Ms will be used in calculations on the FS 659 card. Do not include unacceptable species in this field.

101a. Stratum's INV/SILV SPP #1: O/O Record the stratum's leading species for the applicable data type or layer.

If the leading silviculture species for the stratum is unclear based on your walk-through, collect silviculture heights and ages for each of the potentially leading species. These measurements can be averaged by species and reported to RESULTS.

If the leading or secondary inventory species for the stratum is unclear based on your walk-through, collect inventory heights and ages for each of the potentially leading and secondary inventory species. These measurements can be averaged by species and reported to RESULTS.

While it is optional, there are many benefits to collecting and reporting silviculture heights and ages for the non-leading silviculture species. For example, silviculture heights and ages by species can be used:
-To compare free growing heights for each species to the stocking standard minimum heights
-To predict free growing timing
-To understand growth rates by species

The same sample tree must be used for both the height and age determination.

102a. Inv SPP #1 Height (m): H/H Select the tallest (excluding residuals), living tree in the 3.99m radius plot for the leading inventory species of the stratum. Measure and record the height of the selected tree.

103a. Inv SPP #1 Age: H/H Select the tallest (excluding residuals), living tree in the 3.99m radius plot for the leading inventory species of the stratum. Measure and record the age of the selected tree.

104a. Silv SPP #1 Height (m): **H/H** If collecting free growing information, select a representative free growing tree from within the plot for the leading free growing species of the stratum. Measure and record the height of the selected tree in the "F" row.

If collecting regeneration delay or stocking information, select a representative well-spaced tree from within the plot for the leading WS species of the stratum. Measure and record the height of the selected tree in the "W" row.

If collecting stocking and free growing information on two separate lines, record height for the leading well-spaced and leading free growing species.

105a. Silv SPP #1 Age: **H/H** If collecting free growing information, select a representative free growing tree from within the plot for the leading free growing species of the stratum. Measure and record the age of the selected tree in the "F" row.

If collecting regeneration delay or stocking information, select a representative well-spaced tree from within the plot for the leading well-spaced species of the stratum. Measure and record the age of the selected tree in the "W" row.

If collecting stocking and free growing information on two separate lines, record age for the leading well-spaced and leading free growing species.

101b. Stratum's INV/SILV SPP #2: O/O Record the stratum's secondary species for the applicable data type or layer.

102b. Inv SPP #2 Height (m): H/H Record the height for the second most abundant species of the stratum. Follow the instructions for Field 102a, but for the second most abundant species.

103b. Inv SPP #2 Age: H/H Record the age for the second most abundant inventory species of the stratum. Follow the instructions for Field 101, but for the second most abundant species.

106. Crown Closure (%): H/H Crown closure is the proportion of a stand covered by the crowns of live, commercial trees.

Crown closure is best estimated using visual observation of recent aerial photography, for example, UAV imagery. There are "speckle" diagrams available in the FS660 to help calibrate surveyors' estimates.

Where recent aerial photographs are not available, surveyors are forced to use ground-based visual assessments. These estimates can reflect conditions in and around the plot.

Be cautious- junior surveyors often overestimate crown closure, particularly on stands with lower site indices.

Crown closure can be reported to the nearest 1%; however, it is acceptable to round to the nearest 5%. E.g., 1, 5, 10, 15, 20, etc.

Note: The ideal time to estimate crown closure is during full leaf flush (summer). Crown closure will not be accurate during leaf off for broadleaf species and larch.

Determining Tree Age:

For species that exhibit determinate growth, age can be reliably estimated by counting the number of whorls.

For species that exhibit indeterminate growth or for younger trees, destructive sampling may be necessary to accurately determine age. Age can be determined by cutting a disc from the base of the sample tree and counting the number of rings. Use of an increment borer on larger tree is also an option.

The age of planted trees can be determined by adding the age of the planted stock plus the number of completed growing seasons since the planting treatment. When surveys are completed during the active growing season, record the number of completed year's growth.

For example:

If it's June 2023 and 1+0 trees were planted in September 2020, they would be 3 years old.

If it's June 2023 and 1+0 trees were planted in April 2020, they would be 4 years old.

If it's September 2023 and 1+0 trees were planted in September 2020, they would be 4 years old.

If it's September 2023 and 1+0 trees were planted in April 2020, they would be 5 years old.

If it's September 2023 and 2+0 seedlings were planted in April 2020, they would be 6 years old.

In older or multi-storied stands, tree ages are based on ring counts derived from bored core samples. Samples must include the correction factor for the bore height based on the site index. Refer to the FS660 for the correction factors.

Determining Tree Height:

Measure from the point of germination to the top of the dominant leader of the selected tree.

During the active growing season, include the leader growth (in-season partial growth) in the height measurement.

Height is expressed in metres to 1 decimal place. E.g., 4.1m

Frequency of Measurements:

Measurements for silviculture and inventory heights/ages should be recorded on the first plot and every fourth plot thereafter. If the target species is not present, complete the height measurement at the next plot with the species present.

At minimum, three samples should be collected per stratum, although more samples are encouraged.

107. Plantable: T/N Record the number of plantable spots found in the plot. A plantable spot is defined as suitable microsite on which a seedling could be planted (see fields 60-62). The suitability of the microsite is dependent on-site conditions and limiting factors such as soil moisture, soil temperature, soil nutrients, climatic conditions, tree species and the stock type to be planted. The intent of recording the number of plantable spots is to determine if planting can be completed without site preparation. It will also estimate the number of seedlings that will be required to complete a planting project on the survey area. As a result, it is important to record the number of plantable spots based on the same criteria that will be used by the planters. Since the planters will be instructed to plant trees on microsites as directed by the licensee's silviculture staff, it will be important to discuss planting spot selection with them prior to conducting the survey.

It is recommended that plantability data be collected on all surveys where significant quantities of plantable spots are present. If a multi-storey survey is being completed, plantability is recorded in the row of data corresponding to layer four, or the lowest layer recorded.

If the number of plantable spots meets the planting "M" value (Field 48), record the letter 'M' rather than the numeric value.

108. Preparable: T/N Record the number of preparable spots found in the plot. A preparable spot is defined as a microsite that is presently unsuitable for planting but, with site preparation, could become an acceptable planting microsite. Preparable spots are tallied independent from plantable spots.

109. Germinants/Number "In" Check Box: T/N or H/H Check (✓ or ×) to indicate if Germinants or Number "In" apply.

For strata with basal area specified in the stocking standards or strata with >5m^2/ha, number "In" **must** be recorded if Layer 1 trees are found with a prism sweep. This data is used to calculate the basal area.

110. Germinants/Number "In": T/N or H/H

Germinants can have a large impact on treatment recommendations. While it is an optional field, it is strongly recommended that germinants are collected during natural regeneration or survival assessments.

If Germinants is checked in Field 109, record the number of germinants in the plot.

A germinant is a ≤5cm natural (disregarding the loss of height by a forest health factor). Age is not a consideration.

Note: Planted seedlings under 5cm or well-spaced trees of any size are counted under total trees (Field 95), not germinants (Field 110).

Example 1: A 2-year-old Pli is 8cm. It is not a germinant because it is >5cm.

Example 2: A less than 1-year old Hw is 7cm. It is not a germinant because it is >5cm.

Example 3: A 2-year-old planted Fdc is 4cm due to elk browse. It is not a germinant because it was planted.

Example 4: A 2-year-old natural Cw is 5cm and heavily browsed. It is not a germinant because an elk has removed a portion of its height.

Example 5: A 1-year old Sx is 3cm. It is a germinant because it is a ≤5cm natural.

If Number "In" is checked in Field 110, record the number of Layer 1 trees "IN" the prism sweep.

111. Ground Vegetation – Species: T/H Record the herbaceous, shrub, and broadleaf species present in and around the plot. At minimum, competing vegetation species should be recorded.

Based on local-level interests and needs, Field 111 can also be used to record forage, invasive, edible, medicinal, or culturally important species.

The FS 660 outlines a Vegetation Resource Inventory consistent vegetation abbreviation system. It is recommended but not essential. The first four letters of the genus are listed, followed by the first three letters of the species.

112. Ground Vegetation - % Cover: T/H Record the average percent of the ground that is covered by the vegetation species. This is an ocular estimate of the vegetation percent cover in and around the plot, not just within the plot.

113. Ground Vegetation - Height (m): T/H Record the average height, in meters, of each of the vegetation species. This is an ocular estimate based on the average height of the vegetation in and around the plot, not just within the plot.

114. Forest Health – Pest Code: H/H Record the applicable pest codes for forest health factors. Consider forest health damage on **all** trees within the plot, not just well-spaced or possibly free growing trees. Multiple rows may be required where multiple forest health factors are present in a single plot. Forest health data is collected at every plot.

If there are multiple forest health factors on the same tree, record only the one with the longer and/or more damaging impact. For instance, if a pest causes mortality, it should be prioritized over a forest health factor that causes a growth rate reduction. If you are uncertain about which forest health factors have longer and/or more damaging impact, contact your regional Forest Pathologist and Entomologist for clarification before beginning your surveys.

Refer to the Damage Agent code table for a comprehensive list of forest health factors and their corresponding codes.

There is a key reporting difference between free growing and regeneration delay.

Free growing: Tally only those occurrences of forest health factors where the extent of damage is unacceptable, as defined by the free growing damage criteria. Refer to the FS660 for the damage criteria.

Regen delay: The free growing damage criteria do not apply. Tally **all** incidences of forest health factors (max of 1 per tree). Trees with **very minor** damage can be excluded if they meet the following conditions:

- No wounds, galls, cankers, or mistletoe
- Good foliar colour and needle retention for the tree species and age
- Normal growth (above and below ground)
- Living leader

Report the damage if these conditions are not met or if it is unclear whether they are met.

Trees with reportable damage can be considered well-spaced unless the damage will prevent the tree from attaining free-growing status in the future (e.g., rust canker or gall on the main stem).

Example 1: A four-year-old Fdc has a single browsed branch. Despite this browse, the tree appears normal and healthy. It has a living leader, decent growth, good colour, and no wounds, galls, cankers, or mistletoe. The browse does not need to be recorded or reported.

Example 2: A two-year-old Fdc is partially girdled by a conifer seedling weevil. The seedling is chlorotic, and its leader growth is below average. The IWC damage must be reported.

Note: Do not tally forest health damage on germinants.

Stocking: If the stand is an age or height where it could be free growing, only record those trees that are found to be unacceptable based on the free growing damage criteria. Follow the guidance provided for free growing above. Refer to the FS660 for the damage criteria. If free growing trees will not be tallied, record all incidence of forest health factors (follow regen delay guidance).

Exception: If you tally a tree as free growing during a regeneration delay or stocking survey, do not record acceptable forest health damage, as defined by the free growing damage criteria, for that tree.

115. Forest Health – Live Trees: H/H Record the number of live trees affected by the forest health agent indicated in field 114.

116. Forest Health – Dead Trees: H/H Record the number of dead trees affected by the forest health agent indicated in field 114.

117. Notes: L/L Record site specific details that are relevant to the survey and potential treatment recommendations. For example: tree cover pattern (if dispersed retention present), leader height, local anomalies, etc.

7.6 Forest Health

7.6.1 Damage Criteria

To declare a stand free growing, there must be adequate stocking of healthy, well-spaced trees of a preferred or acceptable species. Free growing damage criteria can help surveyors identify the healthy trees. The criteria are designed to determine the acceptability of individual trees.

There are criteria for:

- even-aged (age class 1) coniferous trees
- broadleaf trees
- multi-storied conifer stands
- SEDRSS, Interior DFP, and Layered stands
- advanced regeneration

The surveyor must select and use the appropriate criteria since they vary by age, species, and silvicultural system. The assumptions made on the impact of pest damage to potential crop trees are founded on these factors.

The criteria are listed in the FS660 Silviculture Survey Reference.

Note: The forest health damage criteria are not up to date in the Establishment to Free Growing guidebooks.

A Delegated Decision Maker (DDM) may allow or require deviations from these criteria if the legal requirement to produce a healthy free growing stand is met.

7.6.2 Resources

For help with forest health identification, consult the Field Guide to Forest Damage in British Columbia or Common Tree Diseases of British Columbia.

To learn about the provincial Forest Health Program, please visit: Forest health - Province of British Columbia. The website contains information on individual forest health factors, aerial overview surveys, forest health strategies, and relevant legislation.

Stand Establishment Decision Aids (SEDA) exist for several forest health agents. They can be accessed for free through the Journal of Ecosystem Management (JEM): https://jem-online.org/index.php/jem/search/search

- Tomentosus Root Rot (2013)
- Laminated Root Disease (2011)
- White Pine Blister Rust (2009)
- Hemlock Dwarf Mistletoe (2004)
- Dothistroma (2009)
- Warren Root Collar Weevil (2009)
- Spruce Weevil & Western Spruce Budworm (2006)
- Spruce/White Pine Weevil (2011)

Other helpful resources may include the following handbooks:

- Managing Root Disease in British Columbia (2018)
- LMH 73: Managing Dwarf Mistletoe in British Columbia (2019)
- LMH 74: Elytroderma needle cast on lodgepole pine in British Columbia (2020)

If a forest health factor is still unknown or uncertain, record and describe the type of damage, obtain a sample, and reach out to the district or regional forest health specialist.

7.6.3 Best Management Practices

1. If a forest health factor is expected to be problematic, schedule the survey for a time when the damage is most apparent and easily seen. **To accurately identify pine rusts in young stands, align survey timing with annual sporulation periods (generally between May and July each year).**

2. Complete a forest cover submission if the attributes of the forest cover inventory significantly change.

For example, using planting inspection plots, you report the forest cover as 1200sph of Fdc and declare regen delay met. You complete a survival survey 1 year later and find 45% mortality due to conifer seedling weevil (IWC). The stocking standards are still met due to Hw natural infill. In this situation, it is highly recommended to submit a new forest cover to RESULTS to reflect this damage and significant shift in silviculture and inventory labels.

3. If survival is expected to be poor, avoid declaring regeneration delay met at the time of planting.

7.6.4 Swiss Needle Cast

Swiss needle cast (SNC) poses an increasing threat to the future growth of British Columbia's coastal forests. Greater monitoring and adaptive strategies are necessary to mitigate the potential negative impacts of SNC.

As a result, the Ministry of Forests released a new SNC data collection procedure on February 1st, 2023, for the Coast region of British Columbia.

The SNC data collection should be completed on all stands with ≥50% Fdc with trees ≥ 5 years old. This data should be captured on all strata where Fdc was the intended crop species. If your operating area experiences high levels of natural infill, consider using a lower Fdc threshold.

The data collection can occur during any survey type and season. It is not linked to a RESULTS forest cover reporting obligation.

For detailed instructions on the SNC data collection procedure, please refer to: https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/silviculture/silviculture-surveys/silviculture-survey-reference-documents

Under the SNC section, there is a spreadsheet with written instructions, the submission template, helpful graphics, and reference pictures.

Several training videos are linked. They can be found on the BC Silviculture Surveys YouTube channel. Please watch these videos before completing the SNC data collection.

For more information on SNC, please refer to: https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/foliar-pathogens/swiss-needle-cast

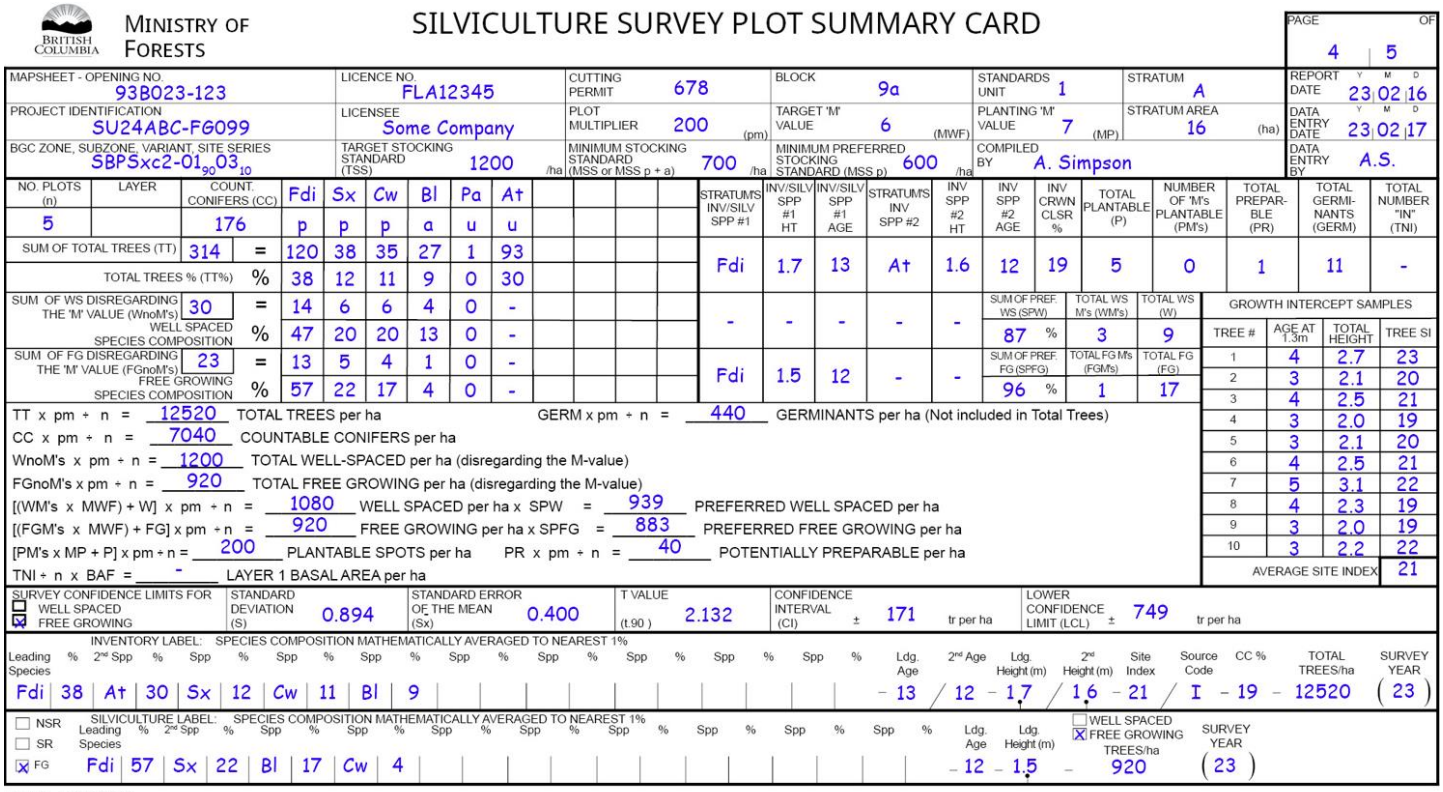
8 Compilation

For each stratum identified and confirmed in the field during the walk-through, a separate compilation must be completed. Various field cards (e.g., Silviculture Survey Summary FS 659, Calculation Card for Silviculture Survey Confidence Limits FS 1138A, and Silviculture Survey Reference FS 660) are available to assist in data compilation.

The FS 659 is used to summarize data collected on the FS 657 and FS 658. Before leaving the opening, statistical calculations must be completed to ensure statistical precision has been met. More plots may need to be established to meet statistical precision. Comments that will be used to create treatment recommendations should also be recorded prior to leaving the opening.

The process of completing the FS 659 is described below. Refer to the FS 657 and FS 658 cards to assist in completing this card.

8.1 Data Field Descriptions for the Ministry of Forests FS 659



MINISTRY OF FORESTS

SILVICULTURE SURVEY PLOT SUMMARY CARD

PAGE 4 OF 5

MAPSHEET - OPENING NO.: 93B023-123	LICENCE NO.: FLA12345	CUTTING PERMIT: 678	BLOCK: 9a	STANDARDS UNIT: 1	STRATUM: A	REPORT DATE (Y M D): 23 02 16
PROJECT IDENTIFICATION: SU24ABC-FG099	LICENSEE: Some Company	PLOT MULTIPLIER: 200 (pm)	TARGET 'M' VALUE: 6 (MWF)	PLANTING 'M' VALUE: 7 (MP)	STRATUM AREA: 16 (ha)	DATA ENTRY DATE (Y M D): 23 02 17
BGC ZONE, SUBZONE, VARIANT, SITE SERIES: SBPSxc2-01 90 03 10	TARGET STOCKING STANDARD (TSS): 1200 /ha	MINIMUM STOCKING STANDARD (MSS or MSS p + a): 700 /ha	MINIMUM PREFERRED STOCKING STANDARD (MSS p): 600 /ha	COMPILED BY: A. Simpson		DATA ENTRY BY: A.S.

NO. PLOTS (n)	LAYER	COUNT: CONIFERS (CC)	Fdi	Sx	Cw	Bl	Pa	At
5		176	p	p	p	a	u	u
SUM OF TOTAL TREES (TT)		314 =	120	38	35	27	1	93
TOTAL TREES % (TT%)		%	38	12	11	9	0	30
SUM OF WS DISREGARDING THE 'M' VALUE (WnoM's)		30 =	14	6	6	4	0	-
WELL SPACED SPECIES COMPOSITION		%	47	20	20	13	0	-
SUM OF FG DISREGARDING THE 'M' VALUE (FGnoM's)		23 =	13	5	4	1	0	-
FREE GROWING SPECIES COMPOSITION		%	57	22	17	4	0	-

STRATUM'S INV/SILV SPP #1	INV/SILV SPP #1 HT	INV/SILV SPP #1 AGE	STRATUM'S INV SPP #2	INV SPP #2 HT	INV SPP #2 AGE	INV CRWN CLSR %	TOTAL PLANTABLE (P)	NUMBER OF 'M's PLANTABLE (PM's)	TOTAL PREPARABLE (PR)	TOTAL GERMINANTS (GERM)	TOTAL NUMBER "IN" (TNI)
Fdi	1.7	13	At	1.6	12	19	5	0	1	11	-

	SUM OF PREF. WS (SPW)	TOTAL WS M's (WM's)	TOTAL WS (W)
	87 %	3	9

	SUM OF PREF. FG (SPFG)	TOTAL FG M's (FGM's)	TOTAL FG (FG)
	96 %	1	17

GROWTH INTERCEPT SAMPLES

TREE #	AGE AT 1.3m	TOTAL HEIGHT	TREE SI
1	4	2.7	23
2	3	2.1	20
3	4	2.5	21
4	3	2.0	19
5	3	2.1	20
6	4	2.5	21
7	5	3.1	22
8	4	2.3	19
9	3	2.0	19
10	3	2.2	22
AVERAGE SITE INDEX			21

TT x pm ÷ n = 12520 TOTAL TREES per ha — GERM x pm ÷ n = 440 GERMINANTS per ha (Not included in Total Trees)

CC x pm ÷ n = 7040 COUNTABLE CONIFERS per ha

WnoM's x pm ÷ n = 1200 TOTAL WELL-SPACED per ha (disregarding the M-value)

FGnoM's x pm ÷ n = 920 TOTAL FREE GROWING per ha (disregarding the M-value)

[(WM's x MWF) + W] x pm ÷ n = 1080 WELL SPACED per ha x SPW = 939 PREFERRED WELL SPACED per ha

[(FGM's x MWF) + FG] x pm ÷ n = 920 FREE GROWING per ha x SPFG = 883 PREFERRED FREE GROWING per ha

[PM's x MP + P] x pm ÷ n = 200 PLANTABLE SPOTS per ha — PR x pm ÷ n = 40 POTENTIALLY PREPARABLE per ha

TNI ÷ n x BAF = - LAYER 1 BASAL AREA per ha

SURVEY CONFIDENCE LIMITS FOR	STANDARD DEVIATION (S)	STANDARD ERROR OF THE MEAN (Sx)	T VALUE (t.90)	CONFIDENCE INTERVAL (CI) ±	LOWER CONFIDENCE LIMIT (LCL) ±
☐ WELL SPACED ☒ FREE GROWING	0.894	0.400	2.132	171 tr per ha	749 tr per ha

INVENTORY LABEL: SPECIES COMPOSITION MATHEMATICALLY AVERAGED TO NEAREST 1%

Leading Species	%	2nd Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Ldg. Age	2nd Age	Ldg. Height (m)	2nd Height (m)	Site Index	Source Code	CC %	TOTAL TREES/ha	SURVEY YEAR
Fdi	38	At	30	Sx	12	Cw	11	Bl	9											13	12	1.7	1.6	21	I	19	12520	(23)

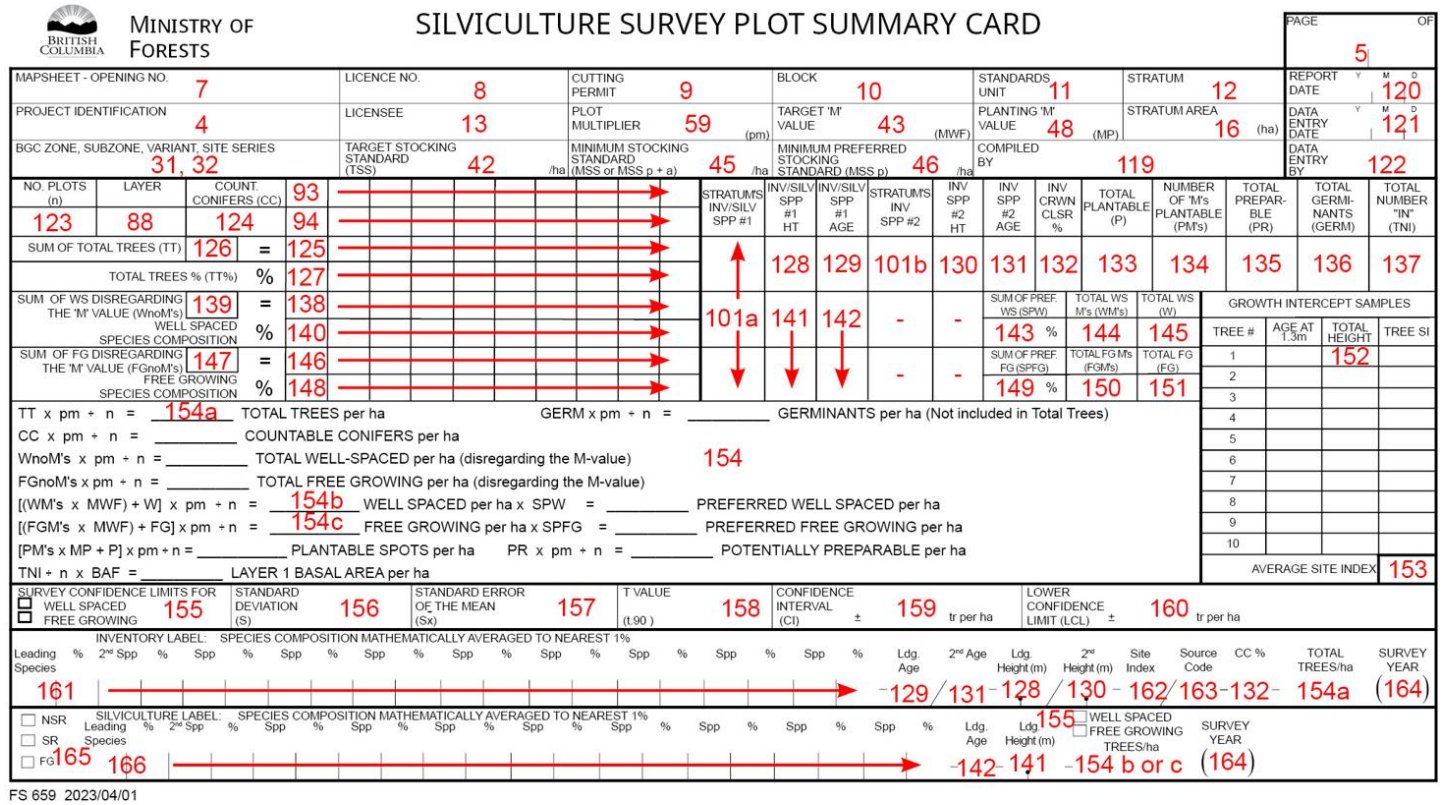
SILVICULTURE LABEL: SPECIES COMPOSITION MATHEMATICALLY AVERAGED TO NEAREST 1%

☐ NSR ☐ SR ☒ FG

Leading Species	%	2nd Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Ldg. Age	Ldg. Height (m)	☐ WELL SPACED ☒ FREE GROWING TREES/ha	SURVEY YEAR
Fdi	57	Sx	22	Bl	17	Cw	4													12	1.5	920	(23)

FS 659 2023/04/01

Figure 25: FS659 Silviculture Survey Summary card, front side, with sample date.



MINISTRY OF FORESTS

SILVICULTURE SURVEY PLOT SUMMARY CARD

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MAPSHEET - OPENING NO.: 7	LICENCE NO.: 8	CUTTING PERMIT: 9	BLOCK: 10	STANDARDS UNIT: 11	STRATUM: 12	REPORT DATE (Y M D): 120
PROJECT IDENTIFICATION: 4	LICENSEE: 13	PLOT MULTIPLIER: 59 (pm)	TARGET 'M' VALUE: 43 (MWF)	PLANTING 'M' VALUE: 48 (MP)	STRATUM AREA: 16 (ha)	DATA ENTRY DATE (Y M D): 121
BGC ZONE, SUBZONE, VARIANT, SITE SERIES: 31, 32	TARGET STOCKING STANDARD (TSS): 42 /ha	MINIMUM STOCKING STANDARD (MSS or MSS p + a): 45 /ha	MINIMUM PREFERRED STOCKING STANDARD (MSS p): 46 /ha	COMPILED BY: 119		DATA ENTRY BY: 122

NO. PLOTS (n)	LAYER	COUNT: CONIFERS (CC)	
123	88	124	94
SUM OF TOTAL TREES (TT)		126 =	125
TOTAL TREES % (TT%)		%	127
SUM OF WS DISREGARDING THE 'M' VALUE (WnoM's)		139 =	138
WELL SPACED SPECIES COMPOSITION		%	140
SUM OF FG DISREGARDING THE 'M' VALUE (FGnoM's)		147 =	146
FREE GROWING SPECIES COMPOSITION		%	148

STRATUM'S INV/SILV SPP #1	INV/SILV SPP #1 HT	INV/SILV SPP #1 AGE	STRATUM'S INV SPP #2	INV SPP #2 HT	INV SPP #2 AGE	INV CRWN CLSR %	TOTAL PLANTABLE (P)	NUMBER OF 'M's PLANTABLE (PM's)	TOTAL PREPARABLE (PR)	TOTAL GERMINANTS (GERM)	TOTAL NUMBER "IN" (TNI)
101a	128	129	101b	130	131	132	133	134	135	136	137
	141	142	-	-	143 %	144	145				
			-	-	149 %	150	151				

	SUM OF PREF. WS (SPW)	TOTAL WS M's (WM's)	TOTAL WS (W)
	143 %	144	145

	SUM OF PREF. FG (SPFG)	TOTAL FG M's (FGM's)	TOTAL FG (FG)
	149 %	150	151

GROWTH INTERCEPT SAMPLES

TREE #	AGE AT 1.3m	TOTAL HEIGHT	TREE SI
1		152	
2			
3			
4			
5			
6			
7			
8			
9			
10			
AVERAGE SITE INDEX			153

TT x pm ÷ n = 154a TOTAL TREES per ha — GERM x pm ÷ n = _____ GERMINANTS per ha (Not included in Total Trees)

CC x pm ÷ n = _____ COUNTABLE CONIFERS per ha

WnoM's x pm ÷ n = _____ TOTAL WELL-SPACED per ha (disregarding the M-value) 154

FGnoM's x pm ÷ n = _____ TOTAL FREE GROWING per ha (disregarding the M-value)

[(WM's x MWF) + W] x pm ÷ n = 154b WELL SPACED per ha x SPW = _____ PREFERRED WELL SPACED per ha

[(FGM's x MWF) + FG] x pm ÷ n = 154c FREE GROWING per ha x SPFG = _____ PREFERRED FREE GROWING per ha

[PM's x MP + P] x pm ÷ n = _____ PLANTABLE SPOTS per ha — PR x pm ÷ n = _____ POTENTIALLY PREPARABLE per ha

TNI ÷ n x BAF = _____ LAYER 1 BASAL AREA per ha

SURVEY CONFIDENCE LIMITS FOR	STANDARD DEVIATION (S)	STANDARD ERROR OF THE MEAN (Sx)	T VALUE (t.90)	CONFIDENCE INTERVAL (CI) ±	LOWER CONFIDENCE LIMIT (LCL) ±
☐ WELL SPACED ☐ FREE GROWING 155	156	157	158	159 tr per ha	160 tr per ha

INVENTORY LABEL: SPECIES COMPOSITION MATHEMATICALLY AVERAGED TO NEAREST 1%

Leading Species	%	2nd Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Ldg. Age	2nd Age	Ldg. Height (m)	2nd Height (m)	Site Index	Source Code	CC %	TOTAL TREES/ha	SURVEY YEAR
161																				129	131	128	130	162	163	132	154a	(164)

SILVICULTURE LABEL: SPECIES COMPOSITION MATHEMATICALLY AVERAGED TO NEAREST 1%

☐ NSR ☐ SR ☐ FG 165

Leading Species	%	2nd Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Spp	%	Ldg. Age	Ldg. Height (m)	155 ☐ WELL SPACED ☐ FREE GROWING TREES/ha	SURVEY YEAR
166																				142	141	154 b or c	(164)

FS 659 2023/04/01

Figure 26: FS659 Silviculture Survey Summary card, front side, with field numbers.

The previously described field numbers will not be repeated in the descriptions to follow. Please refer to the previous section for their description.

Make sure to summarize only the data for one stratum on each summary card.

119. Compiled By: H/H Enter the name or company filling out the FS659 card.

120. Report Date: H/H Enter the date that the FS659 is being filled out.

121. Data Entry Date: H/H Enter the date that the survey information is being entered into the corporate database or RESULTS.

122. Data Entry By: H/H Enter the initials of the person completing the data entry.

123. No. plots (n): H/H Record the number of plots established in the stratum.

124. Countable conifers (CC): N/H[11] Record the sum of the countable conifers from the Countable conifers (field 91) of the FS 658 card.

[11] – Only required for strata with a maximum density requirement in the stocking standards.

125. Blank: H/H Sum total trees (field 95) by species (field 93) across plots.

126. Sum of Total trees (TT): H/H Sum the total tree counts by species (field 125) or sum total trees (field 98) across plots. It is recommended to complete both methods to ensure your calculations are correct.

127. Total trees species composition (TT%): H/H For each species, divide the value from field 125 by the value in field 126 and multiply by 100.

128. Inventory species #1 height (m): H/H Average of the height measurements collected on the FS 658 field 102a. This number must be rounded to the nearest tenth of a meter.

129. Inventory species #1 age (years): H/H Average of the age measurements collected on the FS 658 field 103a. This number must be rounded to a whole number.

130. Inventory species #2 height (m): H/H Average of the height measurements collected on the FS 658 field 102b. This number must be rounded to the nearest tenth of a meter.

131. Inventory species #2 age (years): H/H Average of the age measurements collected on the FS 658 field 103b. This number must be rounded to a whole number.

132. Inventory crown closure %: H/H Average of the crown closure samples recorded in field 106 of the FS 658.

133. Total plantable (P): T/N Record the sum of the plantable spots from field 107 from the FS 658 card, not including M's.

134. Number of M's plantable (PM's): T/N Count the number of M's entered in the plantable spots column (field 107) of the FS 658 card.

135. Total preparable (PR): T/N Record the sum of the preparable spots found in field 108 from the FS 658 card.

136. Total germinants (GERM): T/N If germinants is selected in field 109, record the sum of germinants from field 110 of the FS 658 card. Note: Do not confuse this value with Total "In".

137. Total Number "IN" (TNI): H[12]/H[12] If total “in” is selected in field 109, record the sum of the total trees "in" from field 110 of the FS 658 card. Note: Do not confuse this value with the germinants data.

[12] –Required if basal area is part of the stocking standard or if basal area is >5m^2/ha. It should always be collected as a best practice.

138. Blank: H/H Record the sum of well-spaced trees (field 96) by species (field 93).

139. Sum of WS disregarding the ‘M’ value (WnoM): H/H Record the sum of all values in field 138.

140. Well-spaced Species Composition: H/H For each species, divide the value from field 138 by the value in field 139 and multiply by 100.

141. Silviculture Tree Height (m): H/H Record the average height of the sample well-spaced or free growing trees of the leading species. This is the sum of the heights (field 104a) from the FS 658 card divided by the number of sample heights recorded. This number must be rounded to the nearest tenth of a meter.

If you collected well-spaced heights, record the silviculture tree height in the row associated with well-spaced data. If you collected free growing heights, record the silviculture tree height in the row associated with free growing data.

If you collected heights on multiple species, assess field 140 to determine the leading well-spaced species or field 148 to determine the leading free growing species. Enter in field 141 the average of the sample heights for the leading species.

142. Silviculture Tree Age (years): H/H Record the average age of the sample well-spaced or free growing trees of the leading species. This is the sum of the ages (field 105a) from the FS 658 card divided by the number of sample ages recorded. This number must be rounded to a whole number.

If you collected well-spaced ages, record the silviculture tree age in the row associated with well-spaced data. If you collected free growing ages, record the silviculture tree age in the row associated with free growing data.

If you collected ages on multiple species, assess field 140 to determine the leading well-spaced species or field 148 to determine the leading free growing species. Enter in field 142 the average of the sample ages for the leading species.

143. Sum of Preferred (SPW): H[6]/H[6] Sum the values found in field 140 for each of the columns marked “p” (preferred) as found in field 94.

[6] - If the silviculture plan or prescription was approved prior to April 1, 1994, there will be no minimum stocking standard for preferred species. This field will then be recorded as “-” or N/A. (see section on MSS vs. MSSp vs. MSSpa).

144. Total WS M’s (WM’s): H/H Record the number of ‘M’s in field 99.

145. Total (W): H/H Sum the number of well-spaced trees from field 99, not including the ‘M’s.

146. Blank: H/H Record the sum of free growing trees (field 97) by species (field 93).

147. Sum of FG disregarding the 'M' value (FGnoM): H/H Record the sum of all values in field 146.

148. Free Growing Species Composition: H/H For each species, divide the value from field 146 by the value in field 147 and multiply by 100.

149. Sum of Preferred (SPFG): H[6]/H[6] Sum the values found in field 148 for each of the columns marked "p" (preferred) as found in fields 94.

[6] - If the silviculture plan or prescription was approved prior to April 1, 1994, there will be no minimum stocking standard for preferred species. This field will then be recorded as "-" or N/A. (see section on MSS vs. MSSp vs. MSSpa).

150. Total M's (FGM's): L/H Record the number of 'M's in field 100.

151. Total (FG): L/H Record the sum of the number of free growing trees from field 100, not including the 'M's.

152. GI Sample & Data Spp.: N/H If this stratum is suitable for determining site index by growth intercept method, record the measurements and species here. Data may be collected in this area for ten growth intercept sample trees. Look up the site index for each sample tree on the FS 415 or using the SiteTools software for the site index species. Refer to site index training materials on the growth intercept method.

153. Average Site Index: N/H Average the individual tree site index values from all plots in the stratum.

154. Calculations*:* Follow the formulae provided to determine the resulting values.

H/H - Total Trees per ha

H/H – Germinants per ha

N/H[1] - Countable Conifers per ha

H/H - Total Well-spaced per ha (disregarding the M-value)

L/H - Free Growing per ha (disregarding the M-value)

H/H - Well-spaced per ha

H[2]/H[2] - Preferred Well-spaced per ha

L/H - Free Growing per ha

H[2]/H[2] - Preferred Free Growing per ha

T/N - Plantable Spots per ha

T/N- Potentially Preparable per ha

H/H – Layer 1 Basal Area per ha

[1] – Only required for strata with a maximum density requirement in the stocking standards.

[2] - If the silviculture prescription was approved prior to April 1, 1994, there will be no minimum stocking standard for preferred species and there may also be no minimum preferred for some approved FRPA FSP stocking standards. This field will then be recorded as "-" or N/A. (see section on MSS vs. MSSp vs. MSSpa).This methodology represents the preferred best

management practice approach to calculate the Preferred Well-spaced and Free Growing per ha., for this is the easiest and most efficient approach. Other methodologies are also acceptable as proposed by several practitioners, where the absolute values are used rather than the capped M-value totals.

Statistical Calculations*:* These fields are provided to record the results of the various statistical calculations required following a survey. The methods are fully described in this document under the section entitled Statistics.

The FS 1138A card may be used to calculate the Silviculture survey confidence limits.

155. Survey Confidence Limits For Well-spaced / Free Growing: H/H Check (✓ or ×) the box corresponding to the statistics completed.

156. Standard Deviation (S): H/H Determine the standard deviation on the well-spaced or free growing data. Most surveyors will choose to use a statistical calculator.

157. Standard Error of the Mean ($S_{\bar{x}}$): H/H Determine the standard error of the mean. Most surveyors will choose to use a statistical calculator.

158. T value (t90): H/H Look up the t-value on the FS 660. Look up the value corresponding to the number of plots (field 123) minus one.

159. Confidence Interval (CI): H/H The confidence interval is calculated by multiplying the standard error (field 157) by the t-value (field 158) by the plot multiplier (field 59)

160. Lower Confidence Limit (LCL): H/H The lower confidence limit is calculated by subtracting the confidence interval (field 159) from the well-spaced (field 154b) or free growing per ha (field 154c), depending on which box is selected in field 155.

161. Species & %: H/H Record the species from field 93 and % composition from field 127 in decreasing order of abundance. The species composition should be reported to the nearest 1%. The surveyor may not adjust these values.

All values in field 161 must add up to 100%. Occasionally, due to mathematical rounding, the total of all percentages may result in 99% or 101%. In this rare event, adjust the leading species percent to ensure the sum of all percentages is 100.

If there are greater than 10 species, group the most minor species with the leading species. For example:

Fdi21Sx20Cw13Bl10Pa9At7Pli6Act4Ep4Hw3Lw2Py1 would become

Fdi24Sx20Cw13Bl10Pa9At7Pli6Act4Ep4Hw3 for reporting.

Note: For single layer standards units (SU), the inventory species composition is based on density. For multi-layer SUs, inventory species composition is based on basal area for Layer 1 and density for Layers 2, 3, and 4.

162. Site Index: H/H Record the site index for the leading species in the inventory label. If using growth intercept, enter the average site index from field 153.

A complete discussion on site index determination can be found on the SIBEC website.

163. Source Code: H/H Record the method used to determine the site index for the stratum. Enter the abbreviation.

Code	Description	Surveyor Priority
A	Adjacent stand	Very rare
I	**Growth intercept, or subsequently converted using the average site index relationship table found in the** FS 660	**#1- preferred method for FG Surveys**
O	**November 1998 provincial SIBEC rollover**	**Not used by surveyors**
C	Site index curve, height age reference curves	May have value in some multi-layered stands or stands > 30 years BHA
H	Stand before harvest, rarely used	Very rare
E	SIBEC or Site index from the biogeoclimatic classification	#1- preferred method for RD survey #2- common alternative method for FG survey
M	**Converted from site class**	**#3- "last resort"**
S	**Assigned by District Stewardship Section**	**local preference**

Table 10: Site Index Method Codes

164. Survey Year: H/H Enter the last 2 digits of the survey year. Ex. 2023 = 23.

165. Stocking Status: H/H Check (✓ or ×) the box corresponding to the correct stocking status as determined by this survey.

166. Silviculture Label Spp & %: H/H If the status is SR or NSR, use the well-spaced species composition from field 140. If the status is FG, use the free growing species composition from field 148.

Record the largest % value and corresponding species under Leading Species. Record the second largest value and species under 2nd Spp. Record the remaining values, in decreasing order.

The species composition should be reported to the nearest 1%. The surveyor may not adjust these values. All values in field 166 must equal 100%.

MINISTRY OF FORESTS

SILVICULTURE SURVEY PLOT SUMMARY CARD

PAGE 5 OF 5

MAPSHEET - OPENING NO.: 93B023-123 | LICENCE NO.: FLA12345 | CUTTING PERMIT: 678 | BLOCK: 9a | STANDARDS UNIT: 1 | STRATUM: A | REPORT DATE (Y M D): 23 02 17

SUMMARY OF GROUND VEGETATION — CHECK (✓) APPROPRIATE BOXES

SPECIES (INCLUDE THE MAIN COMPETING SPECIES)	ESTIMATED % COVER	CURRENT HEIGHT (m) MINIMUM	CURRENT HEIGHT (m) MAXIMUM	CURRENT HEIGHT (m) AVERAGE	ANNUAL HT. INCREMENT (cm)	DISTRIBUTION CONTINUOUS	DISTRIBUTION PATCHY	DISTRIBUTION SCATTERED	CURRENT COMPETITION HIGH	CURRENT COMPETITION MEDIUM	CURRENT COMPETITION LOW	CURRENT COMPETITION NIL	POTENTIAL COMPETITION HIGH	POTENTIAL COMPETITION MEDIUM	POTENTIAL COMPETITION LOW	POTENTIAL COMPETITION NIL
At	38	1.0	2.6	2.1	20		✓			✓				✓		
Sali spp.	14	2.0	2.6	2.3	15		✓				✓				✓	
Rubu par	15	1.0	1.6	1.3	10			✓			✓					✓

PEST INFORMATION SUMMARY — REPORT COLUMN 7 INTO RESULTS

1 PEST CODE	2 AREA (ha) IF ONLY PART OF THE STRATUM AFFECTED	3 TOTAL TREES (TT) (sum of Total Trees column)	4 LIVE TREES AFFECTED (sum of Live Trees Affected column)	5 DEAD TREES AFFECTED (sum of Dead Tree column)	6 HOST SPECIES COMP. (TT%) (expressed as a decimal)	7 % HOST TREES AFFECTED {④+⑤ / [(③ X ⑥)+⑤]} x 100
DRA	all	314	8	4	0.59 Bl Fdi Sx	6.4
AD	all		2	0	0.38 Fdi	1.7
IWS	2ha		1	0	0.12 Sx	2.7

RECOMMENDED TREATMENTS

PRIMARY TREATMENT RECOMMENDATIONS AND CONSIDERATIONS	ALTERNATE TREATMENT RECOMMENDATIONS AND CONSIDERATIONS
The stratum has met its free growing requirements.	n/a
No additional treatments are required.	
	1 nice looking Pa was found in plot 5 = 40/ha WS and FG. Pa is
INCLUDE: OBJECTIVES, METHODS, YEAR, SEASON, SPECIES, PRIORITY ETC.	an unacceptable species performing well.

Figure 27: FS 659 Silviculture Survey Summary card, back side, with sample data.

MINISTRY OF FORESTS

SILVICULTURE SURVEY PLOT SUMMARY CARD

PAGE 5 OF

MAPSHEET - OPENING NO.: 7 | LICENCE NO.: 8 | CUTTING PERMIT: 9 | BLOCK: 10 | STANDARDS UNIT: 11 | STRATUM: 12 | REPORT DATE (Y M D): 120

SUMMARY OF GROUND VEGETATION — CHECK (✓) APPROPRIATE BOXES

SPECIES (INCLUDE THE MAIN COMPETING SPECIES)	ESTIMATED % COVER	CURRENT HEIGHT (m) MINIMUM	CURRENT HEIGHT (m) MAXIMUM	CURRENT HEIGHT (m) AVERAGE	ANNUAL HT. INCREMENT (cm)	DISTRIBUTION CONTINUOUS	DISTRIBUTION PATCHY	DISTRIBUTION SCATTERED	CURRENT COMPETITION HIGH	CURRENT COMPETITION MEDIUM	CURRENT COMPETITION LOW	CURRENT COMPETITION NIL	POTENTIAL COMPETITION HIGH	POTENTIAL COMPETITION MEDIUM	POTENTIAL COMPETITION LOW	POTENTIAL COMPETITION NIL
167	168		169		170	171 →										

PEST INFORMATION SUMMARY — REPORT COLUMN 7 INTO RESULTS

1 PEST CODE	2 AREA (ha) IF ONLY PART OF THE STRATUM AFFECTED	3 TOTAL TREES (TT) (sum of Total Trees column)	4 LIVE TREES AFFECTED (sum of Live Trees Affected column)	5 DEAD TREES AFFECTED (sum of Dead Tree column)	6 HOST SPECIES COMP. (TT%) (expressed as a decimal)	7 % HOST TREES AFFECTED {④+⑤ / [(③ X ⑥)+⑤]} x 100
172	173	126	174	175	176	177

RECOMMENDED TREATMENTS

PRIMARY TREATMENT RECOMMENDATIONS AND CONSIDERATIONS	ALTERNATE TREATMENT RECOMMENDATIONS AND CONSIDERATIONS
178	179
INCLUDE: OBJECTIVES, METHODS, YEAR, SEASON, SPECIES, PRIORITY ETC.	

Figure 28: FS 659 Silviculture Survey Summary card, back side, with field numbers.

Previously described field numbers will not be repeated in the descriptions to follow. Refer to a previous section for their description.

167. Species (including the main competing species): T/T Record the species abbreviations from the Ground Vegetation-Species field (111) on the FS 658 card. The seven most significant ground vegetation or broadleaf species are to be recorded in this field.

168. Estimated % Cover: T/T Record the average percent ground cover of each of the species listed in the field 167. The percent ground cover can be averaged from the Ground Vegetation - % Cover (field 112) of the FS 658 card.

169. Current Height (m) – Minimum, Maximum, and Average: T/T Record the average height of each of the vegetation species using the height measurements in field 113. The maximum and minimum values are based on visual observations.

170. Annual Height Increment (cm): T/T Record, in centimeters, the average annual height increment of each of the species listed in field 167. These are determined by visual observations.

This field is more relevant for competing vegetation and invasive species than forage, edible, medicinal, or culturally important species.

171. Distribution, Current Competition, Potential Competition: L/H

Check continuous, patchy, or scattered when describing the distribution pattern of each of the species listed in field 167. These are determined by visual observations.

Continuous	brush is evenly distributed over the stratum.
Patchy	brush-free areas cover approximately the same percentage of ground as brush-covered areas.
Scattered	brush-free areas are larger than brush-covered areas.

Table 11: Distribution definitions

Check the appropriate field when describing the present impact (high, medium, low, or nil) of each of the competing vegetation species. These are determined by visual observations.

Check the appropriate field when describing the potential competition (high, medium, low, and nil) of each of the competing vegetation species. These are determined by visual observations.

The current and potential competition fields may not be necessary for edible, medicinal, invasive, or forage species.

172. Pest Code: H/H Record pest codes for the seven most severe forest health factors entered into the Forest Health-Pest Code (field 114) of the FS 658 card.

173. Area (ha) if only part of the stratum is affected: H/H Record the amount of area (ha) of the stratum affected by the pest listed in field 114 if it is distributed across a portion of the stratum but does not fully meet the requirements for stratification.

Note: This field does not exist in SNAP or SAP or many licensee databases. However, it is a required reporting element for RESULTS, and it is important for the forest health specialists. Please ensure it is entered in RESULTS when applicable.

174. Live trees affected: H/H Record the sum of the live trees affected by each pest code. The number of live trees affected can be found on the Forest Health-Live Trees (field 115) of the FS 658 card.

175. Dead Trees Affected: H/H Record the sum of the dead trees affected by each pest code. The number of dead trees affected can be found in the Forest Health-Dead Trees (field 116) of the FS 658 card.

176. Host Species Comp.: H/H Record the sum of the inventory label species composition for the tree species affected by each pest. These values are found in field 127 and should be expressed as a decimal (i.e., 64% = 0.64).

177. % Host Trees Affected: H/H Complete the provided calculations to obtain the percent of host trees affected by each pest. This is the number submitted to RESULTS.

Note: The following rule of thumb applies - if there is 0% of a species showing up in an inventory label, then there should be 0% host pest incidence reported.

However, a possible scenario may occur where complete mortality of a dominant species has resulted from a pest infestation (Pl from MPB for example), and therefore does not show up in the inventory label, but the surveyor feels the professional practice would be to report the pest incidence somehow. It is recommended as a best management practice for the surveyor to attach a "Pest Incidence Note" to the opening file report in RESULTS to identify the presence of the pest, but still resulting in no incidence value into the database directly.

178. Primary Treatment Recommendations and Considerations: H/H

Treatment recommendations should be specific, reasonable, timely, and legal. For example, they should include the method, season and year, and follow-up activities.

Treatment recommendations should lead to the establishment of preferred species and adequate stocking levels to achieve the target stocking standard at free growing. To do this, treatment recommendations must address site limiting factors.

Recommendations may be administrative, for example, amending a site plan.

If there are recommendations in the silviculture plan or prescription that should not be there, bring this to the attention of the agency responsible for the opening.

179. Alternate Treatment Recommendations and Considerations: H/H Provide an alternative treatment regime in case the primary treatment recommendations cannot be implemented.

Objective Codes: The RESULTS objective code field is now mandatory for drought or frost caused replants or fill plants. If applicable, indicate in the treatment recommendations to use NG (frost) or ND (drought) as the objective code.

8.1.1 Statistics

Silviculture surveys collect information so that decisions can be made on the stocking or free growing status of a stand and so that realistic, sound recommendations can be made for future treatments. **Statistics** enable surveyors to determine how precisely the survey data describes the status of an opening.

The statistical calculations are only necessary when plots are established. Since formal plots are not established during visual assessments, statistical evaluations are not required for visual assessments. Statistics applied to representative sampling is also of limited value as bias is introduced when establishing the plots.

The section below discusses mostly statistics on free growing tree data. However, these statistical procedures are equally applicable to well-spaced trees. They could also be applied to plantable spots or preparable spots by substituting the corresponding data.

The density and distribution of trees within a stratum varies. Surveyors sample only a portion of that stratum's population. A statistical analysis must be completed to obtain an indication of the variability of the sample population and to provide a measure of the confidence of the average number of well-spaced or free growing trees.

For surveys completed on homogenous strata, the statistical requirements can often be met with as few as five plots per stratum. **The FOR has determined that five plots per stratum is the minimum required.**

Non-homogeneous strata require more than the minimum number of plots to meet statistical precision. **The higher the variability in the population, the more plots that are required. However, establishing more plots should not be a substitute for proper stratification.**

The surveyor must also consider the variability of the forest cover when determining the sampling intensity.

In strata where the distribution of free growing trees is variable and the free growing status is not clear, calculation of statistics is extremely important. Calculating confidence intervals for the survey data provides a measure of the variability in the sample population, and therefore a measure of the relative confidence that the decision made will be correct 95% of the time and the results of the survey accurately representing a particular stratum.

8.1.1.1 Definitions Used in Statistics

n	number of plots established
$\bar{X}$	sample mean or average
s	standard deviation of the mean
pm	plot multiplier
s/ha	stems per hectare (may also be referred to as tr/ha)
$se_{\bar{x}}$	standard error (may also be referred to as se)
t90	t value, found on Table 30 of the FS 660.
CI	confidence interval, with repeated surveys of a stratum, 90% of the time the confidence interval will contain the population mean.
LCL	lower confidence limit. There is a 90% chance that the actual number of well-spaced or free growing trees is above the lower confidence limit.
MSS	minimum stocking standard
e	desired survey precision

8.1.1.2 Desired Precision - **e**

Precision is a measure of the variability around the mean. Variability is inherent in sampling, as only part of the population is being measured. For survey results to have a degree of reliability and to be representative of the entire population being sampled, there must be a sufficient number of plots within each stratum.

For regeneration delay and free growing surveys, the desired survey precision has been set by the FOR.

Where the average number of well-spaced or free growing trees per hectare is:

- Less than or equal to 1000 trees per hectare, the precision is +/- 100 trees per hectare.

  OR

- More than 1000 trees per hectare, the precision is 10% of the average number of well-spaced or free growing trees per hectare. For example: If the mean number of free growing trees per hectare is 1125 then, the $\bar{X}$ is 5.625 trees per plot, therefore **e** is 0.5625 trees per plot or 112.5 trees per hectare.

8.1.1.3 FS 1138A

The FS 1138A card is designed to provide a format for a methodical approach to the calculation of statistics. Those less fluent with statistical evaluation often find the card provides a more complete flow of data analysis. The use of this card is optional since the statistical results can be recorded on the FS 659 card.

However, when additional plots are required to meet statistical precision, the 1138A will show the statistical calculations from the “first pass” or first set of calculations. The FS 659 will show

final confidence limits after the additional plots have been established. The 1138A can also be used for the "second pass" or second set of calculations once more plots have been established.

8.1.1.4 Statistical Analysis

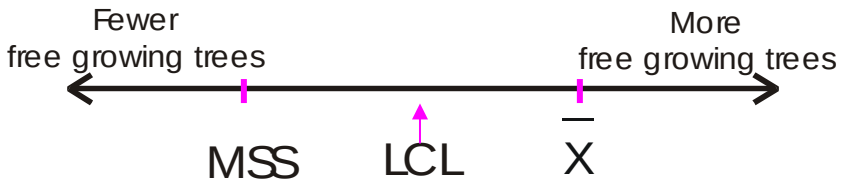
The statistical calculation **MUST** be done in the field to determine the need for additional plots.

There is no statistical analysis required for preferred species alone, only for the combination of preferred and acceptable species.

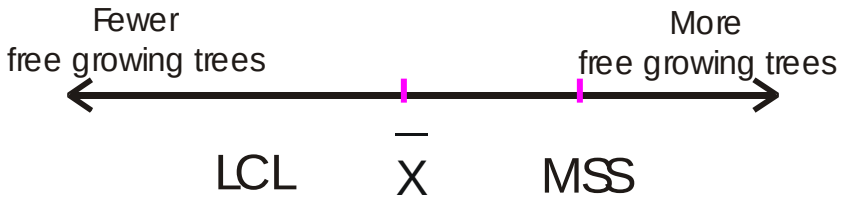
Where plots have been established, a minimum of five plots per stratum is required. More plots may be required to meet the 90 % low confidence interval (LCI).

The following decision rule steps and illustrated scenarios - **performed in the order as presented below** - are to be completed when determining statistical achievement of regeneration delay or free growing:

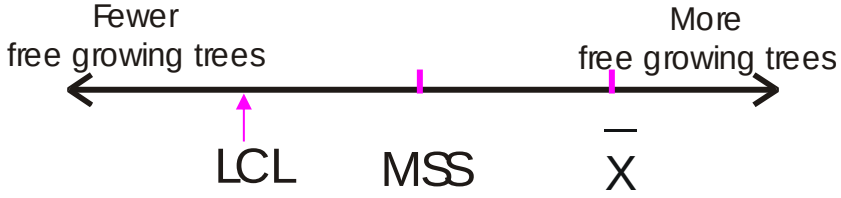
1. If the mean ($\overline{X}$) number of free growing trees per hectare and its 90 % lower confidence limit (LCL) are greater than the minimum stocking standard, the area is considered free growing. No further plots are required. There is no need to proceed any further. It would be considered free growing or, if evaluating regeneration delay, satisfactorily restocked.



2. If the mean ($\overline{X}$) number of free growing trees per hectare is less than the minimum stocking standard (MSS), the area is considered not free growing. No further plots are required. There is no need to proceed any further. It would be considered not free growing or, if evaluating regeneration delay, not satisfactorily restocked.



3. If the $\overline{X}$ is greater than the minimum stocking standard (MSS), but the lower confidence limit is less than the minimum stocking standard, then the stocking decision is uncertain.



4. If there is an uncertain stocking decision **(Step 3)** and the maximum number of plots have been established, then there is no further need for calculation. The stratum is free growing or satisfactorily restocked.

5. If the decision is uncertain, and maximum plots have not been established, then the desired level of precision should be compared with the confidence interval to see if the desired level of precision has been met. If the confidence interval per hectare is less than the e value per hectare, then the desired level of precision has been met, and no further calculations are required. The strata may be considered free growing or stocked, again depending on what data is being evaluated.

If, however, the desired level of precision has ***not*** been met (CI >e), then additional plots are required **(step 6)**.

For an explanation of Desired Precision, see section **8.1.1.2**.

6. If the CI > e, then more plots are required to meet statistical precision.

To determine the number of additional plots required, use the following formula:

$$\left[\frac{t \times s}{e}\right]^2 =$$ The number of plots required to meet precision

The number of plots required to meet precision - The number of plots already established = The number of additional plots required ☞ **No more than 1.5 plots per hectare** are required.

As some plots have already been established, subtract the number of plots established from the value derived using the formula. The resulting value is the total number of plots that are left to be established.

Note: In the formula, use the trees/plot "e" value. E.g., 0.5.

The establishment of additional plots, up to a maximum of 1.5 plots per hectare, should be considered as a secondary step and not a primary one. It should only be implemented if the sample fails to meet the LCL and "e" test in Step 6, provided that the maximum number of plots has not already been established.

The FOR has determined that 1.5 plots per hectare is the maximum required. Therefore, if the formula indicates a need for more plots than this number, only enough additional plots to reach 1.5 plots per hectare should be established. Conversely, if the formula indicates a need for less than 1.5 plots per hectare, only the number of plots required by the formula should be established.

Where the initial plots are established on a systematic pattern, it is equally acceptable to establish the additional plots either, along a single diagonal line which extends across the stratum, or between existing plots on a systematic basis.

In the following example, the original plots are circles. The additional plots required to meet statistical precision are squares. All of these are acceptable methods.

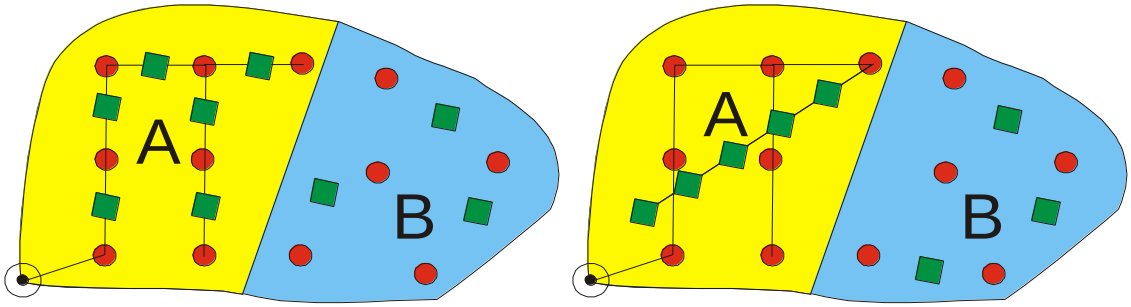


Figure 29 Examples of location of additional plots to meet statistical precision.

7. Re-calculate the statistics as a final evaluation of the sample population.

1) If maximum plots are not established, and only extra plots, then regular statistical analysis is performed using LCL.

2) However, if maximum plots were established up to 1.5 plots per hectare, then the status decision is completed based on the comparison of the $\bar{X}$ and the MSS and not by using the LCL. Therefore, if the $\bar{X}$ is greater than or equal to the MSS, the stratum is determined to be SR or FG. If not, the area is determined to be NSR/NFG.

BRITISH COLUMBIA MINISTRY OF FORESTS

CALCULATION CARD FOR SILVICULTURE SURVEY CONFIDENCE LIMITS

OPENING NUMBER	82B2985	82B2985
STRATUM NUMBER OR LETTER	A	B
AREA	16 ha	14 ha
n = NUMBER OF PLOTS	5	6
$\overline{X}$ = AVERAGE trees/ha	$\overline{X}$ = 4.6 $\overline{X}$ x pm = 920 tr/ha ☐ Well Spaced ☒ Free Growing	$\overline{X}$ = 3 $\overline{X}$ x pm = 600 tr/ha ☐ Well Spaced ☒ Free Growing
S = STANDARD DEVIATION	0.894	1.4142
STANDARD ERROR $S_{\overline{X}} = S/\sqrt{n}$	0.894/2.236=0.400	1.4142/2.449=0.5775
t Value t_{90} for n See FS660	2.132	2.015
CONFIDENCE INTERVAL for t_{90} $CI_{90} = S_{\overline{X}} \times t$	CI_{90} =0.853 CI_{90} x pm =171 tr/ha	CI_{90} =1.163 CI_{90} x pm =233 tr/ha
LOWER CONFIDENCE LIMIT LCL = $\overline{X}$ - CI_{90}	LCL= 3.747 LCL x pm = 749 tr/ha	LCL= 1.837 LCL x pm = 367 tr/ha
MSS p+a trees/ha	700 tr/ha	500 tr/ha
Desired Precision if $\overline{X} \leq 1000$tr/ha e = 0.5 or, if $\overline{X} > 1000$tr/ha e = 0.1 x $\overline{X}$	e = e x pm = tr/ha	e = 0.5 e x pm = 100 tr/ha CI>e
New n = $\left[\frac{t \times S}{e}\right]^2$	n = plots	n = 33 21 plots
	New n - n = number of additional plots to max. of 1.5 x Area.	
RECOMMENDATION	No further plots	Do 15 more plots

FS 1138A 2023/04/01

TSS=1200 MSS=700

TSS=1000 MSS=500

FG #s= 4, 2, 5, 3, 3, 1

Figure 30: Example of a completed 1138A

8.1.1.5 Statistics for the Multi-storey Survey Method

Confidence limits do not apply to multi-storey surveys. Some districts request that surveyors calculate statistics and establish additional plots. Surveyors should consult with the district to confirm their requirements. Currently there are no provincially approved or required methods for statistical analysis on multi-storey surveys.

8.1.1.1 Statistics for the Layered Survey Method

Layered surveys have only one set of stocking standards. Statistics are calculated in the same way as they are for single layered stands with one difference. The number of well spaced trees entered into the calculation for each plot is the sum of well spaced for all 4 layers combined to a maximum of the M value. This concept is applied in the same way for free growing trees.

8.1.2 Treatment Recommendations

The *Forest and Range Practices Act* does not require treatment recommendations. However, the agency responsible for the opening is required to produce a free growing stand. Treatment recommendations that aid in achieving this goal will be an important component of most silviculture surveys.

Surveys conducted for government under the FS 925A (*Silviculture Contract for Silviculture Surveys*) do require treatment recommendations. Many licensees use a similar contract.

In order to develop treatment recommendations, one compares the results of the survey to the standards and the management objectives in the silviculture plan or prescription. Where the present opening fails to meet those standards or management objectives, treatments or actions need to be recommended that will enable the opening to meet those objectives. Effective treatment recommendations are ones that are ecologically suited to the opening, are cost effective, will result in a free growing stand within the prescribed time frames, and will provide for management of preferred and acceptable species at target stocking. Recommendations may also include suggestions for amending the silviculture plan or prescription or the silviculture treatment regime. For each opening, an alternative recommendation should be included. Where applicable, treatment recommendations should include a brief explanation supporting the recommendations made.

Several factors should be considered when making treatment recommendations:

- Does the data collected and summarized equate to the visual observations?
- Is a treatment required to meet the regeneration date?
- Is a treatment required to assure a free growing stand within the prescribed free growing time frame?
- Are the recommended treatments biologically suited to the site?
- Are the recommended treatments cost effective?
- Are the recommended treatments feasible?

Treatment recommendations should be SMART:

Succinct

Measurable

Achievable

Relevant

Timebound

The first step in creating treatment recommendations is to compare the survey data to the standards in the silviculture prescription, site plan or FSP and in the contract. The data collected during the survey should reflect the standards set out in the silviculture prescription, site plan or FSP and in the contract.

The next step is to identify any deficiencies noted in the survey. For example, is the stratum SR, or is it NSR? If there are no treatments required, then there are no recommendations to be made.

Every site has limiting factors such as climate, forest health, competing vegetation, or nutrients. Surveyors must ensure that limiting factors are identified and addressed by the recommendation. The next step is to incorporate the limiting factors into the suggestions.

For each deficiency or limiting factor found in the survey, consider possible solutions. Where a treatment is required to achieve free growing, both a primary and secondary recommendation should be provided. Always aim for the target standards, not the minimum standards. Where possible, try to meet the silviculture prescription, site plan or FSP requirements. This may not always be possible, and amendments may be necessary.

If the standards in the silviculture prescription, site plan or FSP cannot be met, the surveyor may recommend that an amendment be made to bring the silviculture prescription, site plan or FSP more in line with what is actually on the site. When making recommendations for amendments, be specific as to what needs amending. Only recommend amendments for deficiencies that could not be fixed otherwise. Amendments need to be justified. They are not intended to relieve a licensee of responsibility for an agreed-upon, achievable standard.

Some of the types of treatments that surveyors can recommend include, but are not limited to:

- Site preparation
- Planting
- Juvenile Spacing
- Brushing
- Sanitation cutting

Follow-up surveys should also be scheduled as part of the recommendations.

8.1.3 Reports

8.1.3.1 Report Contents

The Forest and Range Practices Act and its Regulations do not explicitly state the individual components of a report.

Historically, reports have required the following items:

- identification of the area under the obligation (licence, cutting permit, block, opening number where available)
- the agreement and name of the holder of the agreement (where applicable)
- the standards unit boundaries and their areas
- the survey strata and their areas
- the biogeoclimatic ecosystem classification
- the incidence of forest health
- the inventory label, including species composition, ages, heights, crown closure, total tree density, site index, site index method and survey year
- the silviculture label, including the number of preferred and acceptable trees per hectare
- number of countable conifers, if near maximum density thresholds

8.1.3.2 RESULTS Reporting

With Bill 23, a written declaration is now required where an obligation under section 29 to establish a free growing stand is fulfilled.

A current forest cover update is required when a milestone declaration is submitted [FPPR s. 97(7)].

The term “current” can be interpreted as referring to the last 18 months. Therefore, the silviculture survey used to complete the forest cover inventory update should have been conducted within 18 months of the declaration date.

8.1.3.3 Regeneration Delay Survey Reports on Woodlots

The WLPPR section 75(2) specifies that a survey be undertaken if the minister believes that the woodlot licence holder has not met the regeneration delay requirements. The details of such a survey are not specified, but one can expect the process discussed earlier in this document would be reasonable.

8.1.3.4 Intermediate Cuttings on Woodlots

Between 1 and 3 years following the completion of harvesting, the woodlot licence holder is responsible to conduct a survey of the following:

- the identification of the area
- the inventory label, including species component, age, height, density and site index,
- the incidence of damage by forest health factors affecting trees

The report is submitted as part of the annual report.

8.1.3.5 Free Growing Surveys on Woodlots

The free growing assessment requirements are similar to those of the major licence holders.

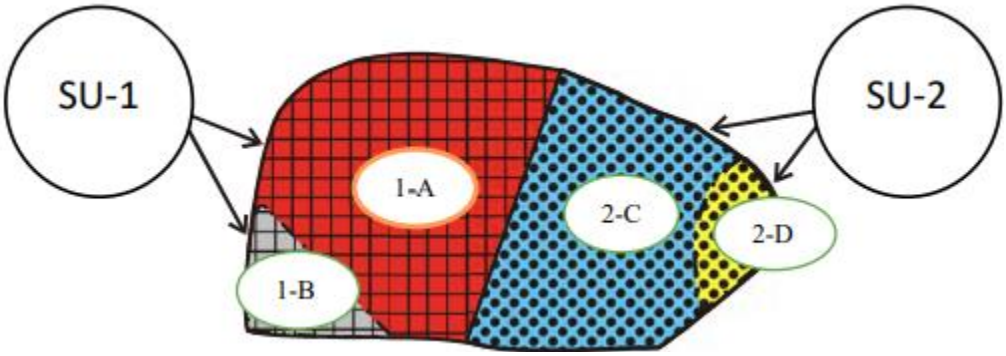
- identification of the area
- the number of healthy well-spaced free growing preferred and acceptable trees per hectare
- the number of healthy well-spaced free growing preferred trees per hectare
- the inventory label and silviculture labels including species, age, height, density, and site index, and
- identification of areas that are:
- satisfactorily stocked (SR)
- not satisfactorily restocked (NSR)
- free growing (FG)

The report is submitted as part of the annual report.

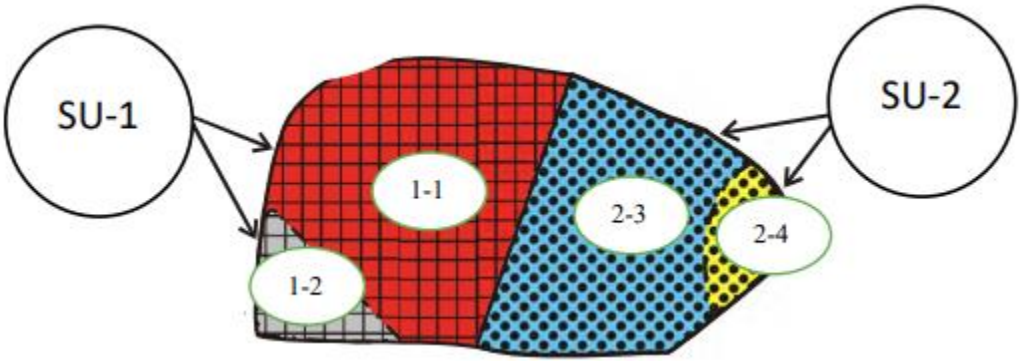
8.1.3.6 SU Nomenclature when stratifying and ultimately reporting survey compilations into RESULTS

It is important to keep nomenclature consistent. The recommended process is to start with the identifier established for a specific SU. The surveyor is limited by the legal documentation as to what the SU is designated as initially, either numerically or alphabetically. Keeping track of the strata/polygon within each SU should follow a sequential pattern, whether it is numeric or alphabetical.

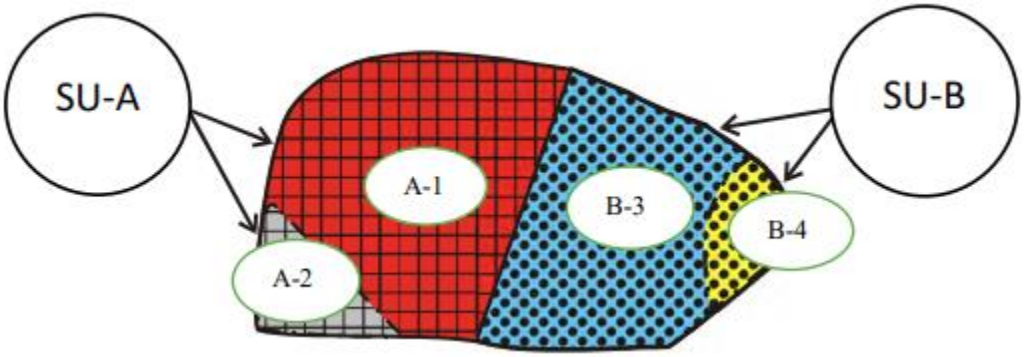
Therefore, the first stratum or polygon within that SU should be labeled "1" or "A". Then the second stratum within that SU should be labeled "2" or "B" and so on. The result is that the SU and the strata/polygon designations are joined to form the Strata/Polygon label (e.g., SU 1 and Strata/polygon A is known as Strata 1-A). The following figures illustrate this best practice.



Figures 31a: Examples of SU nomenclature- Numeric/Alpha



Figures 31b: Examples of SU nomenclature- Numeric/Numeric



Figures 31c: Examples of SU nomenclature- Alpha/Numeric

Note: It would not be incorrect to denote the strata in SU-B as B-1 and B-2; however, strata numbering or lettering is generally not duplicated as this avoids confusion on stratum identification within an opening with multiple SU's.

8.1.4 Inventory Label - Polygon

An inventory label is a standardized method of describing the commercial, living tree species growing on a polygon (traditionally called a stratum).

The inventory species composition and density are determined using tree tallies by species at each plot. The tree tallies exclude germinants. The tallies include all tree species listed in the FS 660 or in the RESULTS tree code list.

Note: For multi-layer or multi-storied stands, the species composition for the Layer 1 inventory label is based on basal area. The species composition for Layers 2, 3, and 4 or the combined understorey inventory label is based on density.

Average age and height are reported for the leading and second species. They are determined using plot-based measurements of the tallest, living tree of the species, excluding residuals.

Crown closure is estimated using aerial photography or a ground based visual assessment.

Age, height, and crown closure measurements are collected at the first and every fourth plot thereafter. Where few plots are established in a large polygon, measurements should be recorded more often. At minimum, three measurements should be recorded per stratum.

The site index can be based on plot information (growth intercept) or polygon ecology information (SIBEC).

The sample inventory label below describes a stratum with the following characteristics:

$Fdi_{38}At_{30}Sx_{12}Bl_{11}Cw_{9}$ – 13/12 - 1.7/1.6 – 21/I – 20 - 12520(22)

- The species composition of the living commercial trees is Douglas-fir 38 percent, aspen 30 percent, spruce 11 percent, subalpine fir 11 percent, and cedar 8 percent.
- The average of the sample ages of the leading species (Fdi) and second species (At) is 13 years and 12 years.
- The average of the sample heights of the leading species (Fdi) and second species (At) is 1.7m and 1.6m.
- The site index of the leading species (Fdi) is 21 meters.
- The source of the site index is growth intercept (I).
- The crown closure of the living commercial conifer and broadleaf trees is 20 percent.
- The total living commercial conifer and broadleaf trees per hectare, excluding germinants, is 12520.
- The survey year is 2022 (22).

8.1.5 Silviculture Label - SU

The silviculture label is a string of data in a standardized format that described the well-spaced or free growing component of a stratum. Most of the data items are selected from the FS 659 summary card when plots are established. When no plots are established, the entire label can be generated from visual observations, but should be done with extreme caution and only by very experienced surveyors. If the information is submitted to meet legal requirements, it is expected to meet precision standards outlined in RISS. If not, it needs to meet contract requirements.

The sample silviculture label below describes a SU with the following characteristics:

FG-$Fdi_{56}Sx_{22}Bl_{13}Cw_{9}$ - 12 –1.5- 920(22)

Note: The stocking status of the stratum is free growing, so free growing data is expressed (vs well-spaced values).

- The prefix identifies the stocking status (NSR, SR, or FG) of the SU. Data following NSR or SR represents well-spaced trees. Data following FG represents free growing trees.
- The species composition of the free growing trees is Douglas-fir 56 percent, spruce 22 percent, subalpine fir 13 percent, and western red cedar 9 percent.
- The average of the free growing sample ages of the leading silviculture species (Fdi) is 12 years.
- The average of the free growing sample heights of the leading silviculture species (Fdi) is 1.5 meters.
- The free growing density is 920 trees per hectare.
- The survey year 2022.

When completing the silviculture label for a free growing survey, the label components (e.g., species, age, height) refer to free growing trees per hectare only if the stand has achieved free growing status. Otherwise, the well-spaced values are used in creating the silviculture label.

9 Alternative Survey Methodologies

Section 9 covers alternative survey methodologies to the basic standard survey techniques presented in Sections 1-8. The application and use criteria for each alternative methodology are stated at the beginning of their respective sections. Many of the fundamental aspects of the basic standard survey procedure may be incorporated into the alternative methods discussed below. If any reference is made to these basic principles, such as sampling principles, please refer to the appropriate sections of the proceeding eight sections for detailed information.

While it is not the focus of this manual to fully describe these alternative procedures, it is important that surveyors understand the assessment options and their potential applications.

A Survey Methodology Selection Matrix Table (Section 9.1.2) is provided to assist in selecting an appropriate survey methodology. It is important to note that the stocking standards and survey methodologies outlined in the approved silviculture plan or prescription take precedence over the recommendations in the matrix or the subsequent sections. However, if stocking standards have been incorrectly applied, such as using uneven-aged stocking standards in a multi-layered opening intended for even-aged management, the site plan or prescription should be amended.

For further guidance, refer to Appendix 9b– Guidance Matrix for Reporting Retention Openings into RESULTS. The matrix links the management regime and stand condition to the Silviculture Survey Procedures Manual and the *Submitting Forest Cover to RESULTS for Openings with Treed Retention*.

9.1 Background Information

9.1.1 Layer Definitions

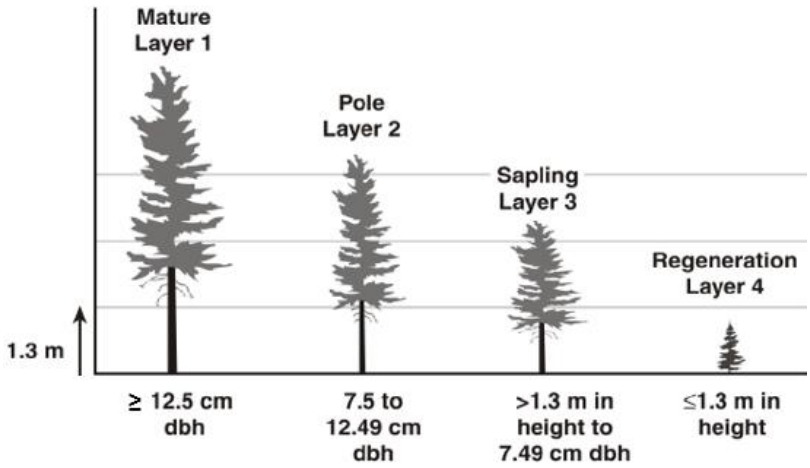


Figure 32: Layer definitions

9.1.2 Silviculture Survey Selection Matrix

	Even-aged Management Regime		Uneven-aged Management Regime
Harvest Entries	Single entry planned.		Multiple entries planned. (Single tree selection silvicultural system)
Stocking Standard	One TSS and MSS		Uneven-aged stocking standards Four TSS and MSS (by layer)
Stand Characteristics	≤ 5 m^2/ha BA	Interior: >5 - <20m2/ha Coast: >5 - <40m2/ha	Interior: >5 - <20m2/ha Coast: >5 - <40m2/ha
Survey Methodology	Standard Even-aged (Sections 1-8)	Layered DFP SEDRSS Mixedwood (broadleaf/conifer)	Multi-storey
Recommended FG Damage Criteria	Even-Aged Damage Criteria (Table 22 of FS660)	Layered/Interior DFP/SEDRSS Damage Criteria (Table 27 and 28 of FS660)	Multi-Storied Damage Criteria (Table 26 of FS660)
Special Considerations	A group selection silvicultural system will have multiple entries but should be surveyed with the standard survey methodology or the small-scale opening method.		The uneven-aged stocking standards outlined in the Reference Guide for Forest Development Plan Stocking Standards are only recommended for use in the IDF when managing with a selection silvicultural system that contains at least three layers. Small area-based tenures like woodlots may also used these standards for specified areas.

Table 12 – Survey Methodology Selection Matrix

9.1.3 Forest Cover Reporting

9.1.3.1 Reference Documents

The *RESULTS Information Submission Specifications* (RISS) describe the minister's information requirements for forest cover inventories, as defined by FPPR s.1.

The *Submitting Forest Cover to RESULTS for Openings with Treed Retention* is a supplementary document to the RISS documents. It provides examples of how to prepare RESULTS forest cover submissions for harvesting associated with silvicultural systems and harvest practices that contain some kind of retention in the form of long-term treed residuals (reserves for the entire rotational planning cycle) or short-term treed residuals (with anticipated subsequent harvest removals prior to the end of the rotation planning cycle).

9.1.3.2 Reporting Requirements

The RISS documents specify that basal area must be collected and reported into RESULTS for Layer 1 stems, where the following situations and circumstances are present in a surveyed standards unit:

1) If the stocking standards in the silviculture plan or prescription require that a specific basal area per hectare be retained after harvest; or
2) For all SUs, regardless of the stocking standards, if the retained overstorey of Layer 1 stems are > 5 m^2/ha.

If basal area is a required reporting attribute (in the situations mentioned above), a complete inventory for the Layer 1 overstorey is necessary.

The standards unit must be reported to RESULTS as a multi-layer stand. The understorey layers must be reported as Layers 2, 3, and 4, or as a combined understorey layer. The SU cannot be reported under Layers "I" and "S".

Under the polygon component, the surveyor must also collect and report:

- Reserve Type: The options are Dispersed or Group.
  - Dispersed: The denuded and residual treed portions are not individually mapped. The denuded and residual portions of the polygon are described in the inventory and silviculture component multi-layer forest cover fields.
  - Group: Mappable reserves ≥0.25ha, outside of the net area to be reforested.
- Reserve Objective: There are several options. Select the code that best describes the primary function of the reserve.
  - TIM: Residuals that are considered short term retention, as part of any applicable silvicultural system, and available for a subsequent harvest entry prior to the end of the current rotational planning cycle (regardless of whether they are harvested).
  - Other codes: If any reserve objective code other than "TIM" is specified, then the residuals are considered long-term retention and are not available for a subsequent harvest entry until the next rotational planning cycle.
- Tree Cover Pattern: The horizontal spatial arrangement of residual patches of overstorey Layer 1 trees in a polygon. Refer to Figure 33 for the tree cover pattern codes.

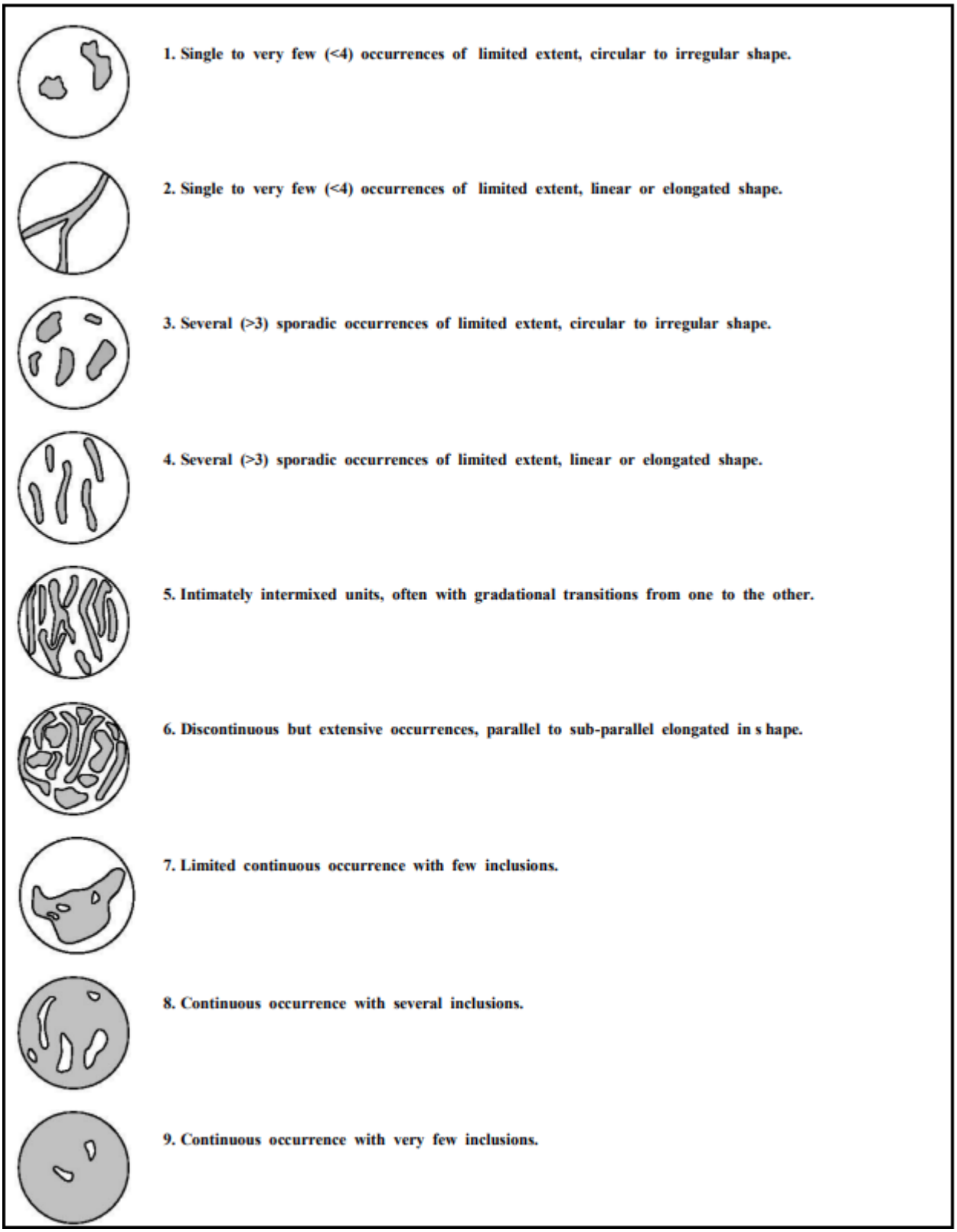


Figure 33: Tree Cover Pattern

9.2 Complex Vertical Structure Survey Methodologies

9.2.1 Multi-storey Survey

Prescribing forest professionals, contract supervisors, and surveyors must know the provincial definition of stand layers, be familiar with basic silvicultural systems, and understand which stand types are suitable for each survey method. This will enable them to determine when to properly employ the provincial multi-storey silviculture survey methodology. Recognizing the application of other assessment procedures will encourage the use of the multi-storey system where it is best suited.

If a surveyor requires more information and detail than is provided in this manual section, please refer to the Multi-Storey Silviculture Survey Course Workbook.

To watch a training video, see Module 2: Retention Survey Techniques and Methodologies Part 1 at 11 minutes.

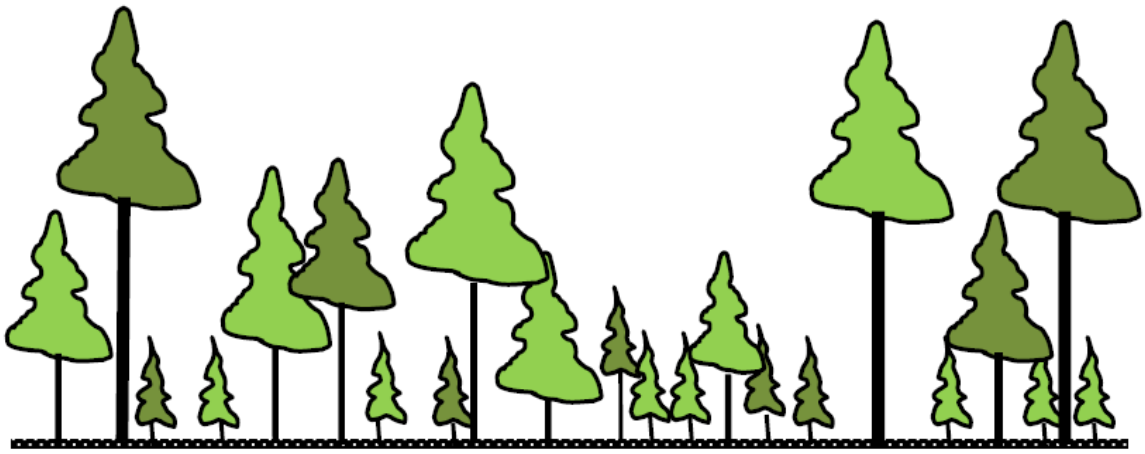


Illustration 1: Multi-storey Uneven-aged Stand Structure: Multi-storey Survey

Key features of a multi-storey survey include:

- Uneven-aged management regime (single tree selection silvicultural system)
- Uneven-aged stocking standards: 4 MSS and 4 TSS
- Layer 1 + 2 ≥ 6% crown closure or >5m2/ha
- Maximum density applies to Layer 3
- No statistics
- Nesting
- Priority to larger layers first for WS/FG

9.2.1.1 Complex Stands Suitable for a Multi-Storey Survey

- The multi-storey survey methodology is suitable to assess stands in which all three of the following criteria apply:

  1) The stand is being managed with a single tree selection silvicultural system;
  2) Layers one and two combined is either:
     i) ≥ 6% crown closure, or
     ii) > 5 m2/ha of basal area in layer 1; and
  3) Layers three and/or four are present.

- The multi-storey survey procedure is best suited to a single tree selection silvicultural system. This is an uneven-aged system, where mature timber is removed either as single stems or in small groups, at relatively short intervals, repeated indefinitely, maintaining an uneven-aged stand. The intent of the system is to recruit trees into successive age classes over time with regeneration occurring in pulses after harvest entries.
    - An uneven-aged system develops or maintains a mixture of three or more distinct layers, with clear differences in height, diameter, and age for the entire cutting cycle.
- The multi-storey survey procedure may be suited to an uneven-aged group selection system where the size of openings is minimal.
- The multi-storey survey procedure may be suited to the irregular shelterwood system. This system is broadly aged, and therefore considered to be between an even-aged and an uneven-aged stand. It has an extended regeneration strategy, and there is often an extended period of overstorey influence on the regeneration. This is like single tree selection, where residual trees are left for long periods beyond the regeneration phase. This system is only acceptable if multiple harvest entries are prescribed as defined above. Other shelterwood systems are not considered to be multi-storey.

9.2.1.2 Complex Stands Not Suited to the Multi-storey Survey System

- Stands being managed under an even-aged system are not well suited to the multi-storey survey procedure. These management categories would include clearcut, clearcut with reserves (dispersed or grouped), patch cut, coppice, seed tree and most shelterwood systems.
- Diameter-limit cuts, or selective harvesting, which target high-quality, larger stems for harvest, may not be suited to a multi-storey stocking standard, based on the lack of intent to leave preferred quality stems of all diameter classes.

Where limited prescription information exists (e.g., salvage harvest areas), surveyors need to consider what an appropriate silvicultural system is and be prepared to discuss assumptions made in the survey report. Considerations may include species composition, stem density, stem quality and age class distribution. Even or uneven-aged management may be prescribed. An amendment or development of a prescription may be required.

Where the stand is unmanaged, and the intent is single tree selection, the development of a stand table to adequately describe stand dynamics is preferred when developing a prescription.

Properly describing stand structure requires an understanding and consistent use of nomenclature for describing multi-storey stands. (See Silviculture Systems publication).

9.2.1.3 Uneven-aged Stocking Standards

Note: The uneven-aged stocking standards outlined in the Reference Guide for Forest Development Plan Stocking Standards are only recommended for use in the IDF when managing with a selection silvicultural system that contains at least three layers.

The overall goal in making a stocking status decision at regeneration delay or free growing is to determine whether adequate stocking (site occupancy) occurs over the stand.

Uneven-aged stocking standards have a Target and Minimum Stocking Standard (TSS and MSS) for each layer. All four layers can contribute to the stocking status of the stratum. Equally, each layer can completely stock the stratum on its own.

Silviculture plans and prescriptions may prescribe standards and survey criteria for a standards unit that deviate from the provincial guidelines; a surveyor must employ those survey criteria when surveying that unit to assess whether the SP standards have been met.

It is recommended that stocking and survey parameters include preferred and acceptable criteria as well as planned residual basal area per hectare.

9.2.1.3.1 Suitable Conversion to Uneven-aged Stocking Standards

Some older silviculture prescriptions for multi-storied stands intended for uneven-aged management provided only even-aged standards. In this situation, an amendment would be necessary to convert the stocking standards to uneven-aged standards. Table 13 and the subsequent bullets can provide the necessary information for the amendment.

A conversion would not be suitable for multi-layer stands intended for even-aged management (single harvest entry) or for multi-layer stands resulting from poor implementation of the prescription (e.g., to accept poor quality residuals where a clear-cut silvicultural system was prescribed).

Target even-aged stocking standard	Layer	Target stock. stds.	Min stock. stds.	Min pref. Stk. stds.	Max. regen	Early FG** delay*	Late FG	Well-spaced sph post spacing (min/max.) layer 3 only
1200	1	600	300	250	7	12	15	
	2	800	400	300	7	12	15	
	3	1000	500	400	7	12	15	500-1000
	4	1200	700	600	7	12	15	
1000	1	400	200	200	7	12	15	
	2	600	300	250	7	12	15	
	3	800	400	300	7	12	15	400-800
	4	1000	500	400	7	12	15	
900	1	400	200	200	7	12	15	
	2	500	300	250	7	12	15	
	3	700	400	300	7	12	15	400-700
	4	900	500	400	7	12	15	
800	1	300	150	150	7	12	15	
	2	400	200	200	7	12	15	
	3	600	300	300	7	12	15	300-600
	4	800	400	400	7	12	15	
600	1	300	150	150	7	12	15	
	2	400	200	200	7	12	15	
	3	500	300	300	7	12	15	300-500
	4	600	400	400	7	12	15	
400	1	200	100	100	7	12	15	
	2	300	125	125	7	12	15	
	3	300	150	150	7	12	15	150-300
	4	400	200	200	7	12	15	

Table 13: Uneven-aged stocking standards (single-tree selection only)

- The minimum inter-tree distance does not apply between layer one well-spaced or free growing trees
- Species: consider even-aged stocking standards. Shade tolerance may impact the species selection decision.
- Minimum height: dry-belt Fdi stands = 40cm; otherwise use even-aged height standards.
- Competing vegetation criteria applies to layers three and four (unless the prescription indicates otherwise).
- Maximum density of 10,000 sph (applicable to conifers in layer three only); 25,000 sph for pine stands in the Southern Interior Region and 20,000 sph for 80% pine stands in the Northern Interior.
- For prescriptions approved before April 1, 1994, maximum density refers to drybelt Douglas-fir and lodgepole pine species only.
- Regeneration delay can be met immediately following harvest if the residual stand has no significant damage or pest problems and meets minimum stocking.
- If regeneration is achieved immediately following harvest, the earliest free growing date is 12 months after completion of harvest.

9.2.1.3.2 Making a stocking status decision using uneven-aged standards

To make a stocking decision, data for all plots in the stratum are summarized. Well-spaced and/or free growing density by layer is calculated. The calculated density is compared to the uneven-aged minimum stocking standard (MSS) starting with layer one. If the layer one density exceeds the MSS for that layer, then the stratum is considered stocked or free growing. If the calculated density is less than the MSS, you **must** combine the calculated density for layer one and two and compare it to the MSS for layer two. If need be, the process continues to layer four where the total calculated density for all four layers is compared to the MSS for layer four. This process is referred to as "nesting." As with even-aged surveys, it may be a requirement to meet both MSS(p+a) and MSS(p).

For this example, assume that the total FG stems are all preferred.

Layer	TSS	MSS(p+a)	MSS(p)	Total FG/ha	"Nested Total"/ha
1	400	200	200	150	150
2	600	300	250	100	250
3	800	400	300	75	325
4	1000	500	400	200	525

In this example, it is not until the 4th layer that the total calculated density, or "nested total" exceeds both the MSS(p+a) and the MSS(p) (i.e., 525/ha > 500/ha).

Refer to the example of a Stocking Decision Key in the Multi-Storey Silviculture Survey Course Workbook.

9.2.1.4 Silviculture and Inventory Labels

It is essential to describe layers properly and adequately in a multi-storey stand to accomplish three main survey objectives. The silviculture-related objectives are to make accurate stocking and sound silviculture management decisions, while the inventory objective is to collect accurate information for inventory purposes.

Data collection in multi-storied stands is much more complex than in single storey stands. Silviculture and inventory information must be collected for each layer.

To understand the data collection and reporting requirements, refer to *Submitting Forest Cover to RESULTS for Openings with Treed Retention*.

9.2.1.4.1 Silviculture Labels

Section 9.1.1 defined the four layers and how they are used to make a stocking decision. The second silviculture-related objective is to make sound management decisions. To accomplish the second objective, there may be a need to subdivide one or more of the four layers.

- Where management objectives are unclear, collecting diameter class information to produce a stand table will allow a manager to develop a sound prescription.
- Recruitment is important in uneven-aged management (the species, quality, and quantity), therefore layer four may be subdivided to characterize new regeneration versus advanced regeneration.

- Any other management objective indicated on the silviculture plan or prescription may require that enhanced layer data be described in order to assess whether the objective has been met.
- Enhanced layer data may provide information for prescribing silviculture treatments (i.e., spacing layer three), or to meet other objectives (e.g., hydrological recovery or visual cover).

9.2.1.5 Ghost Trees

Ghost trees are trees that remain on site for a specified reason (e.g., a wildlife tree) but do not count towards stocking, as they will not be harvested in the future.

- Ghost trees should be identified in the silviculture plan or prescription as being reserved. A rationale and their specifications (i.e., density, distribution, etc.) should be provided.
- If a silviculture plan or prescription does not exist, or if it does not address trees that have been reserved, then the surveyor should:
  a) consult with the contract supervisor or
  b) make a judgment call, record it on the 657 and survey accordingly.
- Ghost trees have significant implications on long-term management objectives.
- Trees within a survey plot that fall within the vertically projected crown (dripline) of a ghost tree are counted towards the total tree count but should be carefully evaluated before being accepted as crop trees.
- Ghost trees need to be accounted for in the inventory label as they occupy growing space and may influence performance of regeneration.

9.2.1.6 Basal Area (BA)

Basal area must be collected by species for layer one. It is used to calculate the inventory species composition and to make stand management decisions. It does not need to be collected for the other layers. The surveyor should select a prism size to capture roughly 4-9 trees per plot, though it is not as critical as during timber cruise sampling. When using a prism, BA is based on a variable radius plot. “In” trees during the sweep can be outside of the fixed area plot.

Basal area must be reported when it exceeds 5m^2/ha. In this situation, an inventory component Layer 1 must be submitted.

Basal area must also be reported when it is part of a stocking standard. In this situation, inventory and silviculture components Layer 1 and 1S must be submitted.

To learn how to report a forest cover inventory for Layer 1 trees, please refer to *Submitting Forest Cover to RESULTS For Openings with Treed Retention.*

Refer to Appendix 4 for guidance on collecting basal area.

9.2.1.7 Modal Diameter

Definition: Modal diameter is the most frequently observed diameter in layer one.

- Modal diameter is not a RESULTS requirement.
- Modal diameter is a useful stand descriptor in management planning for future stand entries: i.e., what would be the most frequent log size.
- Average diameters are inadequate in that they may describe a tree size that does not exist in the stand.
- A stand having two distinct groupings of diameters in layer one is called bimodal: both diameters should be recorded.

9.2.1.8 Steps Required to Complete a Multi-Storey Silviculture Survey

The main steps required to conduct a multi-storey survey are no different than that of a typical even-aged survey. Some of the specific steps are different, and are discussed below.

1. Office Review and Pre-Stratification
2. Walk-through and Survey Design
3. Data Collection
4. Data Compilation and Summary
5. Recommendations and Mapping

9.2.1.8.1 Office Review and Pre-stratification

The office review for a multi-storey survey is similar to that of an even-aged one, and should include a review of the silviculture plan and prescription showing stocking standards, SU typing, previous surveys, ecological classification information, silviculture project reports, forest health information, and history information. Recent imagery is particularly useful when assessing a multi-storey stand. It helps gauge stand structure and crown closure and thereby the block's suitability to the multi-storey survey procedure, as well as pre-stratification. Office pre-stratification using imagery will include dividing areas of varying vertical stand structure into homogenous units (this is in addition to the normal criteria for stratification in a silviculture survey as described in the current FS 660 field cards). The pre-stratification is determined prior to the completion of a survey design. Minimum stratum size was put into legislation in 2007. For a brief summary, see the current FS 660. For a detailed discussion, see the 2007 "Forest Cover Stratification and Milestone Declaration" document.

9.2.1.8.2 Walk-through and Survey Design

The walk-through has particular significance for a multi-storey survey, as it is necessary to confirm that the stand is suited to multi-storey procedures. Optimal prism size and plot size are selected in addition to verification of pre-stratification. Other issues to be addressed during the walk-through include identification of ecological classification, sampling intensity, site index methodology, forest health factors, site-limiting factors, survey objectives, and potential treatments.

Typical sampling intensity for a multi-storey survey is one plot per hectare. A grid system is well-suited, but not a required design. This relatively high intensity has been practiced as statistics are not required with multi-storey surveys. It may be reasonable to reduce plot intensity on uniform types, or excessively large strata when experienced surveyors are employed. Consideration of reduced plot intensity should be discussed with the contract administrator prior to start-up.

9.2.1.8.3 Data Collection

The data collection process is described in a step-by-step process as follows:

1. Count trees by species for Layers 2, 3, and 4 and record in Field 95 of the T2, T3, and T4 rows. These tree counts by species will be used to determine inventory density and species composition for Layers 2, 3, and 4.
2. Count total trees for Layer 1. Record this value in the Totals column (Field 98) for the T1 row. The total tree count will be used to determine inventory density for Layer 1.
3. Sweep the plot. Count Number "In" by species for Layer 1. Record in Field 95 of the T1 row. Record the total in Field 110. The basal area by species will be used to calculate the inventory species composition and total basal area for Layer 1.
4. Record the modal diameter (most frequently observed diameter) for the Layer 1 trees in Field 117.
5. Choose your well-spaced (or free growing) trees using the following rules:

   a) Select the well-spaced trees starting in Layer 1 and "nesting down" to Layer 4.

   "Nesting down" means:
   - selecting all acceptable Layer 1 trees up to a maximum of the equivalent M value for Layer 1, then;
   - selecting well-spaced acceptable Layer 2 trees so that the combined number of well-spaced in Layers 1 and 2 does not exceed the equivalent M value for Layer 2, then;
   - selecting well-spaced acceptable Layer 3 trees so that the combined well-spaced in Layers 1, 2 and 3 does not exceed the equivalent M value for layer 3, then;
   - selecting well-spaced acceptable Layer 4 trees so that the combined well-spaced in Layers 1, 2, 3 and 4 does not exceed the equivalent M value for Layer 4.

   b) All acceptable Layer 1 trees in the plot should be recorded in the well-spaced or free growing rows (Field 96 or 97). The sum of the well-spaced or free growing trees should only be recorded up to the M value in the Totals column (Field 99 or 100).

   c) An acceptable well-spaced tree in Layers 2, 3 or 4 must be:

   - the MITD (minimum inter-tree distance)- as per the silviculture plans and prescriptions - from **all** acceptable Layer 1trees, and;
   - the MITD from the well-spaced trees in the layers above.

   d) If you are doing a regeneration delay or stocking survey, maximize the number of well-spaced trees. If you are doing a free growing survey, maximize the number of free growing trees (i.e., you may select different trees depending upon your objectives).

If you are uncertain whether the stratum is free growing or not, then collect both sets of data so that you have the correct information to produce a silviculture label.

e) All well-spaced, acceptable trees must meet leave tree criteria as described in the prescription and/or Free Growing Damage Criteria for Multi-Storied Stands (Section 26 of the FS 660).

6. Record countable conifers if maximum density in Layer 3 is being approached (all Layer 3 conifers contribute towards maximum density).

7. Record forest health data for each layer. Refer to section 26 of the FS 660.

8. On the first plot and every fourth plot thereafter (minimum of 3 data sets per stratum), collect the following:

   a) Record the ground vegetation.

   b) For each layer, record crown closure.

   c) For each layer, choose a representative well-spaced (or FG) tree of the leading silviculture species from within the fixed area plot. The leading silviculture species may be different for each layer. For the selected trees, measure heights and ages. Heights include in-season growth.

   d) For each layer, choose the tallest, living tree of the leading inventory species and the tallest, living tree of the secondary inventory species. For Layers 2, 3, and 4, the selected tree should be within the fixed area plot. For Layer 1, the selected tree should be "In" the variable radius plot. For the selected trees, measure heights and ages. Heights include in-season growth.

9. Collect site index information. Use SIBEC or site index curves (if mature trees are vigorous).
   Note: The site index species should be the inventory species of the layer with the highest volume or next due for harvest (the layer with the greatest site occupancy).

10. Collect plantable and preparable data every plot. Generally, a "dripline" rule is applied for Layer 1 stems, i.e., spots are not considered plantable or preparable under the crown of a L1 tree. Otherwise, the assessment procedure is as per even–aged surveys.

11. Estimate the overall Tree Cover Pattern for the stratum or SU being surveyed. Refer to Figure 33. Record in the Notes section (Field 117).

Completing a multi-storey survey follows the same steps and sequence as used in a normal even-aged silviculture survey. However, the complexity and importance of some of the steps is much greater than that of a normal survey. Multi-storey surveys will take more time and cost more money.

9.2.1.8.4 Data compilation and summary

Multi-storey data are summarized by layer. Data can be summarized by hand, though it is a time-consuming process and prone to error. It is a more common practice to summarize the data electronically.

Utilizing statistical analysis on a multi-storey survey is difficult due to the nature of how trees are selected during the nesting down process. Currently, statistics are not a requirement when completing multi-storey surveys. Since the data collection rules require accepting all layer one trees that qualify, statistics can be meaningfully calculated for this layer. The lower confidence limit for this layer becomes especially important if the stand has been declared stocked or free growing based on the layer one density alone. Statistical analysis of layers two, three or four, or a combination of them would not be meaningful due to nesting down. If a stratum is not declared stocked or free growing until the cumulative well-spaced for layer four is compared with the MSS for layer four, then some benefit may be gained by determining the lower confidence limit of the mean of the total number of well-spaced (all four layers) in each plot.

9.2.2 Layered Survey

A layered survey is a common method used on layered even-aged stands. It involves recording the survey information by layer but applying even-aged stocking standards.

Stand structures suitable for Layered Surveys are:

- Stands intended for an even-aged management regime (i.e., multiple harvest entries are not planned).
- Low BA (suggested < 10m² Interior, <18m^2 Coast)
- Stems retained post-harvest (planned or unplanned) are of acceptable health and vigor to contribute to stocking and free growing tallies and the next rotational harvest volumes.

Illustration 2: Layered Even-aged Stand Structure – Layered Survey

Key features of a layered survey include:

- Even-aged management
- 1 MSS and 1 TSS
- 1 M value
- No nesting
- Statistics required on the combined layers (1 + 2 + 3 + 4)
- Priority is the maximum WS/FG, not any particular size class
- Maximum density applies to all layers combined.

Using the Layered Survey method, silviculture and inventory information are recorded and reported by layer. However, the well-spaced or free growing information is summed across layers to be compared to the prescribed even-aged stocking standards. Layered surveys have the advantage that the standard even-aged statistical calculations can be used on the survey results.

Note: In some cases, the inventory and silviculture information may be amalgamated into one over-storey and one under-storey layer.

To watch a training video, see Module 2: Retention Survey Techniques & Methodologies Part 2.

Photo Stratification:

- Office pre-stratification from images and/or a map is often difficult in stands where there is a complex residual structure. Recent imagery is beneficial.
- Attempt to divide the stand into homogenous strata based on varying vertical stand structure.

Walk-through

- Confirm or alter pre-stratification based on the actual stand conditions observed.
- Preliminary assessment of which layers will contribute to overstorey and understorey inventory labels.
- Determine an appropriate plot size and BAF.

Data Collection

1. Count trees by species for layers 2, 3, and 4 and record in Field 95 of the T2, T3, and T4 rows. These tree counts by species will be used to determine inventory density and species composition for each layer (L2, 3, 4).
2. Count total trees for Layer 1. Record this value in the Totals column for the T1 row (Field 98). The total tree count will be used to determine inventory density for Layer 1.
3. Sweep the plot. Count Number "In" by species for Layer 1. Record in Field 95 of the T1 row. Record the total in Field 110. The basal area by species will be used to calculate the inventory species composition and total basal area for Layer 1.

   A Layer 1 inventory, including total basal area, is a reporting requirement when the basal area exceeds 5m^2/ha.

   Note: If determining BA with a prism, it is based on a variable radius plot. "In" trees during the sweep can be outside of the fixed area plot.

4. Record the modal diameter (most frequently observed diameter) for the Layer 1 trees.
5. Choose your well-spaced or free growing trees. Preference should be given to the most vigorous preferred and acceptable species that can contribute towards the merchantable volume at the time of the next harvest. The goal is to maximize the number of WS trees or FG trees, regardless of layer. There is no preference by size class (no nesting). There is a single M-value that applies to WS or FG trees from all layers.

   The following criteria should be used:

   a. Layer 1 FG trees are acceptable if they meet the damage criteria outlined in Table 27 of the FS660. They must be capable of contributing merchantable volume to the next rotation. There is no MITD between Layer 1 well-spaced or free growing trees.

   b. Layers 2, 3, and 4 FG trees are acceptable if they meet the damage criteria outlined in Table 28 of the FS660.

MITD will be the dripline or 2m (whichever is most) between:

- All L1 and lower L2 trees
- All Layer 3 and 4 trees that are shade tolerant

MITD will be the 2m (or as prescribed in a SP or FSP) between:

- All L1 and all L3/L4 trees that are highly shade tolerant
- All L2, 3, 4 trees

6. Record forest health data for each layer. Refer to Section 27 and 28 of the FS660.
7. Collect plantable and preparable data. Generally, a "dripline" rule is applied for Layer 1 stems, i.e. spots are not considered plantable or preparable under the crown of a Layer 1 tree. Otherwise, the assessment procedure is as per even–aged surveys.
8. Record countable conifers if maximum density is being approached.
9. Collect site index information. Use SIBEC or site index curves (if mature trees are vigorous).

   Note: The site index species should be the leading inventory species of the layer with the highest volume or next due for harvest (the layer with the greatest site occupancy).

10. On the first plot and every fourth plot thereafter (minimum of 3 samples per stratum), collect the following:
    a. Record the ground vegetation.
    b. For each layer, record the crown closure.
    c. For each layer, choose a representative well-spaced (or FG) tree of the leading silviculture species. The leading silviculture species may be different for each layer. For the selected trees, measure heights and ages. Heights include in-season growth.
    d. For each layer, choose the tallest, living tree of the leading inventory species and the tallest tree of the secondary inventory species. For Layers 2, 3, and 4, the selected tree should be within the fixed area plot. For Layer 1, the selected tree should be "In" the variable radius plot. For the selected trees, measure heights and ages. Heights include in-season growth.

11. Estimate the overall Tree Cover Pattern for the stratum or SU being surveyed of the Layer 1 trees, using Figure 33. Record in the Notes section (Field 118).

Data Summarization and Label Generation

12. Inventory Layer – Information is summarized by layer. For layers 2, 3, and 4, the inventory species composition is based on tree tallies by species at each plot. For layer 1, the species composition is based on basal area. It is recommended to summarize the data electronically to minimize errors.
13. Stocking Standard Determination – All WS (and/or FG) by layer are compiled together to produce a mean WS (and/or FG) per hectare. The combined mean and LCL are compared to the MSS to determine stocking status and/or next steps. Section 8.1.1 can be followed. Note: nesting is not used.
14. Silviculture Label- Report a silviculture label by layer to RESULTS. This will be derived from the WS/FG calculations above.

Note 1: Under certain circumstances, it may be acceptable to report the Silviculture and Inventory labels as an over-storey and under-storey label.
Note 2: FFT surveys may have different standards.

9.2.3 Deviation from Potential Survey-Interior DFP Method

DFP (deviation from potential) is an approach to regeneration stocking assessment in partially cut stands in the BC interior. It is an alternative survey method to the layered survey system and is especially relevant to stands with substantial variation in the size and spatial arrangement of live trees retained after harvest with **an even-aged management regime.** DFP is not a stocking standard, but rather a survey methodology that can be used with stocking standards that have been approved in a Forest Stewardship Plan (FSP) or site plan. Use of DFP as a survey methodology would only be applicable in specific situations such as:

- The harvesting of a Standards Unit with an even-aged management regime has resulted in partial cutting due to:
  a) management of forest health issues; or
  b) retention of crop trees is required to achieve a result or strategy in the FSP to address a land use order objective.
- Previously disturbed or salvaged areas lacking full prescriptions (i.e., post-wildfire rehabilitation) or:
- areas with moderate or high retention of live residual stems for non-timber objectives.

This survey approach is designed to deal with high levels of stocking diversity, particularly with respect to the density, size, and distribution of retained stems within a stratum or Standards Unit. An index, or deviation from potential, is derived from the combination of a stem count of small well-spaced healthy crop trees and a basal area measurement of larger stems. This deviation from potential is a measure of site occupancy and is used as the yardstick to determine if stocking objectives have been met. The derived information is also used to assist in the identification of suitable silvicultural treatments where required. This system was developed with MPB salvage assessments in mind. Surveyors should check with prescriptions and survey administrators to determine if this assessment procedure is an acceptable option in their respective contract.

The website Stocking in Partial Cut Stands provides several reference documents including a DFP training workbook, a technical report, and an extension note.
To watch a training video, start at 11:20 of Module 2: Retention Survey Techniques and Methodologies Part 2.

9.2.3.1 Background DFP Concept

The Deviation from Potential (DFP) method of stocking assessment recognizes two stand components: overstorey trees (Layer 1) and understorey trees (Layers 2, 3, and 4). The DFP method focuses on the future yield from the understorey component. The underlying concept is that understorey yield varies based on understorey density and the amount of overstorey.

The DFP combines the two relationships providing future understorey yield over a range of understorey density and overstorey basal area. Since the DFP is constructed from these fundamental relationships, it provides a solid biological basis for stocking assessments and standards.

Deviation From Potential ranges from 0 to 1. A DFP of 0 at a sample point indicates that the sample point is fully stocked - that is there is no additional space available for added stocking at that point. At the other end of the spectrum, a DFP of 1 (or 100%) indicates the point has no stocking and has a 100% deviation from the potential. If the DFP value were 0.21, this indicates it is 21% below fully stocked, and therefore considered partially stocked. If the DFP value were 0.40, 40% would be considered "open" or seriously understocked.

9.2.3.2 Interior DFP Methodology Suitability

This proposed survey methodology is meant for stands that are to be managed under an even-aged regime – *a hybrid type of Silvicultural System* defined as a partial cut harvest entry where retained overstorey stems contribute towards a regenerative and free growing obligation. Crop tree suitability in the retained overstorey and associated stocking standards are enabled through an approved FSP, Silviculture Prescription, or district-specific stocking standard defaults. Please confirm with the contract administrator if stand conditions and circumstances are appropriate for the use of DFP as a survey methodology.

Interior DFP <u>Suitable</u> Stand Criteria:

1. **Dispersed Retention Residual Basal Area (RBA) ranging from 5 to 19 m^2/ha** (This is an interim range and subject to revision for specific situations) and:
2. **Stands that meet the specific Situations and Circumstances**
   Interior DFP is not intended for a broad application across managed landscapes, but rather is intended to be a tool to address specific management concerns within a local management unit.

Stratification Criteria for Stands <u>Unsuitable</u> for Interior DFP:

1. **<u>Areas ≥ 1.0 ha</u>** with **< 5m^2/ha** of **<u>Dispersed Retention (1)</u>** *(Open stands, clearcuts or stands with low levels of dispersed retention):* Remove as a separate stratum, and survey conventionally with the same even-aged stocking standard;
2. **<u>Areas ≥ 1.0 ha</u>** with **<u>≥ 20 m^2/ha</u>** of **<u>Dispersed Retention</u>** *(full stocking of ecologically suitable species with no openings > 0.1 ha in size):* Defined as an **Intermediate cut** (with no regeneration obligations) requiring a separate stocking standard;
3. **<u>Areas ≥ 0.25 ha Uncut</u>**: *(large areas of reserved stems where no harvested or disturbance has occurred):* Remove from SU and map as a **Grouped Retention** SU, classify as **Group Reserve**, removed from NAR and report in RESULTS;
4. **<u>Areas ≥ 1.0 ha Broadleaf leading</u>**: Interior DFP is designed for conifer management only.

Note: A layer 1 inventory label must be reported to RESULTS if the stratum has > 5 m^2 of dispersed retention as per the document: *<u>Submitting Forest Cover to RESULTS for Openings with Treed Retention</u>*.

9.2.3.1.1 Situations and Circumstances for Interior DFP Surveys

The Forest Stewardship Plan (FSP) **must** specify the situations and circumstances where the DFP survey methodology will be applied. The stocking standards approved in a Forest Stewardship

Plan (FSP) or Silviculture Prescription or accepted as district-approved default stocking standards provide the linkage from stand-level to forest-level management. This type of survey methodology is generally **only applicable** where retention of dispersed stems is required to achieve non-timber FRPA management objectives.

9.2.3.3 Sampling Plot Intensity and Survey Design

Although a statistical analysis is not required to address potential stocking variability in DFP suitable stands, rigorous plot intensity is recommended.
The DFP survey methodology can be used to survey a separate stratum within a Standards Unit, or the entire SU, given the DFP suitability criteria is met for these areas. **The best management practice for sampling intensity is determined by the size of the stratum or Standards Unit as follows**:

- < 5 hectares: a minimum of 5 plots must be established;
- 5 to 20 hectares: one plot per hectare must be established;
- > 20 hectares: one plot per hectare for the first 20 hectare and then 1 plot per 2 hectares for the remaining area.

The recommended fixed radius plot sizes and prism sizes (for layer 1) are as follows:
- **Plot Size:** To tally understorey stems, use a 3.99 m or 5.64 m (if larger mature stems retained) radius plot for the entire stratum or Standards Unit;
- **Prism size:** Choose a prism that captures approximately 4-8 trees per plot and does not capture trees more than 12 m from plot center (BAF 2-5 prisms are reasonable).

9.2.3.3 Interior DFP Survey Sampling Procedures

This approach uses a DFP table as the basis for the stocking decision. It requires measurements of crop BA per plot and well-spaced stocking per plot. This information is used to determine a DFP value. The average DFP value for the stratum must meet the obligation standards (≤0.20). Furthermore, the stratum must meet 2 thresholds related to plots in "open" and "stocked" classes. The obligation criteria are described in Table 14: Interior DFP Regen and FG Obligation Criteria below.

The survey also involves a tally of non-crop BA. The non-crop tally may be used to identify the need for additional harvesting if non crop trees are found to be fully occupying the site. In some cases, the stand may be dominated by trees of non-crop status, and this should be identified prior to assessment to address what should be tallied.

The following steps describe the DFP survey procedure:

1. Tally the Residual Overstorey (Layer 1 trees, ≥ 12.5 cm DBH)
   - Tally Layer 1 trees within the fixed radius plot and record in the Totals column (Field 98) for the T1 row.
   - Record "Number In" by species (crop and non-crop) in Field 95 of the T1 row.
   - Sum the total "Number In" in Field 110 in the T1 row.

- Tally the crop "Number In" by species in Field 97 of the F1 row.
- Sum the crop "Number In" and record in Field 110 of the F1 row.

Note: If determining BA with a prism, it is based on a variable radius plot. "In" trees during the sweep can be outside of the fixed radius plot. Find guidance on crop "Number In" trees below Table 15.

2. Tally the Regeneration Understorey (Layers 2, 3 and 4, ≤12.cm DBH)
   - Tally total living, commercial trees (excluding germinants) by species in Field 95 of the combined understorey total tree row (T2/3/4 row).
   - Tally well-spaced by species in Field 96 of the combined understorey well-spaced row (W2/3/4).
   - Tally free growing by species in Field 97 of the combined understorey free growing row (F2/3/4).

   Note: Layer 2, 3, and 4 well-spaced or free growing trees must be 2.0m or the dripline, whichever is greater, away from ALL Layer 1 stems (crop and non-crop, inside and outside of the plot). Use the MITD from the FSP for all other trees between Layers 2, 3, and 4.

3. Record forest health data at each plot. Refer to Section 27 for Layer 1 trees and Section 28 for Layers 2, 3, and 4 trees of the FS660 for damage criteria.

4. Tally plantable spots and preparable spots at each plot.

5. For each plot, multiply the crop "Number In" by the BAF to determine the basal area. Record in an unused field. Refer to the Table 15. Find the cross-section of the crop BA and plot WS or FG tally (applying M-value) to determine the plot DFP. Record the plot DFP and category (e.g., stocked, partially stocked, open) in unused fields.

6. On the first plot and every fourth plot thereafter (minimum of 3 data sets per stratum), collect the following:
   a. Record of the ground vegetation.
   b. Record the crown closure for layer 1 and for Layers 2/3/4 combined.
   c. For the overstorey layer and combined understorey layer, choose a representative well-spaced (or FG) tree of the leading silviculture species. The leading silviculture species may be different between the overstorey and understorey layers. For the selected trees, measure heights and ages. Heights include in-season growth.
   d. For the overstorey layer and combined understorey layer, choose the tallest, living tree of the leading inventory species and the tallest tree of the secondary inventory species. For Layers 2, 3, and 4, the selected tree should be within the fixed area plot. For Layer 1, the selected tree should be "In" the variable radius plot. For the selected trees, measure heights and ages. Heights include in-season growth.

7. Estimate the overall Tree Cover Pattern for the stratum or SU being surveyed for the Layer 1 trees, using Figure 33. Record in the Notes section (Field 118).

8. Use SIBEC to determine Site Index. If available, the first approximation SIBEC (whole numbers, no SE) is best used for the Layer 1 overstorey SI. The second approximation SIBEC (decimal places, SE values) is suitable for other Layers.

Data Summary

Silviculture and Inventory Labels will be generated for Layer 1 and the combined Layer 2/3/4. The combined understorey layer should be reported to the most abundant understorey layer in RESULTS.

The Layer 1 inventory label will include species composition (based on total BA), heights and ages for the leading and second species, crown closure, site index*, density**, and total BA. The Layer 1 silviculture label will include species composition (based on crop BA), height and age for the leading crop species, and crop basal area. It does not include a WS/FG density.

*Site index for the layer 1 leading inventory species would be provided if Layer 1 is next due for harvest (the layer with the greatest site occupancy).
**Density is only required if the stocking status is immature.

The inventory and silviculture label for the combined understorey layer should follow Section 8.1.4 and 8.1.5.

The survey results are summarized and compared to the thresholds in Table 14:

- The average DFP value from all individual plots.
- The percent of the total plots established per stocking class from the plot data and a value generated for each class – stocked; partial stocked; and open.

The stratum or Standards Unit is found to have met its Regen Obligation or Free Growing Obligation if the following table's criteria have been met.

Table 14: Interior DFP Regen and FG Obligation Criteria

DFP Threshold Value	Obligation Standard: Interior DFP
Average DFP	0.20 or less
Proportion of plots in "open" class (shaded red on DFP table)	≤ 20%
Proportion of plots in "stocked" class (shaded green on DFP table)	≥ 60%

Table 15: Interior DFP-Overstorey Basal Area and WS/FG stems per plot.
(Note: Red cells: "open," yellow: "partially stocked", and green: "stocked" categories)

BA of Crop* Overstorey trees ≥ 12.5 cm dbh	Understorey - well-spaced or free growing stems per plot								
	0	1	2	3	4	5	6	7	8
0	1.00	0.76	0.52	0.34	0.22	0.13	0.07	0.03	0.00
1	0.98	0.74	0.51	0.34	0.21	0.13	0.07	0.03	0.00
2	0.96	0.73	0.50	0.33	0.21	0.13	0.07	0.03	0.00
3	0.93	0.71	0.49	0.32	0.20	0.12	0.07	0.03	0.00
4	0.90	0.68	0.47	0.31	0.20	0.12	0.06	0.03	0.00
5	0.86	0.65	0.45	0.30	0.19	0.11	0.06	0.02	0.00
6	0.82	0.62	0.43	0.28	0.18	0.11	0.06	0.02	0.00
7	0.77	0.58	0.40	0.27	0.17	0.10	0.05	0.02	0.00
8	0.72	0.55	0.38	0.25	0.16	0.09	0.05	0.02	0.00
9	0.67	0.51	0.35	0.23	0.15	0.09	0.05	0.02	0.00
10	0.62	0.47	0.32	0.21	0.14	0.08	0.04	0.02	0.00
11	0.57	0.43	0.30	0.20	0.12	0.07	0.04	0.02	0.00
12	0.52	0.39	0.27	0.18	0.11	0.07	0.04	0.01	0.00
13	0.47	0.35	0.24	0.16	0.10	0.06	0.03	0.01	0.00
14	0.42	0.32	0.22	0.15	0.09	0.05	0.03	0.01	0.00
15	0.38	0.28	0.20	0.13	0.08	0.05	0.03	0.01	0.00
16	0.33	0.25	0.17	0.11	0.07	0.04	0.02	0.01	0.00
17	0.29	0.22	0.15	0.10	0.06	0.04	0.02	0.01	0.00
18	0.26	0.19	0.13	0.09	0.06	0.03	0.02	0.01	0.00
19	0.22	0.17	0.12	0.08	0.05	0.03	0.02	0.01	0.00
20	0.19	0.14	0.10	0.07	0.04	0.02	0.01	0.01	0.00
21	0.16	0.12	0.08	0.06	0.04	0.02	0.01	0.00	0.00
22	0.13	0.10	0.07	0.05	0.03	0.02	0.01	0.00	0.00
23	0.11	0.08	0.06	0.04	0.02	0.01	0.01	0.00	0.00
24	0.09	0.07	0.05	0.03	0.02	0.01	0.01	0.00	0.00
25	0.07	0.05	0.04	0.02	0.02	0.01	0.00	0.00	0.00
26	0.05	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00
27	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00
28	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
29	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Basal Area of Crop Overstorey: to be considered eligible as contributing BA in the first column of the DFP table above, L1's must meet any combination of the following:

- Preferred or acceptable species in the applicable stocking standards, in addition to any other commercially valuable conifer species, all of which meet the Free Growing Damage Criteria for Layered, Interior DFP, and SEDRSS Managed Stands (Section 27 of the FS660).
- Any mature tree specifically reserved to address a result or strategy in the FSP (i.e., planned retention to meet visual quality objectives, cultural heritage objectives, or other non-timber objectives).

9.2.3.4 RESULTS Data Entry

The *Procedures for Submitting Forest Cover to RESULTS for Openings with Treed Retention* provides the content requirements for reporting SUs with Dispersed and Grouped Tree Retention.

The reporting of Polygon, Inventory and Silviculture components are the same as reporting an even-aged clear-cut stand with < 5m^2/ha of retained BA, **except** for the following additional information:

1. Polygon Component
a. Reserve Type: Enter Dispersed.
b. Reserve Objective: Enter TIM (for timber objective, for the retained stems are contributing to the stocking and the next harvest).
c. Tree Cover Pattern: Enter the Tree Cover Pattern Number that best represents the Layer 1 residuals.

2. Inventory Component
a. Layers: Report inventory information for the combined understorey layer into the most abundant layer (L2, L3, or L4). Report the inventory information for the mature trees in Layer 1.
b. Basal Area: Enter Total BA m^2/ha (including crop and non-crop stems) in Layer 1.

3. Silviculture Component
a. Layers: Report silviculture information for the combined understorey layer into the most abundant layer (L2, L3, or L4). Report silviculture information for the mature trees in Layer 1.
b. Basal Area: Enter the Crop BA m^2/ha in Layer 1.
c. WS/FG Density: Enter the well-spaced and/or free growing density in the combined understorey layer. A well-spaced or free growing density is not required for Layer 1.

4. Comments
a. In RESULTS, attach a comment to the milestone declaration. Indicate that the Interior DFP survey methodology was used. Report the mean DFP value and the % stocking classes.

9.2.4 Survey Procedures for Single Entry Dispersed Stocking Standards (SEDRSS)

If you plan to use SEDRSS, please refer to the *Single Entry Dispersed Retention Stocking Standard- Feb 14, 2014* report. For guidance using SEDRSS in coastal fir, please refer to *Appendix 3: Coastal Second Growth Douglas-Fir Retention Stocking Standard.*

For training videos, refer to SEDRSS-Survey Procedures and CSC 2022-SEDRSS Background Info on the BC Silviculture Surveys YouTube channel.

9.2.4.1 Suitability

The SEDRSS survey methodology is suitable for stands managed with a hybrid type of silvicultural system: Single-Entry Dispersed Retention. This is defined as a partial-cut harvest entry, where retained overstorey stems contribute towards a stocking obligation and the next rotation cut. It assumes that further stand entries are not required to meet the stand structural objectives.

The DFP tables associated with this SEDRSS methodology have been calibrated for old growth Coastal Hemlock/Cedar Stands and Coastal Second Growth Douglas-fir stands.

Criteria:

1. The stand must meet the specific situations and circumstances.
2. The basal area for the dispersed retention/residuals ranges from:
    a. ≥9 and <40 m2/ha for old growth Hw/Cw stands; or,
    b. ≥5 and <40m2/ha for second growth Fdc stands.

To apply the proposed methodology to other stand types, new tables may need to be developed and calibrated. Please contact a subject matter expert.

Stratification Criteria for Stands Unsuitable for SEDRSS:

1. Areas ≥ 1.0 ha. with ≤ 8m^2/ha of Dispersed Retention: Create a separate standards unit and apply even-aged stocking standards.
2. Areas ≥ 1.0 ha with ≥ 40 m^2/ha of Dispersed Retention: Create a separate standards unit and apply intermediate cut stocking standards (no regeneration obligation).
3. Areas ≥ 0.25 ha Uncut: Remove from NAR. Map and classify this area as a group retention/reserve. Report to RESULTS.
4. Areas ≥ 1.0 ha. Broadleaf leading: Create a separate standards unit. SEDRSS is designed for conifer management only.

9.2.4.2 Survey Methodology

9.2.4.2.1 SEDRSS Tabular - Survey Sampling Procedures

This approach integrates the overstorey and understorey aspects of the DFP approach and presents them in a tabular format. The Deviation from Potential (DFP) method of stocking assessment recognizes two stand components: overstorey trees (Layer 1) and understorey trees (Layers 2, 3, and 4). The DFP method focuses on the future yield from the understorey component. The concept is that understorey yield varies based on understorey density and the amount of overstorey.

The tabular format is designed to match as closely as possible the current stocking standard tables in the *Reference Guide to FDP Stocking Standards*. The table outlines target and minimum well-spaced (WS) density standards for basal area groupings.

Table 16: Example SEDRSS Tabular Method for CWH vh1 01

SEDRSS BASAL AREA AND REGENERATION GUIDE								
CWHvh1 01		***Low →***		***Basal Area Site Occupancy***		***→ High***		
Basal Area of Layer 1 Crop Trees (m^2/ha)		**0-8**	**9-15**	**16-22**	**23-28**	**29-39**	**≥ 40**	**Approved FSP Leave Tree and Forest Health Criteria Apply. No MITD for Layer 1.**
Layers L2, L3, L4	Well-Spaced SPH	TSS 900 MSS 500	TSS 800 MSS 400	TSS 700 MSS 350	TSS 600 MSS 300	TSS 500 MSS 250	TSS 0 MSS 0	Individual plots within a SU may contain a combination of plots 1 through 6. **At SU level the average combinations 1 through 5 is chosen for reporting.**
Number of SEDRSS Combinations at the field plot level (1 to 6)		1	2	3	4	5	6	
Ecologically Suitable Tree Species and Minimum Heights (m)		Cw 1.5, Hw 3.0, Yc 1.5 Ba 1.8 Ss 3.0						Regeneration Date 6 years, MITD 2.0 meters, all layers L2, L3, L4 are outside of the dripline of all L1 trees.

Table 17: Example SEDRSS Tabular Method for CWH dm 01

SEDRSS BASAL AREA AND REGENERATION GUIDE								
CWHdm 01		***Low →***		***Basal Area Site Occupancy***		***→ High***		
Basal Area of Layer 1 Crop Trees (m^2/ha)		**0-4**	**5-10**	**11-16**	**17-23**	**24-39**	**≥ 40**	**Approved FSP Leave Tree and Forest Health Criteria Apply. No MITD for Layer 1.**
Layers L2, L3, L4	Well-Spaced SPH	TSS 900 MSS 500	TSS 800 MSS 400	TSS 700 MSS 350	TSS 600 MSS 300	TSS 500 MSS 250	TSS 0 MSS 0	Individual plots within a SU may contain a combination of plots 1 through 6. **At SU level the average combinations 2 through 5 is chosen for reporting.**
Number of SEDRSS Combinations at the field plot level (1 to 6)		1	2	3	4	5	6	
Ecologically Suitable Tree Species and Minimum Heights (m)		Cw 1.5 Hw 3.0 Fdc 3.0 Pw 2.5						Regeneration Date 6 years, MITD 2.0 meters, all layers L2, L3, L4 are outside of the dripline of all L1 trees.

Field Procedures

- **Pre-stratification:** Identify the areas suitable for SEDRSS as per the criteria listed in Section 9.2.4.1.
- **Plot Size:** Use a 3.99 m or 5.64 m radius plot depending on stand condition. Use the same plot size throughout the entire SU.
- **Prism size:** Choose a prism that captures a minimum of 4 Layer 1 trees per plot from the pre-harvest condition (in cut areas this would be a combination of standing trees and stumps).

The following steps describe the SEDRSS tabular survey procedure:

1. Tally the Residual Overstorey (Layer 1 trees, ≥ 12.5 cm DBH) using a variable radius plot.
   - Record "Number In" by species (crop and non-crop) in Field 95 of the T1 row.
   - Sum the total "Number In" in Field 110 in the T1 row.
   - Tally the crop "Number In" by species in Field 97 of the F1 row.
   - Sum the crop "Number In" and record in Field 110 of the F1 row.

   Note 1: There is no MITD between crop Layer 1 trees. Crop trees must meet forest health criteria outlined in Section 27 of the FS 660 and the *SEDRSS Implementation Guide*.
   Note 2: There is a BA cap of 40m^2 for the Layer 1 crop trees. I.e., If 50 m^2 is tallied, 40 m^2 is recorded in Field 110 of the F1 row.

2. Look up the TSS and MSS for the plot based on the crop BA (step 1). Use the tabular stocking standard table for the standards unit (e.g., Table 16 and 17). Record in two unused fields.

   For example, if the crop BA is 15 m^2, then the TSS is 800 and the MSS is 400. The M-value would be 4 with a 3.99 m plot or 8 with a 5.64 m plot. The M-value provides a cap to the number of understorey WS/FG trees for the plot (Step 3).

3. Tally the Regeneration Understorey (Layers 2, 3 and 4, ≤12.cm DBH) using a fixed area plot.
   - Tally all living, commercial trees (excluding germinants) by species in Field 95 of the combined understorey total tree row (T2/3/4). In the same row, record the sum of the total tree tallies in Field 98.
   - Tally well-spaced (WS) trees by species in the combined understorey WS row (W2/3/4). Tally all WS trees, including those in excess of the M-value (determined in Step 2), in Field 96. In the same row, record the sum of the WS trees up to the M-value in Field 99.
   - Tally free growing (FG) trees by species in the combined understorey FG row (F2/3/4). Tally all FG trees, including those in excess of the M-value (determined in Step 2), in Field 97. In the same row, record the sum of the FG trees up to the M-value in Field 100.

Note 1: Layer 2, 3, and 4 well-spaced or free growing trees must be outside of the dripline or 2.0 m, whichever is greater, away from **ALL Layer 1 stems (crop and non-crop, inside and outside of the plot**). The MITD is 2.0 m or as specified in the FSP between Layer 2, 3, and 4 WS/FG trees.

4. Record forest health data for Layer 1 and the combined Layer 2/3/4 at each plot. Refer to Section 27 for Layer 1 trees and Section 28 for Layers 2, 3, and 4 trees of the FS 660 for damage criteria or in the *SEDRSS Implementation Guide*. The implementation guide provides photo examples and additional guidance for cedar.

5. Tally plantable spots and preparable spots at each plot.

6. On the first plot and every fourth plot thereafter (minimum of 3 data sets per stratum), collect the following:

    a. Record the ground vegetation.

    b. Record the crown closure for Layer 1 and the combined Layer 2/3/4.

    c. For the overstorey and combined understorey layer, choose a representative well-spaced (or FG) tree of the leading silviculture species. The leading silviculture species may be different between the overstorey and understorey layers. For the selected trees, measure heights and ages. Heights include in-season growth.

    d. For the overstorey and combined understorey layer, choose the tallest, living tree of the leading inventory species and the tallest tree of the secondary inventory species. For Layers 2, 3, and 4, the selected tree should be within the fixed area plot. For Layer 1, the selected tree should be "In" the variable radius plot. For the selected trees, measure heights and ages. Heights include in-season growth.

7. Estimate the overall Tree Cover Pattern for the stratum or SU being surveyed for the Layer 1 trees, using Figure 33. Record in the Notes section (Field 118).

8. Use SIBEC to determine site index. If available, the 1st approximation SIBEC (whole numbers, no SE) is best used for the Layer 1 overstorey SI. The 2nd approximation SIBEC (decimal places, SE values) is suitable for other layers.
*Note: The SI is for the layer with the highest volume or next due for harvest (the layer with the great site occupancy).

Data Summary

9. Silviculture and Inventory Labels will be generated for the overstorey (Layer 1) and combined understorey (L2 + 3+ 4) layer.
   - The Layer 1 inventory label will include species composition (based on total BA), heights and ages for the leading and second species, crown closure, total density (if IMM), and total BA.
   - The Layer 1 silviculture label will include species composition (based on crop BA), height and age for the leading crop species, and crop basal area. It does not include a WS/FG density.
   - The inventory and silviculture label for the combined understorey L2/3/4 layer should follow Section 8.1.4 and 8.1.5.
   - To determine the silviculture species composition for Layer 1 and the combined understorey layer, use the tallies (WS/FG/crop BA) without the M-value applied.
   - The well-spaced and free growing density for the combined understorey layer should be based on the WS and FG totals, with the M-value applied.

10. Determine the average crop BA/ha.
    - Calculate the average crop BA for the residual Layer 1 trees from the plot data. Note: There is a BA cap of 40 m^2. If any plots have >40 m^2 of crop trees, then they should be reduced to 40 m^2 for the purpose of calculating the average crop BA/ha for the stratum.

11. Determine the mean WS or FG/ ha.
    - Calculate the average well-spaced or free growing density per hectare. It should be based on the WS/FG totals, with the M-value applied.
      Note: Statistical analysis is not applicable, due to the lower stocking values used in this methodology.

12. Look up the average Crop BA (step 10) in the tabular table (ex. Table 16 or Table 17) and find the corresponding TSS and MSS.

13. Compare the average stratum WS or FG density (step 11) to the MSS (step 12). **If the WS/FG mean is ≥ the MSS sph, the regeneration or free growing obligation is met.**

9.2.4.2.1.1 RESULTS Data Entry

The *RESULTS Information Submission Specifications* documents have a supplementary document called *Procedures for Submitting Forest Cover to RESULTS for Openings with Treed Retention*. This document clearly provides the content requirements for reporting SU's with Dispersed and Grouped Tree Retention.

The reporting of Polygon, Inventory and Silviculture components are the same as reporting an even-aged clear-cut stand with < 5 m^2/ha, **except** for the following additional information:

1. Polygon Component

   a. Reserve Type: Enter **Dispersed.**

   b. Reserve Objective: Enter **TIM** (for timber objective, for the retained stems are contributing to the stocking and the next harvest).

   c. Tree Cover Pattern: Enter the **Tree Cover Pattern Numbe**r that best represents the pattern of the layer 1 residuals.

2. Inventory Component

   a. Layers: Report an inventory label for the overstorey (Layer 1) and understorey (Layer 2, 3, and 4 combined).

   b. Basal Area: Enter Total BA (including crop and non-crop stems) in Layer 1.

   c. Density: Total density is not required if the stocking status is MAT.

   d. Species Composition: Based on total basal area for Layer 1. Based on density for the understorey layer.

3. Silviculture Component

   a. Layers: Report a silviculture label for the overstorey (Layer 1) and understorey (Layer 2, 3, and 4).

   b. Basal Area: Enter the Crop BA in Layer 1.

   c. WS/FG Density: A well-spaced or free growing density is not required for Layer 1.

   d. Species Composition: Based on crop basal area for Layer 1. Based on density for the understorey layer.

4. Comments

   a. Indicate that the SEDRSS Tabular method was used in the RESULTS declaration comments field. Provide the stratum's average BA, TSS/MSS, and WS/FG density.

9.2.5 Boreal Mixedwood Stand Structures Survey

The following survey procedures apply to the northern forest region on boreal mixedwood stands. The procedures use Mean Stocked Quadrant survey.

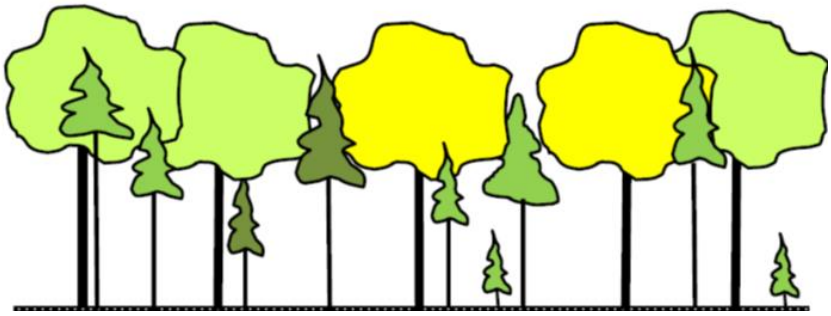


Illustration 3: Boreal Mixedwood Intimate Stand Structure

9.2.5.1 Mean Stocked Quadrant Survey (MSQ)

9.2.5.1.1 Plot locations

Sample plots are located on a 100 m grid (or 50 m grid for strata less than 5 ha) using UTM NAD 83 coordinates. Plot locations should be marked on the map prior to field sampling. All grid points within the NAR of each block should be sampled.

9.2.5.1.2 Sample Size

The sample in each stratum includes full measure plots located on the 100 m grid points. This gives a sample intensity of one plot/ha. If strata are smaller than 5 ha, the sample size should be increased by adding plots on a 50 m grid between the 100 m grid points. At least 5 plots should be established in any stratum. If a multi-block reforestation approach is employed increasing plot density on smaller strata may not be necessary. Also, in multi-block surveys the minimum 5 plots per strata could be applied across multiple blocks containing the same stratum type.

9.2.5.1.3 Measure Plots

Each full measure plot includes a 50 m^2 (3.99 m radius) plot divided into quadrants along cardinal directions to measure tree attributes and, at every 2^{nd} plot, a 100 m^2 (5.64 m radius) plot to collect site tree data (located at the same plot center). Site index should be estimated for each species in the site index plot where suitable site trees of each species have three or more years' height growth above breast height.

9.2.5.1.4 Main Plot - 50 m^2

Quadrant Information - Record each quadrant as stocked if it contains at least one healthy tree of an acceptable species that is free of brush competition (according to current free growing regulations). If a non-stocked quadrant could support tree growth, comment on why there are no trees (e.g., type of non-productive ground, missed plantable spots, brush competition, health problems).

Tree Information - Data for each tree in the plot includes:

i) Quadrant number (1-4).

ii) Tree species.

iii) Height (measure some for reference and visually estimate others).

iv) Forest health codes – use the same codes used in other silviculture surveys.

Brush Information - In each quadrant, record percent cover and average height of brush by species. If brush coverage and height is consistent, brush information may only need to be collected every fourth plot.

NP Area Information - In each quadrant record the type and percent cover of NP area (e.g., rock, water).

9.2.5.1.5 Site Index Plots - 100 m^2

Record site index information for one tree of each species from the site index plot (5.64 m radius) located at each plot center. Site trees are:

i) The largest diameter (dbh) tree in the 100 m^2 plot for that species.

ii) Undamaged (stem damage resulting in less than 5% reduction in height growth).

iii) Not overtopped by other trees or competing vegetation where height growth may be affected.

The second tallest tree can be measured for site index if the tallest is not suitable. This must be noted on the field card. Information collected for each tree should include:

i) Total height

ii) Age at breast height (yrs.)

iii) Total age (yrs.)

iv) Rank in height relative to other trees in the plot of that species (e.g., tallest, 2^{nd} tallest, etc.)

9.2.5.1.6 Compilation

Each stratum identified within a standard unit must have a separate compilation of the results of the survey.

9.2.5.2 Boreal Mixedwood Survey Procedures

The plot radii for stocking assessment is 3.99 metres, and the stocked quadrant approach applies. The plot is divided into quarters along N-S and E-W axes. Once the plot orientation is established, it is "fixed" for the entire survey, i.e., the quadrant orientation cannot be rotated differently in individual plots. The surveyor counts the number of plot quarters (quadrants) stocked with at least one acceptable tree. So, there may be 0, 1, 2, 3, or 4 stocked quadrants in a plot. The average of the plot tallies is Mean Stocked Quadrants (MSQ). MSQ ranges from 0 to 4.0. One plot per hectare is required.

1. If a quadrant is occupied by an acceptable At and there are no Sw present that are greater than the minimum height, then the quadrant is recorded as stocked with aspen. For the regeneration date assessment a minimum of 3 At are required in a quadrant to tally 1 At. For assessments at free growing the ratio is 1:1.

   - The proposal of a ratio of 3 At to tally 1 At at regen date is intended to reflect the risk associated with relying on too low an initial At density given the damaging events that can significantly impact young At stand stocking levels. This ratio requires further evaluation.

2. If one or more Sw greater than the minimum height are present in a quadrant, then the following procedure applies.

   i. First a one-metre radius is assessed around the Sw tree as per the standard free growing assessment procedure. To be tallied as free growing the one-metre radius around the Sw tree cannot contain overtopping branches from non-At or Ac competitors in more than 1 quadrant. This assessment applies to all potential competing vegetation (e.g. Ep, willow, calamagrostis). This one-metre radius can be rotated to minimize the number of quadrants overtopped.

   ii. If the Sw tree does not meet the one-metre radius requirement, then it cannot be tallied as "free growing" or "well growing" in that quadrant of the 3.99-metre radii stocking assessment plot. If there are no free growing Sw in a quadrant of the stocking assessment plot, then the quadrant is assessed for At. If one or more At stems are in the quadrant and meet the provincial free growing standards, then the quadrant is recorded as stocked with At. (At the regeneration date assessment a minimum of 3 At are required in a quadrant to tally 1 At. At free growing the ratio is 1:1.) Regardless of the number of acceptable At in a given quadrant, only 1 At stem is tallied in the quadrant.

   iii. If the Sw tree meets the one-metre radius (i.e. standard free growing) requirement, then a further assessment of the Sw tree is undertaken to determine if it can be classified as likely to remain "well growing" as follows:

For intimate mixedwoods

a. First the BA around the potentially well/free growing is determined. If the BA is 8 m^2 or less, then the Sw can be classed as well/free growing.

b. If the BA around the potentially well/free growing Sw is > 8 m^2, then its Relative-Height-in-the-Canopy (RHC) is determined.

c. To determine RHC:

i. First the height of the Sw is determined. Then the top height and crown bottom of the At stand is determined.

ii. At crown depth is determined by subtracting the At top height from the height of the At crown base.

iii. Subtract the height of the At crown base from the Sw height. Divide this number by the At crown depth to determine RHC.

iv. If the RHC is less than 0.5 then the Sw cannot be considered well/free growing.

d. If the Sw RHC is greater than 0.5 then Sw crown length within the canopy is determined.

i. The length of the Sw crown is determined by subtracting top height from the height of the Sw crown base and dividing by 3.

ii. The resulting number is then compared to the result of subtracting the height of the At crown base from the Sw height.

iii. If this number is greater than 1/3 the Sw crown depth, then the Sw can be considered well/free growing.

e. To be considered well/free growing in intimate mixtures with At BA > 8 m^2 the RHC must be greater than 0.5, and the Sw crown length within the At canopy must be greater than 1/3 Sw crown length.

For successional mixedwoods

a. Determine if Sw height is greater than 2 m.

b. Determine if the average leader length for the past 3 growing seasons is 20 cm or greater.

c. Divide Sw height by DBH and determine if the height-to-diameter ratio (HDR) is 1.0 or less.

d. To be determined well/free growing the Sw must be > 2 m in height, have a 20 cm or greater average leader length for the past 3 growing seasons, and have a HDR of 1.0 or less.

For macro, meso, and micro-patch mixedwoods

a. The individual *Sw* tree to be assessed now becomes the plot center for a 5-metre radius assessment plot.

b. To be assessed as likely to remain well growing, there must not be any *At* within 2 metres of the *Sw* tree (measured stem to stem) in 2 quadrants of the 5-metre radius plot, and 2 quadrants must be free of *At* for 5 metres (measured stem to stem).

c. The 5-metre plot can be rotated to optimize the arrangement of the quadrants. Unlike the standard free growing assessment procedure, the 5-metre radius plot considers *At* both within and outside of the 3.99 radii plot. The 5-metre quadrant can cover any portion of the 3.99-metre radii plot (i.e. it could be oriented either away or towards the plot center).

- ❖ The proposal of the 5522-metre opening is tentative. Ongoing research may indicate the need to adjust this specification.

d. A *Sw* tree meeting these criteria as well as the free growing criteria (as verified in step 2ii above) is tallied in the quadrant. If there are also one or more At occupying the quadrant and recorded as in step 2 ii above, then the quadrant is tallied as ½ *Sw* and ½ *At*. (At the regeneration date assessment a minimum of 3 *At* are required in a quadrant to tally 1 *At*, at free growing the ratio is 1:1.) The maximum stem count for any 3.99-metre radii stocking assessment plot cannot exceed 4.

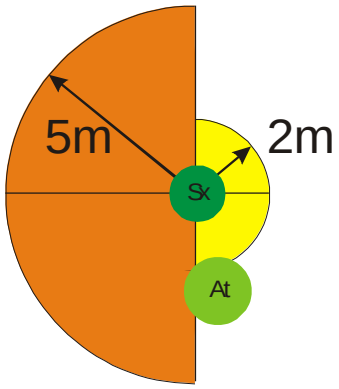


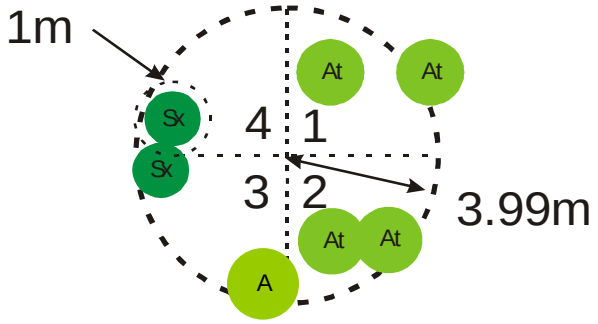
Figure 34: 2255 Concept Diagram

9.2.5.2.1 Example Plots

Plot samples modified from

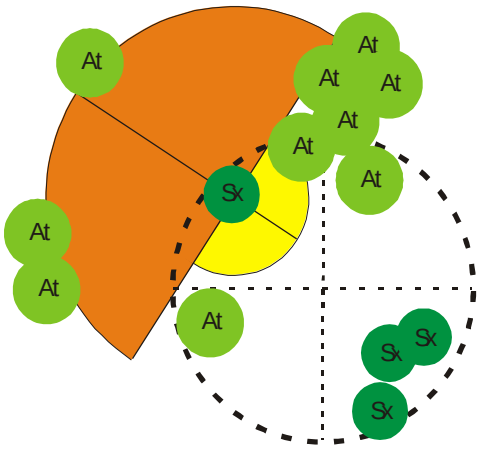
Schaad, A. 2006. Mixedwood Survey Investigation – The 2255 Method. MOF. Victoria.

9.2.5.2.1.1 Quadrant Plot Sample 1-regeneration:



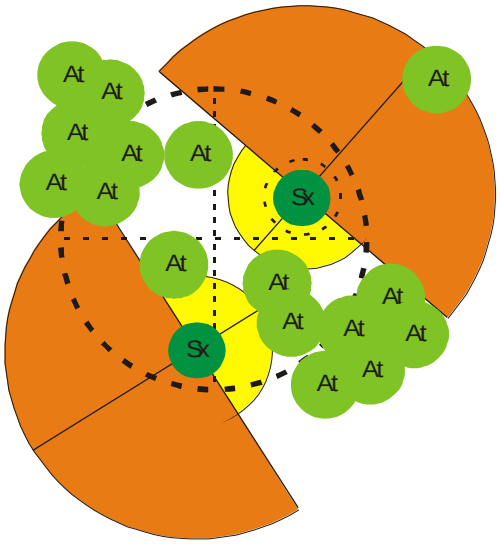
Quadrant	Tally	Comments
1		1 At in the quadrant, one outside with a crown extending inside the quadrant. Do not record as being stocked with At
2	At	3 At present in the quadrant, recorded as stocked with At
3	Sx	
4	Sx	1m dotted line provided for example only.

9.2.5.2.1.2 Quadrant Plot Sample 2 – Free/Well growing - 5522:



Quadrant	Tally	Comments
1	At	
2	Sx	3 Sx present but recorded as 1 quadrant stocked with Sx
3	At	
4	Sx	The aspen stems are outside the quadrant and outside the 5522 area.

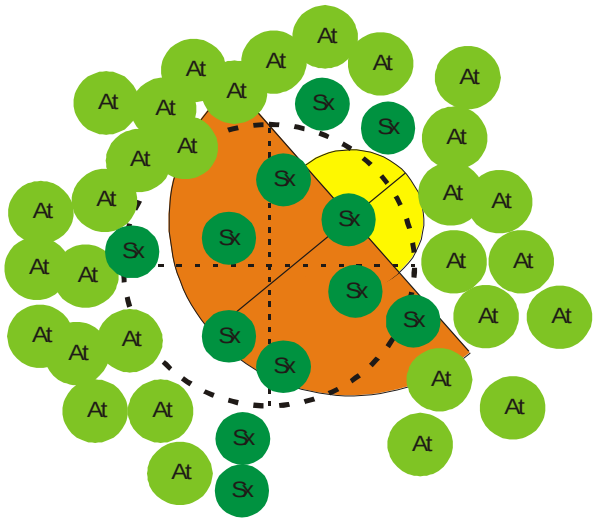
9.2.5.2.1.3 Quadrant Plot Sample 3 - Free/Well growing - 5522:



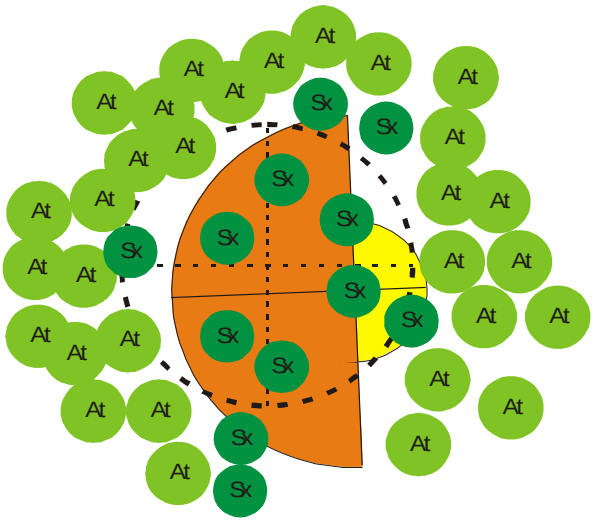
Quadrant	Tally	Comments
1		• The Sx meets the 1m but not the 5522 requirements. The Sx could be made free growing if the At in the 5 m quadrant were removed. This is an understorey spruce over 1m tall, and it is "brushable".
2	At	• Multiple At in the quadrant.
3	½ + ½	• The Sx meets the 1m and the 2255 requirements and there is a well growing At in the quadrant too.
4	At	• Multiple At in the quadrant.

9.2.5.2.1.4 Quadrant Plot Sample 4 - Free/Well growing - 5522:

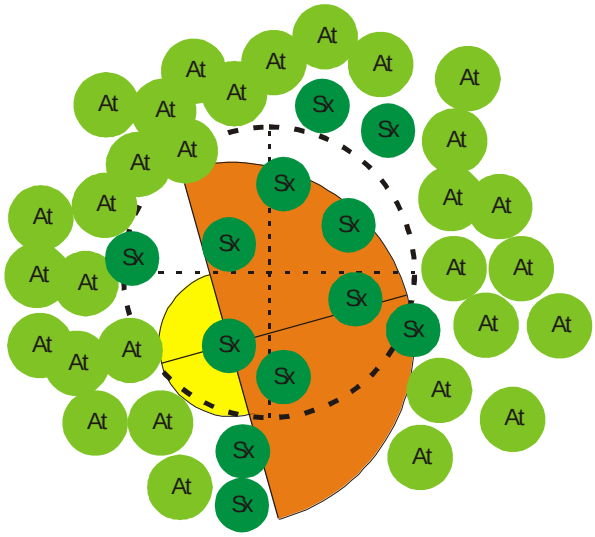
Quadrant 1



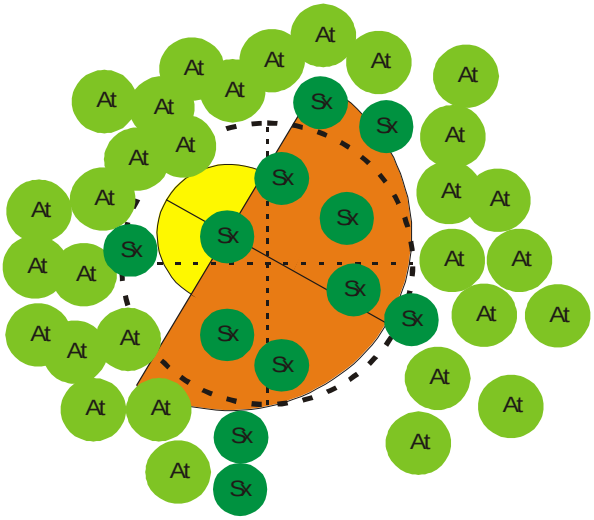
Quadrant 2



Quadrant 3

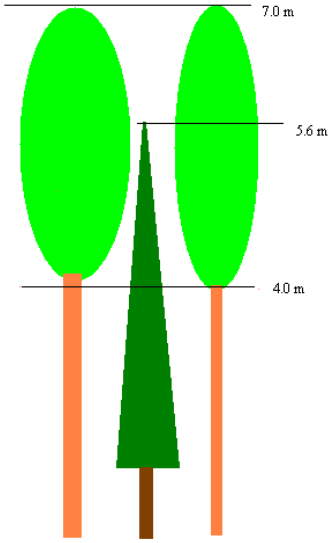


Quadrant 4



Quadrant	Tally	Comments
1	Sx	• The Sx meets the 1m and the 5522.
2	Sx	• The Sx meets the 1m and the 5522.
3	Sx	• The Sx meets the 1m and the 5522.
4	Sx	• The Sx meets the 1m and the 5522.

9.2.5.2.1.5 Plot Sample 5 - Free/Well growing – intimate mix:



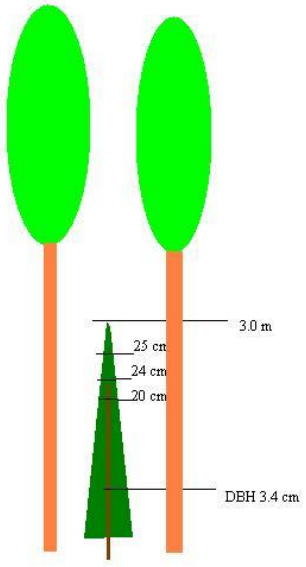
Sw height: 5.6 m
At top height: 7.0 m
At bottom live crown: 4.0 m
At crown depth (ACD): 7.0–4.0 = 3.0 m
Sw height into crown (SHC):5.6–4=1.6 m
RHC: SHC/ACD 1.6/3.0 = 0.53

Sw exceeds the 0.5 RHC requirement.

Sw crown length (SCL):4.5 m
Sw crown in At canopy: SCL/3 – SHC 4.5/3 – 1.6 $\leq$ 0
Sw exceeds the Sw crown in At canopy requirement.

Sw is Free/Well Growing.

9.2.5.2.1.6 Plot Sample 6 - Free/Well growing – successional mix:



Sw height: 3.0 m

Last 3 growing season leader length average:

(25 + 24 + 20)/3 = 23 cm

DBH: 3.4 cm

Sw Height to Diameter ratio: 3.0/3.4=0.88

Sw exceeds the 2.0 m height criteria

Last 3 growing season leader length average exceeds 20 cm

Sw HDR is $\leq$ 1.0

Sw can be considered as Free/Well Growing.

9.3 Complex Horizontal Structure Survey Methodologies

9.3.1 Even-aged Clustered Stand Structures Survey

Cluster treatments result in groups of trees that do not have a relatively even spatial distribution. Cluster treatments can increase biodiversity while reducing planting and vegetation management costs. Cluster treatments may also be used on openings that have a reduced number of microsites suitable for tree survival and growth. Examples of these treatments are cluster planting and cluster juvenile spacing. The silviculture plan or prescription sets a minimum inter-tree distance that is commonly lower than the minimum inter-tree distance used on non-cluster treated openings.

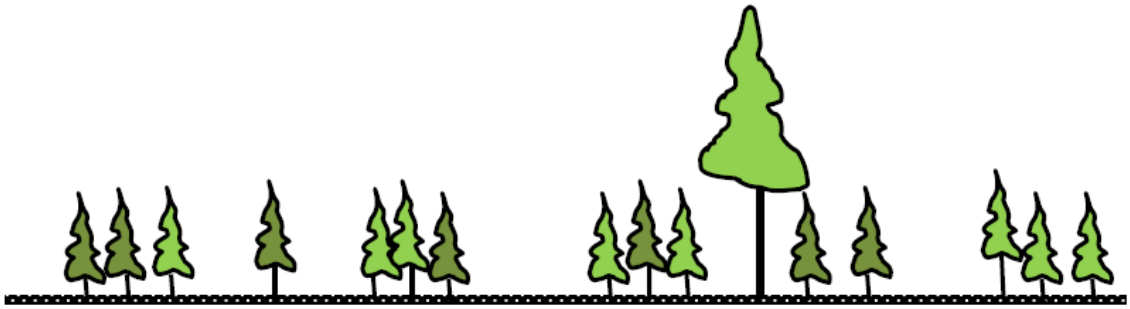


Illustration 4: Even-aged Clustered Stand Structures

The stand level objectives of the cluster treatment must be clearly defined prior to beginning the survey. Objectives may include:

- total trees per hectare
- number of trees per cluster
- minimum inter-tree spacing
- maximum inter-tree spacing
- total clusters per hectare
- target inter-cluster spacing
- cluster “design.”

The survey data collected may change depending on the objective of the survey, but the data and recording techniques will be consistent with other survey types. For example, when determining

planting quality, the conventional planting criteria will be assessed (e.g., plantable spots, number of trees planted, excess trees, satisfactorily planted trees) with the addition of cluster spacing and/or clusters per hectare.

Establishment of plots will follow the same procedures as other silviculture surveys, except that a larger plot radius is recommended. A 5.64-metre radius plot is recommended to be used where there are more than 100 clusters per hectare. Openings having fewer than 100 clusters per hectare may require an even larger plot.

At each plot, the surveyor should record the number of cluster centers that fall within the plot radius and the number of trees that fall within the plot radius. Regardless as to whether the cluster center falls within the plot radius or not, the trees that fall within the plot should be tallied.

9.3.2 Intermediate Cuts – Commercial Thinning Survey (Openings without regeneration objectives)

Openings without regeneration objectives are most often areas of commercial thinning, removal of individual trees or other types of intermediate cutting. The Forest Planning and Practices Regulation requires, for openings without regeneration objectives, a survey to be completed twelve months after the completion of harvesting. The survey enables the District Manager to determine that the requirements of the silviculture plan or prescription and stocking standards have been met.

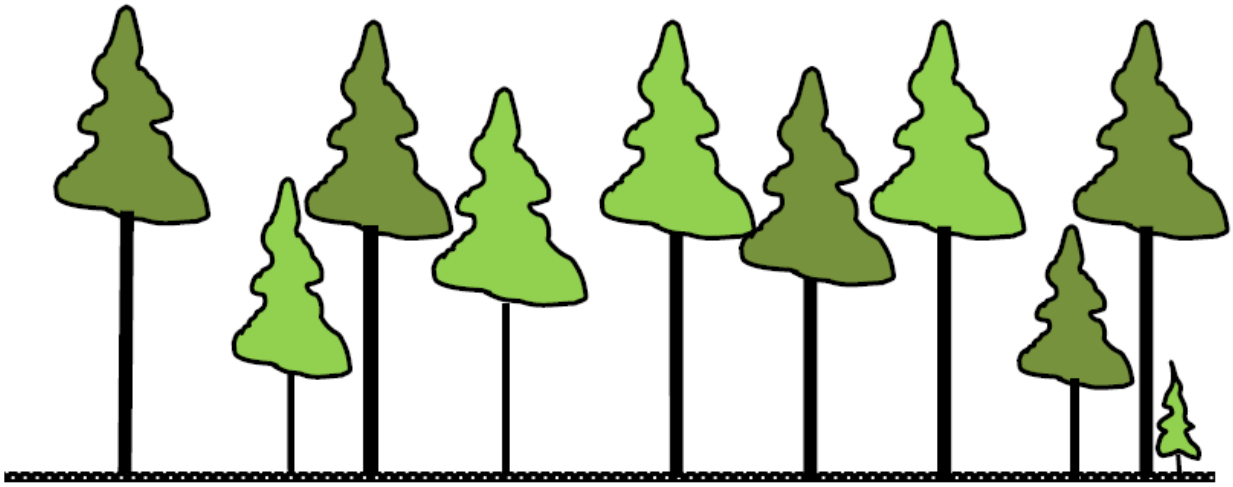


Illustration 5: Intermediate Cuts – Commercial Thinning Even-aged Stand Structures

9.3.2.1 Commercial Thinning Survey Procedures

The majority of the survey components for the commercial thinning survey are the same as for other forms of silviculture surveys. Stratification is completed for all of the reasons applied to other silviculture surveys. There are a few notable differences, including:

- identification of gaps;
- determination of plot method (prism or fixed radius);
- number of sample trees;
- site index method;
- forest health damage criteria for scars; and
- data collection in 5 cm diameter classes.

Identification of gaps in the stocking are particularly important, since there is no intent to regenerate the opening, existing gaps will persist through to the next harvest. The walk-through

should pay particular attention to gaps or voids produced during the commercial thinning operations.

During the walk-through, the surveyor will have to determine the form of sample plots that will be established. If during the walk-through it is determined that four to eight trees will be found in each of the prism sweeps using a BAF 5 prism, (or larger for the coast) then prism plots should be used to survey the stand. The plots should be measured carefully as they would be during timber cruising.

If less than four to eight trees would be found in the BAF 5 prism plots (or larger for the coast) then fixed-radius plots should be used. The plot radius is selected based on the Table 18 below to ensure the survey plots will identify 6 or more crop trees in each fixed-radius plot.

Estimated Crop Tree Density (tr/ha)	Fixed Radius Plot (m)
>1200	3.99
900-1200	5.05
600-899	5.64
350-599	6.31
<350	7.98

Table 18: Plot Radius to Crop Tree Densities Relationship

A minimum number of five crop trees should be sampled for their age and height, rather than the minimum three used during other stocking and free growing surveys.

Site index will usually be determined using the site index (height/age) curve method, since the stand will likely be taller than can be surveyed using the growth intercept method.

The forest health damage criteria have been adjusted to reflect the known harvesting damage potential in commercial thinning as well as the older nature of the candidate stands when compared to the typical free growing stand upon which the free growing damage criteria are applied. Individual wounds may have a maximum size of 400 cm^2 (20 x 20 cm). Multiple wounds may have a maximum cumulative area of 900 cm^2. Any single wound may not extend more than $1/3^{rd}$ of the circumference of the crop tree.

The plot data to be collected is like a pre-and-post stand-tending survey; data is collected in 5 cm-diameter classes.

Where an experienced surveyor is confident during the walk-through that there are no concerns present, the visual assessment survey method may be a suitable alternative to the formal plot establishment process.

9.3.3 Coastal Mixedwood Stand Structure Survey

This section is an excerpt from the discussion paper **Hardwood Management in the Coast Forest Region** published in April 2008. The paper outlines the strategic plan for the management of hardwoods in several management regimes, and how achievement of those stocking standards will be measured. This section focuses on the Mixedwood Management Regime, regarding the management of primarily Red Alder in patch mixtures with conifers (not intimate mixtures).

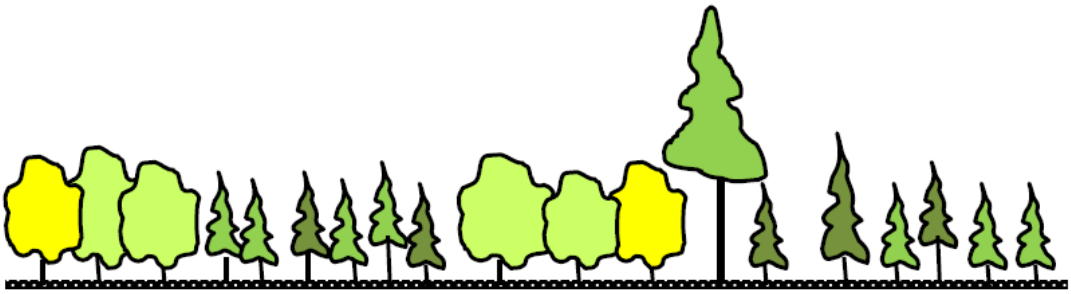


Illustration 6: Coastal Mixedwood - Patch Mixtures – Stand Structures

9.3.3.1 Mixedwood Management Strategy

Under a mixedwood management regime, with either natural or artificial regeneration, the target rotation age to produce a hardwood and a conifer sawlog with minimum size characteristics is 50-70 years.

Under this regime there is an anticipated reduction to Allowable Annual Cut (AAC) when compared to conifer management. This regime is complex to model; the magnitude of the reduction is anticipated to be similar to the extensive management regime.

The regime is sub-divided into forest types or land classes based on the leading species component.

- Conifer leading (C): >80% basal area is conifer
- Conifer leading mixedwood (CD): > 50% but < 80% basal area is conifer
- Deciduous leading mixedwood (DC): > 50% but < 80% basal area is deciduous hardwoods
- Deciduous leading (D): > 80% B=basal area is deciduous broadleaf.

The mixed designations, CD and DC, are recognized to have differentiations based on structural attributes. These classes can be broken into:

- Stratified mixtures: where one component (usually deciduous) makes up the overstorey and the other is in the understorey
- Intimate mixtures: where both components share dominance on the site and each are within the overstorey.
- Mosaic mixtures: where each component is a distinct separate patch.

A mixedwood strategy should outline:

- The objectives for mixedwood management (e.g., products, yield, stand and landscape diversity, etc.)
- The method for classifying and tracking the forest types or land classes (CD, DC)
- The ecosystems where mixedwood management will achieve the desired rotation lengths and product values ((BEC zone/subzone site series)
- The types of mixedwood strategies being pursued
- The stocking standards and free growing criteria associated with each type.

9.3.3.1.1 Types of Mixedwood Strategies

The potential mixedwood strategies are:

- Macro patch mixedwood (large distinct and discreet patches of pure hardwood and pure conifer – e.g., one block hardwood – one conifer, or one half a block as hardwood the other 1/2 conifer)
- Meso patch mixedwood (medium sized distinct and discreet patches of pure hardwood and pure conifer – e.g., a stratum divided into one portion hardwood and the rest conifer)
- Micro patch mixedwood (small distinct and discreet patches >1/2ha - of pure conifer and hardwood intermixed throughout the stratum)
- Intimate mixedwood (intermixing of both conifer and hardwood throughout with the intention of producing a crop of both at the same time in the future)
- Successional mixedwood (intermixing of both conifer and hardwoods but stratifying based on canopy level with the intent of sequentially harvesting one then the other)

At this point, the focus of the Coastal Mixedwood Strategy is on management of **Red Alder** with conifers on similar rotations. The only feasible mixedwood strategies for this focus, given the growth requirements, are the **patch mixedwood strategies** (macro, meso, and micro).

Example regime: Patch mixedwood management

Strategy Option	Site Preparation	Planting density	Final Harvest	Comments
Patch mixedwood (macro, meso, micro)	Optional - mechanical	1000 -1200 sph of conifer Natural regeneration of hardwoods (Alder)	Target Hardwood diameter 30 cm Rotation 50-70 years Target hardwood volume 300 m^3 per ha	-Natural regeneration of hardwoods may be managed for if various criteria are met; (appropriate density and tree distribution, > minimum patch, appropriate ecosystem)

9.3.3.1.2 Stocking standards and free growing criteria

Every mixedwood structural class will have associated with it unique stocking standards and free growing criteria. A definition of what constitutes a free growing tree in each of these structural classes is required to ensure that the desired future conditions are achieved. A free growing Fdc in a large patch mixedwood will look considerably different than a free growing (or well growing) Fdc in an intimate mixture. In a mixedwood scenario, the free growing criteria should describe the attributes of the target tree that indicate that it is currently growing and is anticipated to continue to grow at a rate that is consistent with achieving the targeted future land classification and yield targets.

Within each broad land-class designation there is a range of potential combinations of broadleaf and coniferous species. As such, the management strategy undertaken, and the resultant species mix within each stand will have different impacts on the future realized yield. If a landscape-level approach is taken in the management of the mixedwood resource, determination of future yield targets for each component (broadleaf and coniferous) should be determined and managed for.

9.3.3.1.3 Target rotations and mixedwood strategies

A critical component of mixedwood management is making allowance for the rotation length target for each stand and each component of the stand. Depending on how rotation length is to be defined (e.g., economic, max Mean Annual Increment (MAI), target diameter, etc.) broadleaf and coniferous species can have different rotation lengths. As such, prescribing the desired rotation length for the stand, or the components of that stand, can influence the choice of stocking standards and configuration of the mixedwood strategy undertaken. If a significant difference in rotation length for the desired components of the mixedwood is anticipated, or deliberately targeted, it may result (depending on strategy chosen) in different stocking standards and free growing criteria. It may also limit the configuration of the mixedwood (i.e., the pattern and size of patches) on the unit being managed. This is an important consideration to ensure effective and efficient access of each component at the anticipated harvest time, and not foreclose on future harvest options on the site.

9.3.3.1.4 Patch mixedwood stocking standards (Macro, Meso, and Micro patches)

Stocking standards for the patch mixedwood strategy should consider developing complementary standards that will be applied depending on the land class that the survey plot falls within. In areas designated as CD or DC, survey plots that fall within conifer-dominated portions of the opening will have a coniferous stocking standard applied, and survey plots that fall within broadleaf dominated portions will have the broadleaf stocking standard applied.

In order to focus on the management of target species within each of these patches, the use of coniferous species as acceptable in broadleaf standards or broadleaf species as acceptable in coniferous standards should be avoided. It is assumed that in these situations where lone individuals or groups of individuals of the non-target species occur within a patch, that the tolerance allowances outlined in the Free Growing criteria will compensate for their presence. Inclusion of the non-target species in the stocking standards may cloud the actual achievement of the land class designation on the unit as a whole.

In all patch mixedwood cases, the complementary conifer stocking standard should reflect those developed for the applicable site series the unit falls within for even aged conifer reforestation. A stocking standard combining both the deciduous and coniferous portion could be presented.

Example: **patch mixedwood** stocking standard, deciduous portion only (CWH mm1 – 05)

Preferred	Accept	Stocking density (stems per ha)		Mitd	Regen delay	Free growing (years)		% Ht above brush	Min. Ht.
Species	Species	Preferred	p&a	(m)	(Years)	Early	Late		(m)
Dr		1200	700	2.0	3	5	20	150	4.0

Example: **patch mixedwood** combined deciduous and conifer stocking standard (CWH mm1 – 05)

Class	Preferred	Accept	Stocking density (stems per ha)			Mitd	Regen delay	Free growing (years)		% Ht above brush	Min. Ht.
	Species	Species	Preferred	p&a	Min p	(m)	(Years)	Early	Late		(m)
D	Dr		1200	700		2.0	3	8	20	150	Dr4.0
C	Fd Cw	Pw[31]	900	500	400	2.0	3	8	20	150	Fd3.0 Cw1.5 Pw2.5

9.3.3.1.5 Free Growing Criteria

- For forest health damage criteria and vegetation competition criteria, refer to the FS660.

9.3.3.1.6 Free growing Survey System

- Pre-stratify the block into appropriate polygons assigning land class designations of C, D, CD, or DC.
- In each unit identified as being managed for patch mixedwood strategies, establish a grid of plots based on 1 plot per ha to a minimum of 5 plots per polygon. At each plot, identify the leading land class designation, and then utilize the applicable broadleaf or coniferous stocking standard for that unit.
- Tally the number of plots falling into each land class category and determine the percentage of the plots as either D or C. Determine the overall mixedwood land class designation based on the proportion of the area comprised of both D and C classes. For example, if 60% of the plots are classified as C and 40% of the plots are classified as D the land class for the polygon will be CD.

- All C and D plots will be tallied separately to determine overall achievement of stocking and reporting of inventory labels for each land class within the mixedwood identified polygon.

9.3.3.1.7 Minimum patch size

The establishment of a minimum patch size is essential to ensure that each species being managed for within the mixedwood achieves the desired volume and product value targets. Patch size should be large enough to ensure adequate growth rates and the development of acceptable tree form, so that desired rotation lengths are achieved and so that product value is maximized for each species.

Regarding coastal Red Alder /conifer mixed woods, in order to achieve optimal growth rates, it is recommended that patches not be smaller than ½ ha. Any patch smaller than these sizes should not be tallied as achieving the targeted land class.

9.3.4 Small Scale Harvested Openings Survey– Small Scale Salvage (SSS) or Helicopter Harvested Units.

The following is a suggested methodology to perform a survey of SSS or helicopter harvested openings resulting from harvesting very small openings which are:

- usually < 1 ha in size, and;
- scattered in close proximity across a localized landscape (approximately in an area less than 4 square kilometres - to make it operational).

This suggested survey method is a blend of Representative Sampling and Visual Assessments and should therefore best be performed by experienced surveyors only. A full grid pattern survey design is not recommended for these openings.

Survey Procedure Steps:

1) Opening Identification: Locate all of the openings on a digital map or if unavailable, on orthophotos at a minimum.

2) Pre-stratification and Grouping: Stratify or group the tiny openings into common BEC Subzones, - either by overlapping a BEC layer from MapView or referring to the BEC map for your area. If Predictive Ecosystem Maps (PEMs) are available, these will facilitate the grouping of openings further by site series for the openings. Label these groups of openings into pre-stratified sampling strata.

3) Stocking Standard Reference from Prescription or Default Determination: Reference the existing Stocking Standards if they exist on file. If there are no existing Stocking Standards in an approved silviculture plan or prescription, locate the applicable regional stocking standards for the BEC Subzones and site series in order to establish baseline species and stocking levels needed to declare the openings stocked (SR) or not satisfactorily regenerated (NSR).

4) Visual Assessment Survey of Grouped Openings: An experienced surveyor is recommended to walk-through most of the individual openings within each grouped strata as determined from the previous steps (some openings may be visually assessed from a distance if they appear similar to the adjacent opening). The goal of this assessment survey would be to collect critical data in order to determine the stocking status. A visual assessment collects the information listed below for each opening and target establishing at least one representative plot per final treatment unit (common site series and stocking status) in order to physically confirm the treatment unit status on the ground. Collect the following critical data for each opening and ultimately for each grouped opening treatment unit strata:

i) Inventory Label and Silviculture Label

ii) BEC Subzone and site series

ii) If NSR plantable spots per ha and species prescription

iv) Present brush species and levels and anticipated future levels

v) One photo per treatment type, showing any significant differences observed.

5) Compilation of Grouped Strata and Treatment Units: Compile grouped openings into common treatment units and draft prescriptions for planting/brushing for NSR areas. Enter SR areas into RESULTS (following recommended procedures for entry of SSS into RESULTS – via the guidance document on RESULTS website) as stocked and schedule further treatments or surveys when appropriate.

9.4 Other Alternative Survey Methodologies

9.4.1 Green-up (Adjacency) Survey

9.4.1.1 Objective of a Green – up Survey

The objective of a green-up survey is to determine whether a cut block is greened-up as specified in a silviculture plan (FSP) or as specified in Regulation. In general, the surveyor must at least assess the following:

1. **Area Achieving Green-up Height**: Determine the **proportion of the net area** to be reforested, **meeting Density and Green-up Height requirements** below;
2. **Density:** Estimate the total density of commercially valuable species **(TCV)**– **Total Conifer count of preferred and acceptable species including other commercially valuable species if present** – that are **> 1.3 m in height**;
3. **Green-up Height**: Estimate the **average height of the tallest 10%** of the above identified trees **(tallest trees in a 1/100 of a ha plot – in a 5.64 m radius plot)**.

Prior to commencing green-up data collection, a surveyor must determine if cut block adjacency and green-up status, is an issue for the opening being assessed. FRPA has potential exemptions to green-up requirements, and higher-level plans may have approved exemptions and different value criteria for achievement of green-up. Therefore, it is recommended for the surveyor to seek direction from the contract and/or licensee administrators regarding these specifics and requirement of data collection.

9.4.1.2 Data Collection Method Options

9.4.1.2.1 During a Free Growing Survey

The use or collection of green-up data from or during a free growing survey is the preferred option for surveyors. This is the most efficient opportunity to assess if green-up has been achieved, or when one can forecast green-up achievement and prescribe a verification recce survey.

Four scenarios are proposed for using or collecting green-up data from free growing data and procedures:

1. **Free Growing Survey Recently Completed:**
    a. With High FG Density and Height Data: The results can be used, as long as the FG trees on all of the strata (at least 75% of the net area) meet or exceed the densities listed above for the plan for the cut block and that the FG height of the FG stems exceeds the required green-up heights to the corresponding densities.

b. With Lower FG Density Data then required criteria: If FG trees alone are insufficient to meet the density requirement, the data could be mined (depending on the collect method – cards or data loggers) to extract just the well-spaced trees, regardless of whether they meet forest health criteria. As well, total trees in surplus of the well-spaced and free growing trees (that are still preferred and acceptable species) could be added to the total density tally, for green-up trees need not be well-spaced. However, the green-up height may not be reflected in the data or may be lower than required. With this scenario, depending on the depth and reliability of the data mining, an on-site reassessment of the opening to verify the green-up criteria may be required.

2. Additional Data to be Collected during a planned Free Growing Survey:

a. With Apparent Adequate Density and Green-up Heights: Tally two addition data points per plot:

i. Total number TCV per plot - if different then total conifer (TC) count;

ii. Determine the height of the tallest preferred and acceptable species per plot, based on a 5.64-metre radius sweep.

b. Without Obvious Adequate Density and/or Green-up Heights: If it is relatively clear after a walkthrough or walk-by prior to the establishment of plots that the opening would not achieve green-up, tally only the following data in order to roughly project when the opening could be expected to achieve green-up height, and when to schedule a subsequent recce walkthrough to confirm green-up achievement.

i. Collect an average of the current leader lengths of the total preferred and acceptable species per plot.

9.4.1.2.2 During a Recce Walkthrough

When there is no reliable free growing data, or it is not obvious from the mined survey data that the opening is greened-up, an onsite inspection will be required. It is recommended that an initial ground or aerial inspection recce be performed to determine whether the opening is potential greened-up or not. If it appears potentially greened-up, then it is recommended to perform a recce walkthrough survey that could resemble the sampling design of a combination of a vector, representative or visual assessment of the opening. Sample points or plots can be established along the sampling transects, if desired and as required. Required data to be collected either at each plot or data point or for the complete summary for the opening are:

1. Tally of TCV species per ha. > 1.3m;
2. The average height of the TCV trees per 5.64 plot and/or the average height of 10% of the preferred and acceptable species for the opening;
3. The % of the total strata NAR that has achieved green-up.

Note that this sampling method is only recommend for experienced surveyors familiar with the local management issues in the survey area and they would be confident that their determination of green-up status, could be duplicated by another similarly experienced forest professional.

9.4.2 Use of Planting Quality Inspection plots (FS 704)

The regeneration delay obligation can be achieved through planting. To use planting quality inspection plots (FS 704) to meet the regeneration delay forest cover reporting requirements, certain conditions should be met:

1. Less than 10 percent of the total trees after planting are natural regeneration or previously planted trees. (i.e., silviculture label = inventory label).
2. The minimum planting inter-tree distance must equal or exceed the minimum inter-tree distance specified in the silviculture prescription, site plan or FSP.
3. FS 704 plots are evenly distributed and properly stratified (refer to the stratification criteria in section 2 of the FS660).
4. All the species planted are listed as preferred for the applicable stratum in the silviculture plan or prescription. If both preferred and acceptable species are planted, the FS 704 plots may not be sufficient.
5. The well-spaced trees in the FS 704 plots are tallied to a maximum of the 'M' value for the target stocking standards (not the planting target stocking standard) in order to show that the minimum stocking has been met or exceeded. The total number of well-spaced trees (trees planted > minimum inter tree distance) should also be recorded and reported.

If all of the above conditions exist, the data from the FS 704 plots are adequate evidence that regeneration obligations have been met. The data should be compiled in the same format as a regeneration delay survey and must meet the reporting requirements outlined in the *RESULTS Information Submission Specifications* documents.

If more than 10% of the total trees after planting are naturally regenerated or previously planted trees, or any of the other conditions above do not exist, then a regeneration delay survey must be carried out. The regeneration delay survey can be completed in conjunction with the planting quality inspection or separately.

9.4.3 Use of Juvenile Spacing Quality Inspection plots (FS 749)

Juvenile spacing quality inspection plots can be used to declare an opening free growing if all of the requirements of a free growing survey report are met, and submitted to the District Manager.

Additional data that is not normally collected as part of the juvenile spacing quality inspection plots will be required. The most thorough method to meet the reporting requirements is to complete a minimum number of five free growing plots while collecting the desired number of FS 749 plots.

The visual assessment sampling method is often suitable to collect the needed free growing data following spacing treatments.

10 Provincial Surveys Accreditation and Training

The Silviculture Surveyor Accreditation program is designed to ensure surveyors are capable, well trained and understand the performance expectations required to conduct good-quality silviculture surveys.

Accredited surveyors must pass a two-day provincial accreditation exam that includes a written and field component. Successful candidates must meet the expectations for a range of performance objectives (PO). The Accreditation Brochure and Performance Objectives document describes the POs and exam criteria for success.

Surveyors can design their training to suit their needs. The average surveyor requires considerable field experience under the guidance of a highly skilled, accredited surveyor. Many surveyors pursue training with educational institutions, or with provincial trainers to acquire the needed skills and knowledge. Training and exam dates are posted on the silviculture surveys website. Courses and exams are typically offered at the beginning and end of each field season.

There is no expiry date for the silviculture surveyor accreditation certificate. Therefore, it is the responsibility of each surveyor to keep informed of any changes to standards and procedures.

While the accreditation process ensures that successful candidates have achieved a high standard of competency, the accreditation process provides no assurance that the survey work completed by any one person, or that any particular survey is done to the recommended standard. It is not a replacement for diligent supervision and auditing.

In the fall of 2008, the Association of BC Forest Professionals (ABCFP) passed a bylaw to include Accredited Silviculture Surveyors as potential individuals eligible for Associated Member Status. This means that surveyors who are not already members of the ABCFP as a RPF or RFT, can join this organization as an Associate Member. Associate Members of the ABCFP, have all of the benefits available to all other members and have to abide by all of the professional and ethical conduct bylaws of all other members.

The only difference in this Associate Membership is that the new member would only vote on items pertaining to this Associate Member class, and would not be subject to random practice reviews, and the cost of joining the ABCFP as an Associate Member is considerately less than registered members. The benefit to an individual accredited surveyor to join the ABCFP as an Associate Member depends on their current professional status and goals.

For more information on the silviculture surveyor accreditation process, contact Taisa Brown, the Silviculture Performance Assessment Specialist, at taisa.brown@gov.bc.ca

10.1 Staying Current

Both accredited and non-accredited silviculture surveyors are expected to stay current.

Here are some suggestions for staying up to date in silviculture surveying:

1. Join the BC Silviculture Surveyor distribution list by emailing taisa.brown@gov.bc.ca to receive notifications of updates and new releases.
2. Subscribe to the BC Silviculture Surveys YouTube channel and watch the available training videos.
3. Review and download/print from the Silviculture Surveys website:
    a. 2023 BC Silviculture Survey Procedures Manual
    b. What's New 2023
    c. FS657, FS658, FS659, FS660, FS1138A cards
4. If you use paper cards, order the latest paper cards from www.dcv.gov.bc.ca (government clients) or by emailing dcvcustomerser@gov.bc.ca or calling 1 800 282 7955 (non-government clients).
5. If you use a survey data collection application, ensure you have the latest version downloaded on your mobile device.
6. Review the *RESULTS Information Submission Specifications* and *Submitting Forest Cover to RESULTS for Openings with Treed Retention.*
7. Attend forest health training sessions with your district or regional forest health specialists. If a training session is not planned, request one.
8. Access ecology training:
    a. Attend an ecology training session with your regional ecologists and soil specialists. If a training session is not planned, request one.
    b. Review free, online BEC training content or register for a course with a college or university: https://www.for.gov.bc.ca/hre/becweb/resources/training/index.html
    c. Download district-scale biogeoclimatic field maps and regional field guides.
9. Sign up for a silviculture survey course:
    a. Northern Interior: https://technapro.com/product-category/survey-training/
    b. Southern Interior: https://www.wallis-training.ca/courses/
    c. Coast: http://silverfir.ca/
10. Attend a silviculture workshop (e.g., NSC, SISCO, CSC) or field tour to learn about current issues, latest research, best management practices, and to network with other silviculture surveyors and specialists.

11 Appendices

Appendix 1: Glossary

Acceptable species: Acceptable species are ecologically suited to the site, but management activities are not aimed at establishing them. The reasons for including a species in this category may be increased site limitations such as pest risk, or for biodiversity.

Advance regeneration: Regeneration that was present on an opening prior to harvesting. Advance regeneration, if present, should be carefully evaluated to determine its potential for future management. This term was formerly known as advanced regeneration.

Age class: Any interval into which the age range of trees, forests, stands or forest types are divided for classification and use. Age class is defined by the Forest Analysis and Inventory Branch as groups of 20 years: 1 = 1-20, 2 = 21-40, etc.

Aspect: The direction toward which a slope faces.

Backlog area: The Forest Practices Code of British Columbia Act defines a backlog area as "an area from which timber was harvested, damaged or destroyed before October 1, 1987, and that, in the District Manager's opinion, is insufficiently stocked with healthy well-spaced trees of commercially valuable species".

Basal area (BA): The cumulative cross-sectional area of trees as measured at breast height. The calculation of the basal area can be derived using the following formula:

Average number of trees per plot found "in" a prism sweep x *BAF of the prism used.*

Basal area factor (BAF): The factor used to multiply the number of trees found "in" during the prism sweep to yield the basal area per hectare. For example, with a BAF of 5, each tree found within the prism sweep represents 5 m^2/ha of cumulative cross-sectional area.

Basal resinosis: Large exudations of pitch at the base of the stem, found at or below the root collar. This symptom is often associated with Armillaria root disease or Warren's root collar weevil.

Basic silviculture: The silviculture treatments that are carried out to ensure regeneration to the free growing stage.

Biodiversity: The full spectrum of flora and fauna that occurs in a geographic area. Biodiversity includes species diversity, genetic diversity, and ecosystem diversity.

Biogeoclimatic classification: Ecosystem classification on the basis of vegetation, soils, topography and climate.

Biogeoclimatic zone: A geographic area having similar patterns of energy flow, vegetation and soils as a result of a broadly homogenous macroclimate. Biogeoclimatic zones are typically named after one or more dominant climax tree species occurring on zonal sites. The names often include a geographic or climatic modifier using the terms subzone, variant, site series, site type and site phase.

Breast height (bh): The standard height (1.3 metres above the point of germination) at which the diameter of a standing tree is measured.

Brush: This refers to competing vegetation, such as broadleaf species, shrubs, or herbs.

Brushing: A silviculture treatment to remove broadleaf species, shrubs or herbs that compete with conifers for sunlight, water, and soil nutrients.

Chlorosis or chlorotic: Blanched or yellowish coloring of normally green foliage in plants, caused by a variety of factors, including nutrient or light deficiencies.

Clearcut: A silviculture system resulting in the harvesting of all trees from an area of forest land in a single cut.

Clinometer: An instrument for measuring vertical angles or slopes commonly used to calculate tree heights.

Co-dominant: In upper stands with a closed canopy, those trees whose crowns form the level of the canopy and receive full light from above, but comparatively little from the sides. In young stands, co-dominant trees have above average height growth.

Commencement Date: This term is defined in Forest Planning and Practices Regulation.
(a) the date on which timber harvesting, other than on road rights of way or landings, begins on a cutblock, or
(b) in the case of timber harvesting carried out in contravention of section 52 (1) [unauthorized timber harvesting] of the Act, the date a determination under section 71 [administrative penalties] of the Act takes effect, without any further opportunity for review or appeal in respect of the contravention.

Commercial thinning: The thinning of older, immature stands where trees have reached merchantable size, to provide an interim harvest and a financial return while maintaining or restoring a higher rate of growth on well-spaced, better-quality final-crop trees.

Commercial tree species: For this manual, commercial tree species will include all species in the RESULTS tree list or in Table 6 of the FS660.

Competing vegetation: Vegetation that competes for the limited common resources (space, light, water and nutrients) of a forest site that are otherwise needed for survival and growth by commercially valuable preferred trees.

Conifer: Cone-bearing tree having needles or scale-like leaves, usually evergreen, and producing wood known commercially as softwood.

Countable conifer: Conifers meeting or exceeding a minimum countable height and counted towards the maximum density determination during a free growing survey. See also Maximum density.

Countable height: The height above which all trees are tallied and considered as countable conifers

Crop tree: A tree in a young stand selected to be retained until final harvest.

Crown closure: The stand condition resulting in the crowns of trees touching and effectively blocking sunlight from reaching the forest floor. Crown closure is expressed as a percentage.

Cut block: A specific area with defined boundaries authorized for harvest.

Danger tree: Any tree that is hazardous to people or facilities because of its location, degree of lean, physical damage, overhead hazards, limb, stem, top or root system deterioration, or a combination of any of these. If work in a forestry operation will expose a worker to a dangerous tree, the tree must be removed.

DBH (diameter at breast height): The stem diameter of a tree measured at breast height, 1.3 metres above the point of germination.

Decay: The disintegration of plant tissue; the process by which sound wood is decomposed by the action of wood-destroying fungi and other micro-organisms.

Deciduous: Term applied to trees, commonly broadleaf trees, which usually shed their leaves annually. Also known commercially as hardwoods.

Declination (magnetic): The angle between true north and magnetic north. Declination varies from place to place and can be set on a compass for a particular location.

Defoliator: An agent that damages trees by destroying leaves or needles.

DFP (Deviation from potential): An approach to regeneration stocking assessment in partially cut stands in the BC interior and coast (SEDRSS).

Dominant: Trees with crowns extending above the general level of the canopy and receiving full light from above and partly from the side. Dominant trees are taller than the average trees in the stand, with well-developed crowns.

Drag scarification: A method of site preparation. The objective of drag scarification is to disturb the forest floor and to prepare harvested areas for natural regeneration. Drag scarification is done with anchor chains or sharkfin barrels. These tools are large, specially constructed steel chains that are dragged behind a prime mover such as a skidder.

Dripline: It is a visual boundary for assessing understorey tree's minimum distance from an overstorey tree. The boundary is defined by where the main stem of the understorey tree is **outside** of the outer foliage of the overstorey tree.

Ecosystem: The sum of plants, animals, environmental influences, and their interactions within a particular habitat.

Even-aged: FPPR defines an even-aged stand as a stand of trees consisting of only one or two age classes. Note: The age classes are outlined in the Vegetation Label Details.

FAIB: Forest Analysis and Inventory Branch

Fertilization: The addition of fertilizer to promote tree growth on sites deficient in one or more soil nutrients. Commonly used to improve the vigor of crop trees following juvenile spacing or commercial thinning.

FG: Free growing

Fill planting: Fill planting (FP) is a planting activity where the planting/planted density is <80% of the target stocking standard due to natural ingress, previously planted seedlings, or site limiting factors. The fill planting technique code applies on previously and not previously planted sites.

Forest and Range Practices Act: The 2004 replacement for the Forest Practices Code. The Forest and Range Practices Act is the most current form of forest management legislation in British Columbia.

Forest cover inventory: This means "a survey of trees and tree-related matters in an area that includes information required by the minister."

Forest cover labels: A combination of letter and number codes in a sequential order that describes the forest cover characteristics.

Forest cover map: A map showing relatively homogenous forest stands or cover types produced from the interpretation of aerial photos and from information collected from field surveys. Commonly includes information on species, age class, height class, site and stocking level.

Forest Development Plan: An operational plan under the Forest Practices Code containing a licensee's plans for harvesting, road construction and silviculture activities.

Forest health factor: Biotic or abiotic influences on the forest that are usually naturally-occurring components of forest ecosystems. Biotic influences include fungi, insects, plants, animals, bacteria, and nematodes. Abiotic influences include frost, snow, fire, wind, sun, drought, nutrients, and mechanical human-caused injury.

Forest health pest: A forest health that limits the ability to meet resource management objectives.

Forest Licence (FL): A forest licence is a form of tenure which allows the orderly timber harvest over a portion of a sustained yield management unit. The forest licence provides for the timely reforestation of these harvested areas according to a strategic resource management plan prepared by the Ministry of Forests for each timber supply area. The licence commonly has a term of 15 to 20 years, generally replaceable every five years (some are non-replaceable) and operating areas that shift over time. A forest licence specifies an annual allowable cut and requires management and working plan, and specified management activities.

Forest Practices Code (FPC): Forest Practices Code of British Columbia Act. The Act also includes regulations by Cabinet under the Act and the standards established by the Chief Forester of BC. The term may sometimes be used to refer to Guidebooks. It should be remembered that unlike the Act, the Regulations and the Standards, Guidebooks are not legally enforceable.

Forest Stewardship Plan: A plan (or document) that is (a) required under section 3 of the Forest and Range Practices Act or (b) approved under section 16[1] of the Forest and Range Practices Act.

Fork: A deformation of the main stem resulting in two or more leaders.

FPC: Forest Practices Code.

Free growing height: The minimum height that a crop tree must attain before it forms part of a free growing stand.

Free growing tree: A healthy, preferred or acceptable well-spaced tree that is at least the minimum height and is at least the minimum size relative to competing vegetation within the effective growing space.

Free growing stand: A stand of healthy trees of a commercially valuable species, the growth of which is not impeded to an unacceptable level by competition from plants, shrubs, or other trees.

Fruiting body: The reproductive part of a fungus that contains or bears spores.

Gall: Nodule or lump of malformed bark or woody material caused by a variety of factors such as western gall rust or insects.

Galleries: Passages carved out under bark or in wood by insects feeding or laying eggs.

Germinant: A germinant is a ≤5cm natural (disregarding the loss of height by a forest health factor). Age is not a consideration.

Note: Planted seedlings under 5cm or well-spaced trees of any size are counted under total trees (Field 95), not germinants (Field 110).

Example 1: A 2-year-old Pli is 8cm. It is not a germinant because it is >5cm.

Example 2: A less than 1-year old Hw is 7cm. It is not a germinant because it is >5cm.

Example 3: A 2-year-old planted Fdc is 4cm due to elk browse. It is not a germinant because it was planted.

Example 4: A 2-year-old natural Cw is 5cm and heavily browsed. It is not a germinant because an elk has removed a portion of its height.

Example 5: A 1-year old Sx is 3cm. It is a germinant because it is a ≤5cm natural.

Ghost tree: Trees that, for a specified reason, will not count towards the stocking of the stand but have an impact on the development of the regeneration.

GI: Growth intercept

Global Positioning System (GPS): A navigational tool that allows the user to determine their location on the surface of the earth. The location is determined using a hand-held or aircraft mounted instrument, and the radio signals from several satellites.

Gouting: Excessive swelling of a branch or shoot, often accompanied by misshapen needles and buds. Gouting is most common at nodes or on branches and is frequently caused by balsam woolly adelgid on Abies species.

Growing season: The period of active growth from the start of bud elongation until bud set.

ha: Hectare.

Height class: Any interval into which a range of tree heights is divided for classification and use.

Herbicide: Chemical substances or living organisms that are used to kill or to control vegetation such as brush, weeds and competing or undesirable trees.

Immature: Trees or stands that have grown past the regeneration stage but are not yet mature.

Incidence: The proportion (0 to 1) or percentage (0 to 100) of entities (normally a tree) affected by forest health within a sample unit. This can easily be referred to as the proportion or percentage of forest health factors present within an opening.

Incremental silviculture: Refers to treatments carried out to maintain or to increase the yield and the value of forest stands. Treatments include site rehabilitation, conifer release, spacing, pruning and fertilization.

Infections: Characterized by lesions on the stem and/or branches or characterized by swellings around the point of entrance of a pathogen.

Injury: Damage to a tree by a biological, physical, or chemical agent.

Inter-tree distance: The horizontal distance between two trees on a center-to-center basis. Inter-tree distance is calculated or measured to the nearest 1/10 of a metre, unless otherwise specified. See also Minimum Horizontal Inter-Tree Distance Section.

Intermediate Cut: Stand entries to remove (usually merchantable) trees prior to the final harvest or regeneration cut phase. Usually designed to modify the stand so that continued stand development enhances the quality or growth of established trees.

Juvenile spacing: A silviculture treatment resulting in the reduction in density of young stands, preferably between 3 metres to 5 metres in height, to control stocking, prevent stagnation and improve crop tree quality so that at final harvest end-product quality and value is increased.

Landing: The area where logs are collected for loading.

Layered: A stand is considered layered if the stand is being managed as an even-aged system, where a single harvest entry is planned for all layers within longer rotation cycles (>50 years), and layer 1 and/or 2 are dominant, and one of these two layers is considered in combination with 3 and/or 4. (an even-aged system)

LCL: see Lower Confidence.

Leader: The annual growth of the apical meristem of a tree. It is the extension of the main stem.

Leave trees: Trees selected to be left on an area following harvesting, juvenile spacing or commercial thinning.

LFH (Litter-Fermentation-Humus): The accumulation of organic material over mineral soil. L, F, and H refer to litter, fermentation, and humus respectively.

Licensee: Tenure holder. See Tenure.

Lower Confidence Limit: This statistical value indicates the lowest average number of well-spaced trees per hectare that another survey on the stratum would be expected to find, nine times out of ten.

The LCL of 90 percent must be attained before the opening can be considered satisfactorily restocked or free growing.

Mature: Trees or stands that have sufficiently developed to be harvested.

Maximum density: The maximum allowable stand density of total countable conifers, above which openings must be spaced down to a specified density of well-spaced preferred and/or acceptable stems in order to achieve free growing status. See also Maximum Density.

Median Height: The middle height. Used in the countable conifers and countable broadleaf determination. Refer to Figure 5 and Figure 6 for illustrations of this concept.

Mesic: Within the biogeoclimatic classification system, mesic sites are those that are most common (average) within a single zone. It may also be referred to as zonal.

MFLNRORD: Ministry of Forests, Lands, Natural Resources Operations and Rural Development. Former name for Ministry of Forests (FOR).

Microclimate: The climate of small areas, especially if it differs significantly from the climate of the region.

Microsite: A small area exhibiting specific characteristics that are different from the surrounding area. During planting projects, microsite is commonly referred to as 'acceptable microsite'. Acceptable microsites are those spots that are best suited for the optimum survival and growth of the planted tree.

Milestone Survey: There are two important reporting points and as a result two milestone surveys. These are the regeneration delay survey and the free growing survey. Stocking surveys are not milestone surveys.

Minimum height at free growing: The minimum height that a healthy, well-spaced tree must attain in order to be considered free growing. On areas for which a silviculture plan or prescription was approved on or after April 1, 1994, minimum heights vary by species, biogeoclimatic zone and site series.

Minimum inter-tree distance (MITD): The minimum horizontal distance between two trees on a center-to-center basis. Inter-tree distance is calculated or measured to the nearest 1/10 of a metre, unless otherwise specified. See also Minimum Horizontal Inter-Tree Distance.

Minimum preferred stocking standard (MSSp): The minimum number of well-spaced trees per hectare, of preferred species only, that must be present for the stratum to be considered satisfactorily restocked or free growing.

Minimum stocking standard (MSS, MSSp+a): The minimum number of well-spaced trees per hectare, of preferred and acceptable species, that must be present for the stratum to be considered satisfactorily restocked or free growing.

Moder: A humus form characterized by a greater-than-1-centimetre-thick F horizon and an Ah layer. Typically soil organisms are responsible for the intermediate decomposition rates through soil mixing.

MOF, M of F: former acronym for Ministry of Forests

Mor: A humus form characterized by a greater-than-1-centimetre-thick F horizon and an absent Ah layer. Typically, decomposition is slow due to a lack of soil organism.

Mosaic: Distinct strata that occur in a dispersed manner.

MSS: Minimum stocking standards.

Mull: A humus form developing under conditions that favor rapid decomposition of organic matter. F layers are generally less than 1 centimeter thick; Ah layers are greater than 2 centimeters thick, and extensive soil mixing is caused by soil organisms.

Multi-storey: A stand is considered multi-storied if layer 1 and/or layer 2 have a crown closure greater than 6 percent and one of these two layers is considered in combination with layer 3 and/or layer 4 (an uneven-aged system)

M-value: The maximum number of healthy, well-spaced trees that may be tallied in a single plot. This value is calculated by dividing the target stocking standard for the stratum by the plot multiplier. This prevents over-stocking in one plot compensating for under-stocking in others. This is a key concept in the survey system.

NAR: Net area to be reforested.

Natural regeneration: The renewal of a tree crop by natural means.

Net area to be reforested (NAR): The area on which the licensee is responsible for establishing a free growing crop of trees. This figure is the sum of Standard Unit (SU) areas.

FPPR defines NAR as "the portion of a cutblock that remains after the following have been excluded:

(a) areas occupied by permanent access structures;

(b) contiguous areas that

(i) in their natural state, are not capable of supporting a stand of trees in order to meet the stocking standards for un-excluded areas, and

(ii) are at least 0.1 ha in size and 10 m wide or are identified under section 86;

(c) contiguous areas of non-commercial forest cover that

(i) are present on the cutblock at the commencement of timber harvesting, and

(ii) are at least 0.1 ha in size and 10 m wide or are identified under section 86;

(d) wildlife tree retention areas;

(e) riparian reserve zones;

(f) areas reserved for purposes other than timber harvesting;

Node: A joint or portion of a stem from which a leaf or branch has grown.

Non-productive (NP): Land that is incapable of growing a merchantable stand within a reasonable length of time.

Not satisfactorily restocked (NSR): Productive forest land that has been denuded and has not been regenerated to the specified stocking standards for the opening.

NP: Non-productive.

Not FG: Not free growing.

NSR: Not satisfactorily stocked.

Opening: An area denuded of trees by means of harvesting, insects, disease, fire, wind, flooding, landslide or by any other similar events.

Overstorey: Generally, layer 1 and/or 2 trees growing that may be as a full or partial canopy over layer 3 and /or 4 trees. These may be conifers and or broadleaf trees.

Overtopping: Vegetation that is taller than the crop species, within a 1-metre radius around the crop species.

Pesticides: A general term for chemicals used to kill either vegetative pests (herbicides) or insect pests (insecticides).

Planting: Establishing a new stand by planting seedlings. The planting (PL) technique code in RESULTS refers to a planting activity with a planting/planted density ≥80% of the target stocking standard. It only applies to sites that have not been previously planted.

Plantable spot: A suitable microsite on which a seedling could be planted. The suitability of the microsite is dependent on-site conditions and limiting factors such as soil moisture, soil temperature, soil nutrients, climatic conditions, tree species and stock type to be planted.

Plot multiplier: The factor used to multiply the tree count in the survey plot to yield the equivalent stems per hectare. It is calculated by dividing the area of one hectare (10 000 m^2) by the area of the sample plot. For example, a plot radius of 3.99 m has an area of 50 m^2 and a resulting plot multiplier of 200. (10 000m^2 ÷ 50m^2 = 200)

Point of Commencement (POC, P of C): This term is used to describe "the starting place" of a survey. POCs should be tied into features indicated on the forest cover map or on an air photo (e.g., road junctions, creek crossings or junctions, or block boundaries).

Polygon (or called Stratum): A subdivision of a forest area to be inventoried based on a group of trees with the same or similar species composition, age, and/or height class, (plural = strata).

Population: Consists of the total number of the observations with which we are concerned (e.g., all the well-spaced trees in an opening).

Potential Free Growing Tree: The concept used in the Free Growing Guidelines to identify a tree that may be free growing if there are less than a specified number of countable sized broadleaf trees present in the plot.

Potential Danger Tree: Loosely defined as usually dead trees that may pose a hazard to crews conducting treatments. Wildlife Danger Tree assessment would be necessary to determine its hazard status. The term snag may have been previously used to describe these.

Preferred species: Those species ecologically suited to the site. Management activities are primarily aimed at establishing preferred species. The characteristics of these species are consistent with the desired timber and non-timber objectives for the opening.

Pre-harvest silviculture prescription (PHSP): A legally binding, site-specific plan describing the nature and extent of any timber harvesting and silviculture activities carried out on an opening. The PHSP outlines the required management objectives, standards, and timelines that the owner of the opening must achieve, including reaching a free growing stand. PHSPs are the 'pre-Forest Practices Code' equivalent to Silviculture Prescriptions. With the initiation of the Forest Practices Code, all PHSPs will be treated in the same manner as silviculture prescriptions.

Preparable spot: A microsite that is presently unsuitable for planting, but with site preparation, would become an acceptable planting microsite.

Prism: An optical instrument consisting of a thin wedge of glass. The prism creates the appearance that part of the object being looked at is laterally displaced. If the object and the displaced part of the object overlap, the object is "in" the plot, and if there is no overlap, then the object is "out" of the plot. A prism sweep results in the tally of stems based on stand basal area using a variable radius plot.

Pruning: The removal of the lower branches of crop trees to a pre-determined height, usually correlated to log lengths, to produce clear, knot-free wood. Knot-free wood increases the value of the final wood products.

PSS: Planting stocking standard

Reforestation: The natural or artificial restocking of an area.

Regeneration date / delay: The date by which a minimum number of healthy, well-spaced trees of both the preferred and acceptable species, and the minimum number of preferred species, must be established and afterwards maintained until the stand is declared free growing.

Replant (RP): The replant technique code refers to a planting activity on a previously planted site with a planting/planted density ≥ 80% of the target stocking standard.

Reserve: An area of forest land that, by law or by policy, is not available for harvesting. Areas of land and water set aside for ecosystem protection, outdoor and tourism values, preservation of rare species, wildlife protection, etc.

The retention of live or standing dead trees following harvest for purposes other than regeneration that are pole size or larger. Reserves can be uniformly distributed as single trees or left in small groups.

Reserve tree: A tree that is specifically reserved from harvesting and/or silviculture activities.

Reserve zone: The inner portion of a riparian management area situated adjacent to a stream, lake, or wetland. Reserve zones are established to conserve and to maintain the productivity of aquatic and riparian ecosystems.

Residual basal area: The basal area per hectare left standing after harvest.

Residuals (residual trees): Trees left standing after harvesting.

RESULTS: This is an acronym for Reporting Silviculture Updates and Land status Tracking System. This is the Ministry of Forests' corporate database and application used to track silviculture information on openings. Additional information about RESULTS can be found at **this link.**

RFT (Registered Forest Technician): RFTs perform technical forestry functions in four practice areas: silviculture, forest protection, forest operations and forest measurements.

Riparian: An area of land adjacent to a stream, river, lake, or wetland that contains vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas.

Riparian Management Area (RMA): An area of specified width surrounding or adjacent to streams, lakes, riparian areas, and wetlands. The RMA includes, in many cases, adjacent upland areas. It extends from the top of the stream bank (bank full height) or from the edge of a riparian area or wetland or the natural boundary of a lake, outward to the greater of 1) the specified RMA distance, 2) the top of the inner gorge, or 3) the edge of the flood plain. Where a riparian area or wetland occurs adjacent to a stream or lake, the RMA is measured from the outer edge of the wetland.

Riparian Reserve: A type of reserve adjacent to a water body.

Rotation: The planned number of years between the formation or regeneration of a tree crop or stand and its final cutting at a specified stage of maturity. Rotation can be based on physical, biological, pathological, or economic criteria.

Rotation age: The age at which a stand is considered mature and ready for single entry harvesting under an even aged management strategy.

RPF (Registered Professional Forester): A person registered under the Foresters Act who performs or directs works, services or undertakings requiring specialized knowledge, training, and experience in forestry.

Sanitation cutting: Improving the growth and health of young stands by removing damaged or diseased stems.

Sapling: A young tree that is larger than a seedling but smaller than a pole. Size varies by region.

Satisfactorily restocked (SR): Productive forest land that has been denuded and subsequently regenerated to the specified stocking standards in the silviculture plan or prescription.

Scar: A mark left after re-growth of damaged tissue following an injury.

Scarification: See Drag Scarification.

Screefing: Removing organic material to a specified depth.

Second growth: A second forest that develops after harvest of the original mature forest.

Seedlot: A quantity of cones or seeds having uniformity of species, source, quality, and year of collection.

Shade-tolerance: The capacity of a tree or plant species to develop and grow in the shade of other trees or plants. Shade tolerance is one trait of the silvics of a species and independent of competition vigor.

SIBEC: An acronym for the method of determining site index which uses biogeoclimatic classification system.

Silviculture: The art and science of managing the establishment, growth, composition, health and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Silviculture plans and prescriptions: The generic term used in this document to describe collectively the documents containing the documents which contain the applicable stocking standards and stand management objectives. Pre-harvest Silviculture Prescription (PHSP), Silviculture Prescription (SP), Forest Development Plan (FDP), Forest Stewardship Plan (FSP) and Site Plan (SP) may all be included under this heading.

Silviculture prescription (SP): A legally binding, site-specific plan describing the nature and extent of any timber harvesting and silviculture activities carried out on an opening. The Silviculture Prescription outlines the required management objectives, standards, and timelines that the owner of the opening must achieve, including reaching a free growing stand. Prior to the Forest Practices Code, silviculture prescriptions were known as pre-harvest silviculture prescriptions (PHSPs). The silviculture prescription is one of the many forms of silviculture plans and prescriptions.

Silviculture survey: An examination of an opening for the purpose of providing information to the forest manager on how the site and the stand are progressing relative to the prescribed management objectives.

Silviculture Treatment Regime: A legally required, site-specific list of silviculture treatments that can reasonably be expected to produce the designated stocking levels specified in the site plans by the end of the determined free growing assessment period. Found as a component of a Forest Development Plan and may be part of Forest Stewardship Plan. This regime must be prepared and kept on file by a registered professional forester.

Site class: The measure of the relative productive capacity of a site. No longer used after approximately 1995, when it was replaced by site index.

Site class conversion: The method of determining site index by estimating the site class, and then using the table below to convert site class to site index. This method is the least accurate of site index determination methods.

There are very few instances where this method should be used for conifers. Consider why you have not selected one of the more representative methods before selecting to use the site class conversion method to determine site index.

Inventory Label Leading Species	Region	Good	Medium	Poor	Low
Broadleaf Species					
Ac	Province	26	18	9	3
At	Province	27	20	12	4
Dr	Province	33	23	13	6
E, Ea, Ep	Province	27	20	12	4
B, Ba, Bg	Coastal	29	23	14	5
B, Ba, Bg	Interior	18	15	11	5
Mb	Province	33	23	13	6
Conifer Species					
Bl	Province	18	15	11	5
Cw	Coastal	29	23	15	6
Cw	Interior	22	19	13	5
Fd	Coastal	32	27	18	7
Fd	Interior	20	17	12	5
H, Hm, Hw	Coastal	28	22	14	5
H, Hm, Hw	Interior	21	18	12	4
L, La, Lt, Lw	Province	20	18	10	3
Pa, Pf, Pj, Pl	Province	20	16	11	4
Pw	Province	28	22	12	4
Py	Province	17	14	10	4
S	Coastal	28	21	11	4
S	Interior	19	15	10	5
Ss	Province	28	21	11	4
Sb, Se, Sw	Province	19	15	10	5
Yc	Coastal	29	23	15	6
Yc	Interior	22	19	13	5

Table 19: Site Class to Site Index Conversion

Site index: A measure of site growth potential for a given tree species over a fixed time period. It is the average top height of trees of a certain species at fifty years measured at breast height. The top height trees are the 100 largest DBH trees per hectare of the species being considered. The breast height age is the number of annual growth rings at 1.3 m from the point of germination.

A complete discussion on site index determination can be found here.

Site Plan: The post-2000 Forest Practices Code form of silviculture prescription.

Site preparation: Disturbance of an area's topsoil and ground vegetation to create conditions suitable for regeneration.

Site rehabilitation: The conversion of potentially productive land presently occupied by stands of undesirable species or by brush, back to a condition appropriate for establishing desired coniferous species.

Site series: Subdivisions of site associations. Site series include all sites within a biogeoclimatic subzone that can produce the same climax vegetation unit or plant association.

Slash: The residue left on the ground after felling, juvenile spacing, brushing, pruning or commercial thinning that includes cut trees, uprooted stumps, branches and broken tops.

Sliding rule: The ability to move the early free growing date earlier an amount of time equal to the amount of time the regeneration requirements were met before the regeneration date. This has no effect on the late free growing date. An amendment or other form of approval is not required. See also Adjusting the Early Free Growing Date. Not applicable if the site plan has no early FG date.

Snag: A historic term for standing dead tree, greater than 3 m in height. These are often used by birds for nesting or by wildlife for refuge. They can be a hazard to forest workers, as they could fall unexpectedly. The terms Danger tree or Wildlife tree are more current.

Spacing: See juvenile spacing.

sph: Stems per hectare. This term is interchangeable with trees per hectare or tr/ha.

Satisfactorily restocked (SR): Productive forest land that has been denuded and has been regenerated to the specified stocking standards for the opening.

Stand density: A relative measure of the amount of stocking on a forest area. Often described in terms of stems per hectare.

Stand management prescription (SMP): A site-specific plan describing the nature and extent of the silviculture activities planned for a free growing stand of trees. SMPs facilitate the achievement of specified social, economic, and environmental objectives.

Stand tending: A variety of forest management activities carried out at different stages in the life of a stand. Treatments may include juvenile spacing, brushing, commercial thinning, fertilization, conifer release, site rehabilitation, mistletoe control, seed tree control and pruning.

Standards Unit (SU): An area within a cutblock that is subject to uniform: limits for soil disturbance and regeneration dates, stocking standards, free growing dates and free growing heights.

Stocking class: A numeric code representing a range of stems per hectare. Example, stocking class 1 is mature, with 76+ stems/ha of > 27.5 cm dbh; stocking class 2 is mature, with < 76 stems/ha; stocking class 0 is immature.

Stocking standards: Stocking standards detail site-specific legal requirements that are stated in a pre-harvest silviculture prescription, silviculture prescription, site plan, Forest Development Plan or Forest Stewardship Plans. They specify the standards required to reforest denuded areas with a healthy new crop of trees within specific periods. Stocking standards include but are not limited to such information as the target and minimum number of healthy, well-spaced, preferred

and acceptable trees per hectare, the conifer to brush ratio, the maximum density, the regeneration date and the early and late free growing dates.

Stocking status: Stocking is an indication of growing space occupancy relative to a pre-established standard. Status refers to whether the site has met those standards. Stocking status is most often described as satisfactorily restocked, not satisfactorily restocked, free growing or not free growing.

Stocking survey: A survey used to determine the stocking of an opening by describing both the preferred and acceptable well-spaced and total trees, and to generate an inventory label for updating the forest cover map.

Stratification: The process of defining and identifying populations with similar characteristics within an opening.

Stratum (or called Polygon): A subdivision of a forest area to be inventoried based on a group of trees with the same or similar species composition, age, and/or height class, (plural = strata).

Suppressed: Trees with crowns entirely below the general level of the crown cover and receiving little or no direct light from above or from the sides.

Survival assessment: A survey that estimates the percentage of trees living after a set period of growth after planting.

Target stocking standard (TSS): The number of well-spaced, preferred and acceptable trees per hectare that will, in normal circumstances, produce an optimum free growing crop. Target stocking standards are those standards that should be achieved through silviculture activities.

Tenure: The holding of a property. Land tenure may be broadly categorized into private lands, federal lands, and provincial lands. The Forest Act defines a number of forestry tenures by which the cutting of timber and other user rights to provincial land are assigned. For example, Forest Licence.

Treatment prescription: A legal document describing the operational details required for carrying out individual silviculture activities such as site preparation and planting.

Treatment Unit (TU): An area of land upon which a silviculture activity is planned and carried out, usually within the boundary of an opening. In old PHSPs, TUs are areas managed through the uniform application of stocking standards. In newer SPs, TUs are now referred to as Standards Units (SUs).

Tree Farm Licence (TFL): A form of tenure agreement which allows the long-term practice of sound forest management and harvesting on provincial land or on a combination of provincial and private land by private interests, under the supervision of the FOR.

Understorey: Generally, layer 3 and 4 trees growing under the full or partial canopy of layer 1 and 2 trees. These may be conifers and or broadleaf trees.

Uneven-aged: Stands with a wide range of ages and sizes. FPPR defines an uneven-aged stand as a stand of trees consisting of three or more age classes. Note: The age classes are outlined in the Vegetation Label Details.

Vet (veteran): A living remnant of a former stand. When used in the context of inventory labels, vets must have a combined crown closure of less than six per cent and must be at least 40 years older and 10 m taller than the main stand. This term is being phased out.

VRI: Vegetation Resources Inventory.

Walk-through: An initial reconnaissance of an opening prior to the onset of a survey.

Well-spaced stems per ha: The number of healthy, preferred and acceptable trees, in one hectare, that are all at least the minimum horizontal inter-tree distance from one another. The inter-tree distance is specified in the silviculture plan or prescription.

Whorl: An arrangement of branches in a circle around a stem or tree trunk often, but not always, associated with one year's height growth.

Wildlife tree: A standing live or dead tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife. Characteristics include large diameter and height for the site, current use by wildlife, a declining or dead condition, value as a species, valuable location, and relative scarcity.

Wound: An injury that removes a portion of the bark and cambium from the tree but does not penetrate into the sapwood. Wounds often serve as entry points for wood decay fungi.

Zonal: Within the biogeoclimatic classification system, zonal sites are those that are the most common or average within a single zone. It may also be referred to as mesic.

Appendix 2: Determining area of dispersed strata

For dispersed strata, it is necessary to determine the area represented by each stratum found on an opening. Although the area represented by each stratum may be estimated, a more quantitative measurement may be desired. In this event, there are two methods to consider: Line Intersect and High Intensity Point Sampling.

Option 1: Line Intersect

One method of determining the area represented by each stratum, in dispersed strata, is the line intersect survey. The amount of strip line that crosses each stratum is used to calculate the proportion of the opening that is represented by that stratum. The amount of strip line per hectare required to be sampled on an opening is dependent upon the characteristics of the stratum. An opening with two evenly distributed strata requires less strip line than an opening with more strata or less evenly-distributed strata.

Option 2: High Intensity Point Sampling

Another method of determining the area represented by each stratum, in dispersed strata, is the high intensity point sampling survey. The intent of this survey is to tally large quantities of very simple point samples. The data is used to estimate the area of each stratum. This sampling method provides the same results as the line intersect survey but uses a less onerous field procedure.

There have been no statistical analyses of these procedures to determine the number of point samples required to calculate the precision of the survey. Initial estimates suggest that 100-point samples is a reasonable preliminary sampling intensity.

The following steps describe the point sampling process:

1. Describe each stratum or forest type.
2. Establish the desired quantity of point samples in a systematic method.
3. At each point sample, mark a ✓ or a ✗ to indicate which stratum or forest type the sample is within.

Plot	Stratum/ Forest Type A	Stratum/ Forest Type B	Stratum/ Forest Type C	Stratum/ Forest Type D	Comments
	SR & FG	SR but not FG	NSR	NP	
1	✓				
2	✓				
3		✓			alder
4	✓				
5	✓				
6			✓		plantable
7	✓				
8			✓		slash, but plantable
9				✓	rock, no stumps
10		✓			alder
11	✓				
12	✓				

# of Point Samples					
100	85	10	4	1	

Stratum A	Stratum B	Stratum C	Forest Type D
SR & FG	SR but not FG	NSR	NP
85%	10%	4%	1%

Figure 35: High Intensity Point Sample Plot Card

Appendix 3: List of References and Hyperlinks

The following references are useful to silviculture surveyors in British Columbia. This is not an exhaustive list.

Acts

Ministry of Forests Act
Forest Act
Forest and Range Practices Act
Forest Practices Code

Regulations

Forest Planning and Practices Regulation
Woodlot License Planning and Practices Regulation

Training Materials

How to Determine Site Index
Growth Intercept Method for Silviculture Surveys
Multi-Storey Silviculture Survey Course Workbook
Retention Survey Techniques & Methodologies Training
Juvenile Spacing Quality Inspection
Planting Quality Inspection
Developing Stand Density Management Regimes
Silvicultural Systems Training website
Silvicultural Systems Handbook for British Columbia

Guidebooks

Establishment to Free Growing Guidebook Cariboo
Establishment to Free Growing Guidebook Kamloops
Establishment to Free Growing Guidebook Nelson
Establishment to Free Growing Guidebook Prince George
Establishment to Free Growing Guidebook Prince Rupert
Establishment to Free Growing Guidebook Vancouver

Soil Conservation Guidebook
Soil Conservation Survey
Soil Rehabilitation Guidebook

Silvicultural Systems Guidebook

Green-up Guidebook

Land Management Handbooks

Forest Science Program - Land Management Handbooks

FRDA Handbooks

A Guide to Vegetation Control Equipment
Herbicide Field Handbook
A Guide to the Response of Common Plants in British Columbia to Management Treatments
Effectiveness of Forest Vegetation Control Methods in British Columbia
Autecology of Common Plants in British Columbia: A Literature Review

Operational summaries for Vegetation Management:

Broom - Putting it in its place
Dry Alder Complex
Ericaceous Shrub Complex
Fireweed Complex
Gorse - The spiny competitor
Managing Vegetation with Sheep
Mixed-shrub Complex
Pinegrass Complex
Reedgrass Complex
Wet Alder Complex
Willow Complex
Silviculture Note #26 - Sheep Grazing in Forestry
Silviculture Note #25 - Boreal Plant Community Diversity 10 yrs. after treatment; a report summary

Miscellaneous Publications

Additional publications may be available from Crown Publication

Biogeoclimatic Zones of British Columbia
The Tree Book
Ecosystems of British Columbia
Field Guide to Forest Damage in BC
Provincial Seedling Stock Type Selection and Ordering Guidelines.
Glossary of Forestry Terms

Appendix 4: Best Practices in Estimating Basal Area

Basal area (BA) is the cumulative cross-sectional area, represented in m^2, of the live trees that are greater than or equal to 12.5 centimetres in diameter (Layer 1 trees), measured at breast height, that are determined '***in***' using a prism.

BA Forest Cover Reporting Requirements for each Milestone (Regen and Free Growing)

Basal area must be collected and reported (as a legal requirement) into RESULTS for Layer 1 stems, where stocking standards require that a specific basal area per hectare be retained after harvest and for all SUs, regardless of the stocking standards, where a retained overstorey of Layer 1 stems are > 5 m^2/ha.

Methods of Estimating BA (Layer 1 stems only)

There are 3 acceptable methods of estimating the SU's average BA:

1. **Hand Prism sweep** per plot or sample center, at a sampling intensity as determined as appropriate by the forest professional at the specific milestone. Each plot BA is determined by multiplying the number of Layer 1 stems "***in***" the sweep by the Basal Area Factor (BAF) of the prism used. *For example: If 6 Layer 1 trees were tallied and a BAF 5 was used, then the BA for that plot would be 6 x 5 = 30 m^2/ha. The Average BA for the SU's Forest Cover would be the sum of all BA's per plot divided by the number of samples.*
2. **Prism App (via tablet or iPad) sweep** per plot or sample center, at a sampling intensity as determined as appropriate by the forest professional at the specific milestone. The same procedure for determining BA would be used as for method 1 (hand prism)
3. **A complete DBH measure of all of the Layer 1 stems** in a fixed radius plot (3.99 m radius plot recommended), tallied per plot or sample center, at a sampling intensity as determined as appropriate by the forest professional at the specific milestone. Note: this is the method to use if you are in a survey situation with no Prism or Prism App. *For example: at each plot, measure the DBH of each Layer 1 tree. Back at the office or once finished in the field, calculate the total BA in m^2 for each plot by using πr^2 for each tree. For the SU, calculate the mean of the BA per plot and multiple that times the plot multiplier to determine the BA /ha for the SU. So for an example plot 1 (using a 3.99 m radius plot – multiplier 200), if you had 3 Layer 1 trees at 14.0, 15.0 and 16.0 cm DBH, the BA for that plot would be = 3.141* x *$(.14m/2)^2$ + 3.141* x *$(.15m/2)^2$ + 3.141* x *$(.16m/2)^2$ = 0.053m^2 for plot 1. Then adding up all of the plots for the SU, say for 10 plots, the total BA is 0.62m^2. Then the mean for the 10 plots is = 0.62 / 10 = 0.062 m2. Then the BA/ha for the SU would be = 0.062 m^2* x *200 = 12.4 m^2/ha.*

Selection of a Prism

The prism is a tool used to estimate the amount of BA currently present on a SU.
It is essential that all prisms used on a single stratum be of the same Basal Area Factor (BAF). Using prisms of different sizes on the same SU would have the same effect as using multiple plot

radii plots on a single SU. All data collected for a single SU must be gathered using a single BAF.
Prisms used in the Interior with smaller stems usually are between 5 and 10 BAF prisms. In contrast on the Coast, 10 BAFs and larger are used due to the larger diameter stems.
It is recommended to choose a prism BAF that captures a minimum of four trees per plot from the pre-harvest condition (in cut areas this would be a combination of standing trees and stumps). This will ensure that a sufficient number of stems will be counted "***in***" within the plot centers prism sweep during the survey, in order to achieve a reasonable estimate to the residual BA in the SU.

Use of a Prism
The surveyor should hold the prism directly over and above the plot center, and should look at a tree across the upper edge of the prism. The surveyor should see the tree simultaneously above the prism in its natural position, and also through the prism. Since a ray of light is bent upon passing through the prism, the tree image seen through the prism will be horizontally displaced. If the displacement is greater than the diameter of the tree, the tree is considered "***out***", and therefore not counted. If the displacement is less than or equal to the diameter of the tree, the tree is "***in***", therefore is counted.

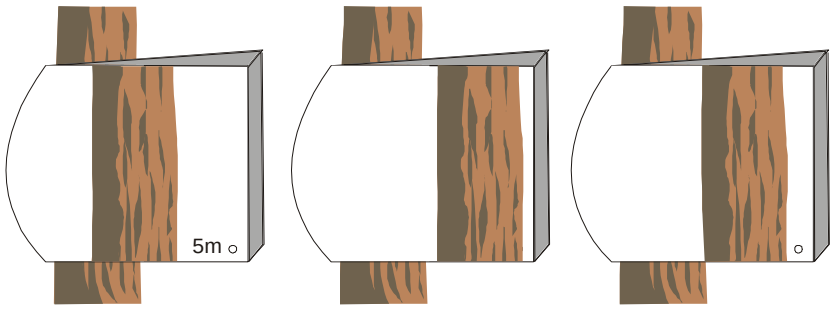


Figure 36: Using a prism to determine if a tree is "*in*", "*out*", or "borderline".

This procedure is repeated for each Layer 1 tree in the plot, until a complete sweep from the first tree is completed back to the same first tree. The total number of trees in the sweep that were "***in***" are now tallied for that plot.

Borderline Trees *(Note: this is not timber cruising; this is for forest cover data collection)*

The precision required for determining basal area is dependant on whether the silviculture plan or prescription for the stratum contains a minimum basal area.

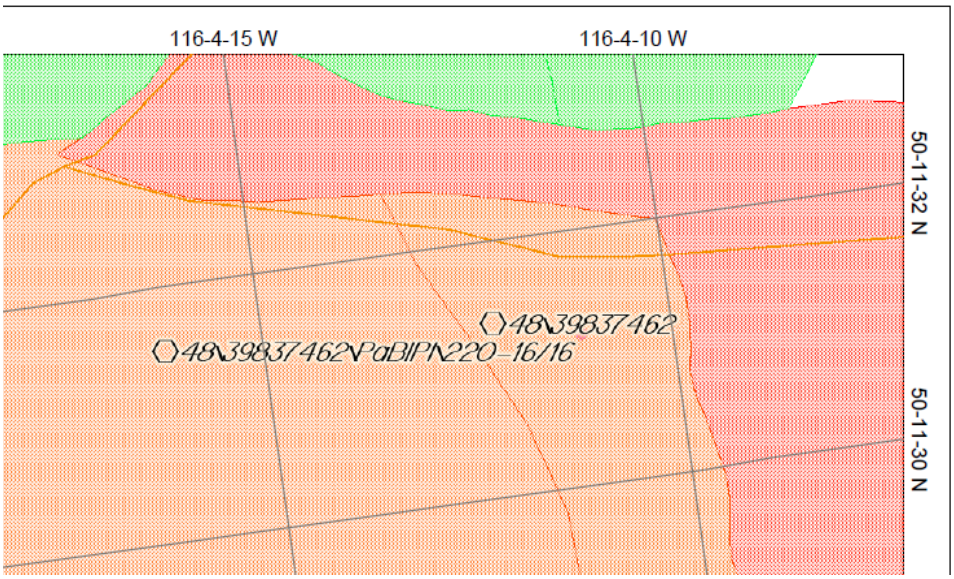
Where a borderline tree is identified:

- using the prism, confirm that the tree is in fact borderline, then,
- make an arbitrary decision to record the tree "***in***" or "***out***." The next time a borderline tree is identified in the stratum, record it opposite to the first. In other words, double check your measurement using the prism, then simply alternate the borderline calls.

- Implement suggested Field Survey Procedures. Dispersed retention stands have high variability and should be sampled with a systematic random procedure. This means a regular interval grid should be deployed at a sufficient sampling intensity to capture the variability of the SU.
- It is recommended to perform a BA estimate at each plot. The average of the plot basal areas should be used for RESULTS reporting.

Appendix 5 Forest Cover Map Legend

The following is an example of the new MapView forest cover label and legend.



- Silv. Symbol and opening#..... ⎔ ***48***
- Polygon #..... ***39837462***
- Species Comp. in order of %..... ***Pa Bl Pl***
- Age Class Code /…….. **(2)**
- Height Class Code / …….. **(*2*)**
- Crown Closure Class Code…… **(*0*)**
- Calculated Site Index……. ***16***
- Estimated Site Index…….. ***16***

New Legend Description and VRI link to the full explanatory text:
https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/stewardship/forest-analysis-inventory/data-management/standards/vegetation_map_legends.pdf

VEGETATION LABEL DETAILS

Example of a Vegetation Label:

LINE DESCRIPTION

O12
123/L
Fd(Hw)
211-20
he,sl
GL78

1 Silviculture symbol and Opening Number
2 Polygon Number and multi-layer stand indicator (L)
3 Species Composition
ex: the most important layer is described as Fd (Dougls Fir) and Hw (Western Hemlock).
4 Age, Height, Crown Closure Class Code - seporator Site Index / estimated SI
ex: stand is age class 2 (21-40 yrs), height class 1 (0.1-10.4m), crown closure class 1 (6-15%), SI 20m
5 Vegetated Density Class (or Non-Forest/Productive Descriptor)
ex: a herb polygon with no distinction between forbs and graminoids, shrubs less that 2m.
6 Disturbance History & year - ex: Logged in 1978

Line 1 - History Record Opeing Number

O12 - opening number valid for BCGS mapsheet
Ø12 - opening number valid for adjacent BCGS mapsheet
Ø12 - opening number valid for NTS mapsheet
blank - opening number has not been assigned

Line 2 - Polygon No. / Multi-layer

VRIMS Polygon Number - ranging from one to nine digits
/L - Multi-layered stand (a separate description of each layer is availiable in the data base, i.e. 1,2)

Line 4

4a AGE CLASS

CODE	LIMITS (years)
1	1-20
2	21-40
3	41-60
4	61-80
5	81-100
6	101-120
7	121-140
8	141-250
9	251 +

4b HEIGHT CLASS

CODE	LIMITS (metres)
1	0.1 - 10.4
2	10.5 - 19.4
3	19.5 - 28.4
4	28.5 - 37.4
5	37.5 - 46.4
6	46.5 - 55.4
7	55.5 - 64.4
8	65.5 +

4c CROWN CLOSURE CLASS

CODE	LIMITS (percentage)
0	0 - 5
1	6 - 15
2	16 - 25
3	26 - 35
4	36 - 45
5	46 - 55
6	56 - 65
7	66 - 75
8	76 - 85
9	86 - 100

4d SITE INDEX

All SI are shown to the nearest meter referenced at 50 years Breast Height Age. SI is based on the age and height of the leading species. When an accurate SI cannot be obtained from age and height, estimated SI is shown after, or replaces the SI.

4e ESTIMATED SITE INDEX

SI is estimated when suitable SI trees arenot present, e.g. young stands (<30yrs). It is denoted by a slash which always precedes it. Associated fields in the data base are Inventory Type Group and SI Estimated source code.

Appendix 6: Table of Age Corrections for Boring Height

The following reference table is provided to correct the counted age. It is also provided on pg. 38 of the FS660.

Bore the sample tree at 1.3 metres above the ground and count the number of rings. This number equals the dbh age.

On the table below locate the row corresponding to the species of the sample tree. Locate the corresponding site index for the strata in which this sample tree is located. Follow up this column to find the number of years to be added to the dbh age.

dbh age + age at 1.3 metres = total age

Fdi: site index of 25 = 8 years to add

Age at 1.3 meters (add this number of years to the dbh age to determine total age)												
	14	13	12	11	10	9	8	7	6	5	4	3
Interior												
Species												
Pli	5	6	7	8	9-10	11-14	15-22	>=23				
Fdi				14-15	16-18	19-22	23-28	>=29				
Cw			5-10	11-16	17-22	23-28	29-35	>=36				
Bl			17	18-19	20-21	22-23	24-26	27-28	29-31	>=32		
Hw						<=6	7-13	14-20	21-27	28-34	>=35	
Sw			14-15	16-17	18-20	21-25	26-33	>=34				
Py	5	6	7	8	9-10	11-14	15-22	>=23				
Pw			14-15	16-17	18-20	21-25	26-33	>=34				
Lw					13-14	15-16	17-21	22-27	>=28			
At						5	6	7	8-9	10-12	13-17	>=18
Ep						5	6	7	8-9	10-12	13-17	>=18
Coastal												
Species												
Ba	<=12	13-14	15-17	18-19	20-21	22-24	25-26	27-29	30-31	>=32		
Fdc				<=16	17-22	23-28	29-35	36-41	42-47	>=48		
Act / Dr	2 years all sites											
Cw				<=16	17-22	23-28	29-35	36-41	42-47	>=48		
Hw								<=20	21-27	28-34	35-42	>=43

Table 20. Boring Height Age Correction

Appendix 7: Technology in Silviculture Surveys

The Use of Unmanned Aerial Vehicles (UAVs)

Unmanned aerial vehicles (UAVs), commonly known as drones, can be used in forestry for many purposes. Some current silviculture applications include:

- Initial reconnaissance
- Stratification
- Treatment mapping
- Post-treatment monitoring
- Visual assessments
- Burn severity mapping.

There are some significant benefits including:

- Fewer slips, trips, and falls
- Faster and lower cost
- More accurate stratification
- Easy to ground truth
- Imagery can be reviewed at the office with co-workers
- Imagery can help with contract negotiations (ex. vegetation management treatments)

Drones typically have a camera which operates on 3 axes, spinning 360º to allow for imagery from various angles and heights.

These images can be used to create:

- Orthomosaics
- 3D point clouds
- Digital Surface Models (DSMs)

Technology is rapidly developing. In the future, UAVs could be used to capture individual stem locations and heights on every tree. Work is ongoing to address important issues including species identification and forest health.

This could move assessments towards a complete inventory (aka. census) vs a sample.

GPS and Tablet Apps

Surveyors may choose to use paper maps and compass, a handheld GPS unit, or a tablet with built-in GPS and mapping software.

For many surveyors, a tablet with Avenza Maps is the most efficient option. However, tablets can break or lose battery power. Surveyors should be prepared with an external portable battery and cable, a field notebook, and a paper map and compass.

If the surveyor is expected to use grid or vector sampling, they should make every effort to be entirely unbiased with plot locations, regardless of how the plots are established (compass, handheld GPS, or tablet). Plots within the NAR should not be moved, except for safety reasons.

GPS Established Strip and Plot Marking

With GPS navigation, surveyors travel between plots without the need for carefully following a bearing in a straight line. They travel where the brush, slash and other obstacles are at a minimum to reduce travel time between plots. The plot locations are determined by coordinate location, and the GPS tracks the travelled route. There is no need to hang flagging ribbon along the route.

In contrast, the plots must be marked more thoroughly than with conventional methods. Anyone wishing to travel back to a previously established plot has no strip line ribbon to follow. The only option is to use the previously collected coordinates to relocate the plots. The coordinates of the original plots would be loaded into a GPS receiver as waypoints. The surveyor or survey inspector uses the “go to” function to navigate to the plot. Consider that if there was some error in the accuracy of the original coordinates, there will also be some error in the data position in the returning navigation. For example, if the original coordinates indicate the plot is 5 m north of the actual location, and the current position of the returning surveyor is indicating a position 5 m to the south of the actual position, then the plot could, in this extreme case, be as much as 10 m away. The returning surveyor will have a difficult time relocating the plot. For this reason, plots must be marked more thoroughly.

The goal of plot marking is to make the plot center easier to find. Two additional pairs of ribbon tied as high as the available vegetation allows are recommended. These ribbons should be located near the edge of the plot boundary, and preferably on opposite sides of the plot. However, remember the intent of these additional ribbons is to allow the plot to be found when a GPS is used to navigate to the vicinity of the plot.

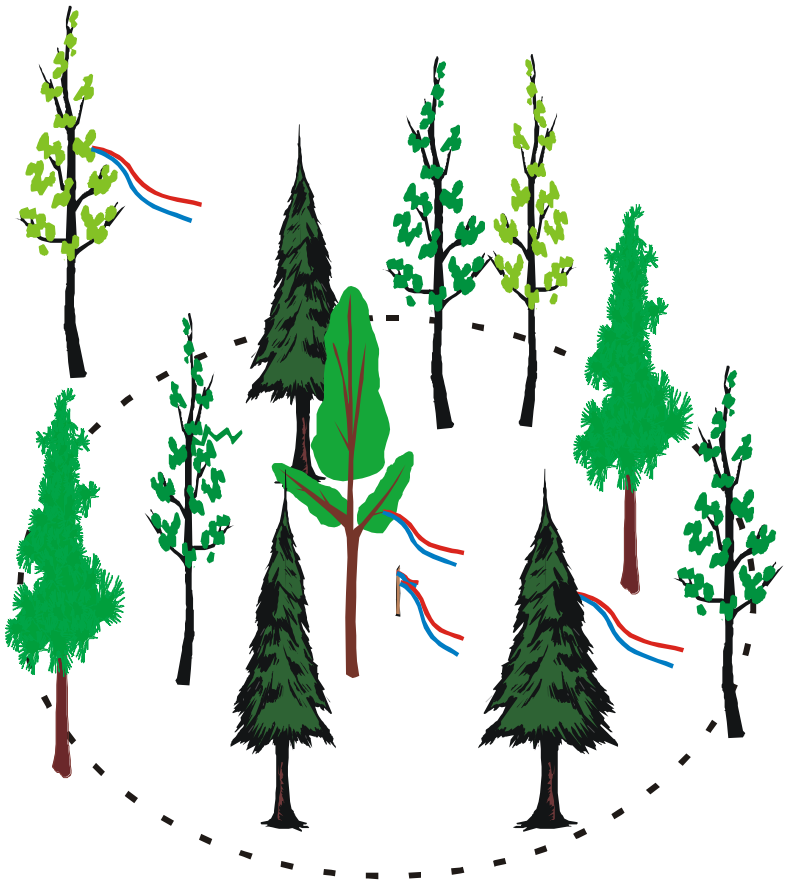


Figure 37: Example of plot marking methods with GPS use

Recommendations for GPS Use in Silviculture Surveys

If one chooses to use GPS receivers as part of a silviculture survey program, the following topics should be addressed at the planning stage. Surveyors should discuss a number of issues with their employers or project administration to ensure compatibility and efficiency.

- Preloading opening and standards unit boundaries is preferred with either handheld GPS or tablet hardware.
- Use the receiver's track function to document the walk-through path for all survey methods. This provides assurance that the walk-through is completed, as well as aids in the efficiency and accuracy of determining strata boundaries.
- Use WAAS or an alternative source or real-time differential correction.
- Adjust the GPS receiver position format to UTM (Universal Transverse Mercator). This provides one location in metres north of the equator (the northing) and metres east of the particular UTM zone one is working within (the easting).

- Create waypoints for strata boundary reference to assist with accurate mapping strata edges. Create waypoints where noteworthy anomalies are identified (e.g., patches too small to stratify).
- The surveyor should provide digital data files for point, line, and any area features, in particular plot locations and path of travel. Select one or more data file formats for the point, line and polygon features that are compatible with the various hardware and software to be used throughout the project. Consider conventions for a file naming format. Consider whether the files will be cumulative or individual. One point file and one line file per opening, or all points related to the project into one file and all the lines for the project in another. Many other variations are also acceptable.
- Tabular documentation of the plot center coordinates in printed reports or maps are recommended.
- When using these GPS methods, there is no need for a point of commencement, subject to survey contract specifications.
- Mark the plot center location more thoroughly with two or more additional ribbon pairs and as high as possible to assist in them being found in the future. Only the ribbon at the center need be marked with the plot number etc.
- Select an acceptable tolerance value to be used where position drift/creep occurs. Two (2) m is suggested at this time, but higher or lower values may also be suitable.
- Do not use recreational grade GPS receivers to determine payment area for treatments or reporting treatments into RESULTS.

Appendix 8: Local Geographic Free Growing Competition Assessment Criteria

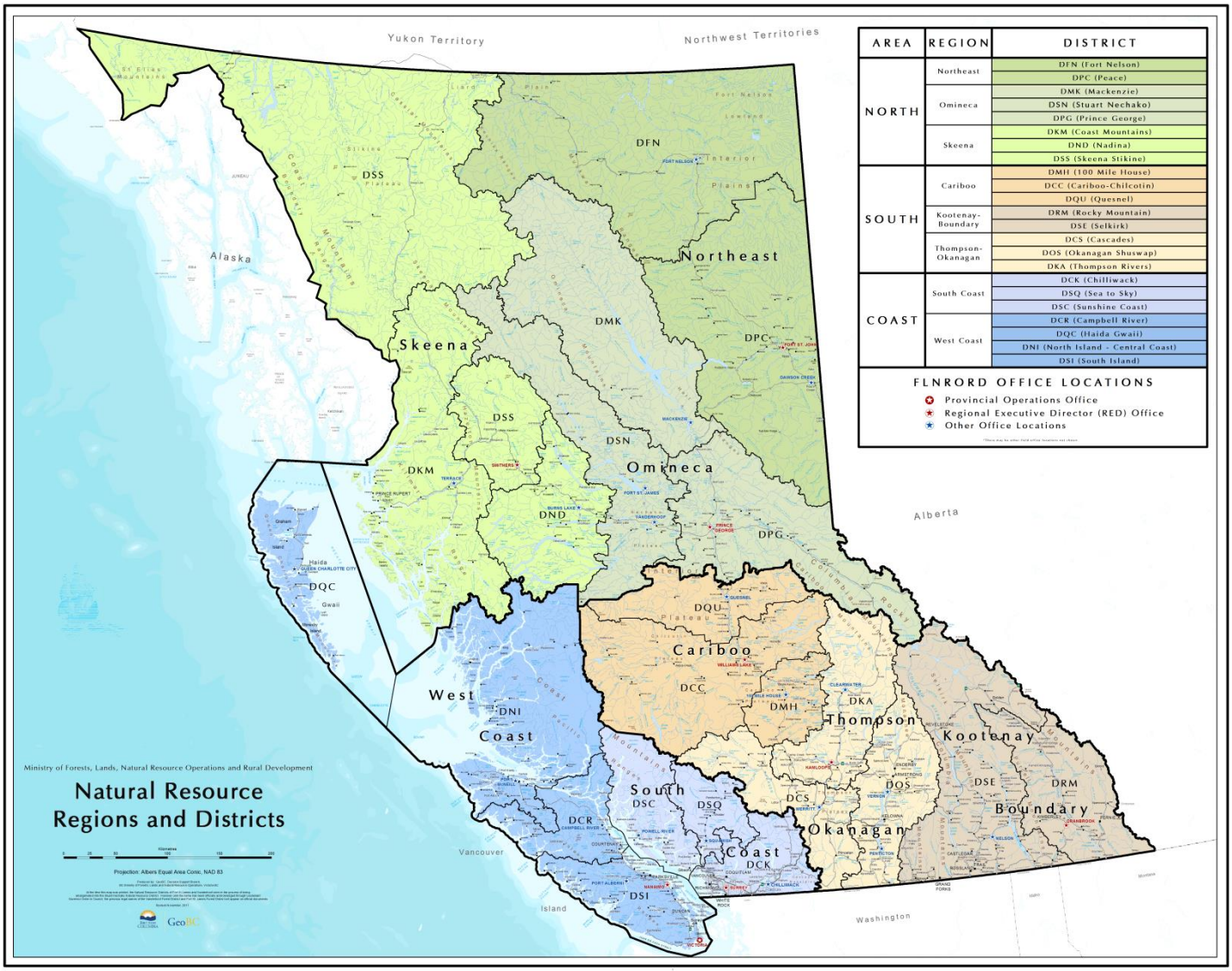


Figure 38: Map of 3 Geographic Areas – Coast, North and South Areas.

8.1 – Coast Area FG Guidance

1) Coast Area Description

The following TSAs are assessed according to guidelines described in Figure 39 (including all area-based tenures within the gross areas of these TSA's, regardless of Natural Resource District boundaries):

- Arrowsmith, Fraser, Pacific (GBR and non-GBR), Haida Gwaii, Soo, Sunshine Coast, Great Bear Rainforest North, Great Bear Rainforest South, North Island, and **Kalum (addition from administrative Coastal Area)**

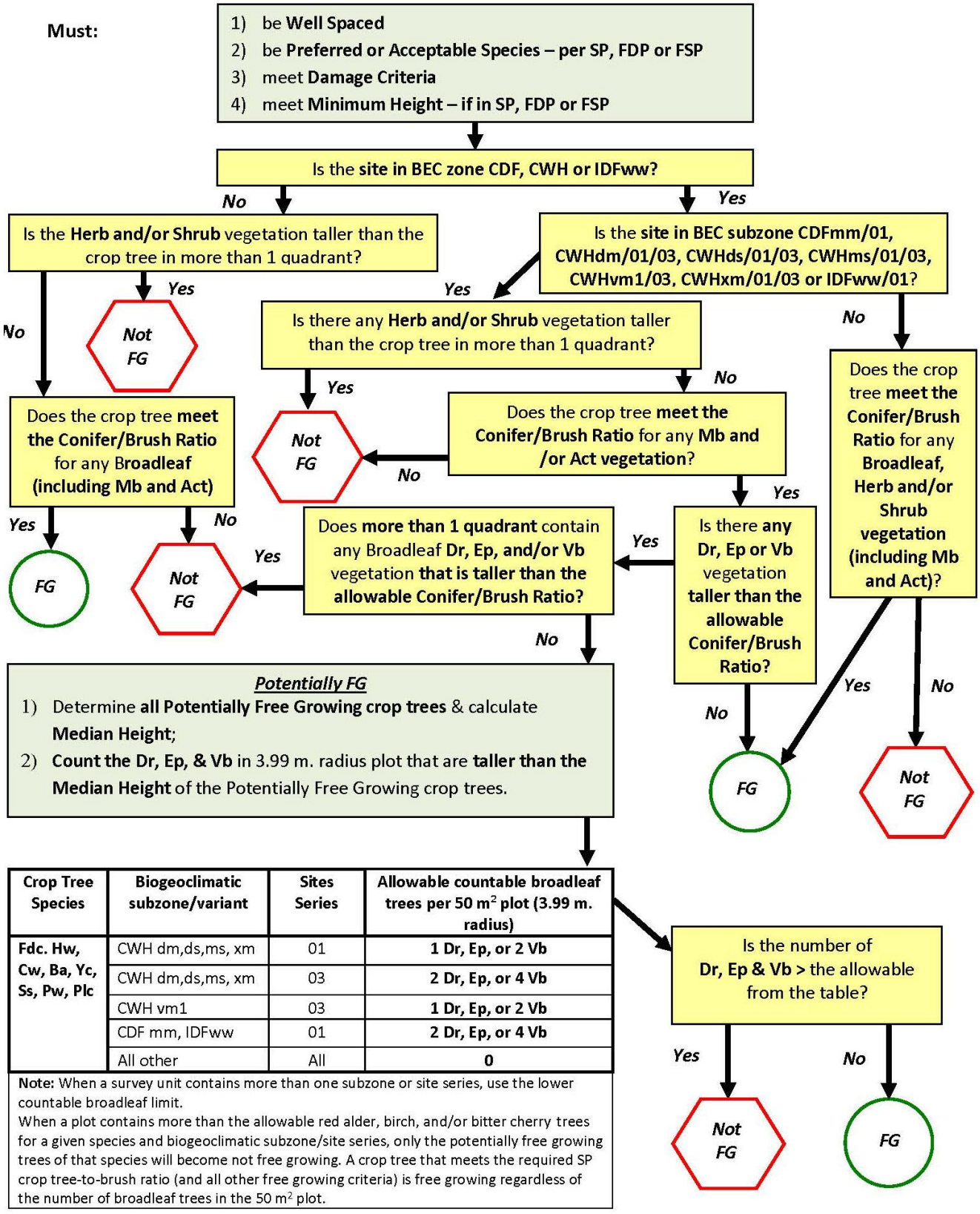


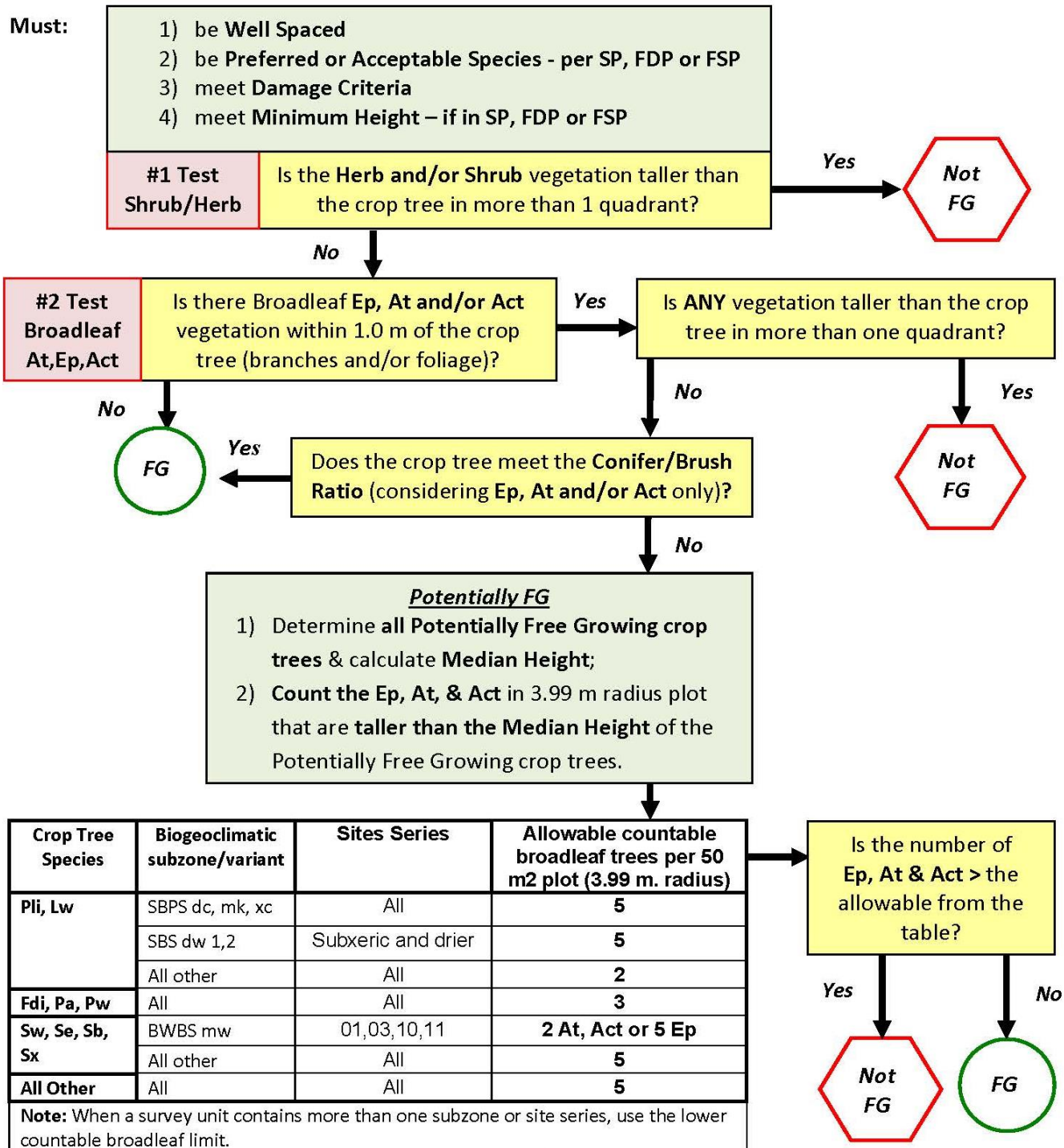
Figure 39. COASTAL Vegetation Competition Decision Key for a Free Growing Crop Tree

8.2 – North (Northern Interior) Area FG Guidance

North Area Description

The following TSAs are assessed according to guidelines described in Figure 40 (including all area-based tenures within the gross areas of these TSA's, regardless of Natural Resource District boundaries):

- Cassiar TSA; Nass TSA; Kispiox TSA; Bulkley TSA; Morice TSA; Lakes TSA; Prince George TSA; Mackenzie; Robson Valley TSA; Dawson Creek TSA; Fort St. John TSA; Fort Nelson TSA.



Crop Tree Species	Biogeoclimatic subzone/variant	Sites Series	Allowable countable broadleaf trees per 50 m2 plot (3.99 m. radius)
Pli, Lw	SBPS dc, mk, xc	All	**5**
	SBS dw 1,2	Subxeric and drier	**5**
	All other	All	**2**
Fdi, Pa, Pw	All	All	**3**
Sw, Se, Sb, Sx	BWBS mw	01,03,10,11	**2 At, Act or 5 Ep**
	All other	All	**5**
All Other	All	All	**5**

Note: When a survey unit contains more than one subzone or site series, use the lower countable broadleaf limit.
When a plot contains more than the allowable aspen, birch, and/or cottonwood trees for a given species and biogeoclimatic subzone/site series, only the potentially free growing trees of that species will become not free growing. A crop tree that meets the required SP crop tree-to-brush ratio (and all other free growing criteria) is free growing regardless of the number of broadleaf trees in the 50 m^2 plot.

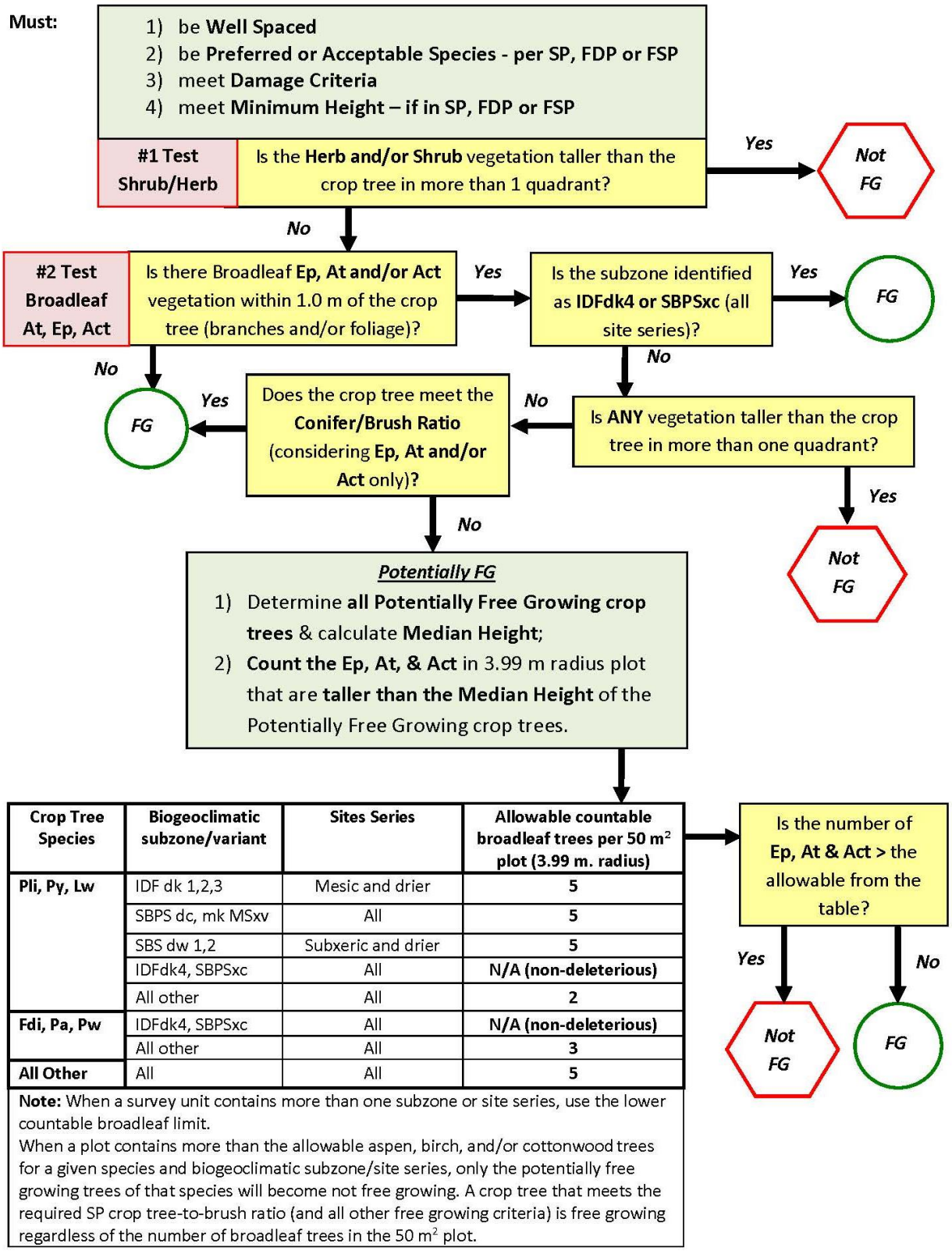
Figure 40. North Vegetation Competition Decision Key for a Free Growing Crop Tree

8.3 – South (Southern Interior) Area FG Guidance

1) <u>South Area Description</u>

The following TSAs are assessed according to guidelines described in Figure 41 (including all area-based tenures within the gross areas of these TSA's, regardless of Natural Resource District boundaries):

- Kamloops TSA; Merritt TSA; Lillooet TSA; Okanagan TSA; Golden TSA; Revelstoke TSA; Invermere TSA; Cranbrook TSA; Kootenay Lake TSA; Arrow TSA; Boundary TSA; Williams Lake TSA; Quesnel TSA; and 100 Mile TSA
- Within the Williams Lake TSA; Quesnel TSA; and 100 Mile TSA, there is additional guidance in Fig 4. for all sites in the **IDFdk4 and the SBPSxc subzones** to consider broadleaf competition as non-deleterious at the plot level if, in the opinion of the professional, the established conifers are not deemed to be suppressed by competing broadleaf competition.
- **Approved Alternative** for Williams Lake TSA; Quesnel TSA; 100 Mile TSA:
    - For sites in the **SBPSmk, SBPSdc, SBSdw1, SBSdw2, IDFdk3, and IDFdk1** where **NO** brushing or broadleaf tree spacing activities have previously been carried out, the alternative guidance in **Section A13.3.1** may be used.



Crop Tree Species	Biogeoclimatic subzone/variant	Sites Series	Allowable countable broadleaf trees per 50 m² plot (3.99 m. radius)
Pli, Py, Lw	IDF dk 1,2,3	Mesic and drier	**5**
	SBPS dc, mk MSxv	All	**5**
	SBS dw 1,2	Subxeric and drier	**5**
	IDFdk4, SBPSxc	All	**N/A (non-deleterious)**
	All other	All	**2**
Fdi, Pa, Pw	IDFdk4, SBPSxc	All	**N/A (non-deleterious)**
	All other	All	**3**
All Other	All	All	**5**

Note: When a survey unit contains more than one subzone or site series, use the lower countable broadleaf limit.
When a plot contains more than the allowable aspen, birch, and/or cottonwood trees for a given species and biogeoclimatic subzone/site series, only the potentially free growing trees of that species will become not free growing. A crop tree that meets the required SP crop tree-to-brush ratio (and all other free growing criteria) is free growing regardless of the number of broadleaf trees in the 50 m² plot.

Figure 41. South Vegetation Competition Decision Key for a Free Growing Crop Tree Standard Guidance

8.4 – South Area Alternative Guidelines

Acceptable alternative FG guidance, applied using a new survey procedure, is presented in this section for the following subzones/variants in the Williams Lake, 100 Mile, and Quesnel TSA's:

- **SBPSmk, SBPSdc, SBSdw1, SBSdw2, IDFdk3, and IDFdk1**

This alternative FG guidance (described in Figure 42) may be applied **only on sites where there has been NO previous brushing or broadleaf tree spacing activity**.

The alternative FG guidance and survey procedure were developed by the Cariboo Region silviculture research section. All BEC subzones/variants and site series included in this section represent ecosystems where research and/or expert opinion have been used to revise thresholds for broadleaf retention to levels that are more biologically appropriate to conifer tolerances (and not in conflict with conifer growth objectives) than those used in previous guidelines. The new survey procedure is intended to simplify the current approach by eliminating the "potential free growing tree" concept.

Significant changes to individual FG criteria used in the previous standard South Area guidelines are:

- The **Conifer/Brush Ratio** expressed as a percentage has been replaced with a **Brush/Conifer Ratio** expressed as a decimal. In the former guidelines, conifers meeting the Conifer/Brush Ratio had to be 150% or 125% (depending on BEC variant) taller than surrounding vegetation within a 1-m cylinder. With the new Brush/Conifer Ratio, broadleaf trees must be > 1.25 times the height of pine or > 1.5 times the height of other conifer species before they are counted as occupying quadrants within the 1-m cylinder or as countable stems.
- Previously, only one quadrant within the 1-m cylinder was allowed to be occupied by overtopping broadleaf trees. Now 0, 1, or 2-adjacent quadrants are allowed to be occupied (2-opposite quadrants, 3 quadrants, and 4 quadrants are not acceptable).
- Allowable numbers of countable broadleaves have been adjusted but are now assessed within a 1.8-m radius of individual crop conifers rather than within the 3.99-m plot (as described below).

Using the new survey procedure (presented in Figure 42):

- Well-spaced trees are still selected in a 3.99-m plot using the same spacing, preferred, or acceptable species, minimum height, and damage criteria used in the standard guidelines.
- Test #1 regarding overtopping Shrub and Herb vegetation is unchanged.
- The new survey procedure uses a "**neighbourhood concept**" as opposed to the "**potentially FG concept**" used in other Decision Keys in this Appendix. There are two tests included in the new survey procedure, and a well-spaced tree must meet **BOTH** criteria to be FG:
    - Occupied Quadrant Test – within a 1.0-m radius around each crop conifer, the number of quadrants occupied by broadleaf vegetation exceeding the new **Brush/Conifer**

Ratio is assessed. It is allowable for 0, 1 or 2-adjacent quadrants to be occupied. It is not acceptable for 2-opposite quadrants, 3 quadrants, or 4 quadrants to be occupied.

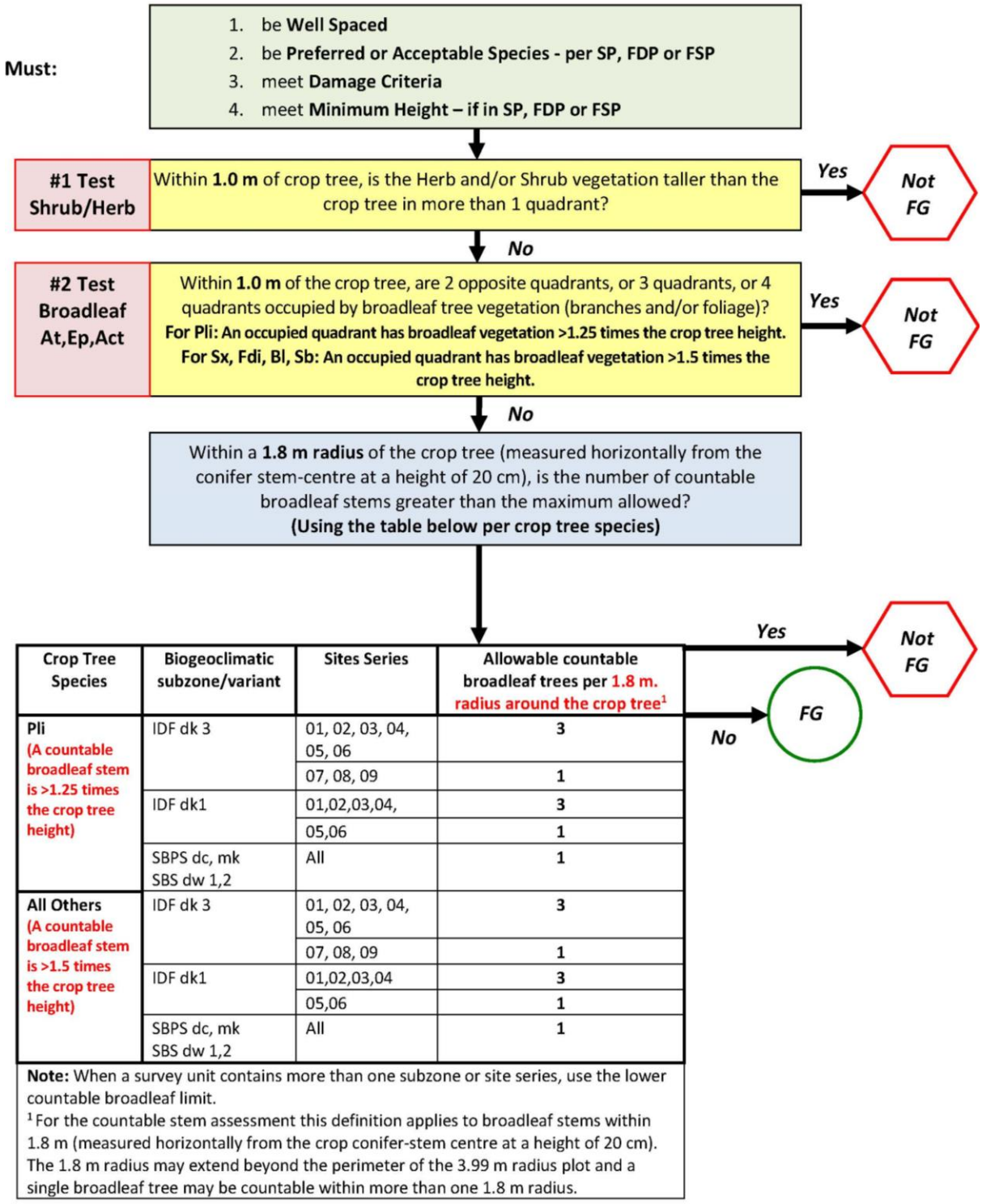
- Countable Broadleaf Test – within a 1.8-m radius around each crop conifer, the number of countable broadleaf stems is tallied and must not exceed allowable densities (as defined by BEC subzone/variant, site series, and conifer species). **The 1.8-m radius is measured horizontally outward from the conifer stem-centre at a height of 20 cm above ground**.
  - Making judgement calls for broadleaf trees at the periphery of the 1.8-m radius:
    - For single broadleaf (At, Ep, Act) stems: the stem is considered to be "in" when its centre at ground level is visually judged, based on the horizontally held plot cord or tape, to fall within the 1.8-m radius.
    - For broadleaf clumps, the number of countable stems is defined as described in Section 3.4.2.5, Figure 4c. For At stems that fork above the ground, the stem is considered to be "in" if the centre of the fork is visually judged, based on the horizontally held plot cord or tape, to fall within the 1.8-m radius.
    - For Ep clumps originating from cut stumps, the clump is "in" if the centre of the cut stump is visually judged, based on the horizontally held plot cord or tape, to fall within the 1.8-m radius. The number of countable stems in the clump is defined in Section 3.4.2.5 Table 1a.
  - Countable broadleaf trees within 1.8 m of well-spaced conifers may fall outside the 3.99-m plot radius, and a single countable broadleaf tree may affect the status of more than one crop conifer where the 1.8-m radius circles overlap.

- If a well-spaced conifer meets **BOTH** the quadrant test and the countable broadleaf test, it is FG. If it fails either test, it is **NOT** FG. A decision as to FG or not FG can therefore be made quickly, on a tree-by-tree basis.

Explanatory notes

- With the new survey procedure, countable broadleaves are assessed only within a 1.8-m radius of each candidate well-spaced conifer. They are not assessed in the 3.99-m plot and there are no "potentially free growing trees". This eliminates the problem of having a clump of broadleaf trees on one side of the plot resulting in failure of trees as much as 7-8 m away.
- A 1.8-m radius circle covers approximately 10 m^2 and six well-spaced 1.8-m circles occupy approximately the same area as a 3.99-m plot (Figure 43).

IMPORTANT: It is advisable for survey contractors to receive training prior to using the alternate FG guidance and the new survey procedure described in Appendix 8.4.



Crop Tree Species	Biogeoclimatic subzone/variant	Sites Series	Allowable countable broadleaf trees per 1.8 m. radius around the crop tree[1]
Pli (A countable broadleaf stem is >1.25 times the crop tree height)	IDF dk 3	01, 02, 03, 04, 05, 06	**3**
		07, 08, 09	**1**
	IDF dk1	01,02,03,04,	**3**
		05,06	**1**
	SBPS dc, mk SBS dw 1,2	All	**1**
All Others (A countable broadleaf stem is >1.5 times the crop tree height)	IDF dk 3	01, 02, 03, 04, 05, 06	**3**
		07, 08, 09	**1**
	IDF dk1	01,02,03,04	**3**
		05,06	**1**
	SBPS dc, mk SBS dw 1,2	All	**1**

Note: When a survey unit contains more than one subzone or site series, use the lower countable broadleaf limit.

[1] For the countable stem assessment this definition applies to broadleaf stems within 1.8 m (measured horizontally from the crop conifer-stem centre at a height of 20 cm). The 1.8 m radius may extend beyond the perimeter of the 3.99 m radius plot and a single broadleaf tree may be countable within more than one 1.8 m radius.

Figure 42: Williams Lake, Quesnel, and 100 Mile TSAs Vegetation Competition Decision Key for a Free Growing Crop Tree using alternative guidelines for SBPSmk, SBPSdc, SBSdw1, SBSdw2, IDFdk3, and IDFdk1 (only on sites where there has been NO previous brushing or broadleaf tree spacing activity).

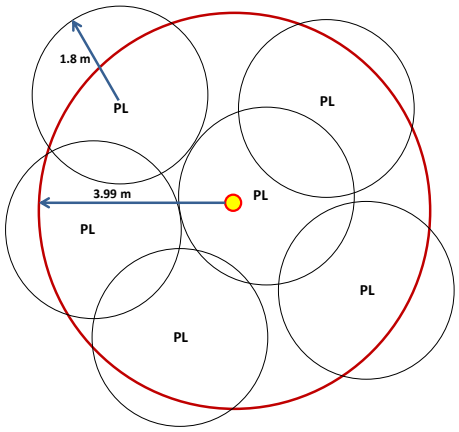
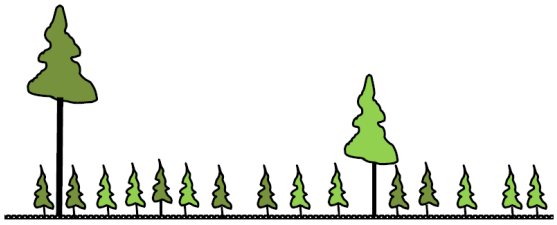


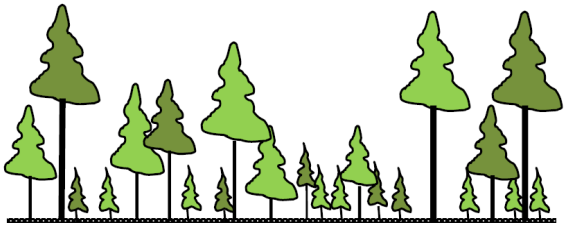
Figure 43: Example of what six 1.8-m radius neighborhoods around well-spaced trees in a 3.99 -m radius plot looks like.

Appendix 9a: Stand Structures

I) Standard Clearcut Even-aged Stand Structure

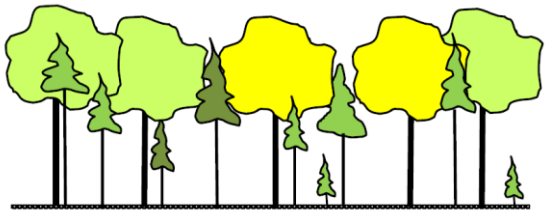


II) Complex Vertical Stand Structure



Multi-storey – Uneven-aged Regime

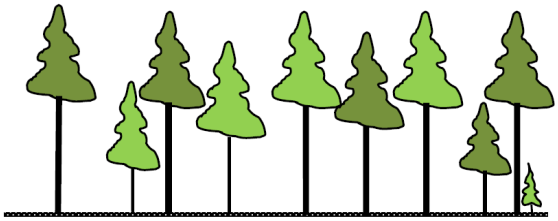
Layered, DFP, SEDRSS- Even-aged Regime



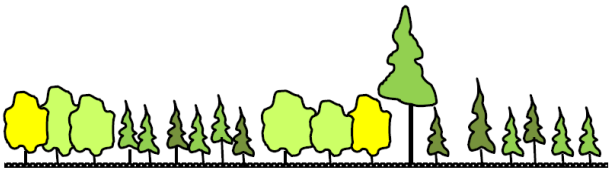
Boreal Mixedwood Intimate Mixture

III) Complex Horizontal Stand Structure

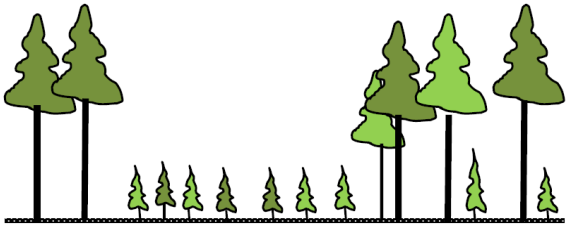
Even-aged Clustered



Intermediate Cut – Commercial Thinning

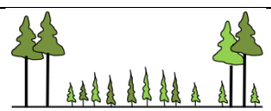


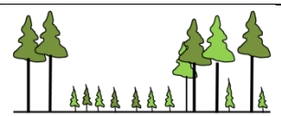
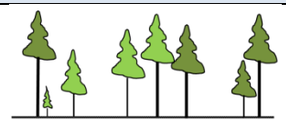
Coastal & Interior Mixedwood – Patch Mixtures

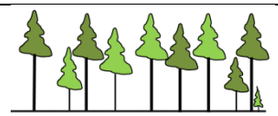


Clearcut with Reserves

Appendix 9b: Guidance Matrix for Reporting Retention Openings into RESULTS

	RETENTION OPENINGS – with > 5 m^2 / ha. Basal Area Retention					
	Silviculture Survey Manual Guidance *Section referenced below in red*				**Treed Retention Submission into RESULTS Guidance (ii)** *Section referenced below in red*	
Steps	**1 →**	**2 →**		**3 →**	**4a**	**or 4b**
	Conifer Management Regime	Planned &/or Resultant Stand Structure ***Sec 1.2***	Stand Structure Example Illustrations	Recommended Survey Methodology	Long Term Retention[5] – Reserves ***Sec 4.1***	Short Term Retention[6] – part of a Silv System ***Sec 4.2***
	1a. Obligation *Timber Priority*					
	Single Entry: Even–Aged Management Regime	Complex Vertical Structure Dispersed Retention[3] ***Low BA (<10m2/ha in Interior)***	 Photo Images 1	Layered ***Sec 9.2.2***	Dispersed ***Sec 4.1.2 & 4.1.3***	Unharvested Stems ***Sec 4.2.4***
	Multiple Entry: Uneven-Aged Management Regime					
	Single Tree Selection	Complex Vertical Structure Dispersed Retention ***IDF only***	 Photo Images 2	Multi-storey ***Sec 9.2.1***		Single Tree ***Sec 4.2.1***
	Group Selection	Complex Horizontal Structure Group Retention[4]– ***Clear Cut Openings[1]***		Clearcut Method ***Sec 7 & 8***		Group Selection ***Sec 4.2.2***

Group Selection	Complex Horizontal Structure Group Retention – ***Small Patch ↑Edge Effect***^{2}	 Photo Images 3	Small Scale Openings Method ***Sec 9.3.4***		Group Selection ***Sec 4.2.2***
1b. Obligation *Non-Timber Priority*					
Single Entry: Even-Aged Management Regime	Complex Vertical Structure Dispersed Retention ***< 20 m^2 Interior < 40 m^2 Coast***	 Photo Images 4	SEDRSS or DFP ***Sec 9.2.3 & 9.2.4***	Dispersed ***Sec 4.1.2 & 4.1.3***	Unharvested Stems ***Sec 4.2.4***
Multiple Entry: Uneven-Aged Management Regime					
Single Tree Selection	Complex Vertical Structure Dispersed Retention ***IDF only***	 Photo Images 2	Multi-storey ***Sec 9.2.1***		Single Tree ***Sec 4.2.1***
Group Selection	Complex Horizontal Structure Group Retention	 Photo Images 5	Clearcut Method ***Sec 7 & 8 OR*** Small Scale Opening ***Sec 9.3.4***		Group Selection ***4.2.2***
1c. No Regen Obligation ***≥ 20 m^2 Interior ≥ 40 m^2 Coast***					
Intermediate Cut (e.g., WUI, ecosystem restoration)	Complex Horizontal Structure Dispersed Retention	 Photo Images 6	Commercial Thin ***Sec 9.3.2.2***		No Regen Objectives ***Sec 4.2.3***

Commercial Thin	Complex Horizontal Structure Dispersed Retention	 Photo Images 7	Commercial Thin ***Sec 9.3.2.2***		No Regen Objectives ***Sec 4.2.3***

Footnotes:

1) Definition of Clearcut: *Openings are at least two tree heights in width.*
2) Definition of Edge Effect*: The forest influence (where openings are less than two tree heights in width, but > 10 m in wide) that occurs along the forest edge and produces an intermediate (or modified) microclimate..*
3) Definition of Dispersed Retention: *Residual treed portions with usually individually separated stems and are not independently mapped (< 0.25 ha if aggregated).*
4) Definition of Grouped Retention: *Unharvested residual treed patches of aggregated individuals that are mappable (≥ 0.25 ha).*
5) Definition of Long-term Residuals: *Residual trees with a reserve objective code other than Timber (i.e. WTP or CMT) and not available for a subsequent harvest entry until after the next rotational planning cycle – referred to as "reserves".*
6) Definition of Short-term Residuals: *Residual trees with a reserve objective code of only Timber and available for a subsequent harvest entry prior to the end of the current rotational planning cycle (whether or not they are actually harvested) – referred to as "retention".*

For more information, refer to *Silvicultural Systems Handbook of BC - MoF 2003*

Photo Images 1: Layered Survey

Photo Images 2: Multi-Storied Survey

Photo Images 3: Small Scale Openings Method

Photo Images 4:

Coastal SEDRSS

Interior DFP

Photo Images 5: **Clearcut or Small-Scale Opening Method**

Photo Images 6: **Intermediate Cuts**-Commercial Thinning **Survey**

Photo Images 7: Intermediate Cuts- **Commecial Thinning Survey**

Appendix 10: Survey Related Acts & Regulations

10.1 Forest and Range Practices Act

In its most simplistic form, the Forest and Range Practices Act requires the establishment of a free growing stand. The Planning and Practices Regulation and the Woodlot Licence Planning and Practices Regulation require a forest inventory be completed. This inventory, simply by the nature of the required timing, is the combined regen delay and free growing surveys for most licences, and the free growing survey only for woodlot licences.

These are a few relevant highlights of FRPA that guide silviculture surveys:

- Part 1defines the terms of forest practice and a free growing stand.
- Part 2 includes a discussion of Forest Stewardship Plans (sec 3 and 5), Site Plans (sec 10) and Woodlot Licence Plans (sec 13).
- Part 3, sections 25-27 discuss forest health and pests on Crown and private land.
- Part 3 sections 29 and 30 discuss the subject of free growing stands. Here the requirement to establish a free growing stand is established for 4 groups: major licence holders, timber sales manager, woodlot licence holders and non-replaceable licence holders. The use of suitable seed is required.
- Part 3 section 31 is to ensure that seed use conforms to the prescribed requirements.
- Part 7 section 107 discusses declaration of obligations. Section 107 (5) (b) indicates the District Manager must not give written notice that an obligation has not been met unless he/she has determined the stand is under threat from competing vegetation or forest health factors or is unlikely to remain free growing without a further treatment.
- Part 9 Section 157 states: "The Lieutenant Governor in Council may make regulations respecting silvicultural systems and silviculture treatments."
- Part 9 section 169 provide the Chief Forester authority to, among other things, make standards regarding tree seed and stocking standards.
- Part 11 - The Transition, section 177 defines silviculture plans and prescriptions as the collective term for pre-harvest silviculture prescriptions, silviculture prescriptions and site plans.

10.2 Forest Planning and Practices Regulation

In Section 1, a number of terms are defined such as standards units, stocking standards, regeneration date, free growing date, forest health factors, net area to be reforested, primary forest activity and silviculture treatment. One that is of particular importance to silviculture surveyors is "forest cover inventory."

- Section 16 deals with stocking standards in a forest stewardship plan.
- Section 26 discusses the minister's consideration of stocking standards (i.e., approval tests).
- Section 34 describes the content requirements for site plans.
- Section 43 describes the use of seed.
- Sections 44, 45 and 46 discuss free growing stands.
- Sections 85-88 describe the requirements for annual reporting, including the precision standards that define ‘form and manner that is satisfactory to the minister”. The timing of the requirements is noteworthy. Each report covering the period of April 1 through March 31 of each year is due before June 1 of each year. Section 87 describes the details of reporting and mapping.
- Sections 97 and 97.1 discuss declarations.
- Section 111 deals with amalgamating obligations to establish a free growing stand.
- Schedule 1 section 6 discusses factors relating to stocking specifications.

10.3 Woodlot Licence Planning and Practices Regulation

- Sections 8, 9, 34 and 35, describe the requirement to produce a Woodlot Licence Plan, map, objectives, free growing stands, and stocking standards.
- Section 12 deals with stocking information for specified areas.
- Section 13 discusses alternative performance requirements.
- Section 33 covers pre-harvest mapping.
- Section 75 identifies surveys are specifically required.
- Section 76 states annual reports are required before April 30 of each year and Section 84 discusses declarations.