

FREP Stand Development Monitoring Protocol



This protocol details steps for field data collection and administration

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Introduction.....	3
Objectives of SDM.....	4
Defining the Population	5
Principles of Polygon Selection	5
Indicators:	6
Basic SDM Survey Skills.....	6
Polygon Selection from the TSA List.....	7
Getting Started: Planning for office and field.....	9
Office Procedures.....	9
Office checklist.....	11
Field Procedures.....	12
Field Gear Checklist	12
Field Methods	13
Filling in the form	16
Stand Development Monitoring Field Card – FS 1357	16
Data analysis	20
Data handling.....	20
Storing SDM Data in the short term	21
Reporting – FREP IMS, RESULTS, and the SDM Milestone report.....	23
Help.....	23
References and additional information	24
Appendix 1.....	24
Appendix 2.....	25
Definitions.....	33
Appendix 3.....	34
Appendix 4.....	35

Introduction

Management of forest and range resources is a complex process that involves the balancing of ecological, social, and economic considerations. Within this context, the objective of the Forest and Range Evaluation Program (FREP) is to determine if forest and range policies and practices in British Columbia (BC) are achieving government's objectives for resource values under the *Forest and Range Practices Act* (FRPA). To accomplish this, specific evaluation tools are designed by technical experts from ministry, industry, academia and other agencies, which are then piloted and implemented by ministry field staff.

One of the most influential components of forest management policy in BC is the obligation to achieve "free-growing" (FG) status for harvested stands within a specified time. The standards and practices associated with achieving this legal milestone require licensees to prepare and submit a Forest Stewardship Plan. This plan outlines key stand attributes (e.g. species composition, stocking standards) that need to be achieved for a licensee to be relieved of their obligation. Management decisions associated with achievement of this free-growing obligation can have a large influence on forest conditions over the mid and long-term. In order to determine whether young stands are meeting the timber objectives set by government, it is critical to assess their health and productivity.

The Stand Development Monitoring (SDM) protocol has been designed to assess the health and productivity of young stands between the ages of 15 and 40 years. Stands in this age range will have typically achieved the FG milestone, and are currently assumed to remain in that healthy well-stocked condition. Key information coming from these stands through a combined analysis of early silviculture records and the SDM data, will provide valuable input into both silviculture and inventory policy decision making. The SDM survey may be the last update of the status of a stand prior to it being harvested, a role currently filled by the FG survey. SDM collects and provides introductory analysis of data in five specific areas: stand density (total, well-spaced (WS) and free-growing (FG) stems per hectare), stand species composition, pest incidence, tree volume and site index. SDM data can be used for a variety of purposes in tracking how stand attributes change in managed forests.

The cross-disciplinary nature of SDM data with links to silviculture, inventory, forest health and growth and yield, allows for a broad examination of current forest management practice in BC. The opportunity exists for data from SDM to be used by licensees to meet some of the requirements of sustainable forest management certification. SDM data can ultimately be used to support revision of standards associated with current practices. Such adaptive management techniques will be essential under a changing environment. Given its direct tie to management practices through the use of operational silviculture records, SDM is uniquely positioned to provide a benchmark measure on which to base a systematic approach of adaptive management for many silvicultural practices.

Objectives of Stand Development Monitoring

There are four objectives for Stand Development Monitoring. These objectives are framed to assess the way we manage forest stands in BC and how well they are performing. The key deliverable from SDM is an unbiased set of data for each assessed inventory polygon that can be used by various stakeholders to answer basic questions on stand health, productivity, and how effective our policies and practices are at sustainably managing our timber resource.

The key objectives of SDM are to:

- A. Assess the health and productivity of young stands under changing environmental conditions;
- B. Review the effectiveness of government policies and forest management practices that govern stand initiation, resource sustainability and risk to the Crown;
- C. Support sustainable forest management (SFM) certification processes; and
- D. Develop in-house expertise within the Ministry regarding the health and productivity of managed stands in all Timber Supply Areas (TSAs).

What SDM Isn't

Although this protocol is designed to measure stands aged 15-40 years, and part of the survey measures key stand attributes specifically related to free-growing, **SDM is not a free-growing survey**. Free-growing survey protocols were developed for young stands aged 5-20 years to relieve licensees of their basic silviculture reforestation obligation. This protocol is not intended as a tool to evaluate licensee performance in meeting their obligations under FRPA. This protocol can, however, provide feedback to industry on how well their site plans and Forest Stewardship Plans have been implemented.

SDM damage criteria

Specific SDM damage criteria (Appendix 3) have been developed for stands aged 15-40 years, which are generally more lenient than even-aged, free-growing damage standards used in FG surveys. The SDM damage criteria have incorporated the fact that competitive relationships between crop trees and brush species have had more time to be resolved. Also for SDM, whether a tree was designated as an acceptable species of conifer at the time of declaration is considered of less importance today, particularly in light of climate change. Broadleaf species are not yet part of SDM in stands that have originally been managed for softwood timber. Broadleaf dominated stands within management units that have active broadleaf management and a partitioned AAC may be included, provided they meet all of the other selection criteria. The efficacy of previous species and stocking standards can be assessed by comparing current stocking to declaration values provided trees are also tallied following the preferred and acceptable designations used at the time of declaration. Trees are still tallied both with and

without the earlier preferred and acceptable designations under this protocol, for use by stakeholders not requiring these designations.

It is recommended that the SDM damage criteria be adopted for use in assessing all stands aged 15-40 years.

Defining the Population

The simple random sample for SDM is drawn from the RESULTS database and includes all even-aged polygons, aged 15-40, by TSA. This population is a subset of the larger inventory of polygons in the Vegetation Resources Inventory (VRI) database. As the SDM population is drawn from RESULTS, we have the earlier silviculture record information for each sample unit that is housed in that database. This retrospective link is a critical aspect of the SDM survey. The larger VRI population of all stands aged 15-40, including those not found in RESULTS, may still be surveyed using the SDM protocol but will not be the primary interest of this FREP protocol. As with other FREP resource values this random sample is referred to as the SDM Master List. The SDM Master List will be stored intact for reference. As a result, each TSA will have a single list of inventory polygons from which to sample. The SDM Master List may be reconstituted every five years to incorporate new polygons that meet the minimum age requirement and exclude polygons that are too old.

Principles of Polygon Selection

The single most important sampling principle of this protocol is that polygons must be selected from each TSA list without bias. The tendency to want to target sampling on stands in areas where problems are already known to exist must be avoided. Such a bias defeats the purpose of this protocol and would limit the ability to make historical comparisons or predictions of the conditions of similar stands throughout the TSA. Only when stands are randomly selected throughout the sampling area is it possible to make inferences about the greater population.

This protocol is derived from more intensive FREP studies that were piloted in several timber supply areas. It is simplified from the original studies in order to be cost effective and easier to implement. This protocol is flexible in terms of the timeline and resources required, in consideration of the larger district FREP monitoring strategy. Both the pilot studies and this protocol adhere to the same sampling standards and mainly vary in the complexity, scale, timing and intensity of sampling.

The SDM protocol is one of several annual district FREP activities that necessitate the flexibility of acquiring data over several years. It is envisioned that SDM will become one of a suite of tools used by field staff to acquire assessments of managed stand conditions.

Indicators:

There are several indicators that are used to assess managed stand development and stand-level forest health. The core indicators include:

- Leading tree species, height class, age and crown closure (Inventory label);
- Total tree density;
- Well-spaced (WS) and free-growing (FG) tree density;
- DBH of all trees ≥ 7.5 cm;
- Pest incidence including live and dead trees;
- Current site index; and
- BEC classification to site series (from FG declaration).

Some optional indicators include:

- WS density of preferred and acceptable tree species;
- Stand management treatments;
- Current stand volumes; and
- Current diameter class distributions.

Basic SDM Survey Skills

This SDM protocol follows some of the basic silviculture survey procedures. Additional data are collected to meet the protocol inventory objectives. Silviculture and inventory survey experience can certainly help, however, it is not required to carry out the SDM protocol. The knowledge and skills that will be beneficial to completing this protocol are:

- Ability to identify forest health pests and diseases;
- Ability to identify tree species and plants (especially indicator plants);
- Knowledge of basic plot establishment and stand attribute measurement procedures and objectives; and
- Proficiency with the techniques of basic forest mensuration and measurement.

One of the most important aspects of this protocol is forest health agent identification. It is highly recommended that regional forest health specialists be contacted and an orientation field session be completed to review survey procedures and the major forest health issues that may be encountered in the survey area prior to commencing the field portion of this protocol.

Polygon Selection from the TSA List

Each TSA will be provided with a list of randomly-selected inventory polygons drawn from RESULTS. These TSA Lists will be located on the Forest and Range Evaluation Program (FREP) sharepoint site at:

<https://sharepoint.forests.gov.bc.ca/frep/rv/timber/Forms/AllItems.aspx>

Previously, each district was provided a list of 60 polygons for each TSA that were even aged, surveyed for FG declaration in the period 1995-2001 and equal or greater than 10 ha. Now, by TSA, the entire RESULTS polygon list for even-aged stands aged 15-40 years, regardless of polygon size is available to sample from. The SDM sample will be limited to those polygons 5 hectares in size and greater. Data from previously completed SDM pilot surveys remains valid. Starting at the top of the TSA list, select enough samples to fulfill your project target number of stands to survey. The sample selected will include FG as well as non-FG polygons. Not only will the District Manager want to know the health and productivity of all stands in the district but this information is also required to be able to conduct TSR analyses.

There are only two reasons to reject an inventory polygon from the TSA list, the first of which is safety. If the safety issue is temporary in nature the polygon will be rescheduled at a later date when the safety issue has been resolved (e.g. bears, wildfire). The second reason is that the polygon has been partially cut or is multi-layered and uneven-aged. SDM is not designed to measure multi-layered or uneven-aged stands. Rejected polygons should be replaced by other polygons on the TSA list.

A polygon may be deferred or re-scheduled for assessment at a later date if any of the following criteria apply:

- Polygon has received a stand management treatment within the past 8 years – Action: record that this polygon is to be assessed at a later date (post 8 years);
- Polygon is within a TFL¹, woodlot, park, ecological reserve, or other portion of the non-timber harvesting land base – Action: - defer at this time. Work needs to be done with FAIB. CMI will potentially assess inventory polygons in TFLs and woodlots.

Difficulty or expense in accessing a polygon (e.g., air- or water-only) is not sufficient reason to reject a polygon from the sample. Relying on easily accessible polygons may introduce bias into your sample and negatively affect the quality of your findings. If uncertain whether a polygon should be rejected due to an atypical circumstance, refer to the SDM Team (SDMT).

Polygons that have recently experienced a major disturbance such as wildfire or rehabilitation following bark beetle attack may be encountered in the sample population and should be

¹ Due to administrative differences, SDM on TFLs should be considered separately from TSA monitoring. There is no reason that the SDM protocol cannot be applied to a TFL but it should be done as an independent project.

recorded as such. These polygons needn't be surveyed but it is important to keep track of these occurrences as they are a reflection of conditions in the sample population. Allow sufficient time to sample all of the polygons chosen for the year. Given resource constraints faced by districts, it would be acceptable to sample a minimum of 10 sites per year over a three year period. A minimum of 30 polygons should be surveyed before any formal reporting on the status of managed stands in a TSA is produced. It is envisioned that field staff will continue to sample stands within TSAs in their districts in order to provide valuable input into future timber supply reviews.

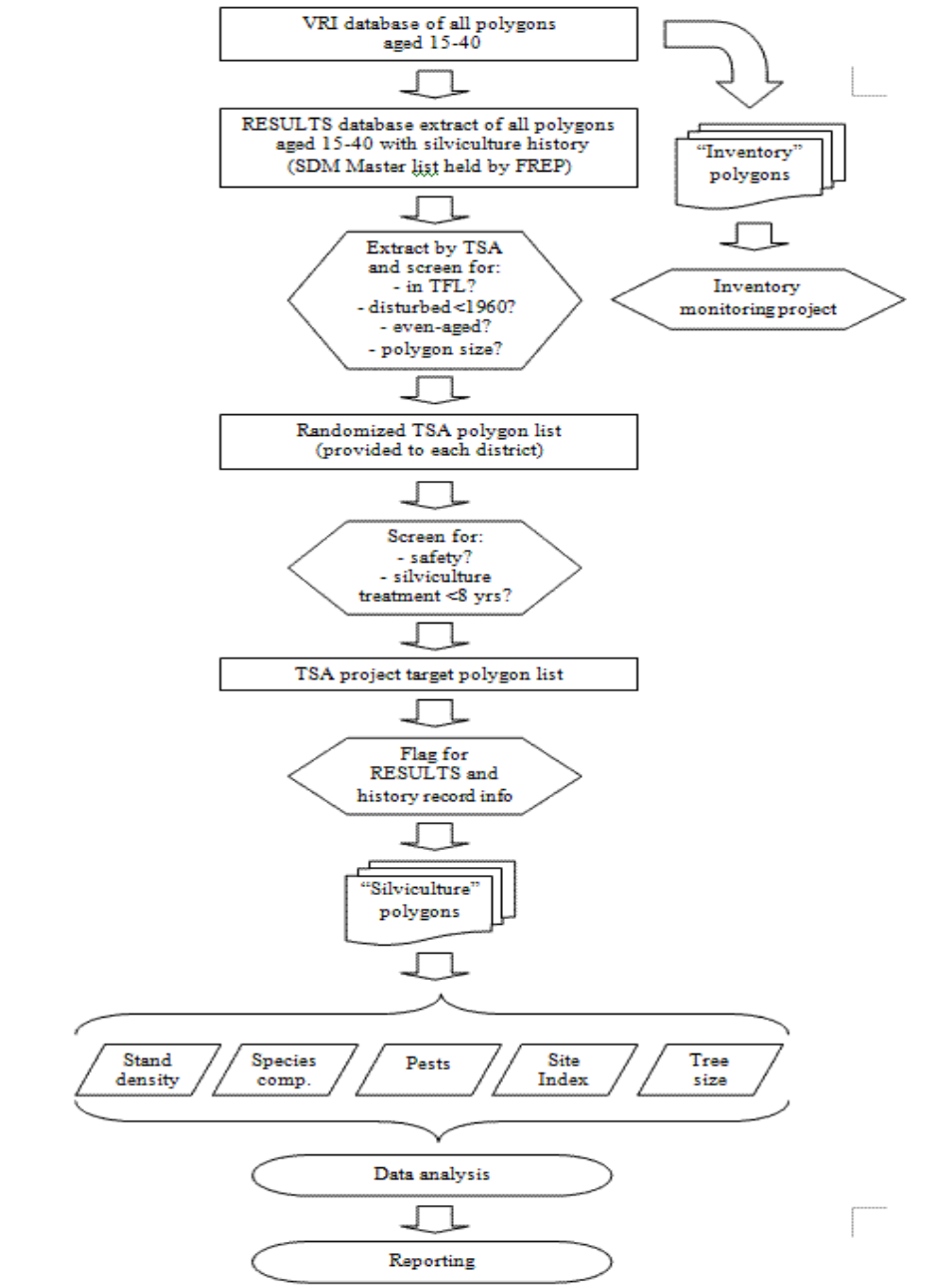


Figure 1. A flowchart of the polygon selection and data flow process.

Getting Started: Planning for office and field

Planning and documentation (office)

The initial office planning step for SDM is crucial. Potential sample polygons need to be researched using information from both electronic databases (RESULTS) and paper opening file (history record) information to ensure that, at minimum, the following pieces of information are available:

- (1) A map showing location of polygon, (e.g. from earlier silviculture surveys);
- (2) Well-spaced tree density;
- (3) Free-growing tree density;
- (4) Total tree density; and
- (5) The polygon inventory label.

If any of these pieces of information are missing the polygon falls outside of the FREP SDM population of interest. It is still possible to survey the polygon to get a snapshot of the current stand conditions but no linkage can be made back for FG comparisons. If discrepancies exist between the opening file and RESULTS, defer to the opening file. The minimum inter tree distance (MITD) used at declaration, the M-value, and the preferred and acceptable species should be available from the earlier silviculture survey report and should be recorded for SDM. If a MITD was not identified at declaration it is assumed to be 2 m, and missing M-values are assumed to be 6 in the interior and 4.5 on the coast, but check M-values against Target Stocking Standards (TSS). Recording all relevant information about a polygon prior to going out into the field can help the logistics of the order in which polygons will be assessed over the field season.

Office Procedures

- Obtain the TSA list of RESULTS polygons (from FREP sharepoint site or otherwise).
- Create a spreadsheet for recording all information about a polygon.
- Pull all electronic and paper files for the first 30 or so polygons on the TSA list starting from the top (files maybe off site)
- Review opening file and use the Opening ID for each polygon to link to RESULTS information to ensure each polygon is a candidate for sampling (i. e., meets the polygon selection criteria)
- Review the opening file and RESULTS information on the polygon and record all essential pieces of information.
- Record the minimum inter-tree-distance (MITD), M-value and the preferred and acceptable species designations from the original free-growing survey where available.
- Check air and ortho photos and confirm that there are no complicating factors (e.g., fire, landslide, etc.) that would compromise the use of the polygon for sampling.
- Using either ARC GIS or Mapview, create maps at 1:10,000 scale for survey planning purposes and a map at 1:25-50,000 for access purposes.

- Selection of the SDM plot locations for each selected individual polygon is best done digitally using either ArcGIS or Mapview in order to obtain accurate plot-centre coordinates for GPS input. It is recommended that in addition to a polygon map, an ortho photo be used to prevent plots from incorrectly being placed outside the polygon, on roads, landings, water bodies, etc. that have been netted out of the NAR.
- An alternate approach to selection of SDM plot locations is through the use of scaled grid overlay template (e.g. applying a 100 m x 100 m grid to the map). Assign an arbitrary number to ALL the intersecting points on the grid that are within the polygon boundary *except* those that fall in areas excluded from the NAR (roads, landings, water bodies, etc.). Randomly select 10, plus one back-up, of the grid point numbers – this can be done simply by drawing the arbitrarily-assigned numbers out of a hat or by using a random number generator. The grid points are selected without replacement (i.e., can only be picked once). Downloading or manually entering the GPS plot co-ordinates in the office is an effective way to save time and avoid bias on field days.
- As the plot locations are pre-determined, the location of the POC can be determined in the field at a convenient location of the surveyor's choosing. Ensure that a route is selected that allows the surveyors to access all the selected points efficiently.
- A large polygon with widely-spaced plot points may require two crews to complete within a day. It is important to have pre-survey planning complete in order to allocate resources appropriately.
- Prepare a FS 1357 field card for each plot with all the planning information filled in.
- Plan your field season's survey schedule (keeping in mind the timing of forest health issues in the field and other FREP projects that need to be completed).

Plan the entire field season in advance, keeping in mind the seasonality of forest health issues, for optimal forest health pest and disease identification.

Office checklist for the SDM protocol	Done	Reviewed
1. Obtain TSA list of polygons for sampling (from Sharepoint site).		
2. Select polygons systematically from the top of the TSA list to fulfill your project objective (minimum of 30 to start).		
3. Confirm sample suitability for polygons. Document why polygons were rejected, deferred or re-scheduled (include re-schedule date).		
4. Obtain opening summaries from RESULTS and examine opening files for silviculture survey results and stand history for each potential sample polygon.		
5. Record WS, FG, MITD, preferred and acceptable species, total tree density, inventory label (from original declaration) and any other pertinent information for each polygon.		
6. Prepare field cards and summary data spreadsheet.		
7. Obtain air photos and create small scale block maps for survey planning (Ensure that the small scale block maps include the 10 + 1 plot location points). Input co-ordinates to a GPS.		
8. Determine accessibility options and set survey schedule.		
9. Obtain all the necessary training and field guides that will ensure accurate data collection in the field.		
10. Conduct surveys.		
11. Conduct quality control checks on field survey methods, plot data and field cards.		
12. Compile data, enter into SDM spreadsheets, and provide plot and survey summaries for stand stocking, species composition, pest incidence, site index, and stand volumes (optional).		
13. Update polygon record in the SDM dedicated TRIM folder.		

Field Procedures

Field Gear Checklist

Use the following checklist to ensure all field gear is available.

Item	Got it?
SDM survey field cards (FS 1357) or electronic data logger	
Airphoto or orthophoto and map with predetermined sampling lines and plot locations	
Compass	
GPS unit (for polygon location and navigating to plot points)	
metal stakes (<50cm) to permanently identify plot centers	
Plot cord(s) suitable for 3.99 and 5.64 m plots, or loggers tape	
DBH measuring tape	
Carpenter's measuring tape for inter-tree distances	
Clinometer (analog or digital, e.g., Vertex)	
Small hatchet or field knife	
Small swede saw, or folding saw	
Hand lens (5x or better)	
Pest field identification guide(s)	
SDM damage criteria	
Pest Management (or other colour) flagging tape	
Increment borer	
Calculator	
Camera	
Personal field and safety gear	

Field Methods

Field review of sample polygon:

1. Compare the air photos, orthophotos, contour maps and other supporting documentation to confirm polygon location, access, plot placement, etc.
2. Prior to going into the field, for each sample polygon, predetermine the location of 11 – 3.99 m radius SDM plots using a 100 m x 100 m grid (for polygons ≥ 10 ha) or 50 m x 50 m grid (for 5-10 ha polygons) using ArcGIS. The 11th plot is a spare in case one of the first 10 plots proves unsuitable. Use a predetermined method of locating the plot center using a GPS unit and follow the Silviculture Survey Manual recommended methods.

It is critical that all survey plots be located within the same polygon as identified in the earlier silviculture survey so that current results can be compared to that prior assessment.

3. A plot may be offset if the plot centre happens to fall in a location that is unsafe to survey (e.g., edge of a cliff or middle of swamp) or the centre falls in an area outside the net area reforested (NAR). Note that you may only offset a plot once. If after that single offset the plot location is still not in a representative part of the strata (i.e., it is not in the NAR) then use the predetermined 11th plot. If another spare plot is required during the survey, then the surveyors will have to randomly select one of the remaining unsurveyed grid intersections as the 12th plot centre. If a plot lands in a void (e.g., beaver pond, rocky outcrop, sand dune, etc.) that is not typed out of the NAR, then it is recorded as a “null plot” and counts toward the 10 required plots. The polygon summary is based on 10 plots.

Field data gathering for each polygon:

1. When starting your field survey, create a POC and mark with flagging ribbon at starting point as “SDM” with the date, surveyor’s initials and distance and bearing to the first randomly located plot. Record a GPS point for the POC. Record all plot data on a **FS 1357** field card (Figure 2. Sample of FS 1357 field card. Figure 2).
2. Mark each plot center with a metal stake (<50 cm) and flagging ribbon (include plot number, date and surveyor’s initials). Record a GPS point for the plot centre.
3. Starting at a bearing of 0° (North), sweep clockwise and tally all trees ≥ 1.3 m in height, including commercial broadleaves, by species and layer. This tally includes **both** live and dead trees although they are tallied separately on the field card. Dead trees are not included in the current total tree count but are included when determining damage agent incidence and to account for any changes in total tree density since the last stand assessment. Dead-and-down trees are to be tallied if their base/root-wad is within the plot.

4. During the same sweep, take the DBH measurements of all layer 1 and 2 trees (≥ 7.5 cm dbh) and enter it in the “Data Volume Trees” section of the field card along with whether the tree is alive or dead. DBH measurements are to the nearest 0.1 cm. It is recommended that during this sweep, all trees ≥ 7.5 cm in DBH (all layer 1 and 2 trees) are marked with ribbon and numbered sequentially.
5. Along with the measurements recorded in the first sweep, assess each tree in the plot for forest health factors and record by species and layer. **Only record damage agents that have rendered the tree unacceptable according to the SDM damage criteria (see Appendix 3).** The SDM field card can accommodate damage agent data tallied by species and layer for **both** live and dead trees. Minor, yet notable forest health damage agents that **do not** result in tree unacceptability can be mentioned in the notes section of the FS 1357.
6. Using a second sweep, tally all well-spaced (WS) and free-growing (FG) trees using the same minimum inter-tree distance (MITD) that was used at the time of FG declaration. WS and FG trees tallied in this sweep are selected on the basis of being the biggest, best trees of the **currently** preferred and acceptable species². Attempt to **minimize** the influence of ingress on WS and FG values at this stage. The only difference between WS and FG in this protocol is the achievement of the species respective minimum height (eg. for lodgepole pine to be considered FG it must be ≥ 2 m yet it could be ≥ 1.3 m and be tallied as WS). Record in the notes section if the WS tally could have increased and by how many trees if WS trees were selected to maximize number of trees rather than using the biggest and best. Field data are collected ignoring the M-value cap. If desired, the M-value cap can be applied during data analysis. It is helpful to mark the WS/FG trees with a second colour of ribbon for visual reference.
7. In an optional third sweep, only the FG and WS tree species based on the preferred and acceptable species stated in the original silviculture survey are tallied, again with an emphasis on the biggest best trees as in Step 6. **Note: This sweep is only necessary if the species acceptability standards at the time of the earlier silviculture survey were different from the current standards.** This sweep is important for a retrospective assessment of free-growing and species acceptability criteria. Once again use the MITD from declaration.
8. In order to determine which trees will serve as volume trees and be measure for height, divide the plot into 4 quadrants (delineated by the four cardinal bearings). Starting at bearing 0° (North) and sweeping clockwise, take the first previously identified, **live or dead** layer 1 or 2 tree (≥ 7.5 cm DBH) in each quadrant and measure its height (its

² Refer to Reference Guide Standards for Forest Development Plan
http://www.for.gov.bc.ca/ftp/hfp/external!/publish/Stocking%20Standards%20for%20FDPs/Reference_Guide.xls

species and DBH should already be listed in the “Data Volume Trees” section). If the tree suffers from an unacceptable forest health factor, identify it here.

9. If a quadrant contains no trees are ≥ 7.5 cm DBH threshold (or no trees at all), continue the sweep back to 0° and then repeat (taking the next sequential tree in the next suitable quadrant) until at least four heights have been recorded for the plot. If there are no trees ≥ 7.5 cm DBH in the plot then no height measurements are required. Heights should be recorded to the nearest 0.1 m.
10. The site index sample tree used in each plot should be the largest (based on DBH) healthy tree of the dominant conifer species within a 5.64 m radius sweep. Sample the selected tree for site index criteria using the growth intercept method³. If there is no healthy dominant conifer tree present in the 5.64 m radius plot, do not record site index data. In stands with more than one dominant conifer species, attempt to capture SI estimates from the range of species present, provided that over the 10-plot sample, at least three SI sample trees exist for each species. Take only one SI estimate per plot.
11. Record the inventory label for each plot based on what can be seen from the plot center. Record species composition of leading, secondary and tertiary species to the nearest 10%. Estimate the average height and age of the leading and secondary species. Note this step is required in order to make comparisons to the original inventory label and to link to empirically derived inventory labels based on SDM data. New inventory labels based on the basal area of the trees tallied in the 10 plot sample will be derived following FAIB procedures.
12. Estimate and record the per cent crown closure (to the nearest 5%) at plot centre.
13. Be sure to total all tally columns in the “Totals” row near the top of the FS1357.
14. Once you have finished a plot, make an ocular sweep of the surrounding stand. In the “Notes” section of the FS1357, comment on whether this plot is representative of the surrounding stand. If not, comment on how this plot differs.
15. At some point during the 10 plot survey, take a representative digital photo of the stand. In addition, photograph any anomalous situations that may require feedback from the SDM development team or the local forest health specialist.

³ Growth intercept method for silviculture surveys. 1995. BC Ministry of Forests. Silviculture Practices Branch.

Filling in the form

The following sections will lead you through the process of filling out the SDM field card ensuring all relevant data is collected.

Stand Development Monitoring Field Card – FS 1357

Information to complete the first part of the *Stand Development Monitoring Field Card (FS 1357)* (Figure 2) will generally be obtained from the opening file or RESULTS data summary for the opening. All information obtained during the office planning phase should be confirmed during the SDM survey.

The form is titled "STAND DEVELOPMENT MONITORING FIELD CARD" and includes the following sections and fields:

- Section 1:** Surveyor Name(s)
- Section 2:** Survey Date
- Section 3:** Page Number
- Section 4:** Mapsheet - Opening No.
- Section 5:** Plot No.
- Section 6:** Polygon No.
- Section 7:** Date
- Section 8:** Time
- Section 9:** Weather
- Section 10:** Forest Health (Scale)
- Section 11:** Preferred Off-Diag.
- Section 12:** Total Area (m²)
- Section 13:** Area (m²)
- Section 14:** Tree No.
- Section 15:** Species
- Section 16-19:** Diameter (cm)
- Section 20-21:** Height (m)
- Section 22-24:** Volume (m³)
- Section 25-26:** DBH (cm)
- Section 27:** Acceptable Off-Diag.
- Section 28-32:** Data Volume (m³)
- Section 33:** Identified Inventory Sample Status
- Section 34:** Notes
- Section 35:** Total Volume (m³)
- Section 36-40:** Species and Volume Data
- Section 41-45:** Species and Volume Data
- Section 46:** Total Volume (m³)

Figure 2. Sample of FS 1357 field card.

Described on the following pages is a detailed description of the information to be recorded on the FS 1357 field card.

- 1. Surveyor Name(s):** Record the name(s) of the person who completed the survey.
- 2. Survey date:** Record the date in which the survey data was collected in the field.
- 3. Page:** Record the page number. Include all survey cards in a logical numbering sequence. There should be at least one page per plot for a minimum of 10 pages per polygon. The goal is to provide a logically organized package of survey cards to include in the finished report.
- 4. Mapsheet - Opening No.:** 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 polygon being surveyed. This

information may be located in the silviculture plan or prescription, opening file, corporate database or on the forest cover map.

5. Polygon: Each opening has one or more polygons as defined in the silviculture plan or prescription. Enter the number of the polygon being surveyed.

6. Location: Record the geographic location of the opening. This information may be located in the silviculture 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.

7. District: Record the name or abbreviation for the forest district. This information may be located in the silviculture prescription, opening file, corporate database, survey contract or from local knowledge. A map of the Forest Districts and Regions may be consulted.

8. Timber Supply Area (TSA): Record the name of the timber supply area the polygon falls within. In the case of sampling a Tree Farm License, Woodlot or other tenure, use the appropriate number.

9. BEC: Record the biogeoclimatic zone, subzone and variant of the polygon. This information can be located in the silviculture plan or prescription, in a corporate database or on biogeoclimatic subzone maps and handbooks. However, biogeoclimatic information should be confirmed during the walk-through.

10. Point of Commencement: For the first plot, record a written description of the location of the point of commencement in the field and the bearing and distance to the first plot. This location should be identifiable on an air photo and a map to ensure the strip lines and plots can be accurately positioned on a map at the completion of the survey.

11. UTM Co-ordinates: Record the Zone, Easting and Northing reading for this plot.

12. Plot No.: Record the plot number assigned to the plot.

13. Minimum Inter-Tree Distance (MITD): Distance used in original free-growing declaration.

14. Tree Species: Record the coniferous and broadleaf tree species that occur in the plot. Do not include non-commercial tree species (as defined by Forest Analysis and Inventory Branch). Refer to the RESULTS tree species codes for a list of the tree species, the codes and the common names of those species that are found in British Columbia. A list is also present on the FS 660 field form. Only conifers are tallied as WS and FG unless broadleaf management is actively pursued within the TSA.

15. Layer: There are three layers (1 – (>12.5 cm dbh), 2 – (7.5-12.5 cm dbh), 3 – (>1.3 m tall and <7.5 cm dbh), that are tallied separately for each tree species in each plot.

16. Total Trees: Record the total number of live coniferous and broadleaf trees within the plot on the first line. This includes both acceptable and unhealthy unacceptable trees. Non-commercial tree species are not tallied under total trees. **Only trees ≥ 1.3 m tall are tallied.**

If filling out paper forms, we strongly suggest using dot tallies in the boxes below the total line of this column in accordance with the species and layer in which the trees are found and also for all other tree counts, live and dead. Use the “Totals” line at the top of the columns to sum the values (including zero values) in that column for each category and use this sum as a final check before moving on to the next plot.

Note that dot tallies are done in the boxes below the total line of this and the following columns in accordance with the species and layer in which the trees are found.

17. Total Conifers: Record the total number of live coniferous trees, including both acceptable and unacceptable trees in the plot on the first line. **All conifers ≥ 1.3 m tall are tallied.**

18. Dead Trees: Record the total number of dead trees ≥ 1.3 m tall, both standing and dead and down, within the plot on the first line.

19. Dead Conifers: Record the total number of dead conifers ≥ 1.3 m tall, both standing and dead and down, within the plot on the first line.

20. Total Well-Spaced (WS): Record the sum of the well spaced trees in the plot, based on current preferred and acceptable tree species without use of the M-value cap, on the first line. Note that the only difference between FG and WS is the achievement of minimum heights in layer 3 trees.

21. Total Free-Growing (FG): Record the sum of the free-growing trees in the plot, based on current preferred and acceptable tree species without the M-value, on the first line.

22. Forest Health Damage Agents: Record the applicable pest code for the unacceptable forest health factors on **each** affected tree within the plot, not just on the well-spaced or free growing trees. Live and dead trees are tallied separately for each damage agent (see below). If a tree has more than one pest, record only the most severe damage or the agent most likely to cause mortality. Refer to the *Damage Agent and Condition Codes FS 747* (Appendix 2) for a comprehensive list of forest health factors and their corresponding pest code. If a forest health factor is unknown or uncertain, describe and record the type of damage, obtain a sample, and consult either the *Field Guide to Forest Damage in British Columbia*, or the district or regional forest health specialist.

If a surveyor wants to record all pest incidence, beyond the damage criteria for other reasons, this can be recorded in "NOTES" but must be separated from the required data.

23. Forest Health – Live Trees: Record the total number of live trees affected by the forest health factors on the first line. Note that dot tallies are to be done in the boxes below the total line of these columns in accordance with the species and layer in which the trees are found.

24. Forest Health – Dead Trees: Record the total number of dead trees affected by the forest health factors on the first line.

25. Preferred and Acceptable – WS: Record the sum of the well spaced trees in the plot, using the preferred and acceptable tree species listed in the original free growing survey and without regard for the M-value, on the first line. Note that dot tallies are done in the boxes below the total line of these two columns in accordance with the species and layer in which the trees are found.

26. Preferred and Acceptable – FG: Record the sum of the free-growing trees in the plot, using the preferred and acceptable tree species listed in the original free growing survey and without regard for the M-value, on the first line.

27. Preferred and Acceptable Species (Original): Record all preferred and acceptable tree species, using the two letter species code, used in the original free-growing survey.

28. Data Volume Trees – Live / Dead: Record if sample tree is alive or dead.

29. Data Volume Trees – Species: Record the abbreviation for the species of the selected tree including commercial broadleaf species. Volume trees are not limited by current preferred and acceptable rules. Volume trees are limited only to being in layers 1 and 2 (≥ 7.5 cm). Record the dbh for both healthy and unhealthy, live and dead trees. For unhealthy/unacceptable trees, record the damage agent.

30. Data Volume Trees – DBH: Record tree diameter at breast height as expressed in cm to 0.1 cm accuracy for all trees, conifers and commercial broadleaves ≥ 7.5 cm dbh in the plot.

31. Data Volume Trees – Height: Record tree height to the nearest 0.1 m accuracy for the first tree ≥ 7.5 cm dbh encountered in each of the four cardinal bearing quadrants in the plot. Repeat sweep taking the second tree per quadrant until four height measurements are taken.

32. Data Volume Trees – Pest: If the measured tree is afflicted by an unacceptable pest as determined using the SDM damage criteria, note the applicable pest code.

Collecting pest information for layer 1 and 2 volume trees allows for the comparison of proportion of gross stand volume contributed by healthy trees as opposed to volume at risk of loss due to pest-caused damage or mortality.

33. Growth Intercept Sample: To determine site index using the growth intercept method, record the measurements and species here. Note that the sample tree should be selected from the population of trees found within the larger 5.64 m radius plot. Refer to site index training materials on the growth intercept method. In stands with more than one dominant tree species attempt to collect SI data for each species but only one SI tree is assessed per plot.

34. Notes: (Optional) Record site specific details that are relevant to the survey. Leader height, regeneration under 1.3 m, local anomalies within a stratum, presence of wildlife trees are but a few of the possible items that might be recorded. The notes can often be as valuable as the numerical values.

35. Inventory Label (see background of Inventory label in Appendix 4)

Note that new inventory labels will be derived using both the ocular estimate method for each plot, similar to current methods used in silviculture surveys, as well as empirically derived from SDM tree tallies during the data compilation phase. The following boxes are to be used to record information from the ocular estimate only.

36. Leading Spp.: Record the abbreviation for the most abundant species.

37. %: Record a visual estimate of the proportion of total trees visible from plot center that are Leading Spp. The species composition is rounded to the nearest 10 percent and expressed as 1=10%, 4=40%. When combined, the species composition must equal 100%.

38. Age: Estimate the age of the first leading species as recorded in field 37 using a combination of harvest date and the age at dbh of the SI tree for guidance.

39. Ht. (m): Estimate the average height of the first leading species as recorded in field 37. Height is expressed in m to 1 decimal place.

40. 2nd Spp.: Record the abbreviation for the second most abundant species.

41. %: Record a visual estimate of the proportion of total trees present that are 2nd Spp. As with field 38, the species composition is rounded to the nearest 10 percent.

42. Age: Estimate the age of the second leading species as recorded in field 41 using a combination of harvest date and the age at dbh of the SI tree for guidance.

43. Ht. (m): Estimate the average height of the second leading species as recorded in field 41. Height is expressed in m to 1 decimal place.

44. Minor Spp.: For the purpose of data collection, minor species can be considered all those species not already recorded in fields 37 or 41 that represent 10% or more of the total species composition.

45. %: Fields 45 and 46 are treated as a matched pair. The percentage entered in field 46 corresponds to the species entered above it in field 45.

46. Cr Ci: Forest Analysis and Inventory Branch prefers that crown closure be determined from the visual observation from aerial photography. There are a number of "speckle" diagrams available to assist with calibrating ones estimate. Since recent aerial photographs are not always available we are forced to use ground based visual assessments. Figure 27a in the FS 660, Silviculture Survey Reference may be useful as a benchmark. It should be used with caution. While it may be effective for robust coastal stands, it often over estimates the interior stands whose crowns are smaller in diameter. Lower site index sites are also greatly over estimated. Crown closure is estimated to the nearest 10%.

Helpful hints using the sample field card data in Figure 3 are also provided.

BRITISH COLUMBIA Forest and Range Evaluation Program		STAND DEVELOPMENT MONITORING FIELD CARD		SURVEYOR NAME(S)		SURVEY DATE		PAGE OF	
093F090-31		A		ALEX WOODS, ERIN HARVARD		10/6/01		1/10	
POLYGON		LOCATION		DISTRICT		PSA		SBSdw3	
CORKSCREW FSR		DVA		P.G.					
POINT OF COMMENCEMENT/BEARING & DISTANCE TO THE PLOT		UTM ZONE		E		N		W	
P.O.C. = 53°49'56"N, 124°10'57"W @ LANDING		10 534951		1241053					
PLOT NO. (360m)		METHOD (20m)		FOREST HEALTH FACTORS		PREFERRED SPP (0808)		ACCEPTABLE SPP (0808)	
1		1.6m		DSC AM NY VT DSG		P11		Fdi, Sx	
LAYER		TOTAL TREES		TOTAL CON.		DEAD TREES		DEAD CON.	
TOTAL S.		28		13		0		0	
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For 2011, the interim solution consists of piloting the use of an electronic tablet (funds permitting) that has MS EXCEL that captures SDM field card plot data and automatically calculates stand stocking, species composition, pest incidence, site index and the proportion of total tree layers by tree classes 1-3. An associated project summary spreadsheet provides a comparative listing of all SDM polygon results alongside the original free-growing survey results. The summary also provides a basis for calculating stand volumes from TASS/TYPSY runs and for identifying the data fields required for acceptance into IMS and RESULTS. Districts are provided the workbook when they undertake a survey project.

District SDM summary reports will provide answers to the following questions:

1. What are the 5 top FH factors in the surveyed managed stands?
2. What proportion of stands are still meeting minimum stocking standards?
3. What proportion of stands are within 100 stems of minimum (e.g. 800 WS) and target (e.g. 1100 WS) stocking standards?
4. How have free-growing densities changed since declaration?
5. How have total densities changed since declaration?
6. What proportion of stands fall within the planted, random and clumped spatial distributions as determined by the ratio of WS/Total stems/ha (W. Bergerud)
7. What proportion of stands have experienced a change in leading inventory species?
8. What is the average SI by leading species determined using the GI method?
9. What is the distribution of total stems by stand layer?
10. How do the numbers or proportions in question 6 line up with TIPSY forecasts?

Storing SDM Data in the short term

There are currently two ways to store SDM data until such time as we can enter this data directly into FREP IMS. These two storage options are TRIM and RESULTS. It is recommended that TRIM be the primary data storage location for all SDM materials (maps, photos, field cards, excel spreadsheets, etc) as there are already files set up. RESULTS can also be used for storing maps, photos and field cards as well as excel spreadsheets. The downside of this is the inability to run reports from either system. It is anticipated that the excel spreadsheet will provide the ability to report out on key questions outlined in the objectives of this protocol. Please electronically file all SDM field materials into TRIM using standard filing procedures. The appropriate file numbers are listed below:

Filing SDM information in TRIM:

For filing SDM protocol and project final reports use the following TRIM file:

Record Number: FOR-23500-66/510F
Title: 881261 - FOREST AND RANGE EVALUATION PROGRAM - Timber: final reports and data sets - Stand Development Monitoring - Protocol and Final Reports

For filing SDM field data and any analyses please use this TRIM file:

Record Number: FOR-23500-66/410F

Title: 881261 - FOREST AND RANGE EVALUATION PROGRAM - Timber: final reports and data sets - Stand Development Monitoring - Field Data and Analysis

To enter SDM materials into RESULTS please use the following procedures:

For SDM surveys that are going to be planned for next year or in future years, forward plan the information in RESULTS. Follow the

- 1) [RESULTS Information Submission Specifications - Government Funded Silviculture Activities](http://www.for.gov.bc.ca/his/results/business.htm#Submission_Specifications) – found at [http://www.for.gov.bc.ca/his/results/business.htm#Submission Specifications](http://www.for.gov.bc.ca/his/results/business.htm#Submission_Specifications)
- 2) For each cutblock to be surveyed enter into the planning screens SU FH SDM and the planned date and planned hectares to be surveyed

For SDM surveys that are completed during the fiscal year, report the following information into RESULTS prior by March 31st

The survey type (SU FH SDM) the actual date of the survey and the actual hectares that have been surveyed using SDM

- 1) The forest cover and Forest health information that was collected during the survey
- 2) Attach any detailed excel spreadsheets that describe detailed plot data and summary of key statistical volume and SDM calculations. Follow the attachment standards [http://www.for.gov.bc.ca/his/Results/RESULTS Attachment Standard for Government Funded Programs 20091214.pdf](http://www.for.gov.bc.ca/his/Results/RESULTS_Attachment_Standard_for_Government_Funded_Programs_20091214.pdf)
- 3) Follow the procedures for silviculture activity reporting and forest cover reporting outlined in the [RESULTS Information Submission Specifications: Licensee Submissions \(Edition 3a\)](http://www.for.gov.bc.ca/his/results/business.htm#Submission_Specifications) – [http://www.for.gov.bc.ca/his/results/business.htm#Submission Specifications](http://www.for.gov.bc.ca/his/results/business.htm#Submission_Specifications)

Managing SDM Excel Spreadsheets

Until FREP IMS can be used to enter SDM data directly from EXCEL spreadsheets the following steps for management of SDM data are imperative.

1. On a monthly basis please save all completed SDM EXCEL spreadsheets for the polygons you have assessed onto the FREP sharepoint site. The address for the sharepoint site is: <https://sharepoint.forests.gov.bc.ca/frep/Pages/Data.aspx?View={2B59FD79-351F-4F21-BC6A-B84FD4A6BE80}&SelectedID=8>

Our Quality Assurance and Reporting Specialist (QARS) for FREP will manage all spreadsheets. There should be a folder for each TSA for SDM spreadsheets. This ensures that each district has a place to access their data as well as the ability of the QARS to roll up

all spreadsheet data into one single file on an annual basis. Once we have built screens for FREP IMS we will be able to upload all data at one time.

2. Please ensure you have uploaded all your EXCEL spreadsheets at the end of the field season.

Reporting – FREP IMS, RESULTS, and the SDM Milestone report

The SDM Milestone report, once developed, will provide a powerful monitoring tool for forest management throughout BC. SDM data will be stored in the FREP IMS database along with the original silviculture survey data for the same stand as reported in RESULTS. Once this milestone is created in the FREP IMS database and begins to be populated through this FREP protocol, most of the detailed data analyses that have been conducted in the larger Post Free-Growing FREP reports will be readily available to all Ministry staff. Areas where managed stands are clearly on track and meeting expectations will be easily identified as will areas of concern. Once the FREP IMS/RESULTS relational database for SDM data is created, the process of updating FREP SDM data will be routine for staff to perform.

Help

For further information on planning, surveying and analyzing SDM data, contact any member of the SDM protocol team which is co-lead by Alex Woods, Skeena Region, Smithers, Stefan Zeglen, West Coast Region, Nanaimo, and Frank Barber, Forest Practices and Investment Branch, Victoria and includes:

Kevin Astridge, Forest Practices and Investment Branch, Victoria
Erin Havard, Northern Interior Forest Region, Smithers
Harry Kope, Forest Practices and Investment Branch, Victoria
Michael Murray, Kootenay Region, Nelson
Leo Rankin, Cariboo Region, Williams Lake
Art Stock, Kootenay Region, Nelson
Dave Weaver, Forest Practices and Investment Branch, Victoria
Ken White, Northern Interior Forest Region, Smithers

References and additional information

Common Tree Diseases of British Columbia

Diseases of *Populus* in British Columbia: A Diagnostic Manual

Field guide to forest damage in British Columbia

Appendix 1.

Forest health damage agent and condition codes (FS 747).

Appendix 2.

STAND DEVELOPMENT MONITORING DAMAGE CRITERIA FOR EVEN-AGED (AGE CLASS 2 & 3) CONIFEROUS TREES

(Revision 6: 11 June, 2010)

INTRODUCTION

The FREP Stand Development Monitoring (SDM) protocol has been developed to assess stand performance, from a timber yield perspective, 10+ years following free-growing declaration. The data gathered will help determine whether these stands are on a trajectory that will result in a productive mature stand. The results of a SDM assessment can be used as an evidentiary base to support Forest Practices and Planning Regulation section 97(6) which states “a free growing stand must also meet the requirements, 20 years after the commencement date or 5 years after the completion of the last of any brushing or spacing treatments, and that it will more likely than not be free of forest health concerns or vegetative competition that could result in its growth being impeded.”

SDM damage criteria are based on the free-growing damage criteria, but they have been tailored for determining the health status of stands at a later stage of development (i.e., even aged, age class 2 & 3). These damage criteria are designed to determine the damage to, and acceptability of, **individual** conifers across the province. These criteria do not apply to broadleaf species. SDM damage criteria, in general, are more lenient than free-growing damage criteria as there is more confidence in a tree’s continued survival than there is at age 10-15 when stands are declared free-growing. The SDM damage criteria are based on the most current knowledge of forest-damaging agents, and are provided to help users exercise their professional judgment in identifying the “healthy” part of “healthy, well-spaced trees”.

The table below lists various types of damage, causal agents and species of trees. Agents and damage are often referred to by their codes listed on the Ministry of Forests Integrated Data Dictionary Pest_Species_Code list (partly listed on the *Silviculture Damage Agent and Condition Codes* (FS 747) field form). Tree species abbreviations are listed in the Forest Productivity Council publication *Minimum Standards for the Establishment and Remeasurement of Permanent Sample Plots in British Columbia (1999)*.

These criteria have been developed with a consideration to both future merchantability and survivorship in mind. These criteria are expected to be revised as SDM matures and as we learn more about the health and productivity of managed stands post free-growing. At the same time, climate change will increase host stress in many areas making trees more susceptible to pests and pathogens. Forest health agents previously considered benign may increase in incidence and severity, warranting their inclusion in these damage criteria.

SDM DAMAGE CRITERIA FOR EVEN-AGED (AGE CLASS 2 & 3) CONIFEROUS TREES (Revision 5).

PLEASE READ the preceding introduction before using the following table and figures.

LOCATION OF DAMAGE	TYPE OF DAMAGE	TREE BEING ASSESSED IS UNACCEPTABLE IF:	HOST SPECIES	LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES	COMMENTS
STEM	Wound (including sunscald and girdling)	<ul style="list-style-type: none"> the tree has a girdling wound which is greater than 33% of the stem circumference, or the tree has a wound which is equal to or greater than 1m in length. 	All	Biotic causes: bear AB, cattle AC, hare AH, moose AM, porcupine AP, squirrel AS, beaver AZ, atropellis canker DSA Abiotic causes: sunscald NZ, logging TL, mechanical TM, fire NB, windthrow NW	A wound is defined as an injury in which the cambium is dead (e.g., sunscald) or completely removed from the tree exposing the sapwood. Measure the wound across the widest point of the exposed sapwood (or dead cambium when the tree is damaged by sunscald). Healed over wounds (=scars) are acceptable.
STEM	Insect mining at root collar	<ul style="list-style-type: none"> the tree is currently attacked by a bark-mining insect such as a weevil or a beetle and exhibits symptoms such as foliage discoloration, thinning and/or reduced height growth increments 	Pl, Sx	root collar weevil IWW, red turpentine beetle, IBT, lodgepole pine beetle IBL	Only trees that are symptomatic should be checked for insect infestation or mining damage. Non-symptomatic trees are presumed to be unaffected by insect mining.
STEM	Deformation (including crook, fork, browse, and dead or broken top)	<ul style="list-style-type: none"> the pith is horizontally displaced more than 30 cm from the point of defect and originates above 30 cm from the point of germination, or the tree has a fork in the lower 2/3 of the stem and the smaller of the stems is $> \frac{1}{4}$ the diameter of the main stem, note forks below 1.3 m are considered as two trees, or the tree has a dead or broken top at a point that is > 5 cm in diameter. 	All All All	Biotic causes: Bear AB, cattle AC, deer AD, elk AE, moose AM, defoliators ID, spruce leader weevil IWS, lodgepole pine terminal weevil IWP, sequoia pitch moth ISQ, Abiotic causes: frost NG, hail NH, snow NY, drought ND, logging TL, mechanical TM, Deep planting TP	For horizontal displacement see Figure 1. For forking , see Figure 2. If unable to determine cause of fork record as damage code K , if cause of fork is clear record under appropriate damage code. Note: forks below 1.3 m are considered as two trees, both stems should be measured for dbh.
STEM	Lean and sweep	<ul style="list-style-type: none"> the tree leans $> 30^\circ$ from the vertical with or without growth correction (sweep) 	All	flooding NF, snow NY, slides NS, wind NW, mechanical TM	
STEM	Suppressed	<ul style="list-style-type: none"> the tree has a height to diameter ratio > 100 or, tree has $< 20\%$ Live Crown 	Pl, Py, Pw, Fd, Sx, Lw	Suppressed light environment, leading to high potential for competition induced mortality VT	Note: Only trees that are clearly not expected to reach rotation should be deemed unacceptable
STEM	Infection (including cankers and galls)	<ul style="list-style-type: none"> any infection occurs on the stem, except DSG DSG stem gall affects $> 25\%$ of stem circumference 	All Pl, Py	comandra blister rust DSC, stalactiform blister rust DSS white pine blister rust DSB, western gall rust DSG,	Note: Wounds caused by rodent feeding around rust cankers should have stem rust recorded as the causal agent.

LOCATION OF DAMAGE	TYPE OF DAMAGE	TREE BEING ASSESSED IS UNACCEPTABLE IF:	HOST SPECIES	LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES	COMMENTS
STEM	Bark mining	<ul style="list-style-type: none"> Any of the following signs are visible: pitch tubes, boring dust, exit holes on bark surface, galleries under the bark 	Pl, Sx, Fd	Douglas-fir beetle IBD, mountain pine beetle IBM, spruce bark beetle IBS, Ips pini IBI, <i>Pityogenes</i> & <i>Pityophthorus</i> IBP	<p>Note: pitch tubes can be associated with trees that have successfully repelled bark beetles, bark must be removed above pitch tube to confirm successful attack (successful galleries will be filled with frass and not pitch, contain adult beetles and/or larval galleries).</p> <p>Stressed trees are susceptible to secondary bark and twig beetles.</p>
BRANCH	Infection (cankers)	<ul style="list-style-type: none"> an infection occurs on a live branch less than 20 cm from the stem. 	Pw, Pl, Py	white pine blister rust DSB, comandra blister rust DSC, stalactiform blister rust DSS	
BRANCH	Gouting	<ul style="list-style-type: none"> any adelgid gouting occurs on a branch. 	Ba, Bg, Bl	balsam woolly adelgid IAB.	Gouting is defined as excessive swelling of a branch or shoot caused by balsam woolly adelgid, and is often accompanied by misshapen needles and buds. It is most common on branch tips and at nodes near the ends of branches. Consult a recent distribution map to identify the geographic extent of this pest.
FOLIAGE	Dothistroma	<ul style="list-style-type: none"> > 50% of tree foliage has been removed by Dothistroma in ICH, CWH, and SBS biogeoclimatic zones. 	All P	Dothistroma needle blight, DFS	See Figure 3
FOLIAGE	Douglas-fir tussock moth and hemlock looper	<ul style="list-style-type: none"> >60% of tree foliage has been removed due to hemlock looper or Douglas-fir tussock moth. 	Fd, Hw	Douglas-fir tussock moth (IDT), hemlock looper (IDL)	
FOLIAGE	Other defoliating insects and disease	<ul style="list-style-type: none"> >80% of tree foliage has been removed due to foliage disease. 	All other conifers Note: Lw	foliage diseases DF, defoliating insects ID	Note: Lw is a deciduous tree so defoliation has less impact, Repeated defoliation attacks will result in dead branches, apply the >80% rule to obviously dead branches, not just defoliated branches as with other conifer species See Figure 3
FOLIAGE	Elytroderma needle cast systemic infection	<ul style="list-style-type: none"> The top 2/3's of the tree is affected and the growth is clearly stunted. 	Pl, Py	Elytroderma needle cast DFE	Note: To confirm infection the surveyor must observe signs of the pathogen as small dark streaks on dead foliage
STEM OR BRANCH	Dwarf mistletoe infection	<ul style="list-style-type: none"> Any layer 1 and 2 tree with a Hawksworth rating >3 (Figure 4). any infection occurs on the stem or a live branch of layer 3 trees. a susceptible tree is located within 2 times the height of the infection on an overtopping tree, which is infected with dwarf mistletoe. 	Hw, Pl, Lw, Fd	Douglas-fir dwarf mistletoe DMF, hemlock dwarf mistletoe DMH, larch dwarf mistletoe DML, lodgepole pine dwarf mistletoe DMP,	<p>Note: To confirm infection, the surveyor must observe mistletoe aerial shoots or basal cups on regeneration or on live or dead fallen brooms.</p> <p>Overtopping tree is a tree that is in an overtopping layer.</p>

LOCATION OF DAMAGE	TYPE OF DAMAGE	TREE BEING ASSESSED IS UNACCEPTABLE IF:	HOST SPECIES	LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES	COMMENTS
ROOTS	Root disease	<ul style="list-style-type: none"> sign(s) or a definitive combination of symptoms of root disease are observed. 	All	armillaria root disease DRA, blackstain root disease DRB laminated root rot DRL, annosus root disease DRN tomentosus root rot DRT,	<p>Signs are direct evidence of the pathogenic fungus including fruiting bodies, distinctive mycelium or rhizomorphs. Symptoms include foliar chlorosis or thinning, pronounced resin flow near the root collar, reduced recent leader growth, a distress cone crop, and wood decay or stain. An individual symptom is not sufficient to identify a root disease.</p>
		<ul style="list-style-type: none"> infected tree found in plot. See comments for well-spaced tree net down calculation. The multiplier for all root disease infected trees is 1. The well-spaced tree that is netted down is the susceptible species that is closest to the infected tree. Note that the WS tree that is netted down may vary depending on the species acceptability rules being followed, those currently used or those used at the time of declaration. 	All	armillaria root disease DRA,	<p>Note: All conifer species are considered susceptible. All broadleaf species are considered not susceptible for survey purposes only.</p>
		Fd, Bg,Hw,Sx, Se, Lw	laminated root rot DRL.	<p>Note: Cw, PI, Pw, Py, and all broadleaf species are considered not susceptible for survey purposes only.</p>	
		Fd, PI, Pw, Sx	black stain root disease DRB.	<p>Note: All other conifers and broadleaf species are considered not susceptible for survey purposes only</p>	
		Se, Sx, Fd, PI	tomentosus root rot DRT.	<p>Note: Bg, Bl, Cw, Cy, Pw, Py, and all broadleaf species are considered not susceptible for survey purposes only.</p>	
Ba, Hw, Ss, Fd	annosus root rot DRN	<p>Note: Cw, Cy, Pw, PI, Py, and all broadleaf species are considered not susceptible for survey purposes only.</p>			
					<p>Example: How to apply net down for all root diseases. If root disease-infected trees are found in the plot: 1. In the first sweep, determine the total number of healthy, well-spaced trees using the prescribed minimum inter-tree distance (MITD) (e.g., 12 trees); 2. In a second independent sweep, determine the number of well-spaced infected trees using MITD (e.g., 1 infected tree); 3. From the number of susceptible healthy well-spaced trees found in step 1, subtract the number of well spaced infected trees. The result (e.g., 11 trees) is the adjusted number of healthy, well-spaced trees tallied for the plot.</p>

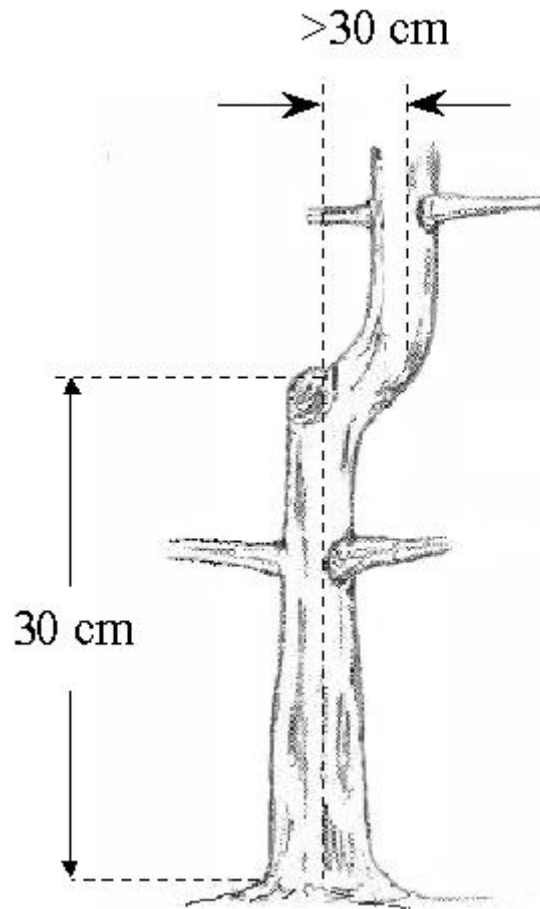


Figure 1. Determining horizontal displacement when assessing stem deformation. This is only done when the tree has five seasons' growth after damage occurs.

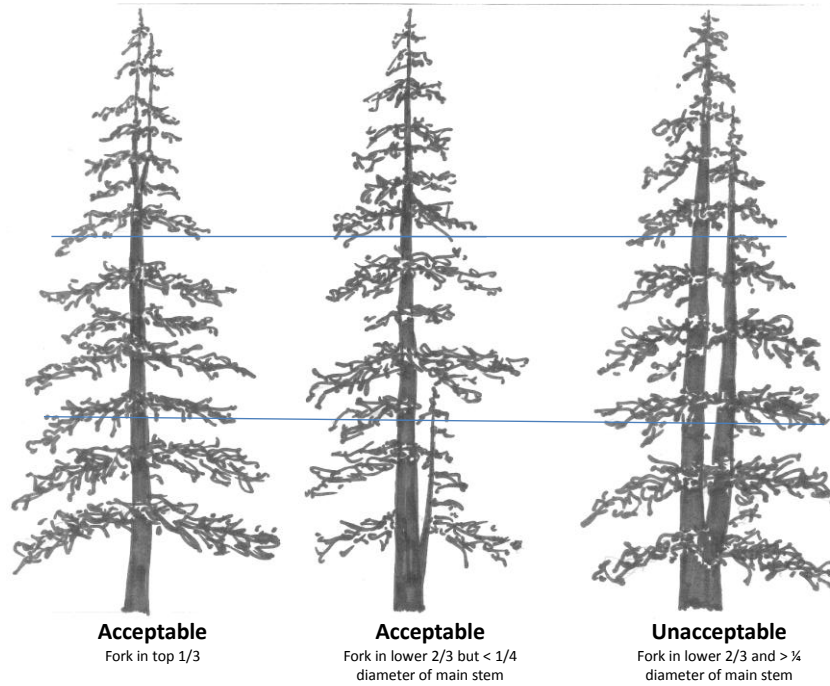


Figure 2. Acceptable and unacceptable forking in age class 2 & 3 conifers (damage code K).

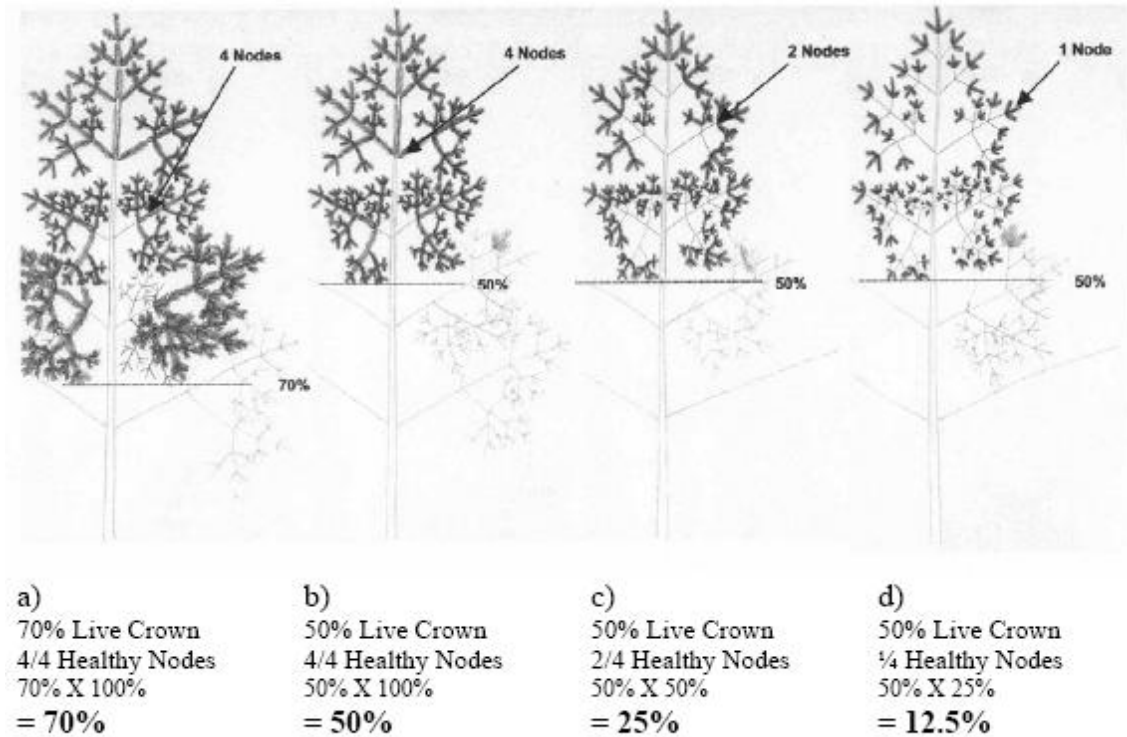


Figure 3. Calculating defoliation for Dothistroma-afflicted conifers.

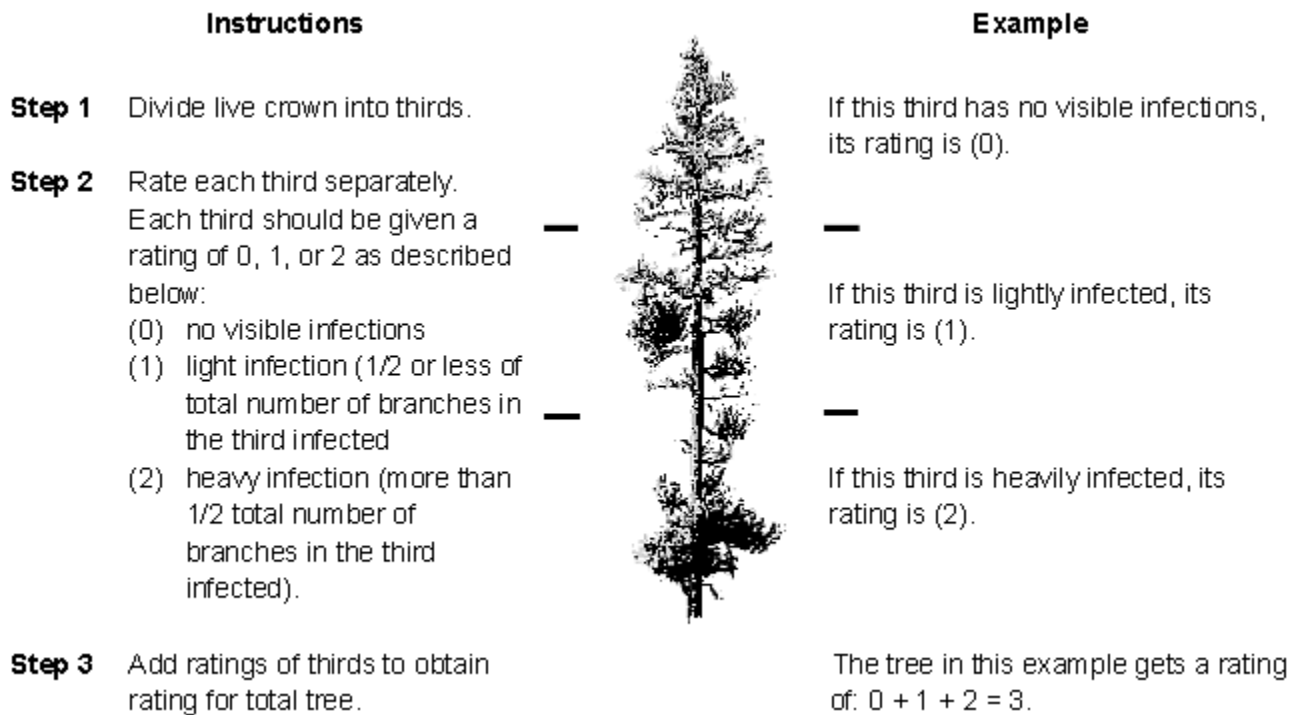


Figure 4. The Hawksworth six-class dwarf mistletoe rating system.

Definitions

basal resinosis (pitching): copious exudation of pitch at the base of the stem at or below the root collar. This symptom often is associated with armillaria root disease or attack by Warren's root collar weevil.

decay: the disintegration of plant tissue. The process by which sound wood is decomposed by the action of wood-destroying fungi and other microorganisms.

fork: two or more leaders have originated from the loss of a leader or apical shoot. At free-growing age, a fork is considered persistent if it has not differentiated in height between competing leaders by more than 5 cm after five years of growth since the leader damage occurred. Forks may provide entry points for decay fungi, are points of weakness during felling, and may create waste in the highest value first log.

gall: nodule or lump of malformed bark or woody material caused by a variety of damaging agents, such as western gall rust and some insects.

gouting: excessive swelling of a branch or shoot, often accompanied by misshapen needles and buds. Most common at nodes on branches and frequently caused by balsam woolly adelgid on true firs (*Abies* spp).

Height to diameter ratio: height in meters divided by dbh in meters.

infection: characterized by a lesion or canker on stem or branches or by swelling around the entrance point of a pathogen.

injury: damage to a tree by a biological, physical or chemical agent.

scar: a wound completely healed-over by callus tissue

wound: an injury where cambium is dead (e.g., sunscald) or completely removed. Wounds often serve as entry points for decay fungi

Appendix 3.

Examples of original free-growing survey map and pre-survey SDM polygon with plot placements provided.

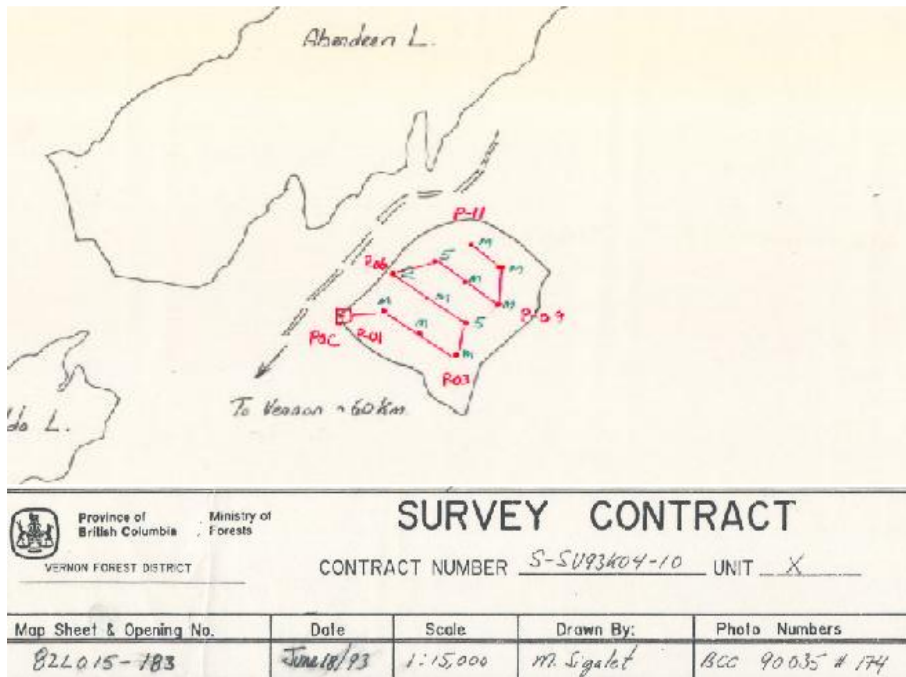


Figure 7. Original survey map with plot locations.

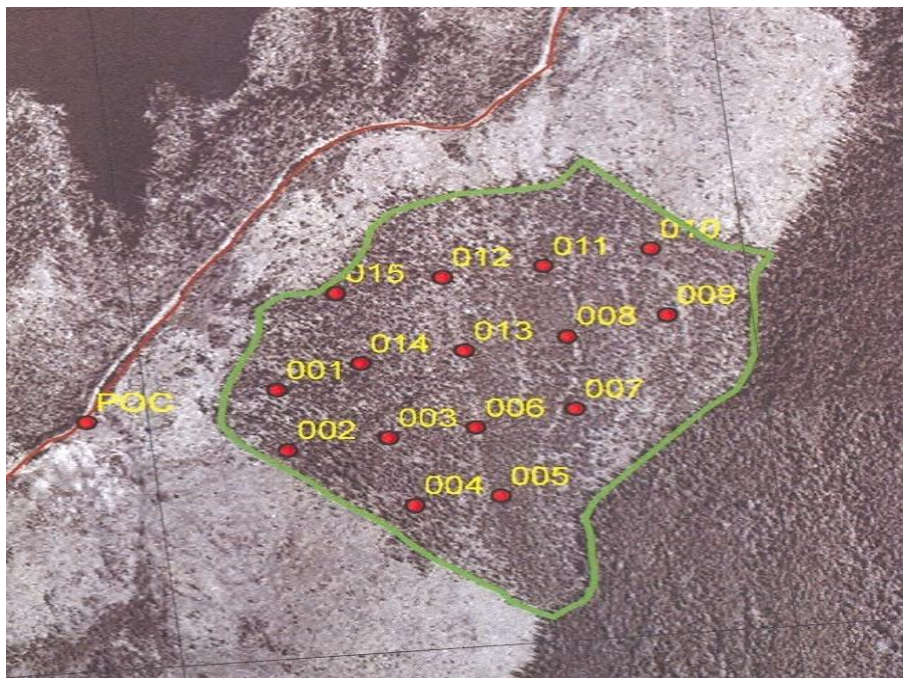


Figure 8. Air photo of survey polygon with plots identified.

Appendix 4.

Inventory Label Background:

We produce inventory labels to concisely describe a few of the more important characteristics of the strata we survey. It is important to recognise an inventory label is a very general description. As such there are a number of liberties taking in the generalization of a very complex young forest into a rudimentary string of numbers and letters. Some surveyors may wish to collect data in a manner different than the methods described below. The inventory label data will be transferred to central Ministry of Forests and Range database. It becomes important that the data be recorded in a consistent manner in order to allow subsequent analysis.

As silviculture surveyors we receive our guidance on the creation of inventory labels from the Ministry of Forests and Range, Forest Analysis and Inventory Branch. The methods described below are considered their second most representative data source. Permanent sample plots are the only superior data source. The label describes “commercial” tree species. For the purpose of creating inventory labels the list of species considered “commercial” can be found in the reference RESULTS tree species codes and the FS 660.

Inventory labels are determined through a combination of visual observations and individual tree measurements from within the stratum. The estimates and measurements are periodically recorded on the FS 658 plot card. Collect at least three sets of observations or approximately one per four plots established to represent each stratum. These will be “roughly” averaged, (mathematically averaged **and** manually adjusted as the surveyor sees fit to best describe the stratum) and combined with data from other sources to generate an inventory label for the stratum.

Species composition is determined by ocular estimate. This method of visual observations is known to be most directly comparable to the methods by Forest Analysis and Inventory Branch on mature stands. The leading and second species should be determined during the walk-through stage of the survey process. The determination of species composition is based on tree density for young stands. Volume is used once merchantable volume is present. Merchantable volume, for this purpose, is considered trees with a dbh of 12.5 cm and greater. In practice this means species composition is based on volume only for layer 1 in multi-story surveys. All the rest are based on visually estimated tree density.

An important expression of the generality of the inventory label can be seen in the requirement for species composition to be rounded to the nearest 10% and expressed as a single digit, e.g. 40% = 4. The combination of all species must sum to 100% or 10.

Inexperienced surveyors often over estimate the minor species present. They also under estimate the proportion represented by small trees that may be visually obscured by larger trees. This is most common where dense layers of shade tolerant species naturally regenerate under the partial shade of larger and older planted trees. Age and height are recorded to the last completed year's growth.