

Ministry of Forests, Lands and Natural Resource Operations

Stand Development Monitoring Protocol

Field and Office Procedures for Stand Development Monitoring Surveys



SDM Technical Committee
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Introduction

The Forest and Range Evaluation Program (FREP) is a long-term commitment by government, under the *Forest and Range Practices Act* (FRPA), to:

1. Assess the effectiveness of forest and range legislation in achieving stewardship objectives;
2. Determine whether forest and range practices are achieving government's objectives, with a focus on biological function and social values;
3. Identify forest and range resource value status and trends; and
4. Identify opportunities for continued improvement of British Columbia's forest and range practices, policies and legislation.

To accomplish this, specific evaluation tools – such as Stand Development Monitoring (SDM) – have been developed by technical experts from ministry, industry, academia and other agencies, and then implemented by ministry field staff. SDM is specifically aimed at supporting monitoring of the FRPA Timber Value.

One major component of forest management policy in British Columbia (BC) is the obligation to achieve “free-growing” (FG) status for harvested stands within 20 years. The standards and practices associated with achieving this legal milestone require licensees to prepare and submit stocking standards within a Forest Stewardship Plan (FSP). 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. Stands that are declared free growing are assumed to be sufficiently stocked with ecologically suitable tree species and free of immediate and long-term forest health issues. In order to determine whether these young stands are meeting the timber objectives set by government, it is critical to assess their mid-rotation condition.

The SDM survey has been designed to assess the health and productivity of young stands between the ages of 20 and 40 years. Stands in this age range will have typically achieved the FG milestone, and are assumed to remain in that healthy well-stocked condition. Key information coming from these stands through a combined analysis of early silviculture records and current SDM data, will provide valuable input into both silviculture and inventory policy and 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 and well-spaced (WS) stems per hectare), stand species composition (inventory and silviculture labels), stand health (incidence of pests), stand basal area and site index. SDM data can be used to track how stand attributes change in managed forests.

SDM data can be used to support revision of standards associated with current policy and practices. Such adaptive management techniques will be essential under changing legislative and environmental conditions.

Objectives of Stand Development Monitoring

There are three 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 questions on stand health, productivity, and the effectiveness of policies and practices in sustainably managing timber resources.

The key objectives of SDM are to:

- A. Assess the health and productivity of young stands;
- B. Review the effectiveness of government standards, policies and forest management practices that govern stand initiation, resource sustainability and risk to the Crown; and
- C. Develop and maintain Ministry expertise regarding the health and productivity of managed stands in all Timber Supply Areas (TSAs).

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 and well-spaced (WS) tree densities;
- DBH of all trees ≥ 7.5 cm in diameter and heights of a subset of these trees;
- Pest incidence, including live and dead trees;
- Current stand basal areas of live and dead trees;
- Current estimated site index.

Some optional indicators include:

- Silviculture label based on preferred and acceptable tree species;
- WS density of preferred and acceptable tree species;
- Stand management planting and tending treatment history;
- Current diameter class distributions; and
- BEC classification (to the variant).

SDM Survey Skills

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

- Ability to identify tree species and plants (especially indicator plants);
- Ability to identify damaging insects, diseases and other causes of tree damage; and
- Knowledge of plot establishment and stand attribute measurement procedures and objectives and proficiency with the techniques of taking basic forest measurements.

- 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.

What SDM Isn't

Although this protocol is designed to measure stands aged 20-40 years, and part of the survey measures key stand attributes identical to those collected at 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 legal silviculture reforestation obligation. SDM is not intended as a tool to evaluate licensee performance in meeting their legal obligations. This protocol can, however, provide feedback to forest managers on how well their site plans and Forest Stewardship Plans have been implemented over the mid-term.

SDM damage criteria

Specific SDM damage criteria (Appendix 2) have been developed for stands aged 21-60 years (age class 2 and 3) that are generally more lenient than the 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. It is recommended that the SDM damage criteria be adopted for use in assessing all stands aged 21-60 years for unacceptable levels of tree damage.

Preferred and acceptable species

Trees are still tallied both with and without the original preferred and acceptable designations under this protocol. The efficacy of previous species preferences and stocking standards can be assessed by comparing current SDM stocking levels to the FG or earlier survey values, provided trees are also tallied following the preferred and acceptable designations originally. Also, for SDM whether a tree was designated as an acceptable conifer species at the time of declaration or earlier survey is considered of less importance today, particularly in light of our changing environment.

Broadleaf species

Stands managed primarily for broadleaf species as crop trees (rather than as incidental components of a stand) should be excluded from SDM at this time. Commercial broadleaf species occurring as incidental components of a stand though are quite acceptable in surveyed polygons even where they are the majority component.

Defining the Population

The sample unit for SDM is the inventory polygon. SDM derives its potential samples from the population of managed stands (polygons) stored in the REporting Silviculture Updates and Land

status Tracking System (RESULTS) database. This database stores all the managed polygons in the province with a silviculture or disturbance history. A list of all the potential even-aged sample polygons with stand ages from 20-40 years old and ≥ 5 ha in area are extracted from RESULTS for every TSA in the province. This TSA Master List may be reconstituted every five years to incorporate new polygons that meet the minimum age requirement and to discard polygons that are too old.

The current focus is limited to those polygons ≥ 5 ha in area so that the 10 plot sample design adequately covers the area without plots overlapping and does not waste effort oversampling a small area without a corresponding improvement to the data collected. It has been found that even with eliminating a large proportion of smaller polygons, about 95% or more of the area of interest within a TSA is captured without diluting sampling effort. An additional filter is applied to the sample population by removing polygons disturbed (harvested) prior to 1975 or that fall within a TFL, park or protected area, or other area deleted from the timber harvesting land base (THLB).

From the filtered TSA Master List a TSA Randomized Polygon Sample List is created. This is a list of 75 polygons that have been drawn randomly from the TSA Master List and provides the pool of potential polygons to be surveyed within a TSA over the next five years. This Sample List is provided to a district for each TSA it administers and can be used to create individual SDM TSA sampling plans. Reasons for rejecting individual candidate polygons from selection for surveying are covered later in this protocol.

Principles of Polygon Selection

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

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

Polygon Selection from the TSA Randomized Sample Polygon List

Each TSA has a list of randomly-selected inventory polygons drawn from the TSA Master List provided by RESULTS. These TSA Randomized Polygon Sample Lists are located on the FREP SharePoint site at: [SDM TSA Sample Lists](#)

The district(s) that administer a TSA (or portion of a TSA) receive a TSA Randomized Polygon Sample List for each TSA (or portion thereof) that lists 75 candidate polygons randomly

extracted from the TSA Master List (see Figure 1). Of these polygons the first 30 are highlighted as the proposed initial sample for that TSA (or portion thereof) for the next 5 years (or until the next Master List is created). More than 30 polygons can be surveyed but the minimum target required before reporting SDM results for a TSA is 30 polygons.

While the first coarse filtering may remove many unsuitable polygons from the potential sample population, further screening of the initial 30 sample polygons may identify additional factors that may be grounds to reject or defer a selected polygon. The following is a detailed list of reasons to reject or defer candidate polygons from an SDM survey that may only become apparent from searching through the History Record, other administrative data or from local knowledge. Remember that **the reason for each rejection or deferment must be documented and submitted annually** with the surveyed polygon data.

Reasons to Reject or Defer Sample Polygons

1. **Safety:** If a polygon is not safe to access or traverse in the course of surveying (e.g., due to slope instability), then it may be rejected. If the safety issue is temporary (e.g., wildlife, wildfire), then the stand may be deferred until the issue is resolved. Access cost is not a reason to reject a polygon.
2. **Uneven-aged:** If a polygon has mature residual trees that contribute $>5 \text{ m}^2/\text{ha}$ of basal area, then the polygon is considered to be uneven-aged and should be rejected. SDM is not designed for use in uneven-aged stands. FREP has a specific protocol for assessing partial cutting and uneven-aged managed stands with dispersed retention.
3. **Average age:** If the average age of trees in the polygon is <20 years, then defer the survey until the average age is 20 years or more. Surveying stands too early increases uncertainty as to future stand development and does not leave enough time for potential forest health impacts to manifest.
4. **Free-growing or prior SDM survey:** If a FG survey (not necessarily a FG declaration) or a prior SDM survey has been completed and reported in RESULTS (i.e., the pre-SDM data is from this survey) 10 growing seasons or less from the new SDM survey year, then that polygon should be deferred until sufficient time has passed. In order to establish trends it is important that the sample periods for visiting stands be sufficiently separated in time for measureable change to occur to stand attributes.
5. **Silviculture activities:** If a polygon has undergone a silviculture treatment (e.g., thinning, pruning, fertilization, etc) that can affect stand development within the prior 8 growing seasons of the SDM survey year, then the polygon should be deferred until the sufficient time has passed.
6. **Broadleaf management:** If a stand is managed primarily for the benefit of broadleaf species (e.g., maple coppice, hybrid poplar plantation, etc) and those species are the desired crop trees, then SDM should not be performed on the stand. Broadleaf species as incidental components of the stand though are quite acceptable in SDM polygons even where they are the majority component.
7. **Polygon fragmentation:** If a polygon is not contiguous but rather consists of more than two or three parts and a number of these parts are small ($<1 \text{ ha}$) and scattered, then consider rejecting the polygon. Polygons that are fragmented mainly by typing out of

roads should not be rejected. Polygons that are obviously a result of mapping artefacts (e.g., treatment buffers that were accidentally mapped as separate units) should be rejected since they are not representative.

8. **Wildfire and other disturbance:** If a polygon, or a significant portion of a polygon, has been destroyed due to a recent wildfire, then the polygon may be rejected from the sample. Damage from wildfires or other disturbance is typically typed out and therefore can significantly change the original polygon attributes making comparisons in time difficult. The key is that the disturbance must be typed out. If, for example, a landslide occurs within the polygon but is not typed out as a separate unit (i.e., NP), then the disturbance is an accepted part of the polygon and the polygon should not be rejected. Sample plots should be placed as if the disturbance is not present. If sample plots fall in a disturbed area with no viable trees then that is what is recorded on the field card.
9. **FFT (and LBIS) FG declarations:** Work by FFT on openings that contain potential survey polygons can interfere with SDM, especially if spatial data references are changed. If an opening containing an SDM candidate polygon has had a FG survey done by FFT, then there is no reason to conduct a SDM survey (see #4). If in declaring an opening FG, the FFT survey altered or amalgamated previous polygons, it may not be possible to conduct future SDM surveys in this opening unless the polygon boundaries can be re-established to the corresponding stand data. To avoid such problems, districts should endeavour to match potential SDM polygons with future FFT openings so as to not duplicate effort or produce survey results that will void SDM work. As such, where possible, it is recommended that SDM surveys be conducted prior to, or in place of, FFT surveys.

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

Allow sufficient time to sample all of the polygons chosen for a year. It is expected that districts will continue to sample stands beyond the required minimum in order to provide more comprehensive input into management practices and future timber supply reviews.

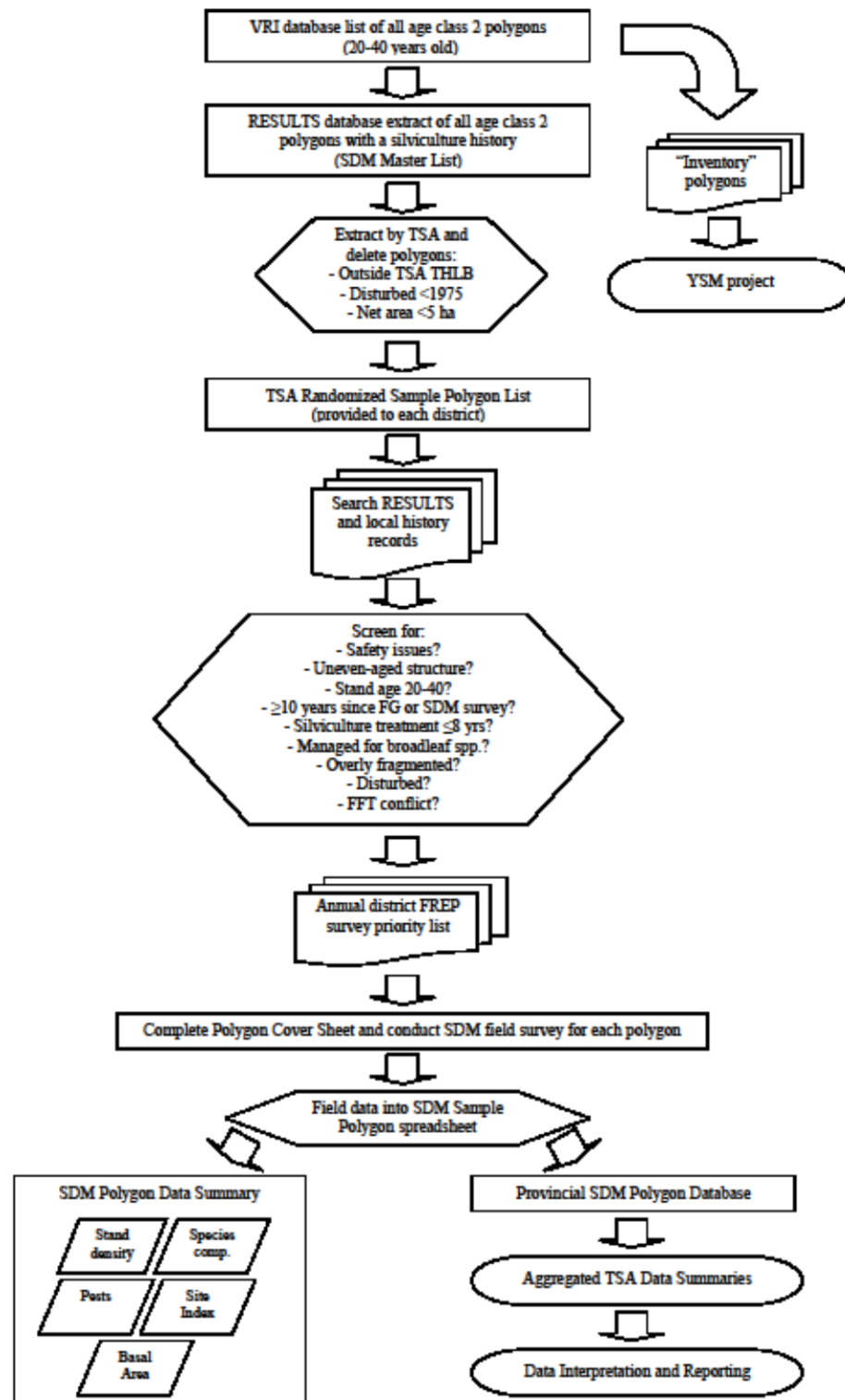


Figure 1. A flowchart of the polygon selection and data compilation process.

Getting Started: Planning for office and field

Planning and documentation (office)

Thorough planning of a season's SDM activities prior to field work is crucial. Candidate sample polygons need to be researched using information from both electronic databases (e.g., RESULTS) and paper opening files (history record) information. Some information is crucial to ensuring that the polygon to be surveyed for SDM is exactly the same area that was surveyed or identified previously for free-growing or another silviculture survey. Do not confuse polygons with Standard Units (SU) or other area identifiers. Some mandatory information is required in order to accurately track pre-SDM, current SDM and, eventually, future SDM data to ensure it all relates to the same piece of ground.

This required pre-survey information should be entered into the Polygon Cover Sheet of the SDM Polygon Data Summary spreadsheet (see Figure 2). This cover sheet can also hold desired information on previous polygon attributes like identifying features, tree densities, species preferences, silviculture and inventory labels, pest incidence and past silviculture activities. Optional information on planting and regeneration history can also be added if it is handy.

SDM Polygon Data Summary v2a (2013-5-27)

2013 Stand Development Monitoring - Polygon Cover Sheet
(completed during office review of onsite files and RESULTS database information)

Last saved on: 2013-12-05

REQUIRED INFORMATION										TSA:	
Mapsheet Identifier*						District:					
Mapsheet		Submapsheet		Opening		Polygon**		Location:			
Opening ID:				Polygon NAR:				BEC:			
FC ID:***				Disturbance Yr:				Year Declared FG:			

DESIRABLE INFORMATION FROM MOST RECENT PRIOR SURVEY														
Most Recent Survey:					FG					If not FG, describe type:				
Method of Survey:					MITD: 2					M-value:				
Year of Survey:					MSS:					TSS:				
Total Tree Density:					Top Height #:					Top Height Species:				
Total Conifers:					Preferred Spp. (Orig):					Min. Ht.				
Total Well-spaced Density†:					Acceptable Spp. (Orig):					Min. Ht.				
Well-spaced Density (M):														
Free-growing Density (M):														

SILVICULTURE LABEL										Minor Spp.	
Ldg Spp		Age		Ht(m)		%		%		%	
%		%		%		%		%		%	

TOP 3 FOREST HEALTH FACTORS											
FHR											
%											

INVENTORY LABEL										Minor Spp.		Total Density		Site Index		SI Source		Crown Closure		Reference Year	
Ldg Spp		Age		Ht(m)		2 nd Spp		%		Age		Ht(m)		%		%		%		%	
%		%		%		%		%		%		%		%		%		%		%	

SILVICULTURE TREATMENTS											
YEAR											
ACTIVITY											

OPTIONAL INFORMATION									
Previous Survey Information: If pre-SDM survey information is available then please fill in the following fields. Ensure that the actual activity area matches the current polygon area.									
IF POLYGON WAS PLANTED									
How many times?									
If available, provide info for last planting									
Year Planted:									
Total Trees Planted:									
Area Planted:									
Species:									
Stock Age:									
REGENERATION SURVEY									
Year Surveyed:									
Total Density:									
Inventory Label:									
Silviculture Label:									
Well-spaced Density:									
Site Index:									

DP: SDM Pre-SDM

Data input by:

SDM Surveyors:

NOTES:

* Keep Mapsheet Identifier split into three groups with leading zeros and no dashes - along with polygon this is the main identifier for the polygon.
** This polygon identifier MUST match the 'SILV_POLYGON_ID' entry from the random sample population list for the TSA.
*** Refers to FOREST_COVER_ID field in TSA random sample list or from FOR ID in Opening Details Reports. This number is unique to a polygon.
† Total Well-spaced Density is the well-spaced tree count before capping by M-value, while Well-spaced Density is capped. Free-growing density is capped.
‡ This is the maximum tree height used to determine site index using the growth intercept method. This can be an average. Include the associated tree species in the next field.

Figure 2. Example of the SDM Polygon Cover Sheet.

The more information provided in the cover sheet the easier it will be to see a full history of the polygon and to create useful comparisons between past and present values for various

stand attributes. 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 stocking standards or earlier silviculture survey and should be noted. If a MITD was not identified at declaration it is assumed to be 2.0 m, and missing M-values are assumed to be 6 in the interior and 4.5 on the coast, but check these M-values against the Target Stocking Standard (TSS). Recording all relevant information about a polygon prior to going out into the field can help reduce confusion later.

Office Procedures

- Obtain the TSA Randomized Sample Polygon List (from FREP SharePoint site).
- Pull all electronic and paper files for the first 30 polygons on the TSA list starting from the top (paper files maybe off site).
- Review opening file and RESULTS information to ensure each polygon is a candidate for sampling (e.g., meets the polygon selection criteria) and to collect pre-SDM survey information. Ensure that you can match the SDM polygon with the exact same area sampled previously during a FG or other previous survey. Do not assume that current SU and polygon IDs refer to the exact same areas.
- Create your district SDM survey list of viable polygons that you will survey over the next 2-3 years. Be sure to document why any polygons are rejected or deferred.
- Check recent orthophoto or satellite images and confirm that there are no complicating factors (e.g., disturbances) that would compromise the use of the polygon for sampling.
- Use the most recent version of the SDM Polygon Summary Spreadsheet (from the FREP SharePoint site) to record all pre-SDM survey data relevant to the sample polygon as well as the plot card data after collection.
- Using either ARC GIS or Mapview, create maps at 1:5,000 to 10,000 scale for survey planning purposes and a larger scale map for access purposes.
- Selection of the SDM plot locations for each individual polygon is best done 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 fall within the polygon boundary *except* those that are in areas excluded from the NAR (roads, landings, water bodies, etc.). Randomly select 10 points, plus one extra, 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. Downloading these plot co-ordinates into a GPS unit in the office is an effective way to save time and avoid plot selection bias on field days.
- As the plot locations are pre-determined, the location of the point of commencement (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 plot 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 (see Figure 6) for each plot with the relevant header information filled in.
- Complete your district SDM survey list that identifies all your target polygons for the current field season.

Plan the entire field season in advance, keeping in mind the seasonality of forest health issues, which can optimize forest health insect and disease identification.

Creating Survey Polygon Maps

In order to isolate or locate the correct polygon using ArcGIS or MapView it is important to refer to a hardcopy map from the opening file that indicates the location, shape and attributes of the specific candidate polygon identified for surveying (see Figure 3). The map in RESULTS (if there is one) is usually less than helpful; avoid using it for locating plot points. Since we want to compare current stand attributes to those recorded in the previous silviculture survey, it is important to ensure that you are surveying that exact same area.

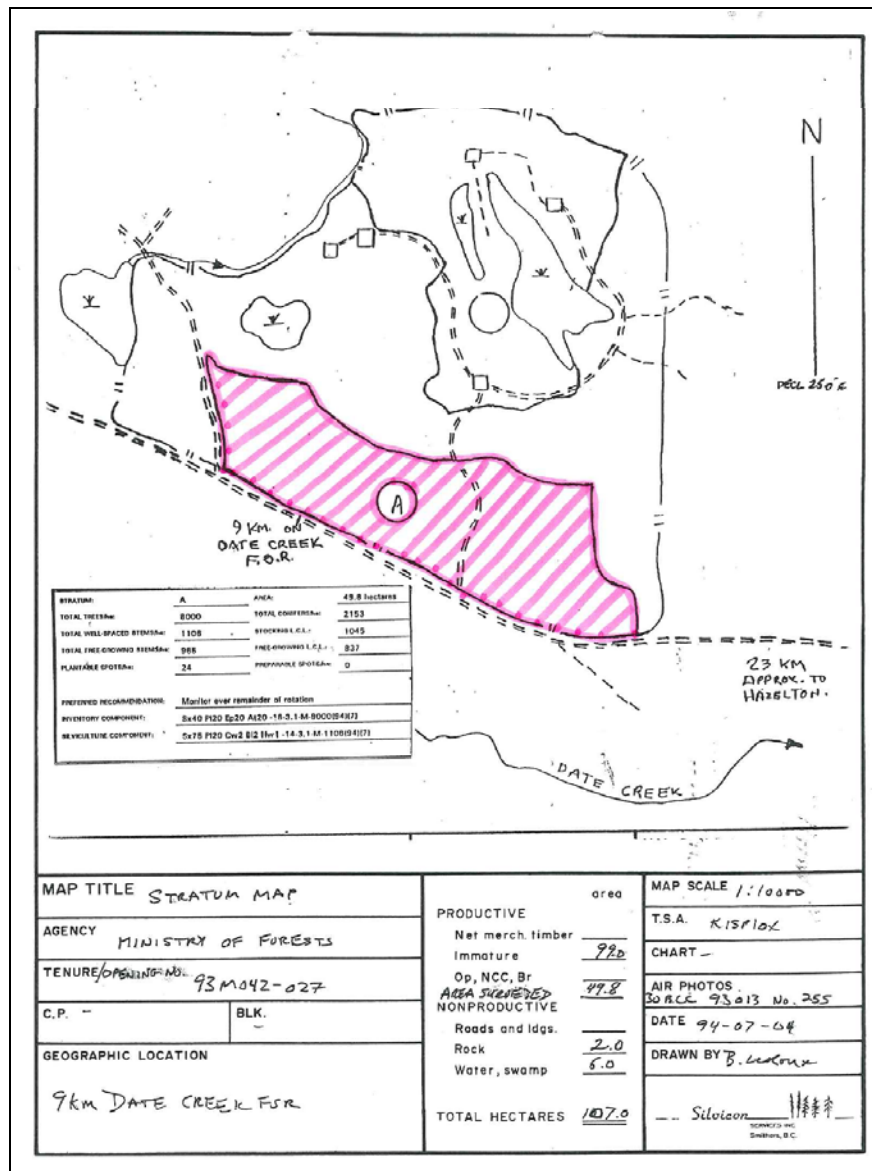


Figure 3. Example of an opening file map showing roads, opening boundaries and delineated interior polygons. The SDM sample polygon is indicated in pink

It is best to use ArcGIS to create the plot maps. The forest cover layer is very large and you should not turn it on until you are zoomed in to the block level.

1. Add the 1:20,000 mapsheet grid and zoom to the mapsheet in question (e.g., "93M042"):
 - Layer Library -> Base Maps -> 20K_Mapsheet_Grid.lyr
2. Add the appropriate orthophoto for this mapsheet. The fastest way to do this is by using the *ortho_finder.mde* Access data file, which tells you where to look for specific

ortho photos on the ArcGIS network. You may need more than one photo if your block straddles a mapsheet boundary. Always use the most recent photo series.

- On most workstations, this will be set as the *O:\ -> airborne-> ortho_tiles -> **
3. Use the opening file map line work to locate your block on the orthophoto and zoom in to about 1:5,000, depending on the polygon size. A one-page (8.5"x11") map is usually sufficient for field use.
 4. Add the LRDW forest cover layer:
 - LRDW.sde -> *WHSE_FOREST_VEGETATION.VEG_COMP_LYR_L1_POLY*
 5. Add the 100m x 100m grid (or 50 m x 50 m grid if the polygon <10 ha). There are several ways to do this, for example:
 - Right-click on the map and select "Properties".
 - Select the "Grids" tab, select "New Grid..." and work through the "Grids and Graticules Wizard" to overlay a georeferenced grid:
 - i. Select "Measured Grid", click "Next".
 - ii. Select "Grid and Labels" and set the style (colour, weight) of your grid lines. Set the "Intervals" (x-axis and y-axis) both to 100m, click "Next".
 - iii. Click "next" again.
 - iv. In the "Grid Properties" box, select "Store as a fixed grid that updates with changes...", and then click "Finish".
 - v. "Measured Grid" should now show up in the grids menu, once you click "apply" it can be added to your map. You should only have to do this process once, and in the future the grid will be available to add to any map you create. The grid, along with UTM coordinate labels should now appear on your map.
 6. Add any titles, scale bars, north arrows, text, etc, that you require and print your map. (see Figure 4).
 7. Arbitrarily number all the grid intersections that fall within the polygon boundary. Include any intersections that fall on, or near to, the boundary because sometimes the Forest Cover Layer linework and orthophoto are not perfectly aligned. Randomly select ten intersections and one spare (the 11th plot) (see Figure 5).
 8. Number the plots 1-11 and enter their corresponding UTM coordinates into your GPS unit. Only use the 11th plot if one of the 10 selected plots is unsuitable according to the SDM protocol.
 9. Give yourself a high-five, GIS is fun!

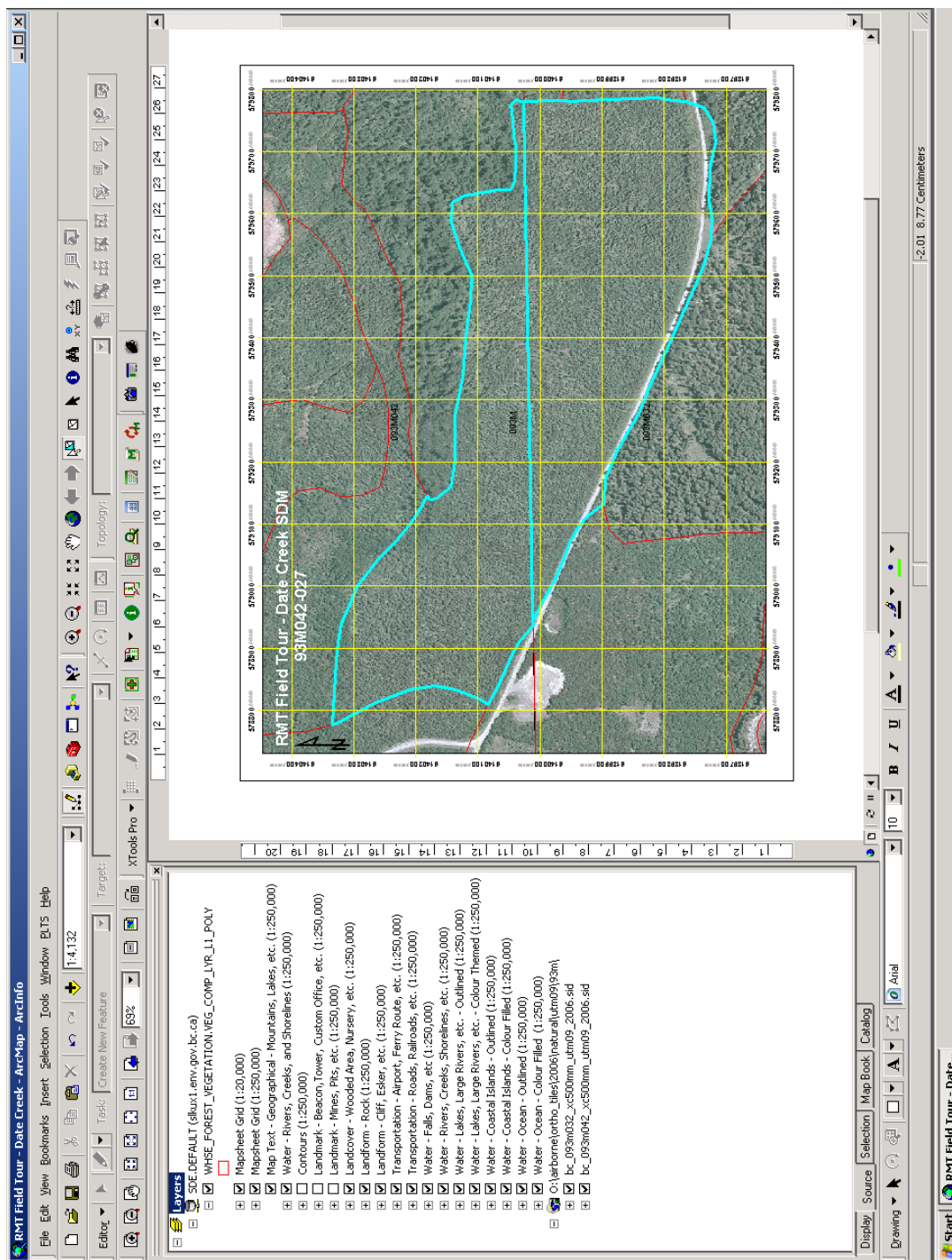


Figure 4. An ArcGIS screen shot showing grid overlay on orthophoto, including forest cover line work. Notice how the apparent outline of the polygon in question doesn't exactly align with the forest cover line work – making it very important to not discard/disqualify selected plots until you identify them in the field.

Figure 5 is a scan of a field-ready polygon map, showing the arbitrarily numbered grid intersections and the 10 randomly-selected plots (plus 1 spare) that will be sampled in the field. Enter the plot numbers on the field cards and do not change the plot numbers on the worksheet tabs in the Polygon Data Summary spreadsheet.

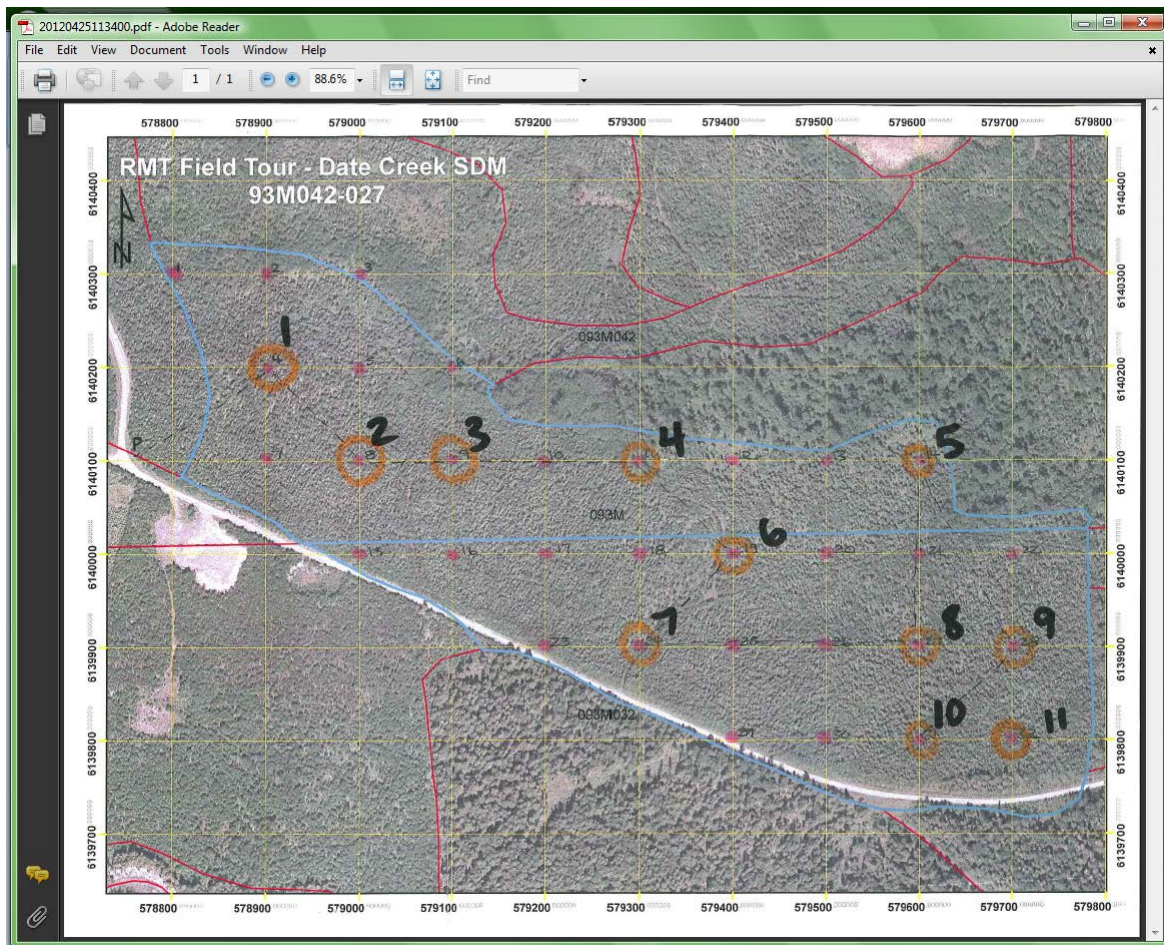


Figure 5. Completed polygon map in ArcGIS with 100 m sample grid overlay.

Office checklist for the SDM protocol	Done	Reviewed
1. Obtain TSA Randomized Sample Polygon List (from SharePoint site).		
2. Select polygons systematically from the top of the TSA list to fulfill your project objective.		
3. Obtain opening summaries from RESULTS and examine opening files for silviculture survey data and stand history for each candidate sample polygon.		
4. Confirm sample suitability for polygons. Document why polygons were rejected or deferred (include re-schedule date). Create your annual survey work list.		
5. Record pre-SDM required, desirable and optional information on SDM Polygon Summary Spreadsheet Cover Sheet.		
6. Obtain photos and create polygon map for survey planning (Ensure the map includes the 10 + 1 extra plot centre points). Input plot center co-ordinates into a GPS unit, if desired.		
7. Determine accessibility options and set survey schedule for the coming field season.		
8. Obtain all the necessary training and field guides that will ensure accurate data collection in the field.		
9. Prepare field cards (FS 1357) and survey gear.		
10. Conduct field surveys.		
11. Conduct quality control checks on field survey methods, plot data and field cards.		
12. Enter data into SDM spreadsheets and obtain calculated stand values from the SDM Polygon Summary worksheet.		
13. Submit polygon spreadsheets, supporting information (e.g., maps and scanned field cards) to SDM SharePoint site.		
14. Optional: Update activities in RESULTS and attach relevant files.		

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 iPad app	
Orthophoto or map with predetermined sampling lines and plot locations	
GPS unit (for polygon location and navigating to plot points)	
Metal stakes (<50cm) to permanently identify plot centers (optional)	
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 field supplement including damage criteria	
Pest Management (or other coloured) flagging ribbon	
Spray paint for tree and quadrant marking (optional)	
Increment borer (plus spare)	
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, boundaries, access, plot placement, etc.

Field data collection for each polygon:

1. When starting the field survey, create a POC and mark with flagging ribbon as “SDM” with the date, surveyor’s initials and distance and bearing to the first plot. Plots do not have to be surveyed in numeric order but rather in the most efficient order. Note the location of the POC. Record all data on the FS 1357 field card (see Figure 6. Sample of FS 1357 (2013/12) field card.).
2. Use the 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 free-growing or other silviculture survey so that current results can be compared to that prior assessment.** If GPS reception is unsuitable or unattainable, navigate to the plot location using physical methods (i.e. hip chain) so long as the plot center location is not biased.
3. Mark each 3.99 m plot center (use of a metal stake is optional) with flagging ribbon (include plot number, date and surveyor initials). Record a GPS point for the plot centre.

Plot centre offsets may be used if a plot centre happens to land (or would land) in an area that is unsafe to survey (i.e., move plot back 10 m because plot center was at the edge of a cliff). **Note: you can only offset once for a plot.** 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 or it has a large number of residual veteran stems) substitute the 11th (extra) plot. You must still end up with 10 plots for the polygon. If a plot lands in an area of the NAR that is permanently inaccessible and has not been typed out (e.g., beaver pond), record that plot as a “zero plot” and it counts toward your 10 plots. If the plot is only temporarily inaccessible, record that plot as a “null plot” and substitute the 11th (extra) plot to make up your 10 plots. The polygon summary is based on only 10 plots.

4. At plot centre and starting from a bearing of 0° (North), sweep clockwise and tally all live and dead conifer and commercial broadleaf trees ≥1.3 m in height by species and layer (1, 2 or 3). This tally includes live and both dead standing and dead downed trees although live and dead are tallied separately on the field card. Dead trees are used in calculations for damage agent incidence. Dead downed trees are to be tallied if their base/root-wad is within the plot.
5. During the same sweep, take the DBH measurements of all layer 1 and 2 trees (≥7.5 cm and ≥12.5 cm DBH, respectively) and enter them in the “Data Volume Trees” section of the field card along with whether the tree is live (L) or dead (D). DBH measurements are

to the nearest 0.1 cm. It is recommended that during this sweep, all trees ≥ 7.5 cm DBH (all layer 1 and 2 trees) be marked with ribbon or paint and numbered sequentially to match the numbers on the field card.

6. Along with the measurements recorded in the first sweep, assess each tree in the plot for damaging forest health factors and record by tree species and layer. **Only record damage agents that render the tree unacceptable according to the SDM damage criteria (see Appendix 2).** If a tree has more than one pest, record only the most severe damage or the agent most likely to cause mortality. 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 field card.
7. Using a second sweep, tally all well-spaced (mandatory) and free-growing (optional) trees using the original minimum inter-tree distance (MITD) noted in the stocking standards (default is 2.0 m). Like FG surveys, WS trees tallied in this sweep are selected on the basis of maximizing the count of trees captured as WS. Attempt to minimize the influence of ingress on WS counts at this stage. The only difference between WS and FG in this protocol is the achievement of the species respective minimum height (e.g., for lodgepole pine to be considered FG it must be ≥ 2 m yet it could be ≥ 1.3 m and still be tallied as WS). Field data are collected ignoring the M-value cap. The M-value cap will be applied during data analysis. It is helpful to mark the WS trees with a second colour of ribbon for visual reference.
8. In an optional third sweep, only the WS tree species based on the preferred and acceptable species stated in the original silviculture survey are tallied¹. **Note: This sweep is only necessary if the species acceptability standards at the time of the earlier silviculture survey were different from the current standard.** This sweep is important for a retrospective assessment and species acceptability criteria. Once again use the original MITD.
9. In order to determine which trees will be measured 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 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. If suitable trees are available a minimum of four tree heights should be recorded per plot.

¹ Refer to [Reference Guide for FDP Stocking Standards](#), (updated Jan. 17, 2014)

If a quadrant contains no trees that are ≥ 7.5 cm DBH (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 leading conifer species within a 5.64 m radius sweep. Sample the selected tree for site index criteria using the growth intercept method². If there is no healthy dominant conifer tree present in the 5.64 m radius plot, do not record site index data. Note: do not select a residual veteran tree as the site index tree (i.e., a veteran is defined as a living remnant of the former stand at least 40 years older and at least 10 m taller than the managed stand). 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 are measured for the leading species**. Take only one SI estimate per plot. It is preferred that Site Tools³ be used to generate the SI estimate from equations rather than from table extrapolations. Ensure that the estimate makes sense for this 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 trees tallied in the 10 plot sample will be derived following the survey.
12. Estimate and record the per cent crown closure (to the nearest 10%) at plot centre.
13. Be sure to total all tally columns in the “Totals” row at the top of each column and ensure that totals for pests recorded for WS and FG trees match the total live and dead trees tallied. In other words, make sure your numbers add up before leaving the plot.
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. This may help you recall details when entering plot data into the spreadsheet. In addition, photograph any anomalous situations that may require feedback from the SDM Team or the local forest health specialist.

² Growth intercept method for silviculture surveys. 1995. BC Ministry of Forests. Silviculture Practices Branch.

³ Site Tools can be downloaded here: http://www.for.gov.bc.ca/hts/growth/sitetools/sitetools_news.html.

Filling in the form

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

Stand Development Monitoring Field Card – FS 1357

Information to complete the header portion of the *Stand Development Monitoring Field Card (FS 1357)* (Figure 6) will generally be obtained from the opening file or RESULTS data summary for the opening. Information obtained during the office planning phase should be confirmed during the SDM survey (e.g., BEC unit).

 Ministry of Forests, Lands and Natural Resource Operations		STAND DEVELOPMENT MONITORING FIELD CARD		SURVEYOR NAME(S) 1		SURVEY DATE 2 1		PAGE OF 3	
MAPSHEET - OPENING NO. 4		POLYGON 5		LOCATION 6		DISTRICT 7		TSA 8	
POINT OF COMMENCEMENT/BEARING & DISTANCE TO THIS PLOT 10		UTM ZONE E 11 N		BEC 9					
PLOT NO. (158m) 12		MTD (ORIG) 13		FOREST HEALTH FACTORS 22		PREF/ACC. 27			
TREE SPP 15		LIVE TREES 16		LIVE CON. 17		DEAD TREES 18		DEAD CON. 19	
WS 20		FS 21		LIVE 23		DEAD 24		WS 25	
FS 26		ACCEPTABLE SPP (ORIG + min FS N.) 27		DATA VOLUME TREES L/D SPP DBH HT PUF 1 28 29 30 31 32 2 3 4 5 6 7 8 9 10 11 12 13 14		GROWTH INTERCEPT SAMPLE (5.64m) SPP 33 DBH TOT HT AGE @ 1.30 W EST NOTES: 34			
INVENTORY LABEL 35		1st Spp 36		2nd Spp 40		Minor Spp 44		Cr Cl	
% Age 37		% Age 38		% Age 39		% Age 41		% Age 42	
% Age 43		% Age 44		% Age 45		% Age 46			

Figure 6. Sample of FS 1357 (2013/12) field card.

Described on the following pages is a detailed description of the information to be recorded on the FS 1357 field card. To order FS 1357 field cards please contact Frank Barber (Frank.Barber@gov.bc.ca) or Jessie Fanucchi (Jessie.Fanucchi@gov.bc.ca).

1. Surveyor Name(s): Record the name(s) of the person(s) who completed the survey.

2. Survey date: Record the date on 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 support the polygon summary.

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 will be located in the opening file, RESULTS 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 identifier 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, RESULTS 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 district. This information may be located in the silviculture prescription, opening file, RESULTS database, survey contract or from local knowledge.

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, RESULTS database or on biogeoclimatic subzone maps and handbooks. Biogeoclimatic information should be confirmed during the walk-through.

10. Point of Commencement (POC): 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 POC 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): Record 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. 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 to 12.49 cm dbh), 3 – (≥1.3 m tall to 7.49 cm dbh), that are tallied separately for each tree species in each plot.

16. Total Live Trees: Tally the total number of live coniferous and broadleaf trees within the plot by species and layer. 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 tally values in that column for each category and use this sum as a 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 Live Conifers: Tally the total number of live coniferous trees, including both acceptable and unacceptable trees in the plot by species and layer. **All conifers ≥1.3 m tall are tallied.**

18. Dead Trees: Tally the total number of dead trees $\geq 1.3\text{m}$ tall, both standing and dead and down, within the plot by species and layer. **Only trees $\geq 1.3\text{ m}$ tall are tallied.**

19. Dead Conifers: Tally the total number of dead conifers $\geq 1.3\text{m}$ tall, both standing and dead and down, within the plot by species and layer. **All dead conifers $\geq 1.3\text{ m}$ tall are tallied.**

20. Total Well-Spaced (WS): Count the number of well-spaced trees in the plot, based on current preferred and acceptable tree species, without use of the M-value cap.

21. (Optional) Total Free-Growing (FG): Count the number of the free-growing trees in the plot, based on current preferred and acceptable tree species, without the M-value and applying the minimum height test. Note that the only difference between FG and WS is the achievement of minimum heights in layer 3 trees.

22. Forest Health Damage Agents: Record the applicable pest code for the unacceptable forest health factors for **each** unacceptable tree within the plot. Live unacceptable 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 1) for a list of forest health factors and their corresponding pest code. If a forest health factor is unknown or uncertain, 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.

Note that while non-FHF damage and mortality caused by vegetative competition (VT) and quality loss indicators (such as forking, UF) are tallied under FHF for computational purposes, they are not considered pests and should be separated from any reporting of FHF incidence in survey results.

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: Tally the total number of live trees made unacceptable by a forest health factor. 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 on which the damage is found.

24. Forest Health – Dead Trees: Tally the total number of dead trees killed by forest health factors.

25. Preferred and Acceptable – WS: Count the number 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. Note that dot tallies are done in the boxes below the total line of these columns in accordance with the species and layer in which the trees are found.

26. Preferred and Acceptable – FG: Count the number 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.

27. Preferred and Acceptable Species (Original + min FG ht): Record all preferred and acceptable tree species, using the appropriate species code. Add the minimum free growing height required, if available.

28. Data Volume Trees – Live / Dead: Record if the layer 1 or 2 tree is alive or dead.

29. Data Volume Trees – Species: Record the species code 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 ($\geq 7.5\text{ cm dbh}$).

30. Data Volume Trees – DBH: Record tree diameter at breast height as expressed in cm, to the nearest 0.1 cm, for all 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 for the first tree ≥ 7.5 cm dbh encountered in each of the four cardinal bearing quadrants in the plot. Repeat sweep, if needed, taking the second tree per quadrant until a maximum of four height measurements are taken.

32. Data Volume Trees – FHF: If the measured tree is afflicted by an unacceptable FHF 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 basal area contributed by healthy trees as opposed to basal area at risk or lost due to pest damage or mortality.

33. Growth Intercept Sample: To determine site index using the growth intercept method, record the tree species and measurements here. Note that the sample tree should be selected from the population of trees found within a larger 5.64 m radius plot. Refer to site index training materials on the growth intercept method for procedures to collect this data. Only one SI tree is assessed per plot.

34. Notes: Record site specific details that are relevant to the survey. Leader height, regeneration under 1.3 m, local anomalies within a polygon, presence of wildlife trees are some 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): Create a new inventory label for the plot. Note that new inventory labels will be derived using an ocular estimate from plot center, similar to current methods used in silviculture surveys.

36. Leading Spp.: Record the tree species code for the leading (most abundant) species.

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

38. Age: Estimate the age of the leading species as recorded in field 36 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 leading species as recorded in field 36. Height is measured to the nearest 0.1 m.

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

41. %: Record a visual estimate of the proportion of total trees present that are the second leading species. As with field 37, the species composition is rounded to the nearest 10 percent.

42. Age: Estimate the age of the second leading species as recorded in field 40 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 40. Height is measured to the nearest 0.1 m.

44. Minor Spp.: For the purpose of data collection, minor species can be considered all those species not already recorded in fields 36 or 40 that represent 10% or more of the total species composition.

45. %: Fields 44 and 45 are treated as a matched pair. The percentage entered in field 45 corresponds to the species entered in field 44.

[illegible]

Data analysis

Individual Polygon Data

Once the field survey is complete, the data on the field forms should be entered into the appropriately numbered plot tabs in the SDM Polygon Data Summary spreadsheet (downloadable from the SDM SharePoint site) created for each individual surveyed polygon. The pages of the plot tabs in the spreadsheet replicate the field card format and allow data to be entered from the same cells that are filled on the field card. Note that the following text refers mainly to the spreadsheet version 2.0 or later (2012 and later survey data). Older versions of the spreadsheet perform many of the same tasks but are not as complete.

Only use the latest version at the link below:

- The SDM Polygon Summary Spreadsheet: [SDM Polygon Summary Spreadsheet](#)
- The documentation for this spreadsheet: [Documentation for the SDM Polygon Summary Spreadsheet](#)

Note that cells shaded yellow in the cover sheet and field card sheets are descriptive and should not be changed (they may be locked to prevent this). Also, the orange-shaded cells are auto-filling, usually from information placed in the Polygon Cover Sheet (see Figure 2) and should not be overwritten, especially the numeric totals since they form an important quality control check on tally numbers. Many of the spreadsheet fields use drop down menus to limit data entry choice and help eliminate transcription errors. Any typographic, numeric or other error makes analysis more difficult and runs the risk of having data rejected from the analysis.

The SDM Polygon Summary Spreadsheet calculates a great number of attributes from the plot data entered into the field card sheets. The red-coloured tabs house calculations for various stand-level attribute variables (Figure 8), the green tab has the FHF calculations, the purple tab has the various validation lists needed to ensure data uniformity using Ministry standard codes. None of the spreadsheets within these tabs need any adjustment since all calculations are made either 'on the fly' as data is entered or when the "*Refresh All*" button is clicked in the "*Data*" tab on the spreadsheet toolbar. This refresh should be done once all the plot data is entered or after reloading a spreadsheet.

Once data entry is complete, a SDM Polygon Summary is provided on the sheet with the orange tab. This summary compiles all the calculated values into one line of attributes describing many of the pre-SDM and SDM values for the polygon. This summary provides immediate feedback to the user on changes occurring in the surveyed stand and may indicate problems in stand development. These past and current values can also be used for analysis purposes when comparing SDM survey results with stand model outputs, comparing intended prescriptive objectives with actual conditions, tracking the incidence of forest health factors and their contribution to tree mortality, and answering other stand-level questions.

Mapsheet Polygon
94C 017 001 1038

Quick Plot Density LCL Calculator

Plot	Total Trees	Total Conifers	WS	WS (M)	FG	FG (M)
1	3	3	2	2	2	2
2	25	24	4	4	4	4
3	32	32	4	4	4	4
4	19	14	3	3	3	3
5	9	9	4	4	4	4
6	7	7	4	4	4	4
7	76	76	5	5	5	5
8	24	24	6	6	6	6
9	92	81	9	9	9	9
10	8	8	3	3	3	3
Total	255	278	44	41	44	41
SPH	5900	5560	880	820	880	820

M Value
6

Note: t-value is calculated within the spreadsheet using the TINV function. It will automatically adjust if the sample size (n) changes.

CAPPED VALUES (M) DATA

WS (M)	Mean WS (M)/plot	SD WS (M)
41	4.100	1.287

WS (M) LCL CALCULATOR

PM (n) Number of Plots: 200

(X) Mean WS: 4.100 *pm(200) 820 e/ha

(SD) Standard Deviation: 1.287

(SD)/n = S_x(mean): 0.4059

If n-1 = 9 then t.90 = 1.833 (from t-table, 0.05)

CL.90 = t*S_x(mean): 0.7459 *pm(200) 149.17 e/ha

LCL X(mean) - CL.90: 3.354 *pm(200) 671 e/ha auto-entered into table

NON-CAPPED VALUES DATA

WS	Mean WS/plot	SD WS
44	4.400	1.955

WS LCL CALCULATOR

PM (n) Number of Plots: 200

(X) Mean WS: 4.400 *pm(200) 880 e/ha

(SD) Standard Deviation: 1.955

(SD)/n = S_x(mean): 0.6182

If n-1 = 9 then t.90 = 1.833 (from t-table, 0.05)

CL.90 = t*S_x(mean): 1.1333 *pm(200) 226.66 e/ha

LCL X(mean) - CL.90: 3.267 *pm(200) 653 e/ha auto-entered into table

FG (M) LCL CALCULATOR

PM (n) Number of Plots: 200

(X) Mean FG: 4.100 *pm(200) 820 e/ha

(SD) Standard Deviation: 1.287

(SD)/n = S_x(mean): 0.4059

If n-1 = 9 then t.90 = 1.833 (from t-table, 0.05)

CL.90 = t*S_x(mean): 0.7459 *pm(200) 149.17 e/ha

LCL X(mean) - CL.90: 3.354 *pm(200) 671 e/ha auto-entered into table

FG LCL CALCULATOR

PM (n) Number of Plots: 200

(X) Mean FG: 4.400 *pm(200) 880 e/ha

(SD) Standard Deviation: 1.955

(SD)/n = S_x(mean): 0.6182

If n-1 = 9 then t.90 = 1.833 (from t-table, 0.05)

CL.90 = t*S_x(mean): 1.1333 *pm(200) 226.66 e/ha

LCL X(mean) - CL.90: 3.267 *pm(200) 653 e/ha auto-entered into table

The "LCL Calculator" tab is automated. It DOES NOT require any input.

Figure 8. Example of SDM Polygon Summary Spreadsheet LCL calculator

When individual SDM Polygon Summary Spreadsheets are filled and checked for data errors, they should be placed in the appropriate TSA folder within the 'SDM field data by TSA' folder on the FREP SharePoint site.

Spreadsheets are usually stored by year of survey and it is good practice to submit supporting information like scan files of the survey plot cards, polygon maps and rationales for excluding polygons from the survey along with the Excel spreadsheet. Quality control will be conducted on submitted spreadsheet to clear up any data errors since aggregated data computations will be affected by miscoded or missing data values.

Aggregated Polygon Data

After polygon spreadsheets are submitted and have passed quality control testing, they will be loaded into the provincial SDM database and become available for completing TSA Data Summaries and other reports. TSA Data Summaries are composites of summarized data from five main areas: Sample Summary statistics, Forest Health, Stand Density, Species Composition and Site Index. These summaries are groupings of polygon information currently available within a TSA for these attributes. Other groupings, for example by district or BEC unit, may be available but the default summary is for a TSA. An example of a TSA Data Summary is provided in Appendix 5.

A TSA data summary will usually only be released once a TSA has at least 30 polygons available to create the summary statistics. Numbers of stands below 30 are insufficient to give reliable information about forest status or trends. Even summaries created with >30 polygons should

be interpreted with care since there may still be very few data points available for any particular stand attribute or from which to make a comparison between sample periods.

Completed TSA Data Summaries will be posted in the 'SDM reporting' folder on the Stand Development Monitoring section of the FREP SharePoint site: ([SDM TSA Data Summaries](#)). Updates will be made at least annually as new survey data are submitted for a TSA.

Output from the individual and aggregated SDM summaries can be used as a starting point for creating more in-depth analysis and reporting. For example, questions regarding the productivity of managed stands can be answered in part by using individual polygon summary data and comparing stand attributes to those produced by TASS/TIPSY during the same time period. A comparison of pest incidence between host trees species across various BEC units can be done using aggregated data from different points in time or different stages of tree development. An analysis of site index estimates for various tree species across different BEC units could be done using the same source of data. These sorts of interpretive exercises are left to the users and are not provided in data summaries.

Storing SDM Data

Preserving SDM field data is important. While working copies of spreadsheets and supporting information should be placed on the SharePoint site for quality control and reference purposes. It is required that field forms and survey data be filed according to the Ministry records classification system for secure storage.

Filing SDM information

For filing SDM field data and any reports or analyses please use the following records classification coding:

Record Number: FOR-23500-40
OPR: District Office
(for field data and other supporting information filed by TSA)

Record Number: FOR-23500-66
OPR: HFP – Forest Practices Branch
(for reports, data summaries and supporting data filed by TSA)

Data Entry into RESULTS

Once SDM field data has been error checked and loaded into the provincial SDM database the relevant polygon attributes that have been updated (forest cover, forest health, ecology and ATU activity) will be submitted for inclusion into RESULTS. **Districts do not have to perform this step it will be done by Resource Practices Branch once a TSA has reached the minimum of 30 surveyed polygons.** However, in order to meet current RESULTS data quality requirements, georeferenced spatial data for each surveyed polygon must be made available to properly identify the surveyed polygon (and relevant opening) and to facilitate matching of updated

attributes to the correct polygon. Districts should ensure that this spatial data is kept and made available when required for the RESULTS update.

All completed SDM surveys may be entered into the “Activities” section of RESULTS. This is so future users can readily identify polygons that have had an SDM survey done and it assists with assuring data continuity if the polygon is revisited. There are specific activity codes that should be used to report SDM survey activity. The coding is:

Base:	SU
Technique:	FH
Method:	SDM
Objectives:	MON

Survey information that may help future users identify the exact area of the survey can be attached to the RESULTS file for that opening. The summary spreadsheet may also be attached as supporting evidence for the survey. Any other additional information that may have been useful in planning or performing the survey may also be attached.

Help

For further information on planning, surveying and analyzing SDM data, contact any member of the SDM Technical Committee which is led by Stefan Zeglen, West Coast Region, Nanaimo, and includes:

Kevin Astridge, Resources Practices Branch, Victoria
Frank Barber, Resources Practices Branch, Victoria
Harry Kope, Resources Practices Branch, Victoria
Dave Weaver, Resources Practices Branch, Victoria

The technical testing team (who tolerate all our annoying requests) consists of:

Tracy Coombes, Merritt
Liz Goyette, Cranbrook
Kathleen Hebb, Vanderhoof
Heather MacLennan, Clearwater
David Rusch, Williams Lake
Blake Fougere, Powell River
Lucy Stad, Chilliwack
Barb Wadey, Revelstoke

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).



CONIFER DAMAGE AGENT AND CONDITION CODES

FIELD CODES	DESCRIPTION	FIELD CODES	DESCRIPTION	FIELD CODES	DESCRIPTION
A	ANIMAL DAMAGE				
AB	BEAR	AP	PORCUPINE	DFB	Delphinella tip blight <i>Delphinella</i> spp.
AC	CATTLE	AS	SQUIRREL	DFC	Large-spored spruce-labrador tea rust <i>Chrysomyxa ledicola</i>
AD	DEER	AV	VOLE	DFD	Spruce needle cast <i>Linula macrospora</i>
AE	ELK	AX	BIRDS	DFE	Elytroderma needle and shoot disease <i>Elytroderma deformans</i>
AH	HARE OR RABBIT	AZ	BEAVER	DFH	Larch needle blight <i>Hypodermella laricis</i>
AM	MOOSE			DFJ	Phaeoseptoria needle cast <i>Phaeoseptoria contortae</i>
AO	PIKA			DFL	Pine needle cast <i>Lophodermella concolor</i>
				DFM	Larch needle cast <i>Meria laricis</i>
N	ABIOTIC INJURIES			DFN	Leptomelanconium needle blight <i>Leptomelanconium pinicola</i>
NAV	Avalanche or snow slide	NK	FUMEKILL	DFO	Lophodermium needle cast <i>Lophodermium sediciosum</i>
NB	FIRE	NL	LIGHTNING	DFP	Fir-fireweed rust <i>Pucciniastrum epilobii</i>
ND	DROUGHT	NN	ROAD SALT	DFR	Douglas-fir needle cast <i>Rhabdocline pseudotsugae</i>
NF	FLOODING	NR	REDBELT	DFS	Dothistroma (red band) needle blight <i>Mycosphaerella pini</i>
NG	FROST	NS	SLIDE	DFU	Cedar leaf blight <i>Didymascella thujina</i>
NGC	Frost crack	NW	WINDTHROW	DFW	Swiss needle cast <i>Phaeocryptopus gaeumannii</i>
NGH	Frost-heaved	NWS	Windthrow-soil failure	DFX	Brown felt blight <i>Herpotrichia</i> spp.
NGK	Shoot / bud frost kill or harvest related	NWT	Windthrow-treatment	DFY	Hendersonia needle cast <i>Hendersonia pinicola</i>
NH	HAIL	NX	WIND SCARRING OR RUBBING	DFZ	Rhizosphaera needle cast <i>Rhizosphaera kalkhoffii</i>
		NY	SNOW, ICE, SNOW PRESS		
		NZ	SUNSCALD		
D	DISEASE			DL	LEADER OR BRANCH DIEBACKS
DB	BROOM RUST			DLD	Dermea canker <i>Dermea pseudotsugae</i>
DBF	Fir broom rust <i>Melampsorella caryophyllacearum</i>			DLF	Red flag disease <i>Potebniamyces balsamicola</i>
DBS	Spruce broom rust <i>Chrysomyxa arctostaphyli</i>			DLK	Conifer cytospora canker <i>Leucostoma kunzei</i>
DD	STEM DECAYS			DLP	Diaporthe canker <i>Diaporthe lokoyae</i>
DDA	White mottled rot <i>Ganoderma applanatum</i>			DLS	Sydowia tip dieback <i>Sclerophoma pithyophila</i>
DDD	Sulfur fungus <i>Laetiporus sulphureus</i>			DFT	Sirococcus tip blight <i>Sirococcus strobilinus</i>
DDE	Rust-red stringy rot <i>Echinodontium tinctorium</i>			DM	DWARF MISTLETOES
DDF	Brown crumbly rot <i>Fomitopsis pinicola</i>			DMF	Douglas-fir dwarf mistletoe <i>Arceuthobium douglasii</i>
DDO	Brown cubical butt & pocket rot of cedar <i>Postia sericeomollis</i>			DMH	Hemlock dwarf mistletoe <i>Arceuthobium tsugense</i>
DDP	Red ring rot <i>Phellinus pini</i>			DML	Larch dwarf mistletoe <i>Arceuthobium laricis</i>
DDQ	Brown trunk rot (quinine fungus) <i>Fomitopsis officinalis</i>			DMP	Lodgepole pine dwarf mistletoe <i>Arceuthobium americanum</i>
DF	FOLIAGE DISEASES			DR	ROOT DISEASES
DFA	Western pine aster rust <i>Coleosporium asterum</i>			DRA	Amillaria root disease <i>Amillaria ostryae</i>
				DRB	Blackstain root disease <i>Leptographium wageneri</i>
				DRC	Laminated root rot (cedar form) <i>Phellinus weinii</i>
				DRL	Laminated root rot (Fd form) <i>Phellinus sulphurascens</i>
				DRN	Annosus root disease <i>Heterobasidion annosum</i>
				DRR	Rhizina root disease <i>Rhizina undulata</i>

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FIELD CODES	DESCRIPTION	FIELD CODES	DESCRIPTION
DRS	Schweinitzii butt rot <i>Phaeolus schweinitzii</i>	IDP	Larch sawfly <i>Pristiphora erichsonii</i>
DRT	Tomentosus root rot <i>Inonotus tomentosus</i>	IDS	Conifer sawflies <i>Neodiprion</i> spp.
DS	STEM DISEASE (CANKER OR RUST)	IDT	Douglas-fir tussock moth <i>Orgyia pseudotsugata</i>
DSA	Atropellis canker <i>Atropellis piniphila</i>	IDV	Variegated outworm <i>Peridroma saucia</i>
DSB	White pine blister rust <i>Cronartium ribicola</i>	IDW	Western spruce budworm <i>Choristoneura occidentalis</i>
DSC	Comandra blister rust <i>Cronartium comandrae</i>	IDZ	Western false hemlock looper <i>Nepytia freemani</i>
DFE	Elytroderma needle and shoot disease <i>Elytroderma deformans</i>	IS	SHOOT AND STEM INSECTS
DSG	Western gall rust <i>Endocronartium harknessii</i>	ISB	Western cedar borer <i>Trachykele blondeli</i>
DSS	Stalactiform blister rust <i>Cronartium coleosporioides</i>	ISE	European pine shoot moth <i>Rhyacionia buoliana</i>
I	INSECTS	ISG	Gouty pitch midge <i>Cecidomyia piniinopis</i>
IA	APHIDS OR ADELGIDS	ISP	Pitch nodule moths <i>Petrova</i> spp.
IAB	Balsam woolly adelgid <i>Adelges piceae</i>	ISS	Western pine shoot borer <i>Eucosma sonomana</i>
IAC	Giant conifer aphid <i>Cinara</i> spp.	ISQ	Sequoia pitch moth <i>Synanthedon sequoiae</i>
IAG	Cooley spruce gall adelgid <i>Adelges cooleyi</i>	IW	WEEVILS
IAL	Larch cone woolly aphid <i>Adelges lariciatus</i>	IWC	Conifer seedling weevil <i>Steremnius carinatus</i>
IAS	Spruce aphid <i>Elatobium abietinum</i>	IWM	Magdalis sp.
IB	BARK BEETLES	IWP	Lodgepole pine terminal weevil <i>Pissodes terminalis</i>
IBB	Western balsam bark beetle <i>Dryocoetes confusus</i>	IWS	White pine weevil (on spruce) <i>Pissodes strobi</i>
IBD	Douglas-fir beetle <i>Dendroctonus pseudotsugae</i>	IWW	Warren's root collar weevil <i>Hyllobius warreni</i>
IBE	Silver fir beetle <i>Pseudohylesinus sericeus</i>	IWY	Cylindrocaptus weevil <i>Cylindrocaptus</i> spp.
IBF	Fir engraver beetle <i>Scolytus ventralis</i>	IWZ	Yosemite bark weevil <i>Pissodes schwartzii</i>
IBH	Hylurgops beetle <i>Hylurgops rugipennis</i>		
IBI	Engraver beetles <i>Ips</i>	M	MITE DAMAGE (TRISETACUS SPECIES)
IBL	Lodgepole pine beetle <i>Dendroctonus murrayanae</i>	T	TREATMENT INJURIES
IBM	Mountain pine beetle <i>Dendroctonus ponderosae</i>	TC	CHEMICAL
IBP	Twig beetles <i>Pityogenes</i> , <i>Pityophthorus</i> spp.	TH	HARVESTED
IBS	Spruce beetle <i>Dendroctonus rufipennis</i>	TL	LOGGING
IBT	Red turpentine beetle <i>Dendroctonus valens</i>	TM	OTHER MECHANICAL DAMAGE (NON-LOGGING)
IBW	Western pine beetle <i>Dendroctonus brevicornis</i>	TP	PLANTING
ID	DEFOLIATING INSECTS	TPM	Planting — poor microsite
IDA	Black army cutworm <i>Actebia fennica</i>	TR	PRUNING
IDB	Two-year budworm <i>Choristoneura biennis</i>	TT	THINNING OR SPACING
IDC	Larch casebearer <i>Coleophora laricella</i>		
IDE	Spruce budworm <i>Choristoneura fumiferana</i>	V	VEGETATION PROBLEMS
IDG	Green-striped forest looper <i>Melanophila imatata</i>	VH	HERBACEOUS COMPETITION
IDH	Western blackheaded budworm <i>Acleris gloverana</i>	VP	VEGETATION PRESS
IDI	Pine needle sheath miner <i>Zelleria haimbachi</i>	VS	SHRUB COMPETITION
IDL	Western hemlock looper <i>Lambdina fiscelliana lugubrosa</i>	VT	TREE COMPETITION

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Note: Use the prefix 'U' for unknown source of damage. Codes for damage of unknown cause include 'UBT' for broken top, 'UCR' for crook, 'UF' for unacceptable forking, and 'USW' for unacceptable sweep or lean.

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 	PI, 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. 	<div>All</div> <div>All</div> <div>All</div>	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	<p>For horizontal displacement see Figure 1.</p> <p>For a crook of unknown cause, use damage code UCR.</p> <p>For forking, see Figure 2. If unable to determine cause of fork, record as damage code UF. If cause of fork is clear, record under appropriate damage code. Note: forks below 1.3 m are considered as two trees and both stems should be measured for dbh.</p> <p>For broken top of unknown cause, use damage code UBT.</p>
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	For sweep or lean of unknown cause, record using damage code USW
STEM	Suppressed	<ul style="list-style-type: none"> the tree has a height to diameter ratio > 100 or, tree has $< 20\%$ Live Crown 	PI, 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 PI, 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.	<p>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.</p>
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	<p>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</p> <p>See Figure 3</p>
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	<p>Note: To confirm infection the surveyor must observe signs of the pathogen as small dark streaks on dead foliage</p>
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. 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. 	<p>All</p> <p>All</p> <p>Fd, Bg, Hw, Sx, Se, Lw</p> <p>Fd, Pl, Pw, Sx</p> <p>Se, Sx, Fd, Pl</p> <p>Ba, Hw, Ss, Fd</p>	<p>armillaria root disease DRA, blackstain root disease DRB laminated root rot DRL, annosus root disease DRN tomentosus root rot DRT,</p> <p>armillaria root disease DRA,</p> <p>laminated root rot DRL.</p> <p>black stain root disease DRB.</p> <p>tomentosus root rot DRT.</p> <p>annosus root rot DRN</p>	<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> <p>Note: All conifer species are considered susceptible. All broadleaf species are considered not susceptible for survey purposes only.</p> <p>Note: Cw, Pl, Pw, Py, and all broadleaf species are considered not susceptible for survey purposes only.</p> <p>Note: All other conifers and broadleaf species are considered not susceptible for survey purposes only</p> <p>Note: Bg, Bl, Cw, Cy, Pw, Py, and all broadleaf species are considered not susceptible for survey purposes only.</p> <p>Note: Cw, Cy, Pw, Pl, 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>

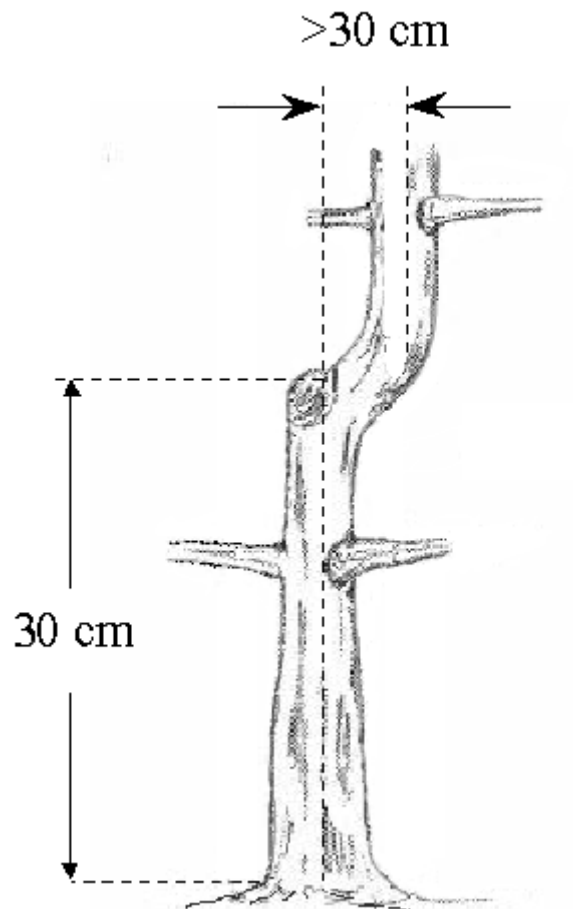


Figure 1. Determining horizontal displacement when assessing stem deformation. This is only done when the tree has five seasons' growth after damage occurs.

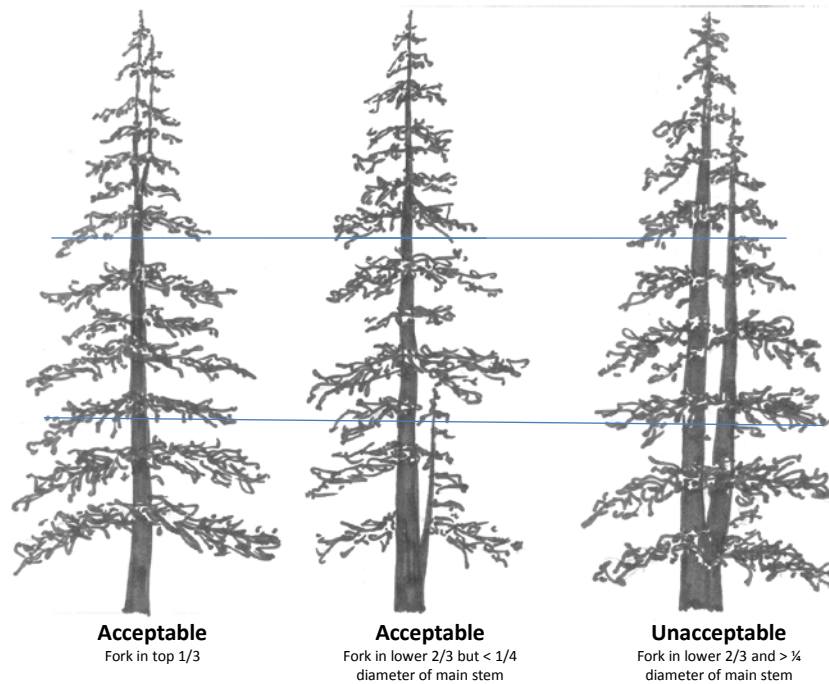


Figure 2. Acceptable and unacceptable forking in age class 2 & 3 conifers (damage code UF).

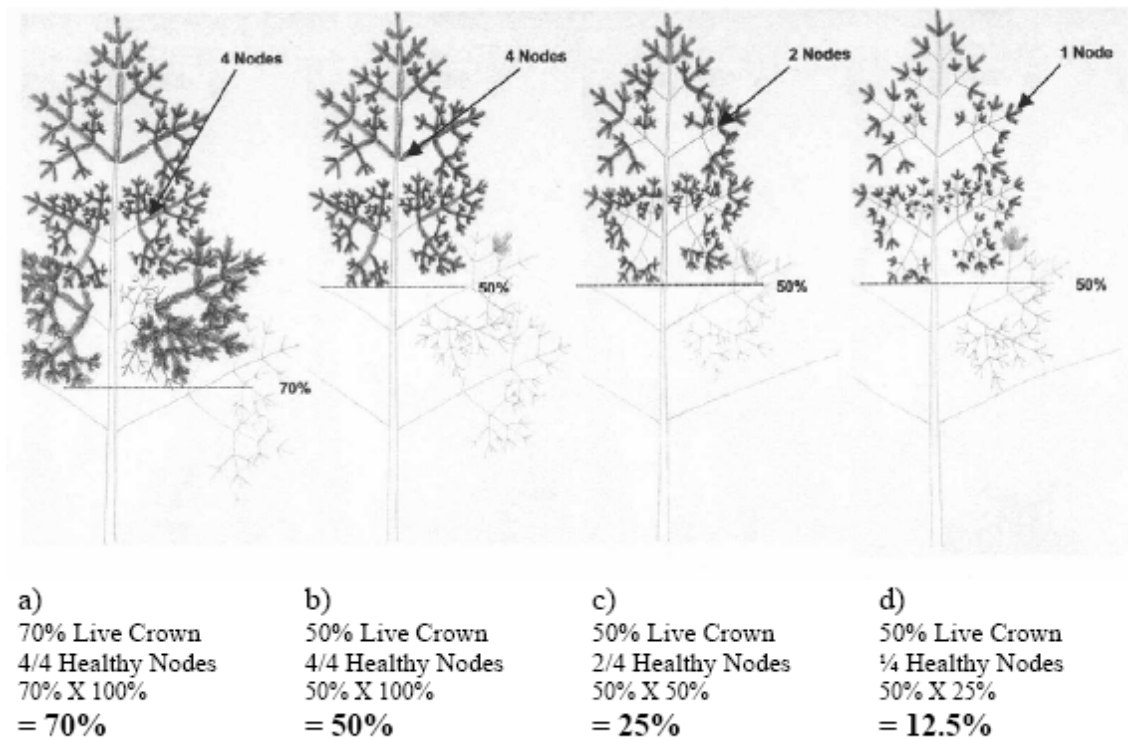


Figure 3. Calculating defoliation for Dothistroma-afflicted conifers.

Instructions	Example
Step 1 Divide live crown into thirds.	If this third has no visible infections, its rating is (0).
Step 2 Rate each third separately. Each third should be given a rating of 0, 1, or 2 as described below: <ul style="list-style-type: none"> (0) no visible infections (1) light infection (1/2 or less of total number of branches in the third infected) (2) heavy infection (more than 1/2 total number of branches in the third infected). 	If this third is lightly infected, its rating is (1). If this third is heavily infected, its rating is (2).
Step 3 Add ratings of thirds to obtain rating for total tree.	The tree in this example gets a rating of: $0 + 1 + 2 = 3$.



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 SDM map.

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

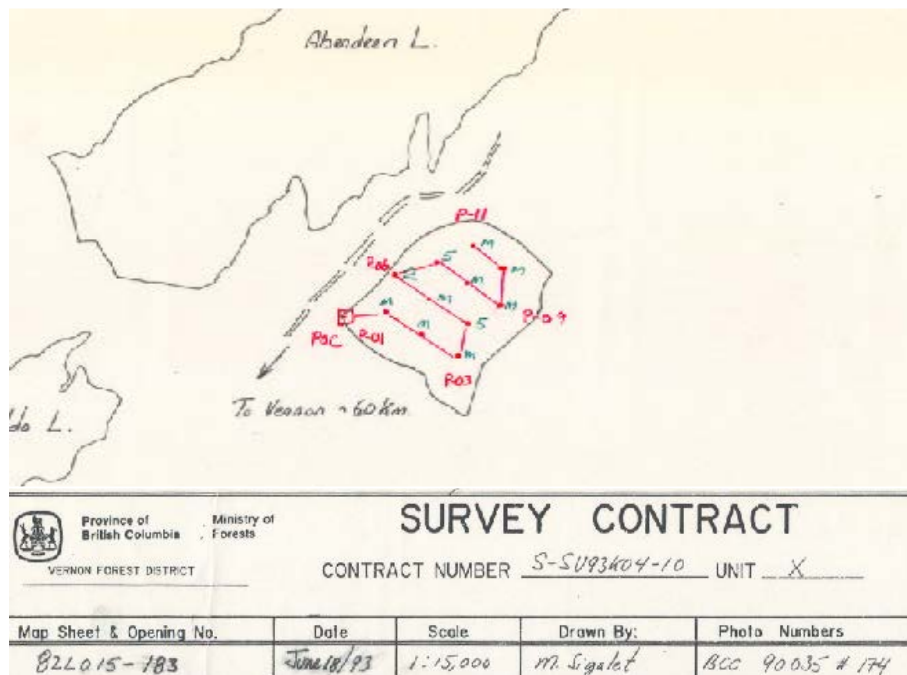


Figure 7. Original survey map with plot locations.

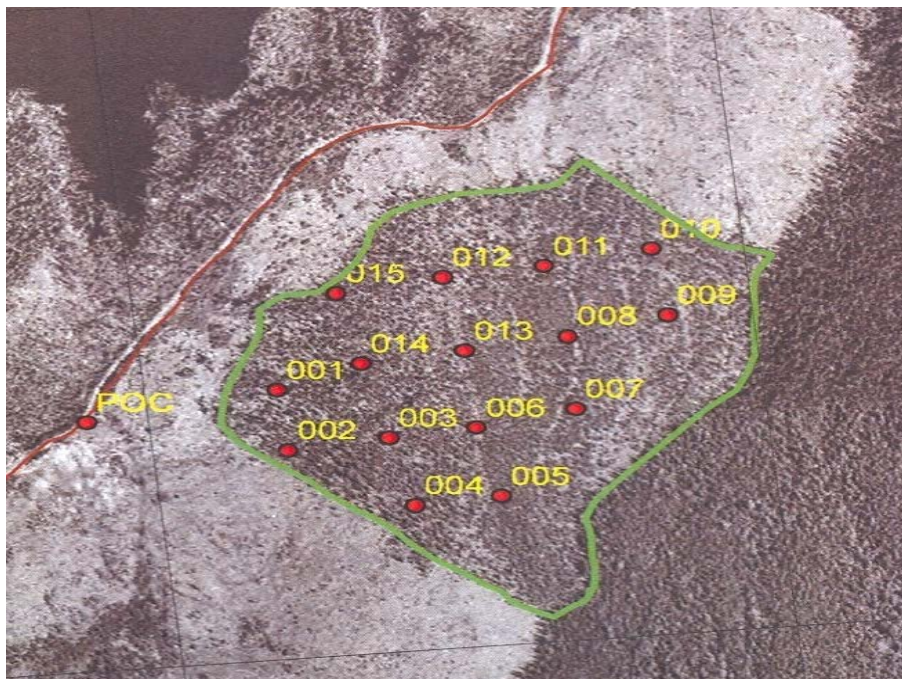


Figure 8. Air photo of survey polygon with plots identified.

Appendix 4 Inventory Label Background

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 taken 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 the Ministry of Forests, Lands and Natural Resource Operations 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's 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 http://www.for.gov.bc.ca/hre/becweb/Downloads/Downloads_SpeciesList/treecode_44.doc, 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 overestimate 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.

Appendix 5 SDM TSA Report – examples

Examples of SDM TSA Reports can be found at this link:

[SDM TSA Data Summaries](#)