

Ministry of Forests, Lands and Natural Resource Operations

# Stand Development Monitoring Protocol

Field and Office Procedures for Stand Development Monitoring Surveys



SDM Technical Committee  
March 2014

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## ***Introduction***

The objective of the Forest and Range Evaluation Program (FREP) is to determine if practices in British Columbia (BC) are achieving government's objectives for resource values under the *Forest and Range Practices Act* (FRPA) or residual openings under the *Forest Practices Code*. To accomplish this, specific evaluation tools – such as **Stand Development Monitoring (SDM)** - are designed by technical experts from ministry, industry, academia and other agencies, and then implemented by ministry field staff.

One major component of forest management policy in British Columbia (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 stocking standards within 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. 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 protocol 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 the 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, well-spaced (WS) and free-growing (FG) stems per hectare), stand species composition (inventory and silviculture labels), stand health, tree 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 policies and forest management practices that govern stand initiation, resource sustainability and risk to the Crown; and
- C. Develop in-house expertise within the Ministry 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 density;
- Well-spaced (WS) and free-growing (FG) tree densities;
- DBH of all trees  $\geq 7.5$  cm in diameter and heights of a subset of these trees;
- Pest incidence, including 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 treatment history;
- Current stand basal areas of live and dead trees;
- Current diameter class distributions; and
- BEC classification (to the variant).

## ***SDM Survey Skills***

This SDM protocol 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 protocol are:

- Ability to identify damaging insects, diseases and other causes of tree damage;
- Ability to identify tree species and plants (especially indicator plants);

- 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. This protocol 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 in the longer 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.

### ***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 and stocking standards can be assessed by comparing SDM stocking levels to the declaration or earlier survey values, provided trees are also tallied following the preferred and acceptable designations used at that time. 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 the stand though are quite acceptable in SDM 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  $\geq 5$  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  $\geq 5$  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, 90% 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 1970 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 that 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 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 monitoring and would limit the ability to make historical comparisons or predictions 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 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.

## ***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 FHF impacts to manifest.
4. **Free-growing survey:** If a FG survey (not necessarily a FG declaration) has been completed and reported in RESULTS (i.e., the pre-SDM data is from this survey) 10 growing seasons or less from the SDM survey year, then that polygon should be deferred until the requirement is met. 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 8 growing seasons of the SDM survey year, then the polygon should be deferred until the requirement is met.
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 parts and a number of these parts are small (<1 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. 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 since FG information will be captured by SDM.

Access cost is not a reason to reject a polygon. Difficulty or expense in accessing a polygon (e.g., air or water-only) 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. 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 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.

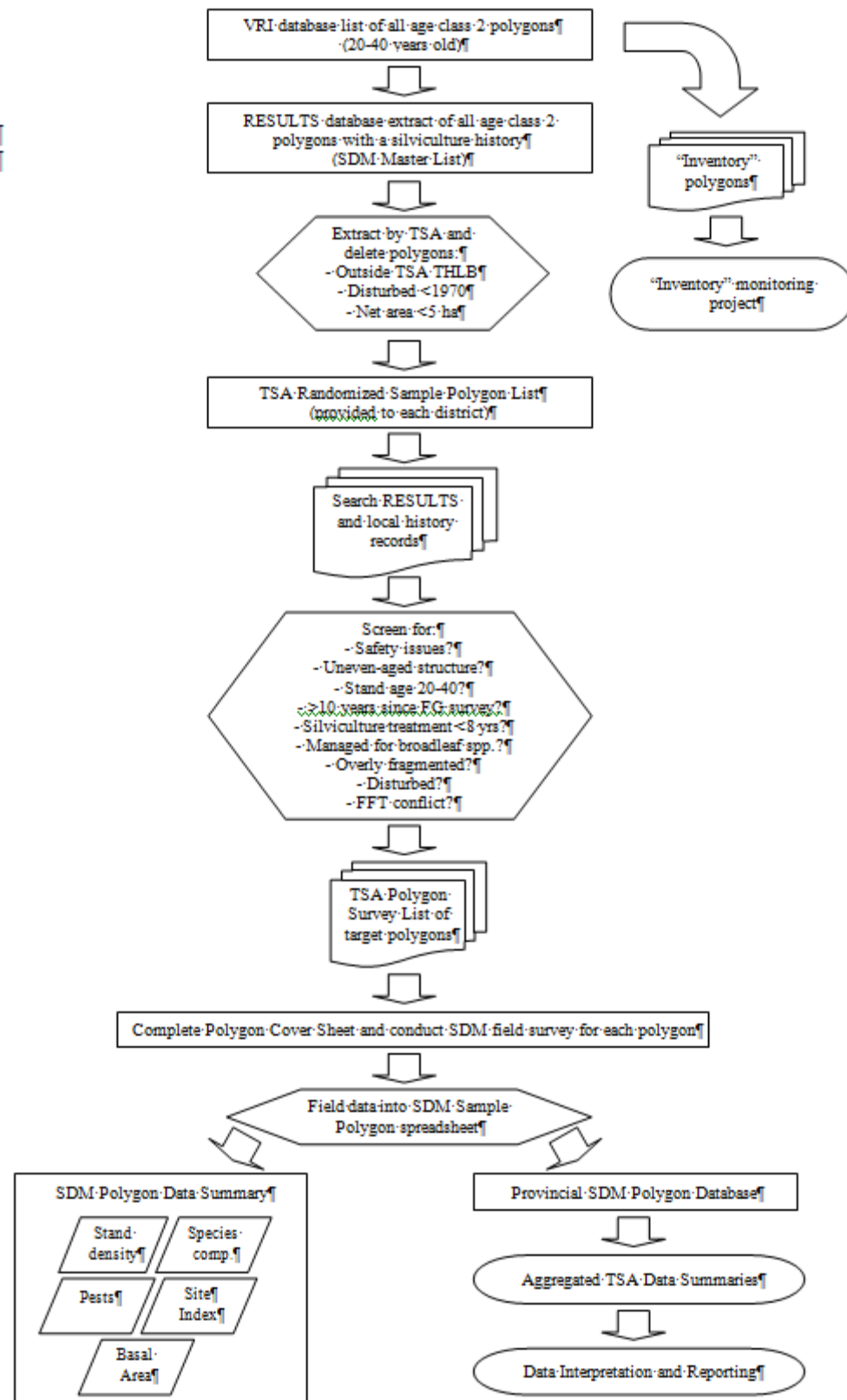


Figure 1. A flowchart of the polygon selection and data compilation process.

## 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 file (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 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:                                 |  |  |  |  | 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 |     |            |   |   |   |   |   |   |   | TOP 3 FOREST HEALTH FACTORS |   |
|--------------------|-----|------------|---|---|---|---|---|---|---|-----------------------------|---|
| Ldg Spp            |     | Minor Spp. |   |   |   |   |   |   |   | FHR                         |   |
| %                  | Age | Ht(m)      | % | % | % | % | % | % | % | %                           | % |

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

| SILVICULTURE TREATMENTS |  |  |  |  |  |  |  |  |  |  |  |
|-------------------------|--|--|--|--|--|--|--|--|--|--|--|
| YEAR                    |  |  |  |  |  |  |  |  |  |  |  |
| ACTIVITY                |  |  |  |  |  |  |  |  |  |  |  |

| OPTIONAL INFORMATION                                                                                                                                                                        |  |  |  |  |  |  |  |  |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|
| Previous Survey Information:<br>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\_NO' 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 that is 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 free-growing stocking standards or earlier silviculture survey and should be noted. 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 these M-values against Target Stocking Standards (TSS). Recording all relevant information about a polygon prior to going out into the field can help with the logistics of which polygons will be assessed over the field season.

### ***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 (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 TSA Polygon 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 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.
- 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 the plot coordinates 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 TSA Polygon 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 either Mapview or ArcGIS it is important to refer to a hardcopy map from the opening file that indicates the location, shape and attributes of the specific polygon identified for surveying in the TSA Sample Polygon List. The map contained in RESULTS (if there is one) is usually less than helpful; avoid using it. As the purpose of SDM is to compare current conditions to the conditions recorded in the previous silviculture survey, it is important to ensure that you are surveying that exact same area.

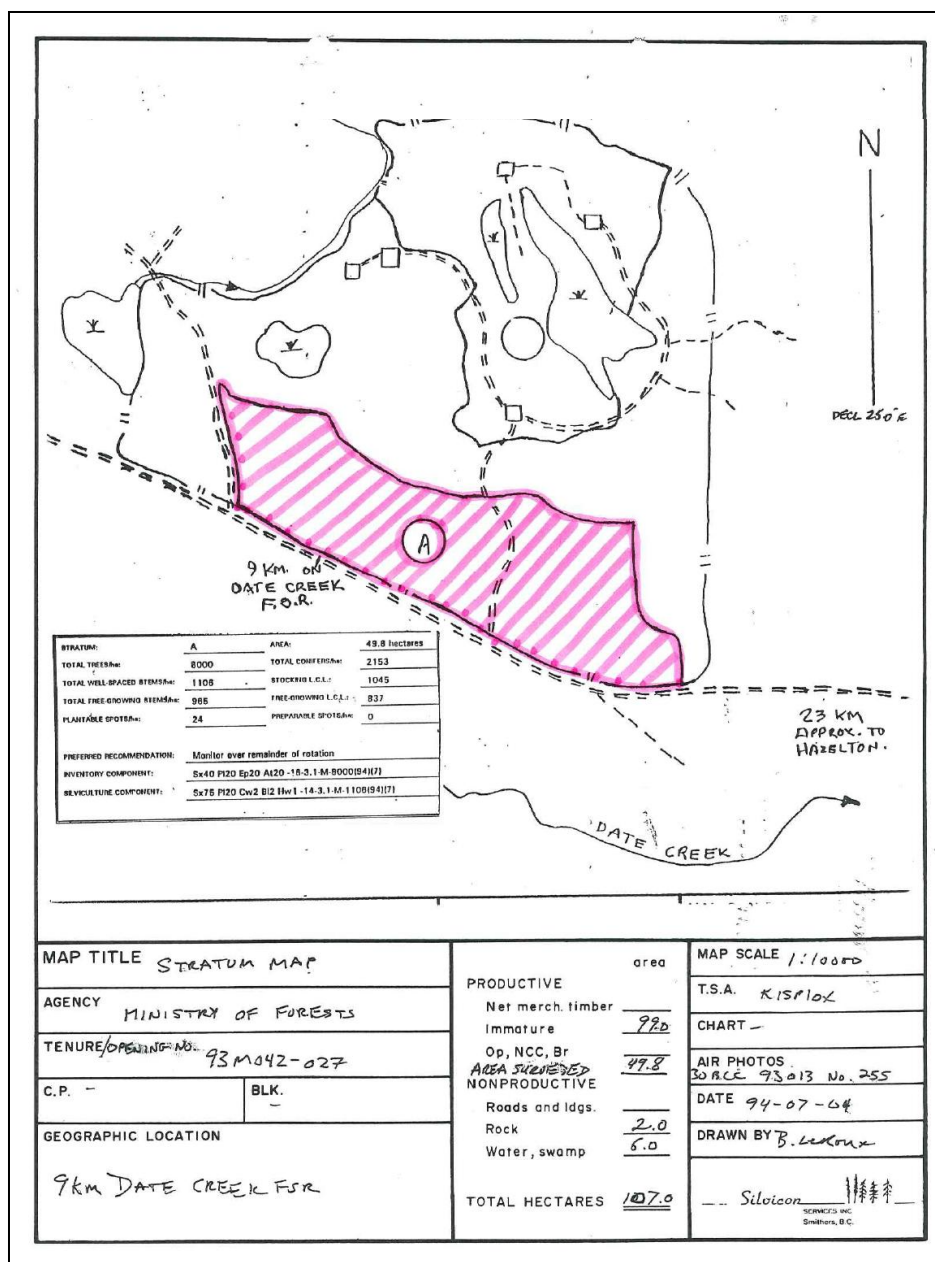


Figure 3. Example of an opening file map showing roads, opening boundaries and delineated interior polygons. The SDM sample polygon is indicated in pink.

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 ortho photo 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 ortho photo 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. (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 ortho photo are not perfectly aligned. Randomly select ten intersections and one spare (the 11<sup>th</sup> plot) (see Figure 5).
8. Number the plots 1-11 and enter their corresponding UTM coordinates into your GPS unit. Only use the 11<sup>th</sup> 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 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 card and do not change the plot numbers on the worksheet tabs in the Polygon Data Summary spreadsheet.

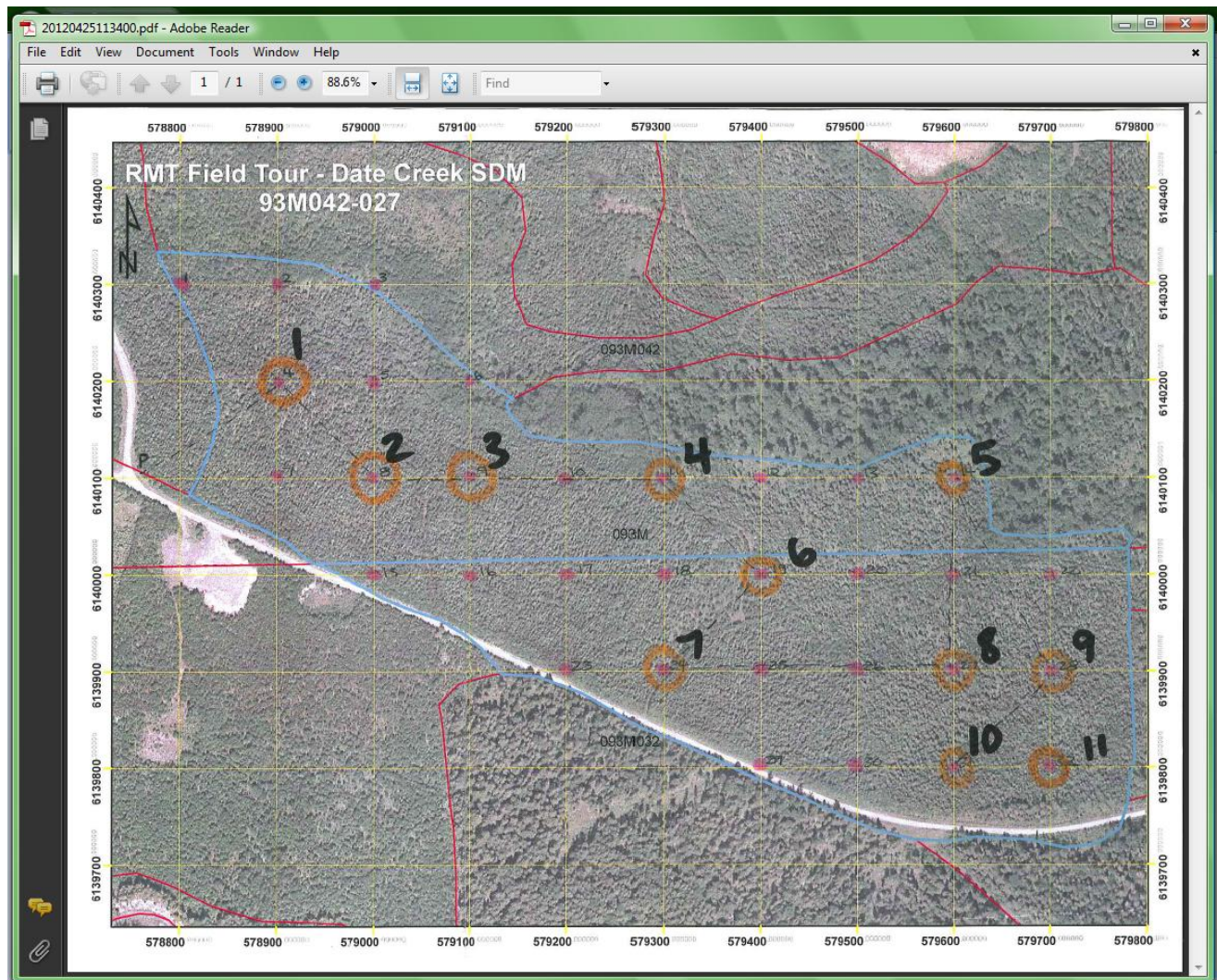


Figure 5. Completed polygon map in ArcGIS with 100 m sample grid overlay.

| 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 (minimum of 30 to start).                                                                                                |      |          |
| 3. Obtain opening summaries from RESULTS and examine opening files for silviculture survey results and stand history for each potential sample polygon.                                                                   |      |          |
| 4. Confirm sample suitability for polygons. <b>Document why polygons were rejected or deferred</b> (include re-schedule date). Create the TSA Polygon Survey List.                                                        |      |          |
| 5. Record pre-SDM required, desirable and optional information on SDM Polygon Summary Spreadsheet cover sheet.                                                                                                            |      |          |
| 6. Obtain air photos and create small scale block maps for survey planning (Ensure that the small scale block maps include the 10 + 1 extra plot location points). Input plot center co-ordinates into a GPS, 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 sheet.                                                                                                               |      |          |
| 13. Submit polygon spreadsheets, supporting information (e.g., maps and scanned field cards) to SDM SharePoint site.                                                                                                      |      |          |
| 14. Update activities in RESULTS and attach relevant files.                                                                                                                                                               |      |          |

## ***Field Procedures***

### **Field Gear Checklist**

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

| <b>Item</b>                                                            | <b>Got it?</b> |
|------------------------------------------------------------------------|----------------|
| SDM survey field cards (FS 1357) or electronic data logger             |                |
| Orthophoto or 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 (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 colour) flagging tape                        |                |
| 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 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 predetermined plot. Plots do not have to be surveyed in numeric order but rather in the most efficient order. Record a GPS point for the POC. Record all plot data on a **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 primitive 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’s 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 11<sup>th</sup> (extra) plot. You will 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 11<sup>th</sup> (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  $\geq 1.3$  m in height by species and layer. 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-and-down 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 ( $\geq 7.5$  cm DBH) and enter them in the “Data Volume Trees” section of the field card along with

whether the tree is living (L) or dead (D). DBH measurements are to the nearest 0.1 cm. It is recommended that during this sweep, all trees  $\geq 7.5$  cm DBH (all layer 1 and 2 trees) be marked with ribbon and numbered sequentially.

6. Along with the measurements recorded in the first sweep, assess each tree in the plot for forest health factors and record by tree species and layer. **Only record damage agents that have rendered 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 and free-growing trees using the original minimum inter-tree distance noted in the stocking standards (default is 2.0 m). WS and FG trees tallied in this sweep are selected on the basis of **being pest free** and of being the biggest, best trees of the **currently** preferred and acceptable species<sup>1</sup>. 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 (e.g., for lodgepole pine to be considered FG it must be  $\geq 2$  m yet it could be  $\geq 1.3$  m and still 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. The M-value cap will be applied during data analysis. It is helpful to mark the WS/FG trees with a second colour of ribbon for visual reference.
8. 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. **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 original MITD.
9. In order to determine which trees will serve as volume trees and 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 ( $\geq 7.5$  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.

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<sup>1</sup> Refer to [Reference Guide for FDP Stocking Standards](#), (616k, updated Nov. 26, 2010)

If a quadrant contains no trees that are  $\geq 7.5$  cm DBH (or no trees at all), continue the sweep back to  $0^\circ$  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  $\geq 7.5$  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 method<sup>2</sup>. If there is no healthy dominant conifer tree present in the 5.64 m radius plot, do not record site index data. Note not to 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 exist for the leading species**. Take only one SI estimate per plot. It is preferred that Site Tools 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 FAIB procedures.
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.

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<sup>2</sup> 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 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. All information obtained during the office planning phase should be confirmed during the SDM survey.

|                                                                                                                                              |  |                                                |  |                       |  |                     |  |                 |  |              |  |              |  |              |  |              |  |              |  |              |  |              |  |
|----------------------------------------------------------------------------------------------------------------------------------------------|--|------------------------------------------------|--|-----------------------|--|---------------------|--|-----------------|--|--------------|--|--------------|--|--------------|--|--------------|--|--------------|--|--------------|--|--------------|--|
|  Ministry of Forests, Lands and Natural Resource Operations |  | <b>STAND DEVELOPMENT MONITORING FIELD CARD</b> |  | SURVEYOR NAME(S)<br>1 |  | SURVEY YEAR<br>2012 |  | PAGE OF<br>3    |  |              |  |              |  |              |  |              |  |              |  |              |  |              |  |
| MAPSHEET - OPENING NO.<br>4                                                                                                                  |  | POLYGON<br>5                                   |  | LOCATION<br>6         |  | DISTRICT<br>7       |  | TSA<br>8        |  |              |  |              |  |              |  |              |  |              |  |              |  |              |  |
| POINT OF COMMENCEMENT BEARING & DISTANCE TO THIS PLOT<br>10                                                                                  |  |                                                |  |                       |  | UTM ZONE<br>E 11 N  |  |                 |  |              |  |              |  |              |  |              |  |              |  |              |  |              |  |
| PLOT NO. (158m)<br>12                                                                                                                        |  | MTD (ORIG)<br>13                               |  | FOREST HEALTH FACTORS |  |                     |  |                 |  |              |  |              |  |              |  |              |  |              |  |              |  |              |  |
| TREE SPP<br>15                                                                                                                               |  | LIVE TREES<br>16                               |  | LIVE CON.<br>17       |  | DEAD TREES<br>18    |  | DEAD CON.<br>19 |  | WS<br>20     |  | FS<br>21     |  | LIVE<br>22   |  | DEAD<br>23   |  | LIVE<br>24   |  | DEAD<br>25   |  | FS<br>26     |  |
| TOTALS<br>14                                                                                                                                 |  | TOTALS<br>16                                   |  | TOTALS<br>17          |  | TOTALS<br>18        |  | TOTALS<br>19    |  | TOTALS<br>20 |  | TOTALS<br>21 |  | TOTALS<br>22 |  | TOTALS<br>23 |  | TOTALS<br>24 |  | TOTALS<br>25 |  | TOTALS<br>26 |  |
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| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  | 8            |  | 9            |  | 10           |  | 11           |  | 12           |  |
| 1                                                                                                                                            |  | 2                                              |  | 3                     |  | 4                   |  | 5               |  | 6            |  | 7            |  |              |  |              |  |              |  |              |  |              |  |

**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. 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  $\geq 7.5$  cm dbh in the plot.

**31. Data Volume Trees – Height:** Record tree height to the nearest 0.1 m for the first tree  $\geq 7.5$  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 Inventory Label Background.):** 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.

**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 but 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%.

| BRITISH COLUMBIA                                                                                       |  | Ministry of Forests, Lands and Natural Resource Operations |  | STAND DEVELOPMENT MONITORING FIELD CARD |  | SURVEYOR NAME(S)        |  | SURVEY Y M D |  | PAGE OF         |  |           |  |           |  |                                   |  |
|--------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------|--|-----------------------------------------|--|-------------------------|--|--------------|--|-----------------|--|-----------|--|-----------|--|-----------------------------------|--|
|                                                                                                        |  |                                                            |  |                                         |  | CURLEY, LARRY, MOE      |  | 12 6 01      |  | 1 10            |  |           |  |           |  |                                   |  |
| MAPSHEET - OPENING NO.<br>093F090-31                                                                   |  |                                                            |  | POLYGON<br>A                            |  | LOCATION<br>HAYWIRE FSR |  |              |  | DISTRICT<br>DVA |  |           |  |           |  |                                   |  |
|                                                                                                        |  |                                                            |  |                                         |  |                         |  |              |  | TSA<br>P.G.     |  |           |  |           |  |                                   |  |
|                                                                                                        |  |                                                            |  |                                         |  |                         |  |              |  | SEC<br>SBSdw3   |  |           |  |           |  |                                   |  |
| POINT OF COMMENCEMENT BEARING & DISTANCE TO THIS PLOT<br>POC = 53° 49' 56" N, 124° 10' 57" W @ LANDING |  |                                                            |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  |                                   |  |
| PLOT NO. (3.99m)<br>①                                                                                  |  |                                                            |  | MITD (ORI)<br>1.6m                      |  | FOREST HEALTH FACTORS   |  |              |  |                 |  |           |  |           |  |                                   |  |
|                                                                                                        |  |                                                            |  |                                         |  | DSC                     |  | AM           |  | NY              |  | VT        |  | DSG       |  | PREF. ACC.                        |  |
|                                                                                                        |  |                                                            |  |                                         |  | LIVE DEAD               |  | LIVE DEAD    |  | LIVE DEAD       |  | LIVE DEAD |  | LIVE DEAD |  | WS FG                             |  |
| TOTALS >                                                                                               |  | 28 13                                                      |  | 0 0                                     |  | 8 8                     |  | 1 0          |  | 15 0            |  | 2 0       |  | 1 0       |  | 8 8                               |  |
|                                                                                                        |  |                                                            |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | ACCEPTABLE SPP (ORI) + min FG ht. |  |
|                                                                                                        |  |                                                            |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | Pli 2.0m<br>Fdi Sx                |  |
|                                                                                                        |  |                                                            |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | DATA VOLUME TREES                 |  |
|                                                                                                        |  |                                                            |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | L/D SPP DBH HT FHF                |  |
| PI                                                                                                     |  | 1                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 1 L PI 8.2 6.5 SPP PI             |  |
|                                                                                                        |  | 2                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 2 L PI 11 6.5 DBH 12.1            |  |
|                                                                                                        |  | 3                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 3 L PI 11 TOT HT 7.2              |  |
| At                                                                                                     |  | 1                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 4 L PI 9.6 5.9 AGE @ 1.3m 13      |  |
|                                                                                                        |  | 2                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 5 L PI 7.9 NY BIEST               |  |
|                                                                                                        |  | 3                                                          |  | 15                                      |  |                         |  |              |  | 15              |  |           |  |           |  | 6 L PI 9.1 NOTES:                 |  |
| Sx                                                                                                     |  | 1                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 7 L PI 9.9 6 DSG                  |  |
|                                                                                                        |  | 2                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 8 L PI 8.2                        |  |
|                                                                                                        |  | 3                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 9                                 |  |
|                                                                                                        |  | 1                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 10                                |  |
|                                                                                                        |  | 2                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 11                                |  |
|                                                                                                        |  | 3                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 12                                |  |
|                                                                                                        |  | 1                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 13                                |  |
|                                                                                                        |  | 2                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 14                                |  |
|                                                                                                        |  | 3                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | INVENTORY LABEL                   |  |
|                                                                                                        |  | 1                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | Log. Spp. PI                      |  |
|                                                                                                        |  | 2                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | Minor Spp. At Sx                  |  |
|                                                                                                        |  | 3                                                          |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | Cr CI                             |  |
|                                                                                                        |  |                                                            |  |                                         |  |                         |  |              |  |                 |  |           |  |           |  | 80 16 6 10 18 5 10 20             |  |

Figure 7. Stand development monitoring field card with example field data.

## **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 or capable.

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.

**Quick Plot Density LCL Calculator**

| Mapsheet    |  | Polygon |  |
|-------------|--|---------|--|
| 94C 017 001 |  | 1038    |  |

| 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         |
| <b>Total</b> | <b>235</b>  | <b>278</b>     | <b>44</b> | <b>41</b> | <b>44</b> | <b>41</b> |

| SPH | 5900 | 5560 | 880 | 620 | 680 | 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 s/ha

(SD) Standard Deviation: 1.287

(SD)/n of n = S<sub>y</sub>(mean): 0.4069

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

CL.90 = t\*S<sub>y</sub>(mean): 0.7459 \*pm(200) 149.17 s/ha

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

**FG (M) LCL CALCULATOR**

| FG (M) | Mean FG (M)/plot | SD FG (M) |
|--------|------------------|-----------|
| 41     | 4.100            | 1.287     |

PM (n) Number of Plots: 200 Auto-entered from WS

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

(SD) Standard Deviation: 1.287

(SD)/n of n = S<sub>X</sub>(mean): 0.4069

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

CL.90 = t\*S<sub>X</sub>(mean): 0.7459 \*pm(200) 149.17 s/ha

LCL X(mean) - CL.90: 3.354 \*pm(200) 671 s/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 s/ha

(SD) Standard Deviation: 1.955

(SD)/n of n = S<sub>y</sub>(mean): 0.6182

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

CL.90 = t\*S<sub>y</sub>(mean): 1.1333 \*pm(200) 226.66 s/ha

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

**FG LCL CALCULATOR**

| FG | Mean FG /plot | SD FG |
|----|---------------|-------|
| 44 | 4.400         | 1.955 |

PM (n) Number of Plots: 200 Auto-entered from WS

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

(SD) Standard Deviation: 1.955

(SD)/n of n = S<sub>X</sub>(mean): 0.6182

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

CL.90 = t\*S<sub>X</sub>(mean): 1.1333 \*pm(200) 226.66 s/ha

LCL X(mean) - CL.90: 3.267 \*pm(200) 653 s/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 survey 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 staff also file paper and digital forms 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)

### **Reporting activities in RESULTS**

All completed SDM surveys should 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 could also be attached.

Updates of polygon survey information for the Forest Cover attributes in RESULTS (e.g., stand density number, inventory label, pest incidence, etc) will be done using the batch RESULTS electronic data upload feature and does not have to be done by districts. These updates will be incorporated into the provincial VRI database on the regular annual cycle.

## ***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  
Mark Sloan, 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                                                      |
|-------------|----------------------------------------------------------------------|-------------|--------------------------|-------------|------------------------------------------------------------------|
| <b>A</b>    | <b>ANIMAL DAMAGE</b>                                                 |             |                          |             |                                                                  |
| 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>Liula macrospora</i>                       |
| AE          | ELK                                                                  | AX          | BIRDS                    | DFE         | Elytrodema needle and shoot disease <i>Elytrodema 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>Menia laricis</i>                           |
| <b>N</b>    | <b>ABIOTIC INJURIES</b>                                              |             |                          | DFN         | Leptomelanconium needle blight <i>Leptomelanconium pinicola</i>  |
| NAV         | Avalanche or snow slide                                              | NK          | FUMEKILL                 | DFO         | Lophodermium needle cast <i>Lophodermium seditionum</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                 |             |                                                                  |
| <b>D</b>    | <b>DISEASE</b>                                                       |             |                          | <b>DL</b>   | <b>LEADER OR BRANCH DIEBACKS</b>                                 |
| 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>                 |             |                          | <b>DM</b>   | <b>DWARF MISTLETOES</b>                                          |
| 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                                                     |             |                          | <b>DR</b>   | <b>ROOT DISEASES</b>                                             |
| DFA         | Western pine aster rust <i>Coleosporium asterum</i>                  |             |                          | DRA         | Amillaria root disease <i>Amillaria oostoyae</i>                 |
|             |                                                                      |             |                          | DRB         | Blackstain root disease <i>Leptographium wageneri</i>            |
|             |                                                                      |             |                          | DRC         | Laminated root rot (cedar form) <i>Phellinus weirii</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.                   |
| <b>DS</b>   | <b>STEM DISEASE (CANKER OR RUST)</b>                            | 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         | Elytrodema needle and shoot disease <i>Elytrodema deformans</i> | <b>IS</b>   | <b>SHOOT AND STEM INSECTS</b>                             |
| 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>       |
| <b>I</b>    | <b>INSECTS</b>                                                  | ISG         | Gouty pitch midge <i>Cecidomyia piniopis</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>               | <b>IW</b>   | <b>WEEVILS</b>                                            |
| 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.                                              |
| <b>IB</b>   | <b>BARK BEETLES</b>                                             | 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>Hylobius warreni</i>       |
| IBE         | Silver fir beetle <i>Pseudohylesinus sericeus</i>               | IWY         | Cylindrocryptus weevil <i>Cylindrocryptus</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>                    | <b>M</b>    | <b>MITE DAMAGE (TRISETACUS SPECIES)</b>                   |
| IBI         | Engraver beetles <i>Ips</i>                                     | <b>T</b>    | <b>TREATMENT INJURIES</b>                                 |
| IBL         | Lodgepole pine beetle <i>Dendroctonus murrayanae</i>            | TC          | CHEMICAL                                                  |
| IBM         | Mountain pine beetle <i>Dendroctonus ponderosae</i>             | TH          | HARVESTED                                                 |
| IBP         | Twig beetles <i>Pityogenes</i> , <i>Pityophthorus</i> spp.      | TL          | LOGGING                                                   |
| IBS         | Spruce beetle <i>Dendroctonus rufipennis</i>                    | TM          | OTHER MECHANICAL DAMAGE (NON-LOGGING)                     |
| IBT         | Red turpentine beetle <i>Dendroctonus valens</i>                | TP          | PLANTING                                                  |
| IBW         | Western pine beetle <i>Dendroctonus brevicornis</i>             | TPM         | Planting — poor microsite                                 |
| <b>ID</b>   | <b>DEFOLIATING INSECTS</b>                                      | TR          | PRUNING                                                   |
| IDA         | Black army cutworm <i>Actebia fennica</i>                       | TT          | THINNING OR SPACING                                       |
| IDB         | Two-year budworm <i>Choristoneura biennis</i>                   | <b>V</b>    | <b>VEGETATION PROBLEMS</b>                                |
| IDC         | Larch casebearer <i>Coleophora laricella</i>                    | VH          | HERBACEOUS COMPETITION                                    |
| IDE         | Spruce budworm <i>Choristoneura fumiferana</i>                  | VP          | VEGETATION PRESS                                          |
| IDG         | Green-striped forest looper <i>Melanophila imatata</i>          | VS          | SHRUB COMPETITION                                         |
| IDH         | Western blackheaded budworm <i>Acleris gloverana</i>            | VT          | TREE COMPETITION                                          |
| IDI         | Pine needle sheath miner <i>Zelleria haimbachi</i>              |             |                                                           |
| IDL         | Western hemlock looper <i>Lambdina fiscellaria lugubrosa</i>    |             |                                                           |

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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               | <b>Wound</b><br>(including sunscald and girdling)                             | <ul style="list-style-type: none"> <li>the tree has a girdling wound which is greater than 33% of the stem circumference, or</li> <li>the tree has a wound which is equal to or greater than 1m in length.</li> </ul>                                                                                                                                                                                                                                                                                    | All                                          | <b>Biotic causes:</b><br>bear AB, cattle AC, hare AH, moose AM, porcupine AP, squirrel AS, beaver AZ, atropellis canker DSA<br><b>Abiotic causes:</b><br>sunscald NZ, logging TL, mechanical TM, fire NB, windthrow NW                                                                         | A <b>wound</b> 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               | <b>Insect mining at root collar</b>                                           | <ul style="list-style-type: none"> <li>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</li> </ul>                                                                                                                                                                                                                                                              | 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               | <b>Deformation</b><br>(including crook, fork, browse, and dead or broken top) | <ul style="list-style-type: none"> <li>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</li> <li>the tree has a fork in the lower 2/3 of the stem and the smaller of the stems is <math>&gt;\frac{1}{4}</math> the diameter of the main stem, note forks below 1.3 m are considered as two trees, or</li> <li>the tree has a dead or broken top at a point that is <math>&gt;5</math> cm in diameter.</li> </ul> | <div>All</div> <div>All</div> <div>All</div> | <b>Biotic causes:</b><br>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,<br><b>Abiotic causes:</b><br>frost NG, hail NH, snow NY, drought ND, logging TL, mechanical TM, Deep planting TP | <p>For <b>horizontal displacement</b> see Figure 1.</p> <p>For a <b>crook</b> of unknown cause, use damage code <b>UCR</b>.</p> <p>For <b>forking</b>, see Figure 2. If unable to determine cause of fork, record as damage code <b>UF</b>. 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 <b>broken top</b> of unknown cause, use damage code <b>UBT</b>.</p> |
| STEM               | <b>Lean and sweep</b>                                                         | <ul style="list-style-type: none"> <li>the tree leans <math>&gt;30^\circ</math> from the vertical with or without growth correction (sweep)</li> </ul>                                                                                                                                                                                                                                                                                                                                                   | All                                          | flooding NF, snow NY, slides NS, wind NW, mechanical TM                                                                                                                                                                                                                                        | For <b>sweep</b> or <b>lean</b> of unknown cause, record using damage code <b>USW</b>                                                                                                                                                                                                                                                                                                                                                                                                      |
| STEM               | <b>Suppressed</b>                                                             | <ul style="list-style-type: none"> <li>the tree has a height to diameter ratio <math>&gt; 100</math></li> <li>or, tree has <math>&lt; 20\%</math> Live Crown</li> </ul>                                                                                                                                                                                                                                                                                                                                  | PI, Py, Pw, Fd, Sx, Lw                       | Suppressed light environment, leading to high potential for competition induced mortality VT                                                                                                                                                                                                   | <b>Note:</b> Only trees that are clearly not expected to reach rotation should be deemed unacceptable.                                                                                                                                                                                                                                                                                                                                                                                     |
| STEM               | <b>Infection</b><br>(including cankers and galls)                             | <ul style="list-style-type: none"> <li>any infection occurs on the stem, except DSG</li> <li>DSG stem gall affects <math>&gt;25\%</math> of stem circumference</li> </ul>                                                                                                                                                                                                                                                                                                                                | All<br>PI, Py                                | comandra blister rust DSC, stalactiform blister rust DSS white pine blister rust DSB, western gall rust DSG,                                                                                                                                                                                   | <b>Note:</b> 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"> <li>Any of the following signs are visible: pitch tubes, boring dust, exit holes on bark surface, galleries under the bark</li> </ul>                                                                                                                                                                           | Pl, Sx, Fd                     | Douglas-fir beetle IBD, mountain pine beetle IBM, spruce bark beetle IBS, Ips pini IB1, <i>Pityogenes</i> & <i>Pityophthorus</i> IBP | <p><b>Note:</b> 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 <b>not</b> 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"> <li>an infection occurs on a live branch less than 20 cm from the stem.</li> </ul>                                                                                                                                                                                                                              | Pw, Pl, Py                     | white pine blister rust DSB, comandra blister rust DSC, stalactiform blister rust DSS                                                |                                                                                                                                                                                                                                                                                                                                                                               |
| BRANCH             | Gouting                                     | <ul style="list-style-type: none"> <li>any adelgid <b>gouting</b> occurs on a branch.</li> </ul>                                                                                                                                                                                                                                                   | Ba, Bg, Bl                     | balsam woolly adelgid IAB.                                                                                                           | <p><b>Gouting</b> 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"> <li>&gt; 50% of tree foliage has been removed by Dothistroma in ICH, CWH, and SBS biogeoclimatic zones.</li> </ul>                                                                                                                                                                                              | All P                          | Dothistroma needle blight, DFS                                                                                                       | See Figure 3                                                                                                                                                                                                                                                                                                                                                                  |
| FOLIAGE            | Douglas-fir tussock moth and hemlock looper | <ul style="list-style-type: none"> <li>&gt;60% of tree foliage has been removed due to hemlock looper or Douglas-fir tussock moth.</li> </ul>                                                                                                                                                                                                      | Fd, Hw                         | Douglas-fir tussock moth (IDT), hemlock looper (IDL)                                                                                 |                                                                                                                                                                                                                                                                                                                                                                               |
| FOLIAGE            | Other defoliating insects and disease       | <ul style="list-style-type: none"> <li>&gt;80% of tree foliage has been removed due to foliage disease.</li> </ul>                                                                                                                                                                                                                                 | All other conifers<br>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 &gt;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"> <li>The top 2/3's of the tree is affected and the growth is clearly stunted.</li> </ul>                                                                                                                                                                                                                         | 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"> <li>Any layer 1 and 2 tree with a Hawksworth rating &gt;3 (Figure 4).</li> <li>any infection occurs on the stem or a live branch of layer 3 trees.</li> <li>a susceptible tree is located within 2 times the height of the infection on an overtopping tree, which is infected with dwarf mistletoe.</li> </ul> | Hw, Pl, Lw, Fd                 | Douglas-fir dwarf mistletoe DMF, hemlock dwarf mistletoe DMH, larch dwarf mistletoe DML, lodgepole pine dwarf mistletoe DMP,         | <p><b>Note:</b> To confirm infection, the surveyor must observe mistletoe aerial shoots or basal cups on regeneration or on live or dead fallen brooms.</p> <p><b>Overtopping tree</b> 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"> <li>sign(s) or a definitive combination of symptoms of root disease are observed.</li> <li>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.</li> </ul> | <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><b>Signs</b> are direct evidence of the pathogenic fungus including fruiting bodies, distinctive mycelium or rhizomorphs. <b>Symptoms</b> 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><b>Note:</b> All conifer species are considered susceptible. All broadleaf species are considered <b>not susceptible</b> for survey purposes only.</p> <p><b>Note:</b> Cw, Pl, Pw, Py, and all broadleaf species are considered <b>not susceptible</b> for survey purposes only.</p> <p><b>Note:</b> All other conifers and broadleaf species are considered <b>not susceptible</b> for survey purposes only</p> <p><b>Note:</b> Bg, Bl, Cw, Cy, Pw, Py, and all broadleaf species are considered <b>not susceptible</b> for survey purposes only.</p> <p><b>Note:</b> Cw, Cy, Pw, Pl, Py, and all broadleaf species are considered <b>not susceptible</b> for survey purposes only.</p> <p><b>Example:</b> How to apply net down for all root diseases. If root disease-infected trees are found in the plot:<br/> 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);<br/> 2. In a second independent sweep, determine the number of well-spaced <b>infected</b> trees using MITD (e.g., 1 infected tree);<br/> 3. From the number of <b>susceptible</b> healthy well-spaced trees found in step 1, subtract the <b>number of well spaced infected trees</b>. The result (e.g., 11 trees) is the adjusted number of healthy, well-spaced trees tallied for the plot.</p> |

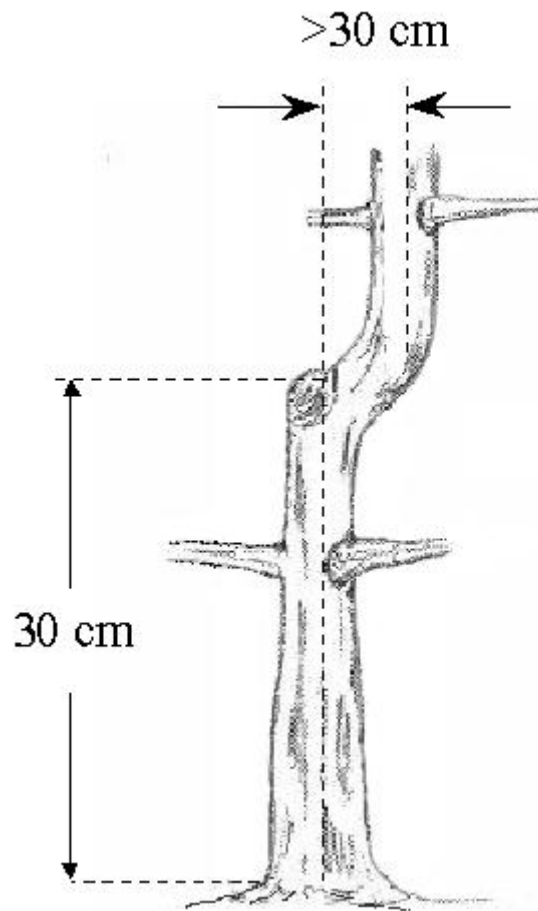


**Figure 1. Determining horizontal displacement when assessing stem deformation. This is only done when the tree has five seasons' growth after damage occurs.**

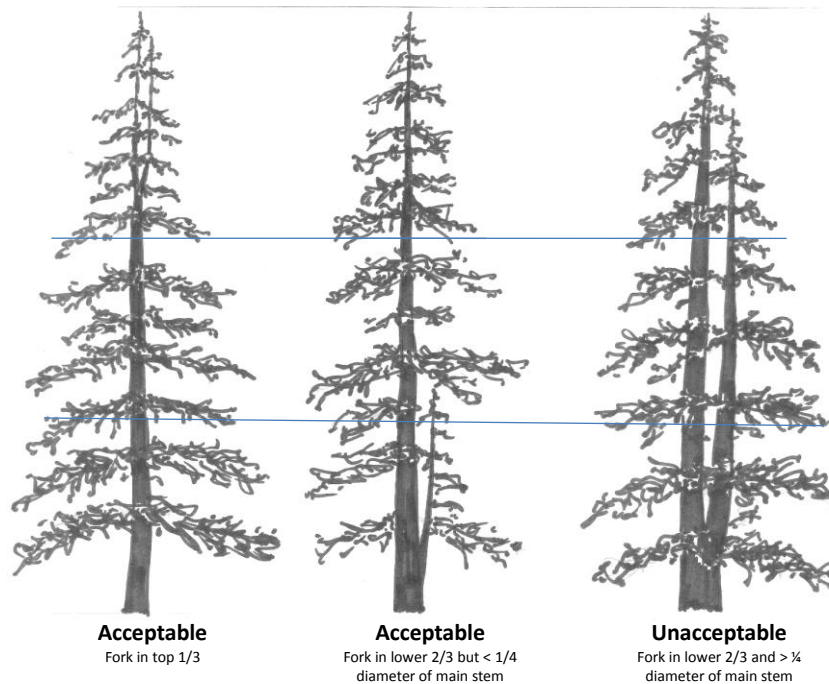


**Figure 2. Acceptable and unacceptable forking in age class 2 & 3 conifers (damage code UF).**

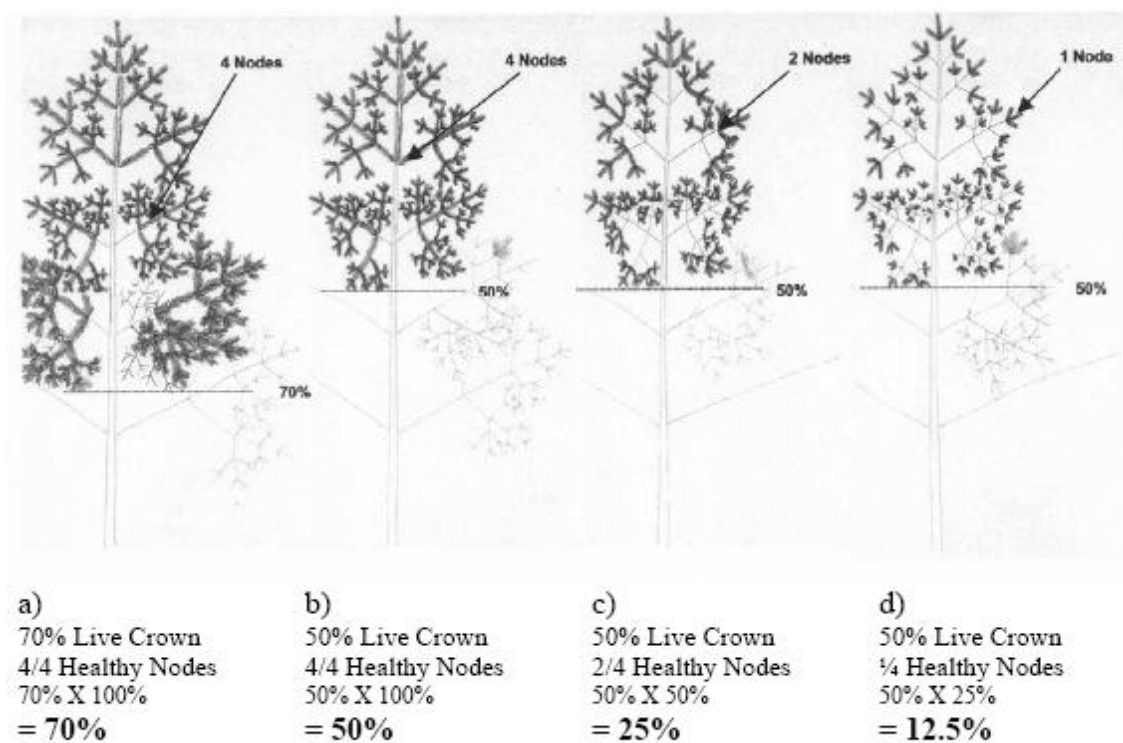


**Figure 3. Calculating defoliation for Dothistroma-afflicted conifers.**

| Instructions                                                                                                                                                                                                                                                                                                                                                                          | Example                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b>Step 1</b> Divide live crown into thirds.                                                                                                                                                                                                                                                                                                                                          | If this third has no visible infections, its rating is (0).                                                        |
| <b>Step 2</b> 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"> <li>(0) no visible infections</li> <li>(1) light infection (1/2 or less of total number of branches in the third infected)</li> <li>(2) heavy infection (more than 1/2 total number of branches in the third infected).</li> </ul> | If this third is lightly infected, its rating is (1).<br><br>If this third is heavily infected, its rating is (2). |
| <b>Step 3</b> 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.

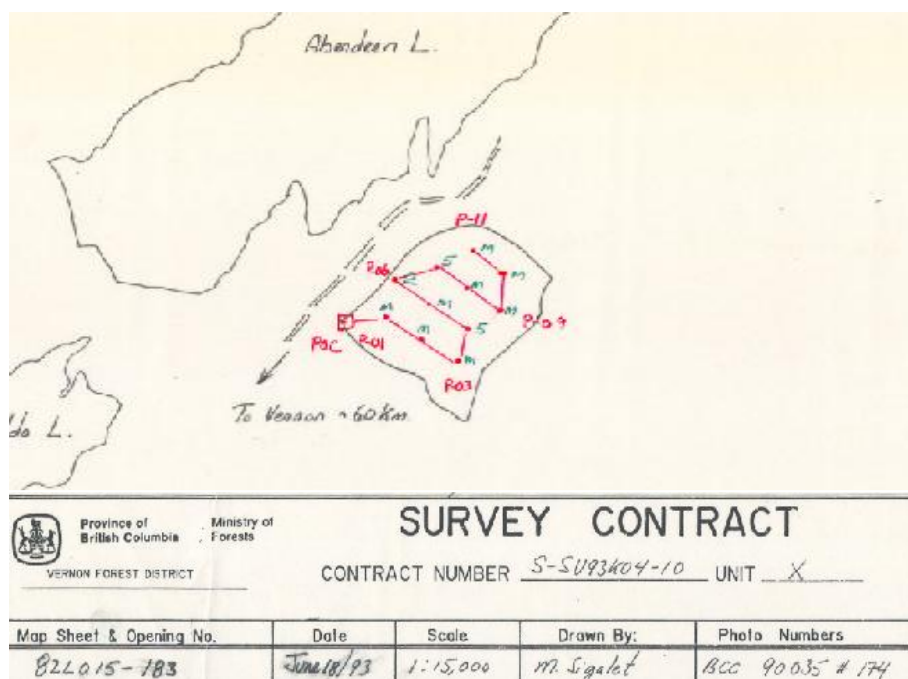


Figure 7. Original survey map with plot locations.

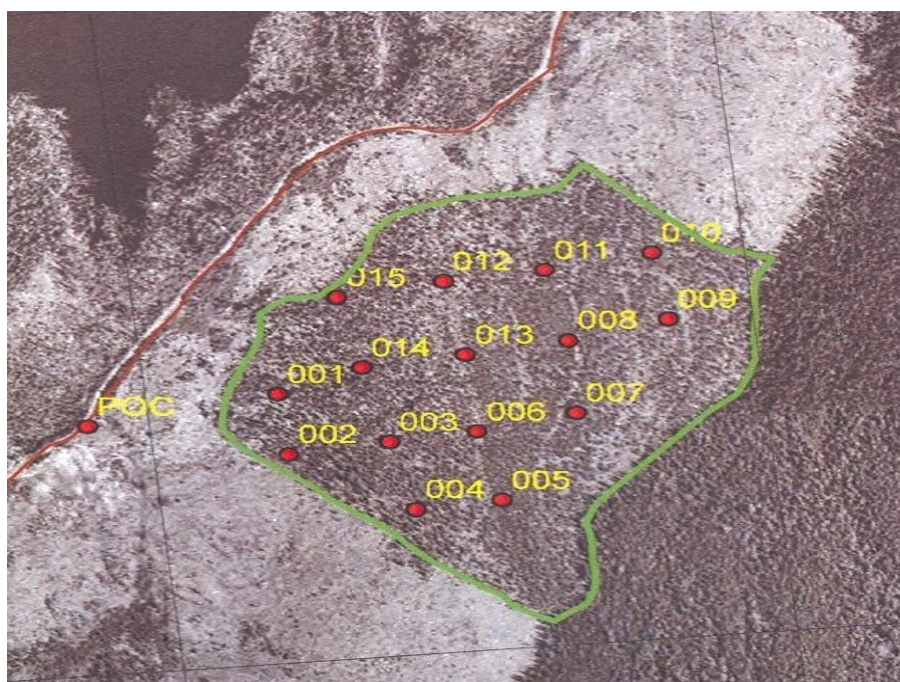


Figure 8. Air photo of survey polygon with plots identified.

## **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](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 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.

## ***Appendix 5 SDM TSA Report – example***

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

[SDM TSA Data Summaries](#)