
Kamloops and Clearwater Forest Districts

Inventory Plan

**MINISTRY OF FORESTS
RESOURCES INVENTORY BRANCH
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1. INTRODUCTION

1.1 Background

The Provincial Vegetation Resources Inventory (VRI) or Provincial Inventory is an improved vegetation (forest) inventory process or toolbox for assessing the quantity and quality of British Columbia's timber and other vegetation resources. It addresses the concerns expressed by the Forest Resources Commission in its 1991 report, *The Future of our Forests*. These concerns included:

- lack of statements of precision of the inventory;
- inadequate information on non-timber vegetation resources;
- lack of reliable estimates of growth rates and stand specific volumes; and
- narrow focus on commercial timber volume and the timber harvesting landbase.

The VRI can be implemented at a number of levels depending on the business needs. It can be deployed over the entire province (one or more Forest Districts at a time), measuring all the timber and non-timber resources. The VRI can also be deployed over a Management Unit (TFL or TSA) or a small watershed within a District, measuring selected resources in specific portions of the landbase.

The Provincial Inventory consists of a system of protocols, models and databases that can be managed through a dispersed computing environment. The Provincial Inventory process can be used to meet today's needs for timber supply, long term planning, silviculture planning, defining sustainability, public information and credibility. The Provincial Inventory can also provide data for computer modeling and decision support systems to support a baseline biodiversity assessment and for research.

The Vegetation Resources Inventory is designed to determine:

- the amount of vegetation cover in the province;
- the location of vegetation resources in the province; and
- the changes in the amount and location of vegetation resource over time.

The principles guiding the implementation of the inventory are:

- to integrate provincial inventory activities (e.g. Management Inventories, Provincial Inventory, National Forest Inventory and Monitoring);
- to implement inventory projects to satisfy business requirements as defined in the inventory plans; and
- to maximize the usefulness of sample plots and minimize overall costs by implementing a cascading plot approach that ensures that information collection meets the VRI standards while meeting multiple goals.

Management Inventories include inventories conducted in Implementation Units¹, to fulfill specific forest management or business needs. Sampling error and sampling intensity are controlled for specific vegetation attributes (e.g., timber volume) to achieve specific inventory objectives. There are several types of Implementation Units in the province: Timber Supply Areas (TSAs), Tree Farm Licenses (TFLs), and other lands (parks, private lands, and other public lands). Within (or across) these Implementation Units there may be Management Inventories addressing specific issues such as Problem Forest Types, or other strata in a TSA (or groups of TSAs).

Management Inventories are typically timber emphasis inventories. Besides providing detailed polygon information for day-to-day forest management, they can also be used to increase precision of the Provincial inventory. The TFL holders or the MoF Regions/Districts are responsible for the planning and implementation of these inventories. However, the Ministry of Forests Resources Inventory Branch requires the TFL holders or Districts to prepare an inventory business plan, which includes a sampling plan, for its approval. An inventory business plan defines the inventory needs, the information needed to meet the needs, and the methods for collecting the information. This business plan then drives the inventory project plans.

1.2 Objectives

This is a plan for implementing the Provincial and Management Inventory activities for the Kamloops and Clearwater Forest Districts in the Kamloops Forest Region. This plan was developed through consultation with various stakeholders on October 21, 1997 in the Kamloops and Clearwater Forest Districts. The stakeholders include the Ministry of Forests Branch, Region and District staff, The Ministry of Environment, Lands and Parks Kamloops Region, Weyerhaeuser Canada, Slocan Forest Products, Ainsworth Lumber Company, International Forest Products Ltd., Riverside Forest Products Ltd., Tolko Industries Ltd., Bell Pole Co. Ltd., and Gilbert Smith Forest Products Ltd. Management issues identified in the recent Timber Supply Review in the TSA were also reviewed.

The purpose of the Inventory Plan is to:

1. define the Management Inventory objectives;
2. define the Provincial Inventory strategy for Kamloops and Clearwater Forest Districts;
3. identify the inventory activities required to satisfy the objectives for both inventories; and
4. outline the implementation steps.

This plan is based on the consultant report, *Kamloops and Clearwater Forest Districts Vegetation Resources Inventory Ground Sampling Plan, Revised Final Report*, prepared

¹ Implementation Units are a specified area of land such as a TSA, TFL, Innovative Forest Practices Agreement area, etc. For any Implementation Unit, there can be none to several Management Unit inventories based on stakeholder business needs.

by J.S. Thrower & Associates. The report was prepared following the procedures outlined in the Ministry of Forests, Resources Inventory Branch procedures *Vegetation Resources Inventory: Preparing a sampling plan for ground sampling* (March 1997). The report has been reviewed by stakeholders in the District and is attached to this Inventory Plan (Appendix A).

This Inventory Plan identifies stakeholder requirements at a given point in time. As such, it is anticipated that there will be changes to this plan. Any changes including plans that are more detailed and roles and responsibilities will be added to this plan as an addendum.

2. BUSINESS CONSIDERATIONS

2.1 Forest Management Issues

Forest management issues were identified during the recent timber supply review (Tables 1a, 1b and 1c). An assessment of potential impacts of the VRI on these management issues is also shown in these tables.

Table 1a. Forest management issues for the Kamloops TSA and the potential impact on the Provincial Inventory.

Management Issues ²	Remarks
1. Watersheds and green-up. Review management assumptions.	Application of the inventory.
2. Root rot, cattle grazing: quantify estimates of non-recoverable losses attributed to cattle grazing.	Application of the inventory.
3. Minimum harvestable ages: review objectives.	Application of the inventory.
4. Archaeological impact assessment: assess medium- to high-potential sites identified through AOA.	Application of the inventory.
5. ESAs: conduct terrain mapping.	Application of the inventory.
6. Clarify reductions for roads, trails, and landings.	Application of the inventory.
7. Unsalvaged losses: quantify losses.	Application of the inventory.
8. Wildlife trees: incorporate biodiversity guidelines into future analysis.	Phase II data includes information on wildlife trees.
9. Old-growth retention of 10%: incorporate biodiversity guidelines into future analysis.	Old-growth status is assessed in Phase II plots.

² BC Ministry of Forests, Timber Supply Branch. 1996. *Forest Management Issues Identified Through the AAC Determination Process, TSA/TFL Timber Supply Reviews: 1992-1996.*. Victoria, BC. pp. 49-54.

	Management Issues ²	Remarks
10	Biodiversity: incorporate biodiversity strategy into future analysis.	Plant lists, forage production, lichen production and shrub transects from Phase II plots provide TSA totals, which could be used to confirm biodiversity levels at the TSA level.
11	Biodiversity guidelines: incorporate Kamloops LRUP biodiversity guidelines into future analysis.	Plant lists, forage production, lichen production and shrub transects from Phase II plots provide TSA totals, which could be used to confirm biodiversity levels at the TSA level.
12	Regenerated stand volumes: assess impact of alternative silviculture systems.	Application of the inventory.
13	Site productivity: review paired plot results and effect on green-up.	Application of the inventory.
14	Silviculture treatments: assess effects of fertilization.	Application of the inventory.
15	Uneven aged stands: new model(s) need to be developed.	Application of the inventory.
16	Inventory audit.	Application of the inventory.
17	Lakes classification: classify remainder of lakes from LRUP.	Application of the inventory.
18	Inoperable areas: harvesting in these areas should be monitored.	Application of the inventory.
19	Recreation (Sun Peaks Resort): review request for removal of 235 ha from timber harvesting landbase.	Application of the inventory.
20	Regeneration impediments: refine timber supply implications.	Application of the inventory.
21	Regeneration delay: monitor delay assumptions.	Application of the inventory.
22	Temporary deferral: quantify impact and examine application of Part 15 Forest Act AAC reduction.	Application of the inventory.

Table 1b. Forest management issues for TFL 18 and the potential impact on the Provincial Inventory.

	Management Issues ³	Remarks
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³ BC Ministry of Forests, Timber Supply Branch. 1996. *Forest Management Issues Identified Through the AAC Determination Process, TSA/TFL Timber Supply Reviews: 1992-1996*. Victoria, BC. pp. 235-237.

Management Issues ³	Remarks
1. Wildlife habitat: assess impact of wildlife habitat and forest cover requirements for next analysis.	Application of the inventory.
2. Inventory audit: if problems indicated, determination may be revisited early.	Application of the inventory.
3. Biodiversity: assess timber supply impacts of biodiversity requirements.	Plant lists, forage production, lichen production and shrub transects from Phase II plots provide District totals, which could be used to confirm biodiversity levels at the District level.
4. Alternative silviculture systems: quantify volume impacts.	Application of the inventory.
5. Unsalvaged losses: provincial review underway.	Application of the inventory.
6. Site productivity: assess results of paired plot work.	Phase II data can be used to check existing site index estimates.
7. Silviculture treatments: performance and rehabilitation required in residual balsam stands.	Application of the inventory.
8. Landscape inventories: incorporate additional areas into visual quality zones.	Application of the inventory.
9. Kamloops LRMP: assess effects of outstanding decisions once Plan is implemented.	Application of the inventory.

Table 1c. Forest management issues for TFL 35 and the potential impact o the Provincial Inventory.

Management Issue ⁴	Remarks
1. Merchantability assumptions: operate across profile and submit annual performance reports.	Application of the inventory.
2. Roads, trails, and landings: incorporate past and future losses into next analysis.	Application of the inventory.
3. Silviculture labels: verify propriety of substituting silviculture labels for inventory labels in analysis in consultation with BCFS staff.	Application of the inventory.
4. Alternative harvest flows: model alternative harvest flows in next	Application of the inventory.

⁴ BC Ministry of Forests, Timber Supply Branch. 1996. *Forest Management Issues Identified Through the AAC Determination Process, TSA/TFL Timber Supply Reviews: 1992-1996*. Victoria, BC. pp. 241-245.

Management Issue ⁴	Remarks
analysis.	
5. Unsalvaged losses: use better data and methodological rigor to support estimates in next analysis.	Application of the inventory.
6. Regeneration and species conversion: verify conversion assumptions and commitment to mixed species planting.	Application of the inventory.
7. Site productivity and species conversion: assumptions of species conversion and site productivity changes need to be verified if to be used in the next determination.	Application of the inventory.
8. Biodiversity: reconcile future age class structure assumptions with biodiversity objectives.	Plant lists, forage production lichen production, and shrub transects from Phase II plots provide TSA totals, which could be used to confirm biodiversity levels at the TSA level.
9. Wildlife habitat, cover requirements: as better information is produced, ensure that current management strategies meet or exceed cover requirements imposed by LRMP.	Application of the inventory.

2.2 Inventory Issues

The following is a summary of inventory issues derived from the forest management issues in the Districts as discussed by the stakeholders:

- ESAs: some of the ESA issues will be covered by terrain mapping but not all therefore, better Phase I is also required.
- Partition of cuts and volumes within the TSA – Cedar/Hemlock stands and Pulpwood Area (PA) stands.
- Clearwater Forest District inventory – individual polygon values may be a problem.
- Balsam residual stands (Clearwater Forest District).
- Insect infestation (Cedar/Hemlock stands), see second bullet.
- Site index assignment (future and existing stands).
- Medicinal plants (First Nations).
- Old-growth characteristics, especially selectively logged stands.
- Biodiversity – plants lists.
- Veteran component – layer ages.
- Range – noxious weeds and range mapping.

- Dry-belt Douglas fir – site productivity, site index, volumes, etc.
- Decay, waste, and breakage.
- Unsalvaged losses – dead potential volumes.
- The International Forest Products Ltd.’s Innovative Forest Practices Agreement (IFPA) area. The geographic area of the IFPA is not yet defined, so this Inventory Plan may need to be revised reflecting any new issues that arise in the future.
- Provincial monitoring of the indicators of sustainable forest management, as defined by the Canadian Council of Forest Ministers⁵ (CCFM). Monitoring would involve measuring changes and trends in some of these indicators, which include percent and extent of area by forest type and age class, and mean annual increment by forest type and age class.
- Issues raised by the Forest Resources Commission’s 1991 report, *The Future of Our Forests*, regarding the inadequacy of forest inventories in the province. These concerns included lack of statements of precision on the inventory, inadequate information on non-timber vegetation, and the narrow focus on commercial timber volume and the operable landbase.

3. INVENTORY PLAN

3.1 Provincial Inventory

3.1.1 Provincial Inventory Landbase

The Landbase for the Kamloops and Clearwater Provincial Inventory is the Kamloops and Clearwater Forest Districts in the Kamloops Forest Region. The landbase consists of the entire Kamloops TSA (approximately 2.7 million ha), Wells Gray Provincial Park, TFL 18, and TFL 35.

3.1.2 Objectives

3.1.2.1 Photo Interpretation

A Phase I photo estimation pilot project is currently ongoing in the Kamloops Forest District. The purpose of this Phase I study is to conduct an operational inventory with a high visitation rate (50%) on two mapsheets. The results of this study should be checked using the VRI sample clusters. It is also recommended that Phase I estimates be derived for the sample polygons (185) in which VRI sample clusters fall (those polygons which

⁵ Canadian Council of Forest Ministers. 1995. *Defining Sustainable Forest management. A Canadian Approach to Criteria and Indicators*. Natural Resources Canada, Canadian Forest Service. Ottawa, ON. 22pp.

have not had Phase I conducted on them yet). This should be done using one photo interpreter to provide consistency among estimates. Existing polygon boundaries would be maintained, and the additional data would be used to evaluate potential benefits of new Phase I estimates. This photo typing may be done before or after the VRI ground sampling.

The Kamloops Forest District is also completing a *retrofit* of the existing inventory information. When complete, the inventory will meet the VRI Phase I standards.

3.1.2.2 Ground Sampling

The purpose of VRI ground sampling is to provide overall totals and averages for timber and non-timber vegetation resources (medicinal plants and other botanical forest products) in the Inventory Unit. The sampling will target a sampling error of $\pm 10\%$ (95% probability) for net timber volume in the treed portion of the Inventory Unit, and to allow for the calculation of sampling errors for other VRI attributes⁶. The key attributes of interest in this VRI are stand age, net volume by species and stand height. Information will be collected on all attributes, but the variability of identified key attributes will be used to set the sample size for the VRI.

3.1.3 Sampling Plan

3.1.3.1 Sample Size

To achieve the inventory objectives as identified above, the sample sizes required to implement the Provincial Inventory are summarized in Table 2. In inventory, a sampling error standard is necessary to provide a basis for determining sample size. In the VRI, the allowable sampling error standard is set at $\pm 10\%$ for volume estimation. This standard does not apply to the other attributes in the inventory.

The number of samples required to achieve the standard is a function of the variation within the Inventory Unit, estimated by the coefficient of variation (CV%). The estimated CV in the Kamloops and Clearwater Forest Districts used to estimate the total number of plots to achieve a sampling error of $\pm 10\%$ for net volume is 57%⁷. To achieve the Provincial Inventory standard at a reasonable cost, two types of VRI plots will be used:

- full VRI samples, where the full suite of information (timber, coarse woody debris, range and ecology) is collected; and
- tree emphasis samples, where only tree information is collected.

⁶ The 10% sampling error level is the provincial standard which was approved by the Chief Forester in June 1997 (Briefing Note to the Chief Forester of 7 May 1997 prepared by the MoF Resources Inventory Branch). This level was chosen based on consideration of the risks associated with misstating the inventory in timber supply analysis.

⁷ The inventory audit CV was inflated by 25% to account for the possible differences between the CV estimates based on the VRI design (a tight 5-plot cluster) and based on the inventory audit (a well-distributed 9-plot cluster).

The total number of full VRI samples (60) will be adequate to achieve a sampling error of $\pm 15\%$ in the treed landbase. Tree emphasis samples (TEP) (70) will then be used to reduce the sampling error in the treed landbase to $\pm 10\%$ to achieve the standard.

In the remaining non treed area of the unit, the number of full VRI samples established (55) will be the ratio of the treed to remaining landbase, multiplied by the number of treed VRI samples required to achieve a sampling error of $\pm 15\%$.

Implementing the two types of samples will ensure a minimum number of full VRI plots are established across the landscape to collect the full suite of VRI information.

Establishing TEPs to boost the number of plots required to achieve the VRI standard will result in saved time and money.

To complete the Provincial Inventory, NVAF (net volume adjustment factor) and WPV (within polygon variation) sampling is required. The numbers of these types of samples are contained in Table 2.

Table 2. The estimated sample size required to implement the Provincial Inventory.

Ground Sampling Activity	Sampling Unit	VRI Samples	Tree Emphasis Samples	Sample Size
Provincial Inventory				
Vegetated Treed	Cluster	60	70	130
Other	Cluster	55		55
Net Volume Adjustment Factor	Trees	75		75
Within Polygon Variation	Polygon	30		30

3.1.3.2 Provincial Inventory Sampling

To achieve the Provincial Inventory objectives, the sampling should be implemented in a two-step process. Step 1 is to install approximately 100 sample clusters in the first field season over the inventory unit. Step 2 is to install the remaining sample clusters in the second field season. The sampling locations will be selected systematically from the sorted list of potential sampling points. This list will include all polygons in the inventory unit and will be sorted by non-vegetated/vegetated and then land type, leading tree species, age and site index. Sampling in the first year will provide experience to refine the process for the second field season, and information to calculate precisely the remaining number of samples required to meet the precision target of $\pm 10\%$ for total net volume in the treed portion of the Districts. An estimated total of 185 sample clusters will be assumed for planning, training, and other logistic considerations. Matching unavailable sampling sites with sub-sampling of sample clusters with difficult access will be anticipated and planned for, as these activities will increase inventory costs.

A two-step approach should also be used for implementing the other ground sampling activities that support the Provincial Inventory process: NVAF sampling and WPV sampling. NVAF provides a factor to adjust the net volume from the ground sampling (derived from the net factoring process and taper equations) to account for hidden decay and possible bias in taper equations. WPV information is used to express the total error of

the inventory and to indicate accuracy of individual polygon estimates. A total of 75 sample trees for NVAF sampling (selected from 15 treed and 1 non-treed polygons) and 30 sample polygons for WPV sampling are required.

3.2 Management Inventory

3.2.1 Management Inventory Landbase

For the Kamloops and Clearwater Forest Districts, five Management Inventories⁸ were created to address the inventory issues raised by the stakeholders. These sub-units correspond to specific vegetation types (enhanced timber inventories; dry-belt Douglas-fir, balsam residual and old-growth forests; range inventory; Pulpwood Agreement #16 (PA#16) forest types; and cedar and hemlock forest types in the Kamloops TSA). Table 3 outlines the area by Inventory Unit within the Kamloops and Clearwater Forest Districts.

A sixth Management Unit, to improve stand descriptions (age, height and species composition), and regenerated site index/productivity estimates in the dry-belt fir stands, balsam residual stands and old-growth (age class 7-9) stands in the Inventory Unit (excluding the parks) was identified. However, this is a growth and yield issue and not addressed in this plan. Table 3 provides an approximation of the area to be assessed by the Provincial and Management Inventories.

⁸ Management Units are separate populations created within the inventory unit to control sampling error and sampling intensity for specific attributes.

Table 3. Area by Inventory Unit within the Kamloops and Clearwater Forest Districts.

Inventory Type	Inventory Unit	Area (ha)
Kamloops/Clearwater VRI	Kamloops Forest District	1,100,000
	Clearwater Forest District	1,000,000
	TFL 18	74,600
	TFL 35	36,000
	Wells Gray Provincial Park	570,000
	Total	2,780,600
Management Unit	Enhanced Timber Inventories	Not Available
	Dry-belt Douglas-fir, Balsam Residual and Old-growth Forests	Not Available
	Range Inventory	Not Applicable
	Pulpwood Agreement #16 Forest Types	Not Available
	Cedar and Hemlock Forest Types in the Kamloops TSA	Not Available

3.2.2 Objectives

3.2.2.1 Photo Interpretation

See Section 3.1.2.1.

3.2.2.2 Ground Sampling

The ground sampling objectives for the Management Inventories are to:

- enhance timber inventories where necessary in the TSA (excluding parks), TFL 18 and TFL 35. The sampling will target a sampling error of $\pm 10\%$ for net timber volume in the timber harvesting landbase of each Management Unit.
- improve stand descriptions (age, height and species composition) and regenerated site index/productivity estimates in the dry-belt fir stands, balsam residual stands and old-growth (age class 7-9) stands in the Inventory Unit (excluding parks).
- improve timber inventory of the PA stands in the Kamloops Forest District and the cedar/hemlock stands in the Kamloops TSA (mainly in the Clearwater Forest District).
- refine the mapping of Range Units and classification of grazing lands in the Kamloops and Clearwater Forest Districts.
- conduct VRI ground sampling and other special inventories in International Forest Products Ltd.'s Innovative Forest Practices Agreement (IFPA) area, if needed.

3.2.3 Sampling Plan

To achieve the objectives of the Management Inventories, Timber Emphasis Sampling will be required. The Timber Emphasis Sampling must meet the minimum sampling requirements as specified in *Implementation Strategy to Integrate Management, Provincial and National Inventories* (MoF, Resources Inventory Branch) The supplemental sampling will involve the installation of approximately:

- 140 sample clusters in the Enhanced Timber Inventories (for TSA only);
- 250 sample clusters in dry-belt Douglas-fir, balsam residual and old-growth forests, and range inventory;
- 150 sample clusters in PA#16 forest types; and
- 150 sample clusters in cedar and hemlock forest types in the Kamloops TSA.

The implementation should proceed in a manner similar to the Provincial Inventory ground sampling. The sampling will be spread over a period of 2 years, with unbiased interim results expected after the first season. Sampling in the first year will provide experience to refine the process for the second field season and information to calculate precisely the remaining number of samples required to meet the precision target of $\pm 10\%$.

The supplemental sampling should focus on tree attributes including call grading, net factoring and sub-sampling trees for stem analysis (addressing only decay, not breakage and waste).

NVAF sampling is a critical component of the VRI design. Stakeholders should identify within their more detailed *Inventory Plans*⁹ the level of NVAF sampling.

4. IMPLEMENTATION STRATEGY

The ground samples that are established to meet the Management Inventory objectives are compatible with the Provincial Inventory objectives providing that these dual-purpose plots are identified prior to establishment. Therefore, Provincial Inventory plots will be identified prior to identifying the Management Inventory ground sampling plots. These coincident plots will be used for both the Provincial and the Management Inventories. Additional Management Inventory samples will be established to meet Management Inventory objectives. This integrated approach, that uses one set of samples to address multiple inventory needs, will result in minimum implementation costs.

There may be a need to enhance the coincident plots for non-timber attributes within the Management Units depending on the implementation strategy chosen. Additional Provincial Inventory ground samples will need to be established in the non-Management Inventory area in order to complete the Provincial Inventory for the Kamloops and Clearwater Forest Districts.

⁹ Inventory Plans are required by stakeholders in order to proceed with their Management Inventories.

The inventory outlined above will be completed to the Ministry of Forests minimum standards as outlined in *Implementation Strategy to Integrate Management, Provincial and National Inventories*.

4.1 Steps

There are several ways to complete the ground sampling in the two-step process stated above. It is hoped that stakeholders will complete all the required ground sampling in a timely manner. One possible scenario is as follows:

1. Install a large number of each Management Inventory sample clusters (e.g., 100) over the entire landbase measuring *only those* tree attributes related to timber volume and site index. Install the Provincial Inventory samples for plots that are designated “multi-purpose” and install tree emphasis plots for the others. This will provide the experience to refine the process for the second field season and will provide information to calculate the required number of remaining sample clusters.
2. Install the remaining Management Inventory sample clusters in the second field season. (Note: the stakeholder may choose to install all ground samples in one field season).

4.1.2 Implementation Process

The implementation process will proceed based on available funding and can be implemented based on a number of scenarios. All implementation scenarios will a common process. One possible implementation process could proceed as follows:

1. Assemble all polygons within the District into one list; check to ensure no areas are missing or double counted.
2. Sort the polygon list according to the criteria: BC Land Cover Classification code, estimated leading tree species, age and site index.
3. Select potential sampling points from the sorted list as described in the Ministry of Forests, Resources Inventory Branch document, *Vegetation Resources Inventory: Preparing a sampling plan for ground sampling*.
4. Stratify list to *vegetated treed* and *remaining area* (non-vegetated, vegetated non-treed).
5. Systematically select the Provincial Inventory samples by stratum.
6. Systematically select the polygons for the within polygon variation sampling from the list of Provincial Inventory samples.
7. Systematically select the 16 NVAF sample points (15 treed and 1 non-treed whether or not volume is indicated) from the Provincial Inventory ground samples.
8. Stratify the District to determine the Provincial Inventory samples that meet Management Inventory objectives. Subtract this number of samples from the total

- required for each Management Inventory. Select the remaining number of Management Inventory samples.
9. For the Management Inventory, systematically select a batch of sampling points from the list of operable sampling points (80% of the sample size) and from the list of inoperable sampling points (20%).
 10. Begin planning for field sampling.
 11. Prepare a field sampling plan that includes sample cluster batches, to ensure an unbiased sample is attained at the end of the first field season. Identify NVAF sample points and ensure they are field sampled early in the field season.
 12. Locate and measure ground sample clusters.
 13. Monitor quality assurance of field data and procedures during field sampling. Arrange for 'audit quality cruisers' to sample auxiliary plots of NVAF samples.
 14. Compile the data in the fall and winter of the first year. This will include computing averages of timber volume, basal area, and regression of photo estimated volume to ground sample volume and the associated standard error of the regression.
 15. Prepare NVAF tree sampling matrix. Begin NVAF destructive sampling.
 16. Prepare for the second step during the winter. This will include calculation of the CV based on the standard error of the regression. The remaining number of samples required to achieve the stated desired precision can then be accurately determined using standard procedures (see Appendix B).
 17. Prepare the remaining samples.
 18. Locate and measure remaining ground sample clusters in the second field season. Complete stem analysis of the NVAF sample trees. Complete the within polygon variation sampling.
 19. Compile all data, do the statistical adjustments and load final inventory results into the provincial database.

4.2 Cost

4.2.1 Provincial Inventory

The Provincial Inventory costs, for planning purposes, are summarized in Table 4. A CV of 57% and the objective precision level of $\pm 10\%$ sampling error (at the 95% probability level) were used to estimate the required number of Provincial Inventory samples.

Sampling efficiency and cost effectiveness will be achieved by implementing the Management Inventory sampling in combination with Provincial Inventory ground sampling. Results of the VRI ground sampling can be evaluated to determine the additional sampling required for meeting the specific objectives.

Table 4. The estimated costs required to complete the Provincial Inventory sample plan.

Ground Sampling Unit	Sample size	Unit Cost* (\$)	Total Cost (\$)
Provincial Inventory			
Sample Cluster (VRI)	115	2,500	287,500
Sample Cluster (tree only)	70	1,500	105,000
Net Volume Adjustment Factor – Tree	75	500	37,500
Within Polygon Variation	30	1,500	45,000
Total			475,000

* The unit costs are based on experience gained from the Boston Bar Operational Trial.

4.2.2 Management Inventory

The costs for completing the Management Inventory plan are identified in Table 5.

Table 5. The estimated costs required to complete the Management Inventory sample plan.

Ground Sampling Unit	Sample size	Unit Cost (\$)	Total Cost (\$)
Management Inventory Sampling			
Enhanced Timber Inventories (TSA only)	140	1,500	210,000
Dry-belt Douglas-fir, Balsam Residual and Old-growth Forests	250	1,500	375,000
Range Inventory	Not Applicable	Not Applicable	Not Applicable
Pulpwood Agreement #16 Forest Types	150	1,500	225,000
Cedar and Hemlock Forest Types in the Kamloops TSA	150	1,500	225,000
Total	690		1,035,000

The sample size determination for the Management Inventory sampling can be found in the consultant report, *Kamloops and Clearwater Forest Districts Vegetation Resources Inventory Ground Sampling Plan, Revised Final Report* (Appendix A). The required number of Management Inventory samples is based on the appropriate CV (estimated) and the objective precision level of $\pm 10\%$ sampling error (at the 95% probability level).

4.2.3 Combining the Management and Provincial Inventory

Implemented separately, the total cost of the Provincial and the Management Inventories would be approximately \$1,510,000. Combining the inventory objectives through a common implementation strategy will realize a saving. Given the multiple Management Inventories within the Kamloops and Clearwater Forest Districts and their overlapping areas, it is difficult to estimate the magnitude of these savings. However, the savings on the Provincial Inventory samples would be approximately \$195,000 based on implementing all of the vegetated treed VRI and tree emphasis samples in combination with the Management Inventory plots.

Table 6 illustrates the cost for one possible implementation scenario where overlap occurs between one of the Management and Provincial Inventories. The total cost could be higher or lower if the assumptions stated above are not valid. For example, an increase in the CV or a reduction in the desired precision level will result in an increase in the number of samples required to achieve the objectives. The relationship between the sampling error and sample size is illustrated in the contractor report (Appendix A).

Table 6. Combined costs to complete the Management and Provincial Inventory sample plans.

Ground Sampling Unit	Sample size	Unit Cost (\$)	Total Cost (\$)
Management Inventory Sampling			
Enhanced Timber Inventories (TSA only)	140	1,500	210,000
Dry-belt Douglas-fir, Balsam Residual and Old-growth Forests	250	1,500	375,000
Range Inventory	Not Applicable		0
Pulpwood Agreement #16 Forest Types	150	1,500	225,000
Cedar and Hemlock Forest Types in the Kamloops TSA	150	1,500	225,000
Incremental Provincial Inventory			
Ground Samples			
Sample Cluster (upgrade to full VRI)	60*	1,000	60,000
Sample Cluster (tree only)	70*	0	0
Provincial Inventory (Remaining)			
Sample Cluster (VRI)	55	2,500	137,500
Sample Cluster (tree only)	0	1,500	0
Net Volume Adjustment Factor - Tree	75	500	37,500
Within Polygon Variation	30	1,500	45,000
Total			1,315,000

*Tree information component to be captured as part of the Management Inventory sample

The total cost could be higher or lower if the assumptions stated above are not valid. For example, an increase in the CV or a reduction in the desired precision level will result in an increase in the number of samples required to achieve the objectives. The relationship between the sampling error and sample size is illustrated in the contractor report (Appendix A).

Depending on the implementation strategy, the savings will vary. The savings realized reflect the comparative overlaps of the Management Inventories. The numbers in Table 6 reflect one possible implementation scenario. Costs will change depending on the actual implementation scenario chosen.

4.3 Monitoring

The Ministry of Forests, Resources Inventory Branch is responsible for monitoring this Inventory Plan.

5. APPROVAL/SIGNING

I have read and concur with the Kamloops and Clearwater Forest Districts Inventory Plan, June 24, 1998. It is understood that this is an agreement-in-principle and does not commit the signatories to completing the inventory activities outlined within the plan. Modifications to this plan or more detailed plans need to be reviewed and approved by the signatories and then appended to this plan.

District Manager
Kamloops Forest District

Weyerhaeuser Canada Limited

District Manager
Clearwater Forest District

Slocan Forest Products Limited

Regional Manager
Kamloops Forest Region

Ainsworth Lumber Company

Director
Resources Inventory Branch

International Forest Products

Riverside Forest Products Ltd.

Bell Pole Co. Limited

Tolko Industries Ltd.

Gilbert Smith Forest Products Limited

Appendix A

Kamloops and Clearwater Forest Districts Vegetation Resources Inventory Ground Sampling Plan

Appendix B

Polygon Selection

Sample selection was not completed for this area.