Fort Nelson Forest District

Vegetation Resources Inventory
Strategic Inventory Plan

MINISTRY OF FORESTS
RESOURCES INVENTORY BRANCH
DECEMBER 29, 1998

Executive Summary

This Strategic Inventory Plan (SIP) outlines the Vegetation Resources Inventory (VRI) activities and products needed to address the forest management issues identified by stakeholders in the Fort Nelson Forest District. The Ministry of Forests (MOF) Resources Inventory Branch prepared this VSIP following consultative meetings involving all key forest inventory stakeholders and in consideration of relevant documentation. The VSIP provides a general strategic direction for implementing the Provincial VRI and Management Inventory activities in the Fort Nelson Forest District.

The stakeholders in the District can also use this VSIP to prepare coordinated VRI Project Implementation Plans (VPIPs). A VPIP is a working document that details the specific operational activities associated with implementing and documenting the inventory activities identified in the VSIP. It identifies the project geographic areas, priorities, plot location coordination, and inventory costs by year, in addition to the roles and responsibilities for implementation. The VPIP may be for Ground Sampling or Photo Interpretation projects. The VSIP and VPIPs can be incorporated into submissions to Forest Renewal BC (FRBC), or other coordinating agency, for funding.

The stakeholders in the Fort Nelson Forest District identified the following VRI activities and products (as defined by RIC standards):

a) Undertake a Photo-Interpreted Estimated inventory (retrofit) to provide spatial data to support timber, ecosystem, habitat, riparian, and other mapping applications that provide information for land management.

b) Undertake timber emphasis ground sampling in the Fort Nelson TSA to provide spatial data and statistically valid timber volumes and other tree attributes to support the timber supply review in this management unit.

c) Conduct Photo-Interpreted Estimates/timber emphasis ground sampling in mixed species stands with spruce understory to provide spatial data to support identification of these stands for timber and wildlife management.

d) Develop more reliable factors to account for decay in mature stands and deciduous stands, using the VRI net volume adjustment factor (NVAF) sampling methodology.

e) Conduct provincial VRI ground sampling to provide baseline spatial and non-spatial data for the entire District, for provincial inventory reporting, monitoring, and research.

The identified VRI activities in the District include both photo-interpretation and ground sampling. For the Photo-Interpreted Estimates inventory, where the re-inventory is recent, the existing polygon timber inventory should be translated to VRI format, and additional VRI (non-timber) attributes added through photo-estimation of the existing photos. New photos should be used in areas with old inventories. Ground sampling should be conducted over the entire District landbase to support the provincial VRI, and the identified management inventories. The sample sizes for this ground sampling are listed in the following table.

Land Type	Number of sample clusters – ALL VRI measurements	Number of sample clusters – Tree measurements only	Total number of sample clusters
Vegetated Treed	70	80	150
Remaining Area (Non-Vegetated; Vegetated Non-Treed)	85	-	85
SubTotal	*155*	*80*	*235*
NVAF sampling			*85 trees*
WPV sampling			*10 polygons*
Management inventories			
Fort Nelson TSA	-	180	180
Mixed-species, spruce understory stands	-	50	50
Mature stands decay estimates			*85 trees*

The stakeholders identified the following implementation priorities:

1. Photo-Interpreted Estimates inventory (prior to 2001).
2. Identification of mixed-species stands with spruce understory (prior to TSR 3).
3. Sampling for decay estimates in mature stands and deciduous stands (prior to TSR 3).
4. Timber emphasis ground sampling in the TSA (prior to TSR 3).
5. Provincial VRI Ground Sampling inventory.

These priorities were based on consideration of:

- Possible loss of approximately $800,000 already invested in aerial photographs, which will become out of data in 2-3 years.
- The need to improve the inventory databases for TSR 3 and TSR 4.

These priorities are subject to further implementation planning at the Forest District level and involving the District, Region and Licensees. The District and Region must identify the critical temporal issues and incorporate them into the VPIPs. Note that the Provincial VRI and management inventories may be implemented by smaller units (e.g. Landscape Units or Supply Blocks) identified at the district level by the District, Region, and licensees. As the Fort St. John District and the Fort Nelson District have common issues, there may also be the opportunity to jointly develop VPIPs to address the issues in both districts.

Funding for the inventory activities is not discussed in this VSIP. The VSIP and VPIPs should be considered in submissions by the Region to Forest Renewal BC (FRBC), or other coordinating agency, for funding.

Table of Contents

List of Tables

List of Figures

1. INTRODUCTION

1.1 Background

This Strategic Inventory Plan (SIP) for the Fort Nelson Forest District outlines the VRI products needed to address the forest management issues identified by stakeholders. It also identifies the Photo-Interpreted Estimates and Ground Sampling activities needed to produce the desired VRI products in the District. The Ministry of Forests (MOF) Resources Inventory Branch prepared this VSIP following consultative meetings involving all key forest inventory stakeholders and in consideration of relevant documentation. The VSIP provides a general strategic direction for implementing the Provincial VRI and Management Inventory activities in the Ft Nelson Forest District.

The stakeholders in the District can use this VSIP to prepare coordinated VRI Project Implementation Plans (PIP). A VPIP is a working document that details the specific operational activities associated with implementing and documenting the inventory activities identified in the VSIP. It identifies the project geographic areas, priorities, plot location coordination, and inventory costs by year, in addition to the roles and responsibilities for implementation. The VPIP may be for Ground Sampling or Photo Interpretation. The VSIP and VPIPs could then be incorporated into submissions to Forest Renewal BC (FRBC), or other coordinating agency, for funding.

Vegetation Resources Inventory

The VRI is an improved vegetation inventory process for assessing the quantity and quality of BC's timber and other vegetation resources. The VRI addresses the inventory design-related issues raised by the Forest Resources Commission in its 1991 report, *The Future of Our Forests*. It was designed by inventory specialists from government, industry, and academia, and has been approved by the BC Resources Inventory Committee (RIC). The RIC objectives are to develop a common set of standards and procedures for provincial resources inventories.

The VRI process consists of procedures for:

1. *Photo-Interpreted Estimates*
    - Delineating and classifying vegetation polygons using the BC Landcover Classification Scheme (BCLCS).
    - Making initial estimates of the vegetation attributes within polygons.
2. *Ground Sampling*
    - Sample planning
    - Locating and establishing sample plots.

- Collecting data related to trees; site, soils, plants and succession; coarse woody debris; and range resources.
- Net Volume Adjustment Factor (NVAF) sampling
- Within Polygon Variation (WPV) sampling.

These VRI procedures and other terms in this report are defined further in the Glossary (Appendix A).

The VRI procedures provide spatial and non-spatial products for resource-specific management interpretations, provincial inventory reporting, monitoring and research. These management interpretations include timber management, ecosystem management, and habitat management. These spatial products include:

- Line work – polygon boundaries.
- Vegetation Inventory File Database – adjusted and unadjusted polygon labels and estimates.

The non-spatial products include:

- Raw Database – Raw data from field cards.
- Summary Database – Compiled data and inventory statistics.
- NVAF Database – NVAF stem analysis data (raw, compiled and statistics).
- WPV Database – WPV polygon data (raw, compiled and statistics).

The new VRI procedures are now being implemented throughout the province. The implementation is based on the following guiding principles:

- To integrate the provincial inventory activities, including the provincial VRI, management inventories, and the National Forest Inventory.
- To implement inventory projects to satisfy business needs as defined in the VSIP and VPIP documents. The VSIP identifies the forest management issues in a District, and the VRI activities and products needed to address the issues; the VPIP identify the priorities and spatial location of the VRI activities (Section 2) .
- To develop spatial VRI products in a non-fragmented way, that is, to implement the photo interpretation activities in blocks (such as mapsheets or watersheds) and estimate all the attributes listed in the photo interpretation manual.
- To implement inventory projects following approved VRI implementation standards as defined in the MOF Resources Inventory Branch 1998 report *Vegetation Resources Inventory Implementation Strategy to Integrate Management, Provincial, and National Inventories*.

Implementing the identified inventories using VRI standards addresses the issues raised by the Forest Resources Commission's 1991 report, *The Future of Our Forests*. The issues

raised relate to the inadequacy of forest inventories in the province. They 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.

1.2 Document Objectives

This VSIP is for the implementation of the provincial VRI and management inventories in the Fort Nelson Forest District in the Prince George Forest Region. It was developed through consultation with various stakeholders in the Fort Nelson Forest District, including the Ministry of Forests (Branch, Region, and District staff), Ministry of Environment Lands and Parks (MELP), and the Licensees, who identified inventory local needs and priorities.

This Plan:

- defines the strategy for the provincial VRI in Fort Nelson Forest District;
- defines the management inventory products;
- identifies the inventory activities required to produce the desired inventory products; and
- outlines a proposed implementation strategy.

A preliminary Plan was reviewed and discussed by the MOF, MELP and other stakeholders in the District during a conference call held on November 19, 1998. This is the final Strategic Inventory Plan for the approval of the MOF District Manager, Regional Manager, Director of the Resources Inventory Branch, Slocan Forest Products Ltd. and other stakeholders.

2. INVENTORY PLANNING

1.1 Planning

This VSIP was developed following the MOF VRI planning process, which is an important component of the overall VRI process and linkages. The overall VRI process and linkages include (Figure 1; Appendix B):

1. Forest management decision processes (land integration planning)
2. Identification of forest management issues
3. VRI Strategic planning (VSIP)
4. VRI District operational planning (VPIPs)
5. Implementation, including development and maintenance of procedures and standards:

A) Management inventories

B) District-wide VRI

C) Database management

6. Data interpretation, including Ecosystem and habitat mapping (information development).

The VRI planning process (Items 2-4 above) involves developing strategic plans (VSIP) and project plans (VPIP) that identify resource-specific management issues, desired inventory products, and priorities. A VSIP outlines the VRI products needed to address the identified forest management issues. It provides a general strategic direction for implementing the Provincial VRI and Management Inventory activities in the District.

The stakeholders in the District can use this VSIP to prepare coordinated VRI Project Implementation Plans (VPIPs). The VPIPs are working documents that detail the specific operational activities associated with implementing and documenting the inventory activities identified in the VSIP. The VPIP may be for Ground Sampling or Photo Interpretation projects. It identifies the project geographic areas, priorities, plot location coordination, and inventory costs by year, in addition to the roles and responsibilities for implementation.

The VSIP and VPIPs provide the framework for coordinating the implementing the provincial VRI over the District, and management inventories over priority areas. It seeks to ensure that production of VRI products addresses important issues over priority areas, and supports resource-specific management interpretations that address forest management issues. This planning process defines the baseline inventory product needs, ensures that the right baseline products are selected to meet a range of applications, and achieves efficiencies in the delivery of the desired inventory products. Coordinated inventory planning also maximizes the value of the inventory data produced over issue areas, by ensuring that the VRI products are useful for addressing more than one resource issue.

1.2 Funding

The stakeholders lead by the District develop criteria for setting priorities among the VRI activities and products identified in the VSIP. Funding for these inventory activities, or follow-up resource-specific management interpretations, is not discussed in the VSIP since funding mechanisms vary from time to time. Presently, it is a regional responsibility that should be addressed at the VRI planning meetings by the regional staff. The VSIP and VPIPs should be considered in submissions by the Region to Forest Renewal BC (FRBC), or other coordinating agency, for funding.

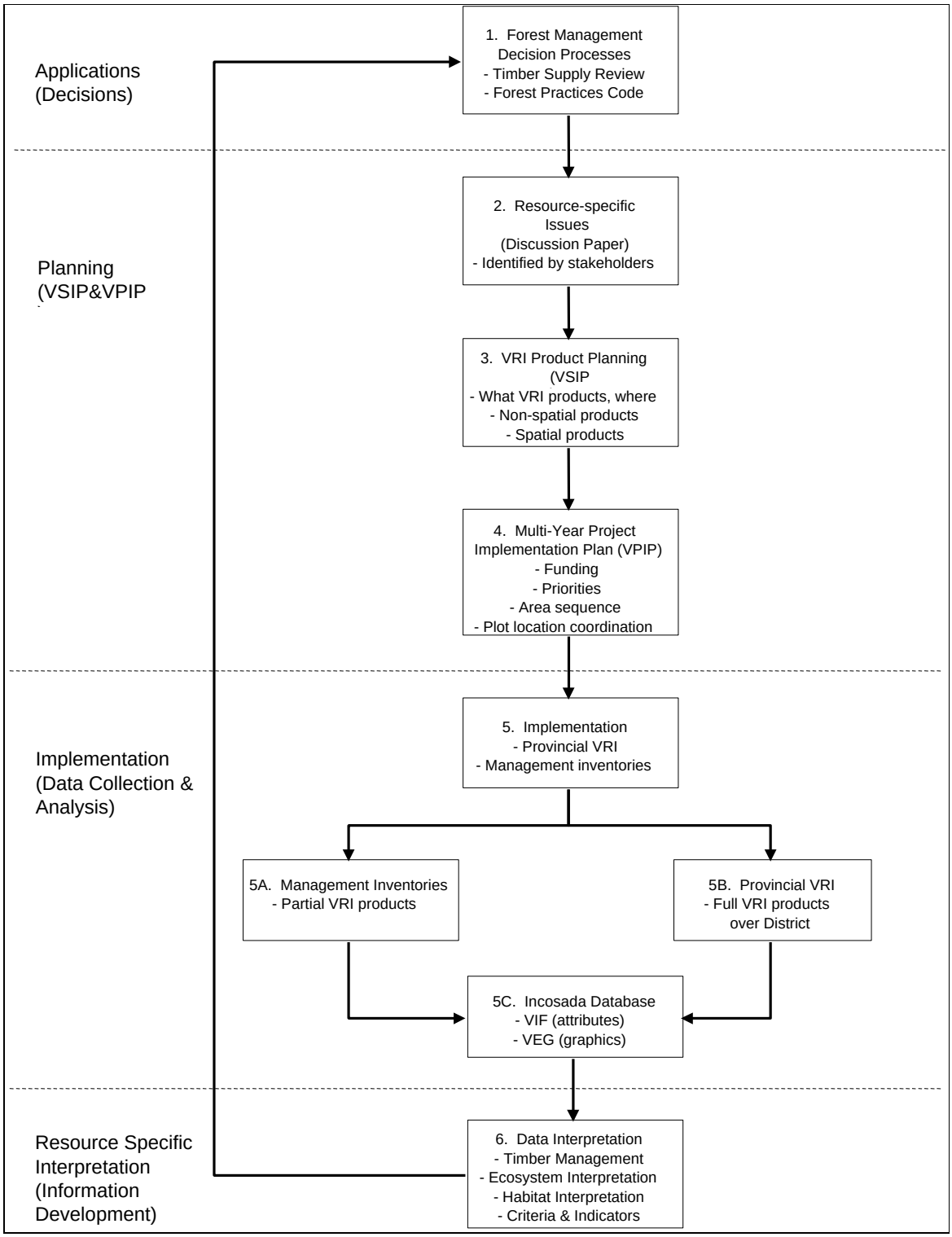

Figure 1. The Vegetation Resources Inventory process.

3. BUSINESS CONSIDERATIONS

3.1 Forest Management Issues

Priority forest management issues arising from timber supply review (TSR) 1 in the Fort Nelson TSA were reviewed (Table 1). (This table should be updated to incorporate forest management issues that will be identified in TSR 2.) An assessment of the potential use of the VRI Photo-Interpreted Estimates and the Ground Sampling is also indicated on some of these management issues. However, the table does not show the relative importance of these various issues. For example, a statistically accurate timber volume estimate may carry more weight than all other issues combined. In this case, the contribution of the VRI Ground Sampling will be quite significant.

Table 1. Forest management issues and the use of the VRI to address issues in the Fort Nelson Forest District.

Issue[1]	VRI		Remarks
	Photo-Interpreted Estimates	Ground Sampling	
1. Reforestation: ensure that reforestation is achieved within acceptable delay standards, although it may be difficult to re-establish the coniferous species component in leading deciduous species stands.	No need	No need	
2. Species mix: need to deploy silviculture methods that retain existing species mix of original stands.	No need	No need	
3. Visually sensitive areas: creation of visually sensitive areas	No need	No need	
4. Resource management zones (geographic areas with similar values and management).	Needed	Needed	Any new inventory may help refine the RMZs

[1] BC Ministry of Forests, Timber Supply Branch. 1996. Forest Management Issues Identified Through the AAC Determination Process, TSA/TFL Timber Supply Reviews: 1992-1996. 31 December 1996. Victoria, BC. P.114.and BC Ministry of Forests, Fort Nelson TSA Timber Supply Review Data Package. July 1997.

Issue[1]	VRI		Remarks
	Photo-Interpreted Estimates	Ground Sampling	
5. Riparian, biodiversity, FENs, old-growth, mature forest cover: clarify timber supply impacts and interactions.	Needed	Needed	Photo-Interpreted Estimates should improve polygon delineation, provide better age class, stand structure, and vegetation attributes, and information on soil moisture and nutrient regime to enhance the interpretation of FENs, riparian areas, seral stage and Natural Disturbance Types interpretation. Ground Sampling will provide overall District totals for coarse woody debris, stumps, potential wildlife trees, and plant lists for species diversity. The reliability of the estimates obtained for these attributes will need to be evaluated based on natural disturbance types before comparisons to the biodiversity guidelines. There is a risk that precise estimates will not be obtained for these attributes. The data set will be used to identify supplemental sampling needs. A new Photo-Interpreted Estimates inventory is particularly important because of the age of the inventory in the District.
6. Protect important ecosystems and habitats for red and blue listed species, key ungulates and other regionally significant species.	Needed	Needed	The VRI is needed to support mapping important ecosystems and habitats for red and blue listed species, key ungulate ranges and other regionally significant species. The Photo-Interpreted Estimates inventory provides a spatial inventory with attributes needed to support ecosystem and habitat mapping. Wildlife habitat mapping can not be accomplished without spatial data; the products are highly relevant to forestry planning. Ground Sampling provides plant lists, forage production, and shrub transects, which can be used to support ecosystem and habitat mapping.

Issue[1]	VRI		Remarks
	Photo-Interpreted Estimates	Ground Sampling	
7. Landscape-level biodiversity – incorporate all guidelines, boundaries, objectives, and prescriptions, including designated landscape units & biodiversity emphases.	Needed	Needed	The VRI can provide supporting data, e.g., potential re-definition of "old growth" based on VRI stand structure and age attributes.
8. Undertake ecosystem and habitat mapping and important areas analysis to assess and protect important ecosystems and habitats for red and blue listed species, key ungulates and other regionally significant species.	Needed	Needed	VRI attributes are utilized in ecosystem and habitat mapping. This mapping needs to be supported after the VRI products are produced in order to address the identified forest management issues.
9. Develop management practices to protect habitat. Work with Ministry of Environment to undertake appropriate forest management practices on important habitats and ecosystems.	Needed	Needed	Rationale for this statement is included in all of the above items. In particular, wildlife habitat spatial information provides a needed inventory-based approach for identifying critical areas and habitat features for wildlife and working with forest managers to protect important ecosystems and habitats.

3.1 VRI Activities and Products

The VRI activities and products that are needed to meet the forest management issues outlined in Table 1, and those identified at the Stakeholders meeting are listed below:

a) Undertake a Photo-Interpreted Estimates inventory over the District to provide spatial data to support provincial and sub-unit timber inventories, habitat mapping, ecosystem mapping, riparian mapping, and other applications.

b) Undertake timber emphasis ground sampling to provide statistically valid timber volumes and other tree attributes in the TSA to support Annual Allowable Cut (AAC) determination in this unit.

c) Conduct a Photo-Interpreted Estimates inventory/timber emphasis ground sampling in mixed-species stands with spruce understory, to provide spatial data to support identification of these stands for timber and wildlife management.

d) Develop more reliable factors to account for decay in mature stands and deciduous stands, using the VRI net volume adjustment factor (NVAF) methodology.

e) Conduct provincial VRI ground sampling over the entire District, to provide spatial and non-spatial data for provincial reporting, monitoring, and research.

Development of land management information from these identified VRI products includes (but not limited to) the following post-inventory activities (not discussed in this Plan):

- Timber supply analysis to support AAC determination.
- Ecosystem and habitat mapping to address ecosystem and habitat forest management issues.
- Seral stage mapping to provide estimates of coarse woody debris and other requirements described in the biodiversity guidelines (Forest Practices Code).
- Monitor standing inventory, decay, and taper, to provide a level of comfort to users on the accuracy of net volume.
- Collect change and trend data at the provincial level for reporting on the indicators of sustainable forest management, as defined by the Canadian Council of Forest Ministers (CCFM).

Note that the following information needs identified by the stakeholders are not addressed directly using the VRI procedures in this Plan:

- Base map information is inaccurate.
- OGSI - potential site index for spruce, pine and aspen; may be role of Research Branch
- Identification of seismic lines; role of Resources Inventory and Timber Supply Branches
- Old growth characteristics; role of MOF/MELP
- Succession - Growth and Yield issue; role of Research Branch

These needs could be addressed through other processes such as research. The next section outlines the inventory plans for the identified VRI activities.

4. INVENTORY PLAN

4.1 Overview

This section outlines plans for inventory activities needed to develop specific VRI products. The VRI activities include Photo-Interpreted Estimates and Ground Sampling.

The ground sampling may be at the District level (provincial VRI) or sub-unit level (management inventories):

- *Provincial VRI* involves ground sampling to provide Ground Sample Plots database for all attributes over an entire Forest District. The Photo-Interpreted Estimates database may use the retrofitted FIP or new photo-interpreted estimates. The Ground Sample Plots data are combined (through statistical analysis) with the Photo-Interpreted Estimates to provide a spatial database at the District level.
- *Management (sub-unit) Inventories* involve ground sampling using selected components of the VRI procedures, to produce VRI databases to address one or more resource-specific management issues (timber, ecosystem, habitat, etc). The Photo-Interpreted Estimates database may use the retrofitted FIP or new photo-interpreted estimates. The Ground Sample Plots data are combined (through statistical analysis) with the Photo-Interpreted Estimates to provide a spatial database at the sub-unit level. Management inventories are coordinated as much as possible to produce VRI products with multiple resource applications.

The VRI baseline products can be used in further analyses, sometimes in conjunction with data sets from additional sources, to produce Resource-Specific Information (RSI) needed to address forest management issues. RSI may include information for timber supply review, habitat management, and ecosystem management to address resource-specific management issues. The VRI-based products are used in VRI ecosystem and habitat mapping. The VRI-EM is an ecosystem map consisting of VRI polygons with "estimated" site series labels in the same format as Terrestrial Ecosystem Mapping (ecosystem, modifiers, structural stage). The VRI-HM products are habitat maps for species at risk, ungulates, or species of management concern, such as grizzly bear.

4.2 Photo-Interpreted Estimates Inventory

4.2.1 Objective

The objective of this inventory is to improve the polygon delineation and estimation in the Fort Nelson Forest District, especially in areas where specific management issues occur. The VRI product is a spatial database consisting of unadjusted photo-interpreted estimates. Ground sampling to check and adjust the Photo-Interpreted Estimates is discussed as a separate process (Section 0).

4.2.2 Target Area

The target area for the photo interpretation is the Fort Nelson Forest District (including the parks and recreational areas). The District should identify priority strata and geographic areas, and develop a photo-interpretation schedule for the District. In setting priorities, the District should consider operating areas, areas with aerial photo coverage, management issues, and important landscape units.

4.2.3 Target Attributes

The target attributes for this inventory are all the attributes listed on the VRI Photo-Interpreted Estimates attribute form. All attributes should be interpreted to the VRI Photo-Interpreted Estimates standards.

4.2.4 Options

The following two options for Photo-Interpreted Estimates Inventory were considered:[2]

Option 1 -Retrofit

The retrofit process is used to incorporate the new standards for VRI delineation and estimation into the existing inventory. It involves limited photo estimation and delineation using the existing document photos for the area. The assumption is that the current inventory is good and the goal is to fill in the gaps between the two inventories. The intent is also to convert the existing database to a full VRI database by collecting the additional data required to complete the database.

The retrofit methodology has the following features:

- field calibration to address the missing attributes and upgrading of existing attribute estimations
- there is no new delineation in what was traditionally referred to as the "productive, forested landbase", since the standards for delineation in the VRI have not changed significantly.
- The interpreter reviews existing attribute estimates, any significant errors or interpretation differences will be noted and corrected.
- empty fields in the database will be populated by returning to the original document photos, other appropriate photography or ortho photography to interpret the attributes.

There are opportunities to include additional features to the retrofit process depending on business needs.

Option 2 - New Photo-estimation

New photo estimation is used to incorporate the new standards for VRI delineation and estimation into an area. It involves the completion of new delineation and polygon estimates for the entire landbase, using the most current photography. The latest VRI standards would be used for all steps in the process. This is an expensive and time consuming project and should only be used in those cases where a VPIP indicates that there

[2] Vegetation Resources Inventory Photo Estimation Retrofit Procedures. 1998. Version 1.0. MOF Resources Inventory Branch, Victoria, BC (Laurence Bowdig)

is a serious problem with the existing inventory. It may also be applicable in those Timber Supply Areas, such as some portions of the Ft Nelson TSA, that have not had a traditional re-inventory in the last 10 years. These inventories are typically 25-35 years old and were not delineated or classified to current standards.

The District will consider a combination of the two options. Option 1 will be considered for the areas that were recently re-inventoried. In other priority areas with old photography, new photo estimation (Option 2) will be considered. The District will also explore recent technologies, such as "Softcopy" (digital photogrammetry), for photo estimation.

1.2.1 Database Management

Two database-management and statistical-adjustment issues were raised at the stakeholder meeting. One concern was that implementing a rollover and a combination of retrofit and new estimation could potentially create database management problems, and that a partial database that does not contain the full set of VRI attributes could create statistical adjustment problems. These issues are addressed as follows:[3]

- Vegetation inventory map and database (VEG and VIF) will be created during rollover.
- Rules will map the existing FIP attributes to VRI attributes.
- After updates, retrofit or new estimation, the VIF file will contain a combination of some "true" vegetation polygons and some rolled FIP polygons.
- These two kinds of polygons will be distinct but treated the same in the database. That is, they will be managed by one procedure in the same file and can co-exist as long as is required.
- There is no problem with statistical adjustment of attributes. Continuous variables (e.g. volume) where pairing of the ground measurements and photo estimates is possible will be adjusted; continuous variables where pairing is not possible, and all categorical variables, will not be adjusted.

[3] Doug Say. E-mail note to Dick Nakatsu, November 9, 1998.

4.2.5 Implementation Strategy

To avoid the risk of losing the approximately $800,000 already invested in acquiring aerial photos in the District, the photo interpreted estimated inventory project should be completed as soon as possible. These photos will be out of date in about 2-3 years. A VPIP for the photo interpreted estimated inventory should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Photo Interpretation*. Preparing a VPIP will involve identifying what needs to be improved (attributes or delineation), where and how. This will involve:

1. **Identifying the needs**. Refer to the Forest Management Issues (Section 3.1) and the VRI Activities and Products (Section 3.2).

2. **Identifying priority areas within the District**. Develop and apply criteria for ranking areas based on management needs, and define project implementation units (e.g. Landscape Units, mapsheets, supply blocks).

3. **Reviewing the existing inventory.** This involves a qualitative and quantitative evaluation of the attributes, the delineation and line transfer; an assessment of calibration data sources; and a review of existing photos, maps, and technology. This inventory review may be waived in the Ft Nelson District since it is obvious that the inventory is very old in many areas and it is urgent to complete the project before the existing photos are out-of-date.

The Photo-Interpreted Estimates project could be implemented as follows:[4]

1. Define target population and objectives.
2. Assemble existing information, including TRIM bases, photos, and updated overlays.
3. Prepare work plan.
4. Seek contractor to do the work.
5. Arrange for training (March to May; Forestry Continuing Studies Network).
6. Conduct fieldwork, which may include field checks/calibration preferably using air calls (May to August).
7. Conduct the photo-interpretation (September to January).
8. Digitize, check plots, and complete final quality assurance (September to April).
9. Prepare Photo-Interpreted Estimates database and project report.

---

[4] *Photo interpretation (Phase I) Project Management Guidelines*. May 1997. Ministry of Forests, Resources Inventory Branch, Victoria, BC. (Contact: Bob Krahn).

1.3 Provincial VRI ground Sampling

4.2.6 Overview

The provincial VRI provides baseline spatial and non-spatial databases for the entire Forest District. The provincial VRI ground sampling activities include Ground Sampling, Net Volume Adjustment Factor (NVAF), and Within Polygon Variation (WPV).

When implemented, the provincial VRI ground sampling would provide:

1. A basis for calculating unbiased overall averages and totals for timber and non-timber vegetation resources for the entire landbase in the District. The overall District totals for attributes (e.g., timber volume) can be broken down by tenure (TSA and parks). Provision of this information addresses the concerns expressed by the Forest Resources Commission in its 1991 report *The Future of Our Forests*.[5]
2. The initial conditions and locations for measuring changes and trends in the indicators of sustainable forest management, at the provincial or District level.[6] The changes and trends can be used to provide a province-wide statement of sustainability of our forest practices that would be based on an inventory with a statistically valid approach. This monitoring information can be used to counter accusations against BC's forestry practices, to protect BC forest products markets, and to address public environmental concerns. This information was not available in previous provincial inventories, as there was no valid monitoring protocol.
3. Baseline VRI data to develop ecosystem and habitat mapping to address ecosystem and habitat management issues in forest land management.
4. Baseline data to confirm District biodiversity guidelines, non-forest classification, and site index-BEC correlations.
5. Additional information for non-timber resources (e.g., plant lists) by indicating where more intensive sampling could improve estimates for specific plants (e.g., medicinal plants) and other botanical products.
6. The VRI plot locations that can be used to measure a variety of other resources (e.g., range), special projects, and management inventories. The plot locations are established in an unbiased way and are re-locatable to allow re-visits.

---

[5] The Forest Resources Commission concerns included a lack of statements of precision of the inventory; inadequate information on non-timber vegetation; lack of reliable estimates of growth rates and stand-specific volumes; and the narrow focus on commercial timber volume and the timber harvesting landbase.

[6] Criteria and indicators of sustainable forest management were defined by the Canadian Council of Forest Ministers (CCFM) in their 1995 report *Defining Sustainable Forest Management. A Canadian Approach to Criteria and Indicators* (Natural Resources Canada, Canadian Forest Service, Ottawa, Ontario. 22 pages).

4.2.7 Landbase

The Fort Nelson Forest District includes the Fort Nelson TSA and parks. It is located in the far northeastern corner of the province (Figure 2). The total area of the Fort Nelson TSA is 8.2 million ha of which approximately 3.7 million ha are forested and approximately 149, 400 ha are parks and recreational areas. According to TSR I, the timber harvesting landbase (THLB) was 774,025 ha (or 9.4% of the total District area). The net landbase supports the present allowable annual cut of 1,500,000 cubic metres. According to TSR I, the average mean annual increment in the coniferous landbase is 1.35 cubic metres/ha/yr, and in the deciduous landbase 2.33 cubic metres/ha/yr. There are 2.6 million ha outside the net landbase which are being managed for other resource uses such as energy exploration, commercial guiding, and hunting operations that are not available to the forest industry.

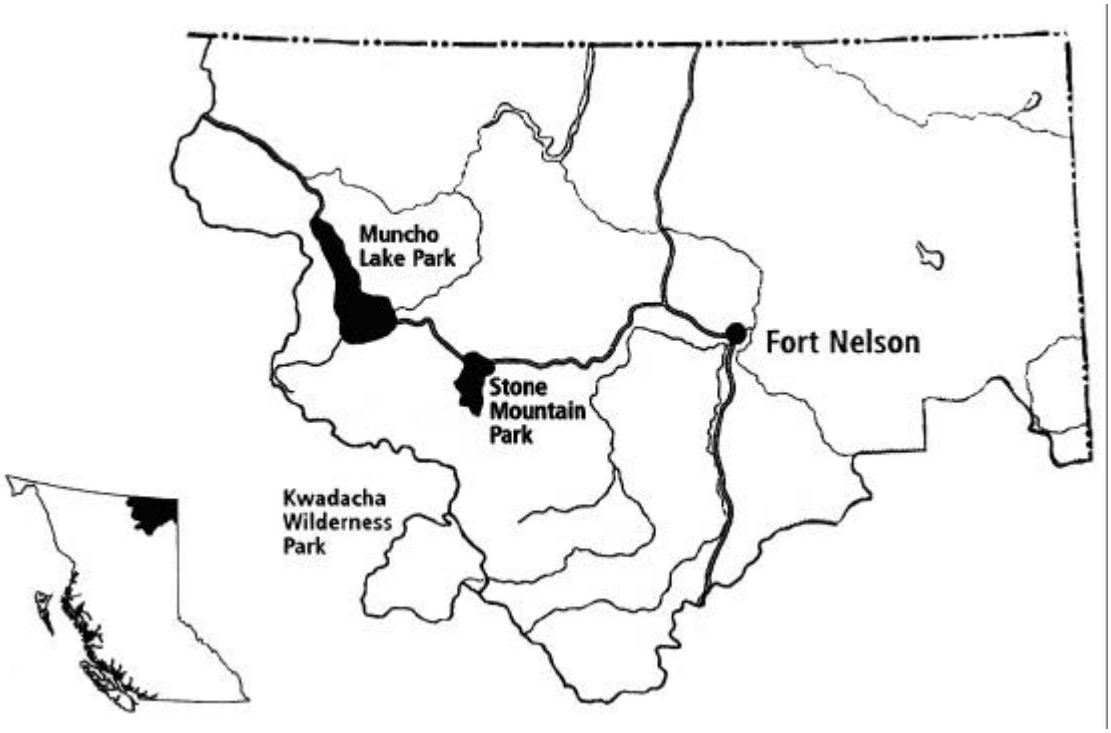

Figure 2. Map of the Fort Nelson TSA in the Prince George Forest Region.

1.1.1 Database to be Sampled

The spatial database developed in Section 4.2 should be used to implement the provincial VRI ground sampling in the Fort Nelson Forest District,. That is, the existing timber information should be retrofitted and additional VRI attributes added through photo-estimation of existing or new photos for other attributes, particularly the non-timber attributes. The retrofitted/new database would then be used to select sample locations for ground sampling.

The ground sampling can be implemented before the retrofit, however, this may lead to some inefficiencies. The inefficiencies arise from the possibility that:

- Some sample plots may have to be revisited if new polygon boundaries partition the sample cluster.
- More plots would be established if the existing phase I estimates are not consistent.

1.1.2 Ground Sampling

Ground Sampling provides the statistical rigor for estimating overall totals and averages for timber and non-timber vegetation resources (medicinal plants and other botanical forest products) in the District. The total number of VRI sample clusters will aim to achieve a sampling error of ±10% (95% probability) for net timber volume in the Vegetated Treed portion of the District and allow for calculation of sampling errors for other VRI attributes. Information will be collected on all attributes, but the variability of net volume will be used to set the sample size for the VRI.

The number of samples required to achieve the sampling error standard is a function of the variation of net volume within the inventory unit, estimated by the coefficient of variation (CV%). The CV used to estimate the total number of plots to achieve a sampling error of ± 10% for net volume was assumed to be 60%.[7] To achieve the VRI standard at a reasonable cost, two types of VRI plots should be used:

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

The sample sizes required to implement the provincial VRI are summarized in Table 2.

Table 2. The estimated sample size required to implement the provincial VRI in the Fort Nelson Forest District.

[7] No inventory audit has been conducted in this unit.

Land Type	Number of sample clusters – ALL VRI measurements	Number of sample clusters – Tree measurements only	Total number of sample clusters
Vegetated Treed	70	80	150
Remaining Area (Non-Vegetated; Vegetated Non-Treed)[8]	85	-	85
Total	*155*	*80*	*235*
NVAF sampling			*85 trees*
WPV sampling			*10 polygons*

A sampling error standard is necessary to provide a basis for determining sample size in inventories. In the VRI, the allowable sampling error standard is set at ±10% for net volume at the District level; however, this standard does not apply to other attributes in the inventory.

The total number of full VRI samples (70) will be adequate to achieve a sampling error of ±15% in the Vegetated Treed landbase. Timber emphasis plots (80) are then be used to reduce the sampling error in the Vegetated Treed landbase to ±10% (the standard for net volume). In the Remaining Area (non-treed and non-vegetated) of the unit, the number of full VRI samples established (85) will be the ratio of the Remaining Area to the Vegetated Treed multiplied by the number of VRI samples required to achieve a sampling error of ± 15% in the Vegetated Treed landbase.

Implementing the two types of samples ensures that 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 savings of time and money.

4.2.8 NVAF and WPV Sampling

To complete the provincial VRI, NVAF and WPV sampling is required. The NVAF sampling provides factors to adjust net tree volume from the Ground Sampling (derived from the net factoring process and taper equations) to account for hidden decay and possible taper equation bias. This involves detailed stem analysis of sample trees to calculate actual net volume, and to compare this with the net volume estimated in the VRI net factoring process and the taper equations. The WPV sampling provides information to estimate the individual polygon true error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon.

[8] We assumed that the Vegetated Treed landbase constitutes about 45% of the District landbase. The sample size in the Remaining Area is proportional to its area relative to that in the vegetated treed. For example, if the vegetated treed portion was 20% of the landbase, then the sample size in the Remaining Area would be 80/20*70 = 280 plots; the suggested number of plots in the Vegetated Treed portion does not change.

As shown in Table 2, a total of 85 sample trees (75 live and 10 dead) are required for NVAF sampling (selected from 15 treed and 1 non-treed polygons), and at least 10 sample polygons are required for WPV sampling.

4.2.9 Statistical Analysis

Statistical analysis is the process of adjusting the estimates from the Photo-Interpreted Estimates using the Ground Sampling observations. The purposes of the analysis are to obtain overall averages and totals for the District that are statistically unbiased, and to adjust the existing or new Photo-Interpreted Estimates information to obtain individual polygon values.

Statistical analysis includes two steps:

1. Statistical estimation of overall values. These values include totals and averages for continuous attributes, and error matrices for categorical variables, for the District.
2. Statistical adjustment, which is the process of assigning values to individual polygons such that their total (or error matrix) for the District matches that obtained in Step 1.

4.2.10 Implementation

To achieve the provincial VRI objectives, the sampling could be implemented over the entire District in a two-step process, or in parts. The two-step process could be done as follows: step 1 is to install approximately 100 sample clusters in the first field season over the entire District; 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 District 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 ±10% for net volume in the treed portion of the District. The sampling in the first year will also provide data to audit the inventory in the mature stands (60 years+). Thus, there would be no need for a separate inventory audit.

An estimated total of 235 sample clusters will be assumed for planning, training, and other logistic considerations. Matching unavailable sites and sub-sampling of sample clusters with difficult access should be anticipated and planned for, as these activities will increase inventory costs.

The 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. Systematically select the provincial VRI samples.
5. Systematically select the polygons for the WPV sampling from the list of provincial VRI samples.
6. Systematically select the 16 NVAF sample points (15 treed and 1 non-treed whether or not volume is indicated) from the provincial VRI ground samples.
7. Begin planning for field sampling.
8. 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.
9. Locate and measure ground sample clusters.
10. Monitor quality assurance of field data and procedures during field sampling. Arrange for 'audit quality cruisers' to sample auxiliary plots of NVAF samples.
11. 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.
12. Prepare NVAF tree sampling matrix. Begin NVAF stem analysis.
13. 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.
14. Prepare the remaining samples.
15. Locate and measure remaining ground sample clusters in the second field season. Complete stem analysis of the NVAF sample trees. Complete WPV sampling.
16. Compile all data, complete the statistical adjustments, and load final inventory results into the provincial VRI database.

A VPIP for the ground sampling should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling*.

4.3 Management Inventories

4.3.1 Overview

Management inventories produce spatial or non-spatial data to address one or more resource-specific management issues (timber supply analysis, ecosystem, and habitat management). They can also be used to increase the precision of the provincial VRI. Provincial VRI plots can also be used in management inventories, leading to gains in efficiency. Management inventories involve ground sampling activities, with sample locations being selected from existing or new photo-interpreted databases. The inventory units (sub-units) for management inventories vary and are defined based on business needs.

Management inventories are the responsibility of the stakeholders such as the TFL Licensees or the Forest Districts. However, the MOF Resources Inventory Branch requires the TFL holders or Districts to prepare a VPIP, which includes a sampling plan, for MOF approval. This requirement ensures proper coordination and maintenance of the provincial VRI standards.

Three sub-units were identified for ground sampling in the Fort Nelson Forest District to address the inventory issues raised by the stakeholders, listed below (some of these sub-units may overlap).

1. A sub-unit consisting of the TSA, to provide statistically valid timber, decay, and waste estimates at the sub-unit level, to support TSR.
2. A sub-unit consisting of mixed-species stands with spruce understory in the District, to provide spatial data to support identification of these stands for wildlife and timber management.
3. A sub-unit consisting of mature stands and deciduous stands in the District to provide estimates of decay factors to be used to net down timber gross volume.

4.3.2 TSA Timber Inventory

Objective

The objective of this Ground Sampling is to provide statistically valid timber volume and site index estimates in the Fort Nelson TSA for timber supply analysis. The sampling should target a sampling error of ±10% (95% probability) for net timber volume in the timber harvesting landbase (THLB) in the TSA.

Target Population

The target population for this management inventory is the Vegetated Treed portion of he TSA landbase.

Sampling Unit

The sampling will be based on *Timber Emphasis Plots* (TEPs). These TEPs can use the same five-point cluster configuration as the VRI; however, measurements should be restricted to tree attributes only. These attributes are contained in VRI Card Types 8, 10, and 11, which must all be completed. Measurements of other vegetation characteristics taken on VRI plots should not be taken in these TEPs. However, as with the VRI plots, these TEPs provide a sampling framework for any additional sampling that may be required in the future.

Sample Selection

The samples should be selected systematically from a sorted list of the polygons in the TSA. This list will include all vegetated polygons in each management unit sorted according to defined criteria. Alternatively, the samples may be selected from the same list of potential sampling points as used in the provincial VRI Ground Sampling.

Sample Size

An estimated total of 150 sample clusters in the THLB is suggested for planning, training, and other logistic considerations. This sample size should provide net timber volume estimate with a sampling error of 10% (95% probability) assuming a CV of 60% in the THLB. Approximately 30 plots are recommended in the non-THLB. Thus the total sample size in the TSA is 180. If the provincial VRI has been completed with 50 clusters sampled, then only extra 130 plots are needed in the THLB and none in the non-THLB.

Supporting Activities

Supporting activities include NVAF and WPV sampling. The NVAF is strongly recommended in this inventory, to improve estimates of tree net volume from the net factoring process and to quantify decay and waste estimates, especially for deciduous stands, if the provincial VRI Ground Sampling is not completed first. Otherwise, the NVAFs from the provincial VRI can be applied to this sub-unit. Within Polygon Variation sampling is also needed to provide information for expressing the total management inventory error and the accuracy of individual polygon estimates.

Implementation

This timber inventory should be coordinated with the Photo-Interpreted Estimates inventory (Section 3). The Ground Sampling in the TSA should be implemented in a two-step process, similar to the VRI Ground Sampling at the District level. The inventory should be implemented in two steps as follows:

- Step 1 should install a small batch of sample clusters (e.g., 40) over the target population (80% in the THLB, and 20% in the Remaining Areas) measuring *only* the tree attributes. This should occur in the first field season (or first half a field season) over the entire sub-unit.

- Step 2 should install the remaining plots in the second field season (or the second half of a field season), if needed.

The implementation could be done over the entire TSA or by Landscape Units, as defined in a VPIP. A VPIP for the ground sampling should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for preparing a Project Implementation Plan for Ground Sampling*.

4.3.3 Identification of Mixed-Species Stands with Spruce Understory

Objective

The objective of this management inventory is to improve the spatial information for the mixed species stands with spruce understory in the District. This information would help to better identify these stands in the database. This objective requires improvements to the Photo-Interpreted Estimates in these stands, followed by limited ground sampling to check these estimates. The photo-interpretation activities can be carried out as outlined in Section 4.2; the following sections describe the ground sampling activities.

Target Population

The target population is all potential mixed-species stands with spruce understory in the District. The mixed-species stands include mixtures of spruce, aspen, and pine.

Sampling Unit

We recommend that ground sampling for this inventory be based on *Timber Emphasis Plots* (TEPs). These TEPs can use the same five-point cluster configuration as the VRI however, measurements should be restricted to tree attributes only, with possible enhancements for vertical structure, stem distribution, and merchantable volume by diameter classes. This sampling should include call grading and net factoring. Many of these attributes are contained in VRI Card Types 8 to 11. It should also include sub-sampling trees for stem analysis in the aspen stands, to address decay and waste issues, not breakage. Measurements of other vegetation characteristics taken on VRI plots should not be taken in these TEP plots. However, as with the VRI plots, these TEPs provide a sampling framework for any additional sampling that may be required in the future.

Sample Selection

All the potential mixed-species polygons in the District should be identified in the database, and assembled into a sorted list. The polygon list should be sorted using attributes including inventory type group. Sample polygons should then be selected systematically from the list by accumulating the estimated total volumes. This will result in polygons being selected with probability proportional to estimated volume. This sorting and systematic selection ensures a uniform distribution of sample polygons over the volume range.

Sample Size

An estimated total of 50 sampling points are suggested for planning, training, and other logistic considerations. This sample size is generally adequate for checking (audit) purposes.

Implementation

We recommend that the Photo-Interpreted Estimates inventory be completed first, followed by ground sampling. The ground sampling in this inventory can be implemented in a two-step process similar to the provincial VRI ground sampling as follows: Step 1 will install a large number of sample clusters (e.g., 30) measuring *only* tree attributes. This will occur in the first half of the field season over the entire sub-unit. Step 2 will install additional plots in the second half of the field season.

A VPIP for the ground sampling should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling*.

4.3.4 Estimating Decay in Mature and Deciduous Stands

Objective

Decay in mature stands and deciduous stands in the District will be estimated using Net Volume Adjustment Factor (NVAF) sampling. The objective of NVAF is to improve estimates of tree net volume. This is accomplished using stem analysis to provide local estimates of decay and tree taper. The NVAF is based on the actual net volume of felled trees.

Target Population

The target population is all mature stands and deciduous stands in the District. While it may be more efficient to combine these stands those in the neighboring Ft St John Forest District, the stands in Ft Nelson are deemed by the Region and District staff to be sufficiently unique to be sampled separately.

Sampling Unit

The NVAF sampling unit is the tree. The attributes of interest are actual merchantable volume per tree and actual percent of sound wood of the merchantable volume.

Sample Selection

The sample selection is a two step process: first, select a sample of polygons to be cruised to generate a population of trees, and second, select a sample of trees from the generated population of trees.

All the potential mature and deciduous polygons in the District should be identified in the database, and assembled into a sorted list. Sample polygons should then be selected

systematically from the list by accumulating the estimated total volumes. This will result in polygons being selected with probability proportional to estimated volume. This sorting and systematic selection ensures a uniform distribution of sample polygons over the volume range.

Sample trees are selected with varying (but known) selection probabilities from the cells of a 3-dimentional matrix defined by four tree diameter (dbh) classes, six severity groups, and two access classes. This matrix is populated with tree data from the sampled clusters.

Sample size

The MOF Resources Inventory Branch recommends a total of 75 live sample trees and 10 dead trees for NVAF stem analysis selected from 15 polygons. Approximately 80% of the polygons should be selected from the THLB and 10% from the remaining area.

Implementation

This project can be implemented following the procedures outlined in the MOF 1998 draft report *Net Volume Adjustment Factor Sampling Standards and Procedures*. This project could be combined with the TSA timber inventory project. In this case, the number of NVAF samples would be enhanced in the mature portion of the TSA.

5. IMPLEMENTATION STRATEGY

5.1 Priorities

The stakeholders identified the following implementation priorities:

1. Photo-Interpreted Estimates inventory (prior to 2001, after which the photos will be out of date).
2. Identification of mixed-species stands with spruce understory (prior to TSR 3).
3. NVAF sampling in mature strands to check decay estimates (prior to TSR 3).
4. Timber emphasis ground sampling in the TSA (prior to TSR 3).
5. Provincial VRI Ground Sampling inventory (prior to TSR 3).

These priorities were based on consideration of:

- Possible loss of approximately $800,000 already invested in aerial photographs, which will become out of data in 2-3 years.
- The need to improve the inventory databases for TSR 3 and TSR 4.

The District, Region and the Licensees will discuss these priorities further. The District will lead this initiative. The District and Region must identify the critical temporal issues and incorporate them into the VPIPs. Note that the Provincial VRI and management inventories may be implemented by smaller units (e.g. Landscape Units or Supply Blocks) identified at the district level by the District, Region, and licensees. This will allow the

District and Region to prioritize the implementation strategy by specific areas or business needs. As the Fort St. John District and the Fort Nelson District had common issues, there may also be the opportunity to jointly develop VPIPs to address the issues in both districts. These spatial priorities should be defined and addressed by the District and Region in the VPIP.

5.2 Project Implementation Plan

The stakeholders should develop detailed multi-year Project Implementation Plans based on this Inventory Plan for submission to FRBC, or other coordinating agency, for funding. The District and Region will coordinate this effort. This Plan will identify inventory activities, priority geographic areas, and costs by year, in addition to roles and responsibilities for implementation. It will also define relationship of this work to other FRBC-related (or other agency) initiatives in the Region.

5.3 Scheduling

The ground samples that are established to meet the management inventory objectives can also meet the provincial VRI objectives providing that these multi-purpose plots are identified in advance. Therefore, provincial VRI plots will be identified prior to identifying the management inventory ground plots. Some of these coincident plots will be used for both the provincial VRI and the management inventory. Additional management inventory samples will be established to meet management inventory objectives. This integrated approach, using one set of samples to address multiple inventory needs, will result in minimum implementation costs.

There may be a need to enhance the multi-purpose plots for non-timber attributes within the sub-unit depending on the implementation strategy chosen. The inventory strategy is therefore to implement the photo-interpretation first followed by ground sampling for management inventories as and when needed. The provincial VRI in the District would be implemented in parts (e.g., TSA, parks) within a defined time frame. Within each part, the provincial VRI plots may be installed before, during, or after the management inventories. The provincial VRI ground sampling in the District could be achieved as follows:

1. Plan the provincial VRI for the District.
2. Select a large pool (e.g., 10,000) of potential sampling points for the entire District.
3. Select both the polygons and the plot locations inside those polygons for the entire District.
4. Indicate the plot locations on large scale maps and enter them into the GIS system. This will allow any group considering sampling for management inventories to identify the plot clusters within the geographic area where they are considering this work. They may also wish to include adjacent plot clusters close to their own area or within a particular mapsheet.

5. Select the number of plots required for the provincial VRI plots and the additional plots needed for the management inventory.
6. Groups of plots can then be completed separately at different times. This information can be combined at a later date with the remaining plot locations in other parts. This will provide VRI plot data for subsequent analysis.
7. Analyze the partial data to provide VRI spatial database.
8. Eventually, combine the data from the management inventories (using stratified sampling methods) and produce a complete inventory for the District. This should not span more than four years, if possible (Figure 3). *If necessary*, some of the management inventories can maintain their earlier preliminary totals. This certainly is the case where many samples have been installed in a partial unit.

Text No.	Task Name
	District VRI by Parts
1	Divide District landbase into non-overlapping sub-units
2	Plan VRI for entire inventory unit & sub-units
3	Select 10,000 potential sampling points for entire inventory unit
4	Select polygons for entire inventory unit
4	Select plot locations for entire inventory unit
5	Indicate plot locations on large scale maps
5	Enter the plot locations into GIS system
6	Select # of plots required for District VRI & sub-units
7	Complete sub-unit plots when desired
8	Analyze partial data
9	Combine sub-unit data
9	Produce complete inventory for District

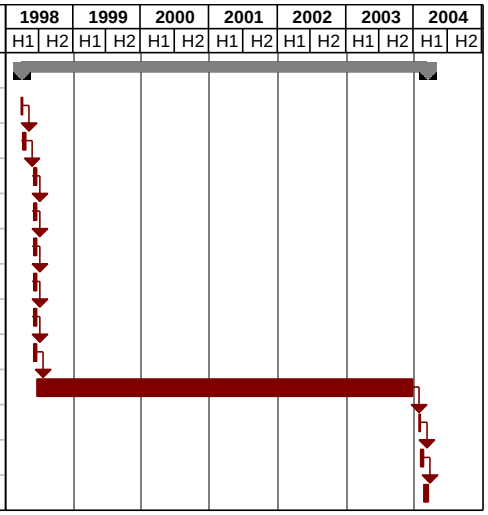

Figure 3. Provincial VRI Implementation in Parts in the Fort Nelson Forest District.

5.4 Monitoring

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

6.

7. APPROVAL/SIGNING

I have read and concur with the Fort Nelson Forest District Inventory Plan, dated Jan 22, 1999. 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.

_____

District Manager
Fort Nelson Forest District

_____

Regional Manager
Prince George Forest Region

_____

Director
Resources Inventory Branch

_____

Slocan Forest Products Ltd.

Appendix A – Glossary of Terms

Ground Sampling

Ground Sampling is the field measurement of timber, ecology, range and/or coarse woody debris values at one or more locations within each sample polygon. The sample polygons are selected proportional to their area from a sorted list. To accommodate the wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

Inventory Unit

An inventory unit is the target population from which the samples are chosen. For the provincial VRI, the inventory unit is the Forest District, which includes the timber harvesting landbase, parks, recreational areas, private, and federal lands. For management inventories, the inventory unit is a subset of the provincial VRI inventory unit that focuses on a geographic area or specific attribute set, depending upon the sampling objectives.

Landcover Classification

The BC Landcover Classification Scheme (BCLCS) was designed specifically to meet the requirements of the VRI, in addition to providing general information useful for "global vegetation accounting" and "integrated resource management." The BCLCS is hierarchical and reflects the current state of the landcover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

Management VRI

Management VRI are specialized inventories that provide more detailed information required for specific resource management, i.e., day-to-day forest management. One or more VRI sampling procedures may be used for management inventories. Management inventories may focus on specific resource types (timber, range, ecology), geographic areas (e.g., landscape unit, TFL), attribute sets (e.g., Douglas-fir leading stands, age class 4+). They may use one or more of the following tools (e.g., photo-interpreted estimates, ground sampling, NVAF sampling).

National Forest Inventory (NFI)

The NFI provides information on Canada's resources across all provinces and allows the Federal Government a consistent framework for reporting on Canada's inventory. The inventory unit for the NFI is the entire country, although it is implemented province-by-province.

Net Volume Adjustment Factor (NVAF) Sampling

NVAF sampling provides factors to adjust net tree volume from the Ground Sampling (derived from the net factoring process and taper equations) to account for hidden decay and possible taper equation bias. This involves detailed stem analysis of sample trees to calculate actual net volume. The actual net volume is compared to the net volume estimated from the VRI net factoring process and the taper equations.

Photo-Interpreted Estimates

Photo-Interpreted Estimates inventory involves the subjective delineation of polygons and the photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in the Photo-Interpreted Estimates inventory. However, if the existing photo-based inventory is acceptable, the database can be translated into VRI format and upgraded to include the additional VRI attributes.

Post-Stratification

Post-stratification involves the division of an inventory unit into strata *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately and the results are applied to the corresponding population post-strata to improve the precision of the inventory's overall averages and totals.

Pre-Stratification

Stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *before* ground sampling to provide estimates for specific areas (strata), or to increase the confidence in the overall estimates by considering the special characteristics of each stratum.

Provincial VRI

The provincial VRI provides baseline data for provincial inventory reporting, monitoring, and research. All of the sampling procedures from the VRI toolbox are utilized for this inventory at the Forest District level. The databases generated from each District inventory will be compiled to generated the Provincial VRI database. The provincial VRI has also been referred to in the past as the District VRI.

Resource-Specific Interpretations

Resource-Specific Interpretations (RSI) utilize the RIC standard VRI baseline data products (provincial VRI or management inventory), in combination with other data sets and analysis (outside of that required to produce VRI), to produce information to address specific-resource management issues (e.g., TSR review, important ecosystems, important habitats). These interpretations include ecosystem interpretations and habitat interpretations.

Retrofit

Retrofitting is the process of translating and upgrading an existing photo-based inventory to VRI standards. If the polygon linework and attributes are of acceptable quality, the existing FIP (Forest Inventory Planning) databases are translated to VIF (Vegetation Inventory Files) databases and the additional attributes required by the VRI are re-estimated from the aerial photographs.

Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet the target precision.

Statistical Analysis

Statistical analysis is the process of adjusting the values of the Photo-Interpreted Estimates variables using the Ground Sampling observations. For each sampled polygon, the ground observations are compared to the photo-estimated values to develop an adjustment factor. This factor is then applied to all polygons in the Photo-Interpreted Estimates database to produce the final adjusted database.

Sub-unit

The term sub-unit describes the inventory unit of a management inventory (i.e. the management inventory target population is a subset of the provincial VRI inventory unit). A sub-unit may be defined by a specific geographic area (e.g., operable land-base) or stand type (e.g., problem forest types) within the Forest District.

Target Precision

Target precision expresses the amount of variation in key attributes (e.g. timber volume) desired in the final results. The target precision usually expressed as the coefficient of

variation (CV) is used to calculate the minimum sample size for subsequent ground sampling.

Vegetation Resources Inventory (VRI)

The VRI is an improved vegetation inventory process for assessing the quantity and quality of BC's vegetation resources. The VRI process is designed to include a flexible set of sampling procedures for collecting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- *Photo-Interpreted Estimates*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground Sampling*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: Intensive sampling of selected polygons to determine the error between the estimated attribute values and the 'true' attribute values.
- *Statistical Adjustment*: the adjustment of the Photo-Interpreted Estimates for all polygons in an inventory unit or management unit using the values measured during Ground Sampling.

The VRI can be deployed over the entire province (provincial VRI) measuring timber and non-timber resources, or over a large management unit (management VRI) measuring selected resources in specific portions of the landbase. The VRI sampling process produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.

Within Polygon Variation (WPV) Sampling

WPV sampling provides information for expressing the true individual polygon error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon. The "true" value for the polygon is an estimate derived from a small sample of polygons that are intensively sampled on the ground.

Appendix B – VRI Process: Steps, Roles and Responsibilities

This Appendix provides an overview of the VRI process.[9] It describes the sequence of steps that apply and who is responsible for what. These steps include:

1. Forest management decision processes (land integration planning)
2. Identification of forest management issues
3. VRI Strategic planning (VSIP)
4. VRI District operational planning (VPIPs)
5. Implementation, including development and maintenance of procedures and standards:
   A) Management inventories
   B) District-wide VRI
   C) Data and warehousing
6. Data interpretation, including Ecosystem and habitat mapping (information development).

Each of these steps and the responsible and participating/supporting agencies are summarized in Table below.

Table 3. VRI overview: steps, roles and responsibilities.

Inventory Sequence	Responsible Agency	Participating/Supporting Agencies
1. FOREST MANAGEMENT DECISIONS (Land Integration Planning)		
Management strategies and prescriptions	Licensee/MOF	MELP
2. IDENTIFY FOREST MANAGEMENT ISSUES	MOF (District)	MELP
3. VRI DISTRICT-LEVEL STRATEGIC PLANNING		

[9] The first draft of this is Appendix was prepared by Ron Kot, MELP.

Development of VSIP	MOF (RIB)	MELP, Industry
4. VRI OPERATIONAL PLANNING		
• Development of VPIPs	MOF (District)	MELP, Industry MOF (RIB)
• Funding Responsibility & Lead Proponent		
- TFLs	Licensee	
- TSA	MOF	
• Submission to FRBC or other funding agency.	Lead Proponent	MOF, Other Stakeholders
5. IMPLEMENTATION		
Methods and Standards (Standards "Stewardship" responsibility)		
VRI		
• Photo interpretation	MOF	MELP
• Ground sampling	MOF	MELP
• Quality Assurance	MOF	MELP
• Net Volume Adjustment factor (NVAF) sampling	MOF	
• Within Polygon Variation (WPV) sampling	MOF	
Ecosystem and habitat Mapping (Information Development)		
• Ecosystem mapping	MELP	MOF
• Habitat mapping	MELP	
A. Management Inventories		
• Inventory Methods and Standards	See 5 above	
• Inventory Implementation		
-TFLs	Licensee	
-TSAs	MOF	
• Products "Custodianship"	MOF/Licensee	
B. VRI District-wide Projects		

• VRI Implementation	MOF (Region)	
C. VRI Data Warehouse	MOF (RIB)	MELP
(Custodianship: Standards, quality control and maintenance)		
6. Ecosystem and Habitat Mapping (Information Development)		
• Methods and Standards	See 5 above	
• Implementation		
-TFLs	Licensee	MELP
-TSAs	MELP	MOF
• Products “Custodianship”	MELP/Licensee	