Quesnel
Timber Supply Area

Vegetation Resources Inventory

Photo Interpretation
Project Implementation Plan
Ver. 3.1

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1.0 INTRODUCTION

1.1 Background Information

1.1.1 Vegetation Resources Inventory

The Vegetation Resources Inventory (VRI) is the Ministry of Forests and Range (MoFR) standard for assessing the quantity and quality of BC's vegetation resources. The VRI process is a multi phased approach that includes field calibration, photo interpretation and various levels of sampling for collecting and reporting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- *Photo Interpretation*: the delineation of polygons from aerial photography or digital imagery and the estimation of a pre-determined set of resource attributes.
- *Ground Sampling*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- *Net Volume Adjustment Factor (NVAF) Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *Within Polygon Variation (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 a management unit measuring selected resources in specific portions of the land base. The VRI produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.

The planned inventory in the Quesnel Timber Supply Area (TSA) will be a VRI. Ultimately, there will be three phases to this VRI; photo-interpretation, ground sampling, and net volume adjustment factor (NVAF) sampling. The VRI will provide an updated and improved foundation inventory for the TSA to support future forest management planning and the Timber Supply Review process.

1.1.2 State of the Current Inventory

The Quesnel TSA was inventoried between 1963 and 1988, with an extensive non-VRI (forest cover base) inventory classification update completed for all polygons between 1994 and 1997. The update process included an extensive field visitation for air and ground calls and was based on colour air photos. However, a few partial map sheets in the TSA are still identified as having a reference year from the 1978-1987 inventory period and the Bowron Park's inventory is dated as pre 1960. A Vegetation Resources Inventory Strategic Inventory Plan (VRISIP) was completed in 1998 and updated in February 1999 for the Quesnel TSA. The VRISIP was not implemented. Funding sources for the recommended inventory activities were not discussed in the document. At the time, it was suggested by MOF that the VSIP should be incorporated in submissions to Forest Renewal BC (FRBC) or other coordinating agencies for funding. At the same time the current MPB infestation was starting to increase in extent. Stakeholders and agencies agreed that implementation of a new inventory should be delayed until the MPB epidemic had started to

wane. The current inventory, while not necessarily of poor quality, does not meet the needs of the Quesnel TSA stakeholders as documented in this plan.

1.1.3 Inventory and Key Business Drivers

Government goals relevant to natural resource management are:

- "Increase access to Crown lands and resources, to create jobs in tourism, mining, forestry, farming, ranching and oil and gas."
- "Establish a working forest land base, to provide greater stability for working families and to enhance long term forestry management and planning."
- "Increase the Allowable Annual Cut over time through scientific forest management, proper planning and incentives to promote enhanced silviculture."
- "Adopt a scientifically based principled approach to environmental management that ensures sustainability, accountability and responsibility."
- "Work to develop an internationally accepted standard for "eco-labelling" of BC forest products."

The recent Mountain Pine Beetle infestation has introduced extremely significant challenges to implementing the above goals. Achieving these goals require access to topical terrestrial land base data including a robust statistically based Vegetation Resources Inventory.

The key business drivers for implementing a new VRI include:

- Support accurate and timely mid-term timber supply and environmental values mitigation strategies as being developed by the *Quesnel TSA Strategic Forest Analysis Steering Committee*.
- Support harvest scheduling and allocation planning for mid-term fibre supply
- Support accurate assessment of reserve, retention and recruitment areas
- Support the increasing demand for more detailed information for resource planning including monitoring functions due to questions surrounding sustainability of resources (that requires sound information to prove that sustainability is being achieved)
- As supporters of the Cariboo-Chilcotin Land Use Plan (C-CLUP), the stakeholders in the TSA are now in the challenging position of requiring this sound information in a TSA heavily impacted by the MPB. The CCLUP guides sustainable resource management plans and activities and balances the economic, environmental and social needs of the people. The plan is designated as a "Higher Level Plan". Goals, objectives and strategies, reflecting identified values, concerns and issues, are managed in broad categories or geographic zones with a targeted intensity of use. The resource land base (80% of the region) is divided into three Resource Development Zones:
    - The Enhanced Resource Development Zone (40% of the region) includes areas where economic benefits and jobs will be increased through intensive resource management and development. In this zone, the plan challenged all local resource users and government to set targets for increased sustainable resource development.

- The Special Resource Development Zone is designated where significant fish, wildlife, ecosystem backcountry recreation and tourism values exist. Timber harvesting, mining and grazing will take place in this zone in a manner that reflects those values.
- The Integrated Resource Management Zone includes areas dedicated to sustained integrated resource use

In order to achieve C-CLUP objectives, access to resource inventory data that is temporally current and spatially relevant is essential to effective CCLUP implementation. This is recognized in sections 4, 5 and 6 (page 207) of the CCLUP Implementation Process report.

- Sustainable Forest Management, as defined by the Canadian Council of Forest Ministers, is designed to "maintain and enhance the long-term health of our forest ecosystems, for the benefit of all living things both nationally and globally, while providing for environmental, economic, social and cultural opportunities for the benefit of present and future generations." A criterion is a category of conditions or processes by which sustainable forest management may be assessed. An indicator is a measure of an aspect of the criterion. Those used in Canada were developed through the Montreal Process initiated in 1994. This was an international meeting where criteria and indicators for the conservation and sustainable management of temperate and boreal forests were developed and agreed to internationally. Terrestrial inventories contribute to the development and assessment of these criteria and indicators as outlined in Appendix II.
- ISO 14001 specifies the requirements for an environmental management system. It applies to those environmental aspects which an organization has control and over which it can be expected to have an influence. However, it does not state specific environmental performance criteria. The Canadian Standards Association Sustainable Forest Management Plan (SFMP) is intended to enable forest management strategies as they develop. Strategies will adaptively evolve as knowledge surrounding forest resource inventories and management practices improves. The requirement for resource value benchmarks is inherent to the SFMP's certification model. Certification costs will consist of forest auditing, timber tracking and monitoring. Costs of certification will depend mainly on the availability of information in the forest inventory and adequacy of forest maps. Regular monitoring and evaluation against the benchmarks for improvement is integral to the certification process. The CSA SFMP process requires registrants to address criteria and critical elements developed by the Canadian Council of Forest Ministers. Local values, goals and indicators to address the criteria are developed in consultation with a local Public Advisory Group. Indicators are chosen locally to reflect national values or criteria. The Sustainable Forestry Initiative Program (SFI) requires that 118 core indicators must be met for a successful certification. Components of the indicators relevant to inventories include:
    - A periodic or ongoing forest inventory
    - A land classification system that provides information on forest type, management conditions, special landforms, unique habitats and special species
    - Soils inventory and maps, where available
    - Access to growth and yield modelling capabilities
    - Up to date maps or a GIS
    - Recommended sustainable harvest levels

- A review of non-timber issues (eg. Biological diversity…)
- A system for monitoring insects and diseases, fuel loading, stand density and other stress indicators to maintain forest health
- Provide funding for forest research to improve the health, productivity and management of all forests
- Financial or in-kind support of research to address forest health and productivity
- Support of programs that offset carbon emissions (eg. Protection of forest areas slated for harvest and restoration of degraded areas)

In the Quesnel TSA Canfor (CSA), Tolko (CSA), BCTSP and West Fraser Mills (SFI) are all actively engaged in certification processes.

- The Timber Supply Review process uses forest resource inventory data as a quantitative basis for strategic yield analysis and sustained yield determinations. The main objectives of the TSR process are to:
  - identify the economic, environmental and social information that reflects current forest management practices—including their effects on the short- and long-term timber supply
  - identify where improved information is required for future timber supply forecasts
  - provide the Chief Forester with information to make any necessary adjustments to the Allowable Annual Cut (expressed in volume)
- Recent Timber Supply Review processes for the Quesnel TSA indicated the issues as outlined in

  Table 1.

Table 1 Summary of Issues: AAC Determination

Table 1 - Summary of Chief Forester's AAC Determination Issues for Quesnel TSA

TSR 1	TSR 2	TSR 3	Issue
	*		Mature volume issues: overestimation in current inventory (11%)
		*	Initiate work in the district to more accurately estimate existing stand volumes
*			OGSI
	*		Site productivity estimates (PEM, SIA/SIBEC)
		*	Initiate work in the district to confirm site productivity, in view of the corresponding potential to increase the mid-term timber supply
	*		MPB issues: "shelf life, monitoring, timber supply, CCLUP, fire hazard, watershed management compromised…
		*	Monitor the MPB infestation with respect to the ongoing achievement of CCLUP objectives and the likely need for continued elevated harvest levels
		*	Monitor harvesting activities and mortality due to the MPB in the PFT
		*	Examine the issue of waste in excess of that accounted for in the yield models so that it is charged to the AAC

Table 1 - Summary of Chief Forester's AAC Determination Issues for Quesnel TSA

TSR 1	TSR 2	TSR 3	Issue
		*	Encourage the resolution of how to implement the stewardship recommendations (from the paper "Forest Stewardship in the Context of Large-Scale Salvage Operations") operationally and in the context of the FRPA
	*		OGMA's
*	*		Landscape Unit planning: complete objectives, Verify stand age/seral stage classes in landscape units/BEC areas with identified concerns
	*		Cut block adjacency
*			PFT and PA PFT: definitions and locations
	*		Caribou: Monitor caribou habitat management so that any changes in practices can be incorporated into the next analysis
	*		MDWR: Monitor mule deer management so that any changes in practices can be incorporated into the next analysis
*	*		Backlog NSR
	*		Operability: steep slopes
*			Stand conversion opportunities
*			Deciduous availability (leading and incremental)
*			Deciduous and mixed stands succession

All of the issues identified as issues by the Chief Forester require direct access to VRI data. Resolving the issues cannot proceed without new VRI data.

- Considerable analysis, expenditure and decisions are being made daily that rely on the current inventory. Examples include C-CLUP Sub-Regional Plans, Short Term Timber Assessment, including Forest Stewardship Plans, mill expansion or reconfiguration plans and assessment of Conservation Legacy.
- VRI data is required to support ecosystem management concepts. Ecosystem management focuses on sustaining ecological and biological elements of the forest while simultaneously sustaining the production of commodities and other resource values for society's use. These "ecological and biological elements" are significantly represented by attributes measured in VRI inventories.
- Required to support habitat supply concepts. Habitat management refers to evaluating the supply of a wide range of habitat used by all species. Managing habitat supply is conducted at coarse and fine levels. Ecosystem Management addresses the coarse aspect of habitat supply. Fine level management of habitat supply addresses specific species (wide ranging or rare). Understanding forest management and the implications for habitat supply may be assessed using Ecosystem Supply models or, for a single species, Habitat Supply models. These models provide indicators of the quality of habitat supply (i.e., not species population dynamics). Species guilds or life-forms, possessing common habitat requirements, are represented by indicator species that can be monitored for occurrence and quantity. The effectiveness of monitoring and modelling programs depends substantially on change projection abilities of what we know of the habitat or resource inventory. Forest management processes, such as forest estate modelling for timber supply, increasingly consider the impact of management decisions on habitat supply. These decisions can affect silvicultural investments, harvest patterns, rate of harvest, rotation lengths and other forest management options.

- The threshold for currently unmerchantable, inoperable and low productivity stands cannot be well defined from the inventory including the partioned Problem Forest Type (PFT) AAC
- Inventory does not reflect any recent successional changes which may have occurred, particularly with respect ro the MPB.
- Timber supply analysis using the existing inventory introduces a higher than normal level of risk to the reliability of timber supply forecasts

General conclusions regarding the state of the Quesnel inventory are:

- Inconsistent standards between inventories makes analysis, thematic mapping and queries difficult
- The age of the inventory and its lack of detail in relation to mitigating the MPB impact
- Quality and reliability of inventory, specifically:
    - All attributes, with the exception of leading species and height, are of low reliability
    - Knowledge of the polygonal characteristics or the attributes following MPB infestation is unknown
    - Insufficient height class and site index differentiation
    - Lack of differentiation due to overly large polygons
    - Incorrect labelling
    - Lack of differentiation between NSR and NCBR
    - Outdated classification fails to capture stand conversion or succession
    - Positional inaccuracies
    - Variable Density Yield Projection model lacks localization
    - Crown closure data lacking
    - Current segregation into 20 year age classes inhibits seral stage analysis
    - Inventory considered to be too general for specific use

1.2 Document Objectives

The Vegetation Resources Inventory Project Implementation Plan (VPIP) is a working document that details the specific operational activities associated with implementation and documentation of the inventory project. It identifies the project geographic areas, priorities, target areas for new photo interpretation, data sources, availability of aerial photographs, format of base files, project scheduling, plot location coordination, approximate or projected inventory costs, and roles and responsibilities for implementation.

1.3 Land Base

The Quesnel TSA is situated in central British Columbia in the Southern Interior Forest Region (see Figure 1). The Quesnel TSA is geographically diverse, bounded by the Columbia Mountains to the east and extending west almost to Tweedsmuir Provincial Park.

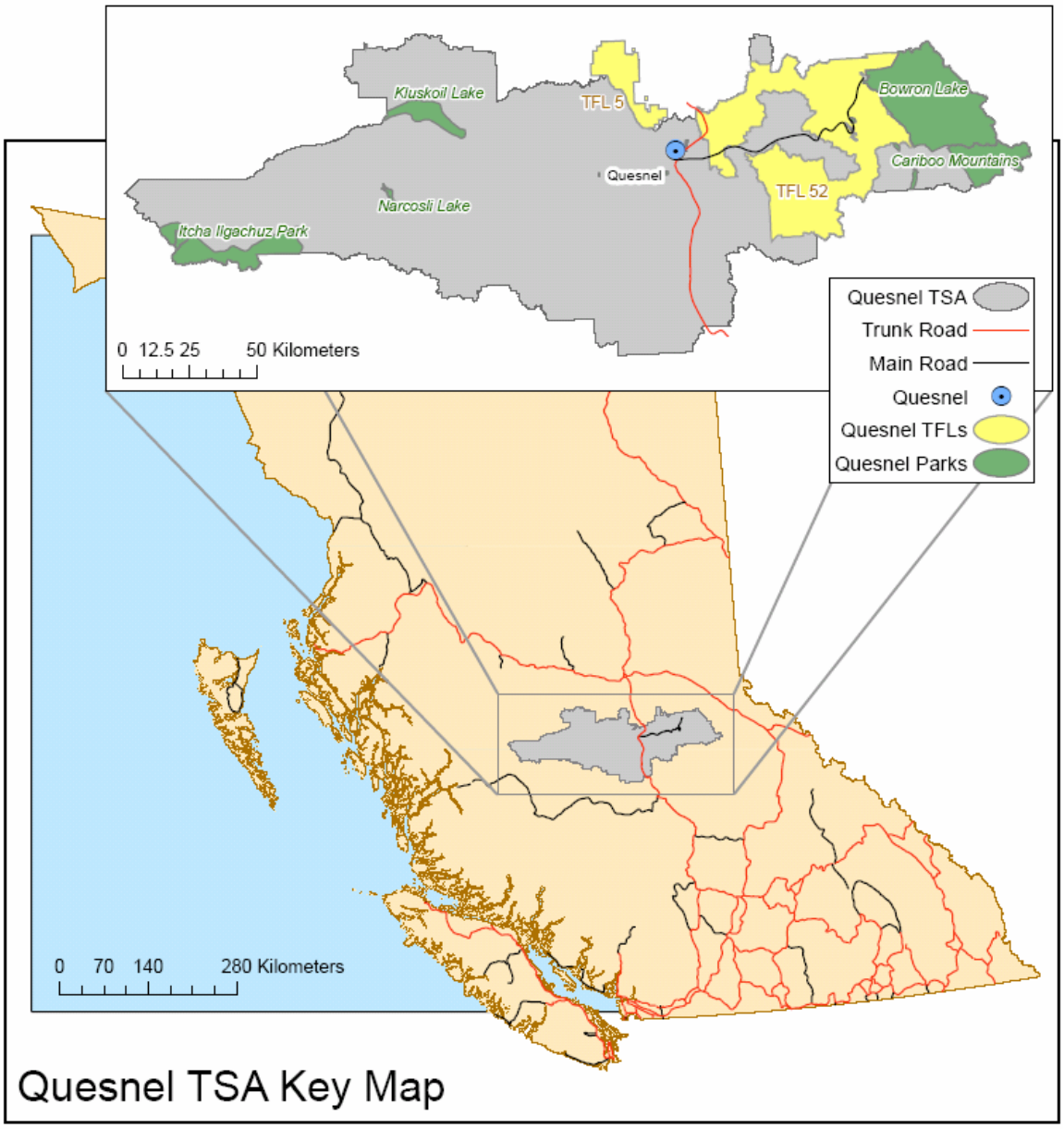

Figure 1 Quesnel TSA Key Map

The Quesnel Forest District covers approximately 2,077,236 hectares, with the Quesnel TSA occupying 1,779,951 hectares. Table 2 provides a further breakdown approximation of the land base, which is based on a blended 1999 TSR dataset that has been updated in places with newer information. It is acknowledged that there are suspected errors for some of the values listed under productive land base reductions. These errors are not resolvable within the timeframe for completing this project implementation plan. However, the information presented in Table 2 is not key to the project implementation plan and is only provided for general information.

The main tree species in the forested land base are broken down by area as follows: lodgepole pine (74.3%), hybrid white spruce (13.8%), Douglas-fir (4.9%), trembling aspen (3.8%), sub-

alpine fir (2.0%), with cedar, hemlock, birch, cottonwood, and larch (1.2%) forming minor components (see Table 2).

In this plan, the assumption is made that the forested land base corresponds to the Vegetated Treed (VT) land base according to the BC Land Cover Classification Scheme (BCLCS).

Table 2 Quesnel Forest District Area Summary

Quesnel Forest District Area Summary	Area (ha)	Percent of TSA (%)
Total Quesnel Forest District	**2,077,236**	**-**
TFL 5	34,390	-
TFL 52	262,895	-
Total Quesnel TSA	**1,779,951**	**100**
Non Forest	180,989	10.2
Non-Crown	106,072	6.0
Woodlots/Schedule N	57,442	3.2
Bowron Provincial Park	113,968	6.4
Caribou Mountain Park	29,377	1.7
Other Parks	59,154	3.3
Productive Landbase	**1,232,949**	**69.3**
Non-commercial	417	0.0
Caribou Non-harvest Zone	74,728	4.2
Class A Lake Buffers	4,534	0.3
Non-merchantable Species	64,094	3.6
Environmentally Sensitive Areas (ESA)	8,919	0.5
Low Productivity	16,667	0.9
Riparian Reserves	26,602	1.5
Riparian Management Zones (RMZ)	15,787	0.9
Residual Non-merchantable	2,406	0.1
Current Roads, Trails, and Landings	37,493	2.1
Wildlife Tree Patch (WTP)	20,818	1.2
Additional Low Productivity Deciduous	14,908	0.8
Old Growth Management Area (OGMA)	111,170	6.2
Total Productive Land Base Reductions	**398,543**	**22.4**
Timber Harvesting Land Base (THLB)	**834,406**	**46.9**

Table 3 Quesnel TSA Tree Species Distribution by Area and Volume in the Productive Forest Land Base (approximation)*

Species	Area (ha)	Area (%)	Volume (m3)	Volume (%)
Lodgepole pine	1,118,208	74.3	154,475,002.6	66.1
Spruce (Sx)	207,689	13.8	49,059,034.6	21.0
Douglas-fir	73,745	4.9	12,302,635.7	5.3

Trembling aspen	57,190	3.8	6,396,321.2	2.7
Sub-alpine fir	30,100	2.0	7,978,292.3	3.4
Other (Cw, Hw, Ep, Act & L)	18,060	1.2	3,385,882.9	1.5

*area includes parks in the Quesnel TSA

Table 4 Quesnel TSA BEC Zone, Sub-zone, and Variant Distribution by Area and Percent (approximation, non-forest excluded)

BEC Zone, Sub-zone, Variant	Area (ha)	Percent (%)
AT	9,846.6	0.62%
AT	**9,846.6**	**0.62%**
ESSFmv1	783.9	0.05%
ESSFwk1	65,200.0	4.07%
ESSFwc3	32,400.0	2.02%
ESSFxv1	17,127.9	1.07%
ESSF All	**115,511.8**	**7.22%**
ICHwk4	21,600.0	1.35%
ICH	**21,600.0**	**1.35%**
IDFdk3	7,118.8	0.44%
IDFxm	2,186.8	0.14%
IDF All	**9,305.6**	**0.58%**
MSxv	339,119.6	21.19%
MS	**339,119.6**	**21.19%**
SBPSdc	263,518.1	16.47%
SBPSmc	47,715.8	2.98%
SBPSmk	173,413.4	10.84%
SBPSxc	80,448.4	5.03%
SBSP All	**565,095.7**	**35.32%**
SBSdk	536.0	0.03%
SBSdw1	110,306.2	6.89%
SBSdw2	167,209.1	10.45%
SBSmc1	9,200.0	0.57%
SBSmc2	82,237.7	5.14%
SBSmc3	14,885.5	0.93%
SBSmh	78,363.3	4.90%
SBSmw	58,800.0	3.67%
SBSwk1	18,000.0	1.12%
SBS All	**539,537.8**	**33.72%**
Quesnel TSA Total	**1,600,017.1**	**100.00%**

2.0 PHOTO INTERPRETATION PROJECT PLAN

2.1 Project Objectives

The objective of the photo interpretation project is to improve and enhance TSA polygon attribute information through an enhanced VRI Phase 1 process in order to produce a more suitable foundation inventory for the TSA to support future forest management planning and TSR. In addition, the Quesnel TSA stakeholders identified the following issues and/or attributes need addressing:

1. All forest stands, including deciduous and deciduous-coniferous mixed stands, require improved polygon level species composition and height estimation accuracy[1].
2. Inventory needs to be brought up to VRI standards for land and vegetation cover reporting.
3. Silviculture history and free growing information requires significant improvement.
4. Better quantify non-recoverable (gross) losses from insects, disease, and wind-throw.
5. Enhance the forest inventory within provincial Parks and protected areas, as they contribute to seral stage balancing, old growth management, and habitat and rare ecosystem representation.
6. Undertake site index adjustment work utilizing the VRI and PEM inventories.
7. Complete VRI Phase 2 and NVAF sampling on the TSA to develop statistically unbiased volume estimates for use in timber supply analysis. The inventory audit results indicate the overall timber inventory appears to be over-estimated for volume. (Quesnel TSA Inventory Audit Report, 1995)
8. Assess wildlife habitat supply in the aftermath of the mountain pine beetle epidemic.
9. Obtain and maintain a statistically defensible vegetation inventory to satisfy certification requirements.
10. Maintain inventory data in a consistent and accessible format (i.e. one seamless VRI coverage updated to the current VRI standards available for use by all of the Quesnel TSA stakeholders).
11. Provide information to assist in an assessment of biophysical factors influence on the intensity of the mountain pine beetle infestation.
12. Provide stratification of mixed stand polygons for subsequent growth and yield projection of polygon attributes for mixed stands where 10 to 40% of the species composition consisting of Pl is expected to die (i.e. For determining the time estimates for Pl mixed stands, non-Pl volume, to reach merchantability and to aid in the development of harvesting strategies for these stands.
13. Through a combination of enhanced field calibration and photo interpretation, identify dead Pl stands, categorize health of young Pl stands, and provide an improved inventory in non-pine stands.

Inventory audit results (see section 2.2 for a summary) aside, the general belief of the Quesnel TSA Stakeholder Group is that the forest cover inventory is dated and in need of replacement, mainly because of the impact of the mountain pine beetle infestation. Specifically, the replacement inventory (VRI) will provide for the following needs as identified by the Stakeholder Group:

1. While new 1:20,000 scale colour aerial photographs of the entire Quesnel Forest District

[1] A process to quantify and assess polygon level improvements will be developed in conjunction with FAIB staff.

(including TFL's 5 and 52, and all parks and protected areas) are not provided by a VRI, they are a requirement for conducting a VRI as the existing aerial photo coverage of the Forest District are over 10 years old. The acquisition of 1:20,000 colour aerial photographs necessary for VRI was completed in the fall of 2006.Their utility beyond the VRI is crucial for a variety of other purposes:

a. salvage planning;
b. mitigation planning (fertilization or other stand treatments);
c. abandonment planning;
d. forest health in managed stands;
e. fire and/or fuel management planning;
f. hydrologic studies and base enhancement; and
g. maintaining habitat values and ecosystem representation.

2. Inclusion of all parks and protected areas for new aerial photo coverage and new VRI (or a correlated surrogate of VRI) as these areas contribute to seral stage balances and old growth management. Currently there is no useful inventory information available for parks in the Quesnel TSA.
3. Improved harvest scheduling through information provided by the VRI, related to shelf life modelling and identification of stands containing merchantable volume.
4. Accommodating other resource values such as wildlife habitat identified through the additional vegetation and non-vegetation cover attributes that the VRI provides (not a timber inventory as currently exists).
5. Improved timber species identification.
6. Improved stand structure identification, especially conifer understories.

The product will be a spatial database consisting of unadjusted photo-interpreted estimates. Ground sampling and NVAF sampling, used to adjust photo-interpreted estimates, will be completed at a later date under another project implementation plan.

2.2 Current Forest Cover Inventory

The Quesnel TSA was inventoried between 1963 and 1988, with a full inventory update for all polygons completed between 1994 and 1995 (Quesnel TSA Inventory Audit Report). A few partial map sheets in the TSA are still identified as having a reference year from the 1978-1987 inventory period and the Bowron Park's inventory is dated as pre 1960.

The inventory audit results for the Quesnel TSA (provided for historical reference) indicated the following (from the Quesnel TSA Inventory Audit Report):

The correlation coefficient of 0.518 for the audit and inventory estimates indicates a moderate relationship among the individual samples. There is a 30m³/ha difference between the mean inventory estimate for mature volume (235m³/ha) and the audit estimate. A paired sample t-test determined that, for the mature component of the total forested area of the TSA, this difference is statistically significant 19 times out of 20. The 95% confidence interval for the mean paired difference is –57 to -3 m³/ha.

Since there is a statistically significant difference between the two estimates, the ground attribute volume was calculated using the VDYP model. The estimated mean ground attribute volume is 211 m³/ha. The difference between the mean ground attribute volume (211 m³/ha) and the mean audit volume (205 m³/ha) is 6 m³/ha. The difference between the mean inventory volume (235

m^3/ha) and the mean ground attribute volume is 24 m^3/ha. This suggests that the majority of the bias in the volume estimates for the Quesnel TSA is associated with some of the inventory attributes.

The objective of the inventory audit in the Quesnel TSA was to assess the overall accuracy of the current Ministry of Forests inventory. The mature, immature, and non-forest components were tested.

Audit results for the mature component of the inventory suggest that the inventory volume is overestimated. Subsequent analysis of post-stratified data also shows a similar volume over estimation in the operable forested area.

Audit results for the immature component of the inventory suggest an acceptable level of accuracy for site index assignment in young stands.

The full inventory audit of the Quesnel TSA re-inventory can be reviewed at the following site:

http://www.for.gov.bc.ca/hts/vri/audits/reports&pub/

Post audit analysis work identified the Narcosli (east and west) as the main source of the problem. A breakdown of samples by BEC zone showed that the Sub-Boreal Pine-Spruce (SBPS) zone stands out with an inventory overestimate of approx. 25 percent. Where the SBPS and the Narcosli overlap the overestimate approached 28 percent[2].

2.3 Target Area

The target area for the proposed photo interpretation project will be all lands within the Quesnel TSA, regardless of ownership. Both TFL's in the Quesnel Forest District (5 and 52) have previously been re-inventoried. The TFL holder, West Fraser Mills Ltd., will be consulted as to the need to include new photo interpretation on either of the TFL's. This will be resolved prior to start of the 2007 fiscal year. In the case of private lands and TFL's, it is expected that any subsequent VRI Phase 2 works will be the responsibility of the land holder or licensee. The Quesnel TSA VRI will tie to these VRI's (best fit) and to other completed and adjacent VRI's (a 'best fit' given some significant photo year discrepancies). All lands will be classified to a V inventory standard; that is, a complete VRI label will be given to each and every polygon. Note that all portions of project maps within this TSA will be completed to VRI standards. No holes, gaps or blank spaces shall exist in the data for the contiguous portion of the TSA and any map sheet (portion within the TSA only) completed as part of the VRI photo interpretation project. See Appendix 1 for a complete list of map sheets for the Quesnel TSA. Map sheet specific areas for the major parks are not provided, as this information could not be acquired (to the required precision) from available sources within the required time frame.

In preparation for a new inventory, 1:20,000 scale colour aerial photographs were acquired during 2005 and 2006.

2.4 Calibration Data Sources

Data sources are used as calibration points for improving the quality of photo interpretation.

[2] from Quesnel Timber Supply Area Rationale for Allowable Annual Cut (AAC) Determination

Existing (historic) data sources will include air calls, ground calls, and observations distributed across the TSA from previous re-inventories. The data sources from the most recent re-inventory (1994 – 1998) will have been completed to Forest Cover standards. These data sources will have species composition derived from volume instead of basal area, and no second leading species data. In addition, the standards to which data sources were completed prior to the most recent re-inventory are unknown. Heights and ages in some or all of the most recent ground calls may have been collected using the Top Height method. This method describes a polygon's potential, not its current achievement as is described under the VRI, and can lead to exaggerated volume estimates.

In theory single species polygons containing data sources from previous re-inventories should not be field calibrated during the VRI. That is, if the leading species has greater than or equal to 80% composition, historical data source information should still be valid and VRI field calibration would be better utilized in previously un-calibrated polygons. Photo estimation of attributes could then be used to adjust previous field data to suit the current standards. However, due to the severity and extent of MPB (and other insect/diseases) the impact on these stands must be classified for primary and secondary structural attributes. Primary structure refers to trees killed by the MPB or other attack. Secondary structure refers to the understory (seedlings and saplings), sub-canopy and canopy trees that will likely survive MPB or other attack. Therefore, field visitation should not be excluded from polygons with previous data sources. It is also recommended that data source locations will be recovered from the existing fc1 files, and all available XO books will be reviewed for actual measured attributes. In this way the VRI will enhance knowledge around shelf life characterization and understory ingress.

Cruise plot data from un-logged timber sales can also be used as calibration points. However, one will have to check on the availability, suitability, condition, and compatibility of cruise plot data for use in calibration, as well as the positional accuracy needed for transferring the cruise plot locations to the new images.

The Cariboo PEM inventory for the Quesnel TSA will contain soil moisture regime and soil nutrient regime data, which will be of utility to the VRI photo-interpretation process. This information will be made available by the licencee group.

2.5 Initial Delineation

Initial delineation will be carried out or supervised by certified VRI photo interpreters, using softcopy (digital) technology. This work will be to VRI Photo Interpretation Standards and be based on the B.C. Land Cover Classification Scheme.

Vegetation resources inventory photo-interpretation in the Quesnel TSA will involve specialized polygon delineation to address soil moisture and bioterrain, based on using the PEM inventory line work. In addition, photo-interpretation procedures will include estimates of tree mortality within delineated polygons." These estimates will undergo calibration based on a field sampling program. This additional delineation criterion will provide for better spatial data with which to model grizzly bear and caribou habitat, it will facilitate the follow-up Site Index work, which is under consideration as a separate project, and it will assist in salvage, mitigation and abandonment planning of MPB-killed stands.

All base maps for the TSA are to Terrain Resources Inventory Mapping (TRIM) II specifications. A planimetric update, in softcopy, of all new roads, trails, and landings will be required as part of

the delineation process. A TRIM II update based on the 2005 photography is in progress as a separate project. It will continue as 2006 photography is acquired.

2.6 Field Work (Calibration)

Field visitation will be carried out or overseen by the same certified VRI staff doing all phases of the photo interpretation work. Field visitation is an opportunity for the photo interpreter to become familiar with the area on the ground and to collect calibration attributes to assist in final attribute estimation.

The Quesnel Stakeholders group recommends the following polygon visitation intensity and distribution (Table 6) with apportionment estimates based on the existing forest cover data for species composition and age class structure (Table 5). The actual number of calibration points may increase or decrease in the face of the final funding allocation. Assumptions are provided to qualify the distribution.

Table 5 Quesnel Forest District Area Summary by Species, Age Class >2 and Stand Composition

Species	Total Area	Area, Pure (>2 Age Class)	Area, Mixed (>2 Age Class)
At	75,874	20,000	39,000
Bl	95,697	36,778	44,488
Ep	16,132	2,181	10,654
Fd	102,014	59,762	35,646
Pl	1,337,291	937,021*	210,288
S	420,750	123,491	205,016
Other (Ac,Cw,Hw,Lw)	10,696	2,606	6,756
All	**2,058,454**	**1,181,839**	**551,849**

* Includes 281,417 ha of problem forest types

Table 6 Quesnel TSA Calibration Summary by Species, Age Class >2 and Stand Composition

Species	Calibration % - Pure (>2 Age Class)	Calibration % - Mixed (>2 Age Class)	No of Samples Pure (>2 Age Class)	No of Samples Mixed (>2 Age Class)
At	10%	20%	120	468
Bl	20%	20%	441	534
Ep	10%	20%	13	128
Fd	20%	20%	717	428
Pl	5%	20%	2,545	2,475
S	20%	20%	1,483	2.460
Other	10%	20%	16	81
All			**5,335**	**6,574**

Assumptions:

- Average polygon size of 10 hectares.

- Number of samples based on a 1,232,949 ha area for the productive forest land base in the Quesnel TSA – **approximately 60% of the above area summary of 2,058,454 hectare**s.
- Proportion of calibration points will be 65% / 25% / 10% air calls / ground calls / 70 mm LSP. The 70 mm LSP will provide more calibration points than conventional ground sampling particularly in the more inaccessible areas. It is proposed that the 70 mm LSP be used for both stand classification and quantifying the understorey components for the VRI.
- Ground calls will be a mix of single point and three point configuration with application dependant on stand complexity.
- An additional air call program may be undertaken for the large parks in the Quesnel TSA as listed in the TSA Area Summary at an approximate polygon visitation rate of 5%. The necessity of this additional visitation will be determined pending the classification approach adopted (i.e. VRI classification or PEM based classification by correlation from TSA new VRI). Appendix I provides a summary of parks area by mapsheet.

All field data point locations and attributes, collected per VRI standards will be submitted to the MoFR in a digital Excel data sheet format. The MoFR will provide a copy of the required format to the Quesnel TSA stakeholders group.

2.7 Attribute Estimation: Final Classification:

Boundaries of uniform strata are to be delineated into polygons based on the BC Land Cover Classification Scheme (BCLCS), attributes estimated, and attribute and graphic information transferred to base maps. Individual polygons will be given unique numbers. Descriptions of polygon attributes are to be entered into the Vegetation Cover Attribute Program (VegCAP), edited and cross-referenced with vegetation cover polygons through unique numbers.

2.8 MoFR VRI: Requirements for VRI data collected for Silviculture Openings.

Some criteria for working with openings have been provided by MoFR Regional VRI Update Staff:

1. Retain existing opening numbers and provide VRI attributes for the largest polygon of the silviculture opening (based on VRI source files). If opening numbers are not in the VRI source files, then obtain the opening numbers from the RESULTS spatial file. MoFR VRI Update section will provide access to the RESULTS data as required.
2. Add new openings that are not in the VRI source files, obtain the opening number from RESULTS and provide full VRI attributes. Additional internal stratification and attribution is not required.
3. Internal stratification of openings is required where an opening has been declared Free Growing in RESULTS (Opening Category = FG). Each polygon requires full attribution plus the designation “FTG” in the VegCAP polygon record project field.
4. Any polygons from the VRI source files that have “FTG” in the project field must be re-interpreted to VRI standards and the FTG designation retained.

2.9 Digital Products

Completed digital data files will be submitted to the MoFR in a digital format suitable to current MoFR standards. The data format will be changing at the beginning of the 2006/07 fiscal year.

2.10 Additional Products Delivered to MoF

- Air / Ground Call location and attribute data in hardcopy and digital format.
- Any digital products produced for the softcopy process.
- Copies of all QC/QA reports.
- Any relevant project documentation.

3.0 PHOTO INTERPRETATION PROJECT IMPLEMENTATION

3.1 Roles and Responsibilities

3.1.1 Project Coordinator

The project coordinator will be an employee of the contractor company that was the winning proponent, and will be subordinate to the Quesnel TSA stakeholder group contract coordinator for the purposes of this project.

The project coordinator's responsibilities will include, but will not be limited to:

1. coordinating the project;
2. monitoring and communicating project progress;
3. ensuring all contractors are qualified and certified;
4. overseeing photo-interpretation activities;
5. ensuring quality assurance is complete; and
6. assisting in coordinating technical expertise where required.
7. ensuring all deliverables are provided to the MoFR
8. submitting all air call / ground call data points to the MoFR in a suitable digital format including the UTM location and reference point

3.1.2 Personnel

Only certified VRI photo interpreters, or photo interpreters under the direct supervision of a certified VRI interpreter will be used to delineate and estimate the attributes of vegetation types. At least 50% of the photo interpreters working on the project will be required to be VRI Certified. The certified VRI photo interpreters list is currently found on the Internet at:

http://www.for.gov.bc.ca/hts/vri/contractinfo/rpt_pi_list.pdf

All certified VRI photo interpreters involved in this undertaking will be required to complete VRI air calls and VRI ground calls within the project area for the purposes of calibration for the photo attribute estimation phase.

3.2 Standards and Procedures

1. Photo Interpretation Procedures.
2. Photo Interpretation Standards.
3. Vegetation Resources Inventory Photo Interpretation Standards and Quality Assurance Procedures (Ver. 3.0, April 2006)
4. Air Calibration (Air Call) Data Collection Guidelines.
5. Ground Calibration (Ground Call) Data Collection Guidelines.
6. BC Land Classification Scheme.
7. Preparation and Creation of FRGIS Data Files – Forest Inventory manual Volume 5 (March 1996).

The standards and procedures documents listed above are constantly being updated. Those versions currently in effect at the time when the project RFP is tendered will be those that the project methodology will reflect.

Over and above these ‘standards’, certain levels of enhancement will be undertaken for the VRI Phase 1 to ensure that it meets the business needs of the Quesnel TSA stakeholder group.

3.3 Quality Control and Quality Assurance

Internal quality control of delineation, field work, attribute estimation, and digital map production will be undertaken by the contractor in accordance with the appropriate standards. The Quality Assurance Procedures for Photo Interpretation, Version 2.0 (March 2004) do not include revisions to address softcopy technology. Any questions concerning these procedures will be directed to a MoFR VRI representative until new procedures are provided.

External third-party quality assurance will be undertaken by a consultant/company that is not involved in the undertaking, and who is chosen by the Quesnel TSA stakeholder group through an open bidding process. Files will be submitted for third-party quality assurance in batches of at least five or as agreed to by the contractor and quality assurance contractor. These will be delivered through hard drives or as per agreed by the contractor and quality assurance contractor.

Copies of all Q&A reports, etc will be provided to the MoFR Regional VRI representative for review.

3.4 Spatial Data

The Ministry of Forests and Range is in the process of creating a revised format for the submission and storage of spatial and attribute data for the VRI program. VRI photo interpretation projects initiated after March 31, 2006 will be completed to this new standard.

4.0 PILOT AREA APPROACH

The VPIP proposes a much higher intensity of Phase 1 inventory than has been previously used elsewhere in the province in order to meet new challenges presented by MPB. It is thought that the historic level of Phase One calibration sampling will not provide adequate information to answer key business needs. Concerns have been raised due to the significant cost that would be incurred using such a high level of sampling, approximately 12,000 sample points or plots for the entire TSA. Sampling intensity will be tested and verified on a limited but representative portion of the management unit prior to undertaking a full scale VRI Phase 1. All other aspects of the VPIP meet current VRI standards.
The objective of the pilot approach is to test the proposed VRI Phase 1 sampling intensity and compare the results to other levels of sampling to:

- Determine the efficacy of this level of sampling as applied to interpretation of both the overstory and residual forest cover layers;
- Confirm if this level of sampling or if a less intensive sampling level is required in order to meet the business needs of both the proponent and the key stakeholders;
- Recommend an optimal sampling level which may generate a net cost savings; and
- Apply the results from this pilot to both the Quesnel TSA inventory and to other management units impacted by MPB.
- To ensure that the current Phase 1 photo interpretation standards are suitable for use in areas heavily impacted by MPB.

The pilot would consist of a number of map sheets randomly selected and large enough in sample size to be representative of the entire TSA. VRI Phase 1 interpretation would commence using the 2005 ortho-photography imagery available from last year's air photo acquisition and currently housed on the BMGS DIMS site. All test areas would be sampled at the proposed level of intensity as well as at lower levels of intensity. Quality assurance or auditing will be performed on all interpreted areas. Sub sets of the sample areas will be run at baseline sampling intensity and intermediate and the results will be compared to the proposed level in order to derive a qualitative assessment. Findings will then be summarized in a report with recommendations for completion of VRI Phase 1 of the remaining Quesnel management unit. All VRI Phase 1 techniques used will follow current VRI standards and will be in accordance with the VPIP provided by the proponent.

The pilot would be completed this fiscal (by March, 2007) with subsequent delivery of the rest of the Phase 1 results in fiscal 2007/08 completed at a level of sampling intensity and potential cost savings based upon this pilot's findings. VRI Phase 2 sampling would commence next fiscal and would be supplemented by the Federal MPB source since ground sampling would consist of VRI standard plus some additional information, for example shelf-life, new call grading, NVAF and monitoring data.
This pilot would thus confirm the need for the significant investment of approximately $2.5m required prior to completing the remainder of the Quesnel TSA proposed in the VSIP and VPIP. If a lower level of sampling is confirmed to meet all business requirements in light of the MPB then this pilot will have realized a net cost savings over the original plan. This pilot would provide the following deliverables:

- Test VRI Phase 1 sampling approach;
- Test VRI photo interpretation standards for MPB application
- VRI Phase interpretation for the pilot samples selected;
- Quality assurance of all of the Phase 1 map sheets selected for the pilot;
- A qualitative and quantitative evaluation of the approach delivered in a brief report on the pilot findings; and

Recommendations for the completion of the Quesnel Phase 1 VRI, including specific recommendations for use of pilot results on other MPB impacted units

The following assumptions apply to this pilot proposal:

- The MPB infestation has largely abated in the Quesnel TSA and further widespread and significant disturbance will not occur;
- The project will be completed using existing technology and this technology is adequate to meet the objectives of this inventory project;
- FIA funding will be available over the next two fiscal years to complete all aspects of the VRI Phase 1 work; and
- Federal MPB funding will be used to complete air photo acquisition in 2006 if necessary and to augment the VRI Phase 2 ground sampling that will be required in subsequent fiscal years 2007 and 2008.

The estimated budget for the pilot is $300,000.00

5.0 SCHEDULE

The schedule for this VRI is presented in Table 7.

Table 7 Quesnel TSA VRI Phase 1 Project Schedule

Item	End Date
VSIP	July 2005
VPIP (Photo Interpretation) Ver.1	March 2006
VPIP (Photo Interpretation) Ver.3	October 2006
Request for Proposals VRI Phase 1 Pilot issued	October 2006
Phase 1 Pilot Contract Award	November 2006
RFP VRI Phase 1 issued	March 2007
VRI Phase 1 Contract Award	April 2007
VRI Phase I Photo Interpretation	March 2008

6.0 COSTS

The VRI per hectare cost estimates for the project are approximately 50% higher than a standard provincial inventory. Justification for these higher costs relates the current Mountain Pine Beetle infestation and the need for better inventory data to manage and mitigate its impact. Specifically, inventory objectives recommended to support the management of this current outbreak are as follows:

- Increased field calibration (visitation) in non-Pl leading and Pl mixed stands;
- Enhanced data collection in all stands with an emphasis on the understorey component;

- Enhanced data collection procedures in all Pl stands to estimate the level of attack and assess the sawlog quality of the dead Pl; and
- Specialized polygon delineation utilizing the PEM inventory to address soil moisture, terrain, and surficial material differences.

Table 8 Costs

VRI Project Component	Unit Cost (est.)	Total (est.)
Scanning / A/T / DiAP viewer set Production	$670-$700 / full map sheet equiv.	$98,000
Orthophoto Production	$260-$325 / map sheet	$57,000
VRI Phase Pilot	$1.75/ha.	$300,000
VRI Phase 1	$1.50 to $1.60 / ha.	$2,185,000
VRI Phase 1 QA Audit (Third Party)	~$0.03 / ha.	$50,000
VRI Projects		**$2,690,000**

7.0 APPROVAL AND SIGN-OFF OF THE PHOTO INTERPRETATION VPIP

I have read and agree that the procedures outlined in this plan meet current MoFR standards.

_____ per C & C Wood Products Ltd. on behalf of the Quesnel TSA Stakeholders Group

_____ per Forest Analysis and Inventory Branch (MoFR)

8.0 APPENDIX I, QUESNEL TSA MAP SHEET AREA SUMMARY

Map Sheet	THLB Area	Gross Area (excluding parks)	Park Area	TFL Area
093A061	4,354.61	5,663.50		
093A062	675.73	1,248.50		
093A071	4,401.53	5,781.25	10.25	8,264.75
093A072	1,362.07	1,584.25		8,784.10
093A073				162.18
093A081		435.00		14,332.83
093A082				14,302.88
093A083	34.03	81.25		4,639.20
093A084	1,794.37	2,716.25	118.00	
093A085	427.59	2,069.00	143.25	
093A086	1,812.00	3,766.00	682.75	
093A087		29.50	29.50	
093A091				14,950.12
093A092	3,279.93	4,626.00		10,238.99
093A093	1,733.61	4,602.25		9,870.69
093A094	9,316.44	13,209.00	2.00	1,064.56
093A095	5,936.16	12,811.75	42.50	
093A096	3,909.22	5,132.25	43.75	
093A097			*	
093A098		5.50	5.50	
093B036	1,024.24	1,230.75		
093B037	2,404.54	3,192.25		
093B038	1,716.04	2,254.75		
093B046	10,253.33	12,238.50	46.00	
093B047	10,460.95	13,739.50		
093B048	8,278.06	11,872.75		
093B049	2,876.19	4,170.00	42.00	
093B051	222.58	247.00		
093B052	1,140.75	1,289.75		
093B053	103.86	209.75		
093B054	7,458.19	9,214.75		
093B055	12,194.57	13,902.75		
093B056	11,900.81	14,027.50		
093B057	11,350.95	14,301.25	40.25	
093B058	3,254.74	12,293.75	7.00	
093B059	5,500.28	9,525.00	8.25	
093B061	5,854.29	6,549.00		
093B062	10,845.55	12,974.75		
093B063	9,001.26	11,491.50		
093B064	11,358.21	13,703.25		
093B065	11,847.26	13,760.75		

Map Sheet	THLB Area	Gross Area (excluding parks)	Park Area	TFL Area
093B066	11,832.59	13,639.50	232.00	
093B067	11,701.60	14,242.75	8.50	
093B068	2,567.56	11,124.75	253.25	
093B069	8,009.08	11,416.25		
093B070	593.76	758.25		
093B071	9,778.69	11,367.75		
093B072	11,289.26	13,715.25		
093B073	10,995.36	14,470.50	18.50	
093B074	11,313.55	12,874.75		
093B075	12,205.38	14,292.00		
093B076	12,506.29	14,297.25		
093B077	11,897.66	14,661.75		
093B078	1,578.70	9,709.25	411.75	
093B079	9,537.95	14,121.25	67.75	
093B080	8,639.19	12,628.00	129.75	
093B081	12,357.25	14,312.75		
093B082	12,152.09	14,542.25		
093B083	9,903.10	13,455.00		
093B084	12,537.51	14,542.50		
093B085	11,179.21	13,908.50	11.00	
093B086	10,751.88	13,305.25	11.50	
093B087	11,246.91	14,473.50		
093B088	2,795.99	9,742.75	157.25	
093B089	7,984.21	12,513.00	51.25	
093B090	10,929.25	14,051.00		94.42
093B091	11,801.01	13,894.75		
093B092	11,196.37	14,059.25	85.25	
093B093	8,774.49	11,705.25	120.75	
093B094	12,673.40	14,271.50		
093B095	10,742.13	13,395.25	54.00	
093B096	8,386.83	13,414.00	87.00	
093B097	7,646.00	13,927.50		
093B098	1,021.37	8,449.00	564.25	
093B099	7,512.97	10,206.00	33.75	2,624.89
093B100	5,773.50	9,816.50		4,360.14
093C070	904.86	1,045.25		
093C074			*	
093C075	2,680.84	3,338.50		
093C076	368.67	2,830.25	1.00	
093C077		233.50		
093C078	6.05	6,900.25		
093C079	3,110.42	9,101.50		
093C080	9,905.01	11,689.25		
093C083	1,094.99	2,112.75		
093C084	489.29	10,248.00	2,765.75	

Map Sheet	THLB Area	Gross Area (excluding parks)	Park Area	TFL Area
093C085	10,754.26	13,635.75	178.25	
093C086	9,337.56	12,828.50	31.50	
093C087	4,263.78	10,789.75		
093C088	1,806.19	13,607.00		
093C089	5,502.34	13,940.50		
093C090	12,282.65	14,446.75		
093C093	6,616.29	8,420.75	257.25	
093C094	5,108.07	11,269.50	281.00	
093C095	8,487.02	10,848.00	294.25	
093C096	10,489.63	12,858.50	144.50	
093C097	9,813.62	12,312.75		
093C098	12,735.47	13,979.25		
093C099	12,690.53	14,184.75		
093C100	9,841.77	12,716.75		
093F003	221.68	246.00		
093F004	357.08	413.25		
093F005	206.59	346.00		
093F006	1,160.87	1,782.50	77.00	
093F007	8,545.11	11,289.50	428.25	
093F008	9,977.40	13,409.75	184.50	
093F009	10,004.77	12,069.50		
093F010	10,735.73	12,646.00		
093F017	57.90	126.25		
093F018	491.51	1,713.50		
093F019	4,474.60	6,838.00	29.75	
093F020	10,188.32	11,962.25	135.25	
093F029	1,316.71	1,526.75		
093F030	6,338.61	9,577.25	1,934.50	
093F039	6,850.44	7,846.00	14.25	
093F040	10,250.43	13,697.25	45.50	
093F049	1,604.09	1,982.00	6.25	
093F050	3,682.98	4,141.00		
093G001	11,552.06	14,074.25		
093G002	11,040.53	13,861.75	2.00	
093G003	11,051.60	13,582.00		
093G004	12,598.56	14,251.25		
093G005	12,298.37	14,392.25	29.75	
093G006	11,626.52	13,965.50		
093G007	5,838.60	12,014.00	24.25	
093G008	715.11	9,312.50	307.75	
093G009	1,750.61	6,304.25	12.00	7,577.44
093G010	7,552.41	9,605.00	5.25	4,640.20
093G011	9,922.92	14,241.75	2,487.00	
093G012	7,405.62	13,962.50	3,195.25	
093G013	11,230.37	14,089.50		

Map Sheet	THLB Area	Gross Area (excluding parks)	Park Area	TFL Area
093G014	13,082.46	14,726.50		
093G015	11,378.67	13,681.00		
093G016	11,184.94	14,127.00	123.25	
093G017	4,741.13	7,685.00	24.00	5,779.61
093G018	1,032.03	5,936.50		1,571.20
093G019	109.08	1,110.25	32.50	10,639.38
093G020	1,203.01	1,344.00		13,531.63
093G021	4,481.94	13,355.00	5,851.50	
093G022	8,573.84	13,134.25	154.25	
093G023	7,752.90	10,700.75	38.00	
093G024	10,746.81	12,397.50		
093G025	6,366.72	11,133.50	47.50	
093G026	9,417.92	12,585.00		1,236.52
093G027	1,005.86	1,320.50	39.25	5,474.13
093G028				54.81
093G029				399.46
093G030	552.63	613.25		8,070.14
093G031	9,486.10	13,561.75	121.75	
093G032	9,371.26	12,154.25	109.75	
093G033	5,992.09	6,920.50	54.75	
093G036	227.21	271.75		10,214.23
093G037				7,319.97
093G040	2,189.73	2,785.25		1,527.83
093G041	7,859.48	8,966.00		
093G042	3,363.62	3,834.00		
093G043	539.56	632.00		
093G046				2,149.39
093G047				755.54
093G050	757.45	873.00		
093H001	8,339.84	9,674.00		4,417.21
093H002	6,126.42	9,619.50		4,943.01
093H003		995.50		13,086.36
093H004	1,959.19	3,334.75	10.50	10,200.58
093H005	1,241.50	1,800.50	1.00	379.02
093H006	1.58	9.00		
093H007		38.50	38.50	
093H008			*	
093H011	11,992.57	14,027.75	16.25	214.78
093H012	2,943.95	3,344.50		11,483.34
093H013		193.50	54.00	14,171.41
093H014		13.25		6,779.46
093H015			14,418.50	
093H016			*	
093H017			*	
093H021	3,770.54	4,217.00		10,439.51
093H022	379.38	421.00		13,556.87

Map Sheet	THLB Area	Gross Area (excluding parks)	Park Area	TFL Area
093H023		402.00	11.50	13,045.43
093H024		6.75		2,051.79
093H025			14,418.50	
093H026			*	
093H031	2,867.90	3,490.75		3,806.97
093H033				3,987.31
093H034				4,461.50
093H035			*	
093H036			*	
093H041	628.32	823.25		
Total	**834,406**	**1,577,452**	**202,499**	**297,285**

*Partial map sheet, area occupied by park unknown

9.0 APPENDIX II, VRI & ECOLOGICAL CRITERIA & INDICATORS

Criteria and Indicators: Ecological

CRITERIA	INDICATOR	INDICATOR	Contribution from Inventories			
			Direct	Partial	Indirect	Not Applicable
Conservation of Biological Diversity	Ecosystem diversity	Percentage and extent, in area, of forest types relative to historical condition	*			
Conservation of Biological Diversity	Ecosystem diversity	Percentage and extent, in area, of forest types relative to total forest area	*			
Conservation of Biological Diversity	Ecosystem diversity	Percentage and extent of area by forest type and age class	*			
Conservation of Biological Diversity	Ecosystem diversity	Area, percentage and representativeness of forest types in protected areas	*			
Conservation of Biological Diversity	Ecosystem diversity	Level of fragmentation and connectedness of forest ecosystem components	*			
Conservation of Biological Diversity	Species diversity	Number of known forest-dependent species classified as extinct, threatened, endangered, rare or vulnerable relative to total number of known forest-dependent species	*			
Conservation of Biological Diversity	Species diversity	Population levels and changes over time of selected species and species guilds		*		
Conservation of Biological Diversity	Species diversity	Number of known forest-dependent species that occupy only a small portion of their former range		*		
Conservation of Biological Diversity	Genetic diversity	Implementation of an in situ/ex situ genetic conservation strategy for commercial and endangered forest vegetation species			*	
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Incidence of disturbance and stress (biotic and abiotic)	Area and severity of insect attack			*	

CRITERIA	INDICATOR	INDICATOR	Contribution from Inventories			
			Direct	Partial	Indirect	Not Applicable
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Incidence of disturbance and stress (biotic and abiotic)	Area and severity of disease infestation			*	
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Incidence of disturbance and stress (biotic and abiotic)	Area and severity of fire damage			*	
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Incidence of disturbance and stress (biotic and abiotic)	Rates of pollutant deposition			*	
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Incidence of disturbance and stress (biotic and abiotic)	Ozone concentrations in forested regions			*	
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Incidence of disturbance and stress (biotic and abiotic)	Crown transparency in percentage by class	*			
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Incidence of disturbance and stress (biotic and abiotic)	Area and severity of occurrence of exotic species detrimental to forest condition		*		
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Incidence of disturbance and stress (biotic and abiotic)	Climate change as measured by temperature sums				*
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Ecosystem resilience	Percentage and extent of area by forest type and age class	*			
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Ecosystem resilience	Percentage of area successfully naturally regenerated and artificially regenerated	*			
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Extant biomass (biota)	Mean annual increment by forest type and age class	*			

CRITERIA	INDICATOR	INDICATOR	Contribution from Inventories			
			Direct	Partial	Indirect	Not Applicable
Maintenance and Enhancement of Forest Ecosystem Condition and Productivity	Extant biomass (biota)	Frequency of occurrence within selected indicator species (vegetation, birds, mammals, fish).		*		
Conservation of Soil and Water Resources	Physical environmental factors	Percentage of harvested area having significant soil compaction, displacement, erosion, puddling, loss of organic matter, etc	*			
Conservation of Soil and Water Resources	Physical environmental factors	Area of forest converted to non-forest land use, for example, urbanization	*			
Conservation of Soil and Water Resources	Physical environmental factors	Water quality as measured by water chemistry, turbidity, etc.			*	
Conservation of Soil and Water Resources	Physical environmental factors	Trends and timing of events in stream flows from forest catchments	*			
Conservation of Soil and Water Resources	Physical environmental factors	Changes in distribution and abundance of aquatic fauna				*
Conservation of Soil and Water Resources	Policy and protection forest factors	Percentage of forest managed primarily for soil and water protection	*			
Conservation of Soil and Water Resources	Policy and protection forest factors	Percentage of forest area having road construction and stream crossing guidelines in place		*		
Conservation of Soil and Water Resources	Policy and protection forest factors	Area, percentage and representativeness of forest types in protected areas	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Tree biomass volumes	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Vegetation (non-tree) biomass estimates		*		
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Percentage of canopy cover	*			

CRITERIA	INDICATOR	INDICATOR	Contribution from Inventories			
			Direct	Partial	Indirect	Not Applicable
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Percentage of biomass volume by general forest type	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Soil carbon pools	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Soil carbon pool decay rates	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Area of forest depletion	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Forest wood product life cycles			*	
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to global carbon budget	Forest sector CO2 emissions			*	
Forest Ecosystem Contributions to Global Ecological Cycles	Forest land conversion	Area of forest permanently converted to non-forest land use (for example, urbanization)	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Forest land conversion	Semi-permanent or temporary loss or gain of forest ecosystems (for example, grasslands, agriculture)	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Forest sector CO2 conservation	Fossil fuel emissions				*
Forest Ecosystem Contributions to Global Ecological Cycles	Forest sector CO2 conservation	Fossil carbon products emissions				*
Forest Ecosystem Contributions to Global Ecological Cycles	Forest sector CO2 conservation	Percentage of forest sector energy usage from renewable sources relative to total sector energy requirement				*

CRITERIA	INDICATOR	INDICATOR	Contribution from Inventories			
			Direct	Partial	Indirect	Not Applicable
Forest Ecosystem Contributions to Global Ecological Cycles	Forest sector policy factors	Recycling rate of forest wood products manufactured and used in Canada				*
Forest Ecosystem Contributions to Global Ecological Cycles	Forest sector policy factors	Participation in the climate change conventions				*
Forest Ecosystem Contributions to Global Ecological Cycles	Forest sector policy factors	Economic incentives for bioenergy use			*	
Forest Ecosystem Contributions to Global Ecological Cycles	Forest sector policy factors	Existence of forest inventories	*			
Forest Ecosystem Contributions to Global Ecological Cycles	Forest sector policy factors	Existence of laws and regulations on forest land management				*
Forest Ecosystem Contributions to Global Ecological Cycles	Contributions to hydrological cycles	Surface area of water within forested areas			*	
Multiple Benefits to Society	Productive capacity	Annual removal of forest products relative to the volume of removals determined to be sustainable	*			
Multiple Benefits to Society	Productive capacity	Distribution of, and changes in, the land base available for timber production	*			
Multiple Benefits to Society	Productive capacity	Animal population trends for selected species of economic importance			*	
Multiple Benefits to Society	Productive capacity	Management and development expenditures		*		
Multiple Benefits to Society	Productive capacity	Availability of habitat for selected wildlife species of economic importance	*			
Multiple Benefits to Society	Competitiveness of resource industries (timber/non-timber related)	Net profitability				*

CRITERIA	INDICATOR	INDICATOR	Contribution from Inventories			
			Direct	Partial	Indirect	Not Applicable
Multiple Benefits to Society	Competitiveness of resource industries (timber/non-timber related)	Trends in global market share				*
Multiple Benefits to Society	Competitiveness of resource industries (timber/non-timber related)	Trends in research and development expenditures in forest products and processing technologies				*
Multiple Benefits to Society	Contribution to the national economy (timber/non-timber sectors)	Contribution to gross domestic product (GDP) of timber and non-timber sectors of the forest economy				*
Multiple Benefits to Society	Contribution to the national economy (timber/non-timber sectors)	Total employment in all forest-related sectors				*
Multiple Benefits to Society	Contribution to the national economy (timber/non-timber sectors)	Utilization of forests for non-market goods and services, including forest land use for subsistence purposes		*		
Multiple Benefits to Society	Contribution to the national economy (timber/non-timber sectors)	Economic value of non-market goods and services		*		
Multiple Benefits to Society	Non-timber values (including option values)	Availability and use of recreational opportunities			*	
Multiple Benefits to Society	Non-timber values (including option values)	Total expenditures by individuals on activities related to non-timber use				*
Multiple Benefits to Society	Non-timber values (including option values)	Membership and expenditures in forest recreation-oriented organizations and clubs				*
Multiple Benefits to Society	Non-timber values (including option values)	Area and percentage of protected forest by degree of protection	*			
Accepting Society's Responsibility for Sustainable Development	Aboriginal and treaty rights	Extent to which forest planning and management processes consider and meet legal obligations with respect to duly established Aboriginal and treaty rights				*

CRITERIA	INDICATOR	INDICATOR	Contribution from Inventories			
			Direct	Partial	Indirect	Not Applicable
Accepting Society's Responsibility for Sustainable Development	Participation by Aboriginal communities in sustainable forest management	Extent of Aboriginal participation in forest-based economic opportunities				*
Accepting Society's Responsibility for Sustainable Development	Participation by Aboriginal communities in sustainable forest management	Extent to which forest management planning takes into account the protection of unique or significant Aboriginal social, cultural or spiritual sites		*		
Accepting Society's Responsibility for Sustainable Development	Participation by Aboriginal communities in sustainable forest management	Number of Aboriginal communities with a significant forestry component in the economic base and the diversity of forest use at the community level				*
Accepting Society's Responsibility for Sustainable Development	Participation by Aboriginal communities in sustainable forest management	Area of forest land available for subsistence purposes		*		
Accepting Society's Responsibility for Sustainable Development	Participation by Aboriginal communities in sustainable forest management	Area of Indian reserve forest lands under integrated management plans				*
Accepting Society's Responsibility for Sustainable Development	Sustainability of forest communities	Number of communities with a significant forestry component in the economic base				*
Accepting Society's Responsibility for Sustainable Development	Sustainability of forest communities	Index of the diversity of the local industrial base				*
Accepting Society's Responsibility for Sustainable Development	Sustainability of forest communities	Diversity of forest use at the community level			*	
Accepting Society's Responsibility for Sustainable Development	Sustainability of forest communities	Number of communities with stewardship or co-management responsibilities				*
Accepting Society's Responsibility for Sustainable Development	Fair and effective decision-making	Degree of public participation in the design of decision-making processes				*

CRITERIA	INDICATOR	INDICATOR	Contribution from Inventories			
			Direct	Partial	Indirect	Not Applicable
Accepting Society's Responsibility for Sustainable Development	Fair and effective decision-making	Degree of public participation in decision-making processes				*
Accepting Society's Responsibility for Sustainable Development	Fair and effective decision-making	Degree of public participation in implementation of decisions and monitoring of progress toward sustainable forest management				*
Accepting Society's Responsibility for Sustainable Development	Informed decision-making	Percentage of area covered by multi-attribute resource inventories	*			
Accepting Society's Responsibility for Sustainable Development	Informed decision-making	Investments in forest-based research and development and information		*		
Accepting Society's Responsibility for Sustainable Development	Informed decision-making	Total effective expenditure on public forestry education				*
Accepting Society's Responsibility for Sustainable Development	Informed decision-making	Percentage of forest area under completed management plans/programs/guidelines which have included public participation		*		
Accepting Society's Responsibility for Sustainable Development	Informed decision-making	Expenditure on international forestry				*
Accepting Society's Responsibility for Sustainable Development	Informed decision-making	Mutual learning mechanisms and processes			*	