Kootenay Lake Timber Supply Area

Vegetation Resources Inventory

Strategic Inventory Plan

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ISSUED: DECEMBER 2006

Executive Summary

This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines VRI activities and products needed to address forest management and inventory issues in the Kootenay Lake Timber Supply Area (TSA). The TSA is located within the Southern Interior Forest Region – Kootenay Lake Forest District, in southeast BC.

The main forest management and inventory issues identified by the attendees at the July 12, 2006 stakeholders meetings include:

- Net merchantable volume;
- Dead trees with potential commercial use;
- Tree height and age, and consequently, improved site index information;
- Coarse woody debris and ecological data that will help make decisions on landscape-level biodiversity and provide information for sustainable forest management planning and ecosystem mapping;
- Levels of MPB attack, current attributes and volumes in MPB stands;
- Problem Forest Types – this population can be better identified and analyzed in the inventory;
- Root rot incidence and severity; and
- Non-forest attributes.

The VRI program will include a Photo-Interpretation, Ground Sampling, Net Volume Adjustment Factor (NVAF), and Statistical Adjustment components as well as a Change Monitoring Inventory (CMI) program. It is expected that 1.1 million ha will be re-inventoried, approximately 100 VRI Phase II plots and 100 NVAF trees will be sampled, and approximately 60 CMI plots will be established. The total expected cost for all VRI activities is approximately $2.5 million.

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Acknowledgements

This plan was developed by Tembec Industries Inc. Direct support and plan development was carried out by various parties including the following: Marcie Belcher, RFT, (Forest Investment Account [FIA], Administrator for Tembec Industries Inc.), Joanne Leesing, RPF, (Joanne J. Leesing), Chris Mulvihill, RPF, (Inventory Forester, Ministry of Forests and Range, Southern Interior Region), Guillaume Therien, PhD, (J.S. Thrower & Associates Ltd.), Hamish Robertson,RPF, (J.S. Thrower & Associates Ltd.), and Warren Nimchuk, RPF, (Timberline Forest Inventory Consultants).

Funding for the project was provided through the FIA Land Base Investment Program.

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1. INTRODUCTION

1.1 BACKGROUND

This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines VRI activities and products needed to address forest management and inventory issues in the Kootenay Lake Timber Supply Area (TSA). The VSIP provides details for photo interpretation, ground sampling, and statistical adjustment of the inventory. Following VSIP approval, the next steps include the preparation of Project Implementation Plans (VPIP) based on this VSIP, and implementation of these VPIPs.

The Kootenay Lake TSA stakeholders include willing participants operating within the TSA. These stakeholders are:

- Ministry of Forests and Range (MOFR)
- BC Timber Sales
- Ministry of Environment
- BC Parks
- First Nations
- Kaslo and District Community Forest
- Harrop-Proctor Community Forest
- Creston Valley Forest Corporation
- Kalesnikoff Lumber Company Ltd.
- Atco Lumber Ltd.
- Wynndel Box and Lumber Ltd.
- J. H. Huscroft Ltd.
- Springer Creek Forest Products
- Tembec Industries Inc.
- Meadow Creek Cedar Ltd.
- Goose Creek Lumber Ltd.

This VSIP follows a meeting with stakeholders that took place on July 12, 2006 in Nelson, BC. More specific details on the meeting attendees is provided in Appendix II.

1.2 VRI OVERVIEW

The VRI is a vegetation inventory process that has been approved by the former Resources Inventory Committee (RIC) to assess the quantity and quality of BC's timber and vegetation resources. The VRI estimates overall population totals and averages, as well as individual polygon attributes, for timber and non-timber resources. Its design is simple, reasonably efficient, statistically defensible, and addresses issues raised by the Forest Resources Commission in its 1991 report, *The Future of Our Forests*.[1] The VRI is broader in scope and more reliable than past inventories because it uses statistically accurate procedures and detailed ground sampling to augment the photo-interpreted estimates.

The VRI consists of several components:[2]

1. Photo Interpreted Estimates (Phase I).
2. Ground Sampling (Phase II) – timber emphasis, ecology, coarse woody debris.
3. Net Volume Adjustment Factor (NVAF) sampling.
4. Change Monitoring Inventory (CMI).
5. Statistical Adjustment.

One or more of these components can address specific forest management or inventory issues. For more detailed information, VRI manuals are available on the MOFR – Forest Analysis and Inventory Branch website. [3]

[1] Forest Resources Commission. 1991. The Future of Our Forests.

[2] A glossary of technical terms is provided in Appendix I.

[3] http://www.for.gov.bc.ca/hts/vri/

1.3 VRI PLANNING

The VRI planning process requires that a VSIP and VPIP be developed for defined units (e.g. TSA, Tree Farm Licence [TFL]). A VSIP outlines VRI products to address forest management issues and provides strategic direction for implementing the inventory activities. A VPIP details the operational activities identified in the VSIP (e.g., ground sampling or photo interpretation projects) and identifies project areas, priorities, and roles and responsibilities.

The VRI planning process is an important component of the overall VRI process and related activities (Figure 1). The intent of the VRI planning process is to ensure that baseline products meet a range of applications and they are efficiently implemented. These processes and activities include:

1. Forest management decision processes (land integration planning);
2. Identifying forest management issues;
3. VRI strategic planning (prepare a VSIP);
4. VRI operational planning (prepare VPIP); and
5. Implementation, including development and maintenance of procedures and standards:
    a. Management inventories;
    b. Database management;
    c. Data interpretation.

The steps for preparing a VSIP include:

1. Licensee stakeholders work with MOFR staff to develop TSA issue statements related to VRI.
2. All agencies and stakeholders meet to refine issues and discuss why these issues need to be considered fundable. The purpose of this meeting is to:
    a. Introduce the VRI tools and process;
    b. Table new issues and issues recorded to date;
    c. Discuss issues that can be funded or not (under current funding mechanisms); this discussion provides general direction for developing the VSIP. This discussion also affects the extent of photo interpretation and the number and type of VRI plots; and
    d. Suggest the VRI tools to address currently fundable issues as well as those issues that may be funded in the future.
3. Meeting minutes are prepared and circulated to all participants for review and feedback.
4. A final VSIP is prepared. This VSIP incorporates items agreed to in Step 5 of the planning process and is signed off by committee members.
5. VPIP process begins.

The steps for preparing a VPIP include:

1. Review and update VSIP recommendations.
2. Secure funding.
3. Identify project activities, scheduling, geographic areas, and estimated costs.
4. Specify roles and responsibilities for project implementation.
5. Prepare VPIP.[4]

[4] Separate VPIPs are required for photo interpretation and ground sampling. The ground sampling VPIP covers both the NVAF and analysis/statistical adjustment projects.

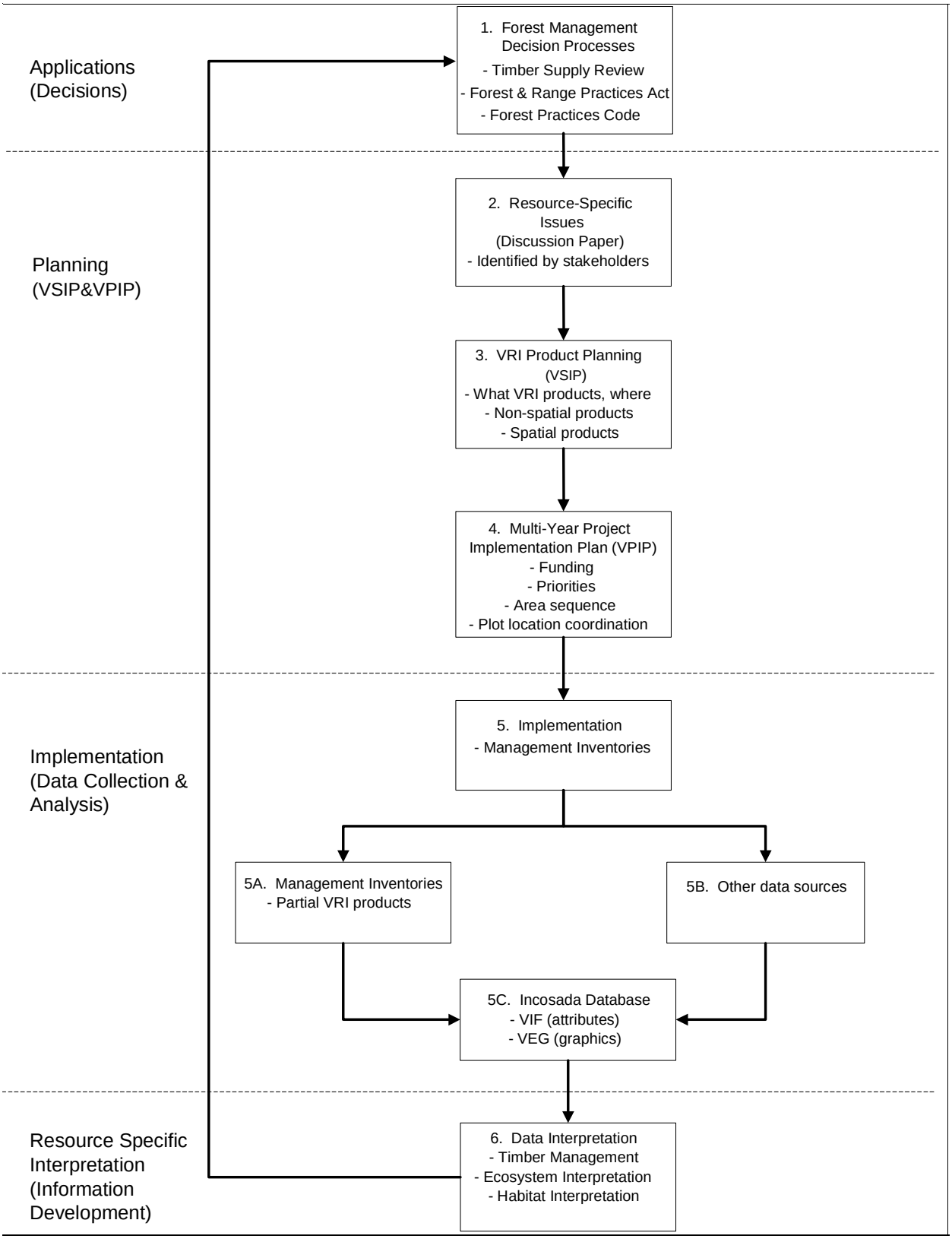

Figure 1. VRI planning process.

1.4 VRI METHODOLOGY

1.4.1 Phase I – Photo-Interpretation

Prior to commencing the Phase I of a VRI project, a *VPIP for Photo Interpretation* must be completed and subsequently approved by the MOFR. This plan will detail photo acquisition requirements, the VRI Phase I process, standards for adherence, and a photo interpretation plan to carry out the Phase I of the VRI.

Phase I is the photo interpretation phase of a VRI and entails polygon delineation and attribute estimation by certified photo interpreters using aerial photographs or softcopy images. The delineation identifies the location of the forest resources and the attribute estimation component provides estimates of numerous attributes including land cover type, crown closure, tree species, height, age, stand structure, basal area, density, slope position, moisture and nutrient regime, snags, shrubs, herbs, and bryoids. Estimation of attributes is based upon field procedures using a combination of air and ground calibration points.

1.4.2 Phase II – Ground Sampling

Prior to commencing Phase II, a *VPIP for Ground Sampling* must be completed and subsequently approved by the MOFR. This plan details the Phase II sample selection process and standards for adherence.

Specifically the Phase II VPIP plan will:

- Detail the Phase II project and sampling objectives;
- Target and identify sample populations and sample selection and sample size details;
- Discuss how existing Phase II sample data will be applied to the new inventory;
- Include discussion of the field program;
- Discuss the proposed data compilation, analysis, and statistical adjustment;
- Include the proposed implementation schedule; and
- Identify the timing and submission of annual deliverables including the Phase II data, final analysis report and adjusted Phase I.

The objective of the ground sampling is to install an adequate number of samples to provide statistically sound information on volume and other attributes, which can be used to adjust the inventory. The samples (samples are "plot clusters" and consist of a main plot and up to 4 associated auxiliaries) selected for the Phase II ground sampling are based on the delineated polygons and attributes estimated during Phase I. Samples are selected randomly using a two-step process. First, polygons are selected proportional to area. Second, a random point is selected within the polygon. Comparison between the sample and the population are provided for key inventory attributes.

1.4.3 Net Volume Adjustment Factor

As per the MOFR VRI standards, all new VRI Phase II must complete an NVAF sampling program. The NVAF sampling is the destructive tree sampling process that accounts for taper bias and hidden decay in the trees and is used to adjust the cruiser's net factor calls. This sampling involves detailed stem analysis of sample trees that have been randomly selected from the Phase II plots. The NVAF is used to correct the VRI estimates of net close tree utilization for all species.

1.4.4 Statistical Adjustment

Adjustment to the Phase I using the results of Phase II sampling data for the entire VRI project area is the final VRI phase. The NVAF information is utilized to adjust the Phase II sample estimates for hidden decay and taper equation bias and the Phase II plot estimates are used to adjust the Phase I photo interpretation attribute estimates. The final

product is a statistically valid new inventory, supported by re-adjustment of photo-estimated attributes based on ground samples.

1.4.5 Change Monitoring Inventory

A CMI program monitors change over time in key forest inventory attributes. These change estimates can then be compared to predictions from growth and yield models. One objective of the CMI program is to act as an early warning system if assumptions used in growth and yield models are inaccurate. The CMI will only indicate that there is a problem with the model(s); it will not give information about the source of the problem. Special studies must be undertaken to investigate the source of the problem identified by the CMI program.

1.5 FUNDING

Funding for VRI activities is provided by the Forest Investment Account (FIA) Land Base Investment Program for the fiscal year 2006-07.

2. BUSINESS CONSIDERATIONS

2.1 LAND BASE

The Kootenay Lake TSA is within the Southern Interior Forest Region – Kootenay Lake Forest District and is administered out of the District Office located east of Nelson. The Kootenay Lake Forest District is situated in the southeastern corner of BC (Figure 2). The Kootenay Lake TSA covers approximately 1.24 million hectares (Table 1), including approximately 220,000 ha in Provincial parks. The timber harvesting landbase (THLB) in Timber Supply Review (TSR) 2 was 257,850 ha (21% of the TSA).[5]

Approximately 49% of the total TSA area is considered Crown Forested Land Base (CFLB); the remaining 51% is considered non-productive (i.e. rock, ice, alpine, etc), or is not managed by the MOFR (i.e. private, First Nations, woodlots, etc). Within the CFLB, only about 43% (or 21% of the total TSA), is in the timber harvesting land base (THLB).

The Kootenay Lake TSA includes both moist and wet climatic regions, and is commonly referred to as part of the Interior Wet Belt. It includes some of the most productive sites in the BC interior. There are four biogeoclimatic (BGC) zones represented in the Kootenay Lake TSA: Interior Cedar-Hemlock (ICH), Engelmann Spruce-Subalpine Fir (ESSF), Alpine Tundra (AT), and Montane Spruce (MS) in the southeastern portion of the TSA.

Table 1. TSR 2 Land Base summary

Land Class	Area (ha)	% of TSA
Total TSA	1,239,633	
Non Crown Ownership	135,997	11%
Crown Ownership	1,103,636	89%
Non-Forested	490,338	40%
Forested	613,299	49%
Non-THLB	355,449	29%
THLB	*257,850*	*21%*

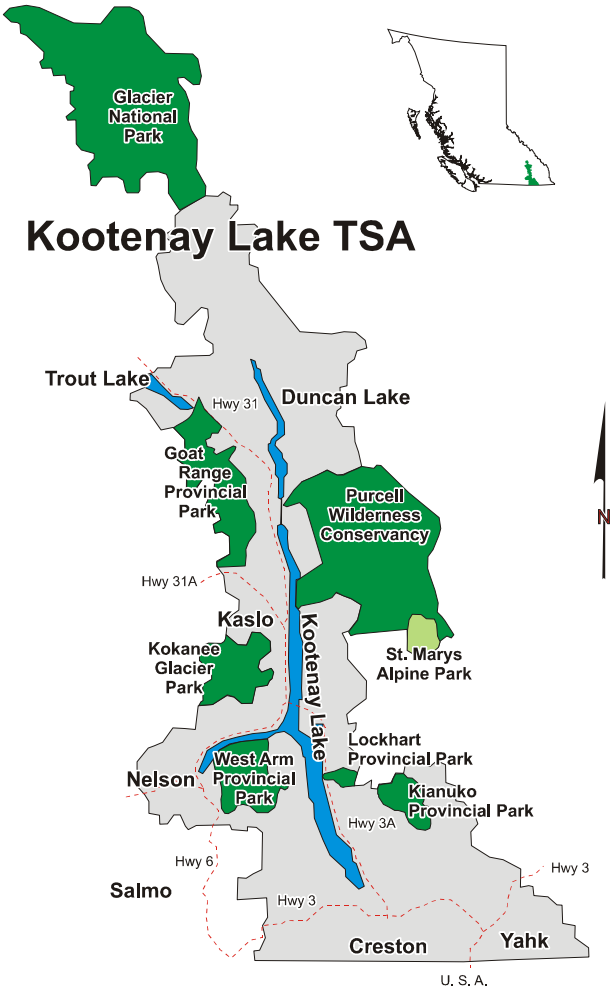

Figure 2. Overview map of Kootenay Lake Timber Supply Area.

The main leading species in the Kootenay Lake TSA THLB are (Figure 3): lodgepole pine (Pl), interior Douglas-fir (Fdi), western larch (Lw), sub-alpine fir (Bl) and interior spruce (Sx). Other species present in the THLB includes western hemlock (Hw), western redcedar (Cw), white pine (Pw), ponderosa pine (Py), and white bark pine (Pa). The age class is mainly concentrated between 61 and 120 years (). There is little area between 21 and 60 years.

[5] BC Ministry of Forests. 2001. Kootenay Lake Timber Supply Area Analysis Report . Unpublished Report, March 2001. p. 11.

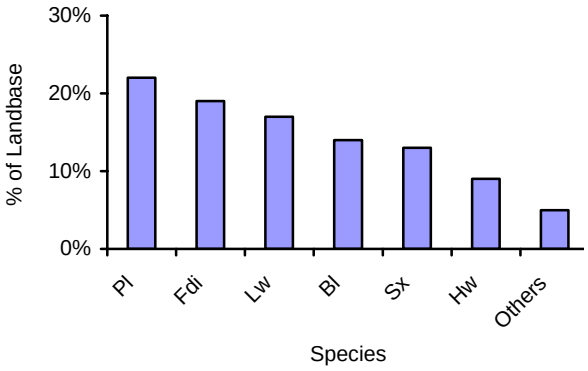

Figure 3. Species distribution in the Kootenay Lake TSA.

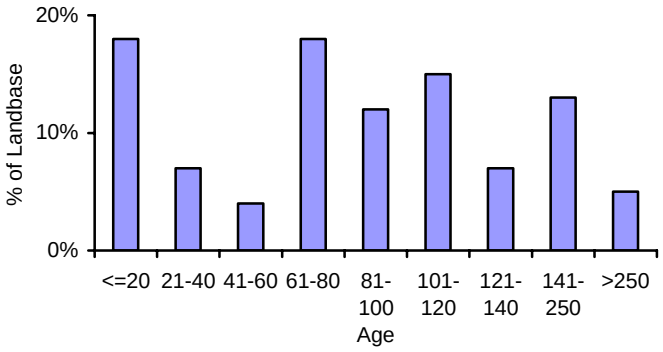

Figure 4. Age class distribution in the Kootenay Lake TSA.

2.2 First Nations

Three First Nations groups have identified traditional territories within the Kootenay Lake TSA: the Ktunaxa Nation Council (KNC), Secewepec Nation (Shuswap) and the Okanagan Nation Alliance. The Lower Kootenay Band is a member band of the Ktunaxa Nation Council and is the only First Nations group with a reserve and/or community within the TSA. The Lower Kootenay Band has approximately 206 members and is located in Creston.[6]

The KNC has submitted a comprehensive land claim that covers the southeast corner of BC, including the Kootenay Lake TSA. The Okanagan Nation Alliance (other than the Westbank whose territory is not within the Kootenay Lake TSA), and the Shuswap are currently not involved in the treaty process.

The KNC originated to promote the political and social development of the Ktunaxa Nation. The KNC is accountable to the Chiefs and Council of the Ktunaxa Nation. Ktunaxa citizenship is comprised of Nation members from seven Bands located throughout historic traditional Ktunaxa territory. Five Bands are located in BC, and two are in the United States. The five bands in B.C. are: Columbia Lake Band (Windermere), St. Mary's Band (Cranbrook), Tobacco Plains Band (Grasmere), Lower Kootenay Band (Creston), and the Shuswap Band (Invermere). The Shuswap Indian Band has most recently joined the Shuswap Nation Tribal Council (SNTC).

A number of Archaeological Overview Assessments (AOA) have been completed in the Kootenay Lake TSA that identify sites of potential archaeological significance and are being used to help protect cultural resources.

2.3 Current Forest Cover Inventory

The Kootenay Lake TSA has one of the oldest inventories in the province. The TSA consists of the Lardeau and Creston Public Sustained Yield Units (PSYU). The inventories were completed in 1969 and 1973, for the Lardeau and Creston PSYU, respectively. Attributes were estimated using standards at the time and converted to digital format in the early 1980s using class midpoint values when only classes were available (as for height and age). The Forest Inventory Planning (FIP) files were converted to the VRI format in 2000. FIP attributes not included in the

[6] *Source: Registered Indian Population by Sex and Residence October 2005, Indian and Northern Affairs Canada.*

VRI are still present while VRI attributes that were not in the FIP files are missing. The disturbance update is current to September 2003.

An inventory audit was completed for the TSA in 1994 and results indicated that the average inventory volume was similar to the average audit volume, indicating no inventory volume bias. The average height and age were also considered to be unbiased. There was little correlation however between ground and inventory values, as shown by the large variations observed at the polygon level. A Pre-Inventory Assessment (PIA) for Kootenay Lake TSA (an early version of a VSIP) was completed in the fall of 1995 to determine the accuracy, consistency and reliability of the current inventory information. This involved a series of 182 ground and air checks to assess the inventory labels. The results showed that:

- 67% of the samples had the correct leading species.
- 46% of the samples had a ground age within 20% of the inventory age.
- 46% of the samples had a ground height within 15% of the inventory height.
- The average height of all samples was within 2.5 m (11%) of the inventory height.
- The average age of all samples was within 13 years (12%) of the inventory age.

The PIA recommended that a new inventory be done in the Kootenay Lake TSA, with emphasis placed on the attributes and delineation of age class 3-5 stands.

2.4 FOREST MANAGEMENT CONSIDERATIONS

The following items have been identified as the main VRI-related forest management and inventory issues in the Kootenay Lake TSA:

	ISSUE:	Phase I Impact	Phase II Impact	COMMENT
1.	***Mountain Pine Beetle Impacted Areas***	Low	Moderate -High	Pl-leading stands make up over 22 percent of the TSA's THLB and is often a minor species in the remaining THLB. New photo-interpreted estimates (Phase I) will not be useful in management of MPB but will be useful once the infestation is finished. Ground sampling (Phase II) provides good volume estimates in stands affected by MPB. CMI samples can also be used to monitor the long-term effects of the MPB infestation.[7]
2.	***Mountain Pine Beetle Shelf Life***	Not Applicable	Moderate -High	It is unlikely that dead Pl stands will retain economic value for up to 10 years. Licensee staff suggest that under current drought conditions salvage operations may only be for two to five years following attack. The MoFR is piloting collection of shelf-life attributes in other VRI and CMI projects in order to build a shelf-life model. Data collection can be incorporated for the Kootenay Lake TSA.[8]

[7] As of 2005, approximately 42,020 hectares of MPB infested Pl existed in the District. Details relating to MPB infestation levels are discussed in the Kootenay Lake Forest District - Forest Health Strategy, updated July 2006.

[8] These are currently non-standard data and new standards are expected to be established by MoFR for the 2007 field season. Any variance will have to be obtained from MoFR and FIA.

3.	***Volume of Dead Wood***	Low	High	Changes in Interior log grades may require the Provincial Chief Forester to consider dead wood volumes in TSR Determinations. Phase II data would provide improved information on dead potential volumes.[8] Alternatively, the inventory audit estimates can be used to estimate dead wood volumes.
4.	***Ungulate Winter Range (UWR); Wildlife Management Areas; Mountain Caribou habitat***	Moderate	Moderate -High	Phase I may provide more detailed information on non-forest attributes and may provide more consistent information on crown closure to support habitat information needs.
5.	***Landscape-Level Biodiversity***	Moderate	Moderate	Phase I can provide more detailed information on forest and non-forest attributes. Phase II will provide data on coarse woody debris, forest succession, and (potentially) ecological attributes.
6.	***Cut-Block Adjacency and Green-up***	Low	Low	Polygon delineation and species composition in younger age classes. CMI can provide feedback on whether regenerating stands are meeting expected green-up projections. Data collected through other survey methods may better address this issue (i.e., silviculture type survey). New Phase I can improve delineation and species composition estimates on openings older than those populated by RESULTS. Phase II will provide attribute information for openings greater than 30 years.
7.	***Site Index Estimates in Immature Stands***	Moderate	High	Phase I can provide better estimates of height for determining site index. Phase II can provide good supporting site index data.
8.	***Current Volumes***	Moderate	High	The stakeholders identified many issues associated with volume estimates including the volume estimates for unmanaged stands, overestimation of volume in older age classes, underestimation of volume in younger age classes and the discrepancy between actual harvested volume and project volumes. New Phase I may provide better attributes for VDYP to use in deriving volumes. Phase II will provide very good data on actual volumes and can be used to adjust the existing inventory.
9.	***Errors in Inventory Attributes***	Moderate	High	Potential errors in species composition, age, and height attributes. Both the Phase I and Phase II may improve individual polygon values and reduce errors in attributes. Further analysis by age and species could also identify trends within the inventory.
10.	***Environmentally Sensitive Areas***	Low	Low	ESAs are not part of current Phase I procedures. Other survey methods will provide better information on ESAs.
11.	***Problem Forest Types***	Moderate	High	New Phase I can verify/improve the estimates in these stands. These areas can be set as separate stratum for Phase II, which will improve attributes and volume estimates.
12.	***Impact of Root Rot in Regenerated Stands***	Low	Low	CMI may be able to provide feedback on the occurrence of root rot in regenerated stands.
13.	***Operability Review***	Low	Low	VRI will provide improved species and volume estimates but will have little impact on operability lines.
14.	***Coordination with PEM process***	Moderate	Moderate	The VRI can provide improved forest inventory information into the PEM process.

15.	***Implications for Managing Species at Risk***	Moderate	Low	New Phase I can provide finer delineation and better information for describing attributes important to identifying and managing species at risk.
16.	***Impact of WTP on Timber Supply***	Moderate	Low	The new Phase I should better quantify areas with WTP's on the landbase.
17.	***Polygon Delineation and Species Composition in Younger Age Classes***	High	Moderate	New Phase I can improve polygon delineation and species composition estimates in younger age classes.
18.	***Decay, Waste and Breakage***	Low	High	The Phase II and NVAF programs will provide better decay and waste estimates. Phase II data could be used to help verify the current loss factors and adjust the Phase I. Breakage is not part of the VRI system.
19.	***Visual Quality Objectives (VQO)***	Low	Low	Information on the extent to which VQO impact timber supply is needed. Approximately 26% of the THLB is covered by VQO constraints; however, VRI will not address VQO estimates. A new visual landscape inventory was considered a priority in the last RMP process.
20.	***Domestic or Community Watersheds***	Low	Low	Approximately 36% of the THLB contains either Domestic of Community watersheds. A new Phase I can provide better information for planning in these areas.
21.	***Age Class Structure of the Non-THLB.***	Moderate	Moderate	The Chief Forester stated in TSR2 that improved understanding of the age class structure in the non-THLB would be desirable. The VRI can provide improved age estimates for this part of the land base.
22.	***Implications of Partial Cutting***	Low	Moderate	Phase II and/or CMI can provide improved information on inventory of partial cuts. Need a better definition of the use to determine applicability.
23.	***Grizzly Bear Habitat/Avalanche Mapping***	High	Low	Phase I will provide better information on locations of avalanches.
24.	***Criteria & Indicators for Sustainable Forest Management***	Moderate	Moderate -High	The Phase II can provide timber, ecological, range and coarse woody debris data to provide spatial and non-spatial baseline data for use in Criteria & Indicator development, monitoring, and reporting as defined by the Canadian Council of Forest Ministers (CCFM). Monitoring involves measuring changes and trends in indicators, including percent and extent of area by forest type and age class, and mean annual increment by forest type and age class.

2.5 SUMMARY OF INVENTORY ISSUES

Completing VRI activities could provide better information on:

- Net merchantable volume;
- Dead trees with potential commercial use;
- Tree height and age, and consequently, improved site index information;
- Coarse woody debris and ecological data that will help make decisions on landscape-level biodiversity and provide information for sustainable forest management planning and ecosystem mapping;
- Levels of MPB attack, current attributes and volumes in MPB stands;

- Problem Forest Types – this population can be better identified and analyzed in the inventory;
- Root rot incidence and severity; and
- Non-forest attributes.

3. STRATEGIC INVENTORY PLAN

3.1 OVERVIEW

This section outlines a strategic inventory plan to develop the VRI program. The main product of the VRI program is a statistically unbiased vegetation inventory. This will require Photo-Interpretation, Ground Sampling, NVAF, and Statistical Adjustment. In addition, a CMI program will be initiated to monitor second-growth stand performance.

3.2 PHASE I - PHOTO-INTERPRETATION

3.2.1 Objective

The objective of the VRI Phase I is to use photo-interpretation to improve TSA polygon information – especially in areas where specific management issues occur. The VRI product is a spatial database consisting of unadjusted photo-interpreted estimates.

3.2.2 Target Area

A new photo-interpreted inventory will be carried out over most of the TSA, excluding large tracts of private land and woodlots[9] with a recent inventory. FIA eligibility relating to funding work in the Provincial Parks[10] must be reviewed and approved prior to starting work.

3.2.3 Target Attributes

All attributes listed on the VRI photo-interpretation attribute form will be targeted. These attributes will be interpreted to current VRI photo-interpretation standards utilizing as much information as possible from the historical data sources to decrease field work costs.

3.2.4 Methods

Photo-interpretation will be done using Softcopy technology. Using new aerial photography is a key component of Phase 1 photo-interpretation. Air photos for use in this project will be a combination of 1:20,000 and 1:30,000 colour photos flown in 2004, 2005 and 2006. Most areas will use the 1:20,000 scale, however, approximately 20 mapsheets in the south-east portion of the TSA will use 1:30,000 photos. Preparation for photo-interpretation (i.e., scanning, triangulation, digital modeling, etc.) can begin immediately on the 2004 and 2005 photos and must be coordinated with Base Mapping and Geomatics Services (BMGS) in Victoria. The 2006 photos are in the process of being acquired.

Polygon delineation is targeted to start the winter of 2006/2007. Ground data collection will start in the 2007 field season (dependant on completion of the photo interpretation work), and attribute estimation completed during the winter of 2007/2008.

Photo-interpreters should meet with the stakeholders group contact before the project begins to incorporate local knowledge and help photo-interpreters become familiarized with issues specific to the Kootenay Lake Forest District. Air and ground field calibration will be established by the photo interpreters to gain local knowledge and improve VRI attribute estimation. There is a large amount of existing data (such as cruise data or recee plots), which may be useful to calibrate data at the photo-interpretation stage.

[9] The MOFR Woodlot Forester will be contacted prior to project initiation.

[10] There is approximately 220,000 hectares of Provincial Park in the Kootenay Lake District. There is ongoing VRI work in the Parks. Any future work will be consistent with these ongoing activities.

3.2.4.1 Integrated VRI with Hybridized PEM / TEM / SEI

Ecosystem mapping has been identified as a priority for the TSA. The licensees plan to integrate the TEM/PEM and VRI inventories to efficiently address the need for vegetation and ecosystem mapping information. The approach that will be implemented is an "Integrated VRI with Hybridized PEM/TEM/SEI".[11] Through this process, ecologists complete VRI/TEM polygon delineation for those polygons considered essential to the TEM process. These polygons typically include those that require a "hardline" approach such as rare or sensitive ecosystems, extreme or special ecosystems, and sites with exceptional ecology and materials. Delineation of the remaining portions of the landscape will be carried out by VRI Phase I interpreters. A set of common base polygons for both VRI and TEM classification will eliminate polygon slivers as well as cross-product labels for future map uses and management interpretations. Details surrounding the specifics will be identified in the Phase I VPIP.

3.2.4.2 Crown Closure in Ungulate Winter Range

Ministry of Environment staff stressed the importance of having accurate crown closure estimates in UWR areas, and as such, photo-interpreters should be mindful of crown closure in UWR areas. Finer delineation based on changes in crown closure and smaller polygon sizes may be required in UWR areas.

3.2.4.3 Avalanche Tack Mapping

Avalanche track mapping is crucial for identifying grizzly bear habitat in the TSA. The VRI is capable of providing very good information on avalanche tracks. The important attributes for grizzly habitat within the avalanche tracks will be discussed with the photo-interpreters prior to beginning the project. Some landscape units (i.e., Tembec's operating area) within the TSA have current avalanche path mapping which should be reviewed for incorporation into the Phase I.

3.3 PHASE II - GROUND SAMPLING

3.3.1 Objective

The objective of the VRI Phase II program is to install enough samples to estimate the average net merchantable volume in the target population with a sampling error of ±10% at a 95% confidence level.

3.3.2 Target Population

The target population will be the Vegetated Treed (VT) area within the TSA, 30 years or older, but may be further defined during development of the Phase II VPIP. If the BC Land Classification Scheme (BCLCS) information is not fully available, VT will be defined as a polygons where a leading species exists and crown closure is greater than or equal to 10%. Polygons with stands established prior to 1978 will be used as the lower limit of the target population.

3.3.3 Sample Size

The coefficient of variation (CV) of the ratio of means between ground and inventory volume for the 1994 inventory audit was 40%.[12] If we increase this CV by 10% to 50%, this would mean that approximately 100 samples are required to achieve the target sampling error. With this sampling size (100 plots), if the CV is 60%, a sampling error of ±12% would be achieved, while with a CV of 40% the sampling error would be ±8%.

3.3.4 Sampling Approach

[11] SEI is a sensitive ecosystem inventory.

[12] The CV of the ratio of means is not explicitly provided in the inventory audit but can easily be computed from the information provided.

The choice of installing full VRI plots (which include ecological, timber, and coarse woody debris information) versus the use of VRI Timber Emphasis Plots (TEP) and Coarse Woody Debris (CWD) data will be reviewed in further detail in the Phase II VPIP. Incorporating the ecological component of the VRI Phase II plot will support the PEM/TEM information needs.

3.3.5 Sample Selection

Sample locations will be selected using the standard MoFR method. First, polygons will be selected using the probability proportional to size with replacement (PPSWR) method. Second, a random point will be selected within the selected polygon using the provincial 100-m grid. If no 100-m grid point falls within the selected polygon, the grid will be halved until at least one point falls within the polygon.

3.4 NET VOLUME ADJUSTMENT FACTOR

3.4.1 Overview

NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume. This ratio is used to statistically adjust the estimate of net merchantable volume of VRI ground samples.

3.4.2 Objective

The objective of the NVAF component is to estimate NVAF ratios with a sampling error of ±10% at a 95% confidence level.

NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume. This ratio is used to statistically adjust the estimate of net merchantable volume of VRI ground samples.

3.4.3 Sample Size

The sample size of the NVAF component will be determined after the Phase II data is collected. The relative species distribution (in terms of net merchantable volume) will be estimated and the sample sizes for each species group will be determined based on the species distribution. The MoFR recommends a minimum of 100 NVAF trees for the land base, of which 25 are dead and 75 live.

3.4.4 Sample Selection

Approximately 25 of the VRI Phase II plots will be enhanced for NVAF sampling when the ground sampling plots area established. A tree matrix will be built with all trees from the auxiliary plots of the NVAF-enhanced samples. The sample in each matrix cell will selected systematically with a random start after the tree list in the cell is sorted by species and diameter at breast height (DBH).

The NVAF program will start at the conclusion of the Phase II field program, possibly at the end of the 2008 field season.

3.5 CHANGE MONITORING INVENTORY

CMI can be used to track and calibrate the modeling assumptions used for second-growth stands and is a key component of sustainable forest management planning. The Kootenay Lake stakeholders intend to implement a CMI program in stands less than 40 years of age, which comprises a significant portion of second-growth stands on the TSA. The sample size must be both cost-effective and large enough to allow some post-stratification. It is expected

that the sample size of the CMI program will increase over time as the population of second-growth stands increases. Initially, the program should include establishment of approximately 60 plots.

The CMI sample plan and sample packages will be completed in the 2006-07 fiscal year. The goal is to implement CMI field program during the 2007 field season and complete the analysis by March 2008.

3.6 ESTIMATED COSTS

The total cost of all the different activities is expected to be approximately $2,500,000 (Table 2). This cost includes project administration and quality assurance requirements.

Table 2. Estimated costs for VRI and PEM/TEM activities in the Kootenay Lake TSA.

VRI Activity	Units	Unit Cost ($/Unit)	Total Cost ($)	Estimated Projected Year
PHASE I (INTEGRATED VRI/PEM/TEM)[A]				
Phase I VPIP	1	$7,000	$7,000	2006-07
Crown Forested Polygons [b]	600,000	$1.50/ha	$900,000	2006-07-08
Crown Non-Forested Polygons [b]	500,000	$1.50/ha	$750,000	2006-07-08
Photo Acquisition / Scanning, AT, Digital Modeling			$350,000	
Sub-Total			$2,007,000	
PHASE II				
Project Management			10,000	2007-08
Phase II VPIP	1	$7,000	$7,000	2007-08
Sample Packages		$10,000	$10,000	2007-08
Full VRI Plots	100	$2,300/plot	$230,000	2007-08-09
Helicopter			35,000	2007-08-09
Quality Assurance	10	$1,500/plot	$15,000	2007-08-09
Sub-Total			*$307,000*	
STATISTICAL ADJUSTMENT				
Project Management	1	$2,500	$2,500	2008-09
Data compilation	1	$1,000	$1,000	2008-09
Report	1	$20,000	$20,000	2008-09
Sub-Total			*$23,500*	
NVAF				
VPIP Update / Tree Selection	1	$2,000	$2,000	2008-09
Destructive Sampling	100	$600/tree	$60,000	2008-09
Helicopter			6,000	2008-09
NVAF Analysis and Reporting	1	$5,000	$5,000	2008-09
Sub-Total			*$73,000*	
CMI				
Project Management				
CMI VPIP	1	$7,000	$7,000	2007-08
Sample Packages	60	$100	$6,000	2007-08
Plot Establishment	60	$1,600/plot	$96,000	2007-08-09
Quality Assurance	6	$1,500/plot	$9,000	2007-08-09
Analysis & Installation Report	1	$5,000	$5,000	2007-08-09
Sub-Total			*$123,000*	
Total			***$2,530,500***	

[a] Preliminary cost estimate for the Integrated VRI/PEM/TEM/SEI photo interpretation work is approximately $1.50 / ha. A cost breakdown relating to VRI / PEM work is estimated to be at 70% - VRI and 30% - PEM.
[b] Includes Quality Assurance and digital mapping production costs.

3.7 SIGN-OFF SHEET

I have read and concur that the Kootenay Lake TSA VRI Strategic Inventory Plan dated November 30, 2006 meets current VRI standards and business needs and considerations.. 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.

_____ _____

Tembec Industries Inc. (lead proponent) *Date*

_____ _____

Jon Vivian, RPF *Date*
Manager Vegetation Resources Inventory
Forest Analysis and Inventory Branch
Ministry of Forests and Range

APPENDIX I – GLOSSARY OF TERMS

Ground Sampling

VRI ground sampling (Phase I) is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. 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.

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.

Net Volume Adjustment Factor (NVAF) Sampling

NVAF sampling provides factors to adjust net tree volume estimated from net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimate net volume is obtained from net factoring and taper equations).

Photo-Interpretation (Phase I)

Photo-interpretation (Phase I) 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.

Post-Stratification

Post-stratification involves the division of an inventory unit into mutually exclusive sub-populations (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.

Pre-Stratification

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

Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet specified target precision or cost. Calculation of a theoretical target sample size requires an estimate of the CV of the key attributes of interest under the proposed sampling procedures and a statement of the precision desired in these attributes.

The formal process for determining sample size for an inventory unit is to anticipate the results (e.g., target sampling error for timber volume) and then determine the approximate sample size corresponding to this desired result. This process would, for example, involve the following steps:

1. Set the target accuracy for the overall inventory unit accuracy to *E* for timber volume (i.e., the sampling error, or half the confidence interval associated with a given probability, e.g., $\pm$15% at the 95% probability level). The number of samples should be adequate to meet the target precision.

2. Estimate the population coefficient of variation (CV_{sample}) of the attribute of interest based on a small sample. This CV_{sample} is defined as a relative measure of the average difference between a polygon ground measurement (assumed the true value) and its corresponding estimate from the inventory.
3. The following formula would then be used to estimate sample size:

$$n = [\frac{t * CV_{sample}}{E}]^2$$

where *t* is the "*t*-value" associated with a given probability and degrees of freedom, and CV_{sample} is a sample-based estimate of the population CV.

The sample size calculations suggested here are general guidelines, not exact requirements. The sample size used in practice is usually a trade-off between the calculated sample size and the expected cost, timing, credibility, flexibility, and comparability of the inventory. The size of the population is usually large enough that it does not affect sample size. The calculated sample size may be increased arbitrarily to allow for post-stratification, increased credibility, more flexibility, and a better starting point for growth projections.

Statistical Adjustment

Statistical adjustment (or 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 within a management unit. A sub-unit may be defined by a specific geographic area (e.g., operable landbase) or stand type (e.g., problem forest types) within the management unit.

Target Population

The target population is the unit from which the samples are chosen. For management inventories, the inventory unit is a TSA, TFL or other geographic area or specific attribute set, depending upon the sampling objectives.

Target sampling error

Target sampling error expresses the desired accuracy of the attribute of interest (e.g., timber volume). It is usually expressed as a percentage value at a given probability level (e.g., $\pm$10 at the 95% probability level). This means that 95% of the time we are confident that the volume estimates are within 10% of the actual volume. Target sampling error is used to calculate the minimum sample size for subsequent ground sampling; see ***Sample Size***.

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:

- BC Landcover classification scheme (BCLCS).
- *Photo-interpreted estimates (Phase I)*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling (Phase II)*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes. The data are used for the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit.

- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *Change Monitoring Inventory (CMI).*

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.

APPENDIX II – KOOTENAY LAKE STAKEHOLDERS LIST

The following list includes all attendees of the Kootenay Lake TSA VRI stakeholders meeting.

- Terry Chow, Tembec Industries Inc
- Stan Hadikin, Kalesnikoff Lumber Company
- Bill Kestell, Goose Creek Lumber Ltd.
- Eric Leslie, Harrop-Proctor Community Forest
- Craig Stemmler, Atco Lumber Ltd.
- Marcie Belcher, Tembec Industries Inc
- Jane Miller, Springer Creek Forest Products
- Irene Strucel, Kaslo Community Forest
- Cal Hauk, MoFR, Southern Interior Region
- Chris Mulvihill, MoFR, Southern Interior Region
- Neil Bow, MoFR, Kootenay Lake
- Stu Clow, Ministry of Agricutlure and Land, ILMB (Old Growth Planning)
- Bruce Fraser, MoFR, Kootenay Lake
- Mike Knapik, Ministry of Environment
- Joanne Leesing, Consultant

Attending via telephone were:

- Gary Johansen, VRI, MoFR Victoria
- Will Smith, VRI, MoFR Victoria
- Laurence Bowdige, MoFR Victoria
- John Wakelin, VRI, MoFR Victoria