VEGETATION RESOURCES INVENTORY (VRI)
PHOTO INTERPRETATION and DIGITAL MAP PRODUCTION
of
LAKES TSA 2013-2016

Prepared for:

The Ministry of Forests, Lands and
Natural Resource Operations (MoFL&NRO)

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1. INTRODUCTION

1.1 PURPOSE

The Purpose of this project completion report is to document and provide a historical reference of the area of interest, project personnel and activities associated with the completion of the Lakes VRI. This project's area of interest included all areas within the Lakes Timber Supply Area (LTSA). Private land, woodlot licences, provincial parks, protected areas, the Burn's Lake and Cheslatta Community Forests were included for the VRI. The TSA VRI project boundary utilized a full map equivalent (FME) strategy rather than the traditional watershed boundaries that define the actual extents of the Lakes TSA. This affected maps along the boundary with Vanderhoof District, Fort St. James District and The Morice TSA. The scope of the project changed slightly in year 3 (2015 & 16 fiscal) to completion of full FMEs along the project's interface with Tweedsmuir Park in the South West (093E030, 40, 50, 60, 70, 79 & 80). Maps that included portions of Entiako Park across Tetachuck Lake were not completed as FMEs and the project retained the South shoreline of Tetachuck Lake as the project boundary.

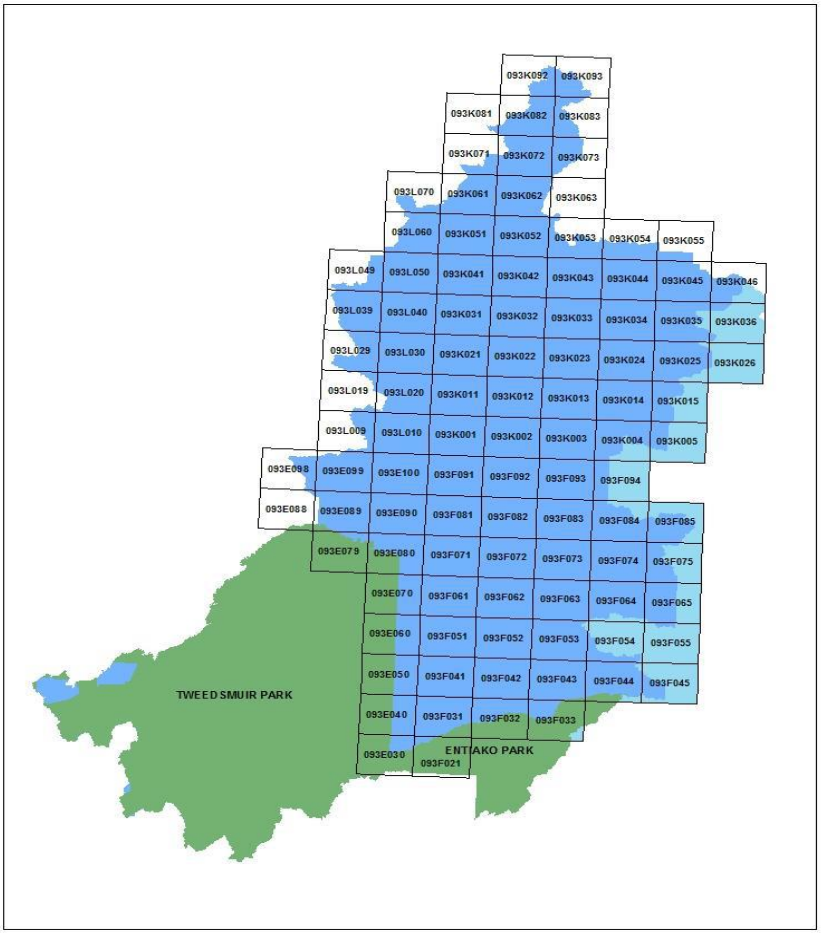


Fig. 1 Lakes VRI Project Map Sheets. The area shown in dark blue is the Lakes TSA VRI project area, light blue is the Vanderhoof TSA. (Lakes TSA VPIP, Nov., 2012).

1.2 TIME FRAME

Work on the Lakes TSA VRI commenced on April 18th, 2013 and was completed March 31rst, 2016.

1.3 PROJECT ADMINISTRATORS

Leigh Black, RPF of Terrestrial Information Services (TIS) was the consultant lead on the project.
Roman Bilek, RFT was the Ministry of Forests, Lands and Natural Resource Operation's (MoFLNRO) VRI Project Manager.

1.4 PLANNING DOCUMENTS (Background)

1.4.1 VPIP

Prior to 2012, most of the existing forest cover inventories for the Lakes TSA dated to 1989 & 1990 and the majority of the area conformed to the Forest Inventory Planning (FIP) standard rather than the VRI standard. The two community forests of Burn's Lake and Cheslatta had been updated to VRI standard and completed on a photo bases captured from 2005-2008. The Tweedsmuir Park area had been inventoried in the 1950s and a small section bordering with the Lakes TSA was re-inventoried in 1996. The entire Lakes VRI Strategic Implementation Plan (VSIP) and VRI Project Implementation Plan (VPIP) documents can be found in Appendix A and B respectively.

An inventory audit completed in 1997 determined that volume estimation of the existing inventory in mature and operable stands was statistically acceptable, however site index (SI) in immature stands was not accurate (VSIP, Sept. 1, 2006). An analysis of VRI Phase II ground sampling in 2008 concluded that volume exceeded VDYP inventory file volume by 10% (VPIP, Nov.28th, 2012).

On July 7th, 2006 at a stakeholder's meeting stated that photo interpreted estimates in mountain pine beetle (MPB) stands had low accuracy and this was significant because approximately 62.4% of the TSA's land base was in lodge pole pine leading stands. On June 6th, 2012 a VRI Phase I planning meeting was held and the stakeholders voiced significant concerns regarding mid term timber supply and the need to base decisions on a current and accurate forest inventory (VPIP, Nov.2012).

The MPB epidemic peaked in the Lakes TSA around 2005 and was expected to have killed 80% or more of the mature lodge pole pine trees. By the start of the acquisition of photography for the Lakes VRI project in 2012, MPB was expected to have run its course across all of the TSA.

The VRI Phase 1 was implemented by the MoFL&NRO with the intent to produce a seamless Phase inventory for all of the LAKES TSA. This new inventory would support land use planning implementation, timber supply analysis, and other specific needs identified in the VPIP.

1.4.2 AERIAL PHOTOGRAPHS

Approximately 3873 digital frame (1:20,000) camera images of the project area were acquired to GeoBC photo standards and specifications in the summer of 2012. The photos captured were inclusive of the entire TSA and were oriented in an East-West (or opposite) direction and captured at 30cm GSD (ground sampling distance). Softcopy image sets were available as RGBnIr 4 band 8 bit JPEG compressed TIF with a Z\I project file (75-100Mb). This allows for natural colour

display of imagery as well as colour infrared display using the same image file and softcopy setup. Terrestrial Information Services used both true colour and infrared view ports simultaneously within the Summit^{tm} 3D image viewing software throughout the project at both softcopy phases (Delineation and Final Attribution). Photo quality was relatively good for interpretation with normal exceptions on steep North facing slopes that seldom receive sufficient light at any time during the day to produce high image quality.

1.4.3 BASE MAPS

The Lakes VRI project conforms to the most current version of the VRIMS Personal Geodatabase Structure and Use and VRIMS Vegetation Cover Polygon Validation Rules published by the Forest Analysis and Inventory Branch.

A TRIM North American Datum (NAD83) base file was used for all lakes and double line rivers in the project. Throughout the project no changes were made to this TRIM file as requested in the agreement. Some watercourse changes were observable along the Cheslatta River however TRIM delineation was not adjusted there.

Roads were not updated during this VRI project.

1.4.4 EXISTING CALIBRATION DATA SOURCES

Most of the Historical Data Sources (HDS) for the lakes VRI Photo Interpretation project were assembled from hard copy black and white photography (1989 & 90) that existed from the previous inventory and was made available to TIS through provisions of the project. Along with the old photography, the MoFL&NRO also provided an existing HDS point spatial data set (6049 points). This data identified the digital locations of several known calibration points within the project area, but was incomplete in points, contained many obsolete points and lacked any attribute data. HDSes from the Burn's Lake Community Forest were not available for this project but some were provided for the Cheslatta Community Forest.

To accomplish the HDST, TIS' strategy was to first augment the MoFL&NRO's existing incomplete spatial point file with new digitized points taken from the old hard copy photo media by TIS classifiers. These new points for some reason or another had not been digitized prior to 2012 or were missing but were determined to be very useful by TIS classifiers. These points were numerous and widespread on the old hard copy photos. After this point digitizing augmentation step was completed, the associated attribute data was also acquired from the old photography for all the HDS spatial points (3993 points) identified as useful within the project area. Table 1 below shows the numbers of ground calls (XG), air calls (XV) and PSPs that were integrated into the Lakes VRI project.

Data Source Origin	TYPE	Number of Data Sources
FIP Ground Calls	XG	1689
FIP Air Calls	XV	1702
Permanent Sample Plots	PSP	574

Table 1. Ground calls (XG), air calls (XV) and PSPs that were integrated into the Lakes VRI project.

Hard copy photography was not supplied for all map sheets in the project and often along the flanks of the project area, there were missing photos or entire dockets of photos that bordered with the Vanderhoof Forest District and Morice TSA

project areas. Several of these maps including those that form the boundary with Tweedsmuir Park did not have HDST completed during the project.

A project standard summarizing Excel [tm] spreadsheet was generated from all the existing HDS information available and supplied as a final project deliverable (March, 2016). In all, the Lakes TSA VRI project utilized 3993 historical data sources, integrating 42.6 HDS/FME into the new inventory.

1.4.5 RESULTS INFORMATION

The RESULTS (Reporting Silviculture Updates and Land Status Tracking System) database indicated approximately 19,950 Opening ID Records within the Lakes TSA project area. The total spatial area of the openings comprised approximately 17% of the project area (LAKES VPIP, 2012) (see Fig. 2 below). Many more silviculture openings were detected on the 2012 photography that were not in the database. These unidentified openings were mostly associated with ongoing aggressive salvage efforts of MPB damaged timber. These openings were given an “Opening ID” of “0” or “-99”as per Photo Interpretation Guidelines for Integrating RESULTS Information.

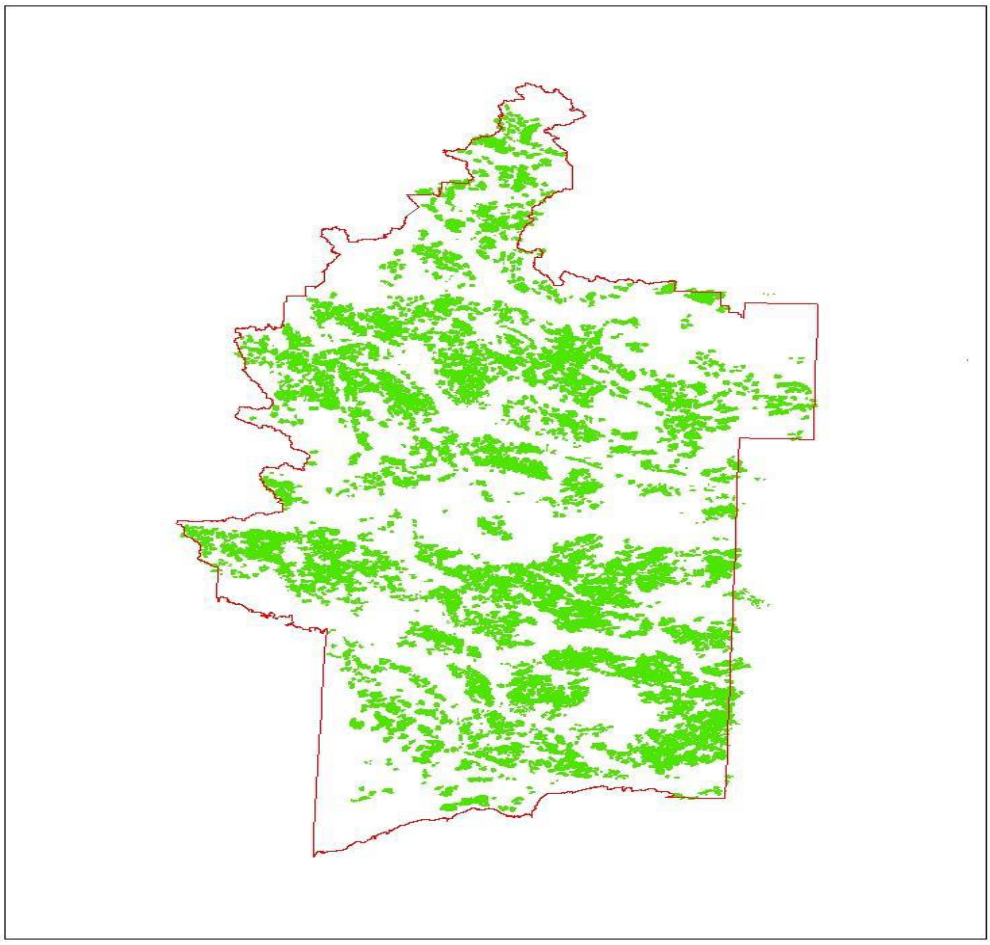


Fig. 2 Spatial distribution of the RESULTS openings contained in the current (2012) database. Results Openings occupy 17% of the project area (Lakes VPIP, Nov.28th, 2012).

The RESULTS data project file provided by the MOFL&NRO was updated during each year of the Lakes VRI project. The first update occurred in February of 2014, and there were two updates in 2015. The last update (Nov. 9th, 2015) was needed as Roman Bilek, RFT detected more RESULTS attribute information existed than was available in the 2015 RESULTS database file (February) supplied to the contractor. The missing RESULTS data applied to the West Fraser Tenure area in the South and South West project area. Some to the 2015-16 fiscal maps completed prior to Nov. 9th, 2015 and within the WF tenure area may not have integrated the most up to date RESULTS data.

2. PROJECT AREA DESCRIPTION

The Lakes TSA is a vast expanse of predominantly Vegetated Treed (VT) landscape within the BC Interior Plateau and spans both the Universal Transverse Mercator (UTM) 9 and 10 geographic zones. Relatively narrow to its length, the gently rolling TSA has its margins defined mainly by watersheds and water bodies. On the North and North East the TSA is bordered by the Fort St. James forest district. On the west flank, the Morice TSA shares boundary with the Lakes TSA. Tweedsmuir Park and Entiako Park form the Southwest and South boundary while Vanderhoof forest district defines the east extents. The total land area of the Lakes TSA is approximately 1.12 million hectares with roughly 10-14% in water bodies. The ecosystems for the area are mostly Sub Boreal Spruce (SBS) 81% with the balance comprised of Engelmann Spruce and Sub Alpine Fir (ESSF) 17% and 1% in Boreal Altai Fescue Alpine (BAFA).

After an amendment (June 1rst, 2015) to the original April 18th, 2013 agreement between TIS and the province of BC, the total re-inventoried area of the Lakes VRI project was finalized at 1,363,520 ha., up from 1.1 million hectares at project start up. The additional areas were contributed through conversion of maps along the Tweedmuir Park boundary to full FME rather than partial. This final project area is distributed over 96 VRI map sheets and equates to 93.6 VRI FMEs.

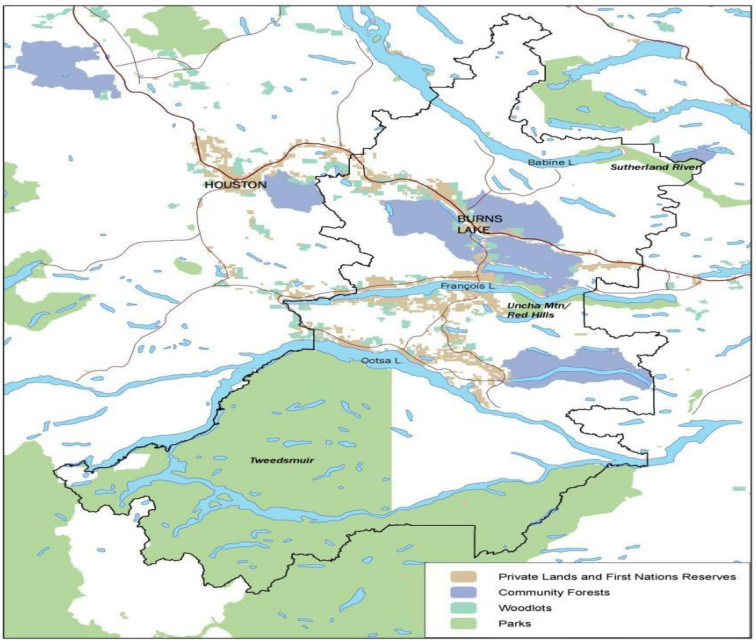


Fig. 3 Project Area (excluded is Tweedmuir Park except for maps 093E030,40,50,60,70,79,80) (VSIP, Nov. 28th, 2012)

3.0 THE 2013-2016 LAKES VRI PROJECT

A strategic decision was made at project start up to divide the Lakes VRI project area into 3 unique fiscal and spatially contiguous deliveries (2013-14, 2014-15 and 2015-16). Logical progression was determined to be from North to South beginning with 093K092 & 93 and progressing southward row by row and year by year. For the most part this was achieved as planned with a few exceptions. 093F065,75,85 and 093F041-F44 &53 were delineated in 2013. 093F044, 65,75,85 were attributed and calibrated in 2014-15. 093F041-F43 &53 were attributed and calibrated in 2015-16.

Table 2. Lakes VRI project final attribution delivery by fiscal year.

LAKES VRI PROJECT COMPLETION RECORD BY YEAR AND MAPSHEET				
2013-14 Final Delivery Maps				
093K092	093K072	093K063	093K042	093K033
093K093	093K073	093K052	093K042	
093K081	093L070	093K053	093K044	
093K083	093K061	093K054	093K045	
093K071	093K062	093L049	093K046	
093F071	093F063	093F055	093F044	
2014-15 Final Delivery Maps				
093K082	093K031	093K023	093L009	093F075
093L060	093K032	093K024	093L010	093F065
093K051	093K034	093K025	093K001	093F044
093K055	093K035	093L019	093K002	
093L050	093L029	093L020	093K005	
093K041	093L030	093K011	093F091	
093L039	093K021	093K012	093F092	
093L040	093K022	093K015	093F085	
2015-16 Final Delivery Maps				
093K013	093E088	093E080	093F063	093F042
093K014	093E089	093F071	093F064	093F043
093K003	093E090	093F072	093E060	093E040
093K004	093F081	093F073	093F051	093F031
093E098	093F082	093F074	093F052	093F032
093E099	093F083	093E070	093F053	093F033
093E100	093F084	093F061	093E050	093E030
093F093	093E079	093F062	093F041	093F021

Table 3. Lakes VRI project delivery by project phase and fiscal year of delivery.

Project Phase	Fiscal Delivery Year			Total FMEs for Project
	2013-14	2014-15	2015-16	
Delineation FME	37	24.6	32	93.6
Calibration FME	41	17.6	35	93.6
Attribution FME	24	32	37.6	93.6

3.2 ANNUAL VRI COMPLETION

3.2.1 FISCAL YEAR 2013-14

The VRI started with contract signing April 18th, 2013. The delineation phase commenced immediately and was completed using 5 VRI Photo Interpretation staff on approximately 29 FME (Table 3) during the period from April 24th to July 12th, 2013. Four maps were retained to test a new method of BC VRI photo interpretation where delineation and final attribution would be performed in the same task setting at the time of final attribution. TIS calibrated these maps in 2013 by completing delineation only around the proposed sampling points (xgv & xv) and then completing calibration normally. This method was later abandoned for reasons of efficiency, but the test was probably not properly done since the classifiers were trainees and had not yet developed efficiency in any project phase.

Field calibration work commenced on July 15th, 2015 and was completed on 41 FME (603xgvs & 790xv, Table 3) during two 10-12 day shifts utilizing 5 VRI Photo Interpretation staff and one VRI Ecological Ground Sampler for support (Rob MacLean). Year one field work was completed by September 10th, 2013.

Sampling plans were submitted digitally (.shp) and focused on the Northern most area of the project with the exception of maps 093F044, 65, 75 & 85 which would normally have been scheduled for 2015-16 calibration. These maps were delineated, calibrated and quality assured in 2013 but would not be final attributed until 2015-16. Private land was not included in the field calibration plan.

Most of the calibration project was completed from two marshalling locations, Burn's Lake and Fort Fraser however a remote tent camp was necessary to complete calibration in the Northeast project area (093K062,63,72,73,82,83,92,93). Crews accessed this area using the Fort St. James-Cunningham FSR. Two crews also stayed in Babine Camp for the Northwestern part of the project. Roman Bilek, RFT was present during 2013-14 fieldwork start up and contributed several days (6) to training and mentoring each new TIS & Silvatech interpreter. This additional training and supervision improved sampling consistency among everyone working on the project. All field data was collected as per the MoFLNRO standards for ***VRI Field Calibration Procedures for Photo Interpretation, Version 1.3 April, 2013***

Final Attribution of 24 FMEs (Table 3) in 2013 began during mid September and was completed in late March of 2014. An interim delivery of 10 final attribution FMEs was contractually set at Dec. 31rst, 2013. TIS did not meet this final attribution goal in its entirety and was subject to an agreed penalty for a late interim delivery of 4 maps. Ease of training and performance of new trainees during final attribution was the main factor affecting slow delivery by TIS in this year 1 of the project. Also one of TIS' new trainees quit after 8 weeks of intensive final attribution training.

All attribution was completed as per the ***VRI Photo Interpretation Procedures, Version 2.9, April 2013*** and quality assurance checked according to the ***VRI Photo Interpretation Quality Assurance Procedures and Standards, Version 3.6 April 2013***.

3.2.2 FISCAL YEAR 2014-15

Year 2 of the Lakes VRI started April 1rst, 2014 with the delineation of 23 FME (Table 3) and finished by June 30th, 2014. The field sampling calibration plan for the 2014 field season was completed and submitted (.shp) in June of 2014. Again no private land was explicitly included in the sample plan. A decision was made not to avoid the Burn's Lake Community forest with proposed calibration points since existing calibration data collected 2006-2008 during a separate VRI project

completed on the BLCF would not be available during the Lakes VRI. TIS classifiers approached the BLCF as if it were indistinguishable among the rest of the forest cover and made not alterations to the calibration, delineation or final attribution procedures in this area. Crews positioned out of Burn's Lake for all of the 2014-15 sample season. Some maps (093F091, 92) were accessed by daily commute from Burn's lake across the ferry to the Southbank of Franscois Lake. Two maps (093F081, 82) were partially calibrated late in November of 2014 during a training exercise designed to acquire local knowledge for a potentially new trainee for the project (Erik Klassen). Erik's contribution to the Lakes VRI was limited to the 4 fieldwork training days, therefore these maps were deferred for completion of calibration and attribution in 2015-16 as was originally planned. All field calibration was completed according to the ***Vegetation Resources Inventory Field Calibration Procedures, Ver. 1.4, April 2014***.
Final attribution for the 2014-15 field season began in August, 2014 and finished March 31rst, 2015.
All delineation and photo interpretation was completed according to the ***Vegetation Resources Inventory Photo Interpretation Procedures, Ver. 3.0, April 2014***. All delineation and final attribution quality assurance was completed according to the ***VRI Photo Interpretation Quality Assurance Procedures and Standards, Version 3.7 April 2014***.

During 2014 the Lakes VRI project saw a significant amendment (Contract Modification Agreement 1. September 1rst, 2014) where the scope of the project changed to include more area to be completed. This new area was in Tweedsmuir Park and located on the Southwest flank of the original project boundary. Map sheets 093E030, 40, 50, 60,70 79 & 80 had been partial map deliveries in the original agreement but with this amendment were changed to full map deliveries. Full map delivery would include sampling plan, delineation, fieldwork and final attribution to be completed during 2015-16 fiscal.

3.2.3 FISCAL YEAR 2015-16

Year 3 of the Lakes VRI began April 1rst, 2015 with the delineation of 32 FME (Table 3). Delineation was completed by June 12th, 2015. As stated above the 2015-16 fiscal included a revised area for the project and delivery of all partial Tweedsmuir maps as full FMEs.

Field work on 35FME (Table 3) began earlier than usual on June 15th, 2015 and TIS crews positioned out of "Moosehorn Lodge" on the north side of Uncha Lake. After approximately 5 days of sampling one crew (2 samplers) was positioned across the Nechako reservoir at the forestry trailer located there last utilized during the forest fires in the area of 2013. This crew completed all road access XGVs across the reservoir. Mainline roads in this calibration area south of the reservoir were mostly clear of fallen dead pine trees since forest development planning had once again started in this area after a long delay. Feeder roads and access roads to cutting permit blocks were heavy in accumulation of fallen dead pine trees therefore the TIS crews carried chainsaws while conducting road access ground calls. The presence of several morel mushroom pickers (2013 fire) were also a factor in keeping the road clear of fallen dead pine trees.

For the newly added area inside the Tweedsmuir Park boundary only air calls (XV) were completed. No ground calls (XGV) were conducted in this contract amendment area (Sept. 1, 2014). Both ground and air calls were performed on the non park sections of those maps that formed the boundary with Tweedsmuir Park (093E030, 40, 50, 60,70, 79, & 80).
All 2015 fieldwork was completed by June 30th, 2015. Final quality assurances were completed during the first week of August. All field work was completed according to the ***Vegetation Resources Inventory Field Calibration Procedures, Ver. 1.5, April 2015***. All quality assurances were completed according to the ***VRI Photo Interpretation Quality Assurance Procedures and Standards, Version 3.8 April 2015***.

Final attribution (37.5 FME see table 3) of the 2015-16 fiscal began in August of 2015 and completed by March 31rst, 2016. All final attribution was completed according to the ***Vegetation Resources Inventory Photo Interpretation Procedures, Ver. 3.1, April 2015***.

3.3 PROJECT PERSONNEL

The Lakes VRI project was completed between April, 2013 and March 31rst, 2016. Terrestrial Information Services (TIS) (Prince George, BC) was the prime contractor on the project and their principal subcontractor was Silvatech Consulting Ltd. (Salmon Arm, BC).

Roman Bilek, RFT coordinated the project on behalf of the Ministry of Forests, Lands and Natural Resource Operations (MoFL&NRO).

Below is a list of the VRI trainee, junior and certified Photo Interpreters involved with the project.

1. Leigh Black, RPF (TIS) Project Manager and VRI Certified Photo Interpreter (2013-14, 2014-15, 2015-16)
2. Robert Rokis, RPF and VRI Certified Photo Interpreter (2013-14 and 2015-16)
3. Marius Hanchewski (Forest Tech. TIS) and VRI Photo Interpretation Trainee (2013-14 only)
4. Paul Belcher, (TIS) Trainee and Junior VRI Photo Interpreter (2013-14, 2014-15, 2015-16)
5. Rob MaClean (TIS) temporary fieldwork support 2013, certified VRI Ecological Ground Sampler
6. Donnavan Meierhofer (TIS) VRI Certified Photo Interpreter (2014-15 & 2015-16)
7. Jodi Friesen, BScEnv. (TIS) Junior VRI Photo Interpreter (2015-16)
8. Rony Mazumder, MSc. For. (TIS) VRI trainee (2015-16, field work only)
9. Phil Wallensteen (Silvatech Consulting Ltd.) and VRI Junior Photo Interpreter (2013-14, 2014-15, 2015-16)
10. Geof Lawless, RPF (Silvatech Consulting Ltd.) and VRI Certified Photo Interpreter (2013-14, 2014-15, 2015-16)
11. Ian Wells (Silvatech Consulting Ltd.) VRI Photo Interpretation Trainee (2013-14, 2014-15, 2015-16)
12. Kela Auger (Forest Dimensions Inc.) VRI Certified Photo Interpreter (2013-14)
13. Andy Little (Forest Dimensions Inc.) VRI Certified Photo Interpreter (2013-14)
14. Chris Snauwert (Forest Dimensions Inc.) VRI Certified Photo Interpreter (2013-14)
15. Erik Klassen (TIS) fieldwork trainee, did not finish, 2014)

3.3.1 3rd Party QA Personnel

Frank Scheithauer RPF - VRI Certified Photo Interpreter (2013-14, 2014-15, 2015-16)

4.0 DELINEATION

All delineation in the Lakes TSA was completed according to the VRI standards for delineation updated annually (2013-2016).

Strategically the Lakes TSA utilized true color and infrared bands viewed in simultaneous stereo viewports to complete the project's delineation task. Using the infrared band simultaneous with true color was contractually required and for the purpose of better discernment of live and dead tree status, concentration and distribution. The strategy proved very

effective for identifying live and dead trees. The IR was also helpful in discerning understory (midterm) tree layers where shadows prevented this detection in the true color frame.

4.1 DELINEATION OF RESULTS

For the Lakes TSA, RESULTS (Reporting Silviculture Updates and Land Status Tracking System) spatial data was integrated in two ways. In 2013-14 all of the RESULTS polygons were redrawn by TIS classifiers to VRI specifications. This included correcting RESULTS spatial data where it was in error by more than +-20m. Using this method, none of the MoFL&NRO provided spatial data was utilized.

During fiscals 2014-15 and 2015-16 all supplied RESULTS data was merged to the working VRI delineation layer then scrutinized for errors and corrected where necessary at the classifier's discretion. Each method employed had pros and cons. and each seemed to rely heavily on classifier diligence for success in quality assurance.

During the VRI project RESULTS files were updated from the initial file provided at project start up. The first update occurred in February 2014 and last update occurred Nov. 9th, 2015. During the final attribution (2015) phase of the project Roman Bilek, RFT detected that more RESULTS information existed than was available in the working RESULTS file actively being integrated to the new VRI. As a remedy Roman ordered a new RESULTS data set cut and this last update was made very early in the 2015-16 final attribution phase of the project. The update attempted to capture more of the missing RESULTS information that seemed to be tied to the are of the West Fraser Tenure located in the South and Southwest of the project. TIS began integration of this new file on Nov. 12th, 2015 therefore some maps (South – Southwest) likely only in the West Fraser Tenure area were completed with existing but unavailable RESULTS information in 2015.

As per ***Appendix C***, minimum polygon size for internal reserves within RESULTS openings was set at 1ha. for the entire Lakes VRI project. Minimum polygon size for RESULTS openings was also set at 1ha for the entire Lakes VRI project. Internal polygons were not delineated in RESULTS openings not yet declared free growing. Free to Grow (FTG) openings were delineated internally if necessary as per normal VRI delineation procedures.

5.0 FIELD CALIBRATION

The Lakes VRI project established a total of 15 ground calls (XGV) and 20 air calls (XV) per FME. A few map sheets (093K001& 002, 093K042& 043, 093L010, 093E080, 093E088 & 089, 093F042-044, 093F053, 093F061 & 062 and 093F071) required slightly less sampling as a significant portion of their cover value was in large lake waterbodies. This adjustment was made to keep the sampling intensity constant throughout the entire vegetated land cover of the project.

Fiscal Year	VRI Call TYPE	Number of VRI Calls Established
2013-14	XV	790
	XGV	603
2014-15	XV	364
	XGV	307
2015-16	XV	618

	XGV	352
Project Totals	XV = 1772	XGV = 1262

Table 4. Numbers of air and ground calls established as calibration data during each fiscal year of the Lakes VRI project.

Terrestrial Information Services used digital data entry to capture all field XGV data. Water proof paper tally cards were not at any time employed. Exports (.txt) for individual plots were produced at various intervals when necessary for quality assurance personal. Seasonal XGV data was exported to excel template file for delivery to MoFL&NRO as a final step each year before the final attribution process began. This data was also converted to .shp files for softcopy use and became the basis of the calibration data set used for the purpose of classification.

5.1 DEAD LAYER SAMPLING IN THE LAKES TSA

Throughout the Lakes VRI project standard VRI ground calibration procedures were used with some local project level modifications needed to better sample dead layer stands. Live and dead volume uncertainty had been identified as of key importance in the VPIP and at the time of project implementation large scale VRI ground call sampling of this dead layer in conjunction with normal live layer requirements was relatively new to the VRI program.

D-layer Sample Design To sample the dead layers in the Lakes TSA, a 5 plot linear configuration was chosen as the basis for dead layer ground calls (XGV). A fixed inter-plot spacing of 30m was used for all of the stands sampled as mountain pine beetle impacted, however at project start up a 50m inter-plot spacing had been chosen as the project standard. The 50m design proved inefficient during the first few days of fieldwork in 2013, so inter-plot spacing was reduced to a 30m standard. Approximately 15-20 samples were established using this 50m inter plot spacing.

Criteria for the determination of MPB impacted stands was set at 1). The stand was lodge pole pine leading in the last inventory 2.) the stand was MPB impacted if more than 25% of the pine was killed by MPB. During sample plan creation, all stands were preselected using the infrared view in a softcopy environment therefore field samplers seldom needed to drop, adjust of convert MPB impacted stands to 1 or 3pt live only calls. The infrared view proved to be a very good tool for determining if a sample was to be measured as a MPB impacted stand or not.

Diameter estimation in dead layer samples was adjusted for the Lakes VRI project. Normal VRI specification calls for the estimation of all stems within each basal area sweep to be estimated to within 5cm classes, however it was decided that a single mean diameter class estimate (5cm) could be used to represent all the dead stems within each basal area sweep. Using this method each dead stem was assigned an equivalent estimated diameter and the challenge was for the interpreter to estimate the mean diameter of all “in” dead trees rather than estimate each individual stem’s diameter. This method was performed at each of the 4 count plots while one full measure plot with intensive diameters (mm) was retained in the most representative location of the 5 point XGV. Throughout the project classifiers were free to use this method or the original method of estimating all diameters.

Dead Sample Trees Ages and heights were not determined for dead trees (layers) unless the stand did not have a live layer available to sample. There were a few instances where live layers were not present however this condition was rare on average in the Lakes TSA. Where this condition did occur (Southward) was usually in the SBSdk and on south facing windswept aspects. For eventual classification, samplers were most often able to extrapolate live layer age height results to the dead layers based on the conditions of cohort being met. Some exceptions occurred where species like Abies lasiocarpa formed the majority of the live layer and the sample’s age/height data then lost reliability as an extrapolation of

the assumed cohort dead layer. In these rare cases samplers were instructed to either make an estimate of dead layer age and height in their sample notes or perform a supplementary age and height measurement on one representative dead pine tree in the sample.

Air calibration on the Lakes TSA was completed as per normal VRI standards with D layers.

5.2 SUPRESSED TREES AND PHOTO SIGNATURE

Throughout the LAKES VRI project TIS samplers were trained with emphasis on deselection of supressed trees in any ground call that did not have a second layer of live trees. With the goal of obtaining calibration sample information that closely represents photo signature, small trees that were considered invisible from a topographic view (aerial photography) were not included in the tally of all "in" trees per plot. This important consideration was critical in developing the sample's ability to closely represent the photo signature observed. Attributes like basal area and density are most affected by this strategy. Including supressed trees tends to distort basal area and density to levels that made these attributes unusable as calibration for photo interpretation.

6.0 DELIVERABLES

VRI deliverables for each map sheet, each project year included the following:

1. A "Sampling Plan" .shp file geodatabase layer identifying all of the proposed air (XV) and ground calls (XGV) for each fiscal season.
2. A digital MS Excel Spreadsheet (MoFL&NRO's VRI-template) summary of all air and ground calls collected by each fiscal.
3. A .shp file geodatabase layer with locations of all established calibration points for each fiscal year of the project
4. Each individual map sheet in Arc personal geodatabase (.mdb) MoFL&NRO VRIMs file format
5. All 3rd party quality assurance documentation for each phase of the project.
6. Final Report for all three fiscal years (2013-2016).

7.0 QUALITY ASSURANCE

Scheithauer Forest Consultants Ltd. provided the quality assurances for the Lakes VRI. Quality assurance was applied according to the most current VRI quality assurance procedures available in any of the three project years. The three main work phases, delineation, field calibration, and final attribution underwent formal quality assurances. The sampling plan was submitted annually for review by Roman Bilek, RFT. Historical data source capture was also quality assured by Scheithauer Forest Consultants Ltd.

All quality assurance batch reports and comparison table documentation was provided to the MoFLNRO on completion.

8.0 CONCLUSIONS AND RECOMMENDATIONS

TRIM data for the project area was adequate, many lakes small and large drawn to normal specifications and these features were static in 2012. Some desynchronization of the Nechako reservoir shorelines with TRIM lake data was observed but left unaltered for this inventory as the reservoir is likely under a permanent change regime. There was also some fluvial erosion induced changes along the Cheslatta River which is normal for this river system and these changes were not incorporated into the new VRI layer as more change is expected and this may be an annual event. The Lakes VRI project detected, mapped and interpreted final attributes for several small islands (>0.5ha) in some of the large lakes (Babine Lake and Nechako Reservoir) within the project. These islands had not formerly been captured by the TRIM data, but have now been integrated into the VRI layer.

New VRI codes were introduced to the VRI program during the Lakes VRI project. One of these codes “DW” or downed woody debris was not implemented until year 3 of the project, therefore years 1 and 2.

In the last year of the project and mainly in the south most maps (SBS dk) where more stands existed in dead condition without live layers there was a need to move toward refining the interpretation of what is significant with respect to a live layer of trees left behind after MPB attack. This is a project specific consideration and enhanced understanding was required due to subsequent Timber Supply Review (TSR) necessities. TSRs require an accurate site index variable to predict stand yield over time.
During normal VRI classification, if “significant” live layers do not exist then then classifiers interpret the SI for the formerly forested polygon. This is a relatively difficult value to interpret accurately. After some discussion at the project management level it was determined that derived site index based on a real tree’s proven age and height on the given site would be a better and more consistent representation of SI for TSR uses than a photo interpreted value. After this awareness was raised, TIS classifiers were instructed to intensify their interpretation of what is significant for a live layer thereby placing more reliance on the TSR tools to calculate a derived SI instead of using the interpreted value. Live layers in dead stands were then described down to 1% crown cover where prior to this understanding anything less than approximately 3% would have been ignored. If the age/ht. from the marginal cover still did not represent the potential of the site (ie: balsam fir releasing from suppression), classifiers were instructed to override any downstream derived calculations of the TSRs tools through insertion of an interpreted SI value regardless of how old the stand was.
The photo interpreted SI precision question in near completely dead stands may be something to consider for future VRI projects having only dead layers without significant live layers.

APPENDICES

Appendix A

Vegetation Resources Inventory

Lakes TSA - Project Implementation Plan for Photo Interpretation

Prepared by
Ministry of Forests Lands and Natural Resource Operations Forest Analysis and Inventory Branch

November 28, 2012

November 2012

Section 1 - Introduction

Background Information

Stakeholders attended a VRI phase 1 planning meeting June 6, 2012 in the Nadina Forest District Office located in Burns Lake for an introduction to the project and to provide input regarding their needs and objectives. Stakeholders for this unit include:

- B.C. Timber Sales
- Nadina District staff
- First Nations
- Local licensees including CanFor, West Fraser, Babine Forest Products, local woodlot owners and community forests.

Significant concerns have been raised regarding the mid-term timber supply given the enormous impact of the mountain pine beetle (MPB) on the pine component in this TSA. Recent uplifts of allowable annual cut (AAC) have occurred in order to expeditiously harvest as much of the beetle killed wood as possible before it exceeds its shelf-life (please see pg 5 in *Lakes TSA Public Discussion Paper*, May, 2010 at **http://www.for.gov.bc.ca/hts/tsa/tsa14/current_tsr_2009/14ts10pdp.pdf**). The recently formed Special Committee on Timber Supply has also identified Lakes as one of the heavily impacted critical units with very high mortality in all of the mature pine stands. The Special Committee on Timber Supply summarized key messages from a series of local public hearings including the need to base decisions on an updated inventory (please see pgs 12, 14 and 25 in *Special Committee on Timber Supply Report*, August, 2012 at **http://www.leg.bc.ca/cmt/39thparl/session-4/timber/reports/PDF/Rpt-TIMBER-39-4-GrowingFibreGrowingValue-2012-08-15.pdf**). The need for current and accurate forest inventory of the Lakes TSA was identified as a critical information source to inform local decision making.

The present inventory consists of a mix of varying currencies and formats and was adequate for planning and timber supply purposes in a pre-MPB world but is obviously now in need of a re-inventory (please see State of the Current Inventory below). A re-inventory of the TSA would provide up-to-date and accurate information on live and dead volumes, stocking and growth rates to inform the mid-term timber supply. The re-inventory process starts by acquiring new imagery as the old air photos were acquired prior to MPB and subsequent harvest uplifts and activities. The new 2012 digital air photos being acquired this field season will provide full coverage of approximately 1.1 million hectares of the TSA exclusive of parks. This new imagery will be used for photo interpretation of live and dead components of the inventory in concert with air and ground calls for calibration purposes.

Overview of the VRI Process

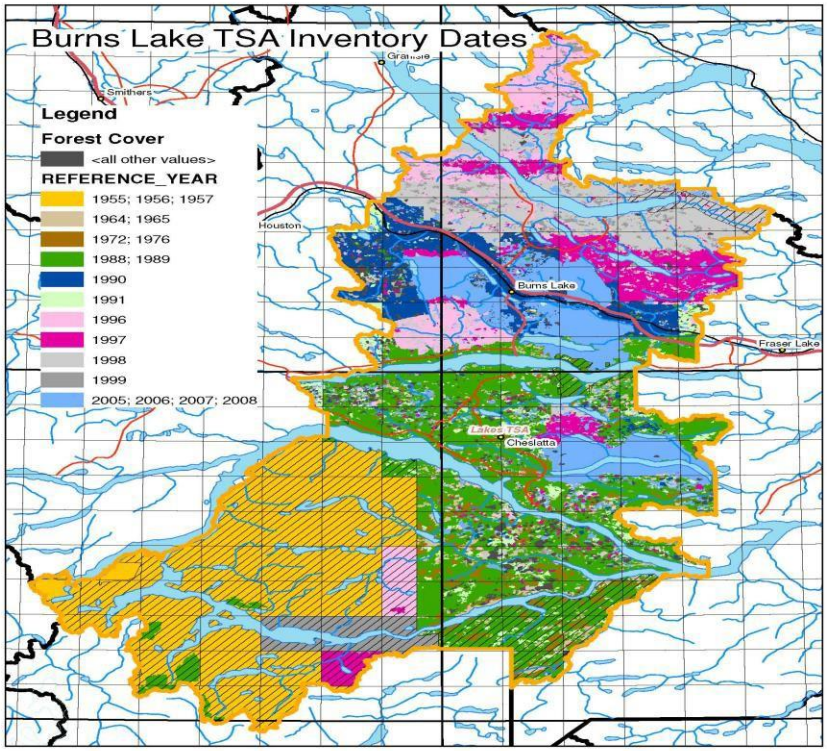
The Vegetation Resources Inventory (VRI) provides a 'strategic' level planning inventory at the management unit level (TSA or TFL) designed to answer two basic questions: where is the resource and how much is there. The VRI inventory standard consists of two Phases that may be undertaken in combination or in certain situations, individually. In Phase I of the inventory, air photos are acquired, and polygons are delineated within an inventory unit. Vegetation attributes of these polygons are estimated by photo interpreters. In Phase II of the inventory, a subset of the polygons is randomly selected for ground sampling and Net Volume Adjustment Factor (NVAF) sampling. The purpose of Phase II ground SAMPLING is to verify our level of confidence in the Phase 1 inventory and to provide supplementary information on stand characteristics (such as tree size distribution) that are not captured in Phase 1.

More details regarding the VRI process and the VRI standards and procedures are available at the MFLNRO Forest Analysis and Inventory Branch website: http://www.for.gov.bc.ca/hts/vri/index.html

State of the Current Inventory

The forest cover attributes for the majority of the TSA conform to the old Forest Inventory Planning (FIP) standard rather than to the latest VRI standard. The majority of the air photos on which the forest cover inventory is based were acquired in the late 1980s and early 1990s. In Tweedsmuir Park the inventory dates from the 1950s. New photography was acquired for the Burns Lake and Cheslatta Community Forests between 2005 and 2008 and both areas were re-inventoried to the current VRI standard (see Figure 1 below – Burns Lake Inventory Dates).

Fig. 1 – Lakes TSA Inventory Dates



Harvest and reforestation updates to the inventory file are current to 2011. Harvest detection mapping based on satellite imagery is current to 2011. Recent fires and free-growing survey results have not been integrated into the inventory file. The inventory file has been projected to 2011 and polygon volumes have been adjusted to reflect MPB mortality observed in the 2010 forest health overview flight.

An inventory analysis was completed in 2008 and VRI Phase 2 ground sample volume exceeded VDYP7 inventory file volume by 10%.

Document Objectives

This inventory planning document is a working document that states the critical reasons and objectives for carrying out a Phase 1 VRI in the Lakes TSA together with details on the area to be inventoried and key steps during the implementation of this Phase 1 inventory project.

This plan identifies the target project area for new photo interpretation within the boundaries of Lakes Timber Supply Area (TSA), including the Vanderhoof TSA adjoining area, and the stages required to be carried out for a successful completion of a photo interpretation project.

The Lakes TSA Landbase

The Lakes timber supply area, in north-central B.C., covers a total of about 1.5 million hectares ranging from Tweedsmuir Provincial Park in the south to Klaytahnkut Lake in the north. About 72 per cent of the land area is managed by the Ministry of Forests, Lands and Natural Resource Operations. Of the total TSA area, 26 percent is not available for timber harvesting purposes because it is reserved for parks, biodiversity and riparian management or because the productivity of the site is too low to support tree crops, leaving about 1.1 million hectares in the THLB (see Table 1 for a summarized breakdown of the TSA and Fig. 2 Lakes Ownership Status). The forest and range resources of the TSA are administered by the Nadina Forest District office located in Burns Lake.
The unit also includes the towns of Decker Lake, François Lake, Grassy Plains and Danskin, as well as several First Nations reserves and communities, and these communities are significantly dependent upon forest resources.

Table 1. Lakes TSA Area Summary

Ownership Description	Area(ha)
Other Crown Land	796,111
Community Forest	120,437
Private	78,902
Park	22,976
Woodlots	20,784
Crown Reserves	6,537
Indian Reserve	1,043
UREP	959
Federal reserve	365
Crown Misc Leases	5
Total	1,048,122

Forests are mostly lodgepole pine and spruce, with balsam at higher elevations and some small isolated areas of Douglas-fir along the shores of Babine and François lakes (see Table 2 below for a more detailed breakdown of species). The mountain pine beetle infestation in the Lakes area appears to have peaked in 2005 and has killed about 80 per cent of the mature pine trees available for harvesting (Please refer to BCMPB Report at: http://www.for.gov.bc.ca/ftp/hre/external/!publish/web/bcmpb/year9/BCMPB.v9.BeetleProjection.Update.pdf.)

Table 2. Project Area by Species Summary (species profile excludes Tweedsmuir and Entiako parks)

Leading Species	Area (ha)	% of Area
Lodgepole Pine	617418	62.4
Spruce (hybrid)	219920	22.2
Trembling Aspen	68,994	8.1
Subalpine Fir	57,874	5.8
Black Spruce	8,975	0.9
Cottonwood	1,619	0.2
Douglas Fir	3,377	0.3
Paper Birch	288	0.1
	989,605	100

The sub-boreal spruce (SBS) is the dominant BEC zone in the Lakes TSA accounting for approximately 81% followed by the Engelmann spruce – sub-alpine fir BEC zone accounting for a further 17% of the unit (see Table 3 Summary of Area by BEC Zone). In both these BEC zones MPB attack predominates the majority of stands. Recovery of unmanaged stands in the predominant SBS BEC zone is likely problematic in many stands based on preliminary analysis of secondary structure in 444 plots in this BEC zone. MPB-impacted stands in the SBS zone pose the greatest risk for future timber supply. As much as 31% of pine-leading stands may fall below the 6 m2 ha-1 threshold in the SBS zone. In terms of BEC zones in the Lakes TSA, the SBS zone which makes up approximately 81% of the Lakes TSA has the greatest proportion of plots with low post-beetle secondary structure basal area (please see *Current State of Knowledge Regarding Secondary Structure in Mountain Pine Beetle Impacted Landscapes – MPB Impacted Stands Assessment Project*, January, 2012, Coates, D and D. Sachs pg 11 at http://www.for.gov.bc.ca/hts/pubs/MPB_Impacted_Stands_Report_January_20_2012.pdf)

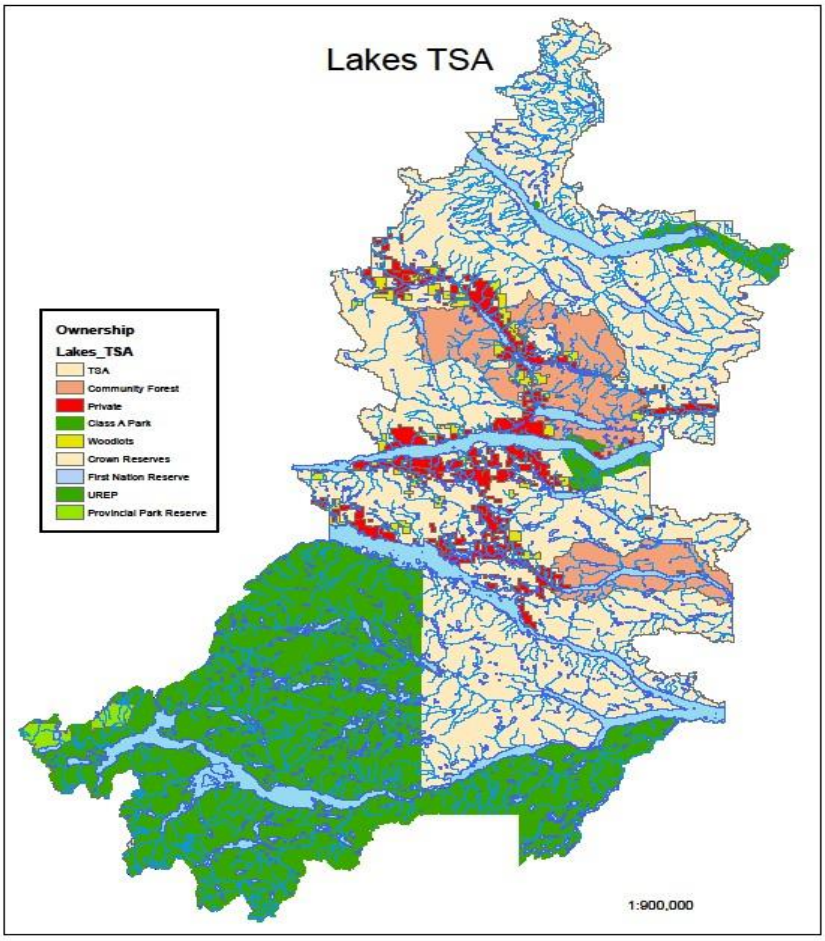
Table 3. Summary of Area by BEC Zone

BEC Zone	ZONE_NAME	Lakes TSA Project Area (ha)	Percent
SBS	Sub-Boreal Spruce	967,639	81
ESSF	Engelmann Spruce -- Subalpine Fir	197,537	17
BAFA - Park	Boreal Altai Fescue Alpine	11,248	1
CWH - Park	Coastal Western Hemlock	10,866	1
MH - Park	Mountain Hemlock	6,155	1
CMA	Coastal Mountain-heather Alpine	960	0
	Total	**1,194,405**	**100**

Woodlots and Community Forest

VRI completed during the MPB infestation period is now out of date and will be completely redone. All photo interpretation calibration points established in these projects are available in the new VRI re- inventory digital and spatial format.

Fig. 2 Lakes TSA Ownership Status.



Section 2 - Photo Interpretation Plan

Project Objectives

The overriding objective of this photo interpretation project is to update the Lakes inventory to account for the massive change due to MPB kill since the last inventory. The new inventory will provide current and more accurate information on both live and dead components of the stands for all pine leading and non-pine polygons within the Lakes TSA outside of protected areas. An accurate re-delineation and re-attribution of the MPB killed pine leading stands is required in order to provide information to inform the mid-term TSR analysis in accordance with the direction of the Special Committee on Timber Supply. In addition, significant harvesting has taken place and needs to be reflected in the new inventory.

Please refer to the TSR background information and reports available at:

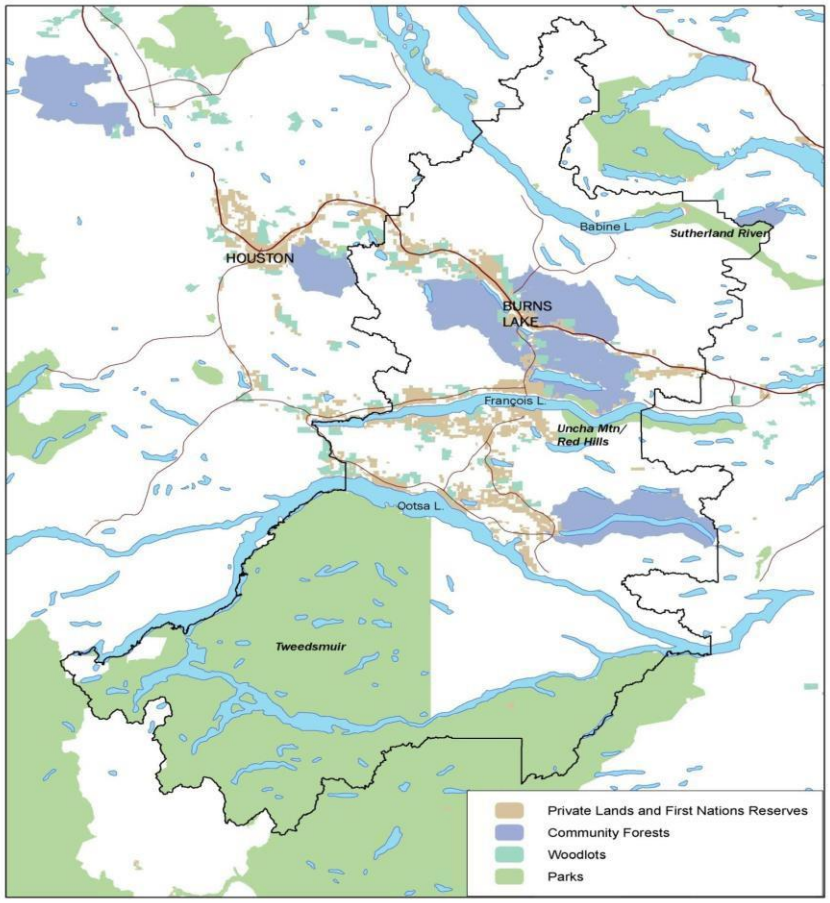
http://www.for.gov.bc.ca/hts/tsa/tsa14/index.htm

To provide inventory information immediately, a separate ground sampling project is underway in the Lakes TSA while this plan is being prepared. In the fall of 2012, 96 inventory ground samples are being re-measured. The sample data will provide current, ground-based estimates of live timber volume, dead timber volume, stocking condition, and other timber characteristics. This ground sample will provide reliable inventory information on live/dead volume that the ministry will use to support near-term decision-making while the phase 1 project is underway. While the separate ground sampling project provides volume estimates from 96 samples, the phase 1 project will provide accurate and current spatial information on where this live/dead volume is located across the TSA in conjunction with other forest cover information such as species composition, stocking, age and height.

Target Area

The entire Lakes TSA will be photo interpreted exclusive of protected areas (Tweedsmuir Park, Entiako Park), including woodlots, private land, small parks and community forests (see Fig. 3 Project Area).

Fig. 3 Project Area (excluded protected areas are shaded in green below)

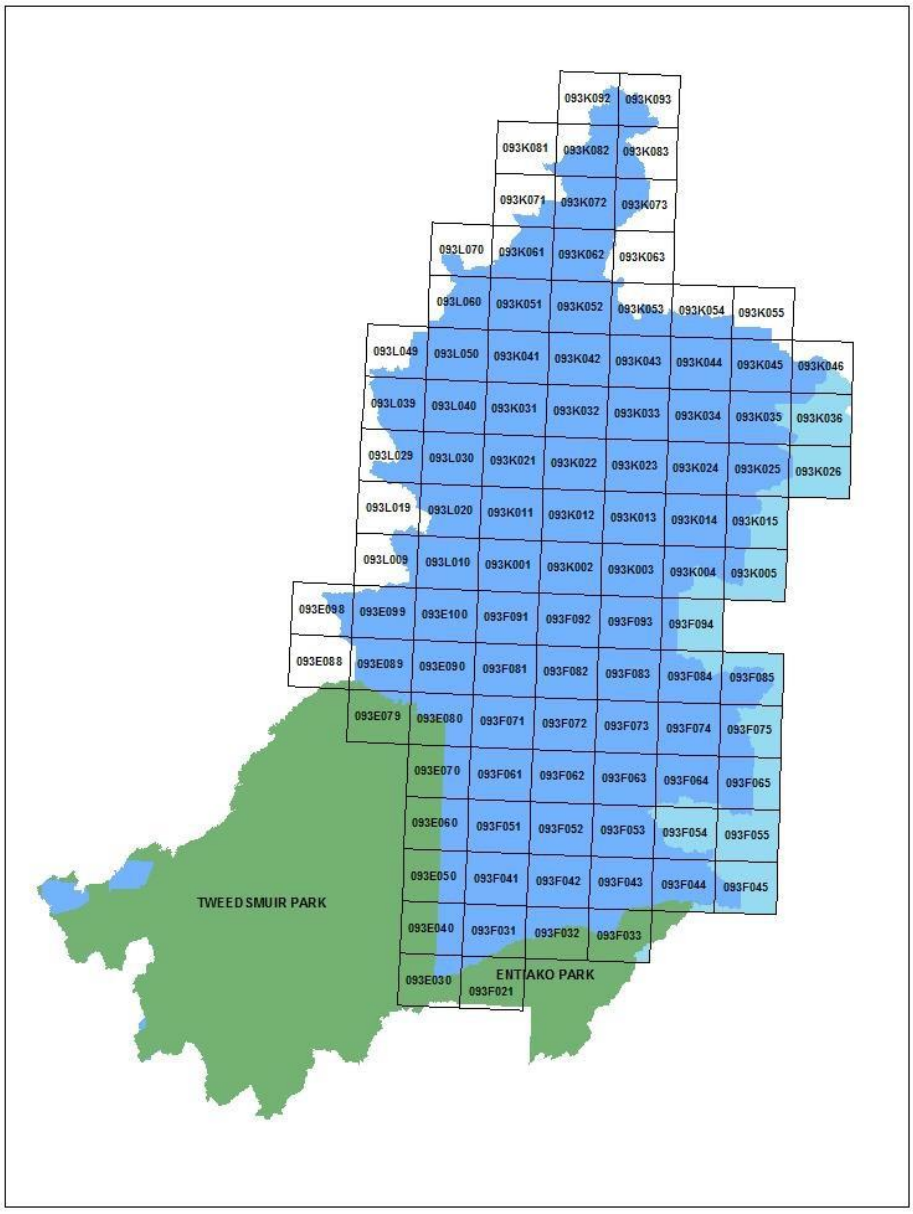


The total Lakes VRI project area is 1,194,411 hectares (approximately 82.5 Full Map Equivalents based on 14,588ha/FME) and encompasses 102 BCGS 1:20000 map sheets. A detail area summary is provided in the attached Appendix A. Note that this includes the addition of approximately 131,138 ha in order to provide complete seamless re-inventory of mapsheets on the adjoining Vanderhoof TSA shown in light blue in Fig. 4 below and is why the total project area is slightly larger than the TSA area tallied in Table 1 on page 3.

Approximately 168,528 hectares, 14% of the total project area, is covered by water.

Re-inventory of the Vanderhoof TSA will be carried out in the same year and all work will tie with the Lakes VRI project. The Ministry will arrange for the exchange of delineation and attribution files with the contractor for the Vanderhoof TSA VRI project.

Fig. 4 Lakes VRI Project Map Sheets (area shown in dark blue - Lakes TSA, light blue - Vanderhoof TSA)



Historical Data Sources

An estimate of 4600 formal inventory data sources was established in the Lakes TSA since the first forest inventory project in 1964. An unknown number of the established data sources were destroyed over the years through harvesting and other disturbances. The actual number of data sources still available will be determined at the data source transfer stage which may be completed prior to the award of the VRI photo interpretation contract.

All data sources that were available in the last re-inventory project are documented on the 1989-90 document photos. A digital spatial location of these points is available in ESRI shape file. Data sources available on the document photos will be reviewed by photo interpreters and data sources that are still relevant to a new inventory on the 2012 imagery will be transferred to a digital format provided by the Ministry.

Table 4: Inventory calibration points established in major forest inventory projects in the Lakes TSA.

Year	Air Calls	Ground Calls
1964	400	181
1965	881	623
1975	165	80
1976	324	1111
1991	**209**	**261**
1992	**164**	**254**
Total	**2143**	**2510**

Situations that would justify removal of existing data sources include a major disturbance (such as a large fire, harvesting or insect/disease damage), large stand structure changes, or as defined in the contract document. A large amount of disturbance has occurred in this unit. Thus the intent of this project will be to rely on the more recent information found in the 1991 and 1992 air calls and ground calls rather than on 1976 or older calls. This leaves an estimated total of 373 air calls and 515 ground calls for reference as the most recent historical information (see Table 4 above).

New Data Sources

The contractor will establish a minimum of 10 ground calls and 20 air calls per map FME with the exact ratio of ground to air calls per FME still to be determined.

The ground call types are restricted to 3-point and 1-point. The type of ground call established in each polygon is based on the species complexity as described in the VRI Photo Interpretation Field Calibration Procedures.

To provide reliable calibration data for photo interpretation of the residual live pine component and visible understory, a modified three-point ground calls will be implemented in the field calibration of the MPB impacted stands. The VRI three-point ground call will include 2 measured and 3 count plots to better capture the dead and live stand species composition.

The ratio of 3-pt versus 1-pt ground call will be confirmed after a review of a sample of the 2012 photo images. Any deviation from these numbers must be agreed upon by the Ministry Project Manager and will be reflected in the field calibration plan.

Current inventory indicates approximately 62% of the project area comprises of pine leading stands. Although pine leading stands traditionally do not require extensive field calibration to achieve reliable photo estimates, a higher than average ground and air calibration program will be required in the MPB stands to ensure reliable determination of live versus dead tree volume component which is a key focus of this inventory.

Prior to the initiation of a field calibration program, a Field Calibration Plan (see Guidelines in Appendix D) is to be submitted to the Ministry Project Manager for approval.

As part of the deliverables, the Ministry requires a complete set of any new data sources be provided in a suitable digital format (as determined by the Ministry), including the geographical locations (UTM coordinates) of these data sources as well as the complete set of field attribute data collected.

A PEM has already been completed for the Lakes TSA together with a number of other site productivity sampling projects of varying vintage. The most recent site productivity data has recently been loaded into a provincial site productivity layer. The most recent PEM passed an accuracy assessment (AA) in accordance with the most recent standards and procedures for this information and is available for use in this project (please see Appendix C).

Other Data Sources

Table 5. Other Data Sources

Data Source Origin	Type	Number of Data Sources
Growth and Yield Permanent Sample Plots (PSP)	PSP	59
Burns Lake Community Forest 2007/08- Ground Calls	XGV	36
Burns Lake Community Forest 2007/08 - Air Calls	XV	194
Cheslatta Community Forest 2008 - Ground Calls	XGV	134
Terrestrial Ecosystem Mapping with tree data	TEM	See below*
Predictive Ecosystem Mapping with tree data Site Productivity Layer (MPB -Site Index)	PEM	See below*

*****The VRI Phase 1 contractor will use the provincial site productivity layer information as a reference for site index (SI) where SI cannot be estimated from suitable live mature trees, i.e. in areas of high MPB mortality. This GIS database contains the latest PEM, TEM and SIBEC information for the Lakes TSA by species. The provincial site productivity layer data and supporting information is available at:

http://www.for.gov.bc.ca/hts/siteprod/provlayer.html

Polygon Delineation

Polygon delineation is to be completed to VRI standards. Any deviation from these standards must be agreed to by the Ministry Project Manager.

It is critical in the MPB impacted stands to capture the residual live tree component; therefore throughout the delineation process the live trees must guide the line placement and

the resulting polygon boundaries. Photo interpreters will not extrapolate visible understory to adjacent polygons. Only when understory is visible will it be summarized as a separate layer in each polygon.

The intent is to follow the process for delineating and attributing MPB impacted stands now underway in the Kamloops TSA Phase 1 VRI (see Appendix B for details). Any amendment of this process would be based on an assessment of the Kamloops project later in this fiscal.

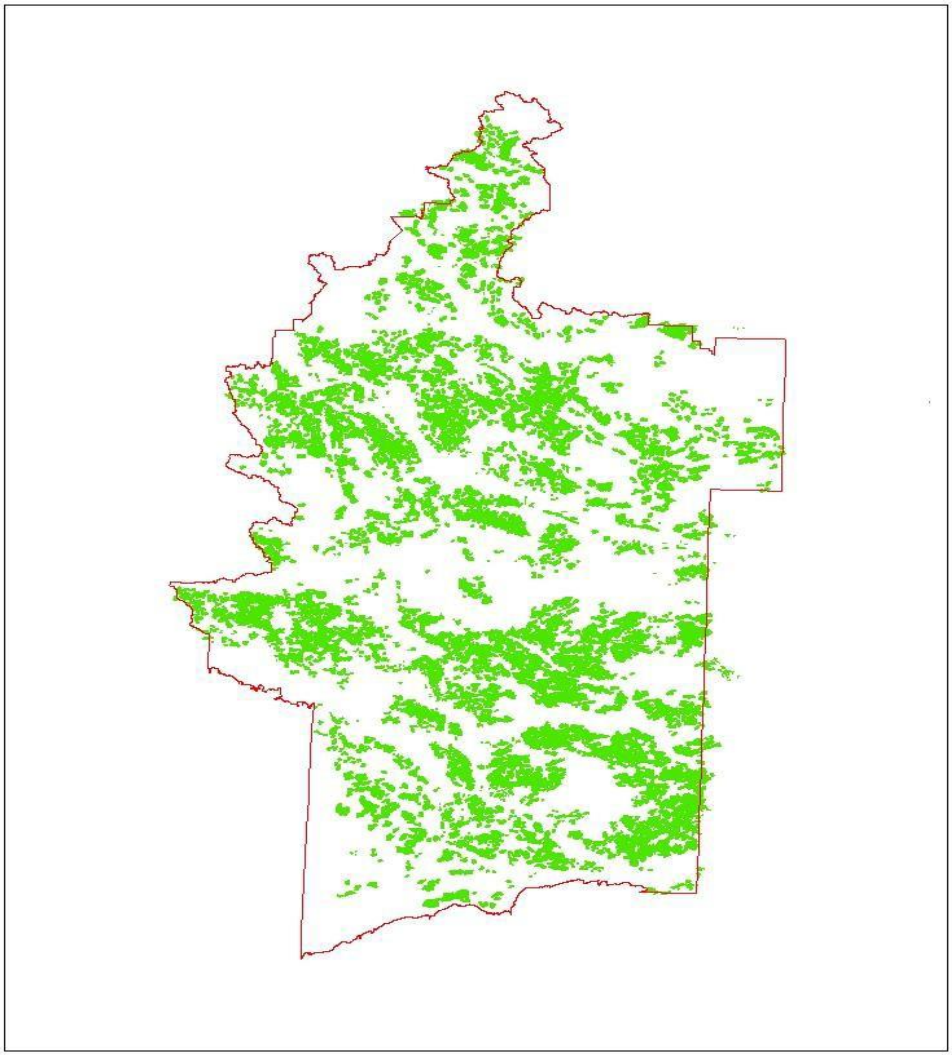
Integrating RESULTS Information

The integration of the RESULTS (Reporting Silviculture Updates and Land status Tracking System) spatial files and tree attribute data will be completed at the delineation and attribution stages of the project.

The RESULTS database indicates approximately 19,950 Opening ID Records that currently exist within the project area. The total spatial area of the openings comprises approximately 17%of the project area (see Fig. 5 below).

An ESRI shape file for the RESULTS openings and tree attributes will be provided to the bidders attending a mandatory project viewing session.

Fig. 5 Lakes project area RESULTS Spatial File Coverage (shown in green) October 2012



There is a review of RESULTS data presently underway and preliminary RESULTS summaries indicate there is missing spatial and attribute data. There are 2046 openings in the Lakes TSA that had opening spatial but no forest cover spatial. Over half of the 2046, 1061 openings, have negative opening ids and are therefore from the old aspatial ISIS/MLSIS corporate database. RESULTS data preparation will need to account for these data gaps and any anomalies in advance of start-up of the photo interpretation work. Any RESULTS data cleanup and rationalization would be conducted through the Nadina District in coordination with the Kamloops update group in advance of project start-up, likely around mid-January, 2013.

Some openings in the air photos won't be found in the RESULTS data cut. Attribution of harvested areas that are not identified in the RESULTS spatial files will be completed in accordance with the procedures for Photo Interpretation Guidelines for Integrating RESULTS Information.

Attribute Estimation

This project will be undertaken in softcopy (digital photogrammetric) format.

The intent is to follow the process for delineating and attributing MPB impacted stands now underway in the Kamloops TSA Phase 1 VRI (see Appendix B for details). Any amendment of this process would be based on an assessment of the Kamloops project later on this fiscal.

Photogrammetric tree heights will be taken where suitable at the discretion of the photo interpreter. There will be no quality assurance carried out of the photogrammetric heights.

Mapping

The Ministry has developed a format and database standards for the submission and storage of spatial and attribute data for VRI Photo interpretation. All new projects must be completed to this standard and submitted to the Ministry Project Manager following successful QA.

The Contractor will adhere to the most current version of the *VRIMS Personal Geodatabase Structure and Use and VRIMS Vegetation Cover Polygon Validation Rules* published by the Forest Analysis and Inventory Branch.

TRIM Base

A TRIM (NAD 83) format base files will be made available to the contractor at the project pre-work meeting.

There will be no changes made to the TRIM feature unless significant changes occurred to the polygonal features such as lakes and double-line rivers. The contractor must maintain a record of any TRIM changes and submit all changes to the Project Manager in ESRI shape file format. The changes will be passed on to GeoBC for TRIM update.

Section 3 - Project Implementation

Project Pre-work meeting

A project pre-work meeting is mandatory. The purpose of a project pre-work meeting is to bring together the Ministry Project Manager, VRI Phase I contractor, MFLNRO representatives and quality assurance personnel prior to project start-up. This meeting will ensure that an efficient communication network is established, identify individuals responsible for all aspects of the project, allow discussion of any issues before project work commences and establish timelines for deliverables and data flow. Minor changes to the contract to complete the Phase I activities may be identified ant this meeting.

A project pre-work checklist, signed off by all parties attending, will be used to organize and guide the meeting.

Scheduling

The project will progress over two fiscal years commencing in the 2013 - 2014 fiscal. Two field seasons will be required for collection of photo interpretation field calibration data.

Approximately two thirds of the photo estimation work will be completed in 2013/14 and the remaining in 2014/15.

A delivery schedule outlining progressive delivery of products will be submitted by the contractor for each fiscal. The format of the delivery schedule will be agreed to at the project pre-work meeting.

Aerial Photography and Photo Scale

The present 2012 digital air photo acquisition is being administered by GeoBC on behalf of FAIB and therefore meets all standards and specifications as summarized below.

Digital frame camera imagery of the project area was acquired to GeoBC photo standards and specifications in the summer of 2012. Flight lines were oriented in an East-West (or opposite) direction and captured at 30cm GSD (ground scale distance). Softcopy image sets will be available as RGBnIr 4 band 8 bit JPEG compressed TIF with a Z\I project file. This will allow for natural colour display of imagery as well as colour infrared display using the same image file and softcopy setup.

For projects utilizing digital softcopy photogrammetric technology, the minimum acceptable scale of the imagery shall be 1:20 000 for coastal areas; 1:20 000 for southern interior and central interior areas; and 1:30 000 for portions of the far northern interior. The use of digital imagery requires the use of a Ground Sampling Distance that is compatible to the minimal acceptable scale in hard copy. The Ministry must be consulted in regards to the appropriate photo-scales or Ground Sampling Distance to be implemented on a project. The year(s) of photograph acquisition for the project area must be included and approved as part of the Plan. As a guideline, the maximum age of the photographs is five years from the date of the start of attribute estimation.

Project Manager

The Ministry Project Manager for the Lakes TSA Phase 1 VRI project is Roman Bilek, FAIB. Responsibilities include the following: coordinating the project; monitoring and communicating project progress with the local stakeholders; ensuring all contractors are qualified and certified; overseeing photo-interpretation activities; ensuring quality assurance is complete and delivered at each stage, and assisting in coordinating technical expertise where required.

Personnel

All VRI photo interpretation work must be completed by or directly supervised by a VRI Certified Photo Interpreter. At least 50% of the photo interpreters working on the project must be certified for VRI photo interpretation. All uncertified photo interpreters are to be directly supervised by a Certified Photo Interpreter working on that project.

Quality Assurance

An independent third-party quality assurance (QA) will be completed on all stages of the project in accordance with the VRI Photo Interpretation Quality Assurance Procedures and Standards.

Quality assurance intensity for each stage of the project is to be completed as follows:

Historical Data Source Transfer	5%
Delineation	5%
Field Calibration	5%
Attribution	5%

Quality assurance for digital map production will be conducted by the Province. Contractors will utilize “VEGCAP for Contractors” validation software to perform quality assurance on data files.

All QA findings and re-work instructions are communicated to the VRI contractor by the Ministry Project Manager.

Deliverables

The VRI photo interpretation project deliverables for each stage of the photo interpretation project are outlined in the VRI Photo Interpretation Procedures and VRI Field Calibration Procedures for Photo Interpretation.

For a multi-year project, deliverables are required at the end of each year fiscal. To provide sufficient time for completion of independent third-party quality assurance and Ministry in-house mapping quality assurance, the final deliverables will be submitted at the end of February of each fiscal.

The most current VRI Phase I standards documentation can be accessed from the following NFLNRO web site:

http://www.for.gov.bc.ca/hts/vri/standards/photo.html

Submission of all final deliverables will be signed-off by a qualified ABCFP registered Forest Professional.

Roles and Responsibilities

MFLNRO

Project Manager is the point of contact for the Ministry and provides overall communication of project activities with contractors and Nadina District staff and stakeholders via the Ministry SharePoint site.

VRI Contractor

Works with the Ministry Project Manager to ensure the planning, coordination and execution of project activities is consistent with the VPIP and contract requirements.

VRI QA Contractor

Works with the VRI Contractor and Ministry Project Manager to ensure that Quality Assurance reporting meet the VRI prescribed standards.

References for Inventory Standards and Procedures

All work will be carried out in accordance with the following British Columbia Government specifications, current at the time of contract signing.

- *Vegetation Resources Inventory Photo Interpretation Procedures*
- *Vegetation Resources Inventory Photo Interpretation Standards and Quality Assurance Procedures*
- *Vegetation Resources Inventory Field Calibration Procedures for Photo Interpretation*
- *Guideline for Integrating RESULTS Information* (currently contained within the VRI photo interpretation procedures)
- *Vegetation Resources Inventory – The B.C. Land Cover Classification Scheme and addendums*
- *VRIMS Personal Geodatabase Structure and Use*
- *VRIMS Vegetation Cover Polygon Validation Rules*

- *Vegetation Resources Inventory Preparing a Project Implementation Plan for Photo interpretation – Appendix D*

Costs

The anticipated cost for completing the project, excluding photo acquisition, but including quality assurance, data capture and field costs based on the level of field calibration to be completed, is 1.2 million dollars. The QA costs are estimated to be between 7% and 10% of the overall photo interpretation project cost for this unit. Note, these estimates are used for project budgeting purposes only, based on current average costs for similar projects.

Inventory Plan for Photo Interpretation of the Lakes TSA

Project Sign-Off Sheet

Lakes Timber Supply Area Vegetation Resources Inventory
Photo Interpretation Project Implementation Plan

I have reviewed and approved the Lakes TSA Vegetation Resources Inventory Photo Interpretation Project Implementation Plan.

Nov 30, 2012

Pat Martin — Date
Manager, Forest Inventory Section
Forest Analysis and Inventory Branch
Ministry of Forests, Lands and Natural Resource Operations

November 2012 17

Appendix A: Project Map Sheet Area Summary

Map	Full Map Equivalent (hectares)	Project Area (hectares)	Map	Full Map Equivalent Area (hectares)	Project Area (hectares)
093E030	14857	2514	093K011	14546	14546
093E040	14823	6252	093K012	14546	14546
093E050	14788	6234	093K013	14546	14546
093E060	14754	6217	093K014	14546	14546
093E070	14719	6202	093K015	14546	14546
093E079	14685	1338	093K021	14511	14511
093E080	14685	9767	093K022	14511	14511
093E088	14650	229	093K023	14511	14511
093E089	14650	13268	093K024	14511	14511
093E090	14650	14650	093K025	14511	14511
093E098	14615	3776	093K026	14511	14511
093E099	14615	13953	093K031	14476	14476
093E100	14615	14615	093K032	14476	14476
093F021	14857	2055	093K033	14476	14476
093F031	14823	13116	093K034	14476	14476
093F032	14823	7121	093K035	14476	14476
093F033	14823	4451	093K036	14476	14476

Map	Full Map Equivalent (hectares)	Project Area (hectares)	Map	Full Map Equivalent Area (hectares)	Project Area (hectares)
093F041	14788	14788	093K041	14441	14441
093F042	14788	14788	093K042	14441	14441
093F043	14788	14541	093K043	14441	14441
093F044	14788	13120	093K044	14441	14441
093F045	14788	14733	093K045	14441	13569
093F051	14754	14754	093K046	14441	7679
093F052	14754	14754	093K051	14406	14406
093F053	14754	14754	093K052	14406	14406
093F054	14754	14754	093K053	14406	7914
093F055	14754	14754	093K054	14406	6161
093F061	14719	14719	093K055	14406	2277
093F062	14719	14719	093K061	14371	11231
093F063	14719	14719	093K062	14371	13562
093F064	14719	14719	093K063	14371	333
093F065	14719	14719	093K071	14336	2884
093F071	14685	14685	093K072	14336	13314
093F072	14685	14685	093K073	14336	6128
093F073	14685	14685	093K081	14301	14301
093F074	14685	14685	093K082	14301	10260

Map	Full Map Equivalent (hectares)	Project Area (hectares)	Map	Full Map Equivalent Area (hectares)	Project Area (hectares)
093F075	14685	14685	093K083	14301	5437
093F081	14650	14650	093K092	14266	3471
093F082	14650	14650	093K093	14266	4524
093F083	14650	14650	093L009	14580	4183
093F084	14650	14650	093L010	14580	14580
093F085	14650	14650	093L019	14546	1658
093F091	14615	14615	093L020	14546	13542
093F092	14615	14615	093L029	14511	8193
093F093	14615	14615	093L030	14511	14511
093F094	14615	14615	093L039	14476	11420
093K001	14580	14580	093L040	14476	14476
093K002	14580	14580	093L049	14441	4695
093K003	14580	14580	093L050	14441	14441
093K004	14580	14580	093L060	14406	10481
093K005	14580	14580	093L070	14371	2832
	Total	623130		Total	571282
Total Project Area(ha)					**1,194,411**

Appendix B: Delineation and Attribution Process in Mountain Pine Beetle Impacted Stands

The Ministry is interested in collecting more attribute information on stands that have significant amounts of dead standing timber. This will apply to all stands, regardless of species, that the photo interpreters estimate have more than 30% mortality, based on density. In these stands, snags/ ha will be estimated as per the standards and the contractor will create a new "Layer D" and collect the following attributes on the dead standing timber:

- Species composition
- Age of leading
- Height of leading
- Basal area
- Stems/ ha
- Crown closure (estimated as % of stems/ha affected)
- Disturbance type

The main areas that will be included are insect infestation and wildfire. While Mountain Pine Beetle is by far the biggest agent that will affect the need for a dead layer, other agents and factors affecting mortality are included in the dead layer.

The following procedure is proposed where stands have been significantly affected by Mountain Pine Beetle. This is recorded below for information; procedures will be discussed and finalized with the contractor at the pre-work conference.

- In MPB killed stands, where the remaining stand would be classified as Vegetated Treed (VTU or VTW), use normal VRI delineation principles in determining boundaries between polygons, and record snags as appropriate for that polygon.
- In MPB killed stands, where the remaining stand would NOT be classified as Vegetated Treed (VNU or VNW), and WOULD HAVE been classified as Vegetated treed prior to MPB attack, separate polygons based on BCLCS level 5 and snag density. For example a MPB killed stand may now be classified as VNU, HE (or By, ST, SL), and would be delineated to that level, PLUS further delineation based on the number of snags remaining.
- The delineation guideline for snags would be +/- 200 snags per hectare. Basal area will be recorded based on live stems as per current procedures.
- Record the site index for the polygon that most closely approximates the new polygon boundary as the "estimated site index" (average or prorate as appropriate)
- If the polygon is VN but has a treed component (IE 8% crown closure), do not put an estimated site index, it will be calculated using the interpreted age and height, unless the stands is less than 30 years of age.

A significant proportion of the pine in the project area is now dead. In stands where there is approximately a 20% or greater loss in volume, it is appropriate to use live and dead trees for the 6 to

8 tree ground calibration tally standards. It is also appropriate to use a dead tree as a sample age/height tree in these situations, if a suitable live tree is not available in close proximity.

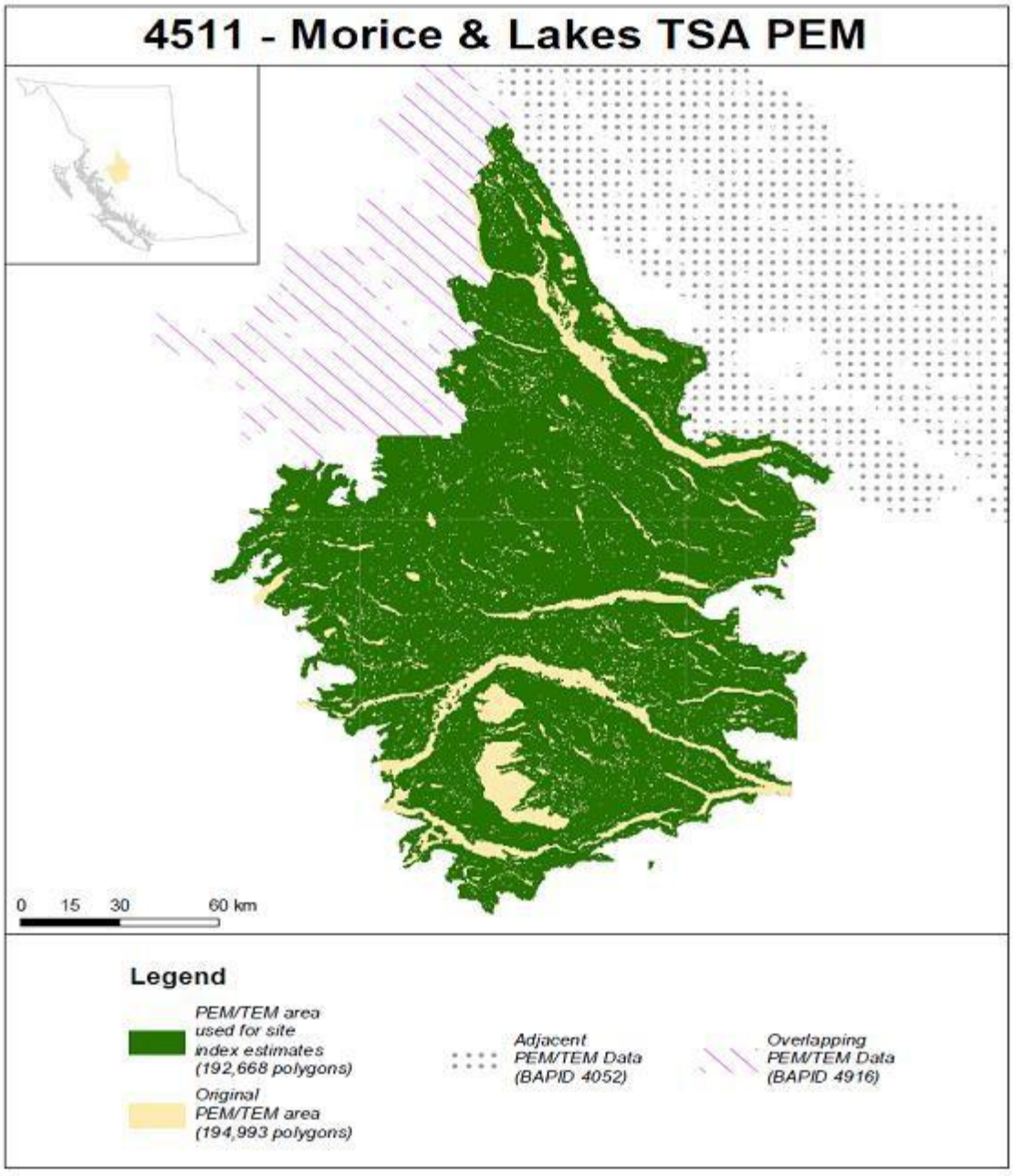
In affected stands, field data will be taken to determine the species composition post beetle, including understory and residual stands as appropriate.

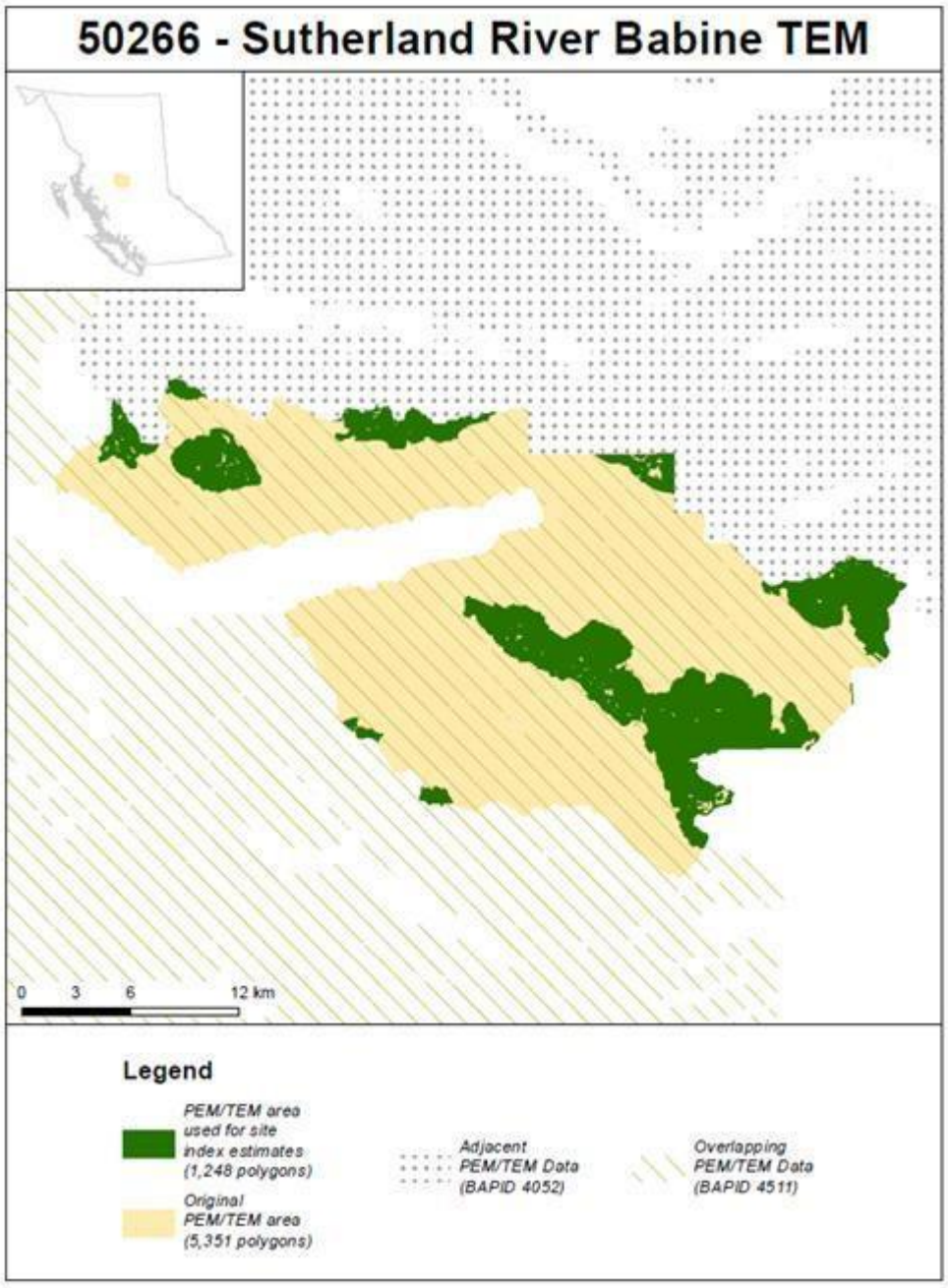
There are a number of other insect outbreaks occurring in the TSA, if the contractor identifies further large scale outbreaks in areas that are not Pine leading, the above procedures may be extended to other species after discussion and approval by the Ministry project manager.

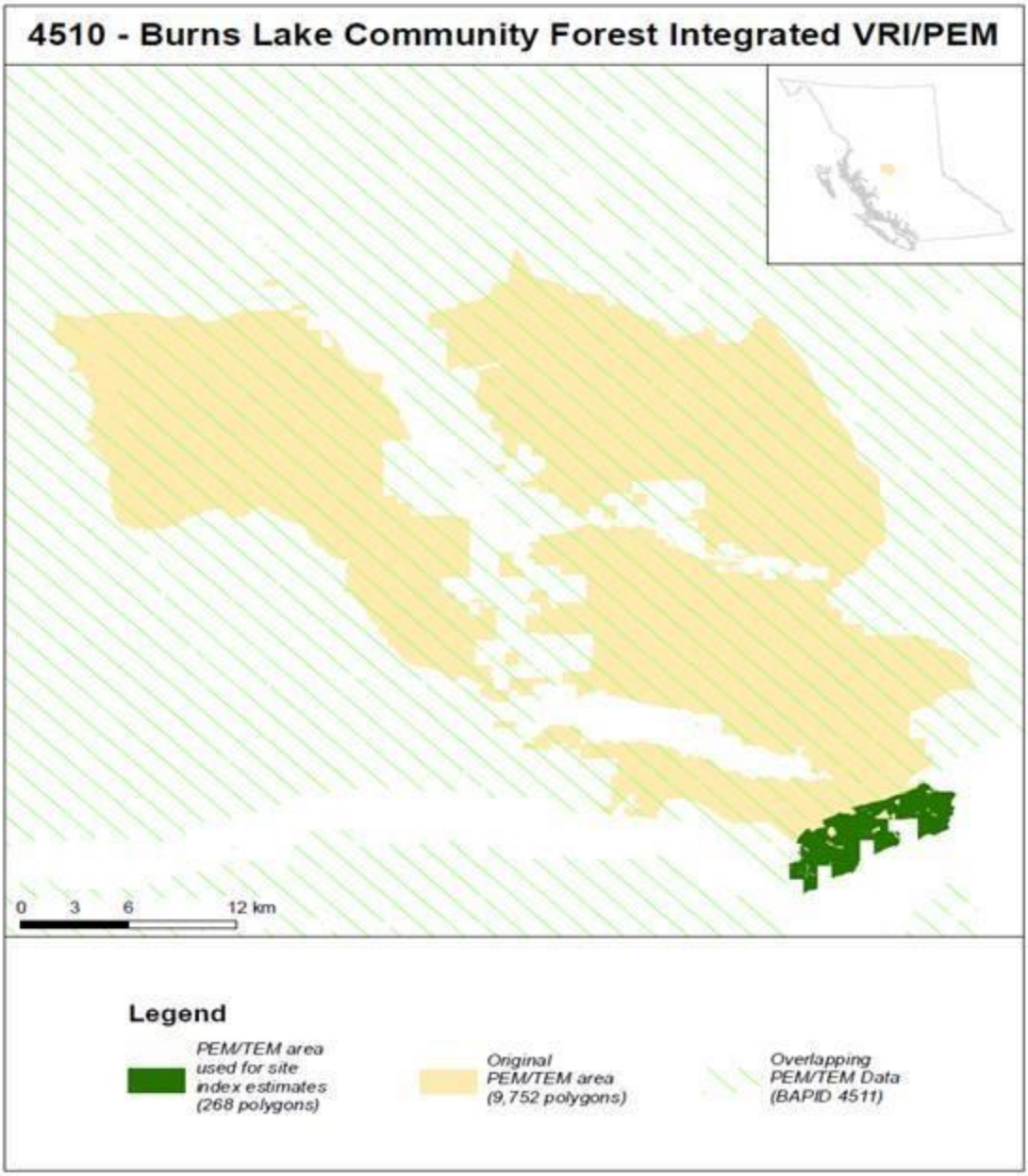
In polygons that have been heavily impacted by MPB, the field crew will take notes on the species composition, age, height, density of understory if it cannot be seen on the photo. This data will not be sampled and will be an ocular based estimate only. Where understory is visible on the photo, data will be collected as per standards – all layers will be considered. Pre-location of the calibration points prior to fieldwork must take this into account.

The determination on whether the understory can be seen for calibration polygons is a field determination based on the residual main canopy and the height, density and size of the understory,

APPENDIX C: Lakes TSA PEM and TEM Completed to Date




50266 - Sutherland River Babine TEM
0 3 6 12 km
Legend
PEM/TEM area used for site index estimates (1,248 polygons)
Original PEM/TEM area (5,351 polygons)
Adjacent PEM/TEM Data (BAPID 4052)
Overlapping PEM/TEM Data (BAPID 4511)


4510 - Burns Lake Community Forest Integrated VRI/PEM
0 3 6 12 km
Legend
PEM/TEM area used for site index estimates (268 polygons)
Original PEM/TEM area (9,752 polygons)
Overlapping PEM/TEM Data (BAPID 4511)

APPENDIX B

Lakes Timber Supply Area

Vegetation Resources Inventory
Strategic Inventory Plan

Nona Phillips Forestry Consulting

September 1, 2006

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Acknowledgements

The enthusiasm of the Stakeholders in this VRI planning process, including the Ministry of Forests & Range staff and the Licensees has provided momentum for this undertaking. Included in this group are those who contributed to making the Stakeholder meeting a success through their part in the presentations or the active discussion. Also acknowledged are those who have guided the preparation of the VRI Strategic and Project Ground Sampling and NVAF Plans, through their extensive experience:

- Jason Platzer, Babine Forest Products
- Jim McCormack, CanFor (Houston)
- Atmo Prasad and Barry Snowdon, MoFR Forest Analysis & Inventory Branch, Timber Supply Section
- Garth O'Meara, Barry Elliott and other District staff participants, MoFR Nadina District
- Dick Nakatsu, Northern Interior Forest Region
- Sam Otukol, Gary Johansen, Will Smith and Graham Hawkins, MoFR FAIB, VRI Section

Gitte Churlish provided expertise on evaluation of the population and ultimately the sample plan development for the VPIP, Chris Mulvihill shared his experience with recent sampling plan development projects, Dave Coates' research has caught the interest of the Stakeholder group and has provided another objective for the field work.

Thank you to the many others who contributed to the development of the planning documents for the Lakes TSA indirectly.

Finally – and perhaps the most critical recognition must be made to the MoFR-lead group who established priorities for the funding allocation from the Federal Government Mountain Pine Beetle funds and will be providing resources for the Lakes TSA VRI project.

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Executive Summary

The Ministry of Forests & Range, Forest Analysis & Inventory Branch is supportive of enhancing inventory knowledge in Mountain Pine Beetle infested TSAs across the province. This has allowed the Lakes TSA planning table to look for solutions to data questions through the ground sampling, NVAF and monitoring activities in Vegetation Resources Inventory.

The initial step was to draw together the identified Stakeholders in this unit to a meeting hosted by the Ministry of Forests & Range in Burns Lake. This was designed to provide an opportunity to:

1. provide a background on the Vegetation Resources Inventory process
2. assess client data needs in the TSA suggested by previous planning processes and generally identify support that can be provided through the Vegetation Resources Inventory
3. provide more TSA-specific recommendations for the undertaking of relevant phases of the VRI based on the forest management issues in the Lakes TSA

Some of the specific concerns that the Stakeholders are seeking information for include:

1. Better estimates of live and dead volume for all species.
2. Estimates of MPB killed pine 'shelf life'
3. Assessment of the accuracy of standing log grades, including the draft Interior log grades.
4. 'Mid-term timber supply' – amount, possible locations, additional data on these stands
5. Potential abundance of secondary structure[1], especially in Lodgepole Pine stands affected by Mountain Pine Beetle
6. Impact of mountain pine beetle on current wood supply.

The following details for the Lakes TSA project have evolved from the Stakeholder's meeting, a follow up Discussion Paper and additional discussions with specialists in the Ministry of Forests Forest Analysis and Inventory Branch, VRI section:

1. The recommended target population for sampling will be the Vegetated Treed component of the landbase, all ages, excluding private land, Indian reserve land, parks, and protected areas.
2. Phase 2 Ground Samples will be established randomly across the landbase, based on the strata determined in the VPIP. In addition to the regular Timber Emphasis data collection, supplementary data collected will include non-VRI ecology to a level that supports the shelf life study, shelf life attributes in pine leading stands, and additional 'small tree plot' data.

[1] Seedlings, saplings, sub-canopy and canopy trees that will likely survive a pine beetle attack (Coates 2006)

3. Net Volume Adjustment Factor destructive sampling will be completed as part of the Phase 2 work. The accuracy of the standing log grades, VRI and the draft Interior log grades, will be confirmed through a bush scale of each destructively sampled tree.
4. Analysis & Adjustment of the current Photo Interpreted Inventory will follow the Phase 2 field work, based on the ground sampling and NVAF data.
5. Supplementary data will be captured for analysis or incorporation in model development or research work.
6. Initiation of a Pine Monitoring project will occur concurrently.
7. A new Phase I or photo interpretation of the TSA will not be part of the project at this time.

The VRI Project Implementation Plan (VPIP) will be completed based on the decisions agreed to in the preparation of this VSIP. The VPIP will provide details for the implementation of VRI ground sampling including details on the sampling plan development – strata development decisions for the ground sampling 'cluster' samples and NVAF, sample lists, roles and responsibilities, implementation steps, and estimated costs.

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1. Introduction

1.1 Background

The Vegetation Resources Inventory (VRI) is one of a number of inventories that have been implemented since the 1990's in the province of British Columbia. The Forest Resources Commission (1991) recommended "that the Government of British Columbia undertake a commitment of complete inventories for all renewable forest resource values using standardized compatible systems". The Resources Information Standards Committee (RISC) has evolved as the group who continues to "support the effective, timely and integrated use of land and resource information from planning and decision making by developing and delivering focused, cost-effective, common, provincial standards and procedures for information collection, management and analysis."

The VRI has been the standard for forest cover inventory since 1996. As stated on the MoFR's website for the Vegetation Resources Inventory, the VRI was designed to answer two questions:

1. Where is the resource located?
2. How much of a given vegetation resource is within an inventory unit?

Among the strengths of the VRI are its statistically accurate procedures, its return to ground sampling and its multi-option approach to answering inventory related questions.

The VRI process starts with a formalized planning requirement, aimed at involving local Stakeholders in the decisions on the direction for the process. This includes preparing a VRI Strategic Inventory Plan (VSIP) followed by one or more VRI Project Implementation Plans (VPIP). This documentation should be thorough enough that those following up on the project in the future can use these documents to build upon.

The current beetle epidemic in the pine forests of British Columbia and the changing information needs related to this epidemic are behind the Lakes TSA initiative. While many similar inventory projects are funded by the Licensees, this TSA was identified by the Forest Analysis and Inventory Branch of the Ministry of Forests & Range as a high priority for developing a plan to supplement currently available data.

1.2 Scope and Objectives

The VSIP attempts to identify issues in the TSA that can be addressed by the Vegetation Resources Inventory. Various components of the inventory can be selected to address specific inventory needs. This document provides direction for the development of the more detail-oriented VPIP.

Nona Phillips Forestry Consulting is preparing this report in consultation with the Lakes TSA Stakeholders. Included in their number are the following:

- MoFR – Forest Analysis and Inventory Branch
  - – Northern Interior Forest Region
  - – Nadina Forest District
- Babine Forest Products, Burns Lake
- Fraser lake Sawmills, Fraser Lake
- Babine Timber Ltd., Burns Lake
- CANFOR, Houston Division
- L & M Lumber, Vanderhoof
- Cheslatta Forest Products, Burns Lake
- Pacific Inland Resources, Smithers
- Tahtsa Timber, Burns Lake
- Houston Forest Products, Houston
- Burns Lake Community Forest

This VSIP has been written following the Stakeholders meeting in Burns Lake held on Friday, July 7, 2006. A list of the stakeholders attending this meeting is in Appendix A.

1.3 Vegetation Resources Inventory Overview

Before deciding the direction for a VRI project, it is important to have familiarity and some understanding of this inventory. There are numerous activities that may be undertaken in combination or in some cases, individually.

The Vegetation Resources Inventory has several components.

1. Phase 1 or Photo Interpretation

The Photo Interpretation phase involves estimating vegetation polygon characteristics from aerial photographs.

The key steps involve:

- Delineating the vegetated and non-vegetated land base into polygons based on similar vegetation characteristics
- Field calibration for the photo interpreters
- Attribute estimation, incorporating historical data, field calibration data and the skills of the photo interpreters
- Digital capture of attribute and graphic information to produce forest cover maps

2. Phase 2 or Ground Sampling activities

The ground sampling phase provides the information necessary to determine how much of a given attribute is within the inventory area.

There are two parts to this phase.

i) Establishment of 'cluster' samples randomly across the project area. The data collected at the cluster samples may include the measurement of timber and/or ecology attributes. Net close utilization volume is obtained by call grading and net factoring trees, and breakage loss factors.

ii) Destructive sampling following the protocols established in the Net Volume Adjustment Factor process is used to correct for errors in the estimation of net tree volume. The NVAF work provides an adjustment factor that is used during sample compilation to produce unbiased estimates of net close utilization tree volume and adjust the net factor volumes from the plot establishment activity.

3. Analysis and Adjustment

- Data analysis is the process of screening, preparing, and comparing compiled ground sample data to the phase 1 inventory data, to determine the relationships between these data.
- Attribute adjustment is the process of applying the relationship between photo estimation data and ground sampling data to the initial estimates in the photo interpreted database.

4. Monitoring plots

Monitoring is not considered part of the Vegetation Resources Inventory "toolkit" but is being included in this project to track changes associated with the pine beetle infestation. The permanent plot design of the National Forest Inventory – British Columbia standard allows for repeated measurement of forest attributes over time, at defined locations. The following are features of this work:

- cross between a VRI and a Growth & Yield Permanent Sample Plot creates a permanent, remeasureable design that is a statistically based system of monitoring and reporting
- most often includes collecting full VRI ground sampling data, including timber and ecology
- intention is to monitor change over a long term at intervals of 5 to 10 years

1.4 Vegetation Resources Inventory Overriding Principles

To ensure consistent and effective implementation of the inventory the following principles guide projects across the province:

- Strategic and Project Implementation Plans are produced to provide background on the VRI process, identify the project area and tailor the inventory to the specific needs of the inventory unit as identified by the Stakeholders. Project Implementation plans identify specific timelines, roles and responsibilities, and deliverables. These plans form a critical part of the

record for Vegetation Resources Inventory projects and they have high value in both the short and long term.

- Implementation will follow standards and procedures established by the Resources Information Standards Committee (RISC) that are available at the website: http://ilmbwww.gov.bc.ca/risc/pubs/teveg/index.htm

1.5 Vegetation Resource Inventory Planning

The MOFR requires that a VSIP be prepared before starting a VRI. This is to ensure that the inventory is tailored to address issues identified in the TSA.

The overall planning process is as follows:

- Identify stakeholders and consult with them throughout the project. Initially, there is a meeting with the stakeholders to describe the process and identify issues specific to their planning area. Throughout the planning process, this client group should be kept informed and at some junctures, involved in the process.
- Develop a VRI Strategic Inventory Plan (VSIP) that creates a project addressing stakeholder needs. Specific VRI tools are identified to support the collection of data or products to resolve issues
- As directed through the VSIP, the VRI Project Implementation Plan (VPIP) will be the more detailed plan, outlining specifics for each prescribed activity.

1.6 Funding

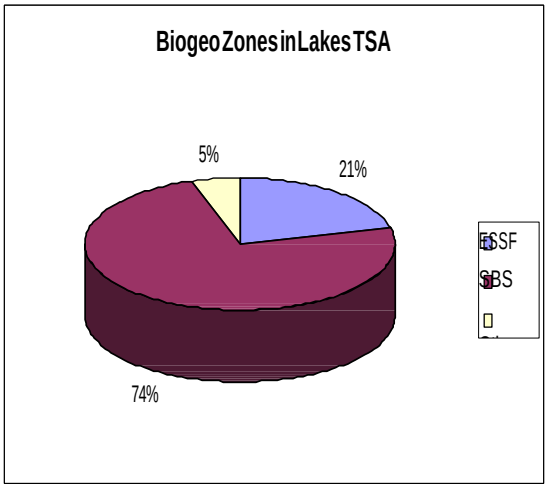
As previously stated, this project is being undertaken through Federal Mountain Pine Beetle funding. At this time funding is available to cover the field work and analysis components of this project. If it is possible, every effort will be made to accelerate all field work for this project to be completed by the end of the 2007 field season, and all analysis by the end of the fiscal year 2007/08. This will help to secure funding and make the data available in the requisite timeframe for the timber supply review (TSR).

2. Business Considerations

2.1 Landbase (adapted from the Lakes TSA AAC Rationale –October, 2004)

The Lakes TSA is located in north central BC between Babine Lake in the north and the Entiako River in the South. It comprises approximately 1.12 million hectares of the Nadina Forest District and includes the community of Burns Lake and several smaller communities. Lakes comprise almost 10% of the TSA area, the three largest being Babine, Francois, and Ootsa. Part of Tweedsmuir Park is in the southern end of the TSA. Figure 1 is an overview map of the area.

The TSA is on the western edge of BC's interior plateau with terrain that is characterized by gently rolling uplands. The predominant biogeoclimatic zone is Sub-Boreal Spruce (SBS) found in the valley bottoms dominated by lodgepole pine, hybrid white spruce, and subalpine fir. The climate here includes severe, snowy winters, and relatively short warm, moist summers. Above this, in steeper terrain, is the Engleman Spruce- Subalpine Fir (ESSF) zone with Engleman spruce and subalpine fir predominating climax forests. Pine is common in pioneer stands establishing following fire. The weather here is cooler and wetter/snowier than SBS. At the highest elevations is the largely treeless, rugged, Alpine Tundra (AT).



About 75% of the TSA is in the "vegetated treed" (VT) category of the BC Land Cover Classification Scheme. Table 1 shows the VT area by mature and immature age classed and by leading species. Pine is by far the largest component of the VT area.

There are several First Nations within the TSA. They are as follows:

- Cheslatta Carrier Nation
- Burns Lake Band
- Nee Tahi Buhn Band
- Skin Tyee Band
- Wet'suwet'en First Nation
- Babine Nation.

In addition, there are seven other First Nations, that don't have reserve land or communities within the TSA, but claim traditional territories that overlap the area. They are:

- Nadleh Whut'en Band
- Office of the Wet'suwet'en

- Stellat'en First Nation
- Tl'azt'en Nation
- Ulkatcho Band
- Yekooche First Nation
- Carrier-Sekani First Nation.

Figure 1. Lakes TSA

Table 1. Land Base of the Lakes TSA

Total TSA Area (ha)	**1,121,723**	
Classification of Vegetated Treed (VT)	**Area (ha)**	**% of VT**
Total VT	**844,457**	**100**
Immature	72,797	9
Mature	771,660	91
Leading Species		
PL SW SX AT BL S	553814	65.6
SB AC B FD EP	80755	9.5
	75657	9.0
	69000	8.2
	45551	5.4
	8366	1.0
	6929	0.8
	1413	0.2
	1449	0.2
	1238	0.1
	286	<1%

2.2 Forest Cover Inventory History

The Lakes TSA completed a reinventory process of their forest cover in 1989-90.

Another significant inventory initiative for the 2001 Timber Supply Review was the Old Growth Site Index (OGSI) work in the TSA. This was part of a Ministry of Forests-lead project in the province by the Growth & Yield section of the provincial inventory group. The work resulted in increased site index values which was incorporated into the TSR process.

The most current update year for the Veg files for the Lakes TSA in the LRDW is 2000.

2.3 Inventory Audit

In response to questions surrounding the accuracy of the forest cover inventory, the Ministry of Forests developed an inventory audit methodology in the 1990s. The procedure was designed to test the overall accuracy of estimates of the total standing volume in a timber supply area.

The sampling entailed assessing three primary components of the inventory: the mature forests, immature forests and non-forest areas. The audit provides information to the Chief Forester about the inventory's statistical reliability when determining annual cut. It provides a general assessment of the uncertainty associated with mature timber volumes, immature site index and non-forest classification.

The results of the audit for the Lakes TSA were released in 1997 and the findings were as follows:

1. Analysis of mature volumes: There was a 3 cubic m/hectare difference between the mean inventory estimate for mature volume and the audit estimate. A paired sample t-test determined that this difference was not statistically significant 19 times out of 20.
2. Analysis of the operable and inoperable volumes: The difference between the mean volume estimates located within the operable forested area in the audit and the inventory was 2 cubic metres. It was not statistically significant, 19 times out of 20. There were inadequate samples in the inoperable forested areas to make any meaningful comparisons.

In conclusion, the audit results for this inventory showed:

1. For the mature component, the inventory is statistically acceptable.
2. There is a similar level of acceptability in the operable forested area.
3. For the immature component, the immature site index assignment may not be accurate. The audit report recommended further review of this component.
4. Growth type groups (GTG) from the inventory (i.e. map labels) matched the audit GTG 52% for 60 year + and 60% for <60 years.

2.4 Forest Management and Inventory Issues

At the Stakeholders' meeting on July 7, 2006 there was a discussion about the TSA issues and how the VRI might help to address them. The mountain pine beetle devastation is currently a chief concern of forest managers so it is not surprising that stakeholders identified the pine beetle as a key focus for the inventory. There are, however, other inventory related concerns.

This section outlines the list of management issues that were discussed at the meeting. Issues #1 to #7 are taken from previous planning processes including Land Use planning and Timber Supply Analysis for the Lakes TSA. Items #8 to 10 were added based on suggestions from participants at the Stakeholders'

meeting. The remaining issues are common ones identified at previous Vegetation Resources Inventory planning tables throughout the province. In some cases, they were felt to be relevant.

A rating of high, moderate, low or not applicable (N/A) has been applied to the effectiveness of Phase I or VRI Photo Interpretation, Phase 2 - Ground Sampling or NVAF and Monitoring activities to providing relevant data for each issue.

	Issue	VRI Effectiveness		Remarks
		Photo-Interpreted Estimates	Ground Sampling	
1.	Mountain Pine Beetle Currently lodgepole pine leading stands, both pure and mixed with other species, represent approximatley 55 percent of the TSA's timber harvesting land base. There needs to be more information about existing structure.	Low	Moderate - High	New photo interpreted Estimates (Phase I) are not useful in management of MPB issues. New Phase I will be useful after the infestation is finished. Ground Sampling (Phase 2) can give good information about current attributes and volumes of MPB stands across the TSA.
2.	Mountain Pine Beetle Shelf Life: Monitor the duration of merchantability of dead timber in beetle attacked areas.	NA	Moderate-High	MOFR is piloting the collection of shelf life attributes in other VRI and Monitoring projects in 2006/07. Data is to be used for building a shelf life model. Shelf life data collection could be incorporated into the ground sampling, NVAF and monitoring projects in the Lakes TSA.
3.	Volume of dead wood. Changes in Interior log grades requires that the Chief Forester consider dead wood volumes in TSR determinations.	Low	High	Ground Sampling would provide good information on dead potential volumes. The NVAF could incorporate a scaling component.
4.	Mortality in immature stands. Timber Supply group is interested in the amount of MPB activity in stands less than 60 years old.	Low	Moderate	Ground Sampling can target a strata with age classes 31 to 60 years to collect data. The Monitoring plot sample selection could also target this population to provide data at establishment and at intervals.
5.	Mid-term source of wood supply	Low	High	Identify strata that define this part of the population. Make this a priority in the ground sampling.
6.	'growth rates' Site index in both managed and unmanaged stands:: - Better estimates in immature stands. - Concern that current SI may underestimate growth rates - SI adjustments for species other than Pl	Moderate	High	Phase I can provide better estimates of height for use in determining Site index. Ground Sampling can provide good data for Site Index based on current stands. Monitoring can provide data, over time. Target populations i.e. managed stands can become strata in either sampling process.
7.	Problem Forest Types - Identification - Improve site productivity estimates	Moderate	High	New PI can verify/improve the estimates in these stands. Targeted Ground Sampling in theses types will provide good data. Area in Lakes TSA is small and will have to consider whether creating separate stratum is worthwhile. Alternately, analysis can target this stratum. Reference "site index" issue.
8.	Landscape-level biodiversity	Moderate	Moderate	Photo interpretation can provide more detailed information on non-forest attributes.

	Issue	VRI Effectiveness		Remarks
		Photo-Interpreted Estimates	Ground Sampling	
				Ground Sampling can provide data on Coarse Woody Debris, Forest Succession and ecology.
9.	Polygon delineation and species composition in younger age classes.	High	Moderate	New Photo Interpretation can improve delineation and species composition estimates on openings older than those populated by RESULTS. Ground Sampling will provide attribute information for openings age 31+.
10.	Additional data on understory is desirable (i.e. poles, saplings) to identify potential for mid term wood supply.	Low	High	Ground sampling can provide data on the understory. An investigation of Dave Coates' paper may result in several additional classes in the 'small tree plot'.
11.	Coordination with PEM process.	Low	Low	In an attempt to increase accuracy in PEM inventories, methodology is being developed that does not icorporate forest cover data as a layer.
12.	'snapshot' estimates of current volumes for managed stands. Concern that the current inventory does not present the existing volume accurately.	Moderate	High	New PIhase I can provide more accurate attributes for VDYP to use in deriving volumes. Ground Sampling will provide very good data on actual volumes. The data can then be used to adjust the database.
13.	Errors in inventory attributes: species composition, age, height.	Moderate	Moderate	Both Phase 1 and 2 may improve individual polygon values and reduce errors in attributes. Further analysis by age and species could also identify trends within the inventory. Photo Interpreted database can be adjusted for some attributes using Ground Sampling.
14.	Environmentally Sensitive Areas	Low	Low	ESAs are not part of current Photo Interpretation procedures. The District agrees that there are much better methods to do this work.
15.	Decay, waste, and breakage	Low	High	NVAF data will provide information on decay and waste. This data could be used to provide information to verify the current loss factors and VRI net factors. Breakage is not part of the VRI system.
16.	Implications of managing for species at risk	Moderate	Low	New Phase I can provide finer delineation and specific attributes for non-forest areas.

In summary, the following information of particular interest to the Stakeholder group could be derived from the completion of VRI activities:

- Provide additional information about current attributes and volumes of mature and immature stands in the TSA. This includes the desire for increased data on Mountain Pine Beetle stands.
- Collected Shelf life data could be analysed to provide local knowledge and could contribute to data collected provincially by other MoFR projects to provide a larger data base for analysis and possibly model development.

- Ground sampling and NVAF sampling would provide good information on volume for 'dead potential' trees.
- By targeting a stratum in immature coniferous polygons (stands up to 60 years of age), data collection in this strata will provide Timber Supply staff with some information on mid-term wood supply.
- Improved site index information can be gained from the collection of age and height data.
- By identifying a stratum based on attributes for "Problem Forest Types', this population can be better identified and analysed in the inventory.
- Collecting non-tree information on the land base, including coarse woody debris, forest succession and ecological attributes can help to make decisions on landscape-level biodiversity.
- Additional data collected in the small tree plot regarding the secondary canopy could support the Research project and work of David Coates, a MoFR Research Silviculturist at the Bulkley Valley Centre for Natural Resources Research & Management.
- Obtain accurate information on non-pine species which will form the mid-term timber supply.

2.5 VRI Activities and Products

2.5.1 VRI Photo Interpretation

New photo interpretation would require the acquisition of new air photos to an acceptable scale. With the acquisition of these photos complete, the process to complete a new Phase I would likely take 2 to 3 years.

As part of the ongoing operational program, part of the TSA was flown and photographed at 1:20,000 scale, colour in 2005. The intention is to complete the photography on the TSA through a MoFR contract in 2006. At this time there is no defined funding to create orthophotos.

The Lakes TSA has a forest cover reinventory dated 1989-1990 that has been updated to 2000. The inventory audit did not indicate that this inventory had any issues regarding the comparison of the actual versus inventory volume. The Chief Forester in his Timber Supply Review documents has not identified any issues with the inventory that would suggest undergoing the expense of a new photo interpretation of the land base.

The most important consideration is whether there is a business need for a new inventory. This new inventory will give an up-to-date snapshot of the forest. There is an assumption that "new is better" but as stated above, no issues have been identified with the overall inventory volume or polygon attributes in the Lakes TSA. There is some frustration over the delay in

update and the change occurring in the forest. New orthophotos could be helpful operationally but a new photo interpretation inventory will not necessarily be better at filling in the information gaps that the Stakeholders have identified. In the case of the Lakes TSA, dramatic changes are occurring on the landscape with the Mountain Pine Beetle infestation. The work that has been lead by the MoFR's Forest Analysis and Inventory Branch suggests that in beetle affected TSAs, the focus should be on ground sampling. In conclusion, a new Phase I should be deferred until the pine beetle attack is over in the TSA.

2.5.2 VRI Ground Sampling

The VRI Ground Sampling phase requires a completed photo interpreted inventory – either new or existing. It involves establishment of 'cluster' ground samples and the NVAF. It should be followed up by the statistical analysis and adjustment of the photo interpreted database.

When undertaking a Phase 2 Ground Sampling program, there are three essential components that must be completed.

1. Decisions on the overall project design, with Stakeholder input: This includes deciding the sampling population, the sample strata and working out the number of samples that will be completed in the project.

2. Selecting activities to be completed in the project from the "ground sampling toolkit": The main modules in Phase 2 VRI include:

    - Full VRI – includes ecological, timber and Coarse Woody Debris (CWD) information to VRI certification standards
    - Timber Emphasis – tree information only is collected
    - CWD – Coarse Woody debris data is collected as an additional option on Timber Emphasis plots
    - Succession information – The Succession card's completion is an option on Timber Emphasis plots

3. Net Volume Adjustment Factor Sampling

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 estimated net volume is obtained from net factoring and taper equations). Net Volume Adjustment Factor destructive sampling has been recognized as a mandatory component of the Phase 2.
The NVAF data provides an adjustment factor that is used during sample compilation to produce unbiased estimates of net merchantable tree volume. Its completion involves the following:

- Step 1 - Random selection of sample trees from a sub-set of the ground samples, following the initial data collection.
- Step 2 – The sample trees selected in Step 1 are felled and sectioned to measure actual net volume.

Each of the Phase 2 activities was presented at the Stakeholders meeting, with some discussion focused on how different options could help to provide answers to 'traditional' questions asked of the VRI inventory. Some additions or variations were proposed to support the Stakeholder's information needs. Section 3 of this document, "Inventory Plan", will outline decisions on the options.

There was also some discussion at the meeting about a plan formulated in the Bulkley TSA planning process to collect interior log grades using a scaler on the NVAF sampling crew. The interest expressed by the group has resulted in government support to pilot this approach on the Lakes TSA project.

2.6 Follow up Activities

2.6.1 Ground Sampling Analysis and Inventory Attribute Adjustment

An initial step in this process will be the decision of the Forest Analysis and Inventory Branch staff regarding utility of ground sampling work completed during previous VRI projects[4]. Branch has indicated that they will review existing VRI sampling projects' data that exists in a portion of the Lakes TSA (including ground samples and NVAF trees) and possibly integrate it at a later date.

For the NVAF work, in addition to the standard procedure's analysis, there will be the analysis related to the scaling procedure added to the Lakes TSA project.

2.6.2 Shelf Life and Secondary Structure Attributes – Analysis

Shelf Life and Secondary Structure Attributes includes data not normally collected during VRI sampling. It will provide valuable baseline data for Shelf life and "Mid-term timber". The additional work being completed includes:

1. Increased diameter classes in the 'Small tree' plot

2. Detailed check and spiral grain measurements of MPB killed pine trees at the Integrated Plot Centre

[4] Babine Enhanced Forest Management Pilot Project

3. Detailed check measurements, log merchantability and grades of felled NVAF sample trees.

4. Dead trees tallied in the auxiliary plots

5. Ecological data to support shelf life work

Since much of this data will be outside of the regular compilation for VRI, it will need to be collected on supplementary data sheets. Compilation will have to be conducted as directed by Branch staff.

2.6.3 Monitoring

The Ministry of Forests & Range has recently undertaken a series of monitoring projects throughout the province, related to studying the effects of the Mountain Pine Beetle infestation. The goal is to monitor the changes and trends of the timber and non-timber resources of MPB affected stands, over time.

The monitoring protocols currently in use were developed for the National Forest Inventory and they are being used for management unit monitoring. The Monitoring project in the Lakes TSA will be undertaken with a similar objective and protocols to the other projects in the province. If new protocols are developed for management units prior to the 2007 field season they will be incorporated into the Lakes TSA work through an amendment to the VPIP.

3 Inventory Plan

3.1 Overview

This section takes the theoretical discussions on the Vegetation Resources Inventory in Sections 1.3, 2.5 and 2.6 and describes how it will be applied in the Lakes TSA project.

3.2 Phase I –Photo Interpretation

Based on the suggestions by the MoFR Forest Inventory and Analysis Branch and the Mountain Pine Beetle study group, there will be no plan prepared to undertake a new photo interpretation inventory in the Lakes TSA at this time.

3.3 Phase II Ground Sampling

3.3.1 Inventory Objectives

The objective of VRI ground sampling is to attain statistically valid timber volumes in the live and dead timber. A sample error objective of +/- 10% for overall inventory volumes, 95% probability will be targeted. In addition, there is other information that will be gained including more accurate polygon-specific attributes and shelf-life data.

3.3.2 Target Population

The target population will be derived from the Vegetated Treed[5] landbase with no lower age limit but excluding private land, Indian reserve, parks, and protected areas.

3.3.3 Sample Size

Based on a sampling objective of +/- 10% for overall inventory volumes, 95% probability, and an estimated CV of 50% (taken from the Lakes TSA Inventory Audit report - http://www.for.gov.bc.ca/hts/vri/audits/reports&pub/reports/lakes-auditreport.pdf), approximately 100 samples will be required. Additional samples will also be collected in immature stands to investigate the impact of MPB on young pine.

The population will be divided into 4 strata. Table 2 shows the planned distribution of samples across the stratum.

[5] B.C. Land Cover Classification Scheme

Table 2[6]: Planned Distribution of Samples

Stratum	Population Area (ha)	Planned number of samples	Number of hectares represented by
Mature – Pure Pl (>80%)	274742.5	35	7849.78
Mature – Pl (50-80%)	190523.6	25	7620.94
Mature – Other coniferous leading, Pl<50%,	306393.5	40	7659.84
Immature	72797.2	15	4853.15

3.3.4 Sample Selection

The sample selection will follow the Provincial standard. The selection of sample polygons is based on stratified sampling using the Probability Proportional to Size with Replacement (PPSWR) sampling method.

Samples will be selected from 4 strata. At previous planning tables these strata were typically based on species groupings. For this TSA the strata may have a link to other interests such as 'mid-term timber'.At the Stakeholders' meeting information on "species groups relative to minimum harvestable age" from the 2001 AAC Rationale was used to roughly identify the population breakdown. Based on this, tentative strata were identified.
It was decided that samples will be located in each stratum based on their proportion in the TSA.

Following this meeting, a 'Discussion Paper' was produced to allow the Stakeholders to comment on the strata that will be the basis for the sample selection. The results of the 'Discussion Paper' review, including decisions on strata and distribution of samples will be reflected in the Project Implementation Plan.

3.3.5 Sampling Approach

VRI Timber Emphasis Plots (TEP) plus Succession will be used to gather data as per the Ground Sampling Procedures manual. According to the Procedures, only auxiliary plots that fall within the sample polygon will be included. The following additional data will be collected:

[6] The actual number of samples and the number of hectares represented by each sample will not be known until after the ground sampling has been completed. A revised Table 1 will be provided in the final analysis documentation.

- Dead trees in the auxiliary plots
- The 'small tree plot' at the IPC will be increased in size to 3.99 m in diameter and two additional size classes will be added
- Shelf life attributes' procedure on all dead PI within the IPC
- Ecological data – A 'Ground Inspection Form' or GIF will be used to identify site series. Its completion should satisfy attributes of interest for MPB - slope, slope position, aspect, soil nutrient, moisture grid position and site series. This work can be collected by a non-certified VRI ecologist who is experienced in the area. This ecology data is deemed to be valuable for both the shelf life attributes study and the mid-term wood supply. The latter relates to results of the study 'Abundance of Secondary Structure in Lodgepole Pine Stands Affected by the Mountain Pine Beetle by K. David Coates et al. where a relationship between secondary structure and biogeoclimatic subzone is identified.

3.3.6 Net Volume Adjustment Factor Sampling

The MoFR Forest Analysis & Inventory Branch will provide a sampling plan that identifies the number of ground samples that may potentially contain trees to be destructively sampled. The actual samples where additional NVAF data is to be collected will be identified during the overall sample selection process (see Section 3.3.4)

Depending on the schedule for work, there are two options for the NVAF tree selection data collection:

1. The samples selected for potential NVAF trees are sampled early in the project, and additional work as required by the NVAF process is completed at all auxiliary plots. When the destructive sampling occurs, there is no requirement to have a Timber certified contractor present since all work is done. This is the preferred option as is most efficient.
2. The samples selected for potential NVAF trees are sampled early in the project, but there is no NVAF 'enhancement' at the auxiliary plots. There will then be a requirement to have a Timber certified contractor present to do the additional data collection <u>on the trees selected for destructive sampling only</u>, at the time of destructive sampling.

As discussed in Section 2.5.2, there will be a scaler present for the NVAF destructive sampling work to provide estimates of log merchantability and log grades based on both the VRI and draft Interior log grades. This additional data collection is a pilot project.

An update in the NVAF sampling standard in 2006 has increased the sample size to 100 trees, 75 live and 25 dead. Forest Analysis & Inventory Branch

staff will provide guidance and assistance to the group to ensure appropriate decisions are made regarding sampling strata, sample size and the live/dead ratio in this TSA.

3.3.7 Monitoring Plots

At the time of the writing of the VSIP, this part of the overall project has only been generally discussed. The intent is to establish 25 monitoring plots on the TSA. This will be completed during the 2007/08 fiscal year. The sampling will follow the Change Monitoring Procedure, and its modifications may include:

- Complete shelf life study work at the plot centre
- Increase the size and classes in the 'small tree plot'
- Modify the Coarse Woody Debris (CWD) as per the pine study monitoring plot procedures
- Modify VRI certified ecology data collection according to the pine study monitoring plot procedures

Options for the location of the monitoring plots are still open at this time, and include:

1. Using a grid to randomly locate the monitoring plots across the TSA landscape.
2. Using a sub-sample of the VRI plots, without focus on the strata.
3. Using a sub-sample of the VRI plots, focusing on specific strata i.e. pine leading.

3.3.8 Implementation

All phases of a ground sampling program could be completed by the end of the 2007/08 fiscal year pending sufficient funding and availability of certified crews.

3.4 VPIP Project Implementation Plan

The next step in the planning process is to develop the VPIP. Using the direction of the VSIP, with input from the Stakeholders, the VPIP will specify the operational details for the inventory.

3.5 Roles and Responsibilities

A VSIP usually outlines organizational roles and responsibilities in the development of a VRI project. Since funding was initiated through the Federal

MPB initiative, VRI section has the majority of these, from the setting of standards to the insuring that these are followed.

The other Stakeholders, including local levels of government and Licensees will be important in their provision of input and possibly some operational support such as GIS and local knowledge for crew work. It is anticipated that they will be included in a final information session when the work is complete.

3.6 Costs

The following Tables, 3, 4, and 5 outline estimated costs for the project.

Table 3. Estimated sample sizes and costs for VRI Phase II activities in the Lakes TSA

VRI Activity	Sample Size	Unit Cost	Total Cost
GROUND SAMPLING			
Contract administration & materials-Year 2 1 and 2?			$11,000
Year 1 - VSIP and VPIP preparation -includes Sampling plan development and package preparation			$30,000
Timber Emphasis Plot – timber and ecology data collection	85	$1,500/sample	$127,500
Year 1 - Timber Emphasis Plots – timber data collection	30	$1,300/sample	$39,000
Year 2 - Timber Emphasis Plots – ecology data collection	30	$600/sample	$18,000
NVAF destructive sampling - includes scaler	120	$750/tree	$90,000
Helicopter access-VRI Est. Year 1-$6,000 and Year 2-$24,000			$30,000
Helicopter access-NVAF			$10,000
Mentoring (crew training) Year 1-$1,000 Year 2-$4,000			$5,000
Quality Assurance-Timber Year 1-$3,000 Year 2-$9,000			$12,000
Quality Assurance-NVAF			$7,000
Final Compilation/analysis and inventory file adjustment			$15,000
Total Phase II			**$394,500**

Costs will be incurred in Year 2 unless otherwise indicated.

NOTE: Non-standard ecology data collection will be reduced by 25 plots if the Monitoring plots are located on a sub-set of the VRI Timber Emphasis samples.

Table 4. Sample size and estimated funding breakdown for VRI Monitoring project

MONITORING			
Contract Administration – includes GIS work			$6,000
Sample Establishment	25	$2,500/sample	$62,500
Helicopter Access			$5,000
Mentoring	1 crew	$1,000	$1,000
Quality Assurance		$3000	$3,000
Total Monitoring			$77,500

Table 5. Estimated funding breakdown by year, based on timing of VRI activities

Year	Activity	Costs
1-2006/07	All costs for plan preparation and establishment of 30 Ground sampling – timber	$79,000
Year 1 total		**$79,000**
2-2007/08	Contract Administration	$11,000
	Ground sampling – timber & ecology	$151,500
	Timber mentoring & QA	$13,000
	Ground sampling – ecology	$18,000
	NVAF	$100,000
	NVAF QA	$7,000
	Analysis & Adjustment	$15,000
	Monitoring	$77,500
Year 2 total		**393,000**
Grand Total		**$472,000**

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The most recent edition of the **Vegetation Resources Inventory Standards and Procedures** will be followed for the completing this project. These are located at the website:
http://ilmbwww.gov.bc.ca/risc/pubs/teveg/index.htm

The following is a list for the critical Standards and Procedures for the Burns Lake TSA VRI project:

Ground Sampling:

Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling Version 2.0, March 2006

Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling Version 3.3, December 2002

Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling Version 3.3 Errata No. 1, April 2005

Vegetation Resources Inventory Ground Sampling Procedures Version 4.5, March 2004

Vegetation Resources Inventory Ground Sampling Procedures Version 4.5 Errata No. 1, February 2005

Vegetation Resources Inventory Quality Assurance Procedures for VRI Ground Sampling Version 3.0, March 2004

Vegetation Resources Inventory Data Collection Standards for VRI Ground Sampling Version 2.1, March 2006
Vegetation Resources Inventory Ground Sampling Data Collection Procedures for Inaccessible Samples Version 1.0, March 2003

Net Volume Adjustment Factor Sampling Standards and Procedures Version 4.1, March 2006

VRI – Analysis and Adjustment

Vegetation Resources Inventory Procedures and Standards for Data Analysis Attribute Adjustment and Implementation of Adjustment in a Corporate Database Version 2.0, March 2004

Monitoring

National Forest Inventory BC Change Monitoring Procedures for Provincial and National Reporting Version 1.4, March 2005

Change Monitoring Inventory Ground Sampling Quality Assurance Procedures Version 1.1, March 2002

Change Monitoring Inventory Ground Sampling Quality Assurance Standards Version 1.1, March 2002

Photo Interpretation

Vegetation Resources Inventory Photo Interpretation Procedures Version 2.4, March 2002

Appendix A

Attendance at Stakeholder Meeting

List of People Contacted

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Based on list provided by the District identifying major licensees in the TSA.

Attendance at Stakeholders' Meeting

Participant	Affiliation
Jason Platzer	Babine Forest Products & Babine Timber Ltd
Ross Hyam (for Alistair Schroff)	Burns Lake Community Forest
Bryan Jakebec	Canfor
Chris Hunter	BC Timber Sales
Jim McCormack	Canfor
Dick Nakatsu	MOFR
Brian Westgate	MOFR
Gary Johansen	MOFR (Forest Analysis Inventory Branch)
Will Smith	MOFR (Forest Analysis Inventory Branch)
Barry Elliott	MOFR
Sue McDirmid	MOFR
John Illes	MOFR
Garth O'Meara	MOFR
Alison Patch	MOFR

Appendix B

Glossary of Terms

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Glossary of Terms (From 14 March 2006 RISC Standard, VRI Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling)

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

Inventory Unit
An inventory unit is the target population from which the samples are chosen. For management unit inventories, the unit is usually a TSA or TFL.

Land Cover Classification
The BC Land Cover Classification Scheme (BCLCCS) 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 BCLCCS is hierarchical and reflects the current state of the land cover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

Management Unit.
A management unit is an administrative area used for inventory reporting purposes. The most common inventory units are TFLs and TSAs. However, forest districts or provincial parks could also be considered as inventory units if they were identifies as areas of interest for reporting purposes.

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

Photo Interpretation
Photo-interpretation involves the subjective delineation of polygons and the photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs are most often used in the photo-interpretation process.
March 2006 13 Preparing a VRI Project Implementation Plan for Ground Sampling
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 may be applied to the corresponding population post-strata to improve the precision of the inventory's overall averages and totals. In the VRI, these strata (leading species) are usually pre-defined in the sample selection phase.

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
A set of sampling units selected randomly to represent a population.

Sample Size
The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet the target precision. The current sampling error requirements for a management unit is +/- 10% at the 95% level of probability.

Sampling Unit
The smallest indivisible unit in the population that is eligible for sample selection.

Statistical Adjustment
Statistical adjustment is the application of adjustment factors, computed from a random sample, to adjust timber attributes.

Sub-unit
A sub-unit is a small area or stratum of interest within an inventory unit such as a TSA or a TFL

Target Population
The population is the portion of a forest district, TFL, or TSA, for which statistical estimates are required. For instance, in a TSA where vegetated treed, vegetated non-treed, and non vegetated polygons are delineated, the target population may be only the vegetated treed (VT) polygons.

Target Sampling Error
Is the precision we expect a sample of a given sample size to produce. This precision depends on confidence we wish to place on a sample and the variability (CV) within the population.

Vegetation Resources Inventory (VRI)

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

- *Photo Interpretation*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground Sampling*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *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 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.

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Appendix C

VSIP Approval Signature Page

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Lakes Timber Supply Area Vegetation Resources Inventory Strategic Inventory Plan Approval

It is the intention of The Ministry of Forests and Range (MOFR), Forest Analysis and Inventory Branch to implement the Lakes TSA Vegetation Resources Inventory Strategic Inventory Plan (VSIP), prepared by Nona Phillips Forestry Consulting and dated September 1, 2006, as described.

I have reviewed the Lakes TSA Vegetation Resources Inventory Strategic Inventory Plan in consultation with MOFR staff, and have concluded that it meets current Vegetation Resources Inventory Standards and MOFR business needs.

_____

Jon Vivian, R.P.F. Date
Manager
Vegetation Resource Inventory Forest
Analysis and Inventory Branch Ministry of
Forests and Range

Appendix C

Photo Interpretation Guidelines for Integrating RESULTS Information

Version 3, March 2013

This document addresses the inclusion of RESULTS Forest Cover spatial and attribute data for depletion (harvest), Regen, Silviculture Reserves, and Free Growing (FG) in new VRI inventories delivered in the ArcMap 9.2 Personal Geodatabase (PGDB) format.

A number of data sources are used for incorporating silviculture information. The following LRDW/BCGW Spatial Files will be provided:

WHSE_FOREST_VEGETATION.RSLT_FOREST_COVER_INV_SVW– known as "Results Forest Cover" WHSE_FOREST_VEGETATION.RSLT_OPENING_POLY_SVW – known as "Results Opening" WHSE_FOREST_TENURE.FTEN_CUT_BLOCK_POLYGONS – known as "Tenures" (technically this is not a RESULTS layer, but is included as such for this document).

All openings must have complete VRI labels provided, regardless of free growing status and the source layer for that opening. If a non free growing opening does not have a treed description provided in RESULTS, the interpreter must provide a complete VRI description of what they see in the photo. Internal opening linework will follow existing delineation criteria for non results polygons as defined in the standards.

If trees are present, a treed label must be provided to VRI standards, and a complete "V" record label must be produced as per regular polygon delineation and attribution criteria. Opening ID's and any other attributes that ARE present in the results data for these polygons must be incorporated.

This document will outline the assumptions, expectations and process for 3 streams of RESULTS data.

1.1 Assumptions/Guidelines:

There are a few guiding principles and /or assumptions that must be considered when integrating RESULTS data into a new Photo Interpretation project.

1. Results data incorporated for each polygon must be reviewed by a photo interpreter. Many contractors are automating the input of RESULTS data. ***It is the photo interpreters responsibility to review the attributes that will be part of the final inventory and ensure that they "make sense".*** For example, occasionally the codes in the RESULTS databases will be incorrect for Wildlife tree patches, and this may cause the incorrect attributes to be chosen as the label for the opening. The interpreter must review the attributes for each results polygon to ensure that automated results incorporation produces an end product that makes sense with the photo.

2. The licensee supplied external boundary linework for each contiguous OPENING_ID will be maintained. Further details regarding external boundary linework is provided in this document.

3. Free Growing (FG) openings are those identified in the attribute database supplied with an OPENING_STATUS_CODE of "FG".

4. Silviculture reserves are normally only typed out when they are completely contained within a larger opening boundary. When reserves are adjacent to existing standing timber outside the block, they are not to be given an opening ID and will usually be included in the adjacent standing timber, unless they would form a separate polygon using normal VRI delineation criteria. Further descriptions and examples are provided in section 3.2.2.

5. A minimum crown closure of 10% is to be assigned to all openings, even if the opening would normally be classified with a crown closure of less than 10%. Openings with more than 10% will be classified according to the crown closure observed.

2 OPENING_ID numbers MUST be provided for each silviculture opening polygon including Silviculture Reserves that are contained within a larger opening boundary (see point 4 above).

1. If the RESULTS Inventory (I) layer is not available, use the layer with the highest density.

2. If an opening is present in the photos, but is not available in any of the RESULTS layers, the boundary will be photo interpreted, and **the opening assigned an "OPENING_ID" of 0 (zero).** Any openings that are on the photo and are in a RESULTS layer but the OPENING_ID field is not filled, will also have a zero populated in the VRI database.

2.1 Results Layer Priorities:

Often the same opening will be present in several of the RESULTS layers. In order to ensure that the most accurate and recent information is incorporated into the VRI, The following priority will be used.

1. Results_Forest_Cover will be used first, this layer has the most complete information, and usually has more accurate boundary information.

2. If the opening is not in Results_Forest_Cover, then the Results_Opening Layer will be used.

3. Where an opening is not present in either Results_Forest_Cover and Results_Opening, then the interpreter will use the FTEN layer as the source for Incorporating into the VRI (boundaries must be re-interpreted if not correct).

3 RESULTS Opening and Polygon Boundaries (Delineation)

There are two types of boundaries of concern when incorporating RESULTS boundaries, External boundaries, which forms the outside edge of a block as determined by a unique

Opening_Id, and internal boundaries which differentiate between the different stand types (Standard Units – SU).

WITHIN the external boundaries of an opening, all polygons will have the same unique Opening_ID.

4 External Opening Boundaries

The accuracy of the opening and polygon boundaries will vary depending on the source data used. Often the external opening boundaries will be correct as shown in RESULTS, but where they vary from what is observable in the photo by more than 20m, the boundary MUST be re-delineated to match the photo. RESULTS boundaries will often overlap each other when they are side by side, and the interpreter must choose which boundary to use whether to re-delineate the boundary between the two openings to make a best compromise between the observable boundary on the photo and the overlapping boundaries from RESULTS.

What might appear to be one large opening on the photo may actually be a number of adjacent openings side by side, and this will be identified by different Opening ID's in the RESULTS databases. The interpreter must keep these opening boundaries separate,

Some older RESULTS boundaries may be quite inaccurate, or difficult to distinguish. However, the boundaries of these openings still must be maintained. Some will require fairly major modifications, and others may have to be used directly as is. The interpreter must maintain close contact with the project manager to ensure that the data has been incorporated as desired.

Extra care must be taken to include opening boundaries that have few trees removed due to single tree selection, salvage logging, etc.

5 Internal Opening Boundaries

Some RESULTS layers will contain internal polygon delineation within an individual Opening boundary. The methodology for incorporation of these lines depends on whether the opening is Free Growing or not, and whether tree attributes are available in the source dataset.

Linework that surrounds roads exclusively (commonly called Road Tubes), are never incorporated into the VRI, these lines are removed and a single line separating adjacent polygons is put in its place or, if the two adjacent polygons have the same label in RESULTS, the polygons will be combined into a single polygon.

5.1.1 Internal opening delineation for openings declared Free Growing

When an opening has been declared Free Growing (Opening_Status is shown as "FG") then the interpreter has the choice to either use the linework from RESULTS or completely re- interpret the internal opening boundaries. Normally the interpreter will use the RESULTS free growing survey internal boundary linework directly if the survey was completed approximately 10 years or less from the date of photography. The only exceptions will be when there are obvious and dramatic differences from the RESULTS survey to what can be observed in the photo. It is expected that the linework for almost all free growing surveys completed 10 years or less from the date of photography will be utilized in the VRI. Polygons less than 1 hectare in size are not normally to be included in the VRI from RESULTS data.

When the survey is more than 10 years old, it is expected that the survey information will still be used as a reference, but the interpreter may change the linework as required.

5.1.2 Internal opening delineation for Openings NOT declared Free Growing

Blocks that are not declared Free Growing (Opening_Status is NOT shown as “FG”) will usually have all of the internal polygon delineation removed, and only the external opening boundary will appear in the VRI. A number of exceptions to this general rule are listed below.

When a silviculture reserve has been identified that is approximately greater than 1 hectare in size, it will be kept as separate polygons within the opening, Normally these are classified in RESULTS with a Silviculture_Reserve_Code of “G” or “W”, but this may not be the case. ***The interpreter should not rely on the silviculture reserve code being correct in the RESULTS data, and must review each opening to ensure a correct label has been applied.***

Additionally there may be occasions when the opening boundary is quite large, but the majority of the polygon is actually standing timber with a number of smaller logged polygons contained within. In these cases the smaller polygon boundaries will be retained, as long as there has been no activity within the standing timber.

The example below shows the line work associated with a single opening in results.

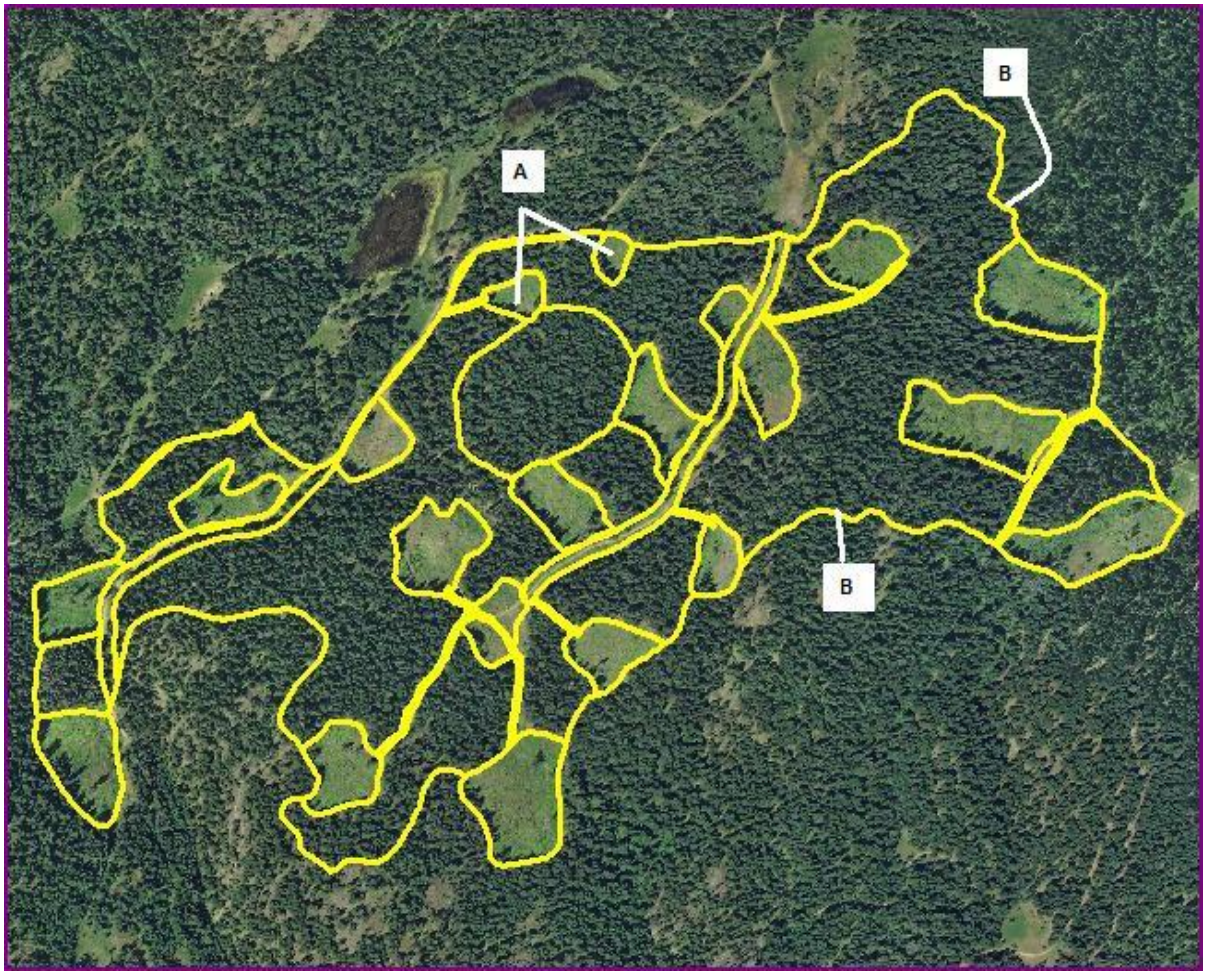


Figure 3.2.1

In figure 3.2.1 the road tubes would be removed, as well as the external opening boundary identified as “B”. The very small openings (less than 0.5 ha) such as indicated by the letter A would also be removed, but most of the cut areas will remain. The end product should look similar to the image below.

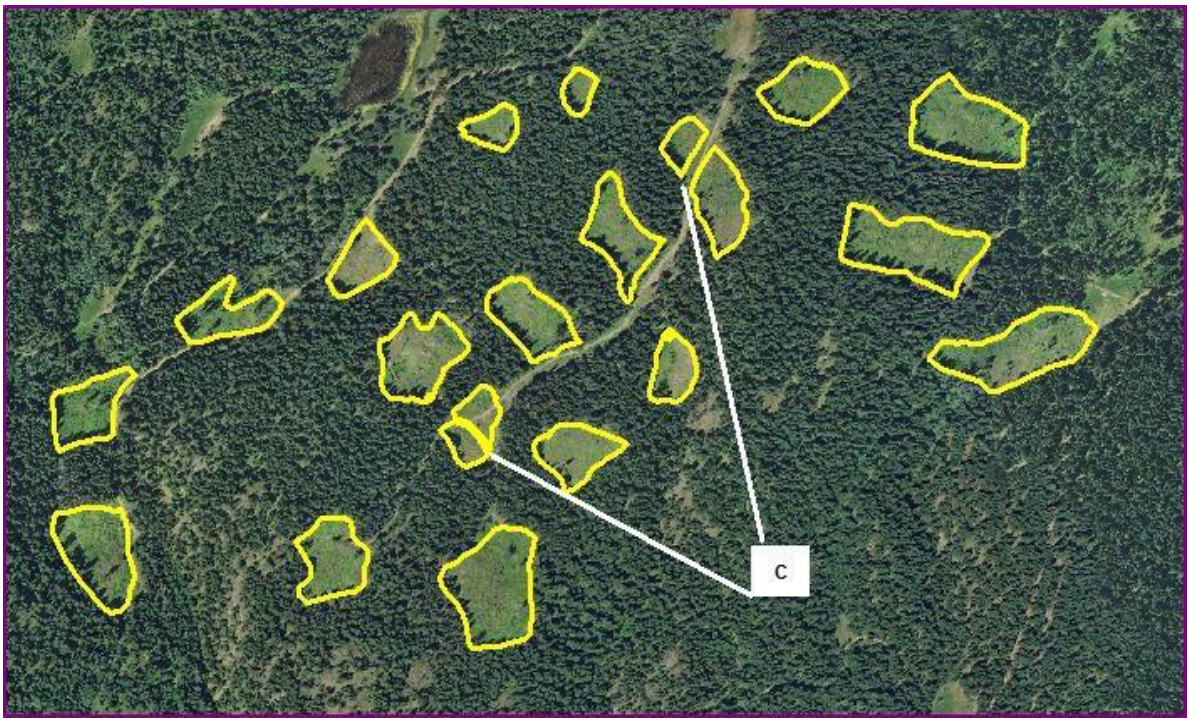


Figure 3.2.2
The polygons shown in item C would be merged together to form single polygons.

Some results polygons are simply too small to type out in the VRI. In the example below, the polygons in yellow are all from the same opening. It is appropriate to amalgamate some of these polygons into one or two separate polygons, and include mature and immature portions in the same polygon. The external boundaries of the opening can be re-drawn.

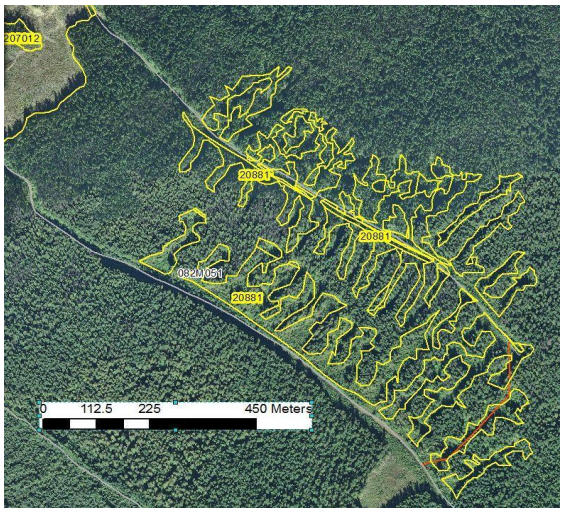


Figure 3.2.3

A final exception to the polygon delineation amalgamation is when an area has not been declared free growing, but it is clearly obvious in the photo that the area would most likely be declared free growing if a new survey was to be completed. An example of this would be if an area was logged in the 1960's and appears to be completely stocked, but a survey has not been completed in the last 20 years. In this case the interpreter should re-delineate the internal opening boundaries. An example is shown in section 4.2.

6 Data Capture Method Codes

All opening boundaries and internal opening boundaries must have a data capture method code. This will show where the polygon boundary was obtained from. Some openings may have a number of sources, An example would be where a boundary was taken from results but needed some rationalization between two adjacent openings. In this case, choose the data capture that was MOST prevalent for the boundary.

- Code 11 for a copied RESULTS boundary
- Code 4 for a photo interpreted opening boundary

4 RESULTS Opening and Polygon Attribution

Attributes provided by RESULTS usually does not provide a complete VRI label. It is the responsibility of the interpreter to provide a complete VRI label that matches the VRI standards. For example Basal Area is quite often missing in Results. The interpreter must use the available results information and local knowledge gained from the air and ground call program to obtain a basal area that is reasonable given the available information. Additionally Land Cover classes and non veg attributes will need to be interpreted.

If treed attributes are not available at all in RESULTS for an opening, the interpreter must interpret what they see. For example a polygon with trees visible must have a treed attributes provided, and a non treed opening would be called Herb, Shrub etc as per normal VRI (V Record) interpretation standards.

Reference years will normally be the date of the survey, not the date of the photo. Inventory attributes (IE volume and age) are “projected” from the reference date, and as the bulk of the data that will be incorporated from RESULTS at the date of the survey, this date will be used in the inventory. The interpreter must take care that any interpreted attributes that are added to the survey information would be correct for that survey date. For example if Basal Area was missing from the survey, the photo was taken in 2010, and the survey was completed in 2000, then the Basal Area will need to be adjusted to the date of the survey (which will be the reference year) so that all attributes are correct for the same year.

Alternatively, all attributes can be dated as the date of the photo, but this is only desirable if complete re-interpretation of the opening is done. There is only one attribute reference year, all the attributes for a polygon must be consistent to that reference year.

There may be multiple RESULTS layers present in the Silviculture database available to the interpreter when viewing the attributes in the results database. These layers do not correspond to inventory layers and must not be carried into the VRI. The Interpreter will use the “I” (Inventory) layer for incorporation into the VRI. If an I layer is not available, the classifier will determine which of the remaining RESULTS layers has the highest density according to the RESULTS database, and use that layer for the description of the polygon. Do not describe other layers in the cutblock.

If the opening contained many small polygons too small to be delineated separately, an appropriate attribute description for these combined polygons may include 2 layers, one for the overstory remnants, which would be classified by the interpreter and a second immature layer that uses RESULTS data as its source. Below is an example of an opening where this would occur.

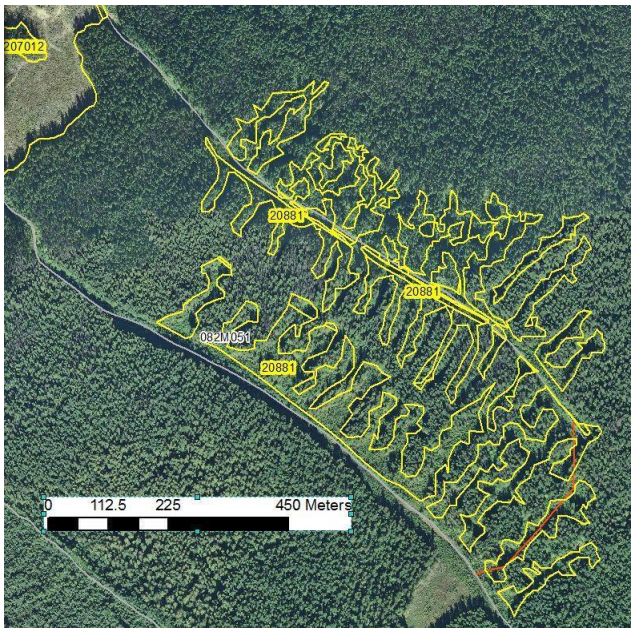


Figure 4.0.1

5 Attribution for Openings declared Free Growing.

When an opening has been declared free growing (Opening_Status is shown as “FG”) then the interpreter has the choice to either use the attribution from RESULTS or completely re- interpret the attributes for the opening. Normally the interpreter will use the RESULTS free growing survey attributes directly if the survey was completed approximately10 years or less from the date of photography. The only exceptions will be when there are obvious and dramatic differences from the RESULTS survey to what can be observed in the photo. It is expected that the attributes for almost all free growing surveys will be utilized in the VRI. Polygons less than 1 hectare in size are not normally to be included in the VRI from RESULTS data.

When the survey is more than 10 years old, it is expected that the survey information will still be used as a reference, but the interpreter may change the attribution as required.

The Project_Name field will be filled with the letters “FTG”, then an underscore, then the project name in ALL CAPITALS (EG FTG_HORSEFLY_VRI) for free growing openings and polygons.

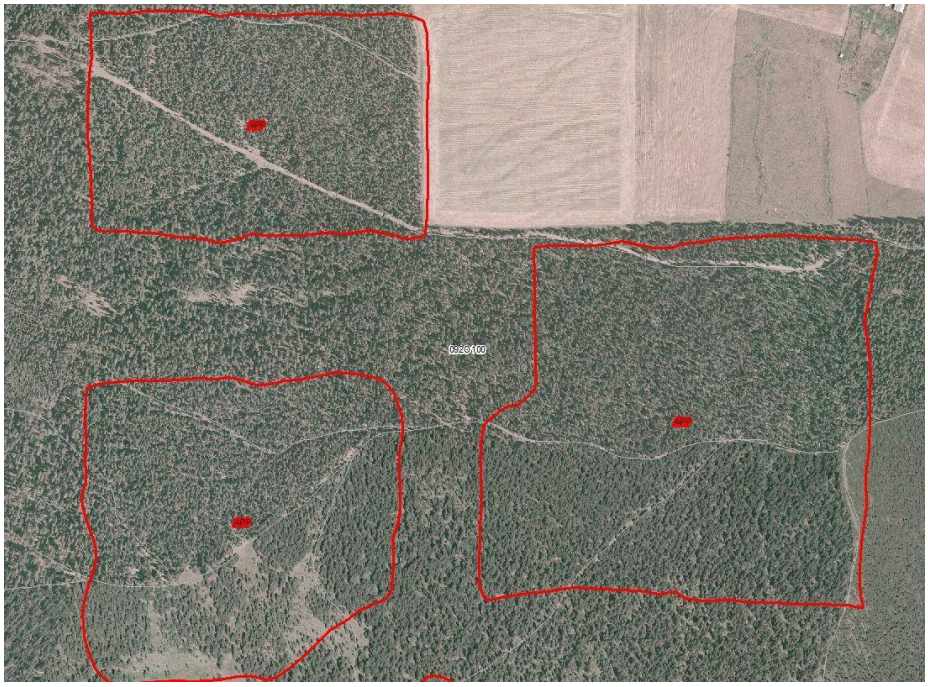
6 Attribution for Openings NOT declared Free Growing

Small amounts of residual trees scattered throughout the polygon will not normally included for non free growing polygons.

Since the internal boundaries are usually removed in polygons that are not free growing, the interpreter will obtain the attributes of the largest polygon in the opening and apply that label to the entire opening. Detailed attributes for the opening will be applied during updates when a free growing survey has been submitted. Care must be taken by the interpreter that a reasonable attribute will be applied in these cases. ***For example the largest polygon in the opening may in fact be a reserve label, and this label should NOT be applied to the opening as a whole.*** An example of this is shown in figures 3.2.1 and 3.2.2. Care must be taken to ensure that the correct RESULTS label for the remaining polygons are applied in the VRI. The largest polygon of the ***remaining*** polygons in section 3.2.2 would be used to obtain the attributes of the largest polygon for the opening.

If tree attributes are not available, the interpreter must interpret what is seen in the photo, whether it be trees, shrubs, herbs, etc. In the example below, the three openings have not yet been declared free growing, and treed attributes are not available in the RESULTS database. Previous VRI RESULTS incorporation required that these polygons be classified as Vegetated, Non Treed, Upland, Shrub-Low, Sparse. This is no longer acceptable, and the classifier must interpret what is seen. When observed in the photo it is clear that there is a treed cover on the polygon.

If there are some residuals left in a recent cutblock (IE approximately less than 10 years between the photo and the date of logging) and are spread out enough through the block to consist of a layer, then the interpreter may interpret these residuals as a separate layer if it is less and 5% crown closure, and the attributes for that layer will not be subject to attribution QA, other than identifying systematic issues. If the layer is more than 5% CC then the layer must be attributed and will be subject to normal QA. The interpreter will use the residual layer from results if available.



Do not enter the project name as “FTG_Project_Name” for these openings. The opening boundaries in this example need to be rationalized with nearby clearings and openings. The remainder of the boundaries may not be readily apparent, The interpreter must use their skills to identify the opening boundary using the information they have available.

7 Attributes Entry Clarification for RESULTS Polygons

In addition to standard VRI attribution, there are a number of other fields that must be populated for RESULTS polygon. Conventions for data entry must also be followed in order to aid in data searching once the VRI has been incorporated into the provincial database. Order of preference for the data source is listed in brackets.

Minimum Attributes	Data Source	Convention
OPENING_ID	From RESULTS Data	If no opening ID is available enter 0 (zero)
OPENING_NUMBER	(1) From RESULTS	
	data (2) Previous Inventory	
	Contractor Supplied	Interpreter's first and last name in ALL Capital letters (i.e. FIRST_LAST NAME)
INTERPRETATION_DATE	Contractor Supplied	
DATE_OF_PHOTOGRAPHY	Contractor Supplied	
	(1) From RESULTS data (2) Contractor Supplied	Care must be taken to ensure that all attributes apply to the same reference
INVENTORY_STANDARD_CD	Contractor Supplied	V
	Contractor	Same name as the Contract Project Description Name (i.e. HORSEFLY_VRI
DISTURBANCE_CODE	From RESULTS data	Most significant impact for the opening
DISTURBANCE_START_YEAR	From RESULTS data	
DISTURBANCE_END_YEAR	From RESULTS data	
DISTURBANCE_TYPE_CODE	From RESULTS data	
ESTIMATED_SITE_INDEX_SPEC	From RESULTS data	Mandatory for polygons under 30 years old
ESTIMATED_SITE_INDEX *	From RESULTS data	Mandatory for polygons under 30 years old
ESTIMATED_SINDEX_SOURCE_CODE	From RESULTS data	Mandatory for polygons under 30 years old