Tolko Industries Ltd.
Tree Farm Licence 49
Vegetation Resource Inventory Phase II
Project Implementation Plan

Prepared for

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1. INTRODUCTION

1.1 BACKGROUND

Tolko Industries Ltd. (formerly Riverside Forest Products Ltd.) installed 87 Vegetation Resource Inventory (VRI) Phase II ground samples in Tree Farm Licence (TFL) 49 in 1997, 1999 and 2000. Those samples were installed under a Project Implementation Plan[1] (VPIP) developed to the provincial Vegetation Resources Inventory (VRI) standard. Tolko's TFL 49 underwent an allowable annual cut (AAC) determination in December 2005 using this inventory data as a base case. As a result, Tolko has been granted an AAC uplift of 200,000m^3 due to salvage efforts related to the current mountain pine beetle (MPB) epidemic.

While the Deputy Chief Forester has granted the uplift for the AAC application, he has recognized areas where Tolko needs improved data to rationalize specific management decisions with a higher degree of certainty.[2] One area of particular emphasis was the need for improved data on unsalvageable losses (now Deadwood).[3] Consequently, Tolko has decided to install and/or remeasure 60 VRI Phase II Timber Emphasis plus Coarse Woody Debris Plots (TEP+CWD).

1.2 GOALS & OBJECTIVES

The goal of this project is to update the TFL 49 inventory and address the Deputy Chief Forester's request to obtain improved data on Deadwood, regenerated stands, and forest health. The specific objectives of this VPIP are to:

1. Describe the area of interest.
2. Define the sample population (where new VRI plots may be installed).
3. Identify the existing VRI Phase II plots in the sample population.
4. List the attributes of interest to measure from existing and new VRI plots.
5. Develop a sample design to meet the goals of updating the current inventory, address Deadwood, and provide a platform to assess changes in the future.
6. Provide sample packages and maps to support field sampling.

1.3 VRI OVERVIEW

The VRI is the Ministry of Forests and Range's (MoFR) forest inventory standard on public lands in BC. Where possible, forest licensees must use the VRI standard in their data package submission for Timber Supply Review (TSR).

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[1] J.S. Thrower & Associates Ltd. 1997. Tree Farm Licence 49 Vegetation Resources Inventory – Timber Emphasis Inventory Ground Sampling Plan. Contract report prepared for the MoFR. JST Project MFI-033. September 30, 1997. 31 pp.

[2] Benskin, H., 2005. Tree Farm Licence 49 Riverside Forest Products Ltd. – Rationale for Allowable Annual Cut (AAC) Determination. December 5, 2005.

[3] Unsalvageable losses (Deadwood) are timber volumes destroyed or damaged, by such agents as fire or disease, that are not recovered through salvage operations. Estimates for unsalvaged losses account for epidemic (abnormal) infestations and for factors that result in losses that are not recovered through salvage harvest programs and are not recognized in yield estimates. (Benskin, 2005)

The VRI is a four-step process (Figure 1):

1. Phase I (unadjusted inventory data) – Estimates of polygon attributes are derived for the target population from photo-interpretation.
2. Phase II (ground sample data) – Measurements are taken from randomly located ground samples in the target population.
3. Net Volume Adjustment Factor (NVAF) sampling – Random trees are selected for stem-analysis, from the Phase II samples, to develop adjustment ratios that correct taper and decay estimation bias.

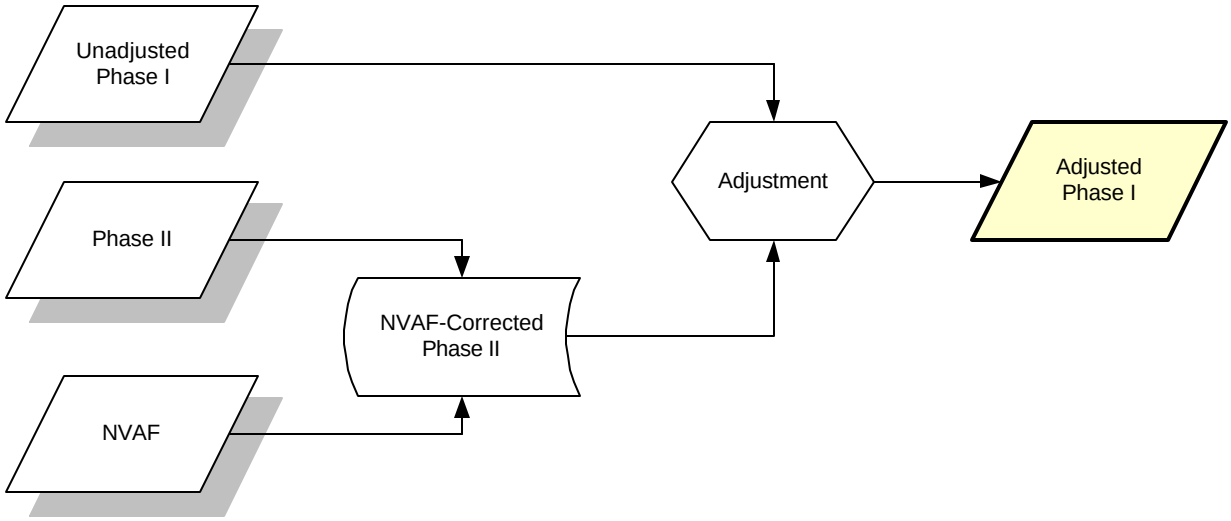

Figure 1. VRI flow-chart.

1.4 TERMS OF REFERENCE

This VPIP was developed by the Timberline Forest Inventory Consultants/J.S. Thrower and Associates Ltd. consortium (TFIC-JST) for Tolko. The Tolko contacts are Rob Kennett, *RPF* and Glen Dick, *RPF*. The TFIC-JST project team is David Carson, *RPF* (project manager), Hugh Carter, *MSc (candidate), RFT*, (lead analyst), Darryl Klassen, *BNRSc, DoT* (GIS) (GIS support), Guillaume Therien, *PhD* (technical support), and Hamish Robertson, *RPF* (technical support). This VPIP will be approved prior to the creation of sample packages.

1.5 TFL 49 LAND BASE

TFL 49 is located west of Okanagan Lake near the communities of Kelowna, Vernon and Armstrong (Figure 2). The TFL is administered by the MoFR Okanagan Shuswap Forest District Office within the Southern Interior Forest Region.

Interior Douglas Fir (IDF), Montane Spruce (MS), and the Engelmann Spruce – Subalpine Fir (ESSF) biogeoclimatic zones (BEC), collectively represent approximately 90% of the TFL (Table 1). The main species are lodgepole pine, Douglas-fir, spruce, and subalpine fir (Table 2).

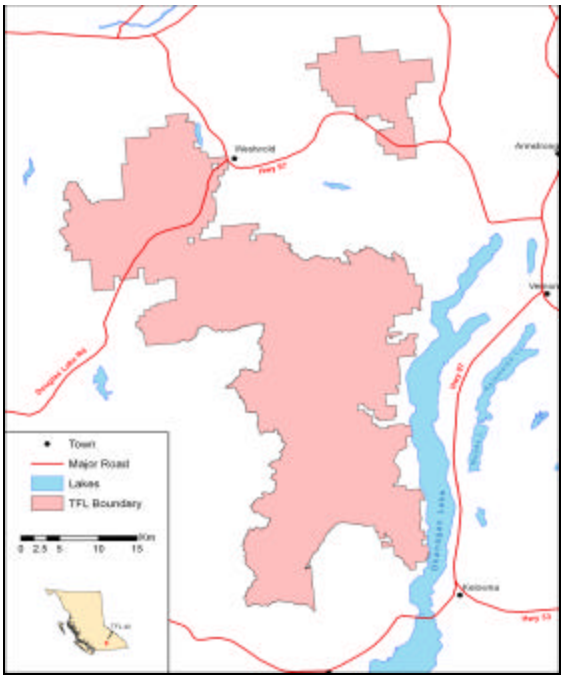

Figure 2. TFL 49 location.

Table 1. Subzone distribution in TFL 49.

BEC	Area (ha)	% of TFL
MS dm2	54,997	38
ESSF dc2	25,692	18
IDF dk1	22,640	16
IDF mw1	11,585	8
ICH mk1	8,167	6
IDF dk2	8,056	6
IDF xh1	5,437	4
ESSF xc	5,139	4
IDF xh2	3,071	2
Total	144,786	100

Table 2. Species and age class distribution of TFL 49.

Leading Species	MoFR Age Classes									Total Area	
	1	2	3	4	5	6	7	8	9	Ha	%
Pl	5,042	7,426	440	3,543	4,147	8,871	13,764	10,503	146	53,881	37%
Fd	390	1,658	2,302	4,690	7,724	6,495	4,141	10,878	517	38,795	27%
Sx	1,752	2,712	124	132	490	1,224	1,616	9,649	1,442	19,138	13%
Bl	780	3,897	2,027	1,285	1,467	1,845	957	3,566	548	16,372	11%
At	576	1,664	102	281	176	228	208	19		3,255	2%
Ep	147	173	124	130	199	86				859	1%
Py	18	22	41	121	53	100	34	327	32	746	1%
Cw	26		20	116	181	66	154	140	16	720	0%
Lw	46	61	64	43				42	2	259	0%
Se	125	32	10							168	0%
Act	3	65	10	2	6	10	4	44		144	0%
Pa								56		56	0%
No Species										10,390	7%
Total ha	*8,906*	*17,709*	*5,264*	*10,343*	*14,443*	*18,925*	*20,878*	*35,225*	*2,703*	*144,786*	
%	*6%*	*12%*	*4%*	*7%*	*10%*	*13%*	*14%*	*24%*	*2%*		

2. TARGET POPULATION

We defined the target population as inventory polygons in the vegetated treed (leading species present and Crown Closure > 10%) portion of the TFL with 2006 ages > 30 years and recent depletions excluded (log date > 20). The data used to define this area included the VRI, updates for harvest depletions (both BCTS and Tolko) and ownership coverages (Table 3). The resulting target population area is 104,002 ha (Table 4).

Table 3. List of GIS coverages and information sources used to define the sample population.

Coverage Description	Source	Date Received
VRI for entire TFL	Terry Lanktree, TFIC-JST	July 31, 2006
Provincial Biogeoclimatic	BC Land & Resource Data Warehouse	July 31, 2006
Ownership	BC Land & Resource Data Warehouse	July 31, 2006
Licensee harvested blocks to 2005	Tolko Industries Ltd.	August 9, 2006

The majority of the target population is distributed across age classes 4 – 8 (>80% of the area) with the largest proportion in age class 8. Age classes 2 and 3 are a minor component only comprising approximately 10% of the population. The largest BEC components in the target are IDF (37%) followed by MS (34%) and ESSF (22%). The Interior Cedar Hemlock (ICH) zone makes up only a minor component of the sample population (6%). Lodgepole pine is the most common species found in TFL 49 and stands with a pine component > 30% occupy almost 50% of the target population.

In the 1997 VRI Ground Sampling Plan, the population of interest was the entire TFL land base.[4] The ground sampling plots installed in the previous ground-sampling program concentrated on polygons with stand ages 60 years and greater; however some plots were established in polygons with younger stand ages. In defining the target population, we included stands >30 years to address the need for information in the younger age classes.[5]

Table 4. Area net-down.

Netdown Category	Area (ha)	Proportion of Area in Previous Category	Proportion of Total Area
TFL 49	144,786	100%	100%
Vegetated-Treed Portion (Spp1 <> "" & Crown Closure >10%)	122,280	84%	84%
Stands > 30 years	108,511	89%	75%
VT with recent harvest depletions	104,002	96%	72%

[4] J.S. Thrower & Associates Ltd. 1997. Tree Farm Licence 49 Vegetation Resources Inventory – Timber Emphasis Inventory Ground Sampling Plan. Contract report prepared for the MoFR. JST Project MFI-033. September 30, 1997. 31 pp.

[5] This was stated as a recommendation in *Vegetation Resources Inventory Phase 2 Adjustment Procedure.* Timberline 2002.

3. SAMPLE DESIGN

3.1 OBJECTIVES

The objectives of the sample design are to:

1. Estimate the average net merchantable volume in the target population with a sampling error of ±10% at a 95% confidence level.
2. Collect information on Deadwood, regenerating stands, and forest health.
3. Provide a platform to reassess Deadwood within the TFL.

The intent is that the data from updating and supplementing the samples in these stands will allow Tolko to address the Deputy Chief Forester's request to assess and quantify Deadwood, and forest health. This will require statistical analysis of the data. Assessing Deadwood must be done by re-measuring some or all of these ground samples in the future.

3.2 SAMPLE SIZE

3.2.1 Ground Sampling

An estimated coefficient of variation (CV) of 60% could be used, as it is the Provincial average. Using a CV of 60% would equate to installing 145 samples to achieve a sampling error of ±10% at a 95% confidence level. A local CV could not be determined with confidence, so we recommend installing a small sample of plots and doing an interim analysis to reassess the CV and determine the number of additional plots that will be needed to meet the desired sampling error. If the CV is found to be higher than 60% after completing the interim analysis, more than 145 plots may be required. To expedite the process of installing plots in the 2006 field season, a list of 90 plots has been generated and of these 90 plots, 60 will be installed. This project expands on the existing TFL Phase II program and we intend on remeasuring a maximum of 40 existing plots (in the 2006 field season) to provide a platform for assessing Deadwood as requested by the chief forester.

Based on the outcome of the 2002 analysis for adjustment it is possible that the CV for TFL 49 is less than 60% (i.e., requiring a sample of less than 145). [6] The mature strata, ignoring the species stratification, produced a sampling error that was acceptable to the MoFR and was done with a sample size of 67. The immature strata however, produced high sampling error and it was recommended that the use of the ratio in this stratum be carefully considered before use. With this information, it is prudent to take a small sample, perform an interim analysis, and definitively obtain the required sample size based on the CV from the new and existing data combined.

Of the 87 existing plots, 76 are in the target population and of the 60 plots to be visited in this 2006 program, 38 existing plots will be revisited. Therefore, to provide 60 plots in the target population, 22 new Phase II plots will need to be selected. To reasonably cover the variability in the land base we will ensure that there are a number of new plots installed that will fall outside of the existing sample polygons[7].

[6] MSRM, 2002. *TFL 49 – Documentation of Analysis for Vegetation Resources Inventory Statistical Adjustment.* March 2002. 23pp.

[7] September 8, 2006 conversation with Sam Otukol regarding addressing the CV of the existing samples in the landbase.

3.2.2 NVAF

An NVAF sampling program has been completed on TFL 49 as well as a study comparing the effectiveness of VRI net factoring and BEC taper equations versus the use of FIZ taper equations and 1976 loss factors.[8] The results of this study indicated that the old taper and 1976 loss factors estimated net volume more accurately than VRI net factoring and BEC taper equations on the sample trees. This being said, the NVAF sampling program was in its infancy when the program was implemented. Tolko has recognized there may be an issue around the previous NVAF and will enhance samples for a future NVAF ground sampling program. The existing sample data is still useful, and needs to be augmented with a new program to ensure that the NVAF is brought up to today's standard. The final NVAF sample plan will be created when the Phase II ground sampling is completed, and will incorporate the existing tree data from 1999 (Refer to Appendix 5).

One sample for every three new NVAF trees planned will be enhanced for a future NVAF ground sampling program. Based on examination of existing trees that have been NVAF destructively sampled (Table 5) 50 extra trees are needed for NVAF sampling, bringing the total to 105 (10 dead and 95 live).[9] Twenty (6 immature and 14 mature) plots will be selected for NVAF enhancement. These NVAF-enhanced ground samples will provide the tree matrix from which NVAF trees will be selected for destructive sampling. The VPIP will be updated when the destructive sampling program is finalized.

Table 5. Expected NVAF sample distribution by species.[a]

Live Or Dead	Species Group	Total Samples Required[a]	Existing Samples	New Sample Size
Dead	All	10	10	0
	Total	*10*	*10*	*0*
Live	Pl	40	17	23
	Fd	21	10	11
	Sx	19	7	12
	Other	15	11	4
	Total	*95*	*45*	*50*
Total		***105***	***55***	***50***

[a] Expected sample size is based on inventory volumes and may change once enhanced plots are analyzed.

3.3 STRATIFICATION

3.3.1 Ground Sampling

Three strata were identified in the target population; these strata reduce the number of ground samples required to achieve the desired sampling error by grouping polygons with similar attributes. The following strata were identified in TFL 49 to achieve a precise estimate of average age, height and volume:

a) Stratum 1 - Inventory polygons with >= 30% pine content.
b) Stratum 2 - Inventory polygons that have a pine component < 30% and are multilayered[10].
c) Stratum 3 - Inventory polygons that are not in Strata 1 or 2.

[8] Timberline, 2002. *Vegetation Resources Inventory Phase 2 adjustment procedure. Tree Farm Licence 49*. December 2002. 12pp.

[9] Based on an email provided by Will Smith (Feb. 8, 2007) suggesting that the sample size requirements for live and dead trees will change to 10 dead and 90 live for the 2007/2008 fiscal year.

[10] Multilayered was defined as any forest cover polygon that had more than one layer. Although the target was defined based on the dominant layer, each polygon was labeled as multilayered or not. Multilayered stands are a source of high variability in the landbase and by stratifying we can potentially bring down the CV, thus requiring fewer plots to meet the sampling error.

The sample size was distributed proportional to area within each sub-stratum. Stratum 2 was over-sampled (as it is seen as an area of high variability) to ensure we can meet our desired sampling error while at the same time using an efficient use of plots.

Table 6. Sample size distribution by stratum and sub-stratum.

Stratum	Sub-Stratum	Area (ha)	Sample Size	Area (ha)/ Plot
1	1	7,323	4	1831
	2	42,879	26	1842
2	1	8,368	9	930
	2	5,730	6	955
3	1	4,329	2	2165
	2	35,373	13	2721

One objective of this VRI program is to obtain estimates of younger age classes in the land base. To acquire an appropriate number of plots in each stand age the strata were sub-stratified and weighted by area (substrata 1 = age class 2- 4, substrata 2 = age class 5-9). By doing this we can be confident that the sample points will cover the three main strata as well as all age classes relative to the area the polygons occupy on the land base. Another objective is to use the new ground sample data to augment the existing sample through analysis.

Table 7. Sample size for the distribution of existing and new VRI Phase II plots in the sample population.

Strata	Area (ha)	Proportion of sample population	Existing established VRI plots	Proportion of existing plots	New VRI plots in sample population	Total # VRI plots
> 30% Pine	50,202	48%	20	53%	10	30
< 30% Pine And Multilayered	14,099	14%	8	21%	7	15
< 30% Pine and Not Multilayered	39,702	38%	10	26%	5	15
Total sample pop	***104,002***	***100%***	***38***	***100%***	***22***	***60***

3.3.2 NVAF

Standard NVAF strata do not have to be the same as the ground sampling strata.[11] Thus, the stratification for NVAF purposes will be based on maturity classes. Two maturity classes were used: immature (30-120 years, 31% of the target population total inventory volume) and mature (121+ years, 69% of the target population total inventory volume). The mature strata will be further broken down into species group (Pl, Fd, Sx, and Other). This maturity-based stratification was selected because it has been used in most previous NVAF projects and corresponds to

Table 8. Species and age class as a percentage of the target population total inventory volume.

Leading Species	MoFR Age Class								
	2	3	4	5	6	7	8	9	*%Total Volume*
PL	0.0	0.2	2.4	3.1	10.0	16.2	16.1	0.3	*48.4*
FD	0.0	0.3	1.2	3.1	3.8	2.8	10.2	0.5	*21.9*
SX	0.0	0.0	0.2	0.4	1.4	2.6	14.8	1.2	*20.6*
BL	0.0	0.4	0.5	0.9	1.2	1.0	2.5	0.3	*6.8*
AT	0.0	0.0	0.2	0.2	0.3	0.2	0.0	0.0	*1.0*
CW	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.0	*0.6*
PY	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	*0.2*
EP	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	*0.2*
ACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.1*
LW	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	*0.1*
PA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*
SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*
% Total Volume	*0.1*	*1.0*	*4.6*	*8.0*	*17.0*	*23.0*	*44.0*	*2.3*	*100*

[11] Ministry of Forests – Forest Analysis and Inventory Branch. 2006. Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling Version 2.0. Victoria BC. p. 8.

variability observed among maturity classes. We expect that 35 mature and 15 immature NVAF trees will be destructively sampled. The allocation by species group within the selection strata will be based on the species proportions calculated during interim analysis. Table 7. shows the percentage of the target population total inventory volume by age class and leading species. This table was used to help determine the sample size of trees while considering the available tree data from the 1999 NVAF.[12] Table 5. shows the expected distribution by species for NVAF destructive sampling.

3.4 SELECTION OF SAMPLE POINTS

3.4.1 Ground Sampling

We randomly selected 22 sample points from the target population using the VRI standard probability proportional to size with replacement (PPSWR) method from the 100 m VRI grid (Appendix 1). These plots were chosen based on the strata to ensure a precise estimate and based on sub-strata to ensure proper distribution of the plots.

When selecting existing sample points, we first had to determine the distribution of plots by strata and sub-strata (substrata 1 = age class 2-4, substrata 2 = age class 5-9). From this we were able to determine the number of plots that would be required for a strata and sub-strata. We randomly chose plots from the existing plots that were in the target, which satisfied the strata and substrata requirements. By doing this we were able to ensure proper distribution of plots and that the plots were chosen with no bias.

3.4.2 NVAF

The ground sampling clusters selected for NVAF enhancement were systematically selected with a random start from a list sorted by leading species. Different random starts were used for each maturity class.

3.5 PLOT TYPE

3.5.1 New Plots

New plots in the sample population will be established as standard VRI TEP + CWD. Each sample point under this design is a cluster of five points (Figure 3). Appendix 3 lists the VRI cards needed to collect this information with recommended modifications (please refer to Section 3.5.3 with regards to non-standard data). The modifications include:

- Measuring all borderline trees at plot centre and borderline NVAF enhanced trees.
- Stem mapping all trees.[13]
- Checking trees in auxiliary plots for presence of root rot.

3.5.2 Existing Plots

Existing plots in the sample population will be re-visited with complete re-measurement[14] to ensure consistency between measurements and to get an accurate estimate for 2006. Through the completion

[12] Refer to Initial TFL 49 NVAF Results based on 1999 Calculation Standard – Will Smith December 6, 2001.

[13] This will accommodate assessing change for variable radius plots.

of other projects, issues have been recognized in remeasuring VRI plots. By addressing these issues, we will enable field crews to work with confidence[15] (Refer to Appendix 4).

Plot re-measurement will follow Provincial establishment methods, with the following additional specific criteria:

- Copies of the existing field cards will be used as reference during field measurements.
- Call grade, net factoring, damage agents, and loss indicators will be re-assessed at the IPC and newly assessed at the NVAF enhanced aux plots.
- The same prism will be used as at establishment.
- The existing tree numbers will be used.
- New trees that have grown past the DBH tagging limit will be numbered and measured.
- Any missed tree from the previous measurement will be numbered and measured.
- Measurement of borderline trees.

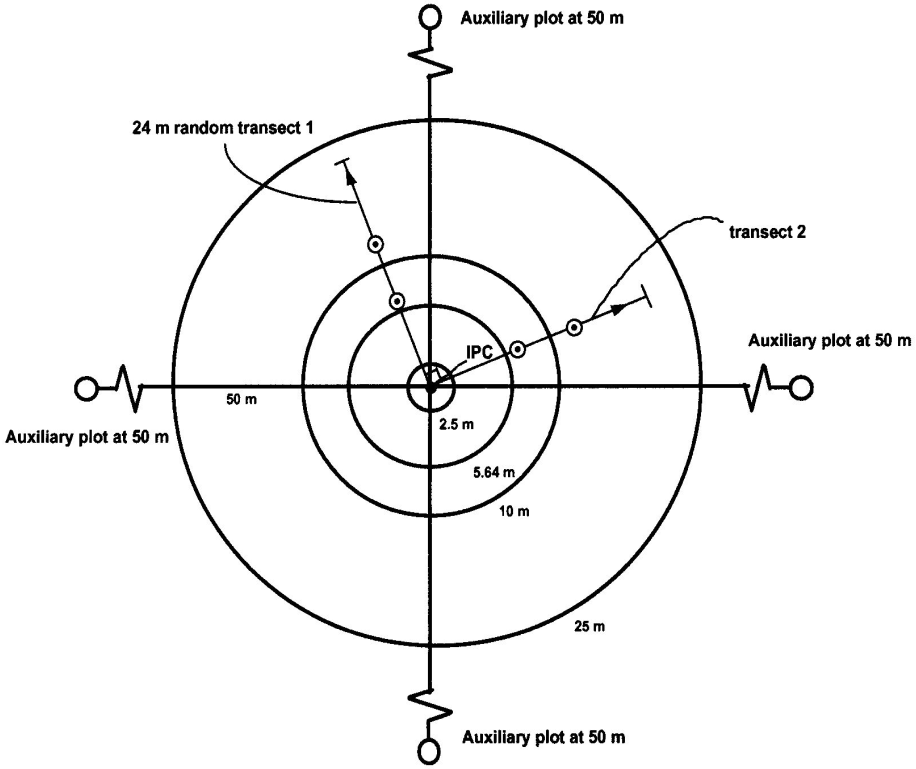

Figure 3. Schematic of the VRI plot cluster. Diagram taken from the VRI manual.

- Stem map all trees.
- Checking trees in auxiliary plots for presence of root rot.

[14] August 8, 2006 email from Matt Makar (Inventory Forester MOFR), on the general need for complete field cards to accommodate the Oracle database.

[15] August 8, 2006 email from Matt Makar (Inventory Forester MOFR), on items that were recognized by field crews when remeasuring variable radius plots.

3.5.3 Non-Standard Data

Should this portion on non-standard data be included in the sample plan Tolko will incur the cost.

To achieve the goal of assessing and quantifying the Deadwood in TFL 49, as well as facilitating the future remeasurement and assessment of change in the plots, some data needs to be collected that is outside of the scope of a typical VRI inventory (refer to Section 3.5.1). Although the MoFR supports the collection of extra data, if they are non-standard, the collection is not FIA fundable.[16] The following is an itemized list of non-standard data, with approximate time per plot, to be collected in TFL 49.

1. Stem map of all trees (20 min. extra per cluster).
2. Full measurement of borderline trees selected at plot centre and NVAF enhanced auxiliary plots (10 min. extra per cluster).
3. Checking for evidence of root rot and recording presence only on all trees in the auxiliary plots. (5 min. extra per cluster).

[16] August 21, 2006 email from Gary Johansen RPF, on the collection of non-standard data in TFL 49.

4. IMPLEMENTATION

4.1 ESTABLISHING NEW VRI PLOTS

Twenty-two new VRI Phase II plots will be established for this project. New plots will be established following sampling methods outlined in section 3.5.1.

4.2 INCORPORATING EXISTING VRI PLOTS

A total of 38 existing VRI Phase II plots in the sample population will be revisited following methods outlined in section 3.5.2.

4.3 COMPILATION, ANALYSIS, AND ADJUSTMENT

All data will be compiled using the MoFR standard VRI compiler at the time of compilation. Some non-standard data will be gathered at the plots in TFL 49 and compiled separately. The concept of using distances to help evaluate change in variable radius plots is not yet an approved MoFR method; however a pilot study is being completed to assess this methodology, which may or may not have an impact on the VRI compiler. Analysis using compilers other than the provincial VRI compiler will not be used for the purposes of adjusting the inventory. Other compilers could be used to address issues internal to Tolko.[17]

Due to the large number of plots required to meet our target sampling error and the cost associated with the sampling, interim analysis will be completed following the first round of ground sampling to determine the number of extra plots required to meet the desired sampling error. All analysis will be completed using the MoFR standards at the time.

For the purposes of adjustment, all work completed will be done to the Provincial standards. All analyses completed that are outside the scope of the adjustment, will be assessed for funding at the time. All non-standard data collected will be only be used in analysis for the purposes of Tolko and not in the Provincial standard adjustment process.

4.4 FUTURE RE-MEASUREMENT

The remeasurement of Deadwood is important to assess losses over time. By comparing the existing VRI data with remeasured dead tree data, it is possible to get an idea of the losses on the land base. By assessing mortality in established VRI ground plots at different time intervals, Tolko will be able to address the concerns of the Deputy Chief Forester as was stated in Section 1.2 Goals and Objectives.

Future re-measurement of plots to assess Deadwood over time can be done as frequently as required. If updates for mortality are the only interest, the plots can be revisited and only trees that have died can be recorded. The statistical analyses can then be redone. This is a reasonable approach, if less than five years have elapsed since the plots were installed. If growth is required in the update, sampling methods for measuring change over time in variable radius plots can be used.

[17] August 23, 2006 emails from Matt Makar (Inventory Forester MOFR) and Sam Otukol (Forest Biometrician), providing direction on the use of MOFR compilers for projects funded by FIA

Any procedures that are used for future remeasurement and inventory update will be reviewed for approval by MOFR using the standards that are in place at the time of re-measurement, if Forest Investment Account funding (or its equivalent at the time) is to be used.[18]

4.5 SCHEDULE

The new VRI Phase II sampling will be implemented in 2006 as follows:

1. Tolko will prepare and submit a VPIP for approval by MoFR (Forest Analysis and Inventory Branch).
2. The sample packages will be competed upon approval of the VPIP.
3. Tolko will hire certified crews to install the TEPs and a certified 3rd party auditor to check their work.
4. Tolko will mentor all crews on the first day of field sampling. The MoFR is invited to participate in mentoring and auditing QA.
5. The contractor crews will supply digital files of the TEP data as well as an Excel spreadsheet with the stem map data, to Tolko, for compilation and QA at the end of each shift.
6. Tolko will audit approximately 10% of the TEPs.
7. Tolko will complete the interim statistical analysis by January 31, 2007.[19]
8. Tolko will assess funding for the completion of the NVAF ground-sampling program, as this is a VRI requirement.
9. Tolko will update the VPIP to address the additional plots needed to meet the target sampling error as well as the NVAF ground-sampling program prior to March 31st, 2007. This is contingent upon the completion of the preliminary field sampling (60 plots) and funding availability in the 2006/2007 fiscal year.
10. Upon completion of the preliminary field sampling (60 plots), an updated VPIP will be submitted for approval by the MoFR (Forest Analysis and Inventory Branch).
11. Tolko will complete the final analysis and adjustment following the completion of VRI and NVAF ground sampling programs project. The analysis is targeted for completion by March 31st 2008. This is contingent upon the availability of certified field samplers and the completion of the target field sampling in the 2007 field season.

4.6 DELIVERABLES

The deliverables for the MoFR and Southern Interior Regional District upon completion of the ground sampling program include:

1. The VPIP.
2. A digital copy of the Phase 1 target population map.
3. A digital copy of the Phase 1 target population data.
4. The Phase 1 data used to determine adjustment factors.
5. Sample list modifications (if any).
6. The sample packages.

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[18] August 23, 2006 emails from Matt Makar (Inventory Forester MOFR) and Sam Otukol (Forest Biometrician), providing clarification of expected remeasurement standards at some future date

[19] Tolko commits to completing at minimum up to step 7 of the schedule within the 2006/2007 fiscal year if preliminary field sampling is completed in the 2006 field season.

7. The plot cards.
8. The ground sampling field data in a digital format accepted by the MOFR.
9. The NVAF destructive sampling data in a digital format accepted by the MOFR.
10. A copy of the quality assurance report.
11. An interim analysis memo.
12. A final analysis and adjustment report.

TFL 49 Vegetation Resource Inventory

5. PHASE II GROUND SAMPLING PLAN

It is the intention of the proponent to implement the TFL 49 Vegetation Resources Inventory Project Implementation Plan (VPIP) as described. As the key stakeholder in the inventory, the Ministry of Forests and Range (MoFR) VRI staff has been consulted throughout the development of this plan.

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Robert Kennett RPF February 16, 2007
Divisional Forester
Planning & Silviculture
Tolko Industries Ltd.
4280 Highway 6, Lumby V0E 2G7

I have reviewed the TFL 49 Vegetation Resources Inventory Ground Phase II Sampling Plan. I will be advising Pricewaterhouse Coopers that the work proposed to this plan meets Vegetation Resources Inventory Standard and MoFR business needs.

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Jon Vivian February 16, 2007
Manager,
Vegetation Resource Inventory Section
Forest analysis and Inventory Branch
Ministry of Forests and Range

APPENDIX 1 – TARGET POPULATION SAMPLE POINTS

The following sample list is a combination of (Table 6.):

1. New plots to be established in the TFL 49 sample population, and
2. Existing plots to be re-measured in TFL 49 from the Phase II programs that occurred in 1997, 1999, and 2000.

Note that some existing plots did not have UTM coordinates of any type. These plots were excluded from the sample list. Some plots had tie point coordinates only and a calculation for x and y distance to the IPC was completed based on the distance and bearing to the IPC recorded on the plot cards.

Table 7 is a list of samples to be used in the event that the crew needs to drop a plot because the sample is outside of the target population (i.e. Logged polygon).

Table 9. List of samples to be remeasured or established.

Project	Measurement Status	Sample No.	Mapsheet No.	Polygon No.	Map Quad No.	UTM Zone	UTM Northing	UTM Easting	BGC Unit	Leading Species	Secondary Species	NVAF	Strata	Age (yrs)	Height (m)	Crown Closure (%)
	Remeasure	2	082L032	88	3	10	5584313	732026	MS dm 2	Pl			1	112	21.5	70
	Remeasure	3	092I050	71	2	10	5590936	708646	MS dm 2	Pl	Bl	Y	1	127	22.3	64
	Remeasure	5	082L022	281	3	11	5572605	303127	ESSF xc	Bl	Pl		3	121	20.2	50
	Remeasure	9	082L023	1620	2	11	5564259	322094	IDF xh 1	Fd	Py		2	95	20.2	42
	Remeasure	14	082L002	1622	2	11	5544796	312247	MS dm 2	Fd	Pl		3	138	24.7	30
	Remeasure	15	082L041	1542	2	11	5589310	297538	IDF dk 1	Fd	Pl		3	152	24.5	50
	Remeasure	16	082L021	690	4	11	5574472	296180	MS dm 2	Fd	Pl	Y	2	170	20	30
	Remeasure	17	082L031	1195	2	11	5580609	297854	IDF dk 1	Fd	Pl	Y	1	173	23.5	60
	Remeasure	18	082L033	392	1	11	5576409	318197	ICH mk 1	Fd	Pl		3	199	25.7	43
	Remeasure	27	082L012	1527	2	11	5557813	309288	IDF dk 2	Pl	Fd	Y	1	122	19.3	60
	Remeasure	28	082L012	856	4	11	5561479	311464	MS dm 2	Pl	Sx		1	125	28.1	55
	Remeasure	29	082L051	142	2	11	5600668	296168	IDF dk 1	Pl	Fd		1	127	23.4	60
	Remeasure	30	082L012	412	3	11	5560245	302241	MS dm 2	Pl	Sx	Y	1	132	26	50
	Remeasure	32	092I050	167	2	10	5590098	711831	MS dm 2	Pl	Bl		1	132	21.8	60
	Remeasure	34	082E093	129	3	11	5541357	299365	ESSF dc 2	Pl	Bl	Y	1	143	23.8	50
	Remeasure	35	082L002	1429	1	11	5543401	304954	MS dm 2	Pl	Sx		1	150	26.3	50
	Remeasure	36	082E092	18	4	11	5541742	298692	ESSF dc 2	Pl	Sx		1	169	27.1	55
	Remeasure	37	082L022	186	3	11	5574474	307574	MS dm 2	Pl	Bl	Y	1	190	25.1	60
	Remeasure	40	082L032	103	3	11	5582328	306222	MS dm 2	Sx	Bl		2	103	17.8	50
	Remeasure	41	082L031	1289	2	11	5579724	297235	IDF dk 1	Sx	Pl	Y	1	129	32.1	50
	Remeasure	43	082L032	905	1	11	5575967	304440	MS dm 2	Sx	Bl		3	183	36.5	40
	Remeasure	45	082L012	1416	1	11	5555132	305920	ESSF dc 2	Sx	Pl	Y	1	202	30.6	53
	Remeasure	50	082L003	71	3	11	5552079	319039	IDF xh 1	Fd	Lw		2	46	8.9	15
	Remeasure	52	082L032	10	3	11	5583637	301583	IDF dk 1	Fd			2	54	16.1	20
	Remeasure	53	082L023	1081	1	11	5569191	319856	IDF mw 1	Fd	Pl	Y	2	120	16.7	12
	Remeasure	54	082L031	1690	2	11	5578006	300258	MS dm 2	Pl	Sx		1	74	16.6	50
	Remeasure	59	082L022	1283	1	11	5565212	305599	ESSF dc 2	Bl	Sx		2	37	3.5	15

Project	Measurement Status	Sample No.	Mapsheet No.	Polygon No.	Map Quad No.	UTM Zone	UTM Northing	UTM Easting	BGC Unit	Leading Species	Secondary Species	NVAF	Strata	Age (yrs)	Height (m)	Crown Closure (%)
	Remeasure	62	082L002	1951	2	11	5543759	309832	MS dm 2	At	Pl	Y	2	31	13.3	70
	Remeasure	63	082L053	217	3	11	5605004	322535	ICH mk 1	Bl	Sx		3	36	7.9	30
	Remeasure	64	082L013	574	1	11	5557000	317342	IDF mw 1	Fd	Pl		1	61	15	50
	Remeasure	75	082L011	57	4	10	5562569	728300	MS dm 2	Bl	Sx	Y	3	155	18.9	45
	Remeasure	79	082L041	1417	2	10	5592456	724651	IDF dk 1	Fd	Pl		3	100	18.7	40
	Remeasure	80	082L021	737	4	10	5573670	721327	IDF dk 1	Fd	Sx		3	110	21.3	60
	Remeasure	86	092I040	365	4	10	5582176	713244	IDF dk 1	Fd	Pl	Y	1	175	27.9	50
	Remeasure	101	082L032	1061	2	11	5579221	312911	ESSF dc 2	Pl	Sx	Y	1	137	24.4	60
	Remeasure	105	082L032	784	1	11	5576099	305770	MS dm 2	Pl	Sx		1	196	29.1	50
	Remeasure	108	082L033	67	1	11	5578337	316774	ESSF dc 2	Sx	Bl		3	114	27.6	40
	Remeasure	128	082L031	1634	2	11	5576820	298401	MS dm 2	Pl	Fd	Y	1	74	16.6	70
	New	130	082E093	884	1	.	.	.	MS dm 2	Sx	Bl		3	202	36.4	40
	New	131	082E094	107	3	.	.	.	IDF dk 2	Fd	At	Y	2	36	10.4	55
	New	132	082L001	10	2	.	.	.	ESSF dc 2	Se	Bl		2	30	4.4	10
	New	133	082L002	818	4	.	.	.	MS dm 2	Bl	Sx		2	102	16.6	20
	New	134	082L002	1071	1	.	.	.	MS dm 2	Pl	Sx		1	222	27	50
	New	135	082L002	1239	1	.	.	.	ESSF dc 2	Bl			2	61	6.8	15
	New	136	082L012	37	3	.	.	.	MS dm 2	Sx	Bl		3	221	33.3	45
	New	137	082L012	177	3	.	.	.	MS dm 2	Bl	Sx		2	33	3.7	20
	New	138	082L012	1714	2	.	.	.	MS dm 2	Pl	Bl		1	127	22.9	60
	New	139	082L012	1924	2	.	.	.	MS dm 2	Bl	Sx	Y	2	42	17.4	40
	New	140	082L021	690	4	.	.	.	MS dm 2	Fd	Pl	Y	2	170	20	30
	New	141	082L022	1706	2	.	.	.	ESSF dc 2	Sx	Bl		3	174	29.7	50
	New	142	082L031	139	3	.	.	.	IDF dk 1	Pl			1	141	24.3	30
	New	143	082L031	1044	1	.	.	.	IDF dk 1	Pl			1	74	17.6	55
	New	144	082L032	1353	2	.	.	.	ESSF dc 2	Bl	Sx		3	56	7.1	45
	New	145	082L041	1154	1	.	.	.	MS dm 2	Pl	Sx		1	111	23.6	55
	New	146	082L053	1160	2	.	.	.	IDF mw 1	Pl	Fd	Y	1	111	23.6	12
	New	147	092I040	83	4	.	.	.	MS dm 2	Pl		Y	1	132	19.7	60
	New	148	092I040	129	4	.	.	.	MS dm 2	Pl	Sx		1	132	28.5	45
	New	149	092I040	240	4	.	.	.	MS dm 2	Pl			1	132	19.2	60
	New	150	092I040	363	4	.	.	.	IDF dk 1	At	Pl		3	116	20.9	65
	New	151	092I050	225	2	.	.	.	MS dm 2	Pl	Sx	Y	1	132	25.4	50

Table 10. List of back-up samples with sample packages created.

Project	Measurement Status	Sample No.	Mapsheet No.	Polygon No.	Map Quad No.	UTM Zone	UTM Northing	UTM Easting	BGC Unit	Leading Species	Secondary Species	NVAF	Strata	Age (yrs)	Height (m)	Crown Closure (%)
	Remeasure	4	082L012	662	4	11	5561840	313500	MS dm 2	Sx	Fd		3	229	31.5	65
	Remeasure	25	082L032	480	1	11	5579882	302716	MS dm 2	Pl	Fd		1	120	23.5	60
	Remeasure	26	082L041	1509	2	11	5588959	294299	IDF dk 1	Pl	Fd		1	122	21.3	45
	Remeasure	33	082L041	1261	1	11	5587558	287461	MS dm 2	Pl			1	135	25.4	60
	Remeasure	38	082L002	1163	1	11	5546936	302986	ESSF dc 2	Pl	Sx		1	205	24	40
	Remeasure	48	082L053	193	3	11	5604731	319814	ICH mk 1	Sx	Bl		3	336	37	50
	Remeasure	58	092I040	498	2	10	5579430	711668	IDF dk 1	Fd	Pl		2	86	17.9	30
	Remeasure	66	082L031	1255	2	11	5578925	299365	MS dm 2	Pl			1	74	17.6	60
	New	152	082L012	88	3	.	.	.	ESSF dc 2	Bl	Sx		3	183	18.7	65
	New	153	082L012	177	3	.	.	.	MS dm 2	Bl	Sx		2	33	3.7	20
	New	154	082L021	678	4	.	.	.	IDF dk 1	Sx	Pl		1	131	25.8	60
	New	155	082L022	1803	2	.	.	.	MS dm 2	Pl	Bl		1	222	26	65
	New	156	082L023	422	3	.	.	.	ICH mk 1	Fd	Pl		2	61	15.6	50
	New	157	082L041	1446	2	.	.	.	IDF dk 1	Fd			3	120	17.5	30
	New	158	082L052	21	4	.	.	.	MS dm 2	Fd	Pl		2	90	18	40

Table 11. List of back-up samples without sample packages created.

Project	Measurement Status	Sample No.	Mapsheet No.	Polygon No.	Map Quad No.	UTM Zone	UTM Northing	UTM Easting	BGC Unit	Leading Species	Secondary Species	NVAF	Strata	Age (yrs)	Height (m)	Crown Closure (%)
	Remeasure	21	082L052	27	4	11	5606504	314677	IDF mw 1	Pl	Fd		1	95	19.7	60
	Remeasure	23	082L041	1158	1	11	5589514	292852	MS dm 2	Pl			1	111	23.6	60
	Remeasure	39	082L022	1720	2	11	5564621	308087	ESSF dc 2	Pl	Bl		1	222	21.9	60
	Remeasure	46	082L002	701	4	11	5550382	310051	MS dm 2	Sx	Bl		3	221	30.5	40
	Remeasure	68	082L013	516	1	11	5557339	318176	IDF mw 1	Fd	Py		3	71	17.3	22
	Remeasure	76	082L012	82	3	10	5565979	734670	MS dm 2	Bl	Sx		3	202	23.6	55
	Remeasure	102	082L011	49	4	11	5562254	299783	ESSF dc 2	Pl	Bl		1	143	24.3	55
	Remeasure	121	082L003	762	1	11	5543273	318520	IDF dk 2	Fd	Pl		2	115	21.2	23
	New	159	082E093	117	3	11	5541509	300583	ESSF dc 2	Sx	Bl		3	141	30.1	45
	New	160	082L003	344	3	11	5548065	317220	IDF dk 2	Fd	Bl		2	34	7.5	65
	New	161	082L013	824	1	11	5553762	319149	IDF xh 1	Fd	Pl		2	36	9.2	10
	New	162	082L021	20	3	11	5575065	293241	IDF dk 1	Pl	Fd		1	111	21	60
	New	163	082L021	165	3	11	5573766	291566	IDF dk 1	Pl	Fd		1	106	19	55
	New	164	082L041	1160	1	11	5589296	293024	IDF dk 1	Pl			1	111	20.5	55
	New	165	082L053	213	3	11	5606878	322856	ESSF dc 2	Pl	Bl		1	33	12.5	20

APPENDIX 2 – LANDBASE AND SAMPLE COMPARISONS

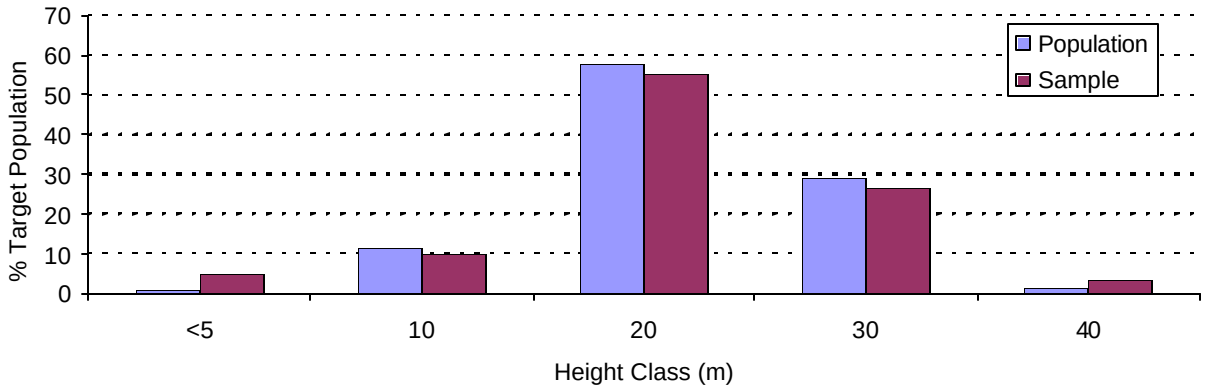

Figure 4. Height distribution in the population and the sample.

Figure 5. Age distribution in the population and the sample.

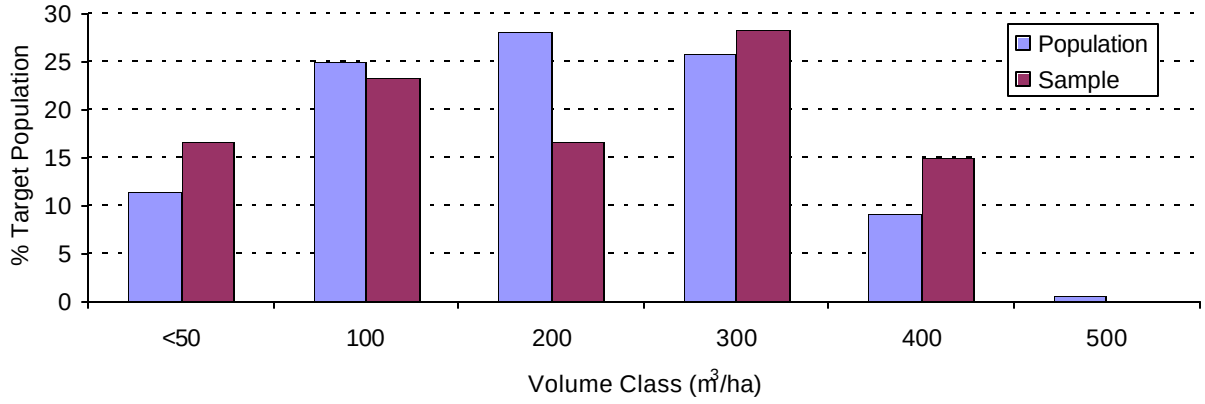

Figure 6. Net merchantable volume distribution in the population and the sample.

APPENDIX 3 – VRI CARDS & MODIFICATIONS

Card	Name	Include	Information Collected	Modifications / Notes
1 – CH	Header	Yes	General sample information and access notes	None
2 – CP	Compass	Yes	Navigation and reference point information	None
3 – CL	Cluster Layout	Yes	Plot and cluster diagrams	None
4 – RS	Range Sampling - Shrub Transect 1	No	Shrub layer structure data and forage plot clippings along first random azimuth	NA
5 – RT	Range Sampling - Shrub Transect 2	No	Shrub layer structure data and forage plot clippings along second random azimuth	NA
6 – EW	CWD Transect 1	Yes	CWD data along first random azimuth	None
7 – EC	CWD Transect 2	Yes	CWD data along transect at 90° to the first	None
8 – TD	Tree Details	Yes	Tree attributes including call grade/net factoring	Measure all borderline trees
9 – TL	Tree Loss Indicators	Yes	Damage agents and loss indicators for trees	None
10 –TS	Small Tree, Stump, and Site Tree Data	Yes	Regeneration and stump data, and site tree data	None
11 – TA	Auxiliary Plot	Yes	Tree attributes, damage agents, loss indicators, and site tree data for aux plots	Tally dead and down trees and borderline trees; stem map all trees. Record presence of root rot.
12 – EP	Ecological Description 1	No	Site and soil classification for pin location	NA
13 – ED	Ecological Description 2	No	Site and soil classification if pin location is not in dominant site	NA
14 – ET	Tree and Shrub Layers	No	Species and percent cover for tree and shrub layers	NA
15 – EH	Herb and Moss Layers	No	Species and percent cover for herb and moss layers	NA
16 – EO	Succession Interpretations	No	Succession and old-growth attributes.	NA

APPENDIX 4 – REMEASUREMENT TROUBLESHOOTING

Issue Encountered	Field Solution
Destructively sampled (NVAF) trees are encountered in aux plots. How is this plot treated?	Measure the plot as if the tree(s) had not been cut and mark on the card that this plot had trees that were destructively sampled. Comparisons in analysis will only be based on remeasured plots from one measurement to the next which may not include these "vandalized' samples.
Destructively sampled (NVAF) tree pieces are encountered in the CWD transect. How are these dealt with?	Treat these pieces as CWD if they are eligible and mark them on the card for consideration when compiling the data.
Dead trees or trees that were not in the original plot are now in the plot. How should these trees be numbered?	Number the "new" trees starting at the number after the last tree in the plot (i.e. If the last tree in the IPC at the original measurement was 5 any new trees would start at number 6, then 7, etc.).
An age tree had a previous age taken and it is an age tree at a subsequent measurement. Does this tree get rebored?	Do not rebore trees that already have had an age taken. Use the previous measurement and add the number of years since the last measurement. Assess the old bark windows for these trees and if swelling and/or scarring is excessive, cut a new window.
A new or existing tree is now larger than the original sample tree. How should this tree be dealt with?	Sample trees may change so be aware of this and do not assume that the sample trees from previous measurements are the same. A new random age tree does not need to be determined after the original measurement.
Do tie point and ref trees need to be revisited?	Yes. However, a lot of time should not be spent at these trees. Update the diameters and freshen paint (if needed). If the buttersoft tag is missing, replace it and if GPS was not acquired at the original measurement try to obtain it. If different access is being used, standard procedures and a new TP tree must be established.
Do new CWD lines need to be established if there are existing ones?	Yes. CWD does need to be completed for the current estimate; however a new line direction does not need to be determined. Use the established line but do not try to identify old pieces. Treat the line as a new sample.
Do stem mapped trees at the IPC need to be re-mapped?	No. Trees that are already stem mapped do not need to be remapped; however; any new trees encountered need to be stem mapped.
What are the criteria for a "borderline tree"?	If a diameter is required to decide if a tree is "in" or "out" then the tree is deemed borderline and full measurements should be taken. These trees need to be identified on the cards as borderline.

APPENDIX 5 – TFL 49 1999 NVAF COMPARISON

TFL 49 NVAF Values for the 1999 Sample

Design Weights - Post 2002 Standard

Species	N	Net CU NVAF	SE	Taper NVAF	SE
Dead	10	0.89	36	1.11	17
Live	46	0.89	9	0.95	5
B	11	0.85	43	1.09	10
F	10	0.97	15	0.99	15
Pl	17	0.86	5	0.87	5
S	7	0.95	4	0.95	4

Original Weights - Pre 2002 Standard

Species	N	Net CU NVAF	SE	Taper NVAF	SE
Dead	10	1.02	24		
Live	46	0.88	9	0.94	6
B	11	0.73	46	0.99	8
F	10	0.96	12	0.98	11
Pl	17	0.97	5	0.98	4
S	7	0.9	3	0.9	4

Produced by Will Smith, MOFR Forest Analysis & Inventory Branch

TFL 49 NVAF Values for the 1999 Sample - With Outlier Removed

Outlier = mature balsam, sample 38, west plot, tree #2

Design Weights - Post 2002 Standard

Species	N	Net CU NVAF	SE
Live	45	0.93	4
B	10	1.03	8

Original Weights - Pre 2002 Standard

Species	N	Net CU NVAF	SE
Live	45	0.92	5
B	10	0.91	9

Produced by Will Smith, MOFR Forest Analysis & Inventory Branch