Strathcona TSA

Documentation of
Vegetation Resources Inventory Statistical Analysis

Prepared for:

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EXECUTIVE SUMMARY

The objective of this project was to complete a VRI statistical analysis of selected Phase I inventory attributes for the Strathcona TSA, based on current Ministry of Forests, Mines & Lands (MFLRNO) standards. This analysis will provide an assessment of the accuracy of the Phase I inventory in this management unit.

The amended VRI Project Implementation Plan (VPIP) in the Strathcona TSA specified the establishment of 102 Phase II ground samples within the population of interest which was defined as: Vegetated Treed (VT) polygons, 30 years of age or greater. After an initial establishment of 50 samples, a decision was made to focus the remaining sample selection in three strata within the Operable portion of the TSA. The revised sample distribution (for a total of 102 samples) as provided in the VPIP amendment was:

1. Operable, Western redcedar and yellow cedar (C-Y) leading stands, greater than 30 years (n=27)
2. Operable, Douglas-fir (Fd) leading stands, greater than 30 years (n=27)
3. Operable, Other species leading, established after 1885 (Other-Immature) and greater than 30 years (n=27)
4. Operable, Other species leading, established before 1886 (Other-Mature) (n=11)
5. Inoperable (VT greater than 30 years) (n=10)

After excluding 4 samples that were either logged prior to establishment or were found to be outside the population of interest, 98 samples remained for the analysis. Because of concerns regarding the accuracy of the photo-interpreted values of basal area and trees/ha, the Phase I photo-estimates of these attributes were replaced by values generated using the FIPSTART module of VDYP7 for this analysis.

The analysis was based on the same strata that were defined for sample selection and focused on six inventory attributes (age, height, basal area/ha at 7.5cm+ dbh, trees/ha at 7.5cm+ dbh, Lorey height, and volume/ha net dwb at 12.5cm+ dbh). The ratio of the weighted mean Phase II ground value to the weighted mean Phase I inventory value was computed for each attribute. A ratio greater than 1.0 suggests that, on average, the Phase I inventory is *under*estimating an attribute, based on the Phase II ground sample information. Similarly, a ratio less than 1.0 suggests that, on average, the Phase I inventory is *over*estimating the value of an attribute. The resulting VRI analysis ratios, and their associated sampling errors, are shown for each attribute, by stratum, in the table that follows.

Overall, inventory volumes in the Strathcona TSA appear to be underestimated by about 14% on average, based on the ground sample information. The average volume underestimation bias ranged from virtually zero in the "Operable Other species – Mature" stratum to as much as 26% in the Inoperable stratum. The volume underestimation bias among the remaining operable strata ranged from roughly 15% to 23%.

When the inoperable samples are excluded from the overall volume comparison, the estimated ratio of means based on operable samples only (n=91) was 1.123 with a sampling error of 12.2% (at a 95% confidence level). The target sampling error of a maximum of 25%, as specified in the amended VPIP, was met in all Operable strata with the exception of the "Operable Other species – Mature" stratum. The sampling error for volume in this stratum was about 31%.

It appears that the largest bias among the inventory attributes is associated with basal area/ha and trees/ha, which in this analysis were generated by the FIPSTART module of VDYP7 (since there was concern about the accuracy of the photo-interpretation of these attributes in this management unit). Basal area/ha, which is a significant driver of volume estimation in the VDYP7 model, was underestimated by nearly 20% over all strata.

Ratio of means comparisons (and sampling error % at a 95% confidence level) for six attributes, based on the 30+ years target population in the Strathcona TSA.

Leading species Stratum	n	Ratio of weighted means (with 95% sampling error shown as % of the ratio)					
		Age (years)	Height (m)	Basal area (m^2/ha at 7.5cm+ dbh)	Trees/ha (at 7.5cm+ dbh)	Lorey height (m)	Volume/ha (m^3/ha at 12.5cm+ dbh net dwb)
Operable Cw-Yc	26	0.784 (±24.7%)	0.988 (±14.8%)	1.133 (±14.3%)	1.055 (±29.1%)	0.978 (±11.7%)	1.145 (±18.5%)
Operable Fd	26	0.962 (±12.3 %)	1.062 (±7.1%)	1.234 (±22.4%)	1.282 (±33.7%)	1.049 (±8.7%)	1.198 (±23.6%)
Operable Other-Immature	26	1.045 (±13.5 %)	0.959 (±10.1%)	1.380 (±11.8%)	1.350 (±24.3%)	1.011 (±11.0%)	1.233 (±18.8%)
Operable Other-Mature	13	0.986 (±27.8 %)	0.978 (±17.8%)	1.063 (±14.4%)	0.992 (±44.1%)	0.928 (±20.3%)	1.007 (±31.4%)
All Operable samples	*91*	*0.940 (±10.0%)*	*0.998 (±6.4%)*	*1.192 (±8.4%)*	*1.223 (±16.9%)*	*0.987 (±6.9%)*	*1.123 (±12.2%)*
Inoperable (all spp)	7	1.324 (±33.3 %)	0.976 (±17.6%)	1.209 (±25.8%)	1.539 (±33.5%)	0.760 (±28.3%)	1.260 (±49.1%)
Overall (all samples)	*98*	*1.072 (±13.3%)*	*0.993 (±6.7%)*	*1.196 (±9.4%)*	*1.315 (±15.9%)*	*0.941 (±8.4%)*	*1.143 (±17.1%)*

Based on issues encountered through the statistical analysis in the Strathcona TSA, the following recommendations are made:

- Investigate the differences between the photo-interpreted and VDYP7-generated estimates of basal area and trees/ha, in relation to the ground-based estimates, to determine opportunities for improving the Phase I estimates of these attributes, either through changes in photo-estimation methodologies or FIPSTART design.
- Recognizing that the total volume bias reported in this analysis is a function of both the input attributes to VDYP7 ("attribute" bias) and assumptions inherent in the VDYP7 model ("model" bias), determine the relative contributions of these two bias sources in the Strathcona TSA to provide more focus for improving volume estimation in this management unit.
- Keep a central repository for sample selection files and documentation to facilitate subsequent analysis.
- For new Phase I inventories, ensure that the data has passed QA before distributing for use.
- Establish a standardized format for the provision of the Phase I data for VRI statistical analysis, which includes reference year and input values at reference year.
- Provide a "key" file, with adequate identifiers to enable linkage between the Phase II sample and the associated Phase I inventory data.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

1.1 Background

A partial new Phase I Vegetation Resources Inventory (VRI) was completed by Timberline on behalf of the Strathcona Timber Supply Area (TSA) licencees between 2005 and 2007. The original Phase II Vegetation Resources Inventory Project Implementation Plan (VPIP), completed in April of 2006, specified the establishment of an initial 50 Phase II samples in Vegetated Treed (VT) stands greater than 30 years of age.

The original VPIP Phase II sample selection pre-stratification was based on leading species and age class and identified 4 strata:

1. Western redcedar and yellow cedar (C-Y) leading stands, greater than 30 years (n=11)
2. Douglas-fir (Fd) leading stands, greater than 30 years (n=10)
3. Other species leading, established after 1885 (H-Immature) (n=11)
4. Other species leading, established before 1886 (H-Mature) (n=18)

The preliminary analysis of this data completed by Timberline in 2007 indicated that a total of 132 samples would be required to meet the original target sampling error of ±10% (at a 95% confidence level), based on a estimated CV of 58%. After consultations with the licensees and the Ministry, it was agreed that an additional 53 plots, focusing on the Operable portion of the TSA[1], would be sufficient to provide the necessary confidence required for a timber supply analysis in this management unit. The revised target sampling error that appears in the amended (2007) VPIP was specified as achieving a ±25% sampling error (at a 95% confidence level) for each stratum in the Operable area. The expected overall sampling error in the Operable area was approximately ±10.5% (at a 95% confidence level).

The revised sample distribution (for a total of 102 samples) as provided in the VPIP amendment was:

6. Operable, Western redcedar and yellow cedar (C-Y) leading stands, greater than 30 years (n=27)
7. Operable, Douglas-fir (Fd) leading stands, greater than 30 years (n=27)
8. Operable, Other species leading, established after 1885 (Other-Immature) and greater than 30 years (n=27)
9. Operable, Other species leading, established before 1886 (Other-Mature) (n=11)
10. Inoperable (VT greater than 30 years) (n=10)

Details of the sample planning for the Strathcona TSA (both the original and amended VPIPs) can be found in the *"Strathcona Timber Supply Area Vegetation Resources Inventory: Project Implementation Plan Version 4.0"*[2], which has been appended to this document for reference.

1.2 Description of the Inventory Unit

The following description of the Strathcona TSA has been excerpted from the VPIP document[3]:

[1] A total of 102 plots, 92 in the Operable and 10 in the Inoperable landbase.

[2] *"Strathcona Timber Supply Area Vegetation Resources Inventory Project Implementation Plan, Version 4.0"*, Timberline Natural Resource Group, March 31, 2008, 38pp.

[3] Ibid. 1

The Strathcona Timber Supply Area (TSA) is situated in the Coast Forest Region and is administered from the Campbell River Forest District Office in Campbell River. The District covers central Vancouver Island from the south end of Strathcona Park to the Brooks Peninsula in the north, several islands in the Strait of Georgia and portions of the mainland to the east. In total, the boundaries of the District encompass approximately 1.4 million hectares, but a significant portion of this is marine area. The Vegetated Treed component of the Strathcona TSA is 327,955 ha (24% of the total District).

The location of the Strathcona TSA is illustrated in Figure 1 below[4].

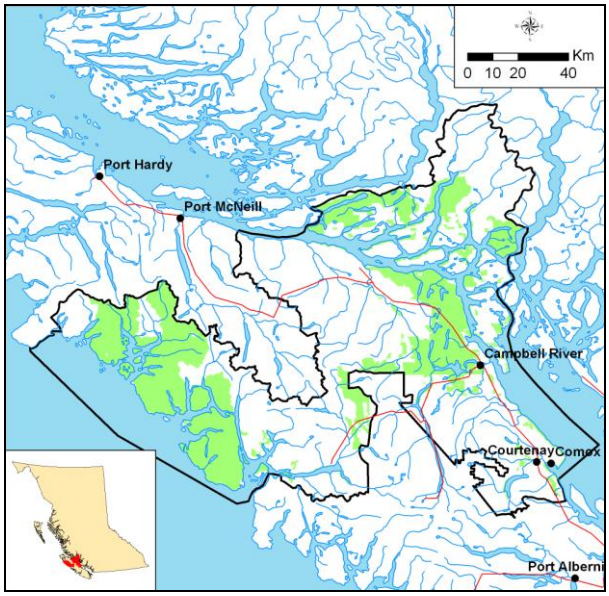

Figure 1: Map of the Campbell River Forest District (green denotes the land component of the Strathcona TSA).

1.3 Scope and Objectives

The objective of this project was to provide a VDYP7-based VRI statistical analysis for the Strathcona TSA, based on current Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) standards. The analysis was to be based on the 102 Phase II samples established in the 2006 and 2007 field seasons. Due to concerns regarding the accuracy of Phase I photo-estimation of basal area and trees per hectare in this management unit[5], it was agreed that the VRI statistical analysis should be based on the assumption of an F-type inventory. Hence the FIPSTART module in VDYP7 was to be used to generate basal area/ha and trees/ha in lieu of using the photo-interpreted values for these attributes.

The Strathcona TSA VRI statistical analysis was restricted to Vegetated Treed (VT) polygons greater than 30 years of age. Compiled Phase II data (including NVAF-adjusted volumes) and the Phase I data were provided by the MFLNRO. The development of statistical ratios of means and sampling errors were carried out in accordance with the recommended MFLNRO procedures as of September 2011. All attribute values were based on live trees only.

[4] Ibid. 1

[5] Sam Otukol, MFLNRO, August 17, 2011 email.

2. METHODS

2.1 Overview of VRI Statistical Analysis

The role of the VRI statistical analysis is to evaluate the accuracy of the Phase I photo-interpreted inventory data, using the Phase II ground sample data as the basis for the comparison.

The process involves first running the Phase I inventory data through the VDYP7 yield model to project the attributes to the same year as the ground sampling. The Phase I inventory data corresponding to the Phase II ground samples are identified and rigorous data checking and plots of the Phase II versus Phase I attribute values are carried out to screen for potential data errors and/or inappropriate matching of Phase I and II data. Analysis is usually done at the stratum level, where strata are typically defined by leading species[6]. After calculating and applying the appropriate sampling weights, mean values of the ground samples attributes and the corresponding Phase I inventory attributes are computed. Ratios of these two values (i.e. the mean Phase II ground sample value / the mean Phase I inventory value) are then calculated along with the corresponding sampling errors, by strata.

These ratios of means, which are developed from the relationship between the Phase II ground sample values and the Phase I photo-interpreted inventory values for the set of polygons that comprised the VRI Phase II ground sample, form the basis of the inventory assessment. The sampling errors for these ratios can be used to interpret the risk and uncertainty associated with the sampling process.

There are six timber attributes that are considered in the current VRI ground sample data analysis:

- Age of the first species,
- Height of the first species,
- Basal area at 7.5cm+ dbh utilization (BA7.5),
- Trees per hectare at 7.5cm+ dbh utilization (TPH7.5),
- Lorey height[7] at 7.5cm+ dbh utilization (LH7.5), and
- Volume net top, stump (CU), decay, waste and breakage at 12.5cm+ dbh utilization.

2.2 Population for Analysis

The population of interest for the Strathcona TSA analysis included Vegetated Treed (VT) polygons that were 30 years of age or greater as of 2006. The total area in this population of interest was 275,237 hectares[8].

2.3 Phase II Sample Selection Pre-Stratification and Weights

Details on the sample distribution by strata for the first (2006) and second (2007) batches of samples selected by Timberline as per the VPIP documents are provided in Appendix A. All samples were selected with probability proportional to size with replacement (PPSWR). For the first (2006) batch of 50 samples, the pre-

[6] The target population is usually pre-stratified prior to sample selection. In some cases, post-stratification may be required at the analysis stage particularly if significant bias trends are observed in the residuals plots of the data. However, post-stratification is generally restricted to subdivision of existing strata Analysis stratification that differs greatly from the original sample selection stratification is usually very inefficient and is not recommended. However, analysis sub-stratification within the original sample selection strata may be used to distinguish important trends if a sufficient number of samples are available. The need for sub-stratification can often be deduced from the plots of residual values.

[7] Lorey height is mean height, weighted by tree basal area. This height measure is generally more stable than unweighted mean height and is an important input attribute in the VDYP7 yield prediction model.

[8] Ibid. 1

stratification stratum assigned to each sample was clearly identified in the VPIP document. However, the sample selection strata were revised in 2007 and all Inoperable samples in the first batch were moved into a separate stratum. Since the 2007 VPIP amendment stated that all additional sample establishment (i.e. the second batch) would be focused on the Operable landbase, no further samples were established in the Inoperable stratum. Therefore, it was assumed that all 10 Inoperable samples indicated in the VPIP amendment came from the first batch of samples established in 2006.

Unfortunately, there was no sample selection documentation (e.g. the VPIP Addendum, the original sample selection list, etc.) to specifically identify which of the first batch samples were moved to the Inoperable stratum. This was problematic from the perspective of determining and assigning strata and corresponding sampling weights. Without knowing which samples from the first batch had been reclassified as Inoperable, the analysis could not proceed based on the operability-dependent revised stratification.

Upon further investigation, the operability criteria and/or maps used by Timberline and the licensees in determining operability could not be located or reproduced. In addition, an overlay of the current operability line (developed in 2010) did not produce the same number of Inoperable samples as reported in the amended VPIP. In an effort to determine which samples were Inoperable, MFLNRO and BCTS staff examined each sample individually. In this manner, eight (8) samples were identified as being the most likely candidates for Inoperable at the time of sample selection[9]. Of these samples, one was excluded since it was outside of the population of interest (a VN polygon). This left 7 samples for analysis in the Inoperable stratum.

The resulting sample distribution among the sample selection strata and the accompanying weights were discussed with Ministry staff and approved for use in this analysis. These are summarized in Table 1. Sampling weights were determined based on the area in each stratum as identified in the VPIP and the number of samples that were actually established and met the population of interest criteria (i.e. VT, 30 years of age or greater). The sampling weights were computed as A_h/n_h.

With the exception of Operable/Inoperable, the stratum assignment for each sample (in terms of leading species stratum and also sub-stratum) was provided in the VPIP document. It should be noted that the stratum assignment at the time of sample selection did not always concur with the leading species on the Phase I inventory file used for the analysis. It was assumed that this was due, in part, to the re-inventory and accompanying polygon redelineation. After discussions with Ministry staff, it was agreed that the sample selection stratum assignment for the samples would be the stratification basis used for the VRI statistical analysis, regardless of the leading species on the current Phase I inventory[10].

[9] Although the amended VPIP indicated that there were 2 additional samples (i.e. 10 not 8) in the Inoperable stratum, these samples could not be clearly identified. Hence Ministry staff made the decision to proceed based on 8 Inoperable samples. Note that the 2 unidentified Inoperable samples were in the "Other-Mature" stratum. See section 3.3 for discussion of the potential impact on sampling error in this stratum.

[10] There were 4 non-cedar leading samples in the CW-Y stratum, 2 non-fir leading samples in the Fd stratum, 7 non-"other species" leading samples in the Other-Immature stratum, and 2 non-"other species" leading samples in the Other-Mature stratum.

Table 1: Stratum areas, VRI Phase II sample distribution and sampling weights for the Strathcona TSA.

Sample Selection Leading Species Stratum	*Sub-stratum*	*Population area A_h (VT, 30+ years)*	*Planned sample allocation*	*Actual Established samples (n_h)*	*Sampling Weight A_h/n_h*
Operable C-Y	0-300 m^3/ha	7,197	7	8	**900**
	300.1-450	9,250	8	7	**1,321**
	450.1+ m^3/ha	12,661	12	11	**1,151**
Operable FD	<=27 m	17,674	9	8	**2,209**
	27.1-32 m	20,996	11	11	**1,909**
	32.1+ m	14,950	7	7	**2,136**
Operable H-Immature	<=22 m	19,596	9	8	**2,450**
	22.1-27 m	18,577	8	8	**2,322**
	27.1+ m	22,338	10	10	**2,234**
Operable H-Mature	0-300 m^3/ha	7,473	1	1	**7,473**
	300.1-450	23,665	6	7	**3,381**
	450.1+ m^3/ha	23,279	4	5	**4,656**
Inoperable	C-Y	30,940	3	2	**15,470**
	FD	2,110	1	1	**2,110**
	H	44,529	6	4	**11,132**
Total		*275,237*	*102*	*98*	

2.4 Data Sources

2.4.1 Phase I photo-interpreted inventory data

The Strathcona TSA VRI Phase I was re-inventoried by Timberline between 2005 and 2007. At the time of this analysis, the data had only been partially loaded to the production copy of the VRIMS database[11]. Hence the Phase I data file ("strat_est_gdb.mdb") used for this analysis was provided on August 22, 2011 through Doug Layden, Timber Supply Analyst for the Strathcona TSA, who also provided the key files used to link the Phase I and Phase II data.

In the initial stage of the analysis, several sample polygons showed significant disparity between the Phase I and the ground sample attributes. These were investigated by Cathy Taylor, Will Smith, Doug Layden and Marc Rousseau (MFLNRO staff). Subsequently, on September 16, 2011 a new set of attributes for 13 polygons were provided in a spreadsheet which superseded the data extracted from "strat_est_gdb.mdb". Some of this data was recovered from back-up files, as recent harvesting updates had changed the polygon from vegetated treed to vegetated non-treed. Or in some cases, the polygon information came from files that were loaded after August 22, or in other cases, the ground sample locations were examined and determined to be in different polygons.

The Phase I inventory attributes provided for analysis are shown in Appendix B.

[11] The first copy of the data provided contained many polygons with reference years prior to 2005, presumably the old data.

Although photo-interpreted basal area and trees/ha values were available for the Phase I data, there was concern about the accuracy of the photo-interpreted values of these attributes in the Strathcona TSA. As a result, MFLNRO staff instructed the analysis to be run assuming an F-type inventory, where basal area and tree/ha would be generated by VDYP7 in the FIPSTART module, rather than using the photo-interpreted values of these attributes.

All Phase I basal area/ha and trees/ha values reported in this analysis were generated by VDYP7 in the FIPSTART module.

A stand-alone run of VDYP7 Console was used to generate the FIPSTART attribute values as well as the inventory volumes, which were not provided on the original VRIMS extract. The Phase I data for each sample was projected to the year of ground sampling, which ranged from 2006 to 2007.

2.4.2 Phase II ground sample data

The amended VPIP document indicates that 102 samples were selected for establishment in the Strathcona TSA. The Phase II data was compiled by MFLNRO and included application of the most up-to-date regional NVAF values. This file was provided by Will Smith (MFLNRO) on September 14, 2011. Bob Krahn (MFLNRO) provided a spreadsheet indicating the plots and samples affected by the re-inventory of the Strathcona TSA.

The compiled data was provided under two project numbers: the project 0371 compilation was based on the original ground sample data, whereas the project 037A compilation was based on the new (i.e. re-inventory) polygon delineation. As a result of new polygon delineation, there were 40 samples where at least one auxiliary plot fell outside of the new polygon boundaries and was removed from the compilation. This analysis was based on the project 037A compilation, reflecting the re-inventory polygon delineation.

The Phase II compiled ground sample attributes used in the analysis are provided in Appendix C.

2.4.3 Data issues related to the statistical adjustment

Some versions of the VPIP document referred to a total sample size of 103. However, sample #30 was never established hence the total number of samples established and compiled was 102. Samples #51, 107 and 108 replaced the original samples #38, 73 and 92 respectively.

Sample #36 was excluded from the analysis since it was determined to be Vegetated Non-treed (VN) and hence outside of the population of interest. Samples #9, 71 and 95 were excluded since they appeared to have been logged between the time of sample selection and sample establishment.

Scatterplots comparing the Phase I and Phase II attributes were examined for outliers but no changes were made to the data used in the analysis. Details are provided in the Data Issues Log in Appendix D.

2.4.4 Height and Age data matching

The data matching used to determine the appropriate Phase I and II heights and ages upon which to base the comparison ratios followed the same basic approach outlined in the MFLRNO procedures and standards document.

For each VRI sample polygon, the Phase II ground sample data was matched with the corresponding Phase I inventory data for the same polygon. The ground heights and ages used in the analysis were based on the

average values for the T, L, S, X & O trees[12] for the ground leading species (by basal area at 4cm + dbh utilization) on the ground. The objective in the matching process was to choose an inventory height and age (i.e. for either the leading or second species) so that the ground and inventory species "matched". Although Phase I second species age and height data were available in the Strathcona TSA, the height and age matching in this analysis was restricted to the leading species data[13].

If a leading species match could not be made at the sp0[14] level, conifer-to-conifer (or deciduous-to-deciduous) matches were allowed. However, conifer-deciduous matches were not considered acceptable. Appendix E provides the details for the height and age data matching. Appendix F provides a comparison between the Phase I inventory leading species and the Phase II ground sample leading species.

Of the 98 samples used in the analysis, 62 (or 63%) indicated a match between the inventory leading species and the ground leading species at 4cm+ dbh utilization. A further 33 samples (34%) were matched based on a conifer-to-conifer basis. Only three samples could not be matched and were therefore excluded from the development of the age and height comparison ratios[15]. A further 3 samples did not have suitable height information collected for the ground leading species in the Phase II sample and hence could not be used in the development of the height ratios[16]. However, all samples were used in the analysis of basal area, trees/ha, Lorey height and volume ratios.

3. RESULTS AND DISCUSSION

3.1 VRI statistical analysis

As a way to compare the Phase I inventory values with the Phase II ground sample values, ratios of the weighted mean[17] Phase II ground sample attribute over the corresponding weighted mean Phase I inventory attribute were computed. The ratios of means were calculated for each of the six key attributes identified in Section 2.1, for each stratum as well as over all samples. The resulting weighted means are shown in Table 2. The ratios of means, and the sampling error associated with each of these statistics, are provided in Table 3.

The relationship between the Phase II ground and the Phase I inventory attributes corresponding to each ratio were examined in scatterplots (Appendix G). The ratios of means were also evaluated for potential bias by

[12] T or "top height" tree is the largest DBH in 0.01 ha plot, regardless of species; L or "leading species" tree is the largest DBH in 0.01 ha plot, of leading species; S or "second species" is the largest DBH in 0.01 ha plot, of second species. T and S trees are selected and measured at the IPC only whereas L trees are selected at the IPC and all auxiliary plots. If a suitable (age or height) leading species sample tree is not found in any given plot in a cluster, a "replacement" tree will be selected. An "O" tree is the closest suitable (for height and age) tree of the leading species to the 5.64m radius plot center. An "X" tree is the closest suitable tree of the leading species outside of the 5.64m radius plot but within a maximum 25m radius of plot centre. For further details, refer to the MFLNRO document "VRI Ground Sampling Procedures Version 4.8, May 2008, Amendment # 1: Modifications to the Leading Species Site Tree Selection Procedures", April, 2009.

[13] Since the Phase I data received by the MFLNRO was not projected to the year of sample establishment, VDYP7 Console was used to do the projection. However, VDYP7 Console is not able to project the second species height data. As a result, the height and age matching was restricted to the leading species age and height data. This impacted 20 samples that were matched on a conifer-conifer basis rather than a match between the leading species.

[14] sp0 refers to the 16 major species codes and is roughly equivalent to the genus level.

[15] Samples # 7, 19, and 89.

[16] Samples #8, 18 and 77.

[17] Weights are provided in Table 1.

plotting the "residual" values[18] as a function of the ratio-adjusted (or "estimated") value for each attribute. In addition, the residuals were plotted as a function of unadjusted inventory age as a check for any age-related trends. These graphs are also included in Appendix G.

Careful examination of the scatterplots in Appendix G did not suggest any significant bias patterns associated with the ratios of means. However, many of the graphs illustrated a weak relationship between the ground and the inventory attribute values and a high level of variability.

[18] A "residual" is computed as *actual minus estimate*. In this case, the actual is the Phase II sample value and the estimate is the ratio-adjusted Phase I value (i.e. Phase I value multiplied by the ratio of means value).

Table 2: Sample-estimated weighted means for the Phase I inventory and Phase II ground sample for six key inventory attributes (based on the 30+ years target population in the Strathcona TSA).

Attribute	***Weighted Means, by sample selection leading species stratum***						
	Operable Cw-Yc	Operable Fd	Operable Other-Immature	Operable Other-Mature	***All Operable samples***	Inoperable (all spp)	***All strata***
Age (years)							
n	25	26	24	13	***88***	7	***95***
Phase II Ground	208	75	61	284	***145***	272	***185***
Phase I Inventory	266	78	58	288	***154***	206	***172***
Height (m)							
n	24	26	24	11	***85***	7	***92***
Phase II Ground	28.2	30.8	25.7	34.9	***27.4***	19.0	***26.6***
Phase I Inventory	28.6	29.0	26.8	35.7	***27.4***	19.4	***26.8***
Basal area (m2/ha) at 7.5cm+ dbh							
n	26	26	26	13	***91***	7	***98***
Phase II Ground	74.7	57.5	63.1	77.1	***67.2***	48.0	***61.8***
Phase I Inventory[19]	65.9	46.7	45.7	72.6	***56.3***	39.7	***51.6***
Trees/ha at 7.5cm+ dbh							
n	26	26	26	13	***91***	7	***98***
Phase II Ground	903	1214	1435	555	***1054***	1405	***1153***
Phase I Inventory[20]	856	947	1063	560	***862***	913	***877***
Lorey height (m)							
n	26	26	26	13	***91***	7	***98***
Phase II Ground	24.9	26.3	24.1	31.2	***26.8***	13.4	***23.0***
Phase I Inventory	25.5	25.1	23.8	33.6	***27.1***	17.7	***24.4***
Volume/ha (m3/ha) at 12.5cm+ dbh net dwb							
n	26	26	26	13	***91***	7	***98***
Phase II Ground	533	460	475	703	***542***	266	***464***
Phase I Inventory	465	384	385	698	***483***	211	***406***

[19] Based on FIPSTART values from VDYP7 (i.e. not the photo-estimated values).

[20] Ibid.

Table 3: Ratio of means comparisons (and sampling error % at a 95% confidence level) for six attributes, based on the 30+ years target population in the Strathcona TSA.

Sample selection Leading species Stratum	***n***	***Ratio of weighted means (with 95% sampling error shown as % of the ratio)***					
		Age (years)	***Height (m)***	***Basal area[21] (m^2/ha at 7.5cm+ dbh)***	***Trees/ha[22] (at 7.5cm+ dbh)***	***Lorey height (m)***	***Volume/ha (m^3/ha at 12.5cm+ dbh net dwb)***
Operable Cw-Yc	26[23]	0.784 (±24.7%)	0.988 (±14.8%)	1.133 (±14.3%)	1.055 (±29.1%)	0.978 (±11.7%)	1.145 (±18.5%)
Operable Fd	26	0.962 (±12.3 %)	1.062 (±7.1%)	1.234 (±22.4%)	1.282 (±33.7%)	1.049 (±8.7%)	1.198 (±23.6%)
Operable Other-Immature	26[24]	1.045 (±13.5 %)	0.959 (±10.1%)	1.380 (±11.8%)	1.350 (±24.3%)	1.011 (±11.0%)	1.233 (±18.8%)
Operable Other-Mature	13[25]	0.986 (±27.8 %)	0.978 (±17.8%)	1.063 (±14.4%)	0.992 (±44.1%)	0.928 (±20.3%)	1.007 (±31.4%)
All Operable samples	*91*	*0.940 (±10.0%)*	*0.998 (±6.4%)*	*1.192 (±8.4%)*	*1.223 (±16.9%)*	*0.987 (±6.9%)*	*1.123 (±12.2%)*
Inoperable (all spp)	7	1.324 (±33.3 %)	0.976 (±17.6%)	1.209 (±25.8%)	1.539 (±33.5%)	0.760 (±28.3%)	1.260 (±49.1%)
Overall (all samples)	*98*	*1.072 (±13.3%)*	*0.993 (±6.7%)*	*1.196 (±9.4%)*	*1.315 (±15.9%)*	*0.941 (±8.4%)*	*1.143 (±17.1%)*

The ratios of means in Table 3 can be used to assess the accuracy of selected attributes within the Phase I inventory. Since the ratios are computed as the Phase II value over the Phase I value, *a ratio of means greater than 1 suggests that the Phase I attribute is underestimated*. Similarly, *a ratio of means value less than 1 indicates that the Phase I is overestimating* the attribute value.

The sample suggests that, on average, the inventory age is overestimated in all operable strata except the "Other species leading – Immature" stratum where there is a roughly 5% age underestimation. Operable Cedar ages in particular are overestimated considerably, by more than 20% on average. However, the variability related to this estimate was relatively high.

Overall, there was relatively minor height estimation bias in this management unit. In most strata the difference between the average Phase I and II height was less than 1 metre. The only notable exception was in the "Operable Fir leading" stratum where the average Phase I inventory height was 1.8m less than the average Phase II ground sample height, representing a 6% height underestimation.

[21] The audit analysis for the Strathcona TSA was based on assuming an F-type inventory, hence the basal area and trees/ha attributes were generated by VDYP7 (in the FIPSTART routine) rather than using the photo-interpreted values.

[22] Ibid

[23] In this stratum, age means and ratios are based on 25 samples and height means and ratios are based on 24 samples (see section 2.4.4).

[24] In this stratum, age and height means and ratios are based on 24 samples (see section 2.4.4).

[25] In this stratum, height means and ratios are based on 11 samples (see section 2.4.4).

Basal area is a major driver of volume in the VDYP7 yield model. As noted previously, the Phase I inventory basal area/ha and trees/ha values were generated using the VDYP7 FIPSTART module. The sample indicated that the Phase I values generated in this manner underestimated basal area/ha by about 20% overall[26]. The "Operable Other species leading" strata were interesting in that basal area/ha was grossly underestimated (by about 38%) in the Immature but only slightly underestimated (about 6%) in the Mature. Examination of the scatterplots in the Immature stratum in particular shows a very weak correlation between the Phase I and Phase II values for this attribute and a high degree of variability.

On average, the sample suggested that trees/ha was also underestimated (particularly in the Inoperable stratum). For all Operable strata combined, the ratio of means for trees/ha was 1.223 with a 16.9% sampling error. Although there appeared to be minimal estimation bias for trees/ha in the "Operable Other species leading – Mature" stratum, there was considerable variability in this stratum as observed in the scatterplots and indicated by the high sampling error.

Lorey height is another significant input for generating volume in the VDYP7 model. Lorey height itself is an attribute that is derived by VDYP7 i.e. it is not directly photo-interpreted, although it is based on photo-interpreted height and influenced by basal area. In most strata the Lorey height results were similar to the results for height, with the exception of the Inoperable stratum where the bias in Lorey height was likely influenced by the bias in basal area.

The assessment for volume estimation is discussed separately in Section 3.2.

Appendix F provides a detailed comparison of how the Phase I inventory leading species compared with the leading species based on the Phase II ground sample compilation. In about 60% of the samples, the inventory reported the same leading species as was found on the ground. However, the accuracy of the inventory leading species varied depending on the species. For example, 73% of the samples where the inventory indicated hemlock leading were found to be hemlock leading on the ground. However, only 50% of the samples that were cedar leading on the inventory were actually cedar leading on the ground.

3.2 Assessment of Phase I inventory volume accuracy

Since volume estimation and yield projection are important components of the VRI inventory and play a key role in timber supply analyses, the information in Tables 2 and 3 have been restated in Table 4 to focus the discussion on volume. Timber supply analyses are typically done on a net decay, waste and breakage volume basis. Hence, the volume/ha accuracy assessment and its associated sampling error is computed on this basis. As was the case for the other attribute comparisons (Section 3.2), the ratios of means for volume were computed as ratios of the weighted mean Phase II (ground sample) volume to the weighted mean Phase I (VDYP7) volume. Hence a ratio greater than 1 indicates that the Phase I inventory is underestimating volume. The results, by stratum, are shown in Table 4.

The Phase II ground sample suggests that, on average, the VDYP7 volumes in the Strathcona TSA are consistently underestimated across all strata with the exception of the "Operable Other-Mature" (i.e. non-fir, non-cedar stratum. Although the average volume estimation bias in the "Operable Other-Mature" stratum was minimal, the sampling error in this stratum was high, reflecting the smaller sample size and relatively high level of variability in this stratum.

In the other strata, the average volume underestimation bias ranged from about 15% for operable cedar samples to 26% for the inoperable samples. Overall, inventory volumes in the Strathcona TSA appear to be underestimated by about 14% on average, based on the ground sample information.

[26] This was consistent with the results for all Operable strata combined, where the basal area ratio of means was 1.190 with a sampling error of 8.4%.

When the inoperable samples are excluded from the overall volume comparison, the estimated ratio of means based on operable samples only (n=91) was 1.123 with a sampling error of 12.2% (at a 95% confidence level).

Table 4: Assessment of Phase I inventory volume accuracy (assuming "F"-type inventory), based on the Phase II ground sample, by stratum for the 30+ years target population in the Strathcona TSA.

Assessment of Phase I inventory volume (m^3/ha) estimates @12.5cm+ dbh utilization net DWB					
Stratum	***n***	***Weighted Mean Phase II vol/ha***	***Weighted Mean Phase inventory vol/ha***	***Estimated ratio of means volume comparison***	***Sampling error % for volume ratio (at 95% confidence level)***
Operable Cw-Yc	26	533	465	1.145	±18.5%
Operable Fd	26	460	384	1.198	±23.6%
Operable Other-Imm.	26	475	385	1.233	±18.8%
Operable Other-Mature	13	703	698	1.007	±31.4%
All Operable samples	*91*	*542*	*483*	*1.123*	*±12.2%*
Inoperable (all spp)	7	266	211	1.260	±49.1%
Overall (all samples)	*98*	*464*	*406*	*1.143*	*±17.1%*

3.3 Sampling error

The sampling error estimates in Tables 3 and 4 were computed using the MFLNRO's Excel-based macro tool[27]. These values can provide an indication of the reliability of the sample-based estimated ratios of means.

After the interim analysis (based on the first batch of samples) was completed by Timberline in July of 2007, the sampling error objectives for the project were revised, in consultation with the Ministry and Licensees. The amended VPIP document for the Strathcona TSA targeted stratum-level sampling errors of 25% for the Operable strata. It was also suggested that the overall sampling error for the operable strata combined would be in the order of 10.5% (at the 95% confidence level).

From Table 4, the target sampling error of a maximum of 25% was met in all Operable strata with the exception of the "Operable Other species – Mature" stratum. The sampling error for volume in this stratum was about 31%. The higher than expected sampling error in this stratum is likely the result of the inclusion of two samples that were considered Inoperable in the original sample selection (i.e. not included in this stratum) but that could not be identified as Inoperable for this analysis and hence were kept in this stratum[28]. Although the sampling error was high in this stratum, the ratio of means for volume was close to 1. Essentially the samples established in this stratum were not sufficient to make any confident conclusions regarding inventory volume estimation, one way or the other.

[27] "VRI Analysis Workbook 2010-10-29_Test_mod.xlsm" provided by Sam Otukol, MFLRNO.

[28] The sampling error computed and reported in the amended VPIP for the "Operable Other-Mature" stratum was 18%, based on 11 samples. As a result, the decision was made not to establish any additional samples in this stratum in the second batch of sampling. The 18% sampling error computed in the VPIP is considerably lower than the 31% (based on 13 samples) computed in Table 3. Extensive investigation could not determine which additional 2 samples in this stratum might have been considered Inoperable in the original VPIP sample selection (see Section 2.3).

As noted in Section 3.2, for all operable strata combined, the estimated ratio of means (n=91) was 1.123 with a sampling error of 12.2% (at a 95% confidence level).

4. CONCLUSIONS AND RECOMMENDATIONS

The VDYP7-based VRI statistical analysis for the Strathcona TSA suggests that, overall, inventory volumes in the population of interest[29] are currently underestimated by 14%. The sampling error for this volume bias estimate was ±17.1% (at the 95% confidence level). For the Operable areas, the focus of timber supply analyses, the sample estimated an average inventory volume underestimation of just over 12%.

The Phase II sampling met the VPIP targets for sampling error by strata in all by one stratum, the "Operable Other-Mature". Volume bias estimates in this stratum were inconclusive. Depending on this importance of this stratum from a timber supply perspective, any additional sampling should be focused in this stratum.

There were concerns regarding the photo-interpreted values for basal area/ha and trees/ha in this management unit. As a result, the inventory was processed though the VDYP7 yield model as an F-type inventory so that VDYP7 would generate the basal area and trees/ha values internally. However, this analysis indicated that the VDYP7 values for these attributes were not without bias. In fact, the sample suggested that FIPSTART underestimates both basal area and trees/ha in this management unit and this underestimation occurred consistently across all strata. Since basal area is a major driver of volume estimation in the VDYP7 model, it is suspected that the observed volume underestimation in the Strathcona TSA may be closely related to the underestimation of basal area.

Based on issues encountered through the statistical analysis in the Strathcona TSA, the following recommendations are made:

- Investigate the differences between the photo-interpreted and VDYP7-generated estimates of basal area and trees/ha in relation to the ground-based estimates to determine opportunities for improving the Phase I estimates for these attributes, either through changes in photo-estimation methodologies or FIPSTART design.
- Recognizing that the total volume bias reported in this analysis is a function of both the input attributes to VDYP7 ("attribute" bias) and assumptions inherent in the VDYP7 model ("model" bias), determine the relative contributions of these two bias sources in the Strathcona TSA to provide more focus for improving volume estimation in this management unit.
- Keep a central repository for sample selection files and documentation to facilitate subsequent analysis. In particular, ensure that the following components are clearly documented to enable computation of sampling weights:
    - Sample selection stratification and sub-stratification criteria;
    - Population of interest area (hectares) in each stratum and sub-stratum;
    - Stratum and sub-stratum assignment for each Phase II sample (including replacement samples).
- For new Phase I inventories, ensure that the data has passed QA before distributing for use.

[29] VT polygons 30 years of age or greater.

- Establish a standardized format for the provision of the Phase I data for VRI statistical analysis, which includes reference year and input values at reference year.[30]
- Provide a "key" file, with adequate identifiers to enable linkage between the Phase II sample and the associated Phase I inventory data. At a minimum this would contain the Phase II cluster id (composed of project id, sample number and type code), and a VRIMS identifier, which would link to the Phase I data extract.

[30] Note that the 1 record / polygon CSV file format, which can be used as input to VDYP7, would meet these requirements. This format is discussed in section 2.4.2 page 11 of the MFLNRO document "Variable Density Yield Projection, Volume 3- VDYP7 Console Interface Guide" (http://www.for.gov.bc.ca/hts/vdyp/user_guides/Volume3_Console_User_guide_W_Flat_file_april2010.pdf)

5. APPENDIX A: SAMPLE DISTRIBUTION AND SAMPLING WEIGHTS

Table A-1: Sample distribution of original 50 samples selected.

Sample selection distribution and sample weights based on TIMBERLINE documentation: From p. 5 of March 31, 2008 version 4 VPIP. Table 4. Phase II sample size by stratum.					Actual sample distribution accounting for: non-establishment, replacement samples and sample exclusions. NOTE: *Stratum assignment is as per original VPIP sample selection document.*
First Batch:					
Stratum	Sub-stratum	Area (ha)	No. Samples	Sampling weight as per VPIP[31]	
C-Y	0-300 m^3/ha	22,372	4	5,593	4
	300.1-450 m3/ha	20,512	4	5,128	4
	450.1+ m3/ha	17,164	3	5,721	3
	Total	60,048	11	5,459	
Fd	≤27 m	19,632	4	4,908	3[32]
	27.1-32 m	18,444	3	6,148	3
	32.1+ m	17,654	3	5,885	3
	Total	55,730	10	5,573	
H-Immature	≤22 m	22,652	4	5,663	4
	22.1-27 m	18,949	3	6,316	3
	27.1+ m	22,599	4	5,650	4
	Total	64,200	11	5,836	
H-Mature	0-450 m3/ha	31,206	6	5,201	4[33]
	450.1-650 m3/ha	36,039	7	5,148	7
	650.1+ m3/ha	28,014	5	5,603	5
	Total	95,259	18	5,292	
Total		*275,237*	*50*	*5,505*	*47*

[31] This sampling weight is for reference only. The sampling weights used in the analysis are shown in Table A-2.

[32] Sample #9 was excluded from this stratum in the analysis since it was recently logged (see Appendix D).

[33] Sample #30 was not established and not replaced. Sample #36 was excluded since it was VN (outside of population).

Table A-2: Sample distribution of all samples (n=102) from VPIP and final analysis sampling weights based on actual sample distribution. *Note: only 7 samples were identified as Inoperable for this analysis.*

Sample selection distribution and sample weights based on TIMBERLINE documentation: From p. 3 of VPIP Amendment: Table 13. Sample Distribution ***All samples (first plus second batch):***					Actual sample distribution accounting for: non-establishment, replacement samples and sample exclusions. NOTE: *Stratum assignment as per original VPIP sample selection document AND operability assignment provided by MFLNRO staff*	**FINAL ANALYSIS SAMPLE WEIGHTS**
Stratum	Sub-stratum	Area (ha) **A**	No. Samples	Sampling weight as per VPIP[34]	**B**	**=A/B**
Operable	0-300 m^3/ha	7,197	7	1,028	8	**900**
C-Y	300.1-450	9,250	8	1,156	7	**1,321**
	450.1+ m^3/ha	12,661	12	1,055	11[35]	**1,151**
	Sub-Total	29,108	27	1,078		
FD	<=27 m	17,674	9	1,964	8[36]	**2,209**
	27.1-32 m	20,996	11	1,909	11	**1,909**
	32.1+ m	14,950	7	2,136	7	**2,136**
	Sub-Total	53,621	27	1,986		
H-Immature	<=22 m	19,596	9	2,177	8	**2,450**
	22.1-27 m	18,577	8	2,322	8	**2,322**
	27.1+ m	22,338	10	2,234	10	**2,234**
	Sub-Total	60,512	27	2,241		
H-Mature	0-300 m^3/ha	7,473	1	7,473	1	**7,473**
	300.1-450	23,665	6	3,944	7	**3,381**
	450.1+ m^3/ha	23,279	4	5,820	5	**4,656**
	Sub-Total	54,417	11	4,947		
Operable	Total	197,658	92	2,148		
Inoperable	C-Y	30,940	3	10,313	2	**15,470**
	FD	2,110	1	2,110	1	**2,110**
	H	44,529	6	7,422		**11,132**
					H-immature = 1	
					H-mature = 3[37]	
	Sub-Total	77,579	10	7,758		
Total		*275,237*	*102*	*2,698*	*98*	

[34] This sampling weight is for reference only; sampling weights used in the analysis are shown in the right-most column.
[35] Samples #71 & 95 were excluded since they were recently logged.
[36] Sample #9 excluded since it was recently logged (no longer VT).
[37] Sample #36 was excluded since it was VN (outside of population).

6. APPENDIX B: PHASE I INVENTORY ATTRIBUTES

SAMPLE	Stratum	Sampling weight	Measurement year (for projection)	Reference Year	Input Age	Input Height	Input BA (photo-estimate)	Input TPH (photo-estimate)	Species Composition	VDYP7 attributes projected to measurement year (FIPSTART generated BA & TPH)					
										Age sp1	Height sp1	BA/ha @7.5cm+ dbh	TPH @7.5cm+ dbh	Lorey height @7.5cm+ dbh	Volume/ha net dwb @12.5cm+ dbh
1	C-Y	1151	2006	2003	300	38	80	400	CW 50 HW 30 BA 20	303	38.1	85.4	573	34.3	718
2	INOP	2110	2006	2003	120	18	20	575	FD 60 HW 40	123	18.2	27.3	863	15.6	123.7
3	H-Imm	2234	2006	2003	40	22	45	1100	FD 70 HW 20 CW 10	43	23.5	41.4	1390	19.4	246.6
4	H-Imm	2322	2006	2003	31	15	20	3800	HW 40 CW 30 SS 20 DR 10	34	16.6	26.8	1234	14.1	111.2
5	H-Imm	2450	2006	2003	50	23	35	950	HW 60 CW 20 FD 10 DR 10	53	24.1	40.2	992	21.2	281.8
6	H-Mat	3381	2006	2003	275	36	65	350	HW 45 CW 30 BA 20 FD 5	278	36.1	76.2	639	32.4	700.7
7	H-Imm	2322	2006	2003	40	23	55	1625	DR 90 HW 10	43	23.6	29.6	706	21.3	230.3
8	H-Mat	4656	2006	2003	300	44	80	250	HW 60 FD 40	303	44.1	71.4	443	43.1	925
10	INOP	15470	2006	2003	170	18	20	350	CW 60 HW 30 FD 10	173	18.1	35.3	828	16.7	157.8
11	C-Y	1321	2006	2003	300	25	50	1050	CW 40 YC 30 HW 20 BA 10	303	25.1	72.3	1185	22.3	434.5
12	H-Mat	3381	2006	2003	300	32	75	650	HW 50 CW 35 BA 15	303	32.1	72.3	659	28.1	552.9
13	C-Y	1151	2006	2003	300	34	75	450	CW 40 HW 40 BA 20	303	34.1	76.7	640	30.5	603.9
14	H-Mat	3381	2006	2003	275	38	70	350	HW 40 CW 30 BA 20 FD 10	278	38.1	75.7	568	34.8	739.3
15	FD	1909	2006	2003	50	28	55	700	FD 80 HW 20	53	29.3	48.7	1125	25	392
16	H-Mat	3381	2007	1999	185	32.4	52	650	HW 65 BA 15 CW 10 YC 10	193	33.0	61.6	636	29.1	556.7
17	H-Mat	4656	2006	2002	300	40	65	350	BA 45 HW 40 CW 15	304	40.2	76.6	553	36.6	837.7
18	H-Mat	4656	2006	2003	300	45	80	425	HW 70 CW 20 BA 10	303	45.1	77.6	391	41.5	882.2
19	C-Y	1321	2007	2003	33	22	35	1100	DR 50 HW 30 CW 20	37	23.0	33.4	855	19.2	214.4
20	FD	2136	2006	2003	60	34	80	630	FD 90 HW 10	63	35.1	54.4	870	30.5	536.6
21	C-Y	900	2006	2003	300	22	40	975	CW 50 HW 20 PL 20 YC 10	303	22.1	56.2	1016	19.5	289.8
22	FD	2209	2006	2003	50	22	50	1500	FD 80 HW 20	53	23.1	42.1	1418	19.4	248.1
23	H-Mat	3381	2006	2003	230	32	55	425	HW 90 CW 10	233	32.1	62.0	588	28.5	527.2
24	C-Y	1151	2007	2003	500	38	80	425	CW 40 HW 25 BA 20 FD 15	504	38.1	82.7	582	35.5	711.6
25	H-Imm	2450	2006	2003	31	20	35	1150	HW 60 BA 25 FD 15	34	21.9	43.8	1487	19.5	286.9
26	H-Imm	2450	2006	2003	41	21	35	1050	HW 40 FD 30 CW 10 PW 10 DR 10	44	22.4	34.8	1092	21.2	243.5
27	H-Imm	2234	2006	2003	80	37	75	800	FD 55 HW 39 CW 6	83	37.8	61.4	811	32	630
28	FD	1909	2006	2003	60	30	50	400	FD 80 HW 10 CW 10	63	31.0	51.4	998	26.2	429.5

SAMPLE	Stratum	Sampling weight	Measurement year (for projection)	Reference Year	Input Age	Input Height	Input BA (photo-estimate)	Input TPH (photo-estimate)	Species Composition	VDYP7 attributes projected to measurement year (FIPSTART generated BA & TPH)					
										Age sp1	Height sp1	BA/ha @7.5cm+ dbh	TPH @7.5cm+ dbh	Lorey height @7.5cm+ dbh	Volume/ha net dwb @12.5cm+ dbh
29	C-Y	900	2007	2003	32	10	20	1600	CW 60 HW 40	36	11.5	16.6	1259	10.4	39.2
31	C-Y	1321	2006	2003	200	28	65	925	CW 50 YC 30 HW 20	203	28.1	76.9	1110	24.4	503.2
32	INOP	11132	2006	2003	250	25	50	400	HW 50 YC 30 BA 10 CW 5 FD 5	253	25.1	63.5	1011	22.4	414.6
33	H-Imm	2322	2007	2003	59	26.7	43	900	HW 80 CW 20	63	28.0	46.8	810	24.3	377.2
34	H-Mat	4656	2007	2003	400	42	95	650	HW 50 CW 30 BA 20	404	42.1	82.6	473	38.3	820.7
35	H-Mat	3381	2006	2003	275	35	65	400	HW 45 CW 45 BA 10	278	35.1	76.0	563	31.3	590
37	C-Y	900	2006	2003	40	12	25	2350	CW 65 HW 25 FD 10	43	12.9	20.4	1236	11.9	62.5
39	H-Mat	3381	2007	2003	275	36	65	750	HW 60 BA 20 CW 20	279	36.2	71.0	558	32.3	665.9
40	INOP	15470	2006	2003	290	19	10	425	YC 40 HW 40 CW 10 BA 10	293	19.1	37.8	787	17.5	183.7
41	H-Imm	2234	2006	2003	56	24	50	1200	CW 40 HW 40 FD 10 BA 10	59	25.1	52.8	1297	23.1	387.5
42	INOP	11132	2006	2003	260	20	10	250	HM 65 BA 25 YC 10	263	20.2	34.2	634	18	187.3
43	H-Mat	4656	2006	2003	300	40	70	375	BA 50 HW 30 YC 10 CW 10	303	40.1	77.6	573	36.1	848.8
44	FD	1909	2006	2003	60	31	70	675	FD 50 HW 40 CW 10	63	32.1	55.2	1015	26.6	472.3
45	INOP	11132	2006	2003	40	12	20	1200	HW 40 CW 40 FD 20	43	12.9	17.0	1056	12.9	55.9
46	INOP	11132	2006	2003	200	22	45	900	HW 50 FD 20 CW 20 YC 10	203	22.1	55.0	1253	19.4	316.4
47	FD	2136	2006	2003	50	27	50	950	FD 75 HW 20 CW 5	53	28.3	46.5	1094	23.9	355.1
48	H-Mat	7473	2006	2003	250	29	50	475	HW 60 CW 40	253	29.1	64.5	656	25.1	432.3
49	H-Imm	2234	2006	2003	60	33	55	425	HW 50 CW 30 FD 20	63	34.1	57.0	789	31.2	580.4
50	FD	2209	2006	2003	150	27	50	850	FD 40 HW 30 CW 20 PL 10	153	27.2	54.7	980	21.9	361.4
51	FD	2136	2006	2003	40	28	65	700	FD 90 HW 10	43	29.9	47.5	1097	25.5	391.3
53	FD	1909	2007	2005	50	31	60	800	FD 70 HW 30	52	31.9	50.4	993	27.4	450.4
54	FD	2209	2007	2003	50	18	25	500	FD 60 PL 40	54	19.1	10.9	367	17.7	61.9
55	H-Imm	2234	2007	2003	56	24	50	1200	CW 40 HW 40 FD 10 BA 10	60	25.4	53.8	1282	23.4	399.7
56	FD	2209	2008	2003	80	32	70	475	FD 60 HW 20 BA 10 CW 10	85	33.0	56.0	872	28.2	503.6
57	H-Imm	2322	2007	2003	70	32	75	1050	HW 50 BA 40 CW 10	74	33.2	61.2	860	29.6	638.3
58	H-Imm	2322	2007	2003	80	35	80	850	HW 60 CW 20 FD 10 DR 10	84	36.0	56.5	652	32.5	610.5
59	C-Y	1321	2007	2003	400	25	55	1100	CW 40 YC 30 HW 20 BA 10	404	25.1	74.3	1176	22.3	430.8
60	C-Y	900	2007	2003	30	15.2	13	2550	CW 50 HW 50	34	17.4	21.0	877	16	98.6
61	FD	2209	2007	2003	50	22	37	850	FD 80 HW 20	54	23.4	37.3	1105	19.9	229
62	FD	1909	2007	2003	60	29	40	325	FD 80 HW 10 PL 10	64	30.3	42.1	739	26.6	363.8

SAMPLE	Stratum	Sampling weight	Measurement year (for projection)	Reference Year	Input Age	Input Height	Input BA (photo-estimate)	Input TPH (photo-estimate)	Species Composition	VDYP7 attributes projected to measurement year (FIPSTART generated BA & TPH)					
										Age sp1	Height sp1	BA/ha @7.5cm+ dbh	TPH @7.5cm+ dbh	Lorey height @7.5cm+ dbh	Volume/ha net dwb @12.5cm+ dbh
63	C-Y	1151	2007	2003	350	37	65	350	CW 60 HW 30 FD 10	354	37.1	87.7	501	34.2	673.6
64	FD	2136	2007	2003	49	33	75	500	FD 100	53	35.1	53.8	667	31.1	528.8
65	C-Y	1151	2007	2003	350	35	50	300	CW 70 HW 30	354	35.1	83.6	439	31.9	556.3
66	FD	1909	2007	2003	60	33	65	350	FD 100	64	34.3	53.0	608	30.8	510.3
67	C-Y	1151	2007	2003	220	30	65	600	CW 40 YC 30 HW 20 BA 10	224	30.2	77.6	987	26.4	559
68	H-Imm	2234	2007	2003	60	34	65	600	HW 50 FD 40 CW 10	64	35.5	58.8	864	33.8	674.3
69	C-Y	1151	2007	2003	275	33	70	550	CW 50 HW 40 FD 10	279	33.2	78.5	667	30.2	589.7
70	H-Imm	2450	2007	2003	31	9	24	4300	HW 90 BA 10	35	10.4	16.6	1642	8.8	25.1
72	H-Imm	2234	2007	2003	34	24	53	600	HW 43 FD 33 SS 18 CW 6	38	26.5	50.9	1377	25	430.5
74	C-Y	900	2007	2003	210	21	50	800	CW 60 PL 30 HW 10	214	21.2	53.0	1105	18.5	273.2
75	C-Y	900	2007	2003	51	20	40	1200	CW 39 HW 38 DR 18 SS 5	55	21.4	39.8	1137	19.9	253.9
76	C-Y	1151	2007	2003	380	36	55	600	BA 60 HW 40	384	36.2	69.7	537	32.1	703.3
77	C-Y	1321	2007	2003	300	30	43	325	CW 80 DR 10 HW 10	304	30.1	64.7	420	27.4	383.5
78	FD	1909	2007	2003	40	24	50	850	FD 40 DR 30 CW 10 AC 10 HW 10	44	25.5	36.4	952	22.1	265.6
79	FD	1909	2007	2003	60	27	40	650	FD 80 HW 10 DR 10	64	28.1	42.8	1010	24.1	334.3
80	FD	2136	2007	2003	54	30	65	800	FD 65 HW 30 CW 5	58	31.7	52.4	1013	26.9	455.1
81	H-Imm	2450	2007	2003	30	15	30	1300	HW 70 FD 20 CW 10	34	17.2	32.3	1653	14.8	135.6
82	FD	2209	2007	2003	300	39	70	350	FD 70 HW 30	304	39.1	66.7	588	34.5	677.5
83	H-Imm	2234	2007	2003	70	32	73	675	FD 50 HW 30 DR 10 CW 10	74	33.1	52.7	894	27.5	470
84	H-Imm	2234	2007	2003	60	26	50	1000	HW 50 CW 30 BA 20	64	27.0	54.1	1063	23.4	421.4
85	H-Imm	2450	2007	2003	35	23	35	950	HW 60 CW 40	39	25.4	44.5	1089	21.3	309.9
86	H-Imm	2450	2007	2003	30	11.7	30	2000	HW 50 FD 50	34	13.5	22.1	1640	11.3	54.7
87	C-Y	1321	2007	2003	300	27	45	725	YC 40 CW 30 HW 30	304	27.1	69.4	935	23.8	439
88	C-Y	1321	2007	2003	180	26	60	500	HW 60 CW 20 FD 20	184	26.3	56.0	899	23.2	392.4
89	H-Imm	2234	2007	2003	46	29	55	1000	DR 65 HW 20 FD 15	50	29.7	38.1	705	27	386.2
90	FD	2209	2007	2003	110	20	45	500	HW 70 FD 30	114	20.5	41.0	1093	18.6	239.1
91	C-Y	1151	2007	2003	300	36	65	375	CW 70 HW 10 FD 10 BA 10	304	36.1	94.1	619	33.2	734.1
93	FD	1909	2007	2003	70	31	65	600	FD 60 HW 30 CW 10	74	32.0	55.6	973	26.9	475.4
94	FD	2136	2007	2003	84	41.5	50	200	FD 100	88	42.5	61.0	412	39.1	725.9
96	FD	1909	2007	2003	54	26.5	55	550	FD 100	58	27.9	45.7	796	24.3	348.2

SAMPLE	Stratum	Sampling weight	Measurement year (for projection)	Reference Year	Input Age	Input Height	Input BA (photo-estimate)	Input TPH (photo-estimate)	Species Composition	VDYP7 attributes projected to measurement year (FIPSTART generated BA & TPH)					
										Age sp1	Height sp1	BA/ha @7.5cm+ dbh	TPH @7.5cm+ dbh	Lorey height @7.5cm+ dbh	Volume/ha net dwb @12.5cm+ dbh
97	C-Y	1151	2007	2003	350	42	105	450	CW 60 YC 20 HW 20	354	42.1	112.4	646	36.9	931.7
98	H-Imm	2450	2007	2003	45	24	45	1000	HW 40 CW 30 BA 20 DR 10	49	25.8	47.0	1100	22.2	353.4
99	C-Y	900	2007	2003	28	18	25	1050	HW 60 BA 20 CW 15 DR 5	32	12.8	22.6	1607	10.8	59.7
100	C-Y	900	2007	2003	300	22	45	1100	CW 40 HW 40 YC 20	304	22.1	57.8	1053	19.6	296.1
101	FD	1909	2007	2003	50	28	50	350	FD 70 HW 20 DR 10	54	29.8	43.8	966	25.6	367
102	C-Y	1151	2007	2003	300	35	50	250	CW 50 FD 30 HW 20	304	35.2	81.2	641	33.9	697.9
103	FD	2136	2007	2003	31	18	35	1150	FD 70 HW 15 CW 10 DR 5	35	20.3	33.2	1439	17	164.8
104	FD	2209	2007	2003	130	16	25	850	PL 65 FD 25 HW 10	134	16.2	32.5	1388	13.9	135.4
105	H-Imm	2322	2007	2003	75	29	60	900	HW 80 FD 10 CW 10	79	30.0	54.7	892	26.6	489.5
107	H-Imm	2322	2007	2003	80	35	80	850	HW 60 CW 20 FD 10 DR 10	84	36.0	56.5	652	32.5	610.5
108	H-Imm	2322	2007	2003	112	38.5	128	986	HW 95 FD 5	116	39.2	61.1	531	35.6	738.5

7. APPENDIX C: PHASE II COMPILED GROUND ATTRIBUTES

SAMPLE	Species composition @4cm+dbh	Basal area/ha @7.5cm+dbh	Trees/ha @7.5cm+dbh	Lorey height @7.5cm+dbh (ht_mean1)	Live Vol/ha with NVAF net dwb (NVL_NWB) @12.5cm+dbh
1	Hw 41 Cw 27 Yc 18 Ba 14	84.0	3066	24.2	453.9
2	Hw 38 Hm 38 Ba 19 Yc 05	49.0	600	15.2	432.8
3	Hw 39 Fd 30 Cw 26 Ba 05	70.4	1614	24.3	504.1
4	Hw 50 Ss 23 Cw 18 Pl 09	18.8	1959	8.2	25.8
5	Hw 72 Cw 17 Dr 06 Fd 05	55.1	1050	17.9	375.7
6	Hw 63 Ba 25 Ss 08 Cw 04	76.8	1477	21.4	683.7
7	Cw 59 Dr 29 Fd 12	69.4	2637	24.0	403.1
8	Cw 63 Hw 25 Fd 12	32.0	53	40.1	328.6
10	Yc 54 Hm 31 Hw 15	39.8	564	15.7	234.1
11	Yc 50 Hw 32 Ba 14 Fd 04	110.0	693	26.6	562.0
12	Hw 43 Yc 29 Hm 14 Ba 14	85.1	632	18.4	188.0
13	Cw 59 Hw 24 Yc 06 Ba 06 Fd 05	81.0	487	38.0	774.6
14	Ba 43 Hw 24 Cw 19 Fd 10 Ss 04	105.0	817	38.2	1269.3
15	Fd 58 Dr 33 Cw 09	43.2	630	21.3	341.4
16	Hw 47 Ba 33 Cw 20	75.9	164	40.2	1010.4
17	Yc 53 Hw 26 Ba 16 Hm 05	96.0	988	22.9	443.6
18	Cw 50 Yc 25 Hw 25	100.0	681	28.8	833.0
19	Hw 50 Cw 43 Ba 07	12.7	987	3.4	35.8
20	Fd 82 Hw 18	69.4	1152	31.5	647.2
21	Cw 77 Hw 23	105.3	1286	14.6	626.5
22	Hw 58 Fd 32 Dr 10	76.0	1131	26.4	645.7
23	Hw 54 Ba 23 Yc 15 Cw 08	69.3	445	33.0	688.1
24	Cw 57 Hw 29 Fd 14	70.9	211	30.4	619.1
25	Hw 60 Ba 33 Cw 07	61.3	879	26.6	542.2
26	Hw 76 Fd 10 Pl 07 Cw 07	50.4	3218	13.3	188.0
27	Cw 47 Hw 35 Fd 18	54.4	612	36.4	435.6
28	Fd 100	21.4	205	31.0	197.6
29	Hw 85 Ba 15	74.3	2128	18.8	448.5
31	Hw 52 Cw 26 Yc 17 Ba 05	92.0	696	26.3	761.1
32	Hm 34 Yc 34 Ba 28 Hw 04	92.8	1205	23.2	734.6
33	Hw 95 Fd 05	112.0	1439	29.6	1030.4
34	Hw 94 Ba 06	72.9	290	37.2	947.2
35	Hw 65 Cw 27 Ba 08	105.3	277	42.0	1325.2
37	Fd 76 Hw 18 Cw 06	29.3	1806	12.3	132.9
39	Ba 94 Hw 06	45.4	400	3.1	500.4
40	Hm 55 Yc 45	32.4	1482	6.8	22.5
41	Cw 71 Hw 29	89.6	1138	28.9	577.5
42	Hm 33 Bl 29 Ba 24 Yc 14	37.8	728	13.1	237.1
43	Ba 61 Hw 39	72.9	1136	35.8	393.2
44	Fd 59 Hw 29 Cw 12	69.4	2538	30.7	534.8
45	Hw 71 Cw 14 Fd 15	45.0	2584	11.7	170.5
46	Hw 60 Fd 25 Cw 15	49.0	2315	11.7	274.1
47	Fd 63 Hw 37	48.6	526	29.2	422.4
48	Cw 64 Hw 18 Ba 18	74.3	177	35.7	718.9

SAMPLE	Species composition @4cm+dbh	Basal area/ha @7.5cm+dbh	Trees/ha @7.5cm+dbh	Lorey height @7.5cm+dbh (ht_mean1)	Live Vol/ha with NVAF net dwb (NVL_NWB) @12.5cm+dbh
49	Hw 69 Cw 15 Fd 08 Pw 08	54.0	1248	23.4	424.7
50	Hw 50 Cw 32 Fd 18	58.8	4167	13.6	228.0
51	Fd 44 Ac 33 Dr 23	27.0	360	27.3	224.3
53	Fd 83 Hw 13 Cw 04	54.0	772	30.8	504.7
54	Fd 64 Pl 36	42.0	1733	19.4	305.2
55	Cw 80 Hw 15 Fd 05	64.0	981	32.9	384.7
56	Fd 56 Hw 34 Cw 06 Yc 04	99.2	2618	20.8	712.3
57	Hw 53 Cw 35 Yc 06 Ba 06	69.4	2377	22.8	413.1
58	Hw 56 Cw 25 Fd 13 Dr 06	65.3	574	30.3	562.6
59	Ba 65 Hw 35	114.8	482	29.8	741.8
60	Hw 94 Ba 06	55.1	1168	24.2	416.9
61	Fd 100	53.3	2961	13.7	214.5
62	Fd 92 Hw 08	36.0	342	24.4	302.7
63	Cw 56 Hw 37 Fd 07	81.0	206	37.9	773.6
64	Fd 90 Cw 06 Hw 04	55.8	841	28.9	511.0
65	Hw 50 Ba 44 Cw 06	85.3	1229	29.8	267.8
66	Fd 83 Cw 17	32.0	382	29.2	276.2
67	Cw 45 Hw 27 Yc 23 Ba 05	137.5	625	25.1	1190.0
68	Fd 40 Hw 40 Dr 12 Pw 04 Cw 04	75.0	1516	27.1	666.5
69	Cw 60 Hw 30 Yc 05 Fd 05	81.0	556	27.3	662.5
70	Hw 84 Dr 08 Ba 04 Ss 04	56.4	1350	19.4	345.6
72	Hw 92 Dr 08	61.3	849	23.5	498.9
74	Cw 44 Hw 22 Yc 22 Tw 12	72.0	1213	7.7	311.2
75	Cw 53 Hw 40 Fd 07	57.2	748	20.1	378.1
76	Cw 64 Ba 27 Hw 09	74.3	90	44.4	798.7
77	Cw 80 Hw 20	80.0	347	25.5	659.3
78	Fd 100	63.0	468	34.6	680.2
79	Hw 58 Fd 38 Cw 04	65.9	1801	14.1	450.6
80	Hw 63 Fd 37	39.2	354	30.4	369.5
81	Hw 88 Cw 12	24.8	1426	7.9	81.9
82	Fd 39 Cw 39 Hw 17 Ba 05	91.1	365	38.9	959.0
83	Hw 58 Fd 33 Cw 09	76.8	764	34.1	787.9
84	Hw 72 Fd 19 Cw 09	78.4	1658	27.4	564.1
85	Hw 50 Cw 40 Dr 10	55.1	1971	19.6	311.6
86	Hw 43 Dr 29 Ss 21 Fd 07	42.0	432	23.4	294.9
87	Yc 67 Hw 27 Hm 06	61.3	1074	17.7	166.2
88	Fd 40 Cw 40 Hw 20	40.0	132	30.4	405.2
89	Cw 54 Hw 27 Dr 12 Fd 07	63.7	657	23.8	466.9
90	Fd 67 Hw 33	175.0	2705	32.5	1218.7
91	Hw 100	64.0	844	29.4	676.9
93	Hw 58 Fd 42	38.4	1125	24.5	274.0
94	Fd 83 Dr 11 Hw 06	44.1	167	40.1	475.9
96	Fd 100	58.2	593	32.3	564.3
97	Cw 42 Hw 37 Ba 16 Yc 05	68.9	847	21.2	536.5
98	Cw 80 Hw 15 Dr 05	32.4	2841	7.9	72.7
99	Cw 41 Fd 32 Hw 23 Dr 04	32.4	1823	15.0	136.4
100	Hw 50 Ba 28 Yc 17 Hm 05	96.0	1788	25.6	298.3

SAMPLE	Species composition @4cm+dbh	Basal area/ha @7.5cm+dbh	Trees/ha @7.5cm+dbh	Lorey height @7.5cm+dbh (ht_mean1)	Live Vol/ha with NVAF net dwb (NVL_NWB) @12.5cm+dbh
101	Fd 75 Dr 25	48.0	650	26.9	399.5
102	Hw 47 Fd 35 Cw 12 Dr 06	68.0	270	31.6	746.0
103	Fd 77 Dr 23	39.0	1166	21.8	273.5
104	Pl 63 Fd 19 Cw 13 Hw 05	31.5	1148	11.7	140.1
105	Hw 74 Dr 11 Fd 11 Cw 04	76.0	1134	28.8	704.9
107	Hw 75 Dr 17 Cw 08	96.0	942	37.4	1061.5
108	Hw 91 Cw 09	77.0	1811	31.4	731.6

8. APPENDIX D: DATA ISSUES

Background notes:

- Population of interest defined as VT polygons, greater than 30 years of age in 2006
- For Phase II compilation, two project IDs were available for Strathcona: 0371 – compilation of all Phase II plots in a sample (i.e. before new delineation of polygons); 037A – Phase II compilation which reflects new delineation of polygons. About 40 samples lost aux plots.
- All compiled Phase II values for this analysis are based on project 037A (reflecting the new polygon delineation).
- Phase I was projected to 2006-2007 (depending on measurement year) using FIPSTART (all BA and TPH values were set to null)
- Phase I Reference year for the samples was between 1999 and 2010

Sample #	***Issue***	***Phase I attributes***	***Phase II attributes***	***Comments? Resolution?***
2	Phase I inventory indicates VN (pop of interest was restricted to VT). ***Exclude this sample?***	VN;with species comp (Hw leading); age=303; ht=12m; BA=10.4; volume =31 m^3/ha; CC=9%; reference year = 2003	Age =247; ht=25m; volume 446 m^3/ha	WS: CT confirmed with photo CC < 10. Plot landed in narrow band of timber. Note that this sample is in the MH zone but was considered F mat in selection. **Outside of pop**. GC: Received new attributes from MR 9/29/11. FDC60HW40 CC 30%. KJ: new attributes used in analysis
36	Phase I inventory indicates VN (pop of interest was restricted to VT). ***Exclude this sample?***	VN; with species comp (Yc leading); age=263 but ht=8m (no BA, TPH or Volume); CC=5%; reference year = 2003	Age =293; ht= not available; volume net dwb = 4.7 m^3/ha	WS: CT confirmed with photo, CC < 10. **Outside of pop**. GC: Received attributes from MR 9/29/11. No change to documented phase 1 KJ: sample excluded from analysis.
22	Phase I inventory indicates VN (pop of interest was restricted to VT). ***Exclude this sample?***	VN – no species comp (hence VDYP7 could not process); reference year=2009	Measurement year=2006; age= 68, ht= 33, volume= 600+ m^3/ha	WS: Landsat scrutiny shows sample still in timber. CT: Original polygon has been redelinated with a new label for the sample location. **Use new phase 1 label** of 75% CC FDC80HW20 50years/22m BA 50 Stems 1500 GC: Received new attributes from MR 9/29/11 as shown above. KJ: new attributes used in analysis

Sample #	***Issue***	***Phase I attributes***	***Phase II attributes***	***Comments? Resolution?***
39	Phase I inventory indicates VN (pop of interest was restricted to VT). ***Exclude this sample?***	VN - no species comp (hence VDYP7 could not process); reference year=2006	Measurement year=2007; Age= 294, ht= 19, vol= 500 m^3/ha	WS: Landsat scrutiny shows sample still in timber. CT has confirmed the old label. **Use new phase 1 label** 55%CC HW60BA20CW20 275 years/36m BA 65 Stems 750 GC: Received new attributes from MR 9/29/11 as shown above. KJ: new attributes used in analysis
66	Phase I inventory indicates VN (pop of interest was restricted to VT). ***Exclude this sample?***	VN - no species comp (hence VDYP7 could not process); reference year=2008	Measurement year=2007; Age= 65, ht= 26, vol= 270 m^3/ha	WS: Landsat scrutiny shows sample still in timber. CT has confirmed the new label. Use **the new phase 1 label of** 70%CC FDC 100 60 years/33m BA 73 GC: Received new attributes from MR 9/29/11 BA 65 Stems 375 - verified as correct. KJ: new attributes used in analysis
95	Phase I inventory indicates VN (pop of interest was restricted to VT). ***Exclude this sample? (sample is also <30 yrs of age)***	VN; with species comp (Hw leading); age=1; ht=0.03m; no BA, TPH or Volume; CC=2%; reference year = 2010	Measurement year=2007; no species comp or volume.	WS: Harvested sample. VRI plot was a fixed area cluster with no trees and no comments, so likely established in the cutblock. **Outside of the population.** **KJ: excluded from analysis**
9	Did this fall in a "hole" in the polygon (valid sample) or was this polygon recently logged (exclude sample) or ??	VT- FD 100% age 72, ht 23.7, volume 253 m^3; reference year=2005	Measurement year=2006; no species comp or volume. Also checked project 0371 (i.e. all aux plots) and ground volume still 0.	WS: Harvested sample. VRI plot was a fixed area cluster with no trees and no comments, so likely established in the cutblock. **Outside of the population.** **KJ: excluded from analysis**
71	Did this fall in a "hole" in the polygon (valid sample) or was this polygon recently logged (exclude sample) or ??	VT -Cw 50 Hw 40 Yc 10 Ba 10, age 500 ht 34, volume 650 m^3; reference year=2003	Measurement year=2007; no species comp or volume. Also checked project 0371 (i.e. all aux plots) and ground volume still 0.	WS: Harvested sample. VRI plot has the comment that the plot lands in a cutblock. **Outside of the population.** **KJ: excluded from analysis**

9. APPENDIX E: HEIGHT AND AGE MATCHING

The current standard for Phase II ground age and height is based on the average of the T, L, S, X and O trees. The matching typology is as follows:

Case 1: Phase I leading species matches the Phase II leading species at the Sp0 level

Case 2: Phase I second species matches the Phase II leading species at the Sp0 level (does not apply in Strathcona TSA since no second species height or age data projected to ground sampling year was available)

Case 3: Phase I leading species matches the Phase II leading species on a conifer-to-conifer (or deciduous-to deciduous) basis

Case 4: Phase I second species matches the Phase II leading species on a conifer-to-conifer (or deciduous-to deciduous) basis (does not apply in Strathcona TSA since no second species height or age data projected to ground sampling year was available)

Case 5: No match

SAMPLE	*Phase II (ground) lead spp @ 4cm+dbh*	*Ph II lead species age (aget_tlsxo)*	*Ph II lead species height (ht_tlsxo)*	*Number of age trees (n_ag_tlsxo)*	*Number of height trees (n_ht_tlsxo)*	*Ph I inventory lead SP01*	*Case for match*	*Ph I age for match (depending on case; msg if case 5 or no Ph II value available)*	*Ph I ht for match (depending on case; msg if case 5 no Ph II value available))*
1	HW	200	21.6	3	1	CW	3	303	38.1
2	HM	247	25.4	3	2	FD	3	123	18.2
3	HW	67	26.0	4	4	FD	3	43	23.5
4	HW	29	7.3	5	5	HW	1	34	16.6
5	HW	49	24.7	4	4	HW	1	53	24.1
6	HW	193	29.7	4	2	HW	1	278	36.1
7	CW	50	20.6	2	2	DR	5	.	.
8	CW	166		1	0	HW	3	303	.
10	YC	379	20.6	4	2	CW	1	173	18.1
11	YC	492	28.7	3	1	CW	1	303	25.1
12	HW	224	21.8	4	4	HW	1	303	32.1
13	CW	343	32.6	3	2	CW	1	303	34.1
14	BA	262	48.2	3	1	HW	3	278	38.1
15	FD	59	33.2	2	2	FD	1	53	29.3
16	HW	265	37.5	4	4	HW	1	193	33.0
17	YC	464	25.3	2	2	BA	3	304	40.2
18	CW	524		1	0	HW	3	303	.
19	HW	51	6.8	2	2	DR	5	.	.
20	FDC	91	34.7	3	3	FD	1	63	35.1
21	CW	484	19.3	6	1	CW	1	303	22.1
22	HW	68	33.2	4	4	FD	3	53	23.1
23	HW	382	37.1	2	1	HW	1	233	32.1
24	CW	188	34.0	1	1	CW	1	504	38.1
25	HW	61	21.3	3	3	HW	1	34	21.9
26	HW	104	17.9	4	3	HW	1	44	22.4
27	CW	77	33.3	4	4	FD	3	83	37.8

SAMPLE	Phase II (ground) lead spp @ 4cm+dbh	Ph II lead species age (aget_tlsxo)	Ph II lead species height (ht_tlsxo)	Number of age trees (n_ag_tlsxo)	Number of height trees (n_ht_tlsxo)	Ph I inventory lead SP01	Case for match	Ph I age for match (depending on case; msg if case 5 or no Ph II value available)	Ph I ht for match (depending on case; msg if case 5 no Ph II value available))
28	FDC	56	30.5	2	2	FD	1	63	31.0
29	HW	36	16.6	4	3	CW	3	36	11.5
31	HW	328	26.7	3	1	CW	3	203	28.1
32	HM	394	28.7	1	1	HW	1	253	25.1
33	HW	76	28.8	3	3	HW	1	63	28.0
34	HW	111	36.4	5	5	HW	1	404	42.1
35	HW	311	46.0	3	2	HW	1	278	35.1
37	FDC	108	13.2	4	2	CW	3	43	12.9
39	BA	294	19.2	1	2	HW	3	279	36.2
40	HM	396	14.1	4	1	YC	3	293	19.1
41	CW	79	29.5	5	5	CW	1	59	25.1
42	HM	210	15.6	3	1	HM	1	263	20.2
43	BA	294	40.9	4	3	BA	1	303	40.1
44	FDC	63	37.5	3	3	FD	1	63	32.1
45	HW	51	15.8	4	4	HW	1	43	12.9
46	HW	118	19.0	4	4	HW	1	203	22.1
47	FDC	64	32.6	5	5	FD	1	53	28.3
48	CW	220	38.4	1	1	HW	3	253	29.1
49	HW	51	25.2	2	2	HW	1	63	34.1
50	HW	98	15.4	5	5	FD	3	153	27.2
51	FDC	45	31.7	1	1	FD	1	43	29.9
53	FDC	62	33.1	5	5	FD	1	52	31.9
54	FDC	66	22.9	2	2	FD	1	54	19.1
55	CW	98	32.9	5	5	CW	1	60	25.4
56	FDC	90	39.0	4	4	FD	1	85	33.0
57	HW	84	19.6	3	3	HW	1	74	33.2
58	HW	56	34.4	3	3	HW	1	84	36.0
59	BA	330	35.1	2	1	CW	3	404	25.1
60	HW	44	26.3	4	4	CW	3	34	17.4
61	FDC	68	16.8	3	3	FD	1	54	23.4
62	FDC	66	31.2	4	3	FD	1	64	30.3
63	CW	119	32.0	2	2	CW	1	354	37.1
64	FDC	58	32.5	5	5	FD	1	53	35.1
65	HW	342	32.4	2	2	CW	3	354	35.1
66	FDC	65	26.1	2	2	FD	1	64	34.3
67	CW	182	40.6	2	1	CW	1	224	30.2
68	FDC	62	35.1	3	3	HW	3	64	35.5
69	CW	118	30.2	3	1	CW	1	279	33.2
70	HW	28	17.6	4	4	HW	1	35	10.4
72	HW	33	26.3	4	4	HW	1	38	26.5
74	CW	216	12.8	3	1	CW	1	214	21.2
75	CW	55	20.1	2	2	CW	1	55	21.4
76	CW	123	54.7	2	1	BA	3	384	36.2
77	CW	158		3	0	CW	1	304	.
78	FDC	57	37.8	3	3	FD	1	44	25.5
79	HW	69	29.7	2	2	FD	3	64	28.1
80	HW	58	30.8	2	2	FD	3	58	31.7
81	HW	29	12.3	4	4	HW	1	34	17.2

SAMPLE	Phase II (ground) lead spp @ 4cm+dbh	Ph II lead species age (aget_tlsxo)	Ph II lead species height (ht_tlsxo)	Number of age trees (n_ag_tlsxo)	Number of height trees (n_ht_tlsxo)	Ph I inventory lead SP01	Case for match	Ph I age for match (depending on case; msg if case 5 or no Ph II value available)	Ph I ht for match (depending on case; msg if case 5 no Ph II value available))
82	CW	210	42.4	1	1	FD	3	304	39.1
83	HW	70	34.4	5	5	FD	3	74	33.1
84	HW	65	32.0	5	5	HW	1	64	27.0
85	HW	43	23.0	1	1	HW	1	39	25.4
86	HW	35	22.6	1	1	HW	1	34	13.5
87	YC	224	10.9	3	1	YC	1	304	27.1
88	FDC	303	46.9	1	1	HW	3	184	26.3
89	CW	69	29.9	1	1	DR	5	.	.
90	FDC	121	29.9	3	3	HW	3	114	20.5
91	HW	158	33.6	2	2	CW	3	304	36.1
93	HW	71	26.2	3	3	FD	3	74	32.0
94	FDC	68	47.1	4	4	FD	1	88	42.5
96	FDC	59	33.9	3	3	FD	1	58	27.9
97	CW	93	25.8	2	2	CW	1	354	42.1
98	CW	42	10.7	5	5	HW	3	49	25.8
99	CW	38	12.7	5	5	HW	3	32	12.8
100	HW	195	25.8	1	1	CW	3	304	22.1
101	FDC	53	32.2	4	4	FD	1	54	29.8
102	HW	140	27.1	3	2	CW	3	304	35.2
103	FDC	41	24.7	3	3	FD	1	35	20.3
104	PLC	103	18.2	4	1	PL	1	134	16.2
105	HW	65	36.6	3	3	HW	1	79	30.0
107	HW	70	38.8	2	2	HW	1	84	36.0
108	HW	92	31.4	5	4	HW	1	116	39.2

10. APPENDIX F: LEADING SPECIES COMPARISON

Tables F-1 and F-2 below summarize the correspondence between the leading species on the Phase I inventory files and the leading species from the Phase II ground sample compilation. For just over 60% of the samples (60 out of 98), the inventory and the ground sample had the same leading species.

Table F-1: Phase II ground vs. Phase I inventory leading species cross-tabulation, based on the VT, 30+ years target population in the Strathcona TSA.

Phase I Inventory leading spp	*Phase II Ground leading species at 4cm+ dbh utilization*							
	BA	*CW*	*DR*	*FD*	*H*	*PL*	*YC*	*Total*
BA	1	1	0	0	0	0	1	3
CW	1	12	0	1	8	0	2	24
DR	0	2	0	0	1	0	0	3
FD	0	2	0	18	8	0	0	28
H	2	5	0	3	27	0	0	37
PL	0	0	0	0	0	1	0	1
YC	0	0	0	0	1	0	1	2
Total	4	22	0	22	45	1	4	98

Table F-2: Phase II ground vs. Phase I inventory leading species cross-tabulation (Table F-1), where each cell is expressed as a percent of the row (Phase I) total.

Phase I Inventory leading spp	*Phase II Ground leading species at 4cm+ dbh utilization*								
	BA	*CW*	*DR*	*FD*	*H*	*PL*	*YC*	*Total %*	*Total count*
BA	33.3%	33.3%	0	0	0	0	33.3%	100%	3
CW	4.15%	50%	0	4.15%	33.3%	0	8.3%	100%	24
DR	0	66.7%	0	0	33.3%	0	0	100%	3
FD	0	7.1%	0	64.3%	28.6%	0	0	100%	28
H	5.4%	13.5%	0	8.1%	73.0%	0	0	100%	37
PL	0	0	0	0	0	100%	0	100%	1
YC	0	0	0	0	50%	0	50%	100%	2
Total %	4.1%	22.4%	0%	22.4%	45.9%	1%	4.1%	100%	
Total count	4	22	0	22	45	1	4		98

Table F-2: Phase II ground vs. Phase I inventory leading species cross-tabulation (Table F-1), where each cell is expressed as a percent of the column (Phase II) total.

Phase I Inventory leading spp	*Phase II Ground leading species at 4cm+ dbh utilization*								
	BA	*CW*	*DR*	*FD*	*H*	*PL*	*YC*	*Total %*	*Total*
BA	25%	4.5%	0	0	0	0	25%	3%	3
CW	25%	54.5%	0	4.5%	17.8%	0	50%	24.5%	24
DR	0	9.1%	0	0	2.2%	0	0	3%	3
FD	0	9.1%	0	81.8%	17.8%	0	0	28.6%	28
H	50%	22.7%	0	13.6%	60%	0	0	37.8%	37
PL	0	0	0	0	0	100%	0	1%	1
YC	0	0	0	0	2.2%	0	25%	2%	2
Total %	100%	100%	-	100%	100%	100%	100%	100%	
Total	4	22	0	22	45	1	4		98

11. APPENDIX G: SCATTERPLOTS AND RESIDUALS FOR STATISTICAL ANALYSIS

CW-YC stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

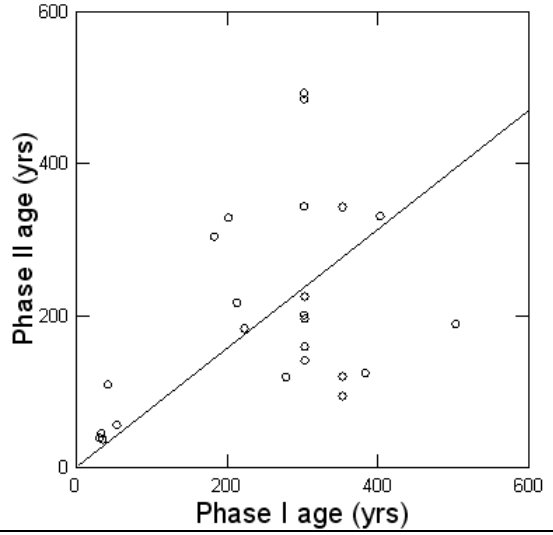

Fig G-1a: Phase II vs. Phase I age. The black line represents the ratio of means.

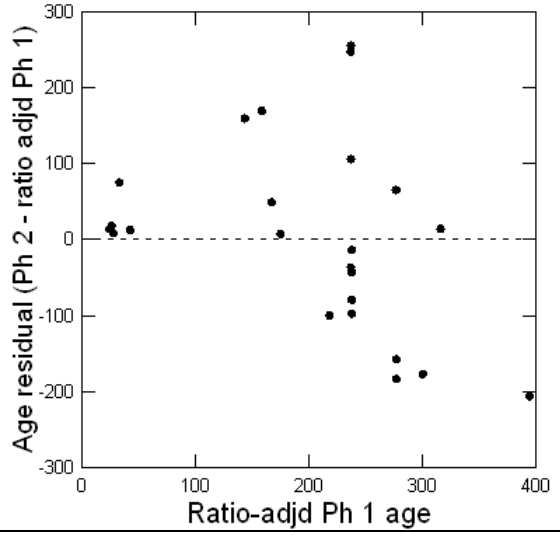

Fig G-1b: Age residuals vs adjusted Phase I inventory age (i.e. R × unadjusted Ph I age).

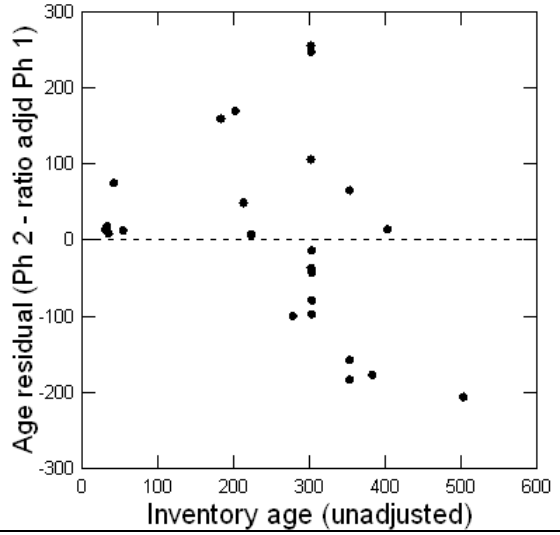

Fig G-1c: Age residuals vs unadjusted Phase I inventory age.

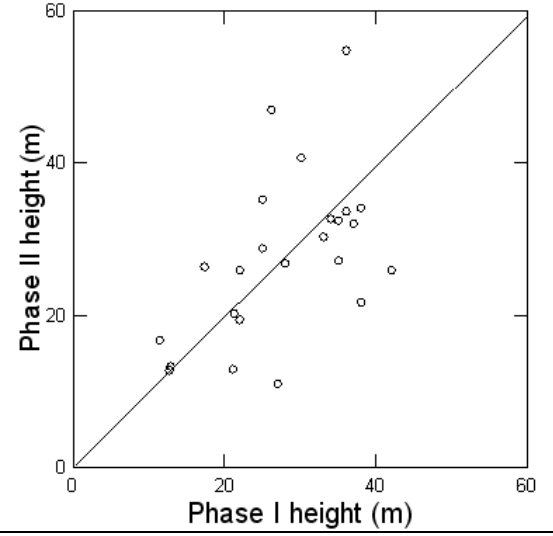

Fig G-2a: Phase II vs. Phase I height. The black line represents the ratio of means.

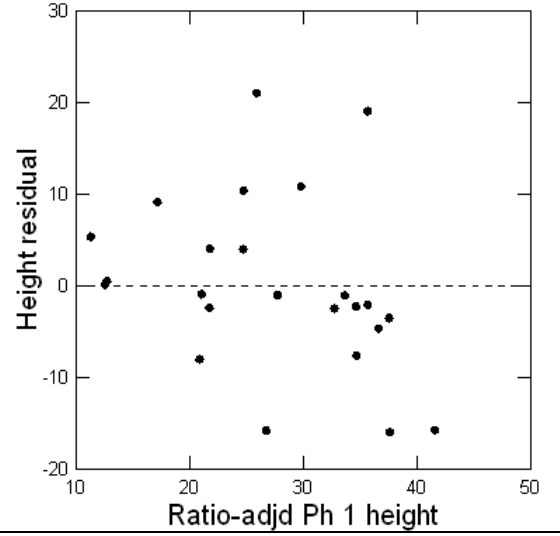

Fig G-2b: Height residuals vs adjusted Phase I inventory height (i.e. R × unadjusted Ph I height).

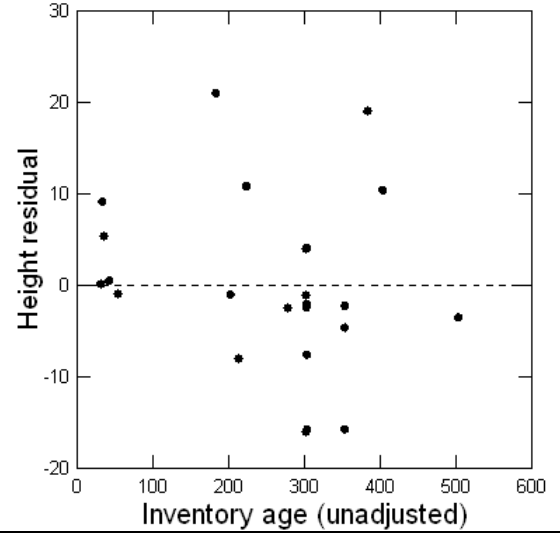

Fig G-2c: Height residuals vs unadjusted Phase I inventory age.

CW-YC stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

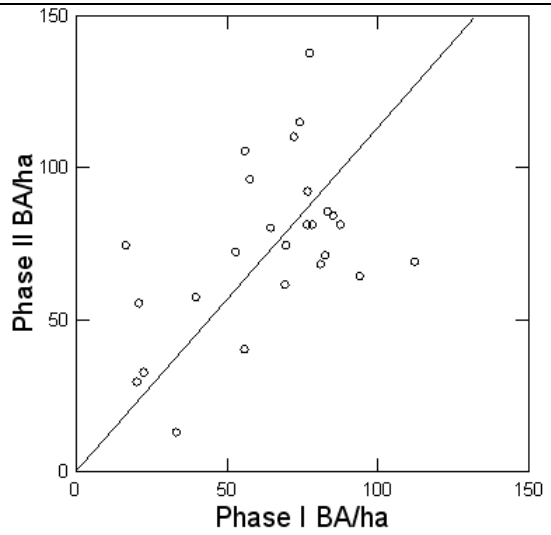

Fig G-3a: Phase II vs. Phase I ba/ha. The black line represents the ratio of means.

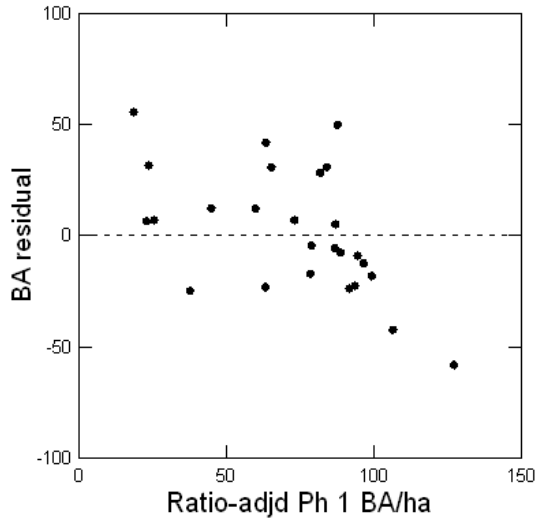

Fig G-3b: Ba/ha residuals vs adjusted Phase I inventory ba/ha (i.e. R × unadjusted Ph I ba/ha).

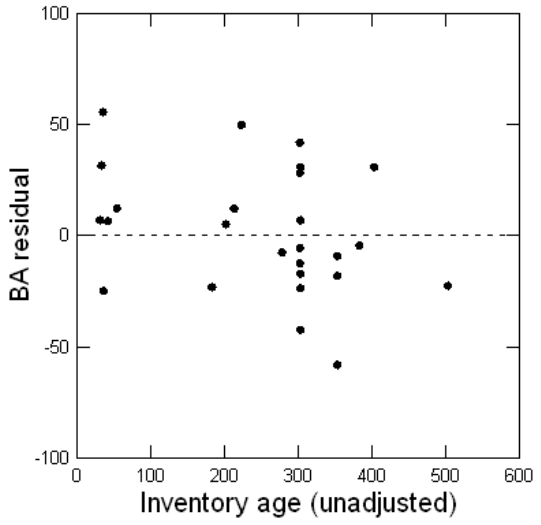

Fig G-3c: Ba/ha residuals vs unadjusted Phase I inventory age.

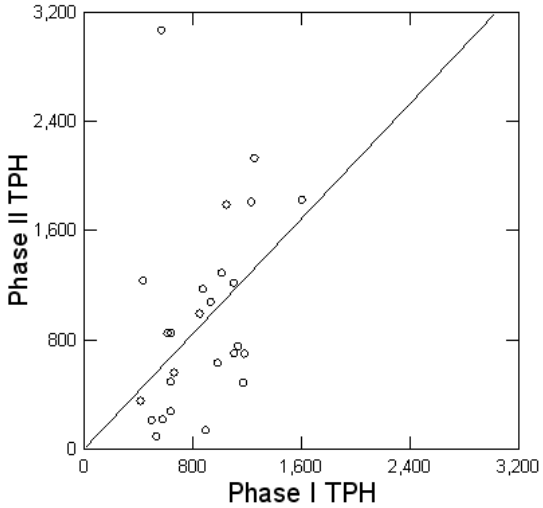

Fig G-4a: Phase II vs. Phase I trees/ha. The black line represents the ratio of means.

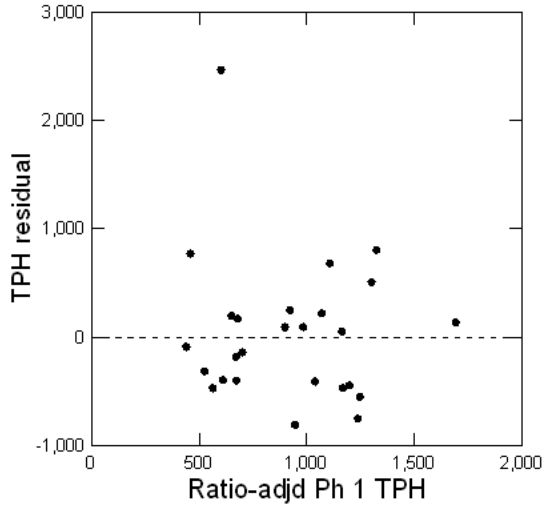

Fig G-4b: Trees/ha residuals vs adjusted Phase I inventory trees /ha (i.e. R × unadjusted Ph I trees /ha).

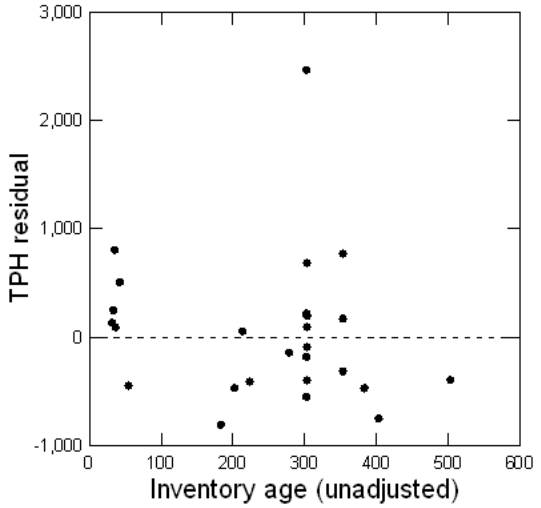

Fig G-4c: Trees /ha residuals vs unadjusted Phase I inventory age.

CW-YC stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

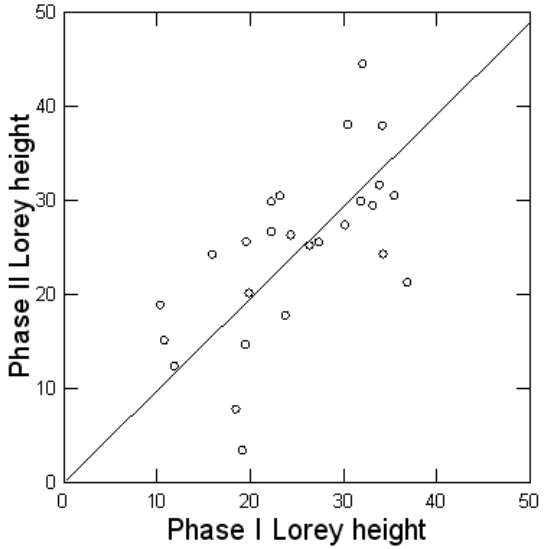

Fig G-5a: Phase II vs. Phase I Lorey height. The black line represents the ratio of means.

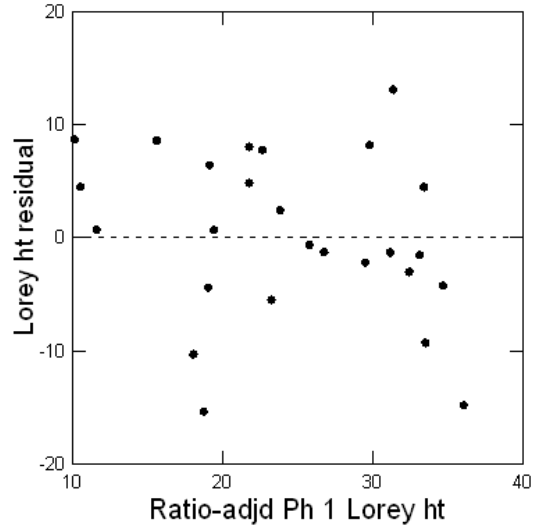

Fig G-5b: Lorey height residuals vs adjusted Phase I inventory Lorey ht (i.e. R × unadjusted Ph I Lorey ht).

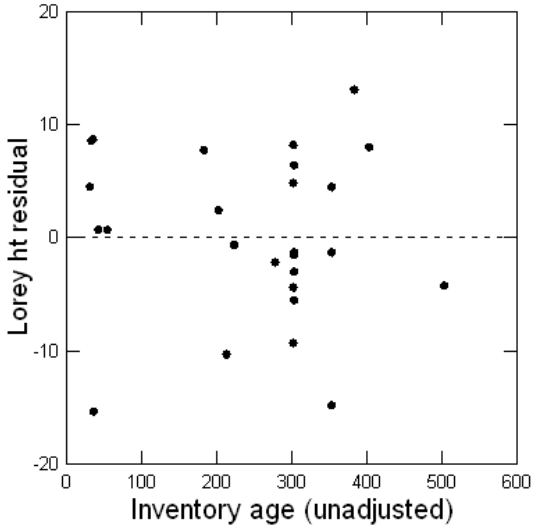

Fig G-5c: Lorey height residuals vs unadjusted Phase I inventory age.

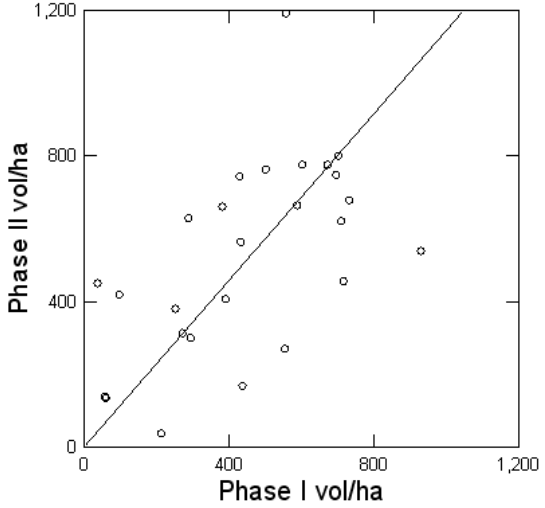

Fig G-6a: Phase II vs. Phase I vol/ha. The black line represents the ratio of means.

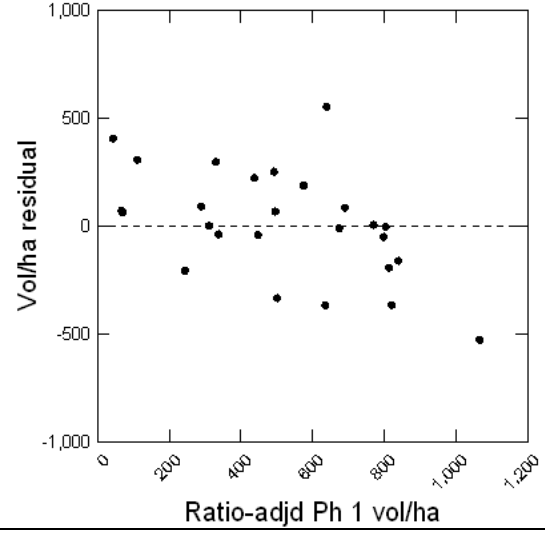

Fig G-6b: Vol/ha residuals vs adjusted Phase I inventory vol/ha (i.e. R × unadjusted Ph I vol/ha).

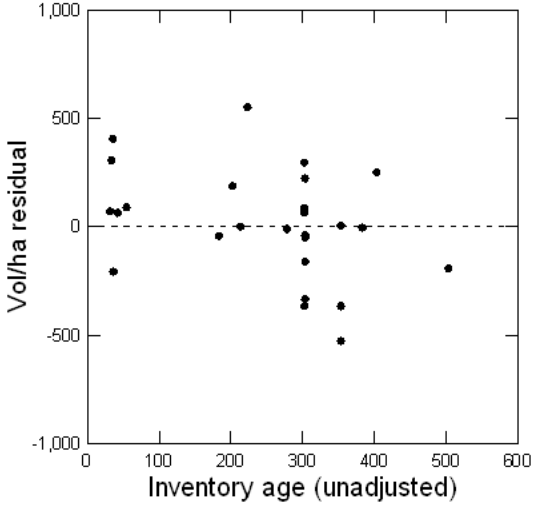

Fig G-6c: Vol/ha residuals vs unadjusted Phase I inventory age.

FD stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

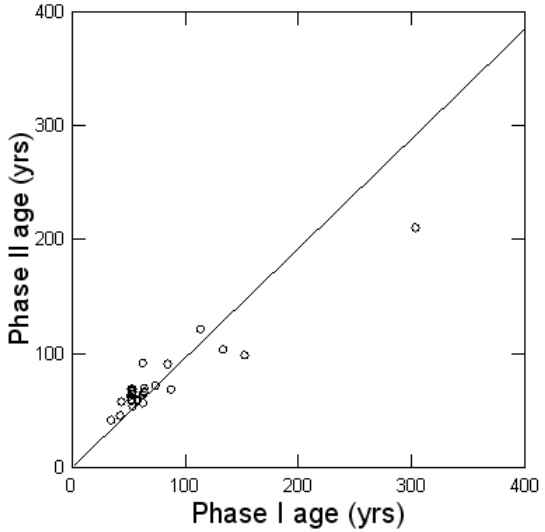

Fig G-7a: Phase II vs. Phase I age. The black line represents the ratio of means.

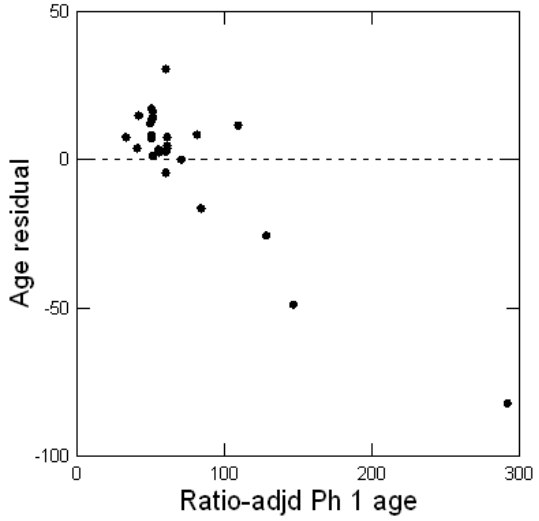

Fig G-7b: Age residuals vs adjusted Phase I inventory age (i.e. R × unadjusted Ph I age).

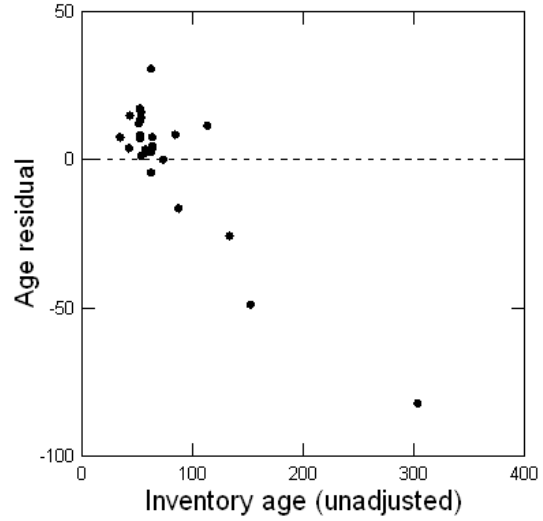

Fig G-7c: Age residuals vs unadjusted Phase I inventory age.

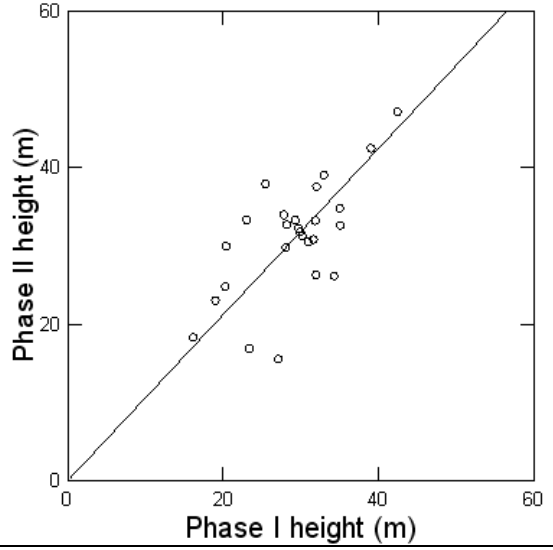

Fig G-8a: Phase II vs. Phase I height. The black line represents the ratio of means.

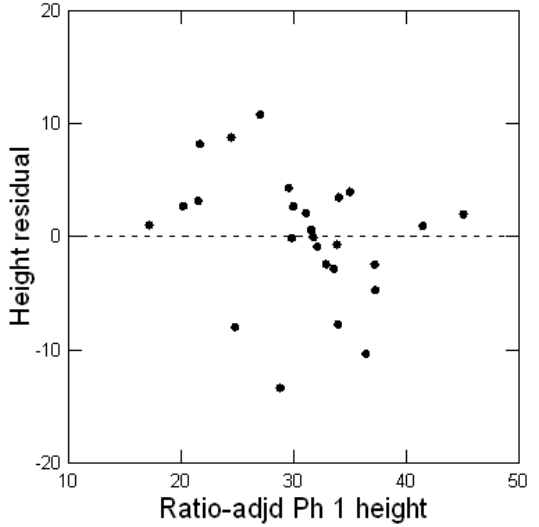

Fig G-8b: Height residuals vs adjusted Phase I inventory height (i.e. R × unadjusted Ph I height).

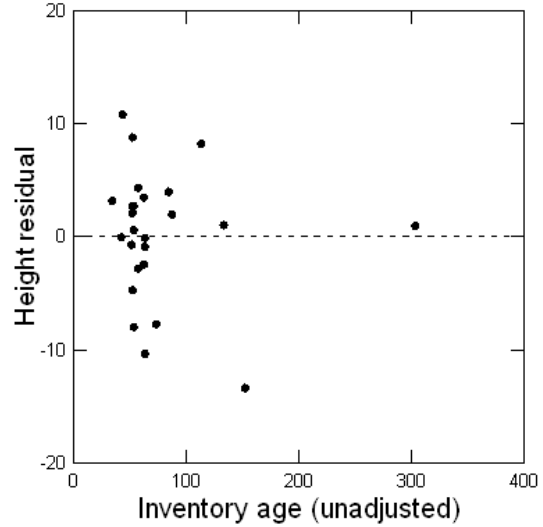

Fig G-8c: Height residuals vs unadjusted Phase I inventory age.

FD stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

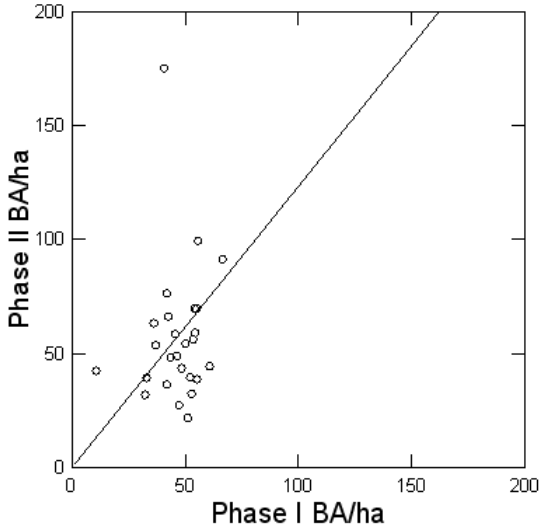

Fig G-9a: Phase II vs. Phase I ba/ha. The black line represents the ratio of means.

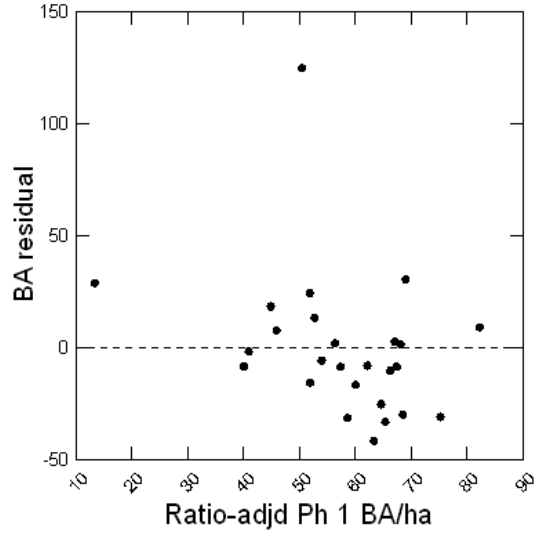

Fig G-9b: Ba/ha residuals vs adjusted Phase I inventory ba/ha (i.e. R × unadjusted Ph I ba/ha).

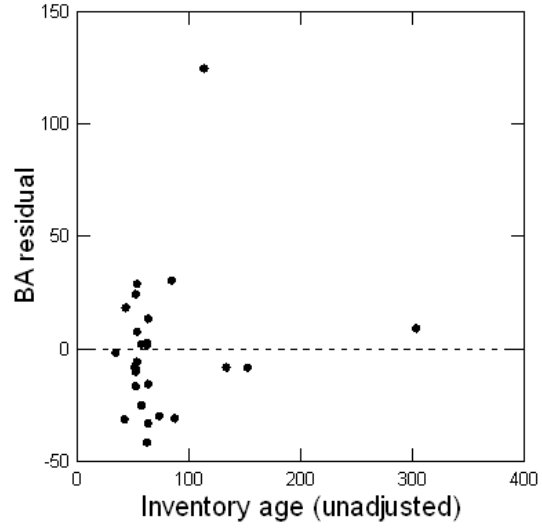

Fig G-9c: Ba/ha residuals vs unadjusted Phase I inventory age.

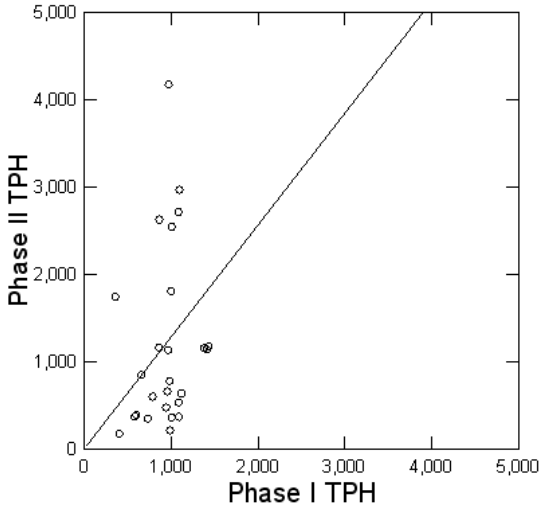

Fig G-10a: Phase II vs. Phase I trees/ha. The black line represents the ratio of means.

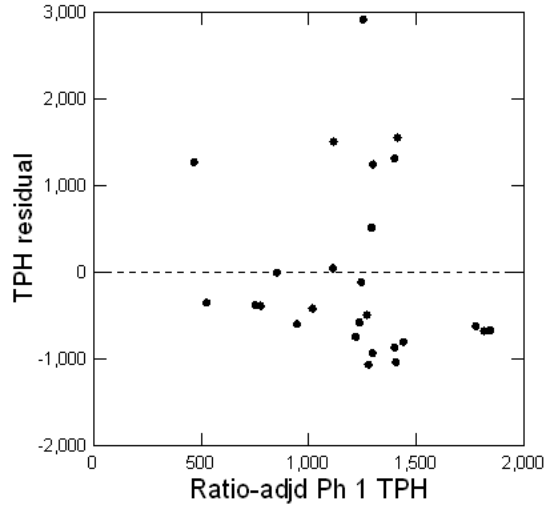

Fig G-10b: Trees/ha residuals vs adjusted Phase I inventory trees /ha (i.e. R × unadjusted Ph I trees /ha).

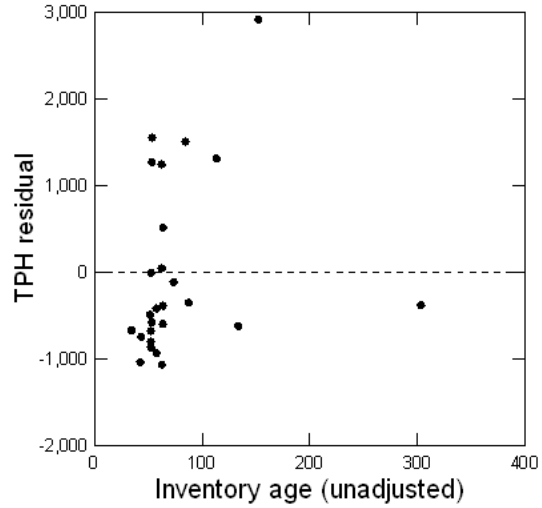

Fig G-10c: Trees /ha residuals vs unadjusted Phase I inventory age.

FD stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

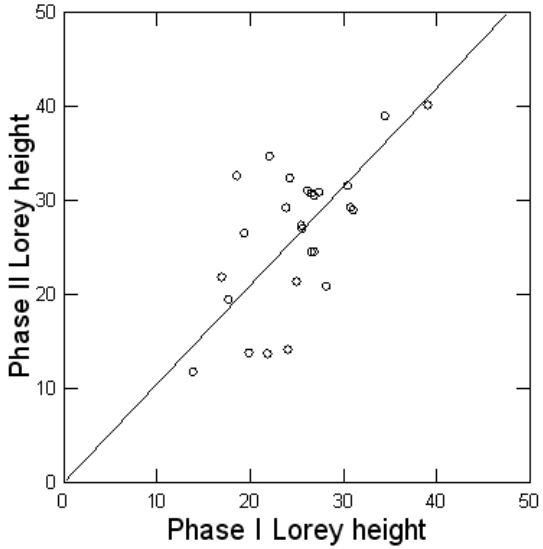

Fig G-11a: Phase II vs. Phase I Lorey height. The black line represents the ratio of means.

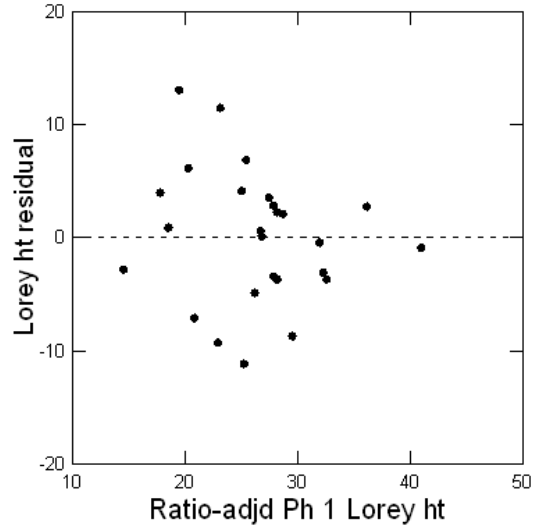

Fig G-11b: Lorey height residuals vs adjusted Phase I inventory Lorey height (i.e. R × unadjusted Ph I Lorey height).

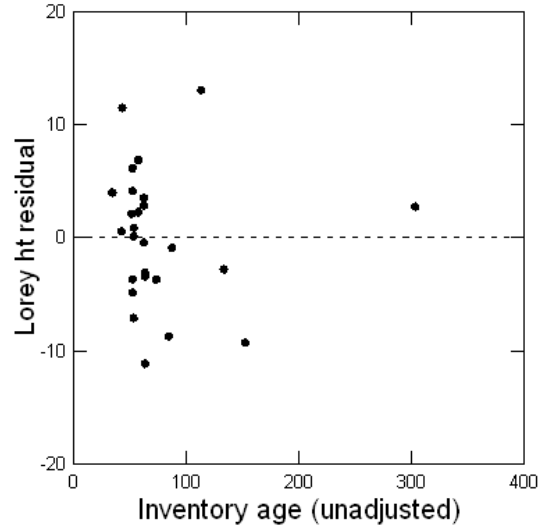

Fig G-11c: Lorey height residuals vs unadjusted Phase I inventory age.

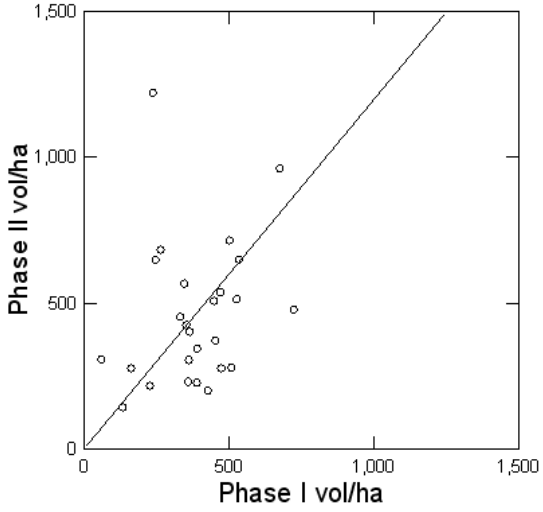

Fig G-12a: Phase II vs. Phase I vol/ha. The black line represents the ratio of means.

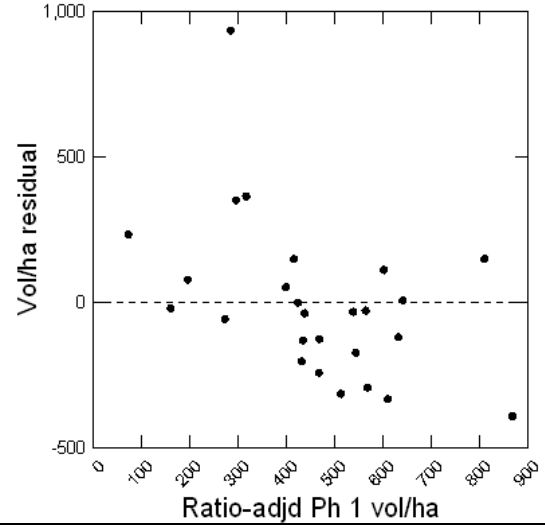

Fig G-12b: Vol/ha residuals vs adjusted Phase I inventory vol/ha (i.e. R × unadjusted Ph I vol/ha).

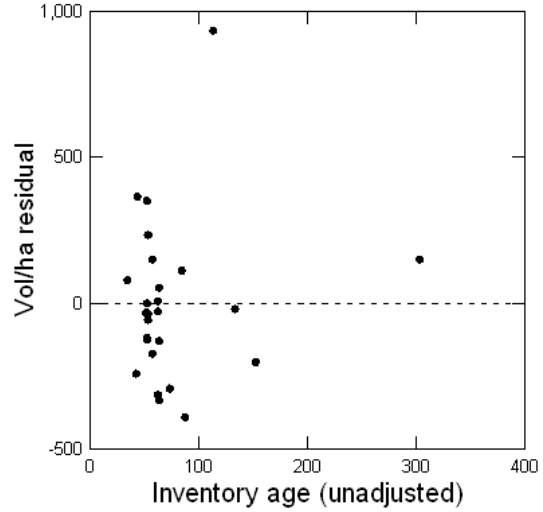

Fig G-12c: Vol/ha residuals vs unadjusted Phase I inventory age.

Other-Immature stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

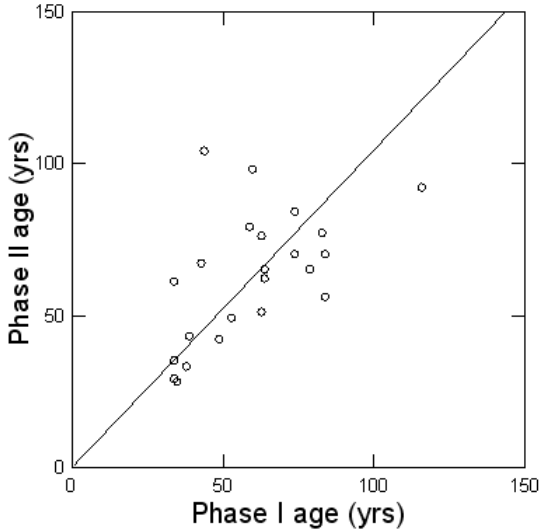

Fig G-13a: Phase II vs. Phase I ba/ha. The black line represents the ratio of means.

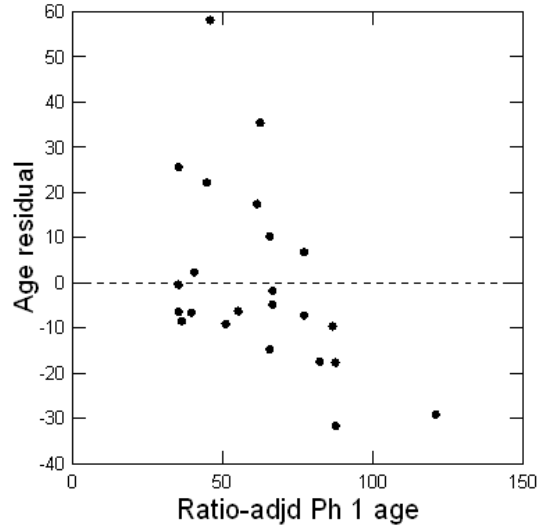

Fig G-13b: Ba/ha residuals vs adjusted Phase I inventory ba/ha (i.e. R × unadjusted Ph I ba/ha).

Fig G-13c: Ba/ha residuals vs unadjusted Phase I inventory age.

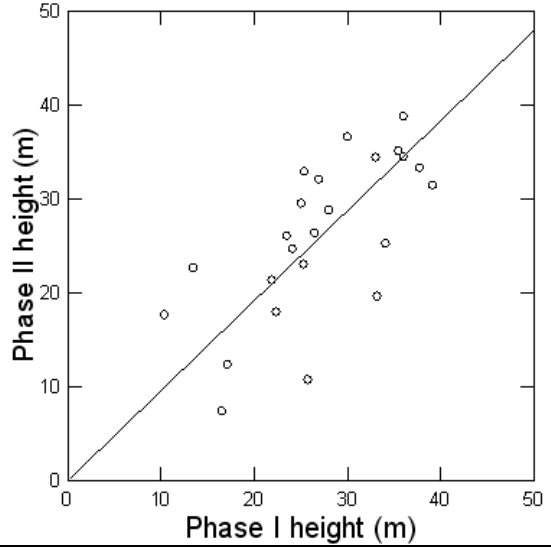

Fig G-14a: Phase II vs. Phase I trees/ha. The black line represents the ratio of means.

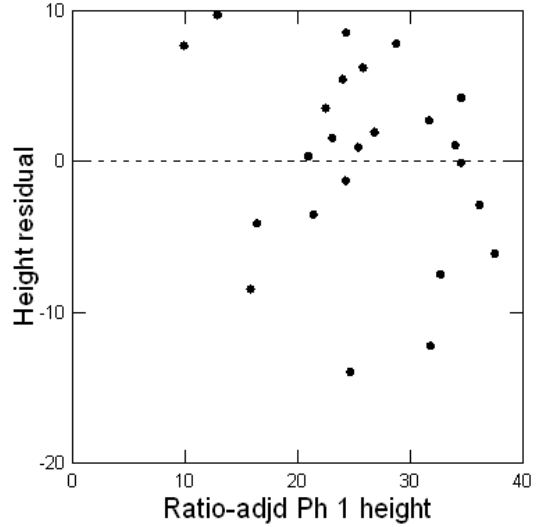

Fig G-14b: Trees/ha residuals vs adjusted Phase I inventory trees /ha (i.e. R × unadjusted Ph I trees /ha).

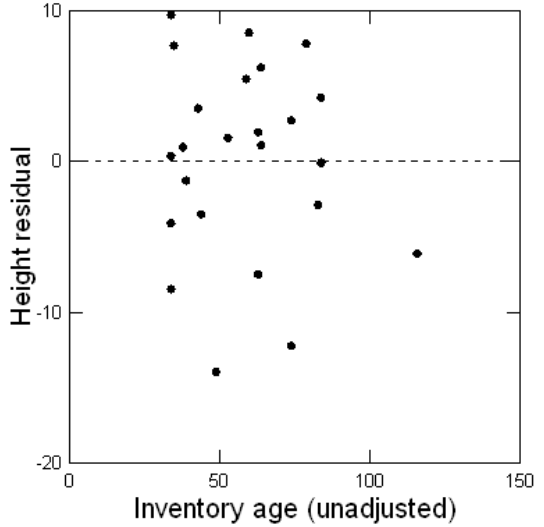

Fig G-14c: Trees /ha residuals vs unadjusted Phase I inventory age.

Other-Immature stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

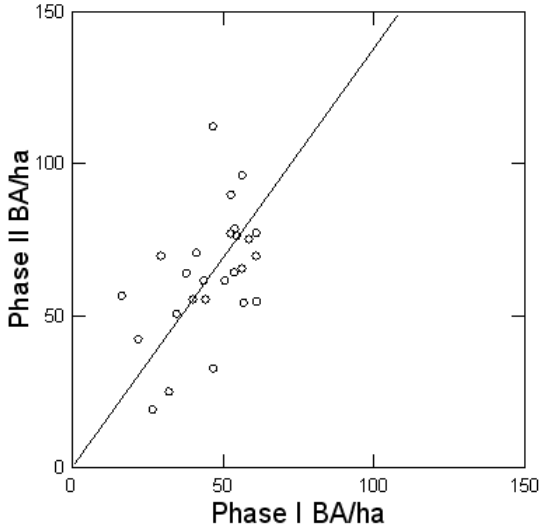

Fig G-15a: Phase II vs. Phase I ba/ha. The black line represents the ratio of means.

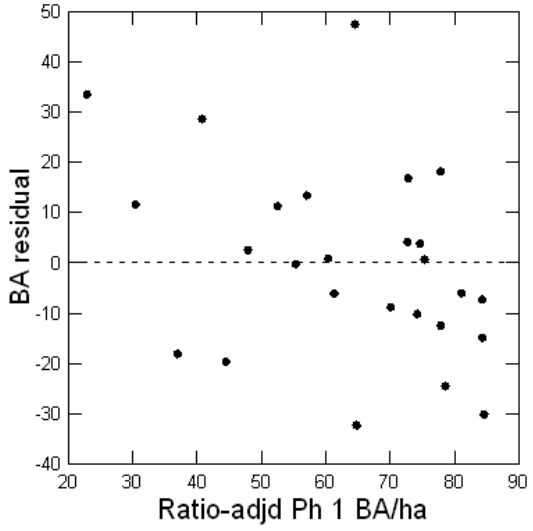

Fig G-15b: Ba/ha residuals vs adjusted Phase I inventory ba/ha (i.e. R × unadjusted Ph I ba/ha).

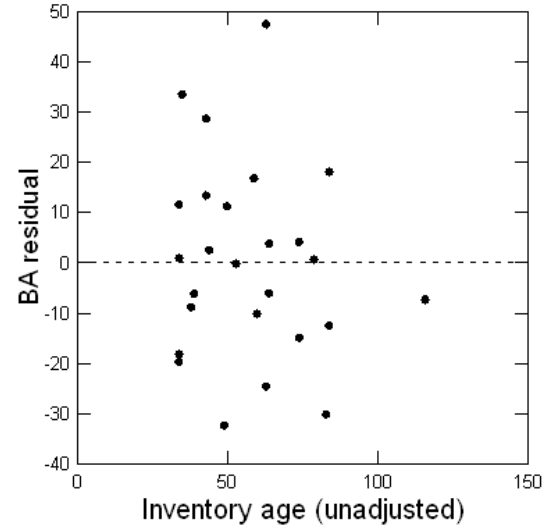

Fig G-15c: Ba/ha residuals vs unadjusted Phase I inventory age.

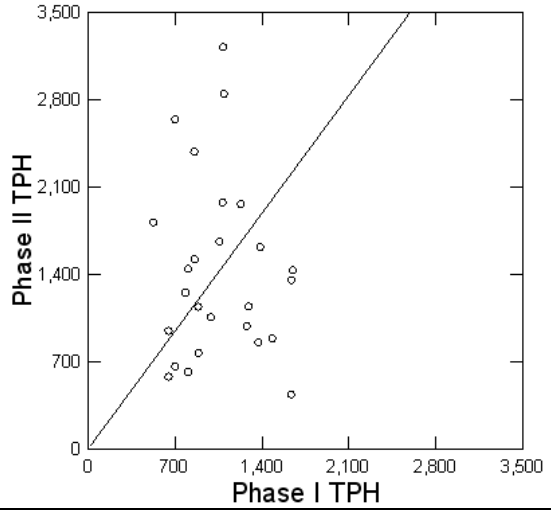

Fig G-16a: Phase II vs. Phase I trees/ha. The black line represents the ratio of means.

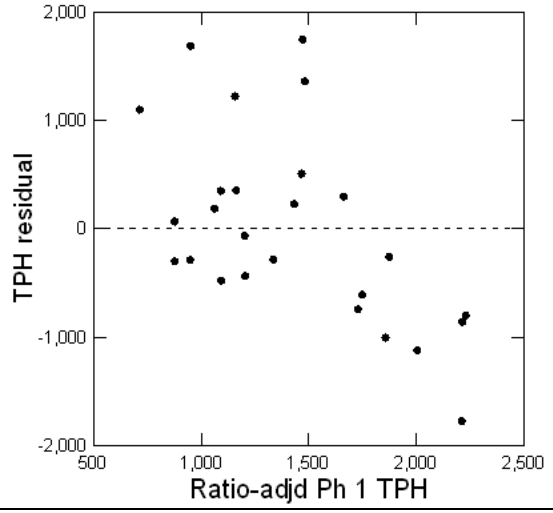

Fig G-16b: Trees/ha residuals vs adjusted Phase I inventory trees /ha (i.e. R × unadjusted Ph I trees /ha).

Fig G-16c: Trees /ha residuals vs unadjusted Phase I inventory age.

Other-Immature stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

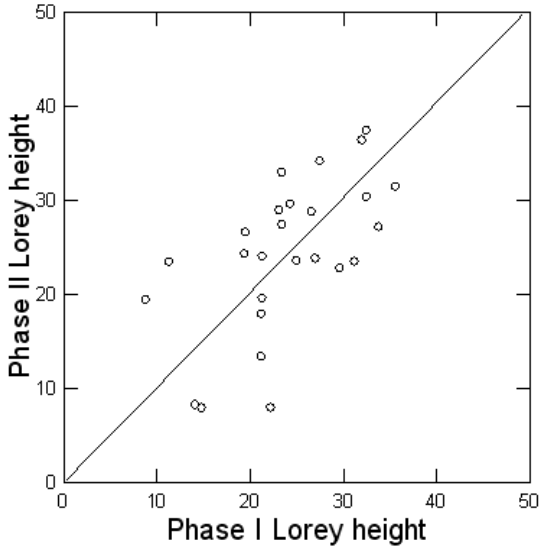

Fig G-17a: Phase II vs. Phase I Lorey height. The black line represents the ratio of means.

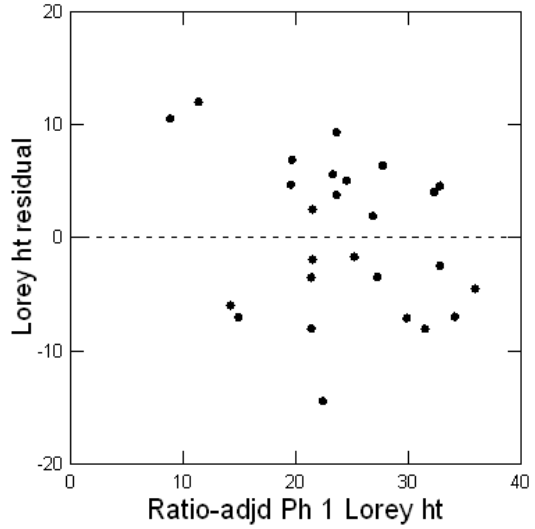

Fig G-17b: Lorey height residuals vs adjusted Phase I inventory Lorey height (i.e. R × unadjusted Ph I Lorey height).

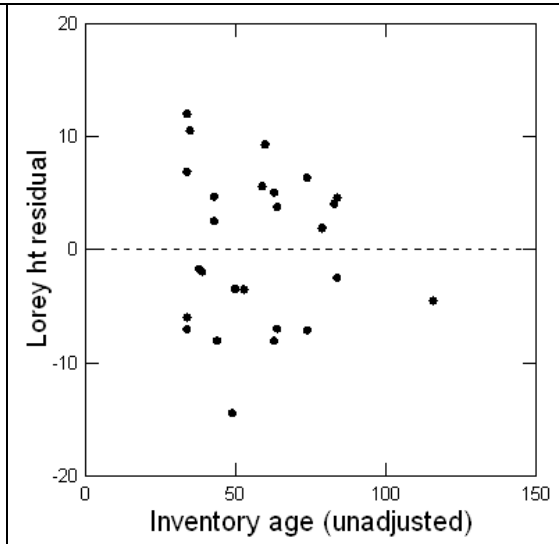

Fig G-17c: Lorey height residuals vs unadjusted Phase I inventory age.

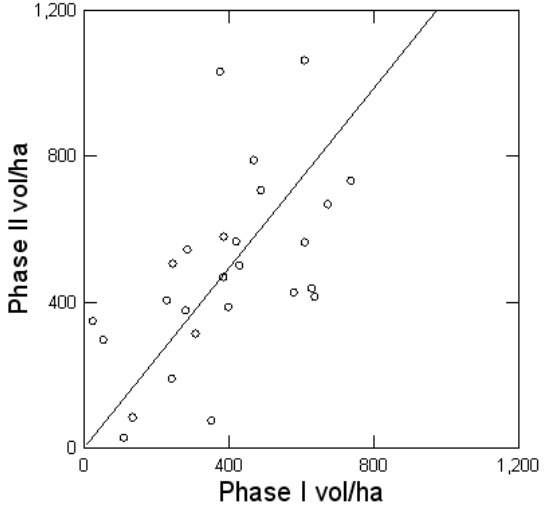

Fig G-18a: Phase II vs. Phase I vol/ha. The black line represents the ratio of means.

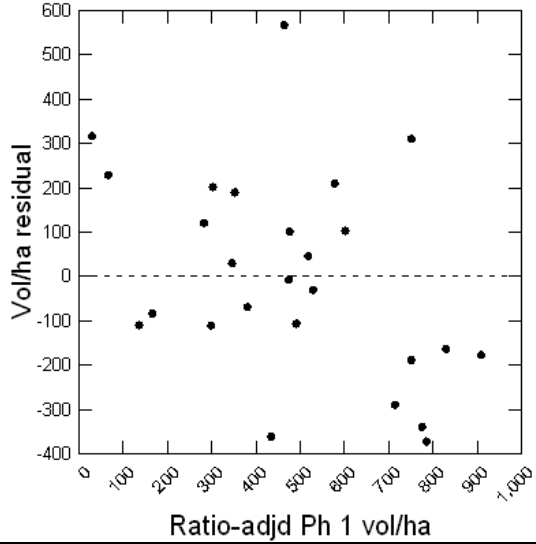

Fig G-18b: Vol/ha residuals vs adjusted Phase I inventory vol/ha (i.e. R × unadjusted Ph I vol/ha).

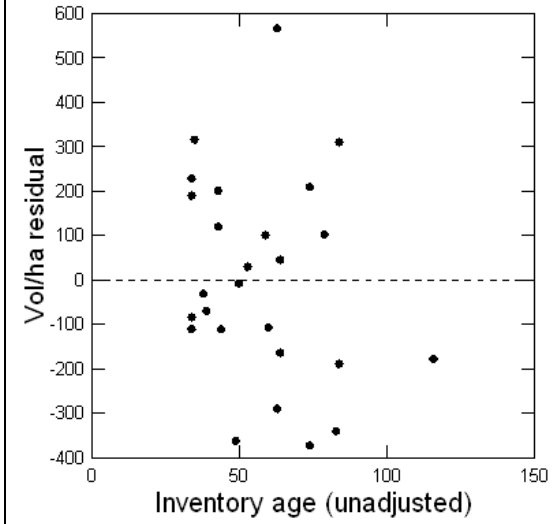

Fig G-18c: Vol/ha residuals vs unadjusted Phase I inventory age.

Other-Mature stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

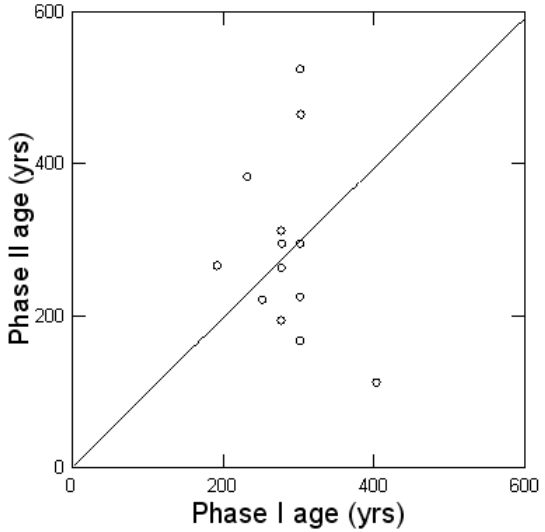

Fig G-19a: Phase II vs. Phase I age. The black line represents the ratio of means.

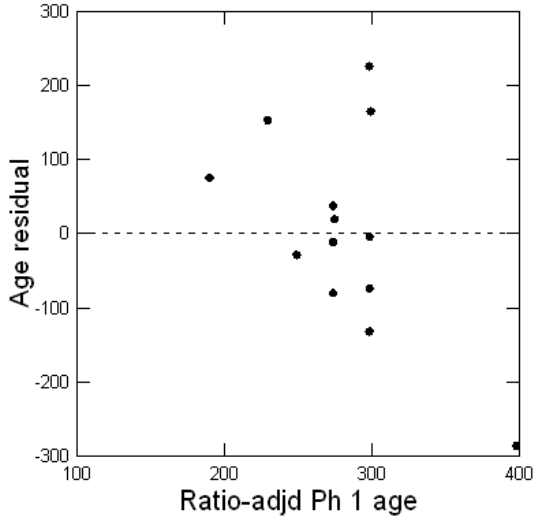

Fig G-19b: Age residuals vs adjusted Phase I inventory age (i.e. R × unadjusted Ph I age).

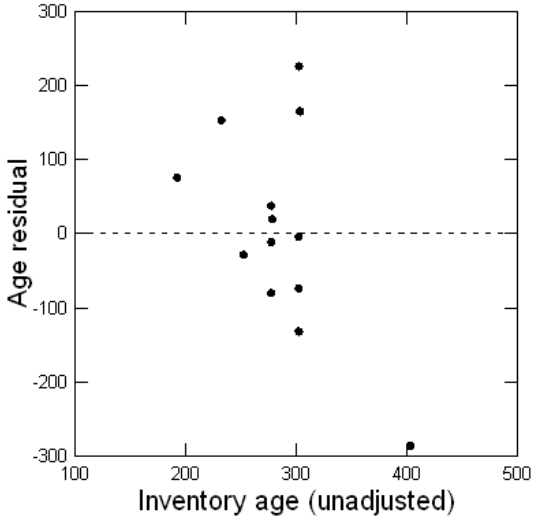

Fig G-19c: Age residuals vs unadjusted Phase I inventory age.

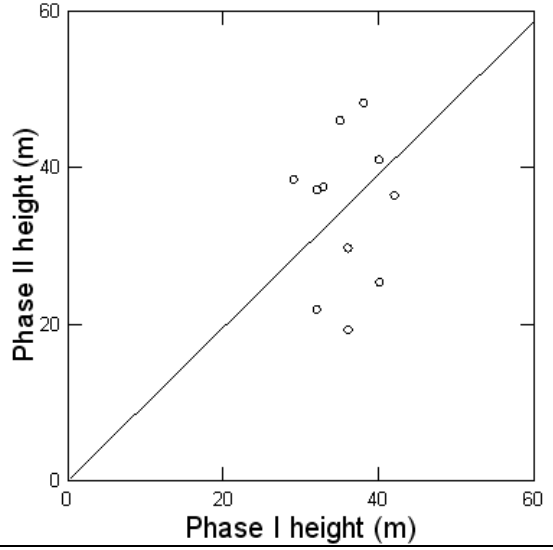

Fig G-20a: Phase II vs. Phase I height. The black line represents the ratio of means.

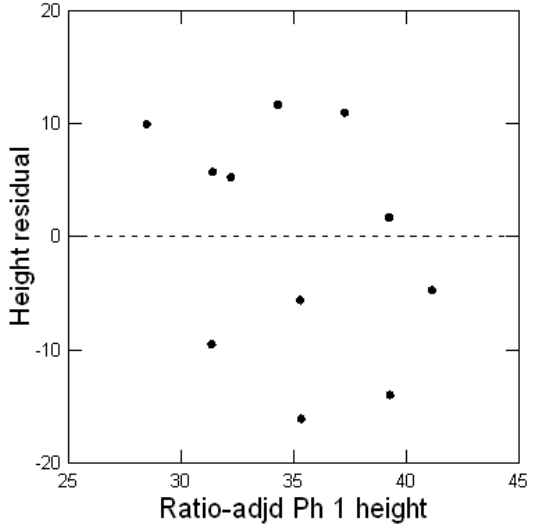

Fig G-20b: Height residuals vs adjusted Phase I inventory height (i.e. R × unadjusted Ph I height).

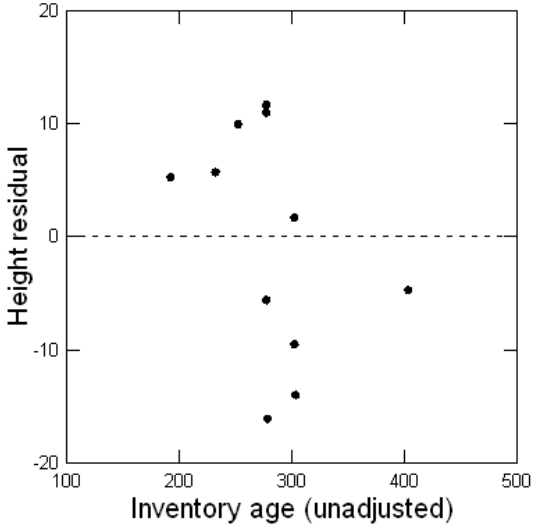

Fig G-20c: Height residuals vs unadjusted Phase I inventory age.

Other-Mature stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

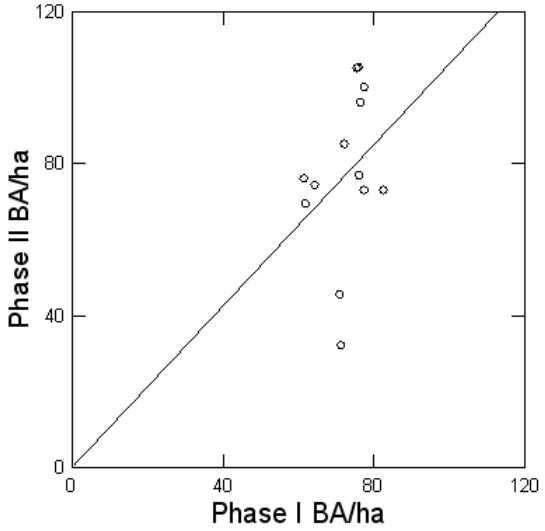

Fig G-21a: Phase II vs. Phase I ba/ha. The black line represents the ratio of means.

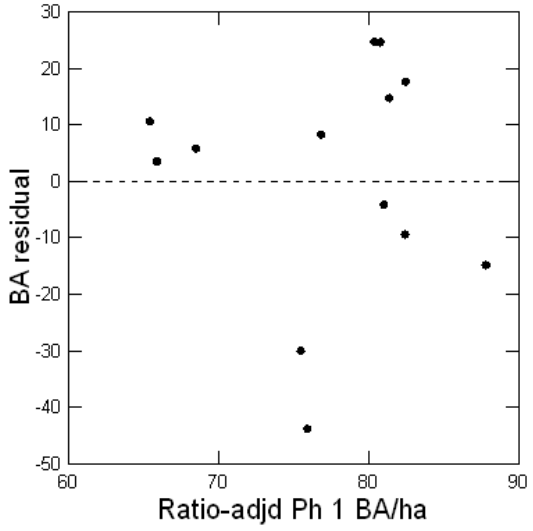

Fig G-21b: Ba/ha residuals vs adjusted Phase I inventory ba/ha (i.e. R × unadjusted Ph I ba/ha).

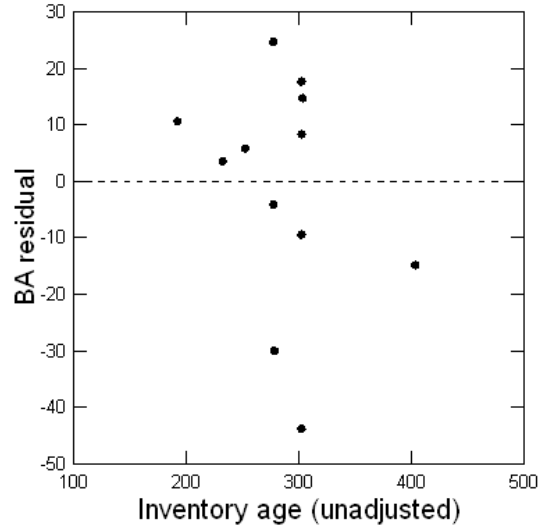

Fig G-21c: Ba/ha residuals vs unadjusted Phase I inventory age.

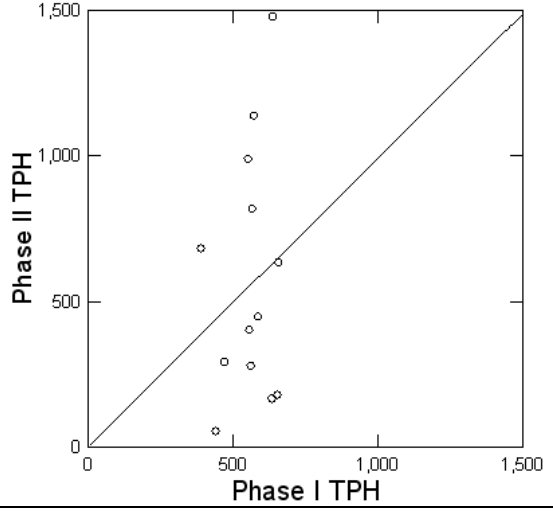

Fig G-22a: Phase II vs. Phase I trees/ha. The black line represents the ratio of means.

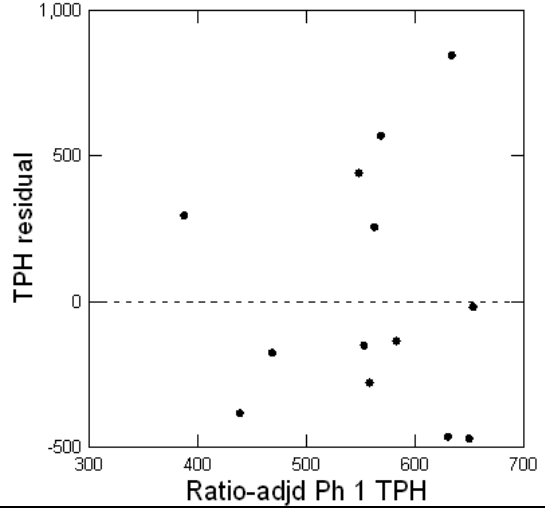

Fig G-22b: Trees/ha residuals vs adjusted Phase I inventory trees /ha (i.e. R × unadjusted Ph I trees /ha).

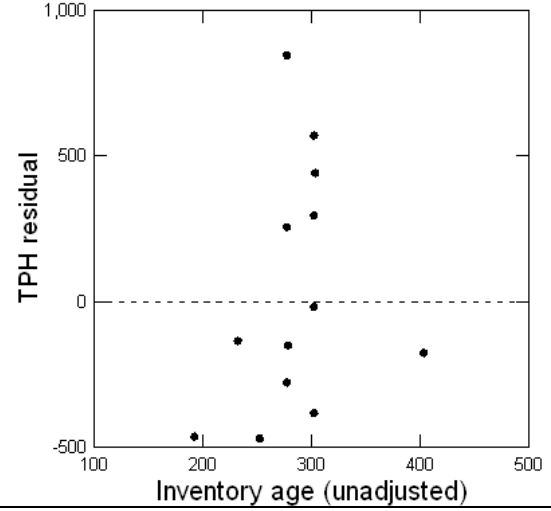

Fig G-22c: Trees /ha residuals vs unadjusted Phase I inventory age.

Other-Mature stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

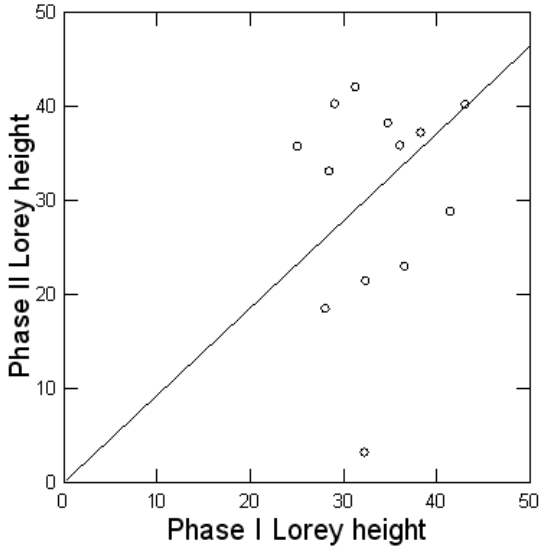

Fig G-23a: Phase II vs. Phase I Lorey height. The black line represents the ratio of means.

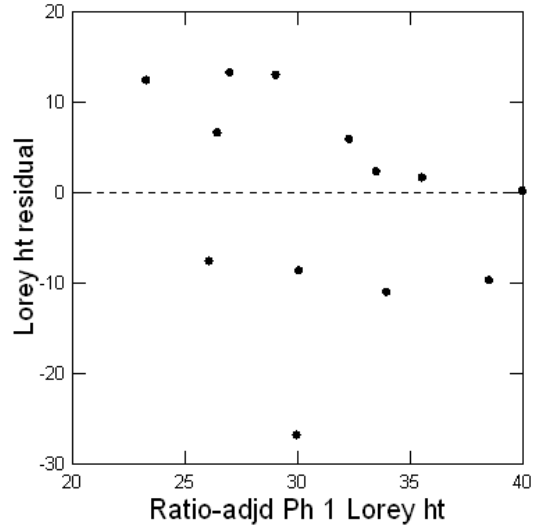

Fig G-23b: Lorey height residuals vs adjusted Phase I inventory Lorey height (i.e. R × unadjusted Ph I Lorey height).

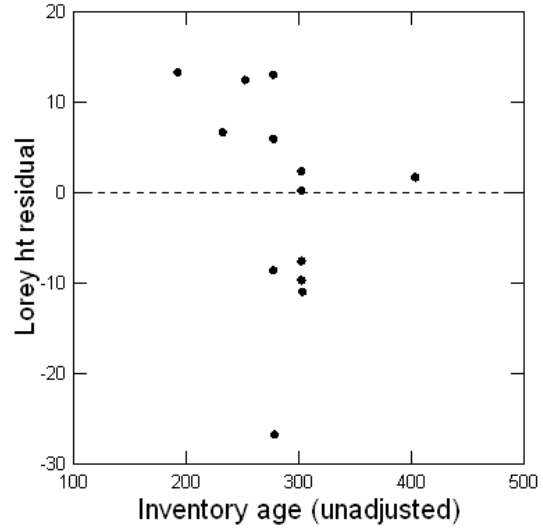

Fig G-23c: Lorey height residuals vs unadjusted Phase I inventory age.

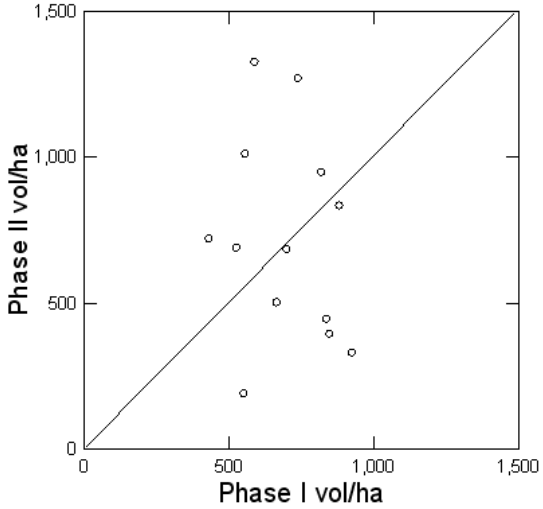

Fig G-24a: Phase II vs. Phase I vol/ha. The black line represents the ratio of means..

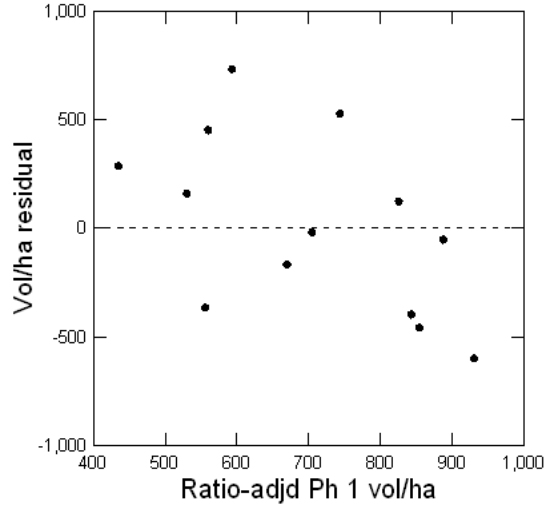

Fig G-24b: Vol/ha residuals vs adjusted Phase I inventory vol/ha (i.e. R × unadjusted Ph I vol/ha).

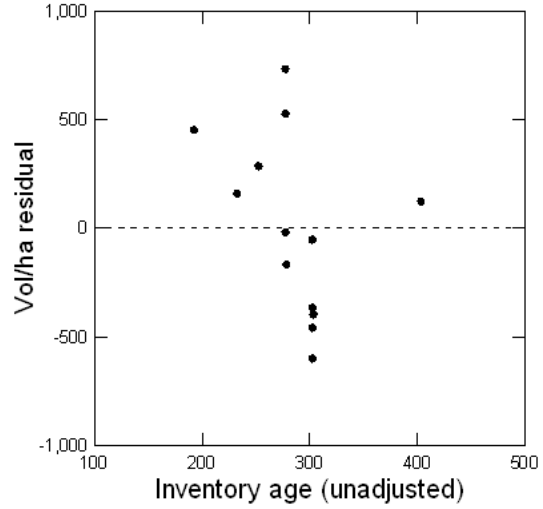

Fig G-24c: Vol/ha residuals vs unadjusted Phase I inventory age.

Inoperable stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

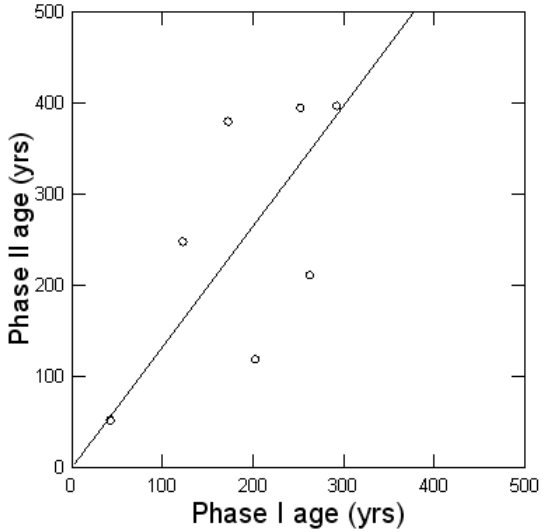

Fig G-25a: Phase II vs. Phase I age. The black line represents the ratio of means.

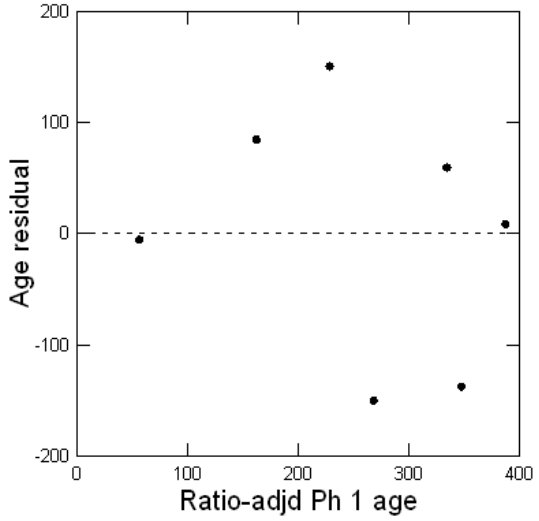

Fig G-25b: Age residuals vs adjusted Phase I inventory age (i.e. R × unadjusted Ph I age).

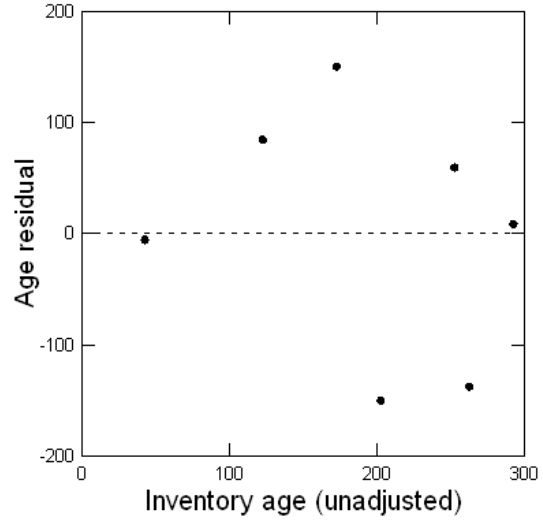

Fig G-25c: Age residuals vs unadjusted Phase I inventory age.

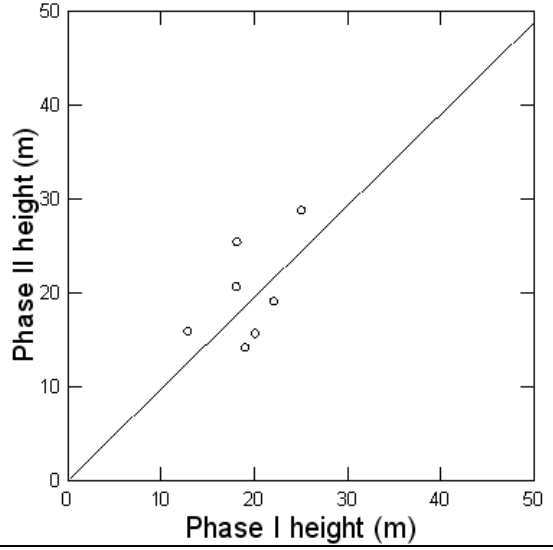

Fig G-26a: Phase II vs. Phase I height. The black line represents the ratio of means.

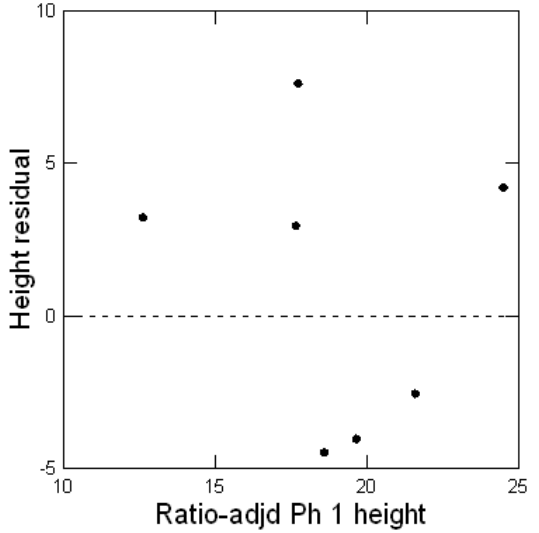

Fig G-26b: Height residuals vs adjusted Phase I inventory height (i.e. R × unadjusted Ph I height).

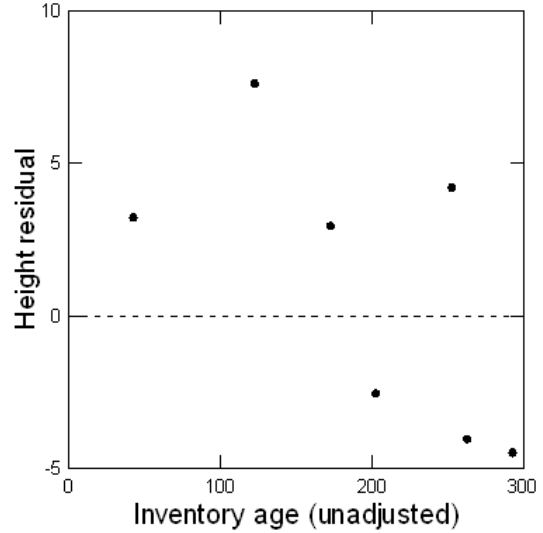

Fig G-26c: Height residuals vs unadjusted Phase I inventory age.

Inoperable stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

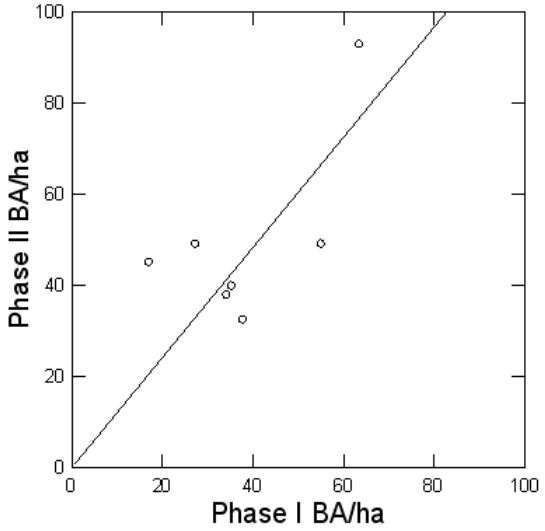

Fig G-27a: Phase II vs. Phase I ba/ha. The black line represents the ratio of means.

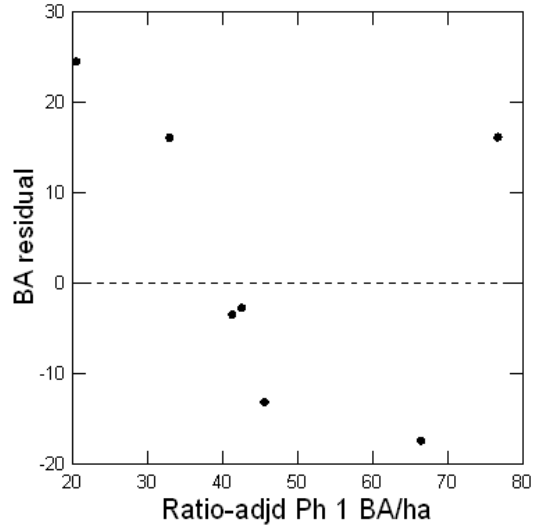

Fig G-27b: Ba/ha residuals vs adjusted Phase I inventory ba/ha (i.e. R × unadjusted Ph I ba/ha).

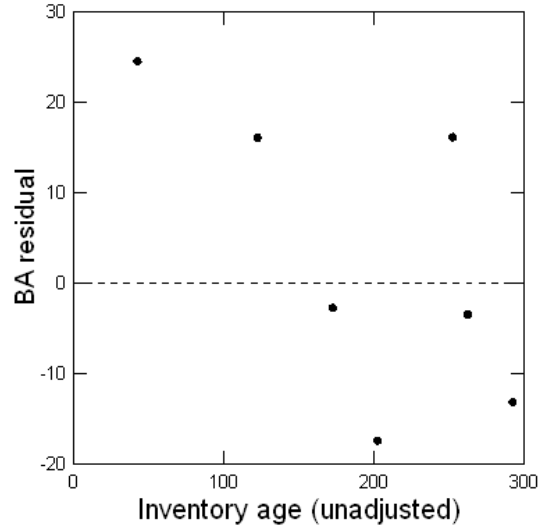

Fig G-27c: Ba/ha residuals vs unadjusted Phase I inventory age.

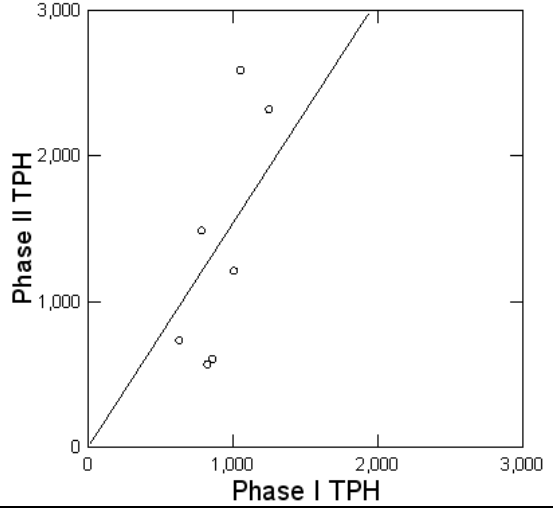

Fig G-28a: Phase II vs. Phase I trees/ha. The black line represents the ratio of means.

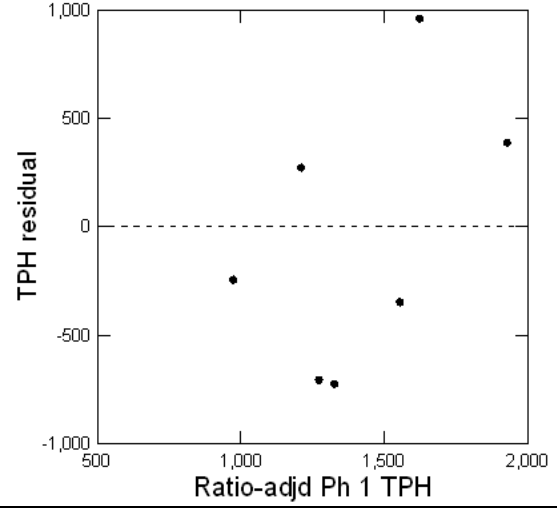

Fig G-28b: Trees/ha residuals vs adjusted Phase I inventory trees /ha (i.e. R × unadjusted Ph I trees /ha).

Fig G-28c: Trees /ha residuals vs unadjusted Phase I inventory age.

Inoperable stratum (RESIDUAL = Phase 2 value – ratio-adjusted Phase 1 value)

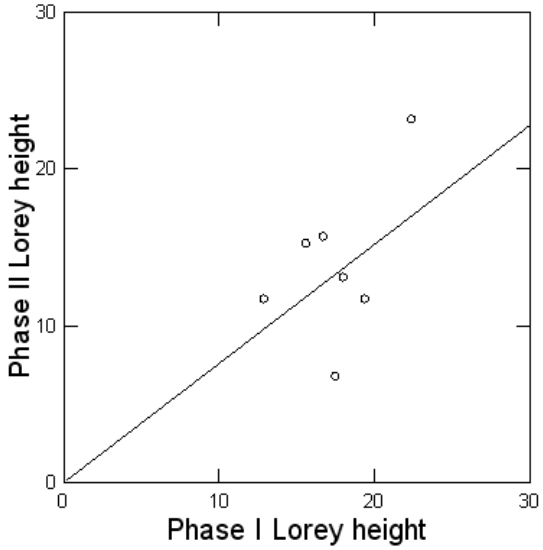

Fig G-29a: Phase II vs. Phase I Lorey height. The black line represents the ratio of means.

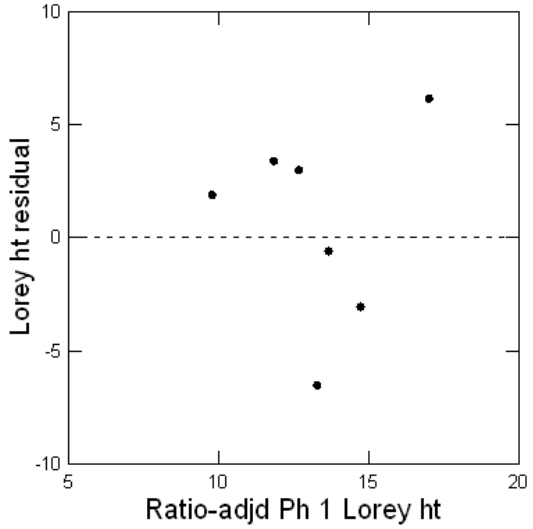

Fig G-29b: Lorey height residuals vs adjusted Phase I inventory Lorey ht (i.e. R × unadjusted Ph I Lorey ht).

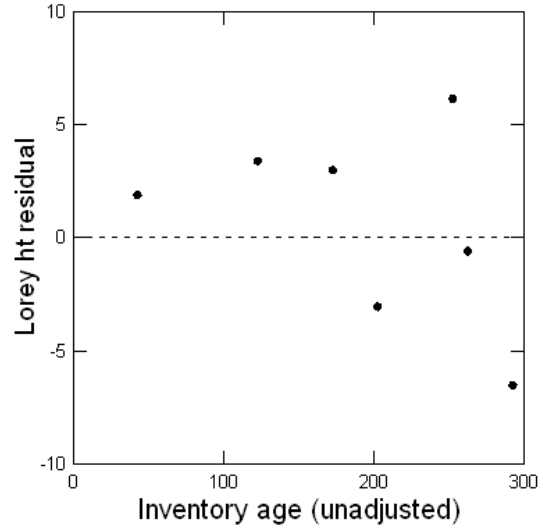

Fig G-29c: Lorey height residuals vs unadjusted Phase I inventory age.

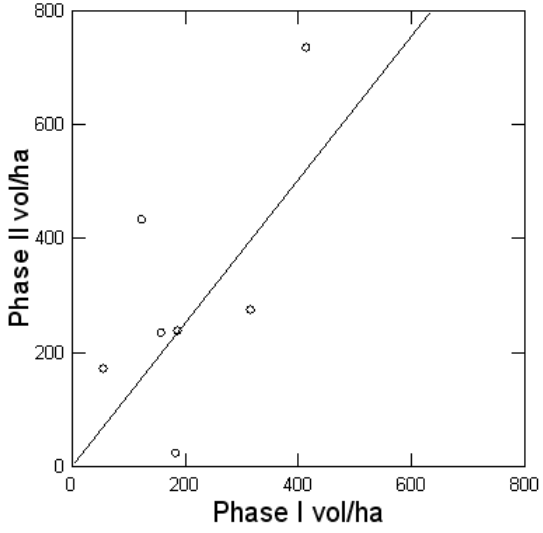

Fig G-30a: Phase II vs. Phase I vol/ha. The black line represents the ratio of means..

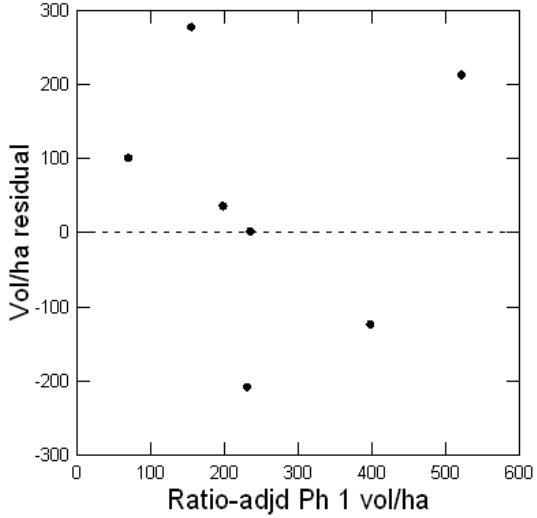

Fig G-30b: Vol/ha residuals vs adjusted Phase I inventory vol/ha (i.e. R × unadjusted Ph I vol/ha).

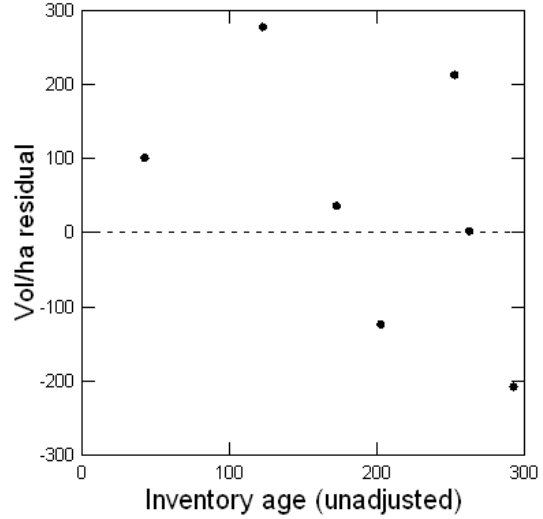

Fig G-30c: Vol/ha residuals vs unadjusted Phase I inventory age.

12. APPENDIX H: VPIP DOCUMENTS

The following is a March 2008 report prepared by Timberline that provides the background for VRI Phase II sample selection in the Strathcona TSA.

Strathcona Timber Supply Area
Vegetation Resources Inventory
Project Implementation Plan
Version 4.0

Prepared for:

Pat Bryant, RPF

Western Forest Products Ltd.

Campbell River, BC

On Behalf of the

Strathcona TSA Licensees

Project: BC0108730

March 31, 2008

Timberline
Natural Resource Group

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1.0 INTRODUCTION

1.1 Background

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

This version of the VPIP contains all sample planning for the Strathcona TSA that took place since April 2006. The Strathcona TSA licencees completed the Phase I VRI in 2006. The original Phase II VPIP was completed in April of 2006 and makes up the majority of this report. The NVAF sample selection was completed in November 2006 after the establishment of the first 50 phase II plots which included the NVAF enhanced plots (Appendix V).

An interim analysis was completed in July of 2007 to determine the number of plots required to achieve the desired sampling error. Discussions with the MoFR regarding the plots needed took place in July and both the licencees and the MoFR agreed to a different sampling objective that involved achieving strata level sampling errors of ±25% (95% probability). These strata were identified as important to Timber Supply Review. Forty-eight (48) new samples were selected and established in the 2007 field season. An amendment to VPIP which explains the new sampling objectives, sample distribution and stratification with the list of sample locations is attached in Appendix VI.

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

1. **Phase I (unadjusted inventory data)** – Polygon attributes are estimated, generally using photo-interpretation for the target population.
2. **Phase II (ground sample data)** – Measurements are taken from randomly located ground samples for the target population.
3. **Net Volume Adjustment Factor (NVAF) sampling** – Random trees are selected for stem-analysis studies to develop adjustment ratios that correct taper and decay estimation bias.
4. **Statistical Adjustment Phase** – The Phase I estimates are adjusted using the NVAF-corrected Phase II ground samples to provide an adjusted unbiased estimate of forest inventory attributes. The final product is an adjusted VRI database.

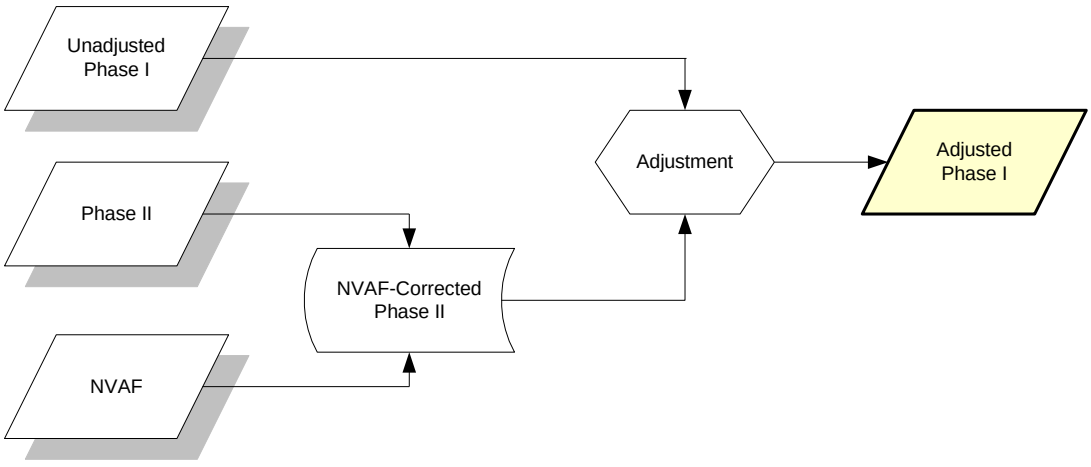

Figure 1. VRI flow-chart.

Timberline Forest Inventory Consultants Ltd. (TFIC) completed the Phase I in February 2006. The Strathcona TSA licensees' goal is to complete Phase II ground sampling and the NVAF program in the 2006 field season, and the statistical adjustment phase before March 31, 2007.

1.2 VPIP Objectives

The objective of this VPIP is to:

1. *Develop the sampling methods required to implement the Strathcona TSA Phase II program.*
2. *Present the proposed NVAF program.*
3. *Outline the strategy for Phase II implementation and the proposed timelines.*

The intent is that MoFR will review and approve the proposed Phase II sampling program. The Strathcona licensees will update this VPIP once the Phase II sampling is complete, and before the NVAF program commences.

1.3 Terms of Reference

This VPIP was prepared for Pat Bryant, *RPF* of Western Forest Products Ltd. on behalf of the Strathcona TSA licensees by Guillaume Thérien, *PhD* (biometrician) and Hamish Robertson, *RPF* (project manager) of Timberline Natural Resource Group Ltd. (Timberline). This October 2008 version of the VPIP contains updated information about the NVAF program, and extra sample selection that occurred on the TSA in 2006 and 2007 respectively.

1.4 Strathcona TSA Land Base

The Strathcona Timber Supply Area (TSA) is situated in the Coast Forest Region and is administered from the Campbell River Forest District Office in Campbell River. The District covers central Vancouver Island from the south end of Strathcona Park to the Brooks Peninsula in the north, several islands in the Strait of Georgia and portions of the mainland to the east. In total, the boundaries of the District encompass approximately 1.4 million hectares, but a significant portion of this is marine area. The Vegetated Treed component of the Strathcona TSA is 327,955 ha (24% of the total District).

Table 1. Campbell River Forest District net down.

Land Class	Area (ha)	% District
Total District	1,383,793	
Outside TSA	712,648	51%
TSA (including water)	671,145	49%
Non-Vegetated	322,758	23%
Vegetated	348,387	25%
Non-Treed	20,432	1%
Treed	327,955	24%

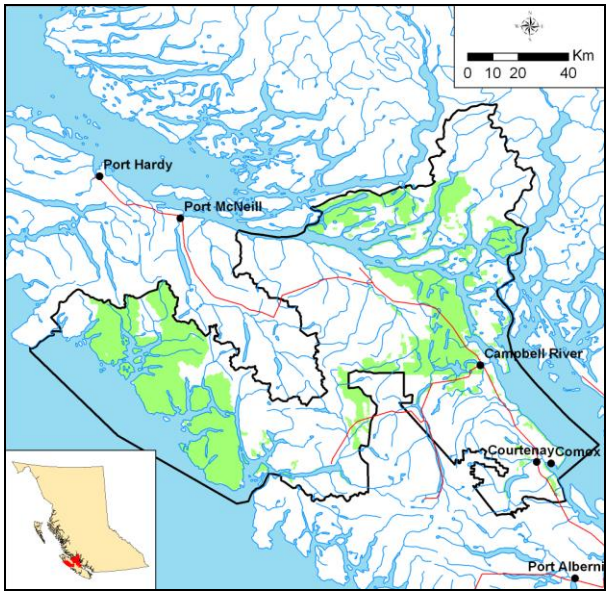

Figure 2. Map of the Campbell River Forest District (green denotes the land component of the Strathcona TSA).

2.0 STRATEGIC PLAN

2.1 Project Overview

The overall goal of the project is to complete the VRI Phase II and NVAF in the 2006/07 fiscal year. A first batch of Phase II plots will be established in early summer followed by preliminary compilations. Additional plots, if needed, will be established in the fall of 2006 if possible, but may be extended into the following fiscal year. The NVAF destructive sampling program will be implemented at the completion of the Phase II sampling program (funding permitted). The goal is to have the Phase II data compilation, analysis, and reporting will be completed before March 2007, pending the timely completion of the Phase II program.

2.2 Goal & Objectives

The goal of this project is to provide the Provincial Chief Forester with the necessary confidence in the Strathcona TSA forest inventory to support Timber Supply Review. The Strathcona TSA licensees objective is to:

> *Develop statistically unbiased volume estimates for stands at least 30 years old in the VT land base in the Strathcona TSA.*

2.3 Target Population

The target population was defined as the VT land base, 30 years and older in 2006 (that is, stands established before 1977). The target population represents approximately 275,237 ha (20% of the total District) (Table 2).

Table 2. Strathcona VRI Phase II target population.

Land Class	Area (ha)	% District
Total District	1,383,793	
Vegetated Treed	327,955	24%
Stands < 30 years	52,718	4%
Target Population	275,237	20%

2.4 Stratification

Pre-stratification of the target population was used to increase sampling efficiency. The stratification was based on the leading species in a stand and age class. The strata were defined as follows:

1. Western redcedar and yellow cedar (C-Y) leading stands, greater than 30 years.
2. Douglas-fir (Fd) leading stands, greater than 30 years.
3. Other species leading, established after 1885 (H-Immature).
4. Other species leading, established before 1886 (H-Mature).

Most Fd-leading stands (93%) were established after 1885 while most C-Y stands (90%) were established before 1886; thus, these species groups did not need to be split by age class. Most of the other stands were hemlock-leading (84% and 85% in the H-Immature and H-Mature, respectively). Inventory adjustment ratios will be computed at the stratum level.

Table 3. Target population stratification.

Stratum	Sub-stratum	Area (ha)	% Stratum	% Target
C-Y	0-300 m^3/ha	22,372	37%	
	300.1-450 m^3/ha	20,512	34%	
	450.1+ m^3/ha	17,164	29%	
	Total	*60,048*		*22%*
Fd	≤27 m	19,632	35%	
	27.1-32 m	18,444	33%	
	32.1+ m	17,654	32%	
	Total	*55,730*		*20%*
H-Immature	≤22 m	22,652	35%	
	22.1-27 m	18,949	30%	
	27.1+ m	22,599	35%	
	Total	*64,200*		*23%*
H-Mature	0-450 m^3/ha	31,206	33%	
	450.1-650 m^3/ha	36,039	38%	
	650.1+ m^3/ha	28,014	29%	
	Total	*95,259*		*35%*

Each stratum was subdivided into sub-strata to ensure a representative distribution of the samples within each stratum. The sub-strata in the Fd and H-Immature strata were based on site index class; those in the C-Y and H-Mature strata were based on stand volume. Sub-stratification was for spatial distribution of plots only. No adjustment ratios will be applied at the sub-strata level.

2.5 Timber Emphasis Sampling

2.5.1 Overview

Timber Emphasis Plot (TEP) installation will be done in the 2006 field season by VRI-certified timber emphasis cruisers. The choice of field samplers will be determined early in the fiscal year following a competitive bid process. The goal is to complete the Phase II field work during the 2006 field season.

2.5.2 Sampling Objectives

The TEP sampling objective is to:

> Install sufficient number of plots to achieve a target sampling error of approximately ±15% (at a 95% confidence level) on net merchantable volume in the target population.

We estimate that approximately 50 samples will be required to achieve the target sampling error. If the interim results show that the target sampling error has not been achieved, the licensees will install more plots.[1]

2.5.3 Sample Size

A first batch of 50 plots from the target population has been selected and will be installed in the four strata (Table 4). Sample size was allocated proportionally to the area of each sub-stratum. Each plot, therefore, represented approximately 5,500 ha. The licensees will complete an interim analysis of the 50 Phase II plots once the data is entered to determine whether further Phase II sampling is required. The sample list is given in Appendix II. The sample and target population were compared by height class, age class, and volume class (Appendix III).

Table 4. Phase II sample size by stratum.

Stratum	Sub-stratum	Area (ha)	No. Plots	Sampling Weight
C-Y	0-300 m^3/ha	22,372	4	5,593
	300.1-450 m^3/ha	20,512	4	5,128
	450.1+ m^3/ha	17,164	3	5,721
	Total	60,048	11	5,459
Fd	≤27 m	19,632	4	4,908
	27.1-32 m	18,444	3	6,148
	32.1+ m	17,654	3	5,885
	Total	55,730	10	5,573
H-Immature	≤22 m	22,652	4	5,663
	22.1-27 m	18,949	3	6,316
	27.1+ m	22,599	4	5,650
	Total	64,200	11	5,836
H-Mature	0-450 m^3/ha	31,206	6	5,201
	450.1-650 m^3/ha	36,039	7	5,148
	650.1+ m^3/ha	28,014	5	5,603
	Total	95,259	18	5,292

2.6 Net Volume Adjustment Factor Sampling

2.6.1 Overview

The Strathcona TSA licensees intend to pursue an NVAF program whereby the Phase II field data will be used to develop a NVAF tree matrix from which to select trees for NVAF destructive sampling. A sub-sample of the VRI Phase II plots must be selected for NVAF-enhancement to build the NVAF tree matrix.

Fifteen (15) VRI Phase II plots (7 immature and 8 mature) were selected to be NVAF-enhanced. This represents approximately one-third of the total number of first batch Phase II plots within each maturity class. The VRI Phase II plots were sorted by stratum and sub-stratum within each maturity class and plots were selected using a systematic sampling design with a random start. Net factoring and call grading will be completed on all auxiliary plots for the NVAF-enhanced plots. If more Phase II plots are needed after the first batch is complete, approximately one-third of these additional plots will be selected for NVAF-enhancement.

2.6.2 NVAF Sample Description

The target population for the NVAF program was stratified into four strata:

1. Dead
2. Immature
3. Mature western redcedar and yellow cedar (Mature-CY)
4. Mature hemlock (Mature-H)
5. Mature others (Mature-O)

[1] Assuming future FIA funding is available to fund the initiative.

Sixty-five (65) NVAF sample trees were allocated across all strata. The number of sample trees within each stratum was assigned based on the estimated net merchantable volume in the stratum and discussion with Will Smith, *RPF* (MOFR – Forest Analysis and Inventory Branch). The Immature stratum was slightly under-sampled (43% of the total volume, 31% of the sample trees) while the Mature-CY stratum was over-sampled (13% of the total volume, 22% of the sample trees).

Table 5. NVAF sample tree distribution by species group and species

Species		Net Merch. Vol.		Trees		
Group	Spp	% Total	% Group	No.	% Total	% Group
Dead	Cw	2%	18%	1	2%	20%
	Fdc	3%	33%	1	2%	20%
	Hm	0%	2%	1	2%	20%
	Hw	2%	25%	0	0%	0%
	Pw	0%	2%	0	0%	0%
	Xc	0%	2%	1	2%	20%
	Yc	2%	18%	1	2%	20%
	Total	*9%*	*100%*	*5*	*8%*	*100%*
Immature	Cw	8%	19%	4	6%	20%
	Dr	1%	3%	1	2%	5%
	Fdc	14%	33%	7	11%	35%
	Hw	20%	45%	8	12%	40%
	Total	*43%*	*100%*	*20*	*31%*	*100%*
Others	B	13%	73%	10	15%	77%
	Fdc	4%	21%	3	5%	23%
	Ss	1%	6%	0	0%	0%
	Total	*17%*	*100%*	*13*	*20%*	*100%*
Mature-CY	Cw	6%	46%	5	8%	38%
	Yc	7%	54%	8	12%	62%
	Total	13%	100%	13	20%	100%
Mature-H	Hm	4%	26%	5	8%	36%
	Hw	13%	74%	9	14%	64%
	Total	17%	100%	14	22%	100%
Total	*Total*	*100%*	*100%*	*65*	*100%*	*100%*

3.0 IMPLEMENTATION PLAN

3.1 Sample Selection

Sample polygons were selected using probability proportional to size with replacement (PPSWR). Each polygon in the sampling frame was listed only once and size was the total area of the polygon. The sample points within the sample polygons were selected from the provincial 100 m grid in a Geographic Information System (GIS) using the simple random sampling (SRS) method.

3.2 Sample Packages

Field sample packages will be prepared once the sample plan is approved. The field sample packages will include:

1. An ortho-photo (1:5,000) showing plot location and GPS points or pin-pricked 1:15,000 aerial photos.
2. 1:20,000 forest cover access maps showing polygon and plot location.
3. Overview map (approx 1:100,000) showing polygon location.

3.3 Timber Emphasis Sampling

3.3.1 Field Crews

Fieldwork is scheduled to begin early in the 2006 field season. A project pre-work meeting will be held on the first day and sampling should begin immediately thereafter. All plots will be installed at the random locations selected by GIS. If a plot location is unsafe the Strathcona TSA licensees and MoFR representative will try to locate an alternate location. If an alternate location cannot be found, the plot will be dropped.

3.3.2 VRI Measurements

The project priority is to measure timber attributes at each plot. Data will be collected to provincial VRI ground sampling standards.[2] Additional attributes beyond VRI requirements will be measured (Section 3.3.3). Certified crews will gather the data using VRI Card Types 1, 2, 3, 8, 9, 10, and 11.

3.3.3 Non-Standard VRI Data

The Strathcona licensees will collect additional, non-standard, VRI data. The purpose of collecting these additional measurements is to supplement the information normally provided by the VRI Phase II sampling. Additional measurements will include (Appendix IV):

1. Measuring the distance from the sample point to the tree in the auxiliary plots.
2. Recording borderline trees that are outside the normal prism plot.

[2] VRI ground sampling procedures are available: http://srmwww.gov.bc.ca/risc/pubs/teveg/vri_gs_2k4/vri_gs_2k4.pdf

3.3.4 Core Counting

Tree ages from sample cores will be counted by the field contractor completing the plot. Ages will be counted in the lab using a microscope and entered into the MoFR data entry program (TIMVEG).

3.3.5 Data Entry

Standard VRI field data will be entered into TIMVEG. Validation reports will be generated for each plot to ensure data integrity. All standard VRI data will be provided to the MoFR to be included in the provincial VRI database. Non-standard data will also be provided to the MoFR in a Microsoft Access™ database.

Global Positioning System (GPS) data will be post-processed by the field contractors, entered into TIMVEG, and delivered with the data at the end of the project.

3.3.6 Pre-work and Quality Assurance

All field crews should attend a pre-work session with the client and the auditor to review the plot methods and ensure that all questions are resolved at the beginning of the project. Western will hire a third party auditor to audit approximately 10% of all plots[3] following the *VRI Ground Sampling Quality Assurance Standards*.[4] Auditing will be done by batch, and failed plots may result in a failed batch.[5]

3.3.7 Plot Supplies

Supplies such as aluminum stakes, field maps, photos, plot cards, handheld data recorders, GPS units, and other required equipment are supplied by the field contract crews.

3.4 Net Volume Adjustment Factor Sampling

Trees from all enhanced-TEPs are used to develop the NVAF tree matrix. Stratification of the tree matrix and sample size within each stratum was reviewed and confirmed with MoFR representatives. A NVAF-certified crew will be hired to complete destructive sampling, with the intent being to have the sampling completed by the end of the 2006 field season.

The NVAF program follows MoFR standards and involves five steps:[6]

1. Create a tree matrix using data from the enhanced TEPs.
2. Select sample trees from the tree matrix.
3. Complete stem analysis of the sample trees.
4. Complete a third-party audit of the sample trees.
5. Analyze the data to develop net volume adjustment factors.

The Strathcona TSA licensees will hire a third party auditor to audit approximately 10% of all plots[7] following the NVAF quality assurance standards.[8]

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[3] The number of TEPs audited should be left to the discretion of the auditor. This has been done on many land bases.

[4] Minimum standards for VRI sampling are located at: http://srmwww.gov.bc.ca/risc/PUBS/TEVEG/VRIQA/VRI_Ground_Sampling_2K2/QA Standards for VRI-02.pdf

[5] Crews may be required to revisit failed plots at their own expense.

[6] NVAF sampling standards can be found at: http://srmwww.gov.bc.ca/risc/pubs/teveg/nvaf2k2/nvaf 02.pdf

3.5 Statistical Adjustment

3.5.1 Data Compilation, Analysis and Adjustment

The Strathcona TSA licensees will use the MoFR SAS compiler to compile all TEPs and NVAF trees. An interim analysis will be completed in the summer of 2006, and if needed, the results will be used to determine the remaining sample size for the fall of 2006.

At the conclusion of the field program, the licensees will complete the analysis and statistical adjustment of the Phase I data to MoFR standards. The analysis will:

- Use the approved MoFR adjustment procedures.
- Calculate ground sample average volumes and inventory volumes for the Strathcona TSA.
- Adjust inventory height and age.
- Generate new VDYP volumes using the adjusted heights and ages.
- Adjust new volume estimates using the ratio of means method.
- Compute sampling errors for the Strathcona TSA area.

[7] The number of TEPs audited will be left to the discretion of the auditor.

[8] The NVAF quality assurance standards are described in the NVAF sampling standards, chapter 10.

4.0 SCHEDULE

4.1 2006/07 Timelines

The Strathcona TSA licensees will complete the preliminary VPIP before March 31, 2006. Early in the 2006/07 fiscal year, the licensees will seek approval of the VPIP by the MoFR, prepare sample packages and solicit bids from consultants with VRI-certified field personnel to install the TEPs.

Sampling will start early in the field season immediately after the pre-work meeting. Crews will be audited at the start of the project and as the auditor deems necessary throughout the project. Data will be entered into TIMVEG and non-standard data into Microsoft Access™.

The licensees will complete a preliminary analysis at the end of the first batch of Phase II plots, and through discussions with the MoFR, will determine whether additional sampling is required. If required, additional Phase II plots will be selected and the VPIP will be updated. The goal is to have the Phase II field work and data entry completed before September 15, 2006. Once the Phase II program is complete, the NVAF tree matrix, sample size and VPIP update will be completed (by the end of September 2006). If there is time to complete the NVAF program within this fiscal, the destructive sampling program will be completed before snowfall in 2006, with data entry completed by November 30, 2006. Once the Phase II sampling program is complete, data compilation, inventory adjustment, and reporting will be completed by March 31, 2007.[9] The following table reflects updated timelines as of October 30, 2006:

Activities	2006										2007		
	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1. Complete VPIP													
2. Select sample locations													
3. Submit VPIP to MoFR													
4. Hire field staff													
5. Mentor TEP crews													
6. TEP sampling													
7. TEP QA													
8. Preliminary Analysis													
9. Select new sample locations (if necessary)													
10. Update VPIP (if necessary)													
11. TEP sampling (if necessary)													
12. NVAF sample plan													
13. Submit NVAF plan to MoFR													
14. NVAF destructive sampling													
15. NVAF audit													
16. Compilation, analysis, & report													

Figure 3. Proposed 2006/07 implementation schedule. Licensees; TEP Crew; VRI Mentor Auditor; NVAF Crew; NVAF Auditor

[9] If the Phase II program is not complete during this fiscal year, this program will be completed in future, as funding levels permit.

4.2 Roles & Responsibilities

Strathcona TSA Licensees

- Develop and update VPIP (as necessary).
- Coordinate project activities.
- Select sample polygons and locations within polygons.
- Prepare sample packages.
- Check data after initial compilation.
- Validate and compile data.
- Provide data to the MoFR.
- Complete interim analyses.
- Complete statistical adjustment.
- Complete final report.

TEP Field Contractors

- Complete field sampling.
- Enter the standard and non-standard sample data (incl. full cores and GPS of plot locations).
- Complete internal quality control and submit data to the Strathcona TSA licensees at the conclusion of field sampling.

NVAF Field Contractor

- Complete destructive sampling.
- Enter the sample data and provide to the Strathcona TSA licensees.

VRI Phase II Auditor

- Third party check-cruiser will audit approximately 10% of the Phase II samples.

NVAF Auditor

- NVAF-certified auditor will audit approximately 10% of the NVAF sample trees.

MoFR

- Review and approve the current version of the VPIP and the updated version in 2006.
- Review and approve the final analysis & the statistical attribute adjustment.
- Be the custodian of the VRI standard and non-standard sample & population data.
- Audit the VRI process to ensure that VPIP commitments and MoFR standards were met.

4.3 Proposed Budget

The proposed Phase II program should cost approximately $157,000, including audit, helicopter costs and the statistical adjustment, NVAF analysis and reporting costs. The proposed NVAF costs are approximately $95,000, including sampling, helicopter, and audit costs.

Table 6. Proposed Phase II and NVAF program cost.

Phase	Cost	%
Field Sampling[a]	$62,000	24
Helicopter estimate	$61,000	24
Field Audit estimate	$14,000	6
Statistical Adjustment & Report	$20,000	8
Sub-total	*$157,000*	62
NVAF Sampling [b]	$78,000	31
Helicopter	$10,000	4
Field Audit	$7,000	3
Sub-total	*$95,000*	38
Total	*$252,000*	

[a] These costs are based on a field crew rate of $1,500/day.

[b] These costs are based on field sampling at $1,200/tree.

4.4 Deliverables

The project deliverables include:

- Phase II sample plot data entered into TIMVEG and Microsoft Access database containing non-standard data.
- NVAF tree data entered into TIMVEG.
- Quality assurance reports completed by the VRI Phase II and NVAF Field Auditors
- Final report including a discussion of the analysis, adjustment and results.

APPENDIX I – GLOSSARY OF TERMS

Ground Sampling

VRI ground sampling (Phase II) is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. To accommodate the wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

Landcover Classification

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

Net Volume Adjustment Factor (NVAF) Sampling

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

Photo-Interpretation (Phase I)

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

Post-Stratification

Post-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately and the results are applied to the corresponding population post-strata.

Pre-Stratification

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

Sample Size

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

Statistical Adjustment

Statistical adjustment (or analysis) is the process of adjusting the values of the photo-interpreted estimates variables using the ground sampling observations. For each sampled polygon, the ground observations are compared to the photo-estimated values to develop an adjustment factor. This factor is then applied to all polygons in the photo-interpreted estimates database to produce the final adjusted database.

Sub-unit

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

Target Population

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

Target Precision

Target precision expresses the amount of variation in key attributes (e.g., timber volume) desired in the final results. The target precision, usually expressed as the coefficient of variation (CV), is used to calculate the minimum sample size for subsequent ground sampling.

Vegetation Resources Inventory (VRI)

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

- BC Landcover classification scheme (BCLCS).
- *Photo-interpreted estimates (Phase I)*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling (Phase II)*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes. The data are used for the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit.
- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: Intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- *Change Monitoring Inventory (CMI)*

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

APPENDIX II – PHASE II & NVAF PLOT LIST

Table 7. Strathcona TSA 50 Phase II plots.

Plot No	NVAF	Maturity	Stratum	Sub Stratum	Map ID	Polygon ID	Area (ha)	Height (m)	Age (yrs)	Volume (m^3/ha)	UTM Zone	UTM Easting	UTM Northing
1	No	Mature	C-Y	450.1+	092K055	109	9.1	40.0	253	701.4	10	349881	5598692
2	Yes	Mature	FD	<=27	092E090	87	13.1	18.0	123	166.3	9	713195	5522764
3	No	Immature	H-Immature	27.1+	092K002	182	4.3	22.0	43	290.6	10	308523	5550680
4	No	Immature	H-Immature	22.1-27	092E094	26	37.1	15.0	34	114.5	9	622242	5539955
5	Yes	Immature	H-Immature	<=22	092E096	180	27.9	16.9	45	151.4	9	655804	5538034
6	No	Mature	H-Mature	450.1-650	092E094	40	13.5	36.0	278	571.6	9	628893	5538630
7	Yes	Immature	H-Immature	22.1-27	092L060	369	5.9	23.0	43	192.8	9	708698	5604584
8	Yes	Mature	H-Mature	650.1+	092K055	108	21.1	45.0	303	718.2	10	349186	5598821
9	No	Immature	FD	<=27	092K004	308	116.9	23.7	75	264.7	10	331606	5543045
10	Yes	Mature	C-Y	300.1-450	092K054	131	58.9	27.0	193	347.4	10	342693	5596587
11	Yes	Mature	C-Y	300.1-450	092E067	421	18.3	25.0	303	376.3	9	668554	5504675
12	Yes	Mature	H-Mature	450.1-650	092L070	51	18.0	29.0	303	469.9	9	709428	5613718
13	No	Mature	C-Y	450.1+	092K044	345	8.9	34.0	303	556.8	10	342424	5594898
14	Yes	Mature	H-Mature	450.1-650	092L005	574	13.4	38.0	278	615.3	9	633097	5540902
15	No	Immature	FD	27.1-32	092F093	92	11.4	28.0	53	358.3	10	323012	5538196
16	No	Mature	H-Mature	450.1-650	092L005	1156	16.4	32.4	192	512.3	9	641860	5551457
17	No	Mature	H-Mature	650.1+	092L015	256	9.9	40.0	304	721.9	9	638962	5558736
18	No	Mature	H-Mature	650.1+	092E095	364	23.8	45.0	303	740.5	9	634809	5538173
19	No	Mature	C-Y	300.1-450	092E087	342	95.7	23.0	303	307	9	666134	5519965
20	Yes	Immature	FD	32.1+	092K013	553	32.9	34.0	63	521.3	10	324730	5558321
21	No	Mature	C-Y	0-300	092E067	976	116.3	22.0	303	269.5	9	659732	5498023
22	Yes	Immature	FD	<=27	092K033	502	9.2	22.0	53	225.5	10	320258	5576201
23	No	Mature	H-Mature	450.1-650	092L013	61	38.4	32.0	233	506.3	9	610985	5558381
24	No	Mature	C-Y	450.1+	092E067	331	18.8	38.0	503	511.1	9	670532	5505155
25	No	Immature	H-Immature	<=22	092K061	248	68.8	12.2	34	37.3	10	298203	5611908
26	No	Immature	H-Immature	<=22	092E080	64	44.2	13.1	36	50	9	714935	5516736
27	Yes	Immature	H-Immature	27.1+	092K023	162	5.7	40.0	93	793.9	10	315223	5572906
28	Yes	Immature	FD	27.1-32	092K003	428	28.8	30.0	63	378.8	10	320356	5549100
29	No	Immature	C-Y	0-300	092L003	41	20.3	12.0	35	48.9	9	609607	5550627
30	No	Mature	H-Mature	0-450	092K044	7	20.5	15.0	203	136.8	10	341491	5596536
31	No	Mature	C-Y	300.1-450	092E067	654	9.0	24.0	303	358.8	9	661884	5501607
32	No	Mature	H-Mature	0-450	092K055	140	18.4	26.0	253	353.9	10	350967	5598348
33	No	Immature	H-Immature	22.1-27	092L013	486	11.4	26.7	62	385.4	9	608577	5553783
34	No	Mature	H-Mature	650.1+	092E067	775	22.9	42.0	403	663.9	9	664606	5501018
35	No	Mature	H-Mature	450.1-650	092E095	102	25.2	35.0	278	549.3	9	640048	5539588
36	No	Mature	H-Mature	0-450	092K061	176	35.9	10.0	203	16.1	10	295846	5613004

Plot No	NVAF	Maturity	Stratum	Sub Stratum	Map ID	Polygon ID	Area (ha)	Height (m)	Age (yrs)	Volume (m^3/ha)	UTM Zone	UTM Easting	UTM Northing
37	Yes	Immature	C-Y	0-300	092K033	470	2.4	12.0	43	40.5	10	316767	5576443
38	No	Immature	FD	32.1+	092F094	44	8.8	35.0	63	550.7	10	332255	5534422
39	No	Mature	H-Mature	450.1-650	092E095	934	23.6	36.0	278	637	9	634020	5533044
40	No	Mature	C-Y	0-300	092K062	212	98.4	19.0	203	214.1	10	309188	5608960
41	No	Immature	H-Immature	27.1+	092K034	81	123.1	22.0	43	276.7	10	332277	5579111
42	Yes	Mature	H-Mature	0-450	092K023	1001	5.2	17.0	278	154.7	10	324674	5564322
43	No	Mature	H-Mature	650.1+	092E100	20	65.5	40.0	303	753.7	9	709603	5542513
44	No	Immature	FD	27.1-32	092K003	250	5.1	31.0	63	518.3	10	314068	5549355
45	No	Immature	H-Immature	<=22	092K034	95	9.2	7.0	43	0	10	330259	5578694
46	Yes	Mature	H-Mature	0-450	092L005	538	11.1	14.0	203	142.4	9	638673	5541430
47	No	Immature	FD	32.1+	092K002	710	22.2	28.0	50	327.6	10	313071	5551895
48	No	Mature	H-Mature	0-450	092E095	1221	5.4	29.0	253	431.9	9	636688	5531354
49	No	Immature	H-Immature	27.1+	092K013	536	29.3	33.0	63	491.4	10	322650	5558805
50	No	Mature	FD	<=27	092K044	85	48.2	26.0	193	360.7	10	330798	5591873

APPENDIX III – TARGET AND SAMPLE COMPARISONS

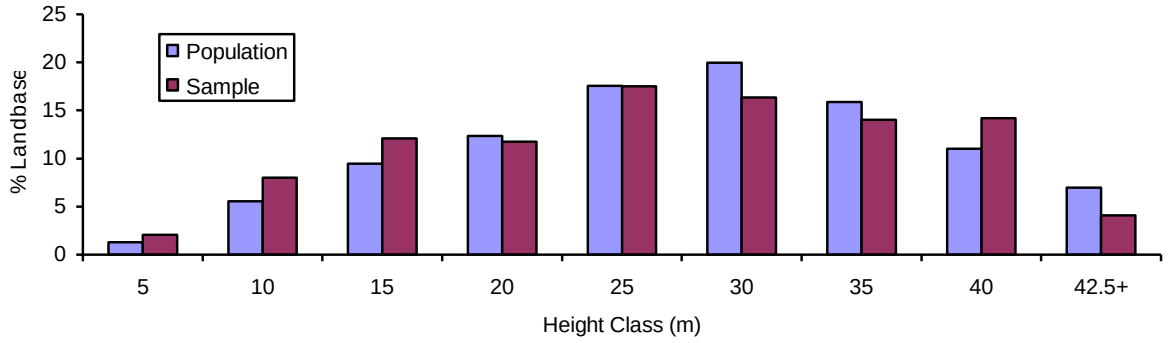

Figure 4. Target and sample population comparison by height class.

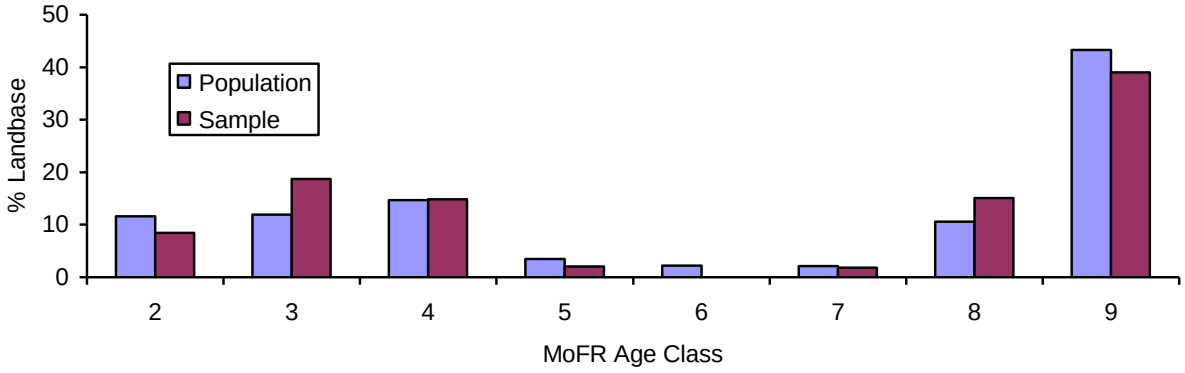

Figure 5. Target and sample population comparison by age class.

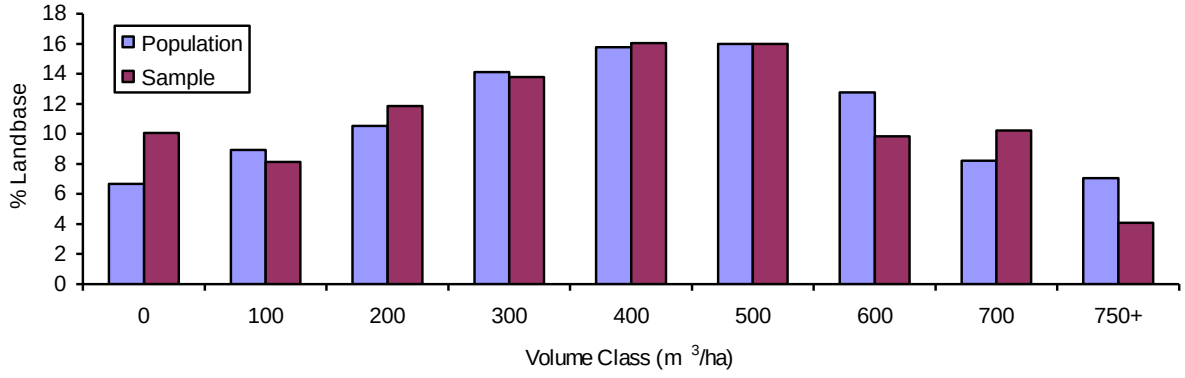

Figure 6. Target and sample population comparison by volume class.

APPENDIX IV – ADDITIONS TO STANDARD VRI METHODS

In order to provide data that better meets the Strathcona licencees' inventory needs, additional field data is being collected beyond provincial VRI standards. The intent is that this data may aid future plot remeasurements. The additions to current VRI methods include:

- Recording the distance plot centre-tree on auxiliary plots.
- Recording borderline trees that are outside the prism plot.
- Establishing the regeneration plot on all points.

Recording the distance plot centre-tree on auxiliary plots

Tree distances are only recorded on the Integrated Plot Centre (IPC). We propose recording this attribute on all auxiliary plots to increase the information on tree distances.

Recording borderline trees outside the prism plot

Recording borderline trees will decrease the likelihood of missing a tree. In the current system, trees are dropped from compilation if the tree was mistakenly recorded as in tree, but it is impossible to know if missed trees should have been included.

APPENDIX V – NVAF SAMPLE SELECTION AND DISTRIBUTION

Strathcona Timber Supply Area
Vegetation Resources Inventory Project
Implementation Plan – NVAF Sample Selection and Distribution

Prepared for:

Pat Bryant, RPF

Western Forest Products Ltd.

Campbell River, BC

On Behalf of the

Strathcona TSA Licensees

Project: BC0107833

November 1, 2005

Timberline Natural Resource Group

Overview

This Appendix describes the steps used to select the Net Volume Adjustment Factor (NVAF) sample trees for the Strathcona Timber Supply Area (TSA) Vegetation Resources Inventory (VRI) project. It describes the stratification used, the number of plots enhanced, the sampling frame, the sample size, and the sampling list.

Stratification

Plots were stratified into two maturity classes: immature and mature. Immature was defined as all polygons with an unadjusted Phase I age of <= 120 years and mature stands were > 120 years.

Plot Enhancement

Fifteen (15) Phase II clusters were enhanced for NVAF purposes (seven mature and eight immature). These clusters were selected systematically with a random start within the maturity class. The clusters were sorted by plot number prior to selection. All auxiliary plots in the sample polygons were NVAF enhanced. Fifty-six (56) plots were enhanced (an average of 3.73 plots/cluster). The average weight for the NVAF-enhanced clusters was approximately 18,000 ha/ plot (Table 8).

Table 8. NVAF-Enhanced plot distribution.

Maturity	Area (ha)	no_plots	Area/plot
Immature	121,007	7	17,287
Mature	154,230	8	19,279
Total	*275,237*	*15*	*18,349*

Sampling Frame

The sampling frame included 240 trees (an average of 16 trees/cluster or 4.3 trees/plot). The sampling frame was stratified into five groups (Table 9):

1. Dead
2. Immature – western redcedar, red alder (Dr)
3. Mature – western redcedar and yellow cedar (CY)
4. Mature – hemlock (H)
5. Mature – Others (which included balsam, Douglas-fir, and Sitka spruce)

Table 9. Sampling frame by species group and species.

Group	Ba	Bl	Cw	Dr	Fdc	Hm	Hw	Pw	Ss	Yc	Total	
Dead			15		14	2	9	1		8	49	20%
Immature			18	2	31		35				86	36%
Mature-CY			11							17	28	12%
Mature-H						19	31				50	21%
Mature-Others	15	5			6				1		27	11%
Total	*15*	*5*	*44*	*2*	*51*	*21*	*75*	*1*	*1*	*25*	*240*	*100%*
	6%	*2%*	*18%*	*1%*	*20%*	*9%*	*31%*	*0%*	*0%*	*10%*		

Sample Size

The total sample size was set to 65 trees. The sample size within each species group was based on the relative net merchantable volume and the expected net factor variability within each group. The sample size was finalized after discussion with Ministry of Forests and Range (MOFR) representatives (Table 10).

Table 10. Sample size distribution.

Species		Net Merch Vol.		No. Trees		
Group	Spp	% Total	% Group	n	% Total	% Group
Dead	Cw	1.6	18.3	3	4.6	60.0
	Fdc	2.9	33.8	1	1.5	20.0
	Hm	0.2	2.4	1	1.5	20.0
	Hw	2.2	25.1	0	0.0	0.0
	Pw	0.2	2.3	0	0.0	0.0
	Yc	1.6	18.1	0	0.0	0.0
	Total	*8.7*	*100.0*	*5*	*7.7*	*100.0*
Immature	Cw	8.3	19.3	4	6.2	20.0
	Dr	1.2	2.8	1	1.5	5.0
	Fdc	14.0	32.6	7	10.8	35.0
	Hw	19.5	45.4	8	12.3	40.0
	Total	*43.0*	*100.0*	*20*	*30.8*	*100.0*
Mature-CY	Cw	6.1	46.0	5	7.7	38.5
	Yc	7.2	54.0	8	12.3	61.5
	Total	*13.4*	*100.0*	*13*	*20.0*	*100.0*
Mature-H	Hm	4.5	25.7	5	7.7	35.7
	Hw	13.0	74.3	9	13.8	64.3
	Total	*17.5*	*100.0*	*14*	*21.5*	*100.0*
Mature-Others	Ba	12.4	71.0	7	10.8	53.8
	Bl	0.4	2.1	3	4.6	23.1
	Fdc	3.6	20.6	3	4.6	23.1
	Ss	1.1	6.3	0	0.0	0.0
	Total	*17.5*	*100.0*	*13*	*20.0*	*100.0*
Total	*Total*	*100.0*		*65*	*100.0*	

Sampling List

The sampling frame was sorted by species group, DBH, and species before tree selection.[10] The trees were selected systematically within each species group with a random start. The number of trees each tree represents varied between 2.1 and 9.8 (Table 11). The sample list is given in Table 5.

Table 11. Average number of trees each NVAF tree represents

Group	Total Trees	Sample Trees	Ratio
Dead	49	5	9.8
Immature	86	20	4.3
Mature-CY	28	13	2.2
Mature-H	50	14	3.6
Mature-Others	27	13	2.1
Total	*240*	*65*	*3.7*

[10] Initially the sampling frame included dead trees with a net factor less than 50%. Two of these trees were selected among the five dead trees. These two trees were replaced by the two trees with the closest DBH. The replacement trees are listed in the sample list, not the original trees.

Table 12. NVAF sample list for the Strathcona TSA

Group	Cluster	Plot	Tree No	Species	DBH
Dead	0371-0002-NO1	E	6	HM	40.5
Dead	0371-0005-NO1	S	5	FD	63
Dead*	0371-0008-NO1	E	4	CW	120.7
Dead	0371-0027-NO1	E	3	CW	110
Dead*	0371-0028-NO1	W	2	CW	40.0
Immature	0371-0005-NO1	E	8	HW	46.3
Immature	0371-0005-NO1	N	3	HW	29.9
Immature	0371-0005-NO1	S	1	HW	40.9
Immature	0371-0005-NO1	S	3	HW	24.6
Immature	0371-0007-NO1	N	1	DR	14.3
Immature	0371-0007-NO1	N	4	CW	23.4
Immature	0371-0007-NO1	N	8	CW	26.5
Immature	0371-0007-NO1	W	1	FDC	53.6
Immature	0371-0007-NO1	W	4	CW	19.6
Immature	0371-0020-NO1	E	6	HW	36
Immature	0371-0020-NO1	N	4	FDC	32.2
Immature	0371-0020-NO1	N	5	FDC	20.2
Immature	0371-0022-NO1	E	2	HW	20.3
Immature	0371-0022-NO1	E	3	HW	32
Immature	0371-0022-NO1	W	1	FDC	38.5
Immature	0371-0027-NO1	E	4	CW	42.1
Immature	0371-0027-NO1	W	2	FDC	69.5
Immature	0371-0037-NO1	N	5	HW	17.9
Immature	0371-0037-NO1	S	3	FDC	14.6
Immature	0371-0037-NO1	W	2	FDC	28.6
Mature-CY	0371-0008-NO1	N	2	CW	134.7
Mature-CY	0371-0010-NO1	N	4	YC	30.7
Mature-CY	0371-0010-NO1	N	7	YC	44.4
Mature-CY	0371-0011-NO1	N	2	YC	125
Mature-CY	0371-0011-NO1	S	1	YC	113
Mature-CY	0371-0011-NO1	S	5	YC	90
Mature-CY	0371-0011-NO1	W	2	YC	158.4
Mature-CY	0371-0011-NO1	W	8	YC	138.5
Mature-CY	0371-0014-NO1	N	4	CW	76.4
Mature-CY	0371-0014-NO1	N	5	CW	85.1
Mature-CY	0371-0014-NO1	W	3	CW	123.4
Mature-CY	0371-0042-NO1	W	7	YC	19.7

Group	Cluster	Plot	Tree No	Species	DBH
Mature-CY	0371-0046-NO1	E	1	CW	54.2
Mature-H	0371-0002-NO1	N	3	HM	54.3
Mature-H	0371-0002-NO1	S	11	HM	67.3
Mature-H	0371-0002-NO1	W	7	HW	62.1
Mature-H	0371-0008-NO1	E	2	HW	51.5
Mature-H	0371-0010-NO1	N	6	HM	37.1
Mature-H	0371-0012-NO1	S	4	HM	52.4
Mature-H	0371-0012-NO1	S	6	HW	44
Mature-H	0371-0012-NO1	W	1	HW	39.9
Mature-H	0371-0012-NO1	W	2	HW	82
Mature-H	0371-0012-NO1	W	4	HM	71.3
Mature-H	0371-0014-NO1	E	1	HW	20
Mature-H	0371-0014-NO1	W	4	HW	14.1
Mature-H	0371-0046-NO1	E	2	HW	12.6
Mature-H	0371-0046-NO1	E	7	HW	27.8
Mature-Others	0371-0002-NO1	W	4	BA	12.6
Mature-Others	0371-0011-NO1	E	5	FDC	174
Mature-Others	0371-0011-NO1	N	6	BA	21.3
Mature-Others	0371-0011-NO1	S	2	BA	45.5
Mature-Others	0371-0014-NO1	S	1	BA	83.4
Mature-Others	0371-0014-NO1	S	3	BA	100.4
Mature-Others	0371-0014-NO1	S	6	BA	77.5
Mature-Others	0371-0042-NO1	N	2	BL	62.1
Mature-Others	0371-0042-NO1	N	3	BA	51.1
Mature-Others	0371-0042-NO1	S	4	BL	18.7
Mature-Others	0371-0042-NO1	S	5	BL	29.2
Mature-Others	0371-0046-NO1	E	6	FDC	65.7
Mature-Others	0371-0046-NO1	N	5	FDC	126

* Replacement tree.

APPENDIX VI – AMENDMENT TO THE STRATCONA TSA VPIP

Amendment to the Strathcona Timber Supply Area
Vegetation Resources Inventory
Project Implementation Plan

Prepared for:

Pat Bryant, RPF

Western Forest Products Ltd.

Campbell River, BC

On Behalf of the

Strathcona TSA Licensees

Project: BC0107833

September 24, 2007

Timberline Natural Resource Group

Rationale

An interim analysis was completed on the VRI for the Strathcona TSA in July 2007.[11] This memo stated that given a target sampling error of ±10% (at a 95% confidence level) and a calculated coefficient of variation (CV) of 58% (based on 49 plots), Western Forest Products Ltd. would need to establish 83 more plots (total of 132 plots). Based on discussions with the MoFR[12] it was agreed that an additional 53 plots (total of 102 plots, 92 in Operable and 10 in Inoperable areas) would be sufficient to provide MoFR timber supply analysts with the necessary confidence in the most important parts of the inventory from a timber supply perspective. This equates to a ±25% sampling error (at a 95% confidence level) for each stratum in the Operable areas. The expected sampling error in the Operable areas for a CV of 58% with 92 samples will be approximately ±10.5% (at a 95% confidence level).

Net Volume Adjustment Factor sampling requirements have been satisfied with the completion of the first batch of plots, thus no additional plots will be NVAF enhanced.

Sampling Objective

The revised sampling objective is to:

> *Install additional plots to achieve a target sampling error of approximately ±25% (at a 95% confidence level) for each stratum on net merchantable volume in the Operable areas of the target population.*

Sample Selection

Sample polygons were selected using probability proportional to size with replacement (PPSWR). Each polygon in the sampling frame was listed only once and size was the total area of the polygon. The sample points within the sample polygons were selected from the provincial 100 m grid in a Geographic Information System (GIS) using the simple random sampling (SRS) method.

Sample Packages

Field sample packages will be prepared once the amended sample plan is approved. The field sample packages will include:

1. An ortho-photo (1:5,000) showing plot location and GPS points or pin-pricked 1:15,000 aerial photos.
2. 1:20,000 forest cover access maps showing polygon and plot location.
3. Overview map (approx 1:100,000) showing polygon location.

[11] Strathcona VRI Phase II – Preliminary Analysis – June 2007.

[12] At a July 10, 2007 meeting between the Strathcona TSA licensees, representatives of the Forest Analysis and Inventory Branch, and Timberline, it was agreed that sampling should focus on gaining a higher level of comfort in strata that are more relevant in timber supply analysis than simply achieving an overall sampling error of ±10% (95% confidence error). This amendment is consistent with these objectives.

Sample Distribution

With the addition of plots installed on the land base, the sampling weighting within each stratum has changed. Table 1 provides the sample distribution in each stratum separated by substrata with the revised sampling weight. No additional plots are needed in the Inoperable areas and in the H-Mature stratum. The Inoperable areas are a low priority and the precision of volume estimates in that stratum is not a concern. The sampling error in the H-Mature stratum is already at 18% and does not require further sampling.

Table 13. Sample Distribution

Stratum	Sub-stratum	Area (ha)	No. Plots	Sampling Weight
Operable	0-300 m^3/ha	7,197	7	1,028
C-Y	300.1-450 m^3/ha	9,250	8	1,156
	450.1+ m^3/ha	12,661	12	1,055
	Sub-Total	29,108	27	1,078
FD	<=27 m	17,674	9	1,964
	27.1-32 m	20,996	11	1,909
	32.1+ m	14,950	7	2,136
	Sub-Total	53,621	27	1,986
H-Immature	<=22 m	19,596	9	2,177
	22.1-27 m	18,577	8	2,322
	27.1+ m	22,338	10	2,234
	Sub-Total	60,512	27	2,241
H-Mature	0-300 m^3/ha	7,473	1	7,473
	300.1-450 m^3/ha	23,665	6	3,944
	450.1+ m^3/ha	23,279	4	5,820
	Sub-Total	54,417	11	4,947
Operable	Total	197,658	92	2,148
Inoperable	C-Y	30,940	3	10,313
	FD	2,110	1	2,110
	H	44,529	6	7,422
	Sub-Total	77,579	10	7,758
Total		*275,237*	*102*	*2,698*

Proposed Budget

The proposed additional plot program should cost approximately $170,000, including audit and helicopter costs,

Deliverables

The project deliverables are commensurate with those outlined in the Strathcona Phase II VRI Project Implementation Plan (VPIP).[13]

Timelines

This portion of the Phase II program on the Strathcona TSA is expected to be completed during the remainder of the 2007 field season. The adjustment and final report will be completed prior to March 31, 2008, provided all sampling is completed during the 2007 field season.

Sample Comparison

The following figures provide comparisons of the population and samples for height, age, and volume using all 103 samples.

[13] Strathcona Timber Supply Area Vegetation Resources Inventory Project Implementation Plan Version 3.0 – October, 2006.

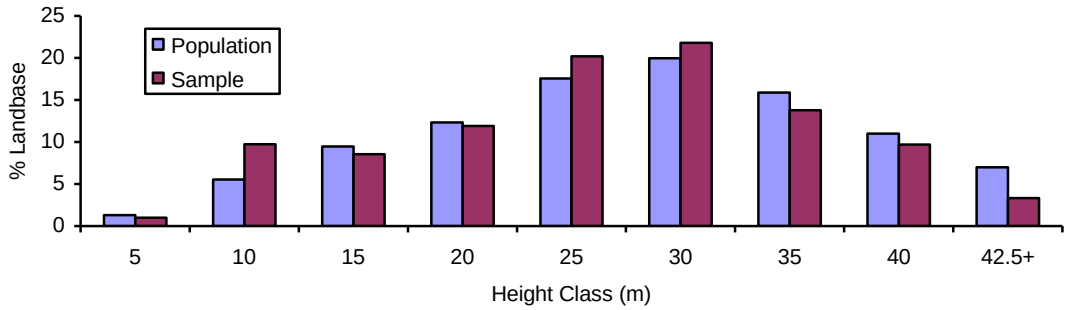

Figure 7. Comparison of population and sample for height.

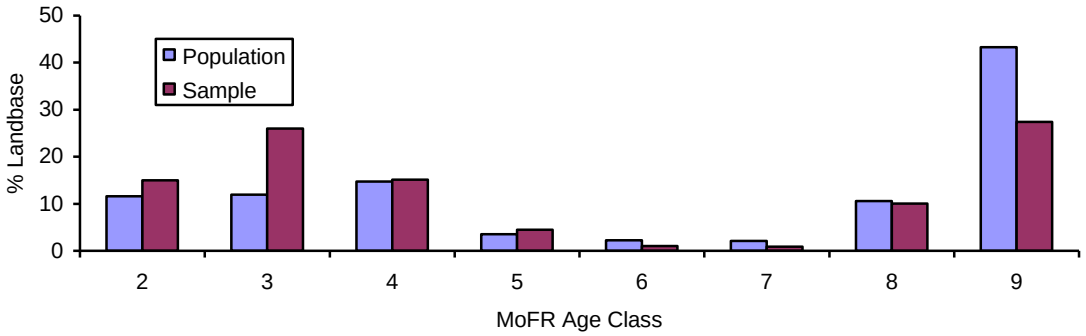

Figure 8. Comparison of sample and population for age.

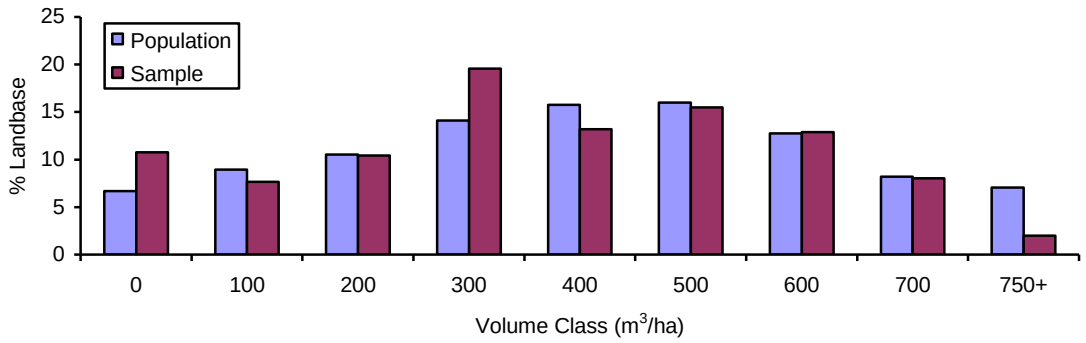

Figure 9. Comparison of sample and population for volume.

ADDITIONAL SAMPLES FOR THE STRATHCONA TSA

Plot				Sub	Map	Polygon	Area	Height	Age	Volume	UTM		
No	NVAF	Maturity	Stratum	Stratum	ID	ID	(ha)	(m)	(yrs)	(m^3/ha)	Zone	Easting	Northing
53	No	Immature	FD	27.1-32	092K013	76	126.0	27	54	324.1	10	320804	5557680
54	No	Immature	FD	<=27	092K003	1078	7.9	18	53	88.8	10	325372	5551996
55	No	Immature	H-Immature	27.1+	092K034	81	123.1	22	43	276.7	10	332352	5578508
56	No	Immature	FD	<=27	092K002	366	22.6	32	83	554.4	10	305862	5546688
57	No	Immature	H-Immature	22.1-27	092K023	416	60.6	32	73	613.8	10	323708	5570061
58	No	Immature	H-Immature	22.1-27	092L059	28	12.3	24	53	369.1	9	696026	5608672
59	No	Mature	C-Y	300.1-450	092E067	931	6.5	25	503	328.5	9	667854	5499751
60	No	Immature	C-Y	0-300	092L005	443	31.2	15.2	33	103.2	9	641351	5541940
61	No	Immature	FD	<=27	092K023	817	12.9	23	53	237.6	10	316237	5565865
62	No	Immature	FD	27.1-32	092K004	110	8.1	29	63	331.7	10	328923	5548352
63	No	Mature	C-Y	450.1+	092E096	485	8.7	37	353	547.1	9	650188	5533606
64	No	Immature	FD	32.1+	092K003	750	26.7	33	52	464.5	10	316946	5548839
65	No	Mature	C-Y	450.1+	092L024	204	42.6	35	353	493.7	9	615433	5566863
66	No	Immature	FD	27.1-32	092F093	341	6.1	33	63	485.1	10	323413	5540679
67	No	Mature	C-Y	450.1+	092E095	193	13.1	30	223	503.3	9	633687	5538727
68	No	Immature	H-Immature	27.1+	092K002	1237	33.1	32	63	577.1	10	313078	5542197
69	No	Mature	C-Y	450.1+	092L005	524	17.2	33	278	536.7	9	637655	5541888
70	No	Immature	H-Immature	<=22	092L013	276	34.9	9	34	0	9	608444	5554577
71	No	Mature	C-Y	450.1+	092E077	791	20.4	34	503	482	9	665869	5509262
72	No	Immature	H-Immature	27.1+	092L014	708	16.7	24	37	335.9	9	625048	5559162
73	No	Immature	H-Immature	22.1-27	092F094	91	2.3	26	53	311.8	10	331094	5535369
74	No	Mature	C-Y	0-300	092E086	105	14.9	20	213	229.8	9	645291	5528709

Plot				Sub	Map	Polygon	Area	Height	Age	Volume	UTM		
No	NVAF	Maturity	Stratum	Stratum	ID	ID	(ha)	(m)	(yrs)	(m^3/ha)	Zone	Easting	Northing
75	No	Immature	C-Y	0-300	092L004	330	132.7	21	51	225.8	9	620519	5545381
76	No	Mature	C-Y	450.1+	092K045	137	28.2	40	403	671.6	10	347538	5592788
77	No	Mature	C-Y	300.1-450	092E096	551	1.1	30	303	378.7	9	647738	5532407
78	No	Immature	FD	27.1-32	092K003	143	13.7	24	43	200.4	10	315003	5550217
79	No	Immature	FD	27.1-32	092K022	460	21.9	40	88	707	10	311882	5574342
80	No	Immature	FD	32.1+	092K002	426	93.3	32	57	555.5	10	310085	5552216
81	No	Immature	H-Immature	<=22	092L060	435	24.3	11	33	17.5	9	711123	5603982
82	No	Mature	FD	<=27	092K033	504	4.0	39	303	636.1	10	320449	5575994
83	No	Immature	H-Immature	27.1+	092K033	415	78.6	29	63	483.8	10	321704	5577342
84	No	Immature	H-Immature	27.1+	092E077	443	31.0	25.8	53	338.4	9	671812	5508104
85	No	Immature	H-Immature	<=22	092E096	431	19.5	12.2	34	46.6	9	646292	5533547
86	No	Immature	H-Immature	<=22	092L013	522	22.8	11.7	33	15.6	9	613592	5555790
87	No	Mature	C-Y	300.1-450	092L070	32	8.3	27	303	410.3	9	710307	5614254
88	No	Mature	C-Y	300.1-450	092E087	555	1.4	28	203	330.3	9	667358	5521814
89	No	Immature	H-Immature	27.1+	092K052	163	159.1	30.2	38	356.1	10	302611	5602224
90	No	Immature	FD	<=27	092E087	91	1.9	16	113	114.2	9	661794	5528383
91	No	Mature	C-Y	450.1+	092L014	532	18.7	36	303	581.6	9	622540	5556960
92	No	Immature	H-Immature	22.1-27	092L004	68	130.1	22	48	283.2	9	627934	5549785
93	No	Immature	FD	27.1-32	092K013	624	19.1	31	73	517.9	10	317099	5557531
94	No	Immature	FD	32.1+	092K013	1371	14.2	44	73	731.8	10	326439	5558551
95	No	Mature	C-Y	450.1+	092L006	45	33.3	33	353	513.5	9	650060	5551393
96	No	Immature	FD	27.1-32	092K003	445	7.7	26.5	57	323.5	10	317511	5545517
97	No	Mature	C-Y	450.1+	092K063	432	17.0	42	453	656.9	10	326558	5612953
98	No	Immature	H-Immature	<=22	092E077	503	82.4	15.5	42	112.9	9	668797	5510980
99	No	Immature	C-Y	0-300	092L004	115	55.7	18	40	154.3	9	620650	5549484
100	No	Mature	C-Y	0-300	092L013	158	6.3	22	303	297.9	9	613886	5553503

Plot No	NVAF	Maturity	Stratum	Sub Stratum	Map ID	Polygon ID	Area (ha)	Height (m)	Age (yrs)	Volume (m^3/ha)	UTM Zone	UTM Easting	UTM Northing
101	No	Immature	FD	27.1-32	092F093	29	6.9	28	53	406.9	10	326731	5541144
102	No	Mature	C-Y	450.1+	092K051	272	13.3	35	303	539.7	10	288002	5604617
103	No	Immature	FD	32.1+	092K023	455	96.7	23	35	187.5	10	317262	5568923
104	No	Mature	FD	<=27	092L059	231	15.4	28	203	315.8	9	695745	5598356
105	No	Immature	H-Immature	22.1-27	092K033	190	15.2	33	83	587.8	10	320514	5577591