Prince George Timber Supply Area
Deciduous Vegetation Resources Inventory

Statistical Analysis and Adjustment

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EXECUTIVE SUMMARY

The Prince George (PG) Timber Supply Area (TSA) forest cover inventory is based on photo-interpreted inventory attribute estimates. Stakeholders in the TSA require a separate adjustment of the operable deciduous leading polygons to provide more reliable attribute estimates for deciduous species. These stand types exist in both the Fort St. James (FSJ) and Prince George (PG) Forest Districts.

The Net Volume Adjustment Factor (NVAF) sampling program was completed during the 2009 field season and the ratios were calculated by Timberline Natural Resource Group Ltd. (Timberline).

Height, age, basal area, stems per hectare, Lorey height, and total live net merchantable volume were adjusted following Ministry of Forests and Range (MFR) VRI adjustment methods.

The target population represents components of the FSJ and PG Forest District target populations as defined in the separate VRI programs.[1] In 2008 the deciduous target population was defined as the operable and deciduous leading polygons in both Forest Districts. In the FSJ Forest District the deciduous component used for this analysis was approximately 88,000 ha. In the PG Forest District the deciduous component used for this analysis was approximately 114,000 ha. The total deciduous target population represents approximately 202,200 ha. The target population was stratified by maturity class into the following two strata:

1. Immature – 80 years or less.
2. Mature – 81 years or greater.

After adjustment, **height did not change and age decreased by 17%**. **Basal area decreased by 7% and stems per hectare increased by 8%**. The overall impact on **site index was an increase of 10% and Lorey height decreased by 7%**. The current Phase I live **volume increased by approximately 16%.** The sampling error for the volume adjustment was ±15.5% (95% probability)

The main source of uncertainty in the inventory is variability in the volume in the Immature stratum. The sampling error for this stratum was approximately ±29% which is relatively high compared to the Mature stratum (±19%).

The recommendations from this project are that the adjusted height, age, basal area, stems per hectare, Lorey height, and volume for the deciduous population be used in TSR3.

[1] Timberline Natural Resource Group Ltd., 2010. *Prince George Forest District Vegetation Resources Inventory – Statistical Analysis and Adjustment*. January 2010. 63 p.

Timberline Natural Resource Group Ltd., 2010. *Fort St. James Forest District Vegetation Resources Inventory – Statistical Analysis and Adjustment*. January 2010. 68 p.

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1.0 INTRODUCTION

1.1 Vegetation Resources Inventory Overview

The Vegetation Resources Inventory (VRI) is the Ministry of Forests and Range's (MFR) forest inventory standard on public lands in BC. Where possible, forest licensees must use the VRI standard in their Data Package submission for Timber Supply Review (TSR).

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

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

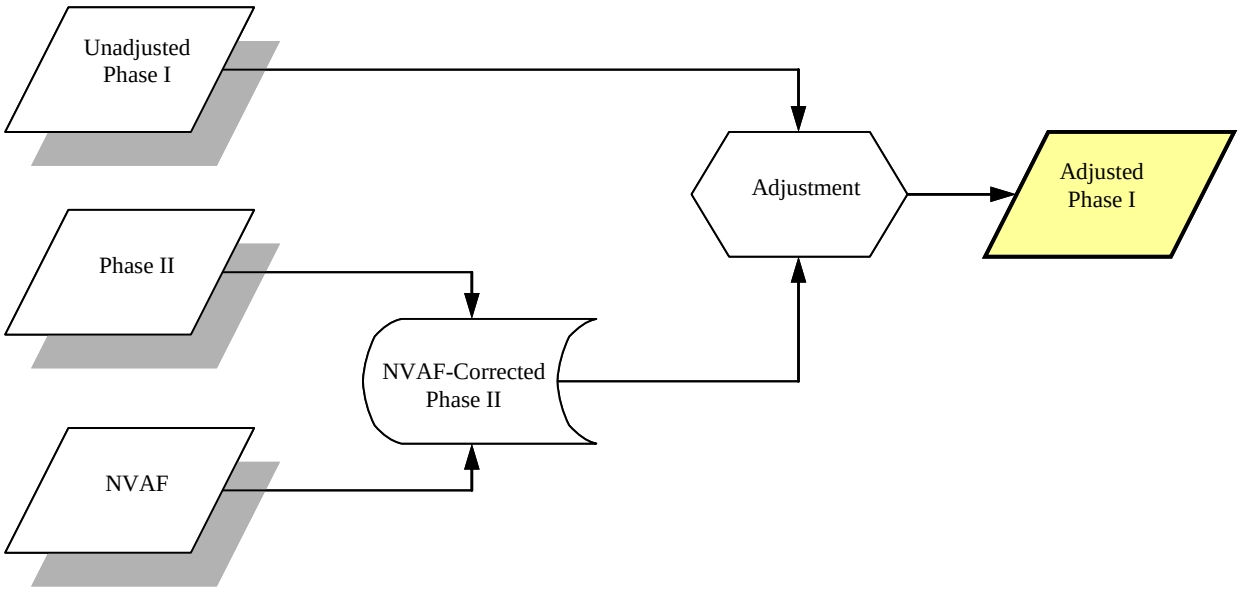

Figure 1. VRI Flow-chart.

1.2 Prince George Timber Supply Area VRI Program

The Prince George (PG) Timber Supply Area (TSA) is composed of the Vanderhoof, Fort St. James (FSJ) and PG Forest Districts. VRI programs were completely separately by these Forest Districts to reduce the size of the overall program and because timber supply analyses were analyzed separately by Forest District.

The PG TSA VRI program was initiated in 2000. The TSA Phase I was completed over three years by Timberline Natural Resource Group Ltd. (Timberline), Geowest Consultants, Arc Alpine Resource Consultants, Triathlon Forest Dimensions, and Integrated Resource Consultants (IRC). All Phase I work concluded in 2005. Forsite Consultants Ltd. and Timberline Natural Resource Group Ltd (Timberline) completed the majority of the Phase II program over the 2006 and 2007 field seasons. All Phase II sampling that occurred during the 2008 field season was completed by Terrestrial Information Systems. Twelve (12) NVAF trees were destructively sampled by McColl Forestry Ltd. in the 2009 field season and added to ten (10) existing deciduous trees destructively sampled in 2007. Timberline completed the design, NVAF analysis, and statistical adjustment of the Phase I.

1.3 Problem Statement

The PG TSA forest cover inventory is based on photo-interpreted inventory attribute estimates, which are assumed to have some bias. Stakeholders in the TSA require an adjustment of the operable deciduous leading polygons to provide more reliable attribute estimates for deciduous species. These stand types exist in both the FSJ and PG Forest Districts.

1.4 Project and Report Objectives

The project objectives were to:

1. *Compile the VRI Phase II (ground data) samples located in the deciduous target population to MFR standards;*
2. *Complete a statistical adjustment of the deciduous target population and report on the results; and*
3. *Deliver the adjusted data to the MFR and report on the results.*

The report objective is to:

a. *Document the statistical adjustment procedures used in the Deciduous population;*
b. *Identify areas of uncertainty in the data; and*
c. *Provide recommendations for its use in TSR.*

1.5 Terms of Reference

Timberline prepared this report for the PG TSA licencees. Bruce Bradley, *RPF* (Canadian Forest Products Ltd.) was the licencee contact person. Hamish Robertson, *RPF* (Timberline) was the project manager and Hugh Carter, *MSc, RFT* (Timberline) completed the analysis and prepared

the report. The results from this report will be reviewed by the MFR Forest Analysis and Inventory Branch (FAIB) prior to use in TSR.

2.0 DATA

2.1 Land Base

The FSJ and PG Forest Districts are situated in the north-central interior of BC and cover approximately 6.6 million ha. The cities of PG and Fort St. James are the main urban centres in these Forest Districts respectively.

Deciduous stands in the FSJ and PG Forest Districts represent a strategically important component of future timber supply.

2.2 Target Population

The target population represents components of the FSJ and PG Forest District target populations as defined in the separate VRI programs.[3] In 2008 the deciduous target population was defined as the operable and deciduous leading polygons in both Forest Districts. These areas were segregated from District target populations and combined to make up the deciduous population. The combined target population covers 202,000 ha; approximately 6% of the total combined area of the two Forest Districts.

Table 1. Deciduous population net down.

Land Class	Area (ha)	% District
Total FSJ FD	*3,185,198*	*100%*
FSJ Target Population	1,910,822	60%
FSJ Deciduous Population	88,407	3%
Problem polygons[2]	48	0%
Total PG FD	*3,396,737*	*100%*
PG Target Population	1,529,063	45%
PG Deciduous Population	114,323	3%
Problem Polygons	471	0%
Total Deciduous Target Population	*202,211*	*6%*

2.3 Stratification

The target population was stratified based on maturity class. Stands less than 81 years (in 2007) were deemed Immature, and Mature otherwise (Table 2). The population was further substratified by site index class and samples were distributed by these substrata. Originally the target population was selected using an operability definition that resulted in split VRI polygons (operable and inoperable). For this analysis if a polygon was split it was deemed to be operable and the total polygon was used for analysis. This was done to reduce the risk of different adjustment ratios being applied to the same polygon. This resulted in slight changes in the areas of each stratum. The sampling weights were recalculated to account for these changes.

[2] Fifty-three (53) polygons (approximately 519 ha) in the deciduous population had the same species called twice and VDYP7 would not produce any outputs. These polygons were excluded from the target population and not used in the analysis

[3] Timberline Natural Resource Group Ltd., 2009. *Prince George Forest District Vegetation Resources Inventory – Statistical Analysis and Adjustment*. March 2009. 55 p.

Timberline Natural Resource Group Ltd., 2009. *Fort St. James Forest District Vegetation Resources Inventory – Statistical Analysis and Adjustment*. March 2009. 60 p.

Approximately two thirds of the deciduous target population (64%) was located in Mature stands. Stands in the 15.0-19.0m site index class made up the majority of the population (59%). Adjustment statistics were computed at the stratum level only; sub-strata were only used for sample selection.

Table 2. 2007 stratification scenario.

Stratum	Sub-Stratum	PG Area (ha)	FSJ Area (ha)	Total Area (ha)	% Pop.	% Stratum
Immature	<15.0 m	10,208	10,101	20,309	10.0	27.9
	15.0-19.9 m	27,633	10,738	38,372	19.0	52.6
	≥20.0 m	12,442	1,766	14,208	7.0	19.5
	Sub-Total	*50,283*	*22,605*	*72,888*	*36.0*	*100.0*
Mature	<15.0 m	7,275	19,700	26,975	13.3	20.9
	15.0-19.9 m	41,486	39,249	80,735	39.9	62.4
	≥20.0 m	14,808	6,806	21,614	10.7	16.7
	Sub-Total	*63,569*	*65,755*	*129,323*	*64.0*	*100.0*
Total		*113,851*	*88,360*	*202,211*	*100.0*	

The overall average height, age, site index, and net merch. volumes were 22.7 m, 96 yrs, 17.3 m, and 189.4 m^3/ha respectively. The Phase I averages were highest for height, age, basal area, and volume in the Mature stratum. The site index on average was very similar between the strata (Table 3).

Table 3. Phase I (photo-interpretation) inventory statistics.

Stratum	Area (ha)	Height (m)	Age (yrs)	SI (m)	BA (m^2/ha)	SPH (trees/ha)	Lorey Ht. (m)	Vol. 12.5cm+ (m^3/ha)
Immature	72,888	17.9	61	17.2	28.6	1,218	16.4	126.0
Mature	129,323	25.5	115	17.3	37.5	703	23.1	225.1
Total	*202,211*	*22.7*	*96*	*17.3*	*34.3*	*889*	*20.7*	*189.4*

2.4 NVAF

A focused destructive sampling program for deciduous trees was completed during the 2009 field season. Twelve (12) trees were selected and sampled, then added to the eleven (11) existing deciduous trees previously sampled in the FSJ and PG Forest Districts (for a total of 23 deciduous trees). The data was combined to generate deciduous ratios that were applied to the three different populations. All ratios were calculated by Timberline and approved by the MFR Volume and Decay Sampling Officer (January 2010).

Table 4 provides a summary of the cruiser called Phase II volumes for deciduous and coniferous trees compared to the destructively sampled volumes as supplied by the MFR. In general, the

Phase II overstated tree volumes in all land bases.[4] Phase II overstated the volume by approximately 5% on average (Refer to Appendix I for all deciduous NVAF trees).

Table 4. NVAF tree summary statistics.

Original Unit	Live/ Dead		Spp	No. Trees	Avg. Volume (m^3) VRI	NVAF	% Diff.
Prince George	Live	Immature	All	15	0.5107	0.5237	+2.5%
Forest District		Mature	Balsam	20	0.3988	0.3793	-4.9%
			Cedar	12	1.2470	0.8286	-33.6%
			Spruce	20	0.9609	0.9672	+0.7%
			Others	15	0.3642	0.3533	-3.0%
	Dead	All	All	25	0.4113	0.4174	+1.5%
	Total		*Total*	*107*	*0.5667*	*0.5218*	*-7.9%*
Fort St. James	Live	Immature	All	23	0.1717	0.1643	-4.3%
Forest District		Mature	Bl	24	0.3166	0.3086	-2.5%
			Pl	23	0.4798	0.4849	+1.1%
			Others	23	0.6022	0.5427	-9.9%
	Dead	All	All	30	0.2794	0.2828	+1.2%
	Total		*Total*	*123*	*0.3037*	*0.2964*	*-2.4%*
Deciduous	Live	Immature	Deciduous	8	0.1910	0.1704	-10.8%
Population		Mature	Deciduous	15	0.4733	0.4618	-2.4%
	Total		*Total*	*23*	*0.3456*	*0.3299*	*-4.5%*

2.5 Phase II (Ground Sampling)

2.5.1 Actual Sample Size

Fifty-seven (57) plots were selected; 17 from the initial Phase II program and 40 from plots selected specifically for this program. One sample landed in a problem polygon and was dropped because Phase I attributes could not be generated in VDYP7. Therefore, 56 plots remained for analysis (Table 5). Thirteen (13) of these 56 plots were part of the original PG sample selection, and three were part of the original FSJ sample selection.

Table 5. Phase II plot distribution.

Label	No. Plots	(%)
Samples Established	57	100%
Dropped[5]	1	2%
Valid Plots	56	98%
Existing PG	13	23%
Existing FSJ	3	5%
New PG	19	34%
New FSJ	21	38%
Total for Analysis	*56*	*100%*

[4] This could be due to cruiser called decay and/or volume calculation differences. An investigation of taper would need to be completed to determine if volume calculation differences were significant.

[5] Sample 49 was located in a problem polygons as explained in Footnote #2 and dropped from the analysis.

2.5.2 Sampling Weights

Forty (40) plots were initially selected in 2008 with equal probability (i.e., each plot represented the same amount of area) and these were added to the existing 16 samples located in the deciduous population. The weights were re-computed based on the final list of plots (56) located in the target population (Table 6). Sampling weights ranged from 2,842 ha to 4,496 ha or in relative terms from 1 to 1.6. The average weight was 3,611 ha/plot or 1.3 in relative terms. The sampling weight for each individual ground sample is provided in Appendix II.

Table 6. Phase II plot sampling weights.

		Previously Adjusted		
Stratum	Sub-Stratum	Area (ha)	No. Plots	Area/ Plot
Immature	<15.0 m	20,309	6	3385
	15.0-19.9 m	38,372	9	4264
	≥20.0 m	14,208	5	2842
	Sub-Total	*72,888*	*20*	*3,644*
Mature	<15.0 m	26,975	6	4,496
	15.0-19.9 m	80,735	24	3364
	≥20.0 m	21,614	6	3602
	Sub-Total	*129,323*	*36*	*3,592*
	Total	*202,211*	*56*	*3,611*

2.5.3 Phase II Statistics

The overall average Phase II plot height, age, site index and live volume were 22.4 m, 79 yrs, 19.2 m, and 220.2 m^3/ha respectively. The Mature stands in the deciduous target population had relatively higher basal areas, heights, and volumes as one would expect (Table **7**). The site index was higher on average in the Immature stratum. The Phase I and Phase II data is provided in Appendix III.

Table 7. Deciduous Phase II inventory statistics.

Stratum	n	Height (m)	Age (yrs)	SI (m)	L. Ht. (m)	BA (m^2/ha)	SPH (trees/ha)	Vol (m^3/ha)		
								Live	Dead	Total
Immature	20	18.2	56	20.5	15.0	23.2	974	129.2	7.4	136.6
Mature	36	24.5	91	18.6	21.7	37.2	882	271.5	26.3	297.8
Total	*56*	*22.4*	*79*	*19.2*	*19.3*	*32.2*	*915*	*220.2*	*19.5*	*239.7*

Note: Phase II (ground sampling) volume was whole-stem volume less tops, stumps, NVAF-corrected cruiser-called decay, waste, and breakage.

3.0 METHODS

3.1 Phase I Projection

The photo-interpretation for both the PG and FSJ Forest Districts was based on photos taken between 1959 and 2004. The majority of the Phase II plots (42 of 56 plots) were sampled in 2008 and all polygons were projected to 2008. The photo-interpreted age was projected to 2008 by adding the required number of years. The photo-interpreted height, stocking class, and corresponding net merchantable volume were projected to 2008 using VDYP7 (version 7.5c.27). The model did not project BA, SPH, or volume where heights were less than 7.6m so these polygons were assumed to have no volume, BA, stems per hectare. All other critical VDYP7 inputs (species composition, crown closure, forest inventory zone, inventory standard, and BGC) were not modified.

3.2 NVAF

The NVAF ratios were generated by Timberline in January 2010 and approved by the MFR Volume and Decay Officer. Ratios were computed using the design-based method and applied to the Phase II net merchantable volume computed from the raw data. Twelve (12) deciduous trees were destructively sampled during the 2009 field season to account for decay differences in deciduous trees. These trees were pooled together with the eleven (11) existing deciduous trees sampled in the FSJ and PG Forest Districts. Deciduous ratios were computed for both the PG and FSJ Forest Districts combined. All appropriate weights were applied for the design-based method and approved by the MFR Volume and Decay officer on December 23rd 2009.

Coniferous ratios calculated for the Fort St. James and Prince George Forest Districts were applied to the conifer trees in the deciduous population samples depending on which Forest District the sample was located. No dead deciduous trees were sampled and no deciduous dead ratios were generated. The dead ratios calculated for the conifer trees were applied to dead trees based on the Forest District in which they were located.

3.3 Phase II Compilation

The Phase II (ground sampling) data was compiled using the MFR SAS VRI Phase II compiler. [6] Dead trees (standing and fallen) were recorded in all auxiliary plots. The plot type_cd[7] attribute was changed in the samples established prior to 2008 to initiate the proper compilation of this dead tree information. It was important to include dead tree attributes to get a reasonably accurate representation of the dead tree information in both Forest Districts. Auxiliary plot inclusion in the cluster was based on the crew decision at ground sampling time. It is therefore possible that a field crew identified an auxiliary plot as inside (or outside) the sampled polygon despite the polygon boundary indicating the opposite.

[6] The SAS compiler was supplied by the MFR on February 4, 2009.

[7] Based on communication with Gitte Churlish the type_cd was changed to "Nxx" to allow for the proper compilation of this dead tree information.

3.4 Statistical Adjustment

The most recent MFR VRI statistical adjustment standards[8] were used to adjust height, age, basal area (7.5cm+), stems per hectare (7.5cm+), Lorey height (12.5cm+), and live net merchantable volume (12.5cm+). The MFR adjustment procedures assume that the unadjusted (Phase I) inventory volume is biased due to two sources of error:

1. An attribute bias associated with the photo-interpreted height, age, basal area, and stems per hectare; and
2. A model bias inherent to the growth and yield model used to estimate volume (VDYP7).

Three critical attributes needed for volume prediction are not adjusted in the process but are important for determination of other critical attributes. The "inventory standard" attribute determines how basal area and stems per hectare are either used or generated, BGC zones are important for estimating volume loss and are needed for every polygon, and species composition is used to distribute the volume. Leaving species composition unadjusted is assumed to create a negligible bias.

The interim attribute adjustment procedure is a two-step process (Figure 2) described as follows:

- Step 1: Phase I height, age, basal area (7.5cm+), and stems per hectare (7.5cm+) bias are corrected using an adjustment ratio of means (ROM) calculated from the Phase I and Phase II plots. An attribute-adjusted volume is then estimated using VDYP7 with the adjusted height and age.
- Step 2: An adjustment ratio estimated from the attribute-adjusted volume (12.5cm+) and the NVAF-corrected Phase II volume is calculated and this ratio is used to correct the model bias in the attribute-adjusted volume.
- Step 2b: An adjustment ratio estimated from the attribute-adjusted Lorey height (12.5cm+) and the Phase II Lorey height (all live trees including ones with broken tops [i.e., ht_mean1])[9] is calculated and this ratio is used to correct the model bias in the attribute-adjusted Lorey height.

[8] Ministry of Forests and Range. 2008. *Vegetation Resources Inventory Interim Procedures and Standards for Statistical Adjustment of Baseline VRI Timber Attributes*. Unpublished Report, January 2008. 36 pp.

[9] As instructed by Sam Otukol in an e-mail communication December 16, 2009.

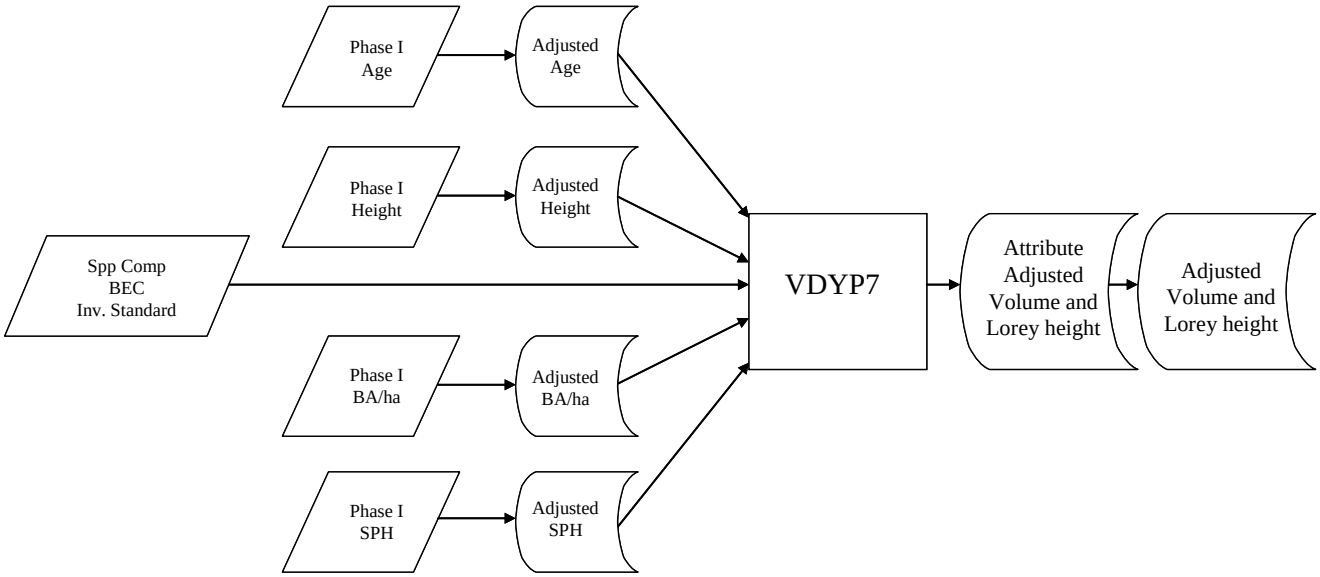

Figure 2. Interim procedures for adjustment of baseline VRI timber attributes.

4.0 RESULTS

4.1 NVAF

The average NVAF ratio for live deciduous trees was 0.892 for the Immature stratum and 0.976 for the Mature stratum, with an overall average of 0.938 (Table 8). The overall 95% sampling error (E%) for live deciduous trees was 16.5%. The individual deciduous stratum sampling errors were determined to be too high for any level of comfort and the overall average ratio (0.938) was applied to all deciduous trees. Conifer ratios were applied based on species group and Forest District.

Table 8. NVAF ratios

Live/ Dead	Prince George[10]					Fort St James[11]					Deciduous			
		Spp	n	Ratio	95% E%		Spp	n	Ratio	95% E%		n	Ratio	95% E%
Live	Imm.	All	15	1.026	9.9	Imm.	All	23	0.957	11	Imm.	8	0.892	22.5
	Mat.	Bl	20	0.951	7.8	Mat.	Bl	24	0.975	8.8	Mat.	15	0.976	25.6
		Cw	12	0.664	43.9		Pl	23	1.011	3.6				
		S	20	1.007	3.6		O	23	0.901	11				
		O	15	0.97	13.8									
Dead	All	All	25	1.015	7.4	All	All	30	1.012	5.3				
Total		*Total*	*107*	*0.958*	*4.4*		*Total*	*123*	*0.981*	*3.8*	*Total*	*23*	*0.938*	*16.5*

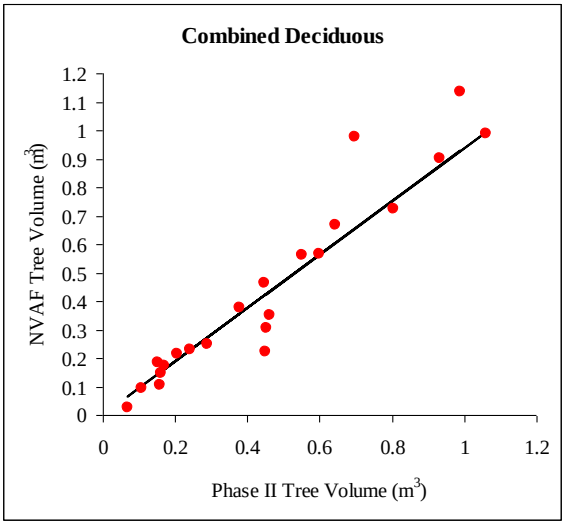

Figure 3. NVAF scatterplots.

[10] Graphs and full analysis can be found Timberline Natural Resource Group Ltd., 2010. *Prince George Forest District Vegetation Resources Inventory – Statistical Analysis and Adjustment*. January 2010. 63 p.

[11] Graphs and full analysis can be found in Timberline Natural Resource Group Ltd., 2010. *Fort St. James Forest District Vegetation Resources Inventory – Statistical Analysis and Adjustment*. January 2010. 68 p.

4.2 Height

Ten (10) plots had no suitable height observation, leaving 46 plots for analysis. On average, there was no appreciable height difference between the Phase I and Phase II height estimates; the overall sampling error was 6% (Table 9, Figure 4). In the Immature stratum, height was under-estimated in Phase I on average by approximately 8%.

Table 9. Height adjustment statistics for the target population.

	Unadjusted Pop.		Sample				Adjusted. Population		
Stratum	Area (ha)	Avg. (m)	n	Phase I (m)	Phase II (m)	ROM	Adj. Avg. (m)	95% E (m)	(%)
Immature	72,888	17.9	14	16.8	18.0	1.076	19.3	2.9	14.9
Mature	129,323	25.5	32	25.1	24.5	0.976	24.9	1.4	5.5
Total	*202,211*	*22.7*	*46*	*22.1*	*22.1*	*1.004*	*22.8*	*1.3*	*5.7*

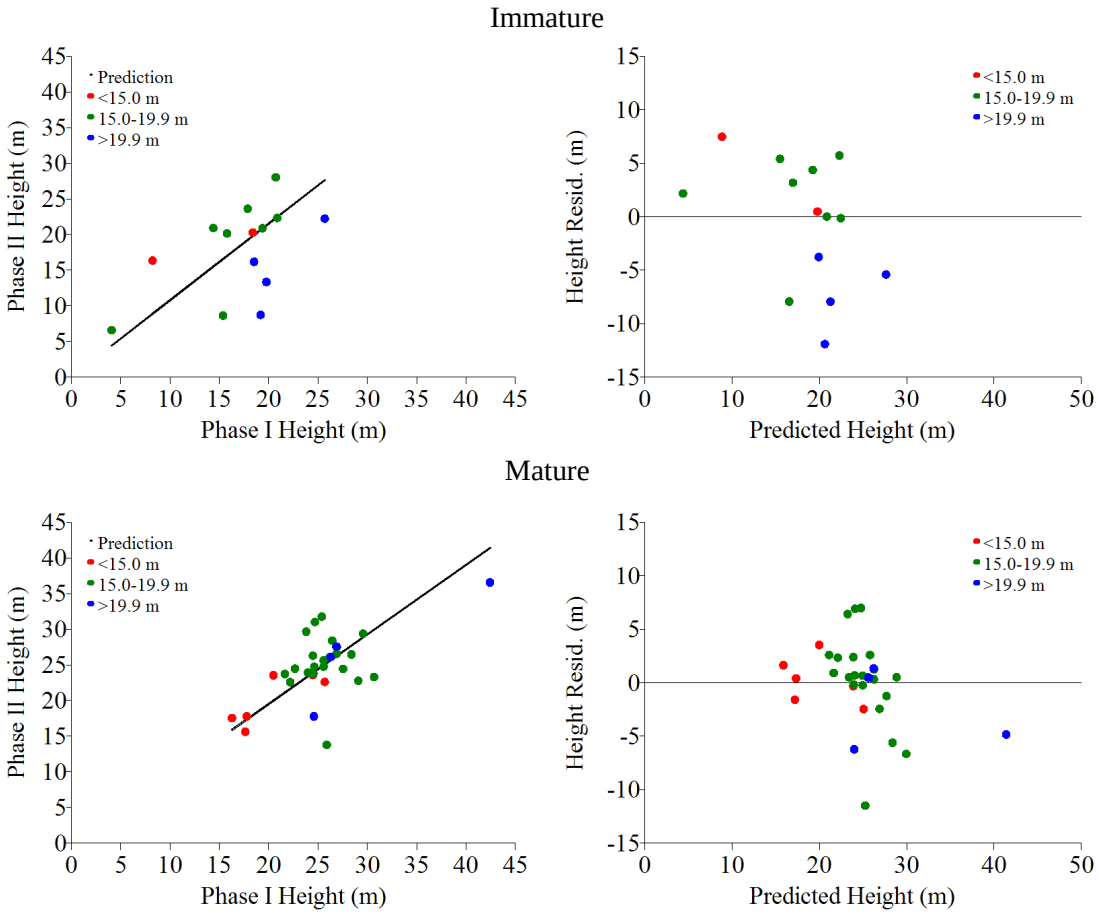

Figure 4. Height scatterplots by stratum.

4.3 Age

Ten (10) plots had no suitable age observation, leaving 46 plots for analysis. Phase I Age was over-estimated on average by approximately 17% (Table 10, Figure 5). Age in Immature stands with was over-estimated by almost 20%. The overall sampling error was ±9% (95% probability).

Table 10. Age adjustment statistics for the target population.

	Unadjusted Pop.		Sample				Adjusted Pop.		
	Area	Avg.	n	Phase I	Phase II	ROM	Adj. Avg.	95% E	
Stratum	(ha)	(yrs)		(yrs)	(yrs)		(yrs)	(yrs)	(%)
Immature	72,888	61	14	57	55	0.964	59	8	12.8
Mature	129,323	115	32	116	91	0.791	91	11	12.1
Total	*202,211*	*96*	*46*	*95*	*78*	*0.831*	*80*	*7*	*9.3*

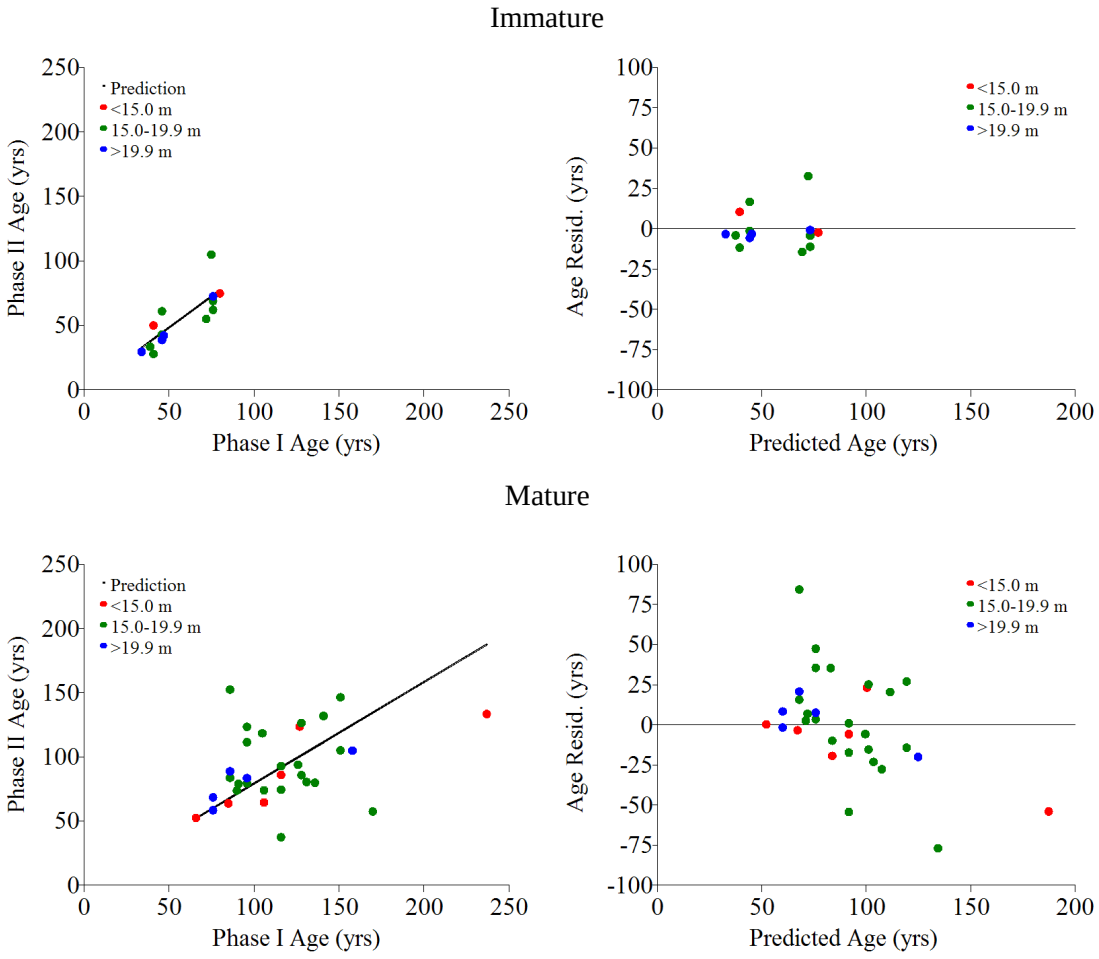

Figure 5. Age scatterplots by stratum.

4.4 Basal Area

Fifty-six (56) samples were used for the basal area analysis. Phase I basal area was over-estimated on average by approximately 7% (Table 11, Figure 6). Basal area in Immature stands was over-estimated by approximately 12%. The overall sampling error was 13% (95% probability).

Table 11. Basal area adjustment statistics for the target population.

	Unadjusted Pop.		Sample				Adjusted Pop.		
	Area	Avg.	n	Phase I	Phase II	ROM	Adj. Avg.	95% E	
Stratum	(ha)	(m^2/ha)		(m^2/ha)	(m^2/ha)		(m^2/ha)	(m^2/ha)	(%)
Immature	72,888	28.6	20	26.5	23.2	0.876	25.0	6.0	24.1
Mature	129,323	37.5	36	39.3	37.2	0.946	35.5	5.7	15.9
Total	*202,211*	*34.3*	*56*	*34.7*	*32.2*	*0.925*	*31.8*	*4.1*	*13.0*

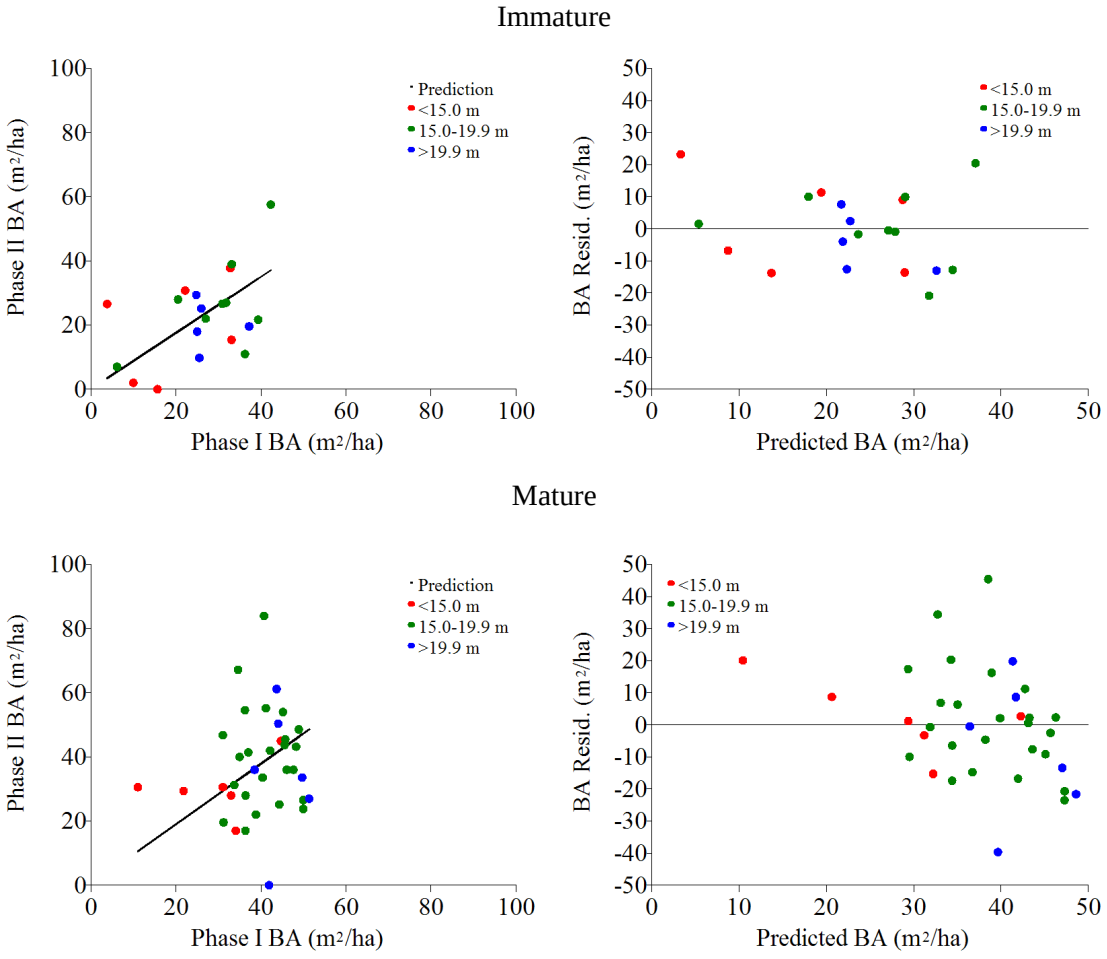

Figure 6. Basal area (7.5cm+) live only scatterplots by stratum.

4.5 Stems per hectare

Fifty-six (56) samples were used for the stems per hectare analysis. Phase I stems per hectare was under-estimated on average by approximately 8% (Table 12, Figure 7). Basal area in Mature stands was under-estimated by approximately 24%. The overall sampling error was approximately 19% (95% probability).

Table 12. Stems per hectare adjustment statistics for the target population.

	Unadjusted Pop.		Sample				Adjusted Pop.		
	Area	Avg.	n	Phase I	Phase II	ROM	Adj. Avg.	95% E	
Stratum	(ha)	(trees/ha)		(trees/ha)	(trees/ha)		(trees/ha)	(trees/ha)	(%)
Immature	72,888	1,218	20	1,079	974	0.903	1,100	316	28.7
Mature	129,323	703	36	709	882	1.243	874	222	25.4
Total	*202,211*	*889*	*56*	*843*	*915*	*1.075*	*955*	*178*	*18.6*

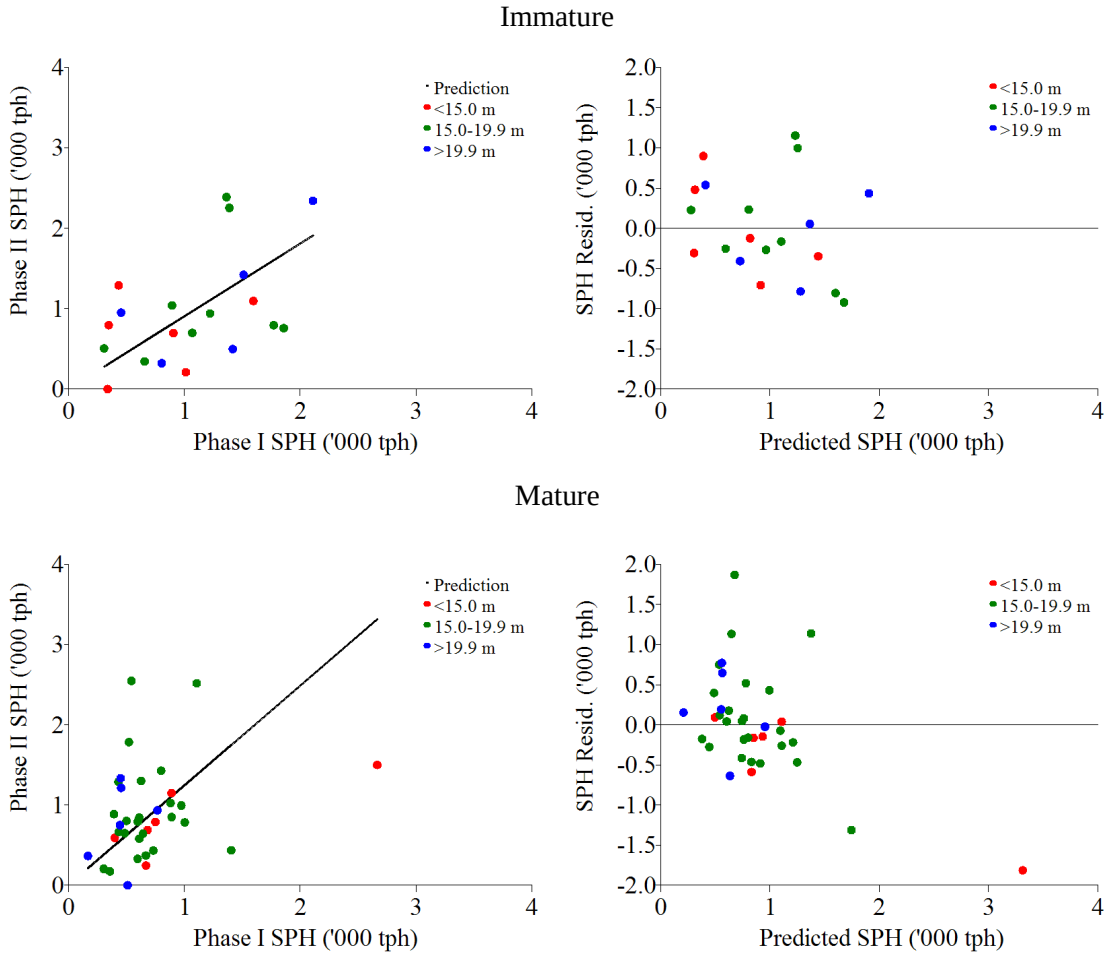

Figure 7. Stems per hectare (7.5cm+) live only scatterplots by stratum.

4.6 Input-Adjusted Lorey Height

After adjusting the bias in height, age, basal area, and stems per hectare, VDYP7 Lorey heights were re-estimated using the adjusted input (Table 13). Attribute-adjusted Lorey heights decreased 0.8%. These attribute-adjusted Lorey heights reflect the changes in basal area and stems per hectare across the deciduous population.

Table 13. Lorey Height change due to input attributes adjustment.

Stratum	Area (ha)	Vol. (m^3/ha) 12.5+ using live only			
		Phase I	Attribute-Adjusted	Diff. (m)	(%)
Immature	72,888	16.4	17.2	+0.8	+5.2
Mature	129,323	23.1	22.4	-0.7	-3.2
Total	*202,211*	*20.7*	*20.6*	*-0.2*	*-0.8*

4.7 Input-adjusted VDYP7 Volume

After adjusting the bias in height, age, basal area, and stems per hectare, VDYP7 volumes were re-estimated using the adjusted input. Attribute-adjusted volumes decreased by 4% when compared to the Phase I volumes (Table 14). These attribute-adjusted volumes reflect the relatively small decrease in overall basal area.

Table 14. Volume change due to input attributes adjustment.

Stratum	Area (ha)	Vol. (m^3/ha) 12.5+ using live only			
		Phase I	Attribute-Adjusted	Diff. (m)	(%)
Immature	72,888	126.0	120.7	-5.3	-4.2
Mature	129,323	225.1	216.9	-8.1	-3.6
Total	*202,211*	*189.4*	*182.2*	*-7.1*	*-3.8*

4.8 Site Index

Site index is not directly adjusted in the VRI standard statistical adjustment. Instead, an adjusted site index is derived from adjusted height and age. The inventory leading species site index increased by approximately 10% after adjustment (Table 15). The increases were consistent amongst strata and there was very little difference when comparing the strata average site index.

Table 15. Site index change after adjustment.

Stratum	Area (ha)	Site Index (m)	Adj. Site Index (m)	Difference (%)
Immature	72,888	17.2	18.9	+10.1
Mature	129,323	17.3	18.9	+9.2
Total	*202,211*	*17.3*	*18.9*	*+9.5*

4.9 Lorey Height

All fifty-six (56) samples were used for the Lorey height analysis. The Lorey height decreased by approximately 6% after adjustment (Table 16, Figure 8). The largest decrease in Lorey Height was evident in the Immature stratum where it decreased by approximately 14% with a sampling error of ±18% (95% confidence). The adjusted average Lorey height was approximately 19m. The overall sampling error was approximately ±7% (95% probability).

Table 16. Lorey height (12.5cm+) adjustment statistics.

Stratum	Attr. Adj. Lorey Ht. Area (ha)	Attr. Adj. Lorey Ht. Avg. (m)	Sample n	Sample Phase I (m)	Sample Phase II (m)	Sample ROM	Adjusted Population Adj. Avg. (m)	Adjusted Population 95% E (m)	Adjusted Population 95% E (%)
Immature	72,888	17.2	20	17.5	15.0	0.856	14.8	2.7	18.0
Mature	129,323	22.4	36	22.3	21.7	0.972	21.8	1.7	8.0
Total	*202,211*	*20.6*	*56*	*20.6*	*19.3*	*0.937*	*19.3*	*1.4*	*7.4*

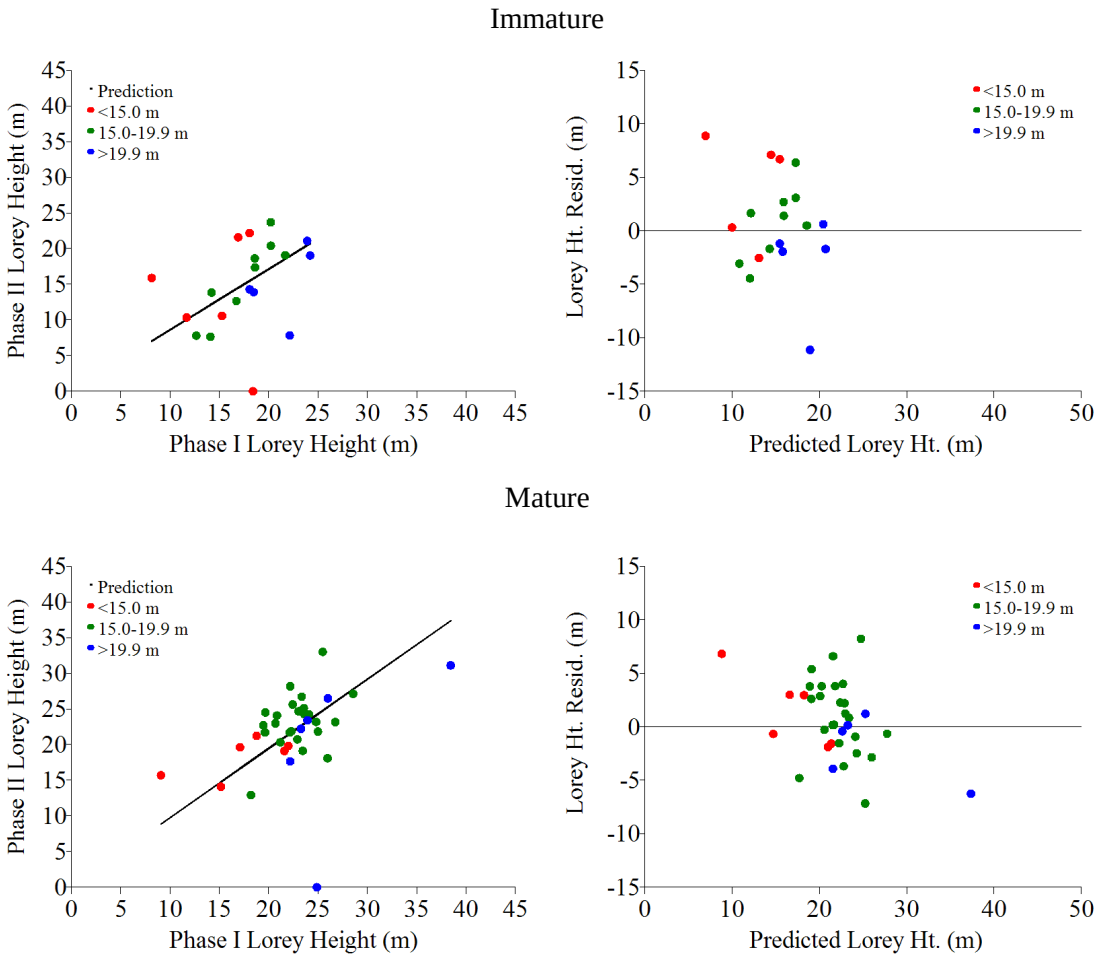

Figure 8. Lorey height (12.5cm+) scatterplots by stratum.

4.10 Unadjusted vs. Adjusted Lorey Height

After adjustment, the Phase I Lorey Height decreased by 7% (Table 17). The decrease was largest in the Immature stratum where Lorey height decreased by 10%.

Table 17. Unadjusted and adjusted Lorey height (m).

Stratum	Area (ha)	Lorey Height (12.5cm+) Unadj. (m)	Adj. (m)	Diff. (m)	Diff. (%)
Immature	72,888	16.4	14.8	-1.6	-10.0%
Mature	129,323	23.1	21.8	-1.4	-5.9%
Total	*202,211*	*20.7*	*19.3*	*-1.5*	*-7.0%*

4.11 Live Net Merchantable Volume

All fifty-six (56) samples were used for the volume analysis. The live net merchantable volume increased by approximately 17% after adjustment (Table 18, Figure 9). Adjustment ratios were very consistent between strata; however the sampling error for the Immature stratum was almost twice as high as the Mature. The adjusted average live volume/ha was approximately 213 m^3/ha. The expected sampling error was approximately ±19% (based on 56 samples and an estimated CV of 70%) and the overall sampling error was approximately ±16% (95% probability).

Table 18. Net merchantable volume (12.5cm+) adjustment statistics.

	Attr. Adj. Vol.		Sample				Adjusted Population		
Stratum	Area (ha)	Avg. (m^3/ha)	n	Phase I (m^3/ha)	Phase II (m^3/ha)	ROM	Adj. Avg. (m^3/ha)	95% E (m^3/ha)	(%)
Immature	72,888	120.7	20	110.4	129.2	1.171	141.3	41.6	29.4
Mature	129,323	216.9	36	232.2	271.5	1.169	253.6	47.9	18.9
Total	*202,211*	*182.2*	*56*	*188.3*	*220.2*	*1.170*	*213.1*	*33.5*	*15.7*

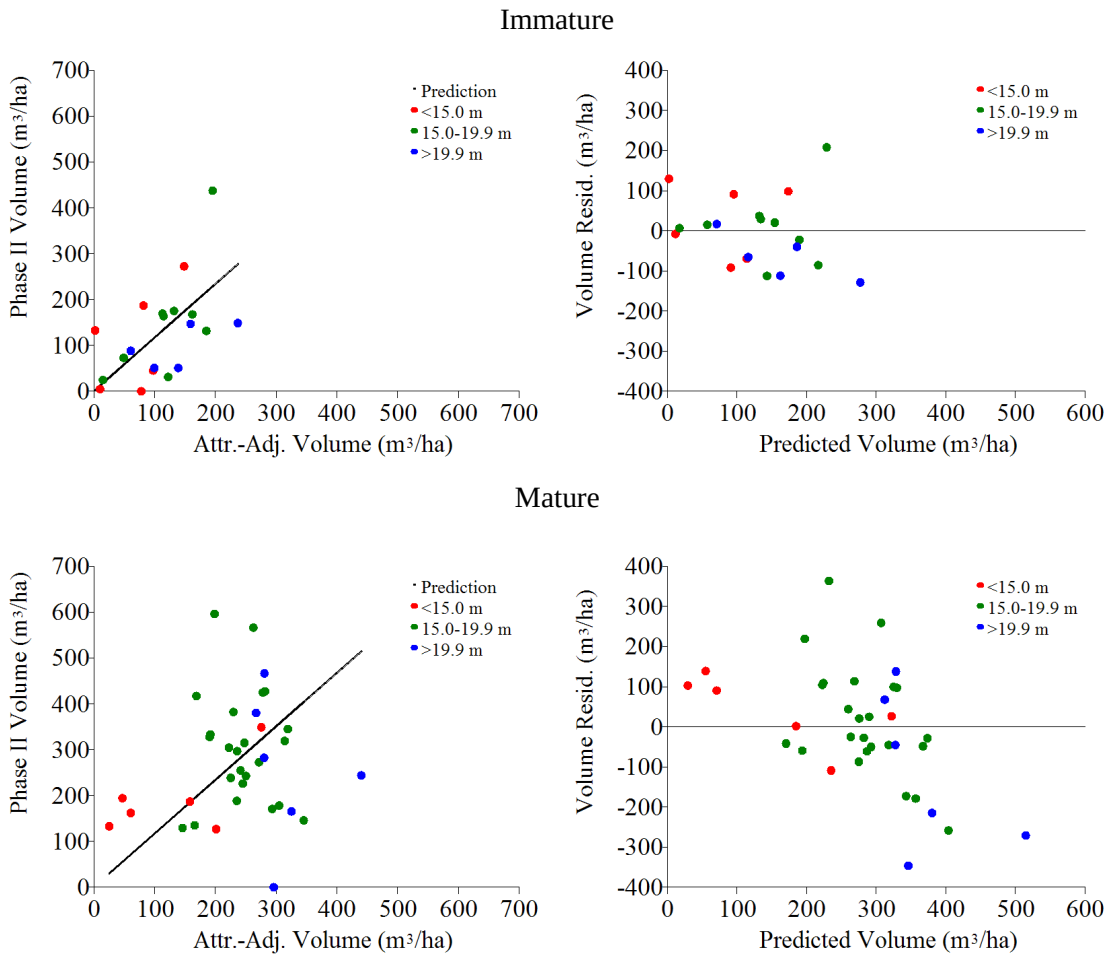

Figure 9. Volume (12.5cm+) scatterplots by stratum.

4.12 Unadjusted vs. Adjusted Volume

After adjustment, the live net merch Phase I inventory volume increased by 13% (Table 19). The increase was largest in the Mature stratum where the volume increased by approximately 13%.

Table 19. Unadjusted and adjusted live net merch volume (m^3/ha).

Stratum	Area (ha)	Volume (12.5cm+)			
		Unadjusted	Adjusted	Diff. (m^3/ha)	Diff. (%)
Immature	72,888	126.0	141.3	15.3	12.1%
Mature	129,323	225.1	253.6	28.5	12.7%
Total	*202,211*	*189.4*	*213.1*	*23.7*	*12.5%*

5.0 DISCUSSION

5.1 Sample vs. Population

A sample must adequately cover the range of Phase I values in the population to avoid extrapolating information to areas that were not sampled (given that all samples had a chance of being sampled). A minimal amount of extrapolation will be required with a random sample since the minimum and maximum values observed in the population will not always be included in the sample. With a random sample of size n, one would expect on average that 100%/2n of the population is below or above the minimum or maximum observed in the sample.

Table 20. Population outside of the sampled range.

Stratum	Expected Proportion	Age		Height		Volume	
		Below	Above	Below	Above	Below	Above
Immature	2.5	10.8	0.0	1.5	0.0	1.7	0.2
Mature	1.6	0.1	4.9	0.1	0.2	0.2	1.4

Small portions of area were outside of the expected proportion for all attributes for all variables (Table 20). A significant portion of area was outside the sampled area for age in the Immature stratum, meaning that there is the potential for biased estimates for this attributes in the areas of the strata. Areas not covered for volume in the deciduous target population were below the expected values.

5.2 Accuracy and Precision

The statistical adjustment provides unbiased estimates at the scale in which the ratios were computed. In the case of the deciduous population, unbiased estimates will be at the stratum level. There is always a possibility that local bias exists within a stratum. It would be inappropriate to estimate sub-stratum bias given the small sample size provided at a smaller scale.

Based on a sample size of 56 samples with an assumed coefficient of variation of 70%, the expected sampling error for the deciduous area was ±19% (95% probability).[12] The overall sampling error achieved in this project was lower than anticipated (±15.7%).

[12] Timberline Natural Resource Group Ltd., 2008. *Prince George Forest District Vegetation Resources Inventory Project Implementation Plan – Addendum for Deciduous Sampling*. Unpublished. 7 p.

Timberline Natural Resource Group Ltd., 2008. *Fort St. James Forest District Vegetation Resources Inventory Project Implementation Plan – Addendum for Deciduous Sampling*. Unpublished. 7 p.

5.3 Risks and Uncertainties

5.3.1 Immature Stratum

The overall sampling error (16%) for the deciduous population was lower than expected (19%) which provides the necessary level of comfort in the adjustment for this part of the population. However when the stratum sampling errors are examined the Immature stratum is almost twice as variable as the Mature stratum and is likely due to the relatively small sample size (20).

5.3.2 Age Trend

The statistical adjustment removes the bias in each stratum. It is however possible that within each stratum an age-related trend exists which could become a source of concern in TSR. All residuals were plotted against stand age to detect any age-related trend and none were identified.

6.0 CONCLUSIONS

Following adjustment the overall average site index increased from 17.3m to 18.9m and the live merchantable volume increased by 30.6 m^3/ha, height did not change and age decreased by 17%. Basal area decreased by 7% and stems per hectare increased by 8%. The overall impact on site index was an increase of 10%. The Lorey height decreased by approximately 7%. The current Phase I live volume increased by approximately 13%. The sampling error for the volume adjustment was ±15.7% (95% probability).

The main source of uncertainty in the inventory is the variability in the volume for the Immature stratum. The sampling error for this stratum was approximately ±29% which means which is relatively high compared to the Mature stratum (±19%).

6.1 Recommendations

A statistical adjustment was completed for the deciduous components of the PG and FSJ Forest Districts using the standard MFR methodology. Unbiased estimates of height, age, basal area, stems per hectare, and volume were obtained using the VRI statistical adjustment methods. These estimates represent the best available inventory estimates. Therefore, we recommend that:

> *The PG and FSJ Forest District stakeholders use the adjusted estimates of height, age, basal area, stems per hectare and volume for the deciduous population in future TSR.*

The Phase II data collected for CWD and forest health agents provides insight into the forest health issues within the target population. Therefore, we recommend that:

> *The stakeholders consider the available Phase II data for CWD and forest health and use it to do more in-depth analyses and guide other initiatives.*

The Phase II data collected on the TSA contains a rich set of information that can be used for a variety of broad scale strategic planning. Therefore, we recommend that:

> *The stakeholders consider using this data to help future planning.*

APPENDIX I – NVAF SAMPLE LIST

Table 21. NVAF tree list in the Deciduous Population.

Project ID	Live/ Dead	Species Group	Sample	Plot	Tree No.	Species	DBH (cm)	Age (yrs)	Volume (m^3)		Total Weight
									NVAF	VRI	
DJA1	Live	Immature	0201	N	002	EP	18.8	84	0.2158	0.2062	9,867,180
DJA1	Live	Immature	0201	W	001	AT	18.1	165	0.0274	0.0685	7,772,673
DJA1	Live	Immature	0201	W	002	AT	20.7	64	0.0951	0.1081	3,888,638
DPG1	Live	Immature	0049	N	007	EP	29.5	39	0.3777	0.3769	26,225,750
DPG1	Live	Immature	0049	S	003	EP	19.9	40	0.1058	0.1584	71,695,266
DPG1	Live	Immature	0049	S	004	EP	20.0	42	0.1729	0.1705	59,621,278
DPG1	Live	Immature	0095	N	008	EP	21.5	25	0.1460	0.1618	17,467,553
DPG1	Live	Immature	0301	W	001	AC	25.4	48	0.2505	0.2501	5,409,923
024D	Live	Mature	0004	E	003	AT	27.3	75	0.5634	0.5515	2,930,989
024D	Live	Mature	0004	S	001	AT	29.5	77	0.6665	0.6432	2,414,009
024D	Live	Mature	0004	W	002	AT	23.3	79	0.3040	0.4517	7,648,201
024D	Live	Mature	0004	W	003	AT	36.6	84	0.9892	1.0603	3,124,080
024D	Live	Mature	0004	W	005	AT	35.5	83	0.9012	0.9312	3,211,950
024D	Live	Mature	0014	N	003	AT	35.6	152	0.7261	0.8045	2,258,525
024D	Live	Mature	0014	W	001	AT	26.7	107	0.4639	0.4476	3,977,079
024D	Live	Mature	0014	W	003	AT	21.4	105	0.2242	0.4510	6,237,884
024D	Live	Mature	0014	W	006	AT	21.9	85	0.2505	0.2894	6,063,407
DJA1	Live	Mature	0003	E	002	AT	18.9	79	0.2314	0.2416	41,588,195
DJA1	Live	Mature	0003	E	004	AT	28.7	98	0.5645	0.5993	17,904,609
DPG1	Live	Mature	0005	W	004	AT	33.2	109	0.9781	0.6982	31,985,999
DPG1	Live	Mature	0069	W	003	AT	46.0	166	1.1343	0.9893	8,677,211
DPG1	Live	Mature	0081	S	002	AT	23.0	79	0.1862	0.1533	20,440,508
DPG1	Live	Mature	0085	S	001	AT	26.3	112	0.3515	0.4626	85,883,563

Note: Volume is whole-stem volume less top, stump, decay, and waste.

APPENDIX II – PHASE II SAMPLING WEIGHTS & PLOT LOCATIONS

Table 22. Deciduous Phase II sampling weights and plot locations.

Proj. ID	Sample No.	Zone	Easting	Northing	Stratum	Substratum	Sampling Weight
024D	0001	10	547290	5969119	Mature	15.0-19.9 m	3,364
024D	0002	10	371056	6051213	Mature	<15.0 m	4,496
024D	0003	10	519163	6073361	Mature	≥20.0 m	3,602
024D	0004	10	525119	6046335	Mature	15.0-19.9 m	3,364
024D	0005	10	553811	5981166	Mature	15.0-19.9 m	3,364
024D	0006	10	556740	5993376	Immature	≥20.0 m	2,842
024D	0007	10	520323	6006645	Mature	15.0-19.9 m	3,364
024D	0008	9	611242	6243814	Mature	≥20.0 m	3,602
024D	0009	10	311807	6135572	Mature	15.0-19.9 m	3,364
024D	0010	9	552216	6302589	Mature	15.0-19.9 m	3,364
024D	0011	10	404324	6034355	Immature	<15.0 m	3,385
024D	0012	10	426555	6026879	Immature	≥20.0 m	2,842
024D	0013	10	513186	6006148	Mature	15.0-19.9 m	3,364
024D	0014	10	439283	6021937	Mature	<15.0 m	4,496
024D	0015	10	317106	6149176	Mature	15.0-19.9 m	3,364
024D	0016	10	488706	5942248	Immature	≥20.0 m	2,842
024D	0017	10	547196	5950574	Immature	15.0-19.9 m	4,263
024D	0018	9	600600	6239650	Immature	<15.0 m	3,385
024D	0019	10	439157	6019037	Mature	<15.0 m	4,496
024D	0020	10	491978	6086949	Mature	15.0-19.9 m	3,364
024D	0021	10	514455	6073563	Immature	15.0-19.9 m	4,263
024D	0022	9	686144	6152828	Mature	≥20.0 m	3,602
024D	0023	10	214628	6318308	Mature	<15.0 m	4,496
024D	0024	10	422787	6076878	Mature	15.0-19.9 m	3,364
024D	0025	9	682543	6148061	Mature	15.0-19.9 m	3,364
024D	0026	10	506855	6085713	Mature	≥20.0 m	3,602
024D	0027	10	339422	6075724	Mature	15.0-19.9 m	3,364
024D	0028	10	572180	6040219	Immature	≥20.0 m	2,842
024D	0029	10	347917	6049396	Mature	15.0-19.9 m	3,364
024D	0030	10	395140	6056397	Mature	15.0-19.9 m	3,364
024D	0031	10	365587	6085036	Immature	15.0-19.9 m	4,263
024D	0032	10	532430	6097749	Mature	<15.0 m	4,496

Proj. ID	Sample No.	Zone	Easting	Northing	Stratum	Substratum	Sampling Weight
024D	0033	10	562770	5951515	Immature	15.0-19.9 m	4,263
024D	0034	10	399641	6035052	Immature	<15.0 m	3,385
024D	0035	10	530540	6070064	Immature	15.0-19.9 m	4,263
024D	0036	10	480128	5975991	Immature	<15.0 m	3,385
024D	0037	10	529943	6037010	Mature	15.0-19.9 m	3,364
024D	0038	10	400996	6083215	Mature	<15.0 m	4,496
024D	0039	10	354699	6174533	Immature	<15.0 m	3,385
024D	0040	10	529569	6077526	Immature	15.0-19.9 m	4,263
DJA1	0104	9	686367	6135994	Mature	15.0-19.9 m	3,364
DJA1	0201	10	352777	6076159	Immature	<15.0 m	3,385
DJA1	0203	10	388427	6068214	Mature	15.0-19.9 m	3,364
DPG1	0002	10	518921	5950372	Mature	15.0-19.9 m	3,364
DPG1	0019	10	551431	5958200	Mature	15.0-19.9 m	3,364
DPG1	0035	10	531041	5971312	Immature	15.0-19.9 m	4,263
DPG1	0040	10	504081	6081613	Mature	15.0-19.9 m	3,364
DPG1	0047	10	507621	6070636	Immature	15.0-19.9 m	4,263
DPG1	0057	10	525612	6081398	Mature	≥20.0 m	3,602
DPG1	0065	10	528457	6077474	Immature	15.0-19.9 m	4,263
DPG1	0067	11	496033	6085577	Mature	15.0-19.9 m	3,364
DPG1	0068	10	515626	5960141	Mature	15.0-19.9 m	3,364
DPG1	0069	10	465575	5928603	Mature	15.0-19.9 m	3,364
DPG1	0079	10	538702	5965272	Mature	15.0-19.9 m	3,364
DPG1	0088	10	508044	5998454	Mature	≥20.0 m	3,602
DPG1	0132	10	514546	5948863	Immature	≥20.0 m	2,842

APPENDIX III – PHASE I & II DATA

Table 23. Deciduous Phase I data from sampled polygons.

Proj. ID	Sample No.	Origin FD	Area (ha)	Spp1	Ht1 (m)	Age1 (yrs)	SI1 (m)	BA (m^2/ha)	SPH (trees/ha)	Spp2	Ht2 (m)	Age2 (yrs)	SI2 (m)	Case	Lorey Height 12.5cm+ (m)		Volume 12.5cm+ (m^3/ha)	
															Unadjusted	Attribute Adjusted	Unadjusted	Attribute Adjusted
024D	0001	PG	16.0	SW	32.7	140	18.7	36.4	306	AT	32.5	126	22.4	3	29.4	28.6	300.5	293.7
024D	0002	FSJ	32.0	SW	25.7	156	11.5	34.1	671	AT	24.5	116	16.2	2	22.5	22.0	207.2	201.5
024D	0003	PG	14.7	AT	26.9	86	21.0	44.1	456					1	24.8	24.0	274.2	267.3
024D	0004	PG	13.1	AT	22.7	96	16.3	47.7	1,006	PL	22.6	96	17.1	1	20.4	19.7	230.2	222.6
024D	0005	PG	13.8	AC	29.6	116	19.7	50.0	360	SW	28.9	116	17.9	3	26.4	25.5	319.2	305.4
024D	0006	PG	22.8	AT	24.6	61	22.8	26.0	457	EP	19.8	51	20.3	5	22.3	23.9	164.9	159.3
024D	0007	PG	7.7	SXW	24.7	131	16.1	48.3	394	AT	28.4	136	18.2	1	24.5	20.9	299.9	248.1
024D	0008	FSJ	7.2	AC	42.4	158	30.4	49.7	169	SX	43.8	158	28.4	3	39.8	38.5	453.3	440.6
024D	0009	FSJ	18.1	AT	24.4	128	15.4	48.9	1,109	BL	22.2	128	12.0	2	21.4	20.7	261.2	250.5
024D	0010	FSJ	7.8	AT	21.3	85	16.2	38.8	893	SX	25.9	170	10.7	4	18.9	18.2	174.8	166
024D	0011	FSJ	26.3	EP	15.0	61	13.8	33.1	1,598	AT	17.1	61	15.6	5	14.1	15.3	99.4	97.8
024D	0012	FSJ	2.2	AT	19.8	46	21.6	24.8	2,112	SW	20.8	56	22.9	3	17.2	18.5	65.2	60.9
024D	0014	FSJ	27.8	AT	18.7	86	14.0	11.1	401	SW	17.8	66	17.2	4	17.6	17.1	52.7	47.2
024D	0015	FSJ	53.9	AT	28.7	151	17.7	40.4	645	PL	28.4	151	19.3	4	25.6	25.0	274.6	272.1
024D	0017	PG	19.4	AT	14.7	41	17.5	36.3	1,224	SW	15.4	39	25.8	4	13.2	14.1	128.4	122.6
024D	0018	FSJ	25.1	AT	18.3	80	14.3	32.8	907	PLI	18.4	80	14.9	2	17.0	18.1	156.1	148.7
024D	0019	FSJ	4.9	AT	20.6	106	13.8	31.1	752	PL	20.5	106	14.6	4	19.4	18.8	167.7	158.4
024D	0020	PG	13.8	AT	25.6	116	17.1	34.6	488	SXW	27.2	96	19.1	1	22.8	22.2	204.4	198.8
024D	0021	PG	21.5	AT	18.9	76	15.1	27.0	660	PL	17.9	76	14.9	4	17.3	18.6	118.1	114.9

Proj. ID	Sample No.	Origin FD	Area (ha)	Spp1	Ht1 (m)	Age1 (yrs)	SI1 (m)	BA (m^2/ha)	SPH (trees/ha)	Spp2	Ht2 (m)	Age2 (yrs)	SI2 (m)	Case	Lorey Height 12.5cm+ (m)		Volume 12.5cm+ (m^3/ha)	
															Unadjusted	Attribute Adjusted	Unadjusted	Attribute Adjusted
024D	0022	FSJ	18.3	AC	29.6	96	21.7	38.5	446	SW	26.3	96	18.5	4	26.8	26.0	291.0	280.4
024D	0023	FSJ	21.7	AT	10.4	107	6.4	33.0	2,667	BL	16.3	237	4.1	2	9.4	9.1	36.9	25.4
024D	0024	FSJ	9.2	AT	26.5	126	17.2	31.1	628	SW	28.8	126	16.6	1	24.2	23.5	198.7	192
024D	0025	FSJ	8.3	AT	30.7	151	19.4	36.4	598	SW	32.0	151	17.1	1	27.5	26.8	248.0	245.5
024D	0026	PG	15.7	AT	26.9	86	21.0	43.7	452	SXW	25.7	76	21.8	2	24.0	23.3	290.9	281.1
024D	0027	FSJ	12.8	AT	24.6	105	17.1	31.2	670					3	21.9	21.2	149.3	146.1
024D	0028	PG	15.1	EP	22.1	37	20.7	25.0	1,514	S	19.2	34	34.5	2	14.4	22.2	78.9	139
024D	0029	FSJ	7.1	AT	25.6	90	19.4	37.0	613	EP	21.5	90	15.9	1	22.8	22.2	245.1	236
024D	0030	FSJ	6.5	AT	29.1	128	19.3	50.0	600	PL	27.5	128	19.4	1	26.8	26.0	346.9	345.7
024D	0031	FSJ	9.9	AT	20.7	75	16.9	42.3	895	SW	23.1	85	17.7	1	18.8	20.2	200.4	195.8
024D	0032	PG	10.6	EP	22.9	127	14.3	44.7	685	SX	25.7	127	14.1	4	22.4	21.6	290.2	275.9
024D	0033	PG	16.0	AT	12.5	41	15.0	6.2	309	SW	4.1	41	9.4	4	11.8	12.7	15.8	15.1
024D	0034	FSJ	7.7	EP	16.9	66	14.7	15.7	340	SW	22.3	91	16.0	4	17.0	18.4	79.1	78.2
024D	0035	PG	5.2	AT	17.6	46	19.3	33.2	1,366	SXW	15.8	46	22.4	2	15.6	16.8	137.8	132.1
024D	0036	PG	42.3	PL	8.3	41	11.3	3.8	435	AT	8.0	41	10.2	3	7.6	8.2	2.4	2.2
024D	0037	PG	14.7	AT	21.7	91	15.9	44.4	1,406	PL	21.7	91	16.7	1	20.3	19.7	254.7	235.6
024D	0038	FSJ	13.2	AT	17.7	85	13.2	21.8	892	SW	19.1	85	14.3	1	15.7	15.2	69.1	60.9
024D	0039	FSJ	7.2	AT	11.9	50	12.6	10.0	1,015	PLI	16.5	150	9.4	4	10.9	11.7	11.0	10.2
024D	0040	PG	10.7	AT	20.3	67	17.6	31.8	1,860	EP	19.5	62	17.7	5	17.4	18.6	118.8	113.1
DJA1	0104	FSJ	18.2	AT	26.9	121	17.9	46.1	976	SW	29.3	141	15.6	1	23.8	22.9	248.7	241.6
DJA1	0201	FSJ	6.8	AT	16.8	65	14.7	22.2	349	EP	15.8	65	13.9	5	15.7	16.9	84.2	81.8
DJA1	0203	FSJ	20.1	AT	26.9	136	17.0	36.3	801	SW	25.8	131	13.7	1	24.3	23.4	171.0	169.1
DPG1	0002	PG	12.0	AT	27.6	116	18.8	45.7	883	PLI	25.6	96	19.8	4	24.8	24.1	325.3	314.4

Proj. ID	Sample No.	Origin FD	Area (ha)	Spp1	Ht1 (m)	Age1 (yrs)	SI1 (m)	BA (m^2/ha)	SPH (trees/ha)	Spp2	Ht2 (m)	Age2 (yrs)	SI2 (m)	Case	Lorey Height 12.5cm+ (m)		Volume 12.5cm+ (m^3/ha)	
															Unadjusted	Attribute Adjusted	Unadjusted	Attribute Adjusted
DPG1	0013	PG	4.2	AT	27.6	106	19.6	41.2	503	PL	28.5	106	21.6	1	25.6	24.8	284.3	278.2
DPG1	0016	PG	25.4	AT	25.0	76	20.6	37.2	807	SW	25.7	76	21.8	4	22.5	24.2	244.6	237.1
DPG1	0019	PG	19.5	EP	20.7	86	15.6	35.0	432	SW	25.4	86	19.3	4	20.2	19.5	198.3	190.7
DPG1	0035	PG	7.3	EP	14.4	46	15.9	20.5	1,390	SW	14.3	41	22.9	3	13.1	14.2	50.3	49.2
DPG1	0040	PG	18.0	EP	23.8	86	18.3	33.7	613	BL	22.4	76	18.6	3	23.2	22.5	235.7	225.6
DPG1	0047	PG	15.2	AT	20.9	76	16.9	39.4	1,070	SXW	18.9	66	18.3	1	18.8	20.2	190.3	185.4
DPG1	0057	PG	10.4	AT	25.9	86	20.1	51.4	770	SXW	24.6	76	20.8	4	22.9	22.2	339.9	325.5
DPG1	0065	PG	25.4	EP	21.3	67	18.6	31.0	1,773	SX	19.4	72	17.2	2	19.9	21.7	163.4	162.3
DPG1	0067	PG	24.7	AT	26.6	106	18.8	45.2	523	SXW	26.2	96	18.4	2	24.4	23.7	288.1	282.2
DPG1	0068	PG	21.7	SW	27.9	116	17.0	45.6	734	EP	24.5	116	16.2	4	23.8	23.1	333.6	319.8
DPG1	0069	PG	15.2	AT	26.4	151	15.8	42.2	436	SW	24.7	141	12.0	4	24.3	23.6	227.3	229.9
DPG1	0079	PG	4.8	EP	22.6	106	15.4	40.8	545	SW	24.0	116	13.9	4	23.1	22.3	272.9	262.9
DPG1	0088	PG	27.3	AT	28.9	86	22.8	41.9	512	SW	27.2	96	19.1	5	25.7	24.9	307.3	296.3
DPG1	0132	PG	28.3	AT	18.5	47	22.0	25.5	1,419	PL	21.4	47	23.5	1	18.5	18.1	118.2	99.5

Table 24. Deciduous Phase II data from sampled polygons.

Proj. ID	Sample No.	Feature ID	Species	Height (m)	Age (yrs)	Site Index (m)	Basal Area (m^2/ha)	SPH (trees/ha)	Lorey Height (m)	Volume 12.5cm+ (m^3/ha)
024D	0001	D6436D1F4B22E47AF27A93ADBBA195E2	S				17.0	204	27.1	170.7
024D	0002	D2D463364FE674ACF3F2D4A87B60B115	AT	23.6	86	18.2	17.0	246	19.8	127.0
024D	0003	59A796D349ACCA4545D0A7B3101506BE	AT	27.6	89	21.4	50.4	1,215	23.4	380.7
024D	0004	D952A3C44CD5AFF40E9F64A92DD971B8	AT	24.5	80	19.7	36.0	784	24.5	304.8
024D	0005	6630FB934FD011A8FCD4B6AA23D175C9	ACT	29.4	37	35.7	23.8	172	33.0	178.4
024D	0006	2164305A4CA61C853901B491972AC6CE	SXW		54		25.2	951	21.1	147.1
024D	0007	C786D96B4A03CEC17C36939E42BBABBC	SXW	24.8	81	19.4	43.2	888	24.1	315.3
024D	0008	D737509249C3B9F5D0047F81F30EFA0E	ACT	36.6	105		33.6	365	31.1	244.3
024D	0009	E7FE53AF4632CEF05F0517BBDB69C0EB	BL	22.6	127	12.5	48.6	2,519	23.0	242.9
024D	0010	51A5F8E24399AB74B38B4EAE02319D01	BL	13.8	58	15.4	22.0	850	12.9	135.0
024D	0011	5905E7F446C9E06DB222C6B30400ADAF	FDI				15.4	1,096	10.6	45.1
024D	0012	56C379F946E3C93A98C0D6A69579A13A	EP	13.4	39	17.1	29.4	2,343	13.9	88.3
024D	0014	9FFBF7524F9256B30EB86D8E2FF9A735	SXW	17.8	53	20.3	30.6	591	19.6	194.6
024D	0015	CDE9BFBC4842364465F776AB6EF05D99	PLI	26.5	147	15.9	33.6	642	21.8	272.9
024D	0017	1541C1F64C1F8FC031036CB8D8C9E013	S	8.7	34	17.9	11.0	941	7.6	31.0
024D	0018	309E62AE4266B136DBFD52BF89BD956C	PLI	20.3	75	18.4	37.8	696	22.2	272.7
024D	0019	36D9DD324B7DB43FF41559AB8F4D57C3	SXW	23.6	65	21.9	30.6	789	21.2	186.9
024D	0020	BD9F721D45D7CE0FF52A5B8D178E1F4A	AT				67.2	649	28.2	596.8
024D	0021	F2DBDFB4468BE35C0AAEAF91DF781B98	S	23.7	69	20.8	22.0	343	17.4	164.1
024D	0022	C8D18C9E4FCCDA2C50606C90B81B11C8	SXW	26.2	84	19.9	36.0	749	26.5	282.6
024D	0023	90A91A454396CAAC3EBA54A62F969280	BL	17.6	134	9.9	28.0	1,501	15.7	133.1
024D	0024	7EF494FF4AE70EC2472B34AE56C3A2C9	AT	28.4	94	21.8	46.8	1,301	19.1	333.9
024D	0025	666889D544A87855DE77F69680FFE7BB	AT	23.3	105	16.1	28.0	330	23.2	226.4

Proj. ID	Sample No.	Feature ID	Species	Height (m)	Age (yrs)	Site Index (m)	Basal Area (m^2/ha)	SPH (trees/ha)	Lorey Height (m)	Volume 12.5cm+ (m^3/ha)
024D	0026	3862B4AA46CD1A387AF92097DA0B51D8	SXW		69		61.2	1,335	22.2	467.0
024D	0027	138BC8AE4003720FE99D3298534F2BF1	EP	23.8	119	15.5	19.6	370	20.4	129.5
024D	0028	EFFD1D0E43E7A9A9012D29B314E11E4B	S	8.8	30	20.6	17.9	1,421	7.8	50.9
024D	0029	86A683744F7D885D82599DB4D6DBAD54	AT	25.7	74	21.3	41.4	844	21.7	297.2
024D	0030	10CD30BB41E44DBE5B238FA6685ABADD	AT	22.8	86	17.8	26.6	794	18.1	145.9
024D	0031	B80F7E83417A53EEA090F7825CB33C3C	AT	28.1	105	21.9	57.6	1,041	23.7	438.2
024D	0032	D443D84C4464AFC6490467A92BA5F2A2	BL	22.6	124	14.5	45.0	689	19.1	349.1
024D	0033	5BBF17A149AF6635A4A43B92196DEDA9	SXW	6.6	28	23.7	7.0	507	7.8	24.6
024D	0034	9FF3795D46CFAB0A2C78CFB9EA9CB404	PLI				0.0	0	0.0	0.0
024D	0035	FE36F3B040F4CAE53C6710A884C2561F	SXW	20.2	61	19.9	39.0	2,389	12.7	175.3
024D	0036	E7A2F3484747524F7BD7C281CBD7F891	SXW	16.4	50	20.0	26.6	1,291	15.9	132.9
024D	0037	667600834A5A7B578EA796B7881BC0E0	AT	23.8	79	19.0	25.2	435	21.7	188.6
024D	0038	9813DA2C43672AC02379FD9873617482	AT	15.7	64	14.3	29.4	1,149	14.1	162.1
024D	0039	B15C87D34FAE8306EBAEB1B9F581B476	BL				2.0	209	10.4	4.5
024D	0040	8EB0E4334C3C50A044D24C9111CC0C95	S	20.2	64	19.4	27.0	757	18.6	169.3
DJA1	0104	58F42435428B0BBA6EB0E1A1690A541F	AT	26.6			36.0	994	20.8	255.4
DJA1	0201	1A9B649A4C513F8B1D3ECDBB2652A9A0	SXW				30.8	796	21.6	187.2
DJA1	0203	538E558F420D25D433AC95BB00B5C560	AT	27.6	80	22.9	54.6	1,428	26.7	418.0
DPG1	0002	6AB210D74538E3CBC5F40A8EACFB8CA4	FDI	24.8	112	16.2	45.5	1,025	24.3	319.4
DPG1	0013	5F611D2D485D67122940EE966ECED4C1	AT	24.5	74	20.6	55.2	803	23.2	425.3
DPG1	0016	8E7F82FE4C70B784D137719283A8DAF1	SXW	22.3	73	18.7	19.6	321	19.1	148.7
DPG1	0019	4BFC782E40C1CA19C8EC3CA347B8F2B3	SXW	31.8	153	17.4	40.0	1,290	22.7	327.9
DPG1	0035	6BF6101248DE34C25B3A3788CE346D43	ACT	21.0	43	24.1	28.0	2,254	13.9	72.8
DPG1	0040	C0AD4D9A4948D4EFBC85E79A38704CAC	AT	29.7	84	23.8	31.3	580	25.7	238.8

Proj. ID	Sample No.	Feature ID	Species	Height (m)	Age (yrs)	Site Index (m)	Basal Area (m^2/ha)	SPH (trees/ha)	Lorey Height (m)	Volume 12.5cm+ (m^3/ha)
DPG1	0047	9113B35A4639B6A119EEF3BD26B33B8D	AT	22.4	62	21.1	21.7	698	20.4	131.6
DPG1	0057	92793B4644413F60436B58A019D733D7	BL	17.8	59	18.7	27.0	934	17.7	165.7
DPG1	0065	D6D2837A45723CB65F323C85A78A9F32	SX	20.9	55	22.5	26.7	795	19.1	167.7
DPG1	0067	DB14C57546F85FF8C2C6018A6746E285	SXW	26.1	124	14.3	54.0	1,786	24.3	427.8
DPG1	0068	27A908CF401F998C5113588BE3D5DD12	AT	26.3	93	20.0	43.8	432	24.7	345.6
DPG1	0069	F509430940E333ABB979BBAAFF26F68C	SXW	31.1	132	17.7	42.0	664	25.1	382.6
DPG1	0079	1359E3324C6563FFD01A61BED699F649	SXW	24.0	75	19.7	84.0	2,549	21.9	566.9
DPG1	0088	D87059424581EAAA3438478BB2F11C08					0.0	0	0.0	0.0
DPG1	0132	ADB1DF5B4574F07E10DF1281F0ADB82F	AT	16.2	42	18.6	9.8	497	14.3	51.0