TFL46

Documentation of

Vegetation Resources Inventory Statistical Analysis

Prepared For:
Forest Analysis and Inventory Branch
Ministry of Forests, Lands and
Natural Resource Operations

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Executive Summary

The objective of this project was to provide an assessment of the accuracy of the Phase I inventory of TFL46 by completing a VRI statistical analysis of selected Phase I inventory attributes in the target population of interest. The analysis was based on current Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) standards.

The analysis focused on seven attributes: age, height, basal area of trees with Dbh ≥ 7.5 cm, trees/ha of trees with Dbh ≥ 7.5 cm, Lorey height, volume/ha net of decay waste and breakage of trees with Dbh ≥ 12.5 cm and site index. The ratios of Phase II Ground and Phase I Inventory means are given in Table 1. A ratio greater than 1 indicates that, on average, the Phase I inventory is underestimating an attribute, based on the Phase II ground sample. Similarly, a ratio less than 1 indicates overestimation. A ratio close to 1 indicates little bias (Phase I is accurate). A small sampling error indicates the bias is relatively consistent (Phase I is precise).

Table 1. The ratios of means (Phase II Ground/Phase I Inventory) are given by strata for seven attributes for TFL 46. Shaded cells are associated with small sample sizes and the ratios should be used with caution.

Stratum	Leading species substratum	n	Age (years)	Height (m)	Basal area (m^2/ha)	Trees/ha	Lorey height (m)	Volume net dwb (m^3/ha)	SI (m)
			Ratio of weighted means (with 95% sampling error shown as % of the ratio)						
Immature	Fd	42	1.080 (11.1%)	0.991 (5.8%)	0.886 (10.7%)	0.834 (26.6%)	0.981 (7.1%)	0.860 (13.5%)	1.040 (6.1%)
	Hemlock	13	1.041 (9.4%)	0.959 (11.7%)	1.007 (23.4%)	1.197 (32.5%)	0.967 (12.7%)	0.844 (27.4%)	0.976 (11.4%)
	Other	3	0.807 (63.4%)	0.978 (10.9%)	0.878 (41.8%)	0.964 (54.8%)	0.968 (23.9%)	0.816 (59.4%)	1.101 (18.4%)
	Subtotal	58	1.050 (9.1%)	0.983 (5.1%)	0.913 (9.9%)	0.917 (20.7%)	0.977 (6.2%)	0.852 (12.2%)	1.029 (5.4%)
Mature	Fd	3	1.124 (25.1%)	1.106 (30.7%)	1.104 (32.1%)	1.074 (86.8%)	1.097 (30.1%)	1.185 (57.8%)	1.127 (40.3%)
	Hemlock	17	1.081 (18.0%)	0.964 (8.5%)	1.086 (14.1%)	2.142 (56.8%)	0.906 (11.4%)	1.126 (22.2%)	1.081 (17.3%)
	Other	11	1.016 (27.0%)	0.935 (7.5%)	0.853 (25.9%)	1.454 (27.6%)	0.849 (15.6%)	0.896 (29.9%)	1.065 (8.6%)
	Subtotal	31	1.062 (14.5%)	0.967 (6.7%)	1.011 (12.3%)	1.834 (39.3%)	0.905 (9.3%)	1.060 (17.7%)	1.108 (11.1%)
All		89	1.059 (7.7%)	0.976 (4.0%)	0.959 (7.6%)	1.069 (22.4%)	0.945 (5.1%)	0.956 (10.1%)	1.047 (5.2%)

The leading species substrata ratios vary considerably within strata, generally have high sampling error and small sample sizes and should be used with caution.

Generally, age, height, Lorey height and site index are well estimated at the strata level and overall (bias < 10% and sampling error < 10%). Age and site index are consistently underestimated and height and Lorey height are consistently overestimated. The trends with basal area and volume are less consistent and generally have the highest sampling error (ignoring trees/ha).

Acknowledgements

This project was coordinated by Graham Hawkins. Thank you to the Forest Analysis and Inventory Branch for providing the data. Thank you to Graham Hawkins, Bob Krahn, Matt Makar, Chris Mulvihill, Sam Otukol, Qiong Su and Will Smith for contributing to the project.

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1. Introduction

1.1 Scope and objectives

The objective of this project was to provide a VDYP7-based VRI statistical analysis for TFL 46, based on current MFLNRO standards (FAIB 2011) and the Churlish (2011a) analysis of Quesnel East. The analysis is based on 89 Phase II samples established in the 2007 field season. All attribute values are based on live trees only. The analysis includes examining model and attribute-related components of volume bias.

1.2 Background

Details of the ground sample planning for TFL 46 are given in *"Teal Cedar Products Ltd. Tree Farm Licence 46 Vegetation Resources Inventory Phase II Project Implementation Plan Updated for the NVAF program only"* (J.S. Thrower & Associated Ltd. 2008) available from the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO).

2. Data

2.1 Target Population for Analysis

TFL 46 is located on southern Vancouver Island (Figure 1) in the Coastal Western Hemlock (CWH) and Mountain Hemlock (MH) biogeoclimatic zones. The main species are Douglas-fir (Fd) and western hemlock (Hw) in the younger stands, and Hw and red cedar (Cw) in the older stands.

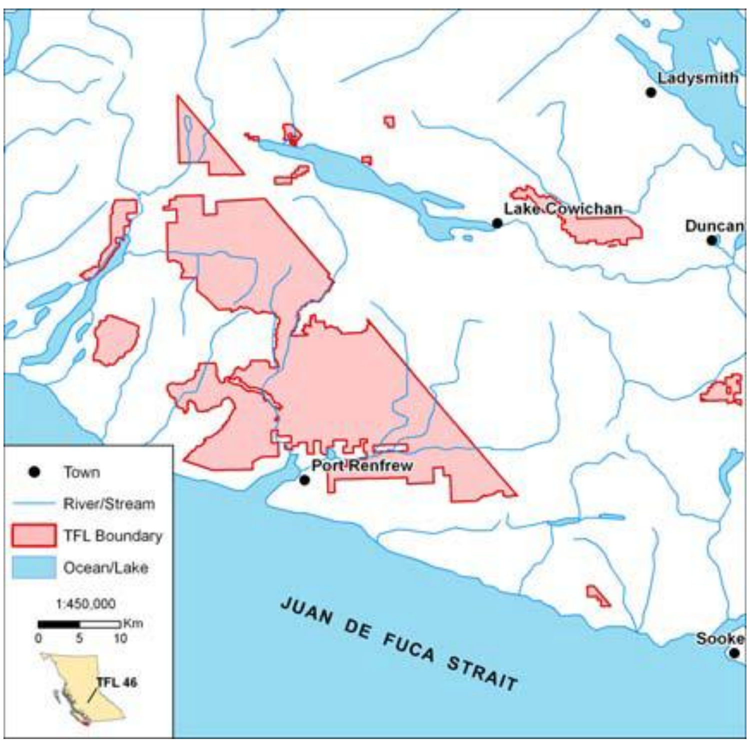

Figure 1. The location of TFL46 on southern Vancouver Island. Taken from J.S. Thrower (2008).

The target population for TFL 46 was defined as the operable polygons where the main layer is treed and established before 1977. A polygon was considered operable if at least 50% of its area was operable.

The main layer was defined as the layer with the largest basal area. A layer was considered treed if the leading species was present with a minimum crown closure of 10%. The total area of the target population was 52,537 ha (Table 1; 67% of the total landbase). Forest cover polygons were either entirely included or excluded from the target population; no polygon was partially included.

- Mature – 81 years and older, and
- Immature – 30 to 80 years.

The landbase is summarized in Table 1. The majority of the target population (Vegetated treed polygons ≥ 30 years old) is dominated by Douglas-fir leading polygons (50%), followed by Hemlock (34%) and other species (17%), mainly cedar.

Table 1. The land base of TFL 46 is summarized.

Land Classification	Area (ha)	% of TFL	% of Vegetated	% of treed
Total area	78,347			
Non-vegetated	3,545	5%		
Vegetated	74,802	95%		
Non-treed	8,825	11%	12%	
Treed	65,977	84%	88%	
0-29 years	13,340	17%		20%
30+ years	52,537	67%		80%

2.2 Phase I Inventory

The Phase I inventory is from aerial photography flown in 2005.

2.3 Phase II Sample Selection, Stratification and Weights

For the sample selection, pre-stratification was carried out based on age groupings: Immature (30-80 years) and mature (greater than 80 years old). Further sub-stratification, by leading species group, was applied by strata to ensure adequate representation of the samples across the target population (Table 2). Sample 33 was omitted (see 3.4) and the sample weights recalculated.

Table 2. The sample weights for TFL 46 are given. One plot was dropped.

Land base Age class	Stratum	Area (ha) (A)	% of area	Planned		Actual	
				Number of samples (n)	Weight = A/n	Number of samples (n)	Weight = A/n
Immature	Fd	24,220	46%	42	577	42	577
	Hemlock	7,679	14%	13	591	13	591
	Other	2,491	5%	4	623	3	830
	Subtotal	34,390	65%	59		58	
Mature	Fd	1,893	4%	3	631	3	631
	Hemlock	10,365	19%	17	610	17	610
	Other	6,568	12%	11	597	11	597
	Subtotal	18,826	35%	31		31	

3. METHODS

3.1 Overview of VRI Statistical Analysis

The goal 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 standard for comparison.

The process involves first projecting Phase I inventory data to the year of ground sampling using the VDYP7 growth model. The Phase I inventory data corresponding to the Phase II ground samples are identified and data screening is undertaken to identify potential data errors and/or inappropriate matching of Phase I and II data. Analysis is usually undertaken at the stratum level, where strata are typically defined by leading species. After calculating and applying the appropriate sampling weights, mean values of the ground sample attributes and the corresponding Phase I inventory attributes are computed. The ratio of these two values (i.e. the mean Phase II ground sample value / the mean Phase I inventory value) is then calculated along with the corresponding sampling errors, by stratum.

These ratios of means form the basis of the inventory assessment. The sampling errors for these ratios are an indication of the risk and uncertainty associated with the sampling process.

Seven timber attributes are considered in the current VRI ground sample data analysis:

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

The analysis of model and attribute-related components of volume bias follow the Strathcona TSA analysis by Churlish and Jahraus (2011b).

3.2 Phase I Inventory projection

The Phase I data were provided by the MFLNRO. The data had been projected to 2011. The data were projected backwards to 2007 (the year of ground sampling) using VDYP7 Console version 7.7a.33. The 2007 projections were compared to Appendix II of Timberline (2010). The leading species and leading species ages were identical except for sample 92. The Timberline age was 255 while the backward projection age was 225. In the 2011 file, the leading species age was 259 and the secondary species age was 229. It seems like VDYP7 switched the ages of the leading and secondary species.

The leading species site index (SI) was estimated using SiteTools 3.3 and the projected height and age of the leading species. The SI for the secondary species was also estimated.

The Phase I polygons were matched to the Phase II samples using the mapsheet and polygon information in Table 21 of Timberline (2010).

3.3 Phase II ground sample data

The Phase II ground samples were provided by the MFLNRO. All were measured in 2007. The Phase II ground SI was estimated as the average SI of the T, L, X and O trees.

3.4 Data issues

Sample 33 could not be matched and is likely outside the current TFL boundary and was therefore dropped. The sampling weights were revised (Table 2).

3.5 Height and Age matching

The data matching followed the FAIB (2011) 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, X & O trees for the ground leading species (by basal area at 4 cm + 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”.

If a leading species match could not be made at the species group level, conifer-to-conifer (or deciduous-to-deciduous) matches were allowed. However, conifer-deciduous matches were not considered acceptable. Section 10 (Appendix D) provides the details of the height and age data matching. Section 4.3 compares the Phase I inventory leading species and the Phase II ground sample leading species.

Of the 89 samples used in the analysis, 59 (or 66%) had a match between the inventory leading species and the ground leading species at 4 cm+ Dbh utilization (Table 11). A further 17 samples (19%) were matched based on the ground leading and inventory secondary species. The remaining 13 samples were matched on a conifer-to-conifer or deciduous-to-deciduous basis. Some ground samples did not have age or height available for the leading species (all were in the mature stratum – see Table 19). These were not used in computing the means and ratios for age, height or site index. All samples were used in the development of basal area, trees/ha, Lorey height and volume ratios.

3.6 Site index

The height and age matching rules were used for site index but only cases 1 and 2 were considered satisfactory matches. That is, if the Phase I and Phase II leading species were the same, the Phase I SI and Phase II leading species SI were matched. Also, if the Phase I leading species and Phase II secondary species were the same, the Phase I SI (leading species) and Phase II secondary species SI were matched. No other cases were considered matches.

4. Results and Discussion

Results are given by maturity, leading species class within maturity and overall results. The sample sizes by leading species within maturity class are generally small and the results are highly variable and are given for information only. In Table 5, leading species ratios are shaded to indicate they are less reliable.

4.1 Attribute bias

The Phase I inventory and Phase II ground sample weighted means were computed by strata for the seven key attributes identified in section 3.1 and (Table 3). The ratios of means were calculated for the seven key attributes (Table 4).

Table 3. The weighted means for the Phase I inventory and Phase II ground samples are given for TFL 46. Shading indicates conditions with small sample sizes. Shading indicates the numbers are less reliable and given for information only.

Attribute	Statistic	Immature				Mature				All
		Fd	Hem	Other	Subtotal	Fd	Hem	Other	Subtotal	
Age	n	42	13	3	58	3	16	8	27	85
(years)	Phase II Ground mean	52.4	51.2	56.5	52.3	296.6	258.2	269.3	265.8	121.4
	Phase I inventory mean	48.5	49.2	70.0	49.9	264.0	238.8	265.0	249.3	114.6
Height	n	42	13	3	58	3	15	8	26	84
(m)	Phase II Ground mean	28.8	27.8	37.8	29.1	41.9	38.7	39.5	39.3	32.4
	Phase I inventory mean	29.1	29.0	38.6	29.6	37.9	40.2	42.3	40.5	33.1
Basal area	n	42	13	3	58	3	17	11	31	89
(m^2/ha)	Phase II Ground mean	44.7	52.2	48.8	46.6	90.9	88.3	63.2	79.8	58.4
at 7.5 cm+ Dbh	Phase I inventory mean	50.5	51.9	55.5	51.1	82.4	81.3	74.2	78.9	61.0
Trees/ha	n	42	13	3	58	3	17	11	31	89
at 7.5 cm+ Dbh	Phase II Ground mean	754	1112	521	822	369	759	371	585	735
	Phase I inventory mean	904	929	540	889	343	354	255	319	684
Lorey height	n	42	13	3	58	3	17	11	31	89
(m)	Phase II Ground mean	25.5	26.1	30.5	25.9	40.7	33.9	33.0	34.3	28.9
	Phase I inventory mean	26.0	27.0	31.5	26.6	37.1	37.4	38.8	37.9	30.6
Volume (m^3/ha)	n	42	13	3	58	3	17	11	31	89
at 12.5 cm+	Phase II Ground mean	374	425	505	393	1047	962	666	867	562.1
Dbh net dwb	Phase I inventory mean	435	504	618	461	883	854	743	818	589.2
SI	n	40	10	3	53	3	12	8	23	76
(m)	Phase II Ground mean	35.0	32.4	36.7	34.6	18.1	19.1	19.6	19.1	29.9
	Phase I inventory mean	33.6	33.2	33.3	33.5	16.0	17.7	18.4	17.7	28.6

For the immature stratum subtotals (all leading species combined) and the mature stratum subtotals, the Phase I means are all within about 10% of the Phase II means except for immature volume and immature trees/hectare. The sampling errors were all less than 10% of the mean except for volume and trees per hectare. There is much more variation within the leading species substratum. If the substrata with small samples sizes are ignored (Immature Other and Mature Fd), Phase I estimates of age, height, Lorey height and site index are generally within 10% of the Phase II mean.

Table 4. The ratios of means (Phase II Ground/Phase I Inventory) are given by strata for TFL 46. Shading indicates less reliable results that are given for information only.

Stratum	Leading species substratum	n	Ratio of weighted means (with 95% sampling error shown as % of the ratio)						
			Age (years)	Height (m)	Basal area (m^2/ha)	Trees/ha	Lorey height (m)	Volume net dwb (m^3/ha)	SI (m)
Immature	Fd	42	1.080 (11.1%)	0.991 (5.8%)	0.886 (10.7%)	0.834 (26.6%)	0.981 (7.1%)	0.860 (13.5%)	1.040 (6.1%)
	Hemlock	13	1.041 (9.4%)	0.959 (11.7%)	1.007 (23.4%)	1.197 (32.5%)	0.967 (12.7%)	0.844 (27.4%)	0.976 (11.4%)
	Other	3	0.807 (63.4%)	0.978 (10.9%)	0.878 (41.8%)	0.964 (54.8%)	0.968 (23.9%)	0.816 (59.4%)	1.101 (18.4%)
	Subtotal	58	1.050 (9.1%)	0.983 (5.1%)	0.913 (9.9%)	0.917 (20.7%)	0.977 (6.2%)	0.852 (12.2%)	1.029 (5.4%)
Mature	Fd	3	1.124 (25.1%)	1.106 (30.7%)	1.104 (32.1%)	1.074 (86.8%)	1.097 (30.1%)	1.185 (57.8%)	1.127 (40.3%)
	Hemlock	17	1.081 (18.0%)	0.964 (8.5%)	1.086 (14.1%)	2.142 (56.8%)	0.906 (11.4%)	1.126 (22.2%)	1.081 (17.3%)
	Other	11	1.016 (27.0%)	0.935 (7.5%)	0.853 (25.9%)	1.454 (27.6%)	0.849 (15.6%)	0.896 (29.9%)	1.065 (8.6%)
	Subtotal	31	1.062 (14.5%)	0.967 (6.7%)	1.011 (12.3%)	1.834 (39.3%)	0.905 (9.3%)	1.060 (17.7%)	1.108 (11.1%)
All		89	1.059 (7.7%)	0.976 (4.0%)	0.959 (7.6%)	1.069 (22.4%)	0.945 (5.1%)	0.956 (10.1%)	1.047 (5.2%)

4.2 Model and Attribute-related volume bias

This section focuses on volume net of decay, waste and breakage at the 12.5 cm utilization level. In the Mature stratum, 5 polygons did not have a height associated with the leading species and could not be processed by VDYP7. These 5 plots were dropped in the analysis of model- and attribute-related bias.

Model-related bias is the bias arising from using different models to estimate volume. For the Phase I inventory, volumes are estimated using VDYP7. For the Phase II ground sample, volumes are estimated using the ground compiler. The ground compiler is considered more accurate and the difference between the two volumes is the total bias. The model-bias is assessed using VDYP7 to estimate the volume using the Phase II ground summaries (column C in Table 5) and comparing the volume to the ground compiler volume (column A). The difference between total bias and model-related bias is termed attribute-related bias.

The ratio for volume for the immature stratum is 0.852 with a sampling error of 12.2% indicating the Phase II ground volumes are approximately 85% of the Phase I inventory volumes and this is fairly consistent across leading species. When partitioned into model- and attribute-related bias, for the immature stratum, the attribute bias is large and negative and the model-related bias is smaller (Table 5) and positive. Overestimation of the photo interpreted attributes is responsible for most of the total volume bias and is compensated by some underestimation of volume in VDYP.

The Mature stratum also shows a positive model-related bias but for Fd and Hemlock, the attribute-related bias is positive indicating an underestimation of photo-interpreted attributes. The total volume bias in the immature stratum is -68 m^3/ha or (15%) compared to the mature stratum bias of 80 m^3/ha (or 9%). At the population level, the total bias is small (-15 m^3/ha or 2%).

The results for leading species substratum are similar but more variable. The main exception is the very small immature - other substrata which had a negative model- related volume bias based on a sample size of 3.

Table 5. Weighted mean volumes net DWB (Dbh ≥ 12.5 cm) by stratum for TFL 46. For the bias, the mean is followed by the mean expressed as a percentage of the Phase I volume (B). The means differ slightly from Table 4 because 5 mature plots without leading species height were dropped. Shading indicates less reliable results that are given for information only.

Stratum	Leading species substratum	n	Weighted mean volume (m^3/ha) estimates net DWB for Dbh ≥ 12.5cm					
			Phase II ground A	VDYP7 Phase I (VRIStart) attributes) B	VDYP7 with Phase II attributes as input C	Model-related volume bias A-C	Attribute-related volume bias C-B	Total volume bias A-B
Immature	Fd	42	374.2	435.3	319.7	54.5 (13%)	-115.5 (-27%)	-61.1 (-14%)
	Hemlock	13	425.3	504.2	386.2	39.1 (8%)	-117.9 (-23%)	-78.9 (-16%)
	Other	3	504.9	618.4	600.8	-95.9 (-16%)	-17.5 (-3%)	-113.5 (-18%)
	Subtotal	58	393.1	461.1	375.5	17.5 (4%)	-85.5 (-19%)	-68.0 (-15%)
Mature	Fd	3	1047.2	883.4	938.2	109 (12%)	54.8 (6%)	163.8 (19%)
	Hemlock	15	1014.8	890.7	950.8	63.9 (7%)	60.1 (7%)	124.1 (14%)
	Other	8	772.4	785.5	636.7	135.7 (17%)	-148.8 (-19%)	-13.1 (-2%)
	Subtotal	26	933.5	853.3	800.2	133.4 (16%)	-53.2 (-6%)	80.2 (9%)
All		84	586.5	601.5	527.5	59.0 (10%)	-74.0 (-12%)	-15.0 (-2%)

The same conclusions are reached examining the ratios in Table 6. The model bias ratio is generally greater than one, indicating the VDYP7 underestimates volume. Table 6 and Figure 12 also illustrate the much higher variability of the attribute bias compared to the model bias. The sampling error associated with the model bias is about half that of attribute bias and can be seen in the variability around the 1:1 line in Figure 12. In practical terms, this means that, for instance, the model bias for the Immature stratum is about 4% of the Phase I volume and it is consistently close to 4% where as the attribute bias is about -19% of the Phase I volume but is highly variable.

Table 6. The ratios of mean volumes (net DWB Dbh ≥ 12.5cm) representing total, model and attribute bias, with associated sampling error % at a 95% confidence level for TFL 46. The total bias ratio (A/B) differs slightly from Table 4 because 5 mature plots without leading species height were dropped. Shading indicates less reliable results that are given for information only.

Stratum	Leading species substratum	n	Ratio of weighted mean volume/ha net DWB Dbh ≥ 12.5cm		
			Total bias: ground/Inventory (A/B)	Model bias: Ground/VDYP7(Ground attributes) (A/C)	Attribute bias: VDYP7 (Ground attributes)/Inventory (C/B)
Immature	Fd	42	0.860 (13.5%)	1.17 (6.3%)	0.735 (14.1%)
	Hemlock	13	0.844 (27.4%)	1.101 (12.6%)	0.766 (27.4%)
	Other	3	0.816 (59.4%)	0.84 (5.5%)	0.972 (56.2%)
	Subtotal	58	0.852 (12.2%)	1.047 (11.2%)	0.814 (7.1%)
Mature	Fd	3	1.185 (57.8%)	1.116 (17.9%)	1.062 (75.7%)
	Hemlock	15	1.139 (24.0%)	1.146 (14.9%)	0.983 (26.0%)
	Other	8	1.045 (34.0%)	1.439 (24.9%)	0.623 (40.0%)
	Subtotal	26	1.094 (20.6%)	1.167 (15.0%)	0.938 (11.7%)
All			0.975 (10.9%)	1.112 (8.8%)	0.877 (6.1%)

The relationship between the bias components is given in Figure 2.

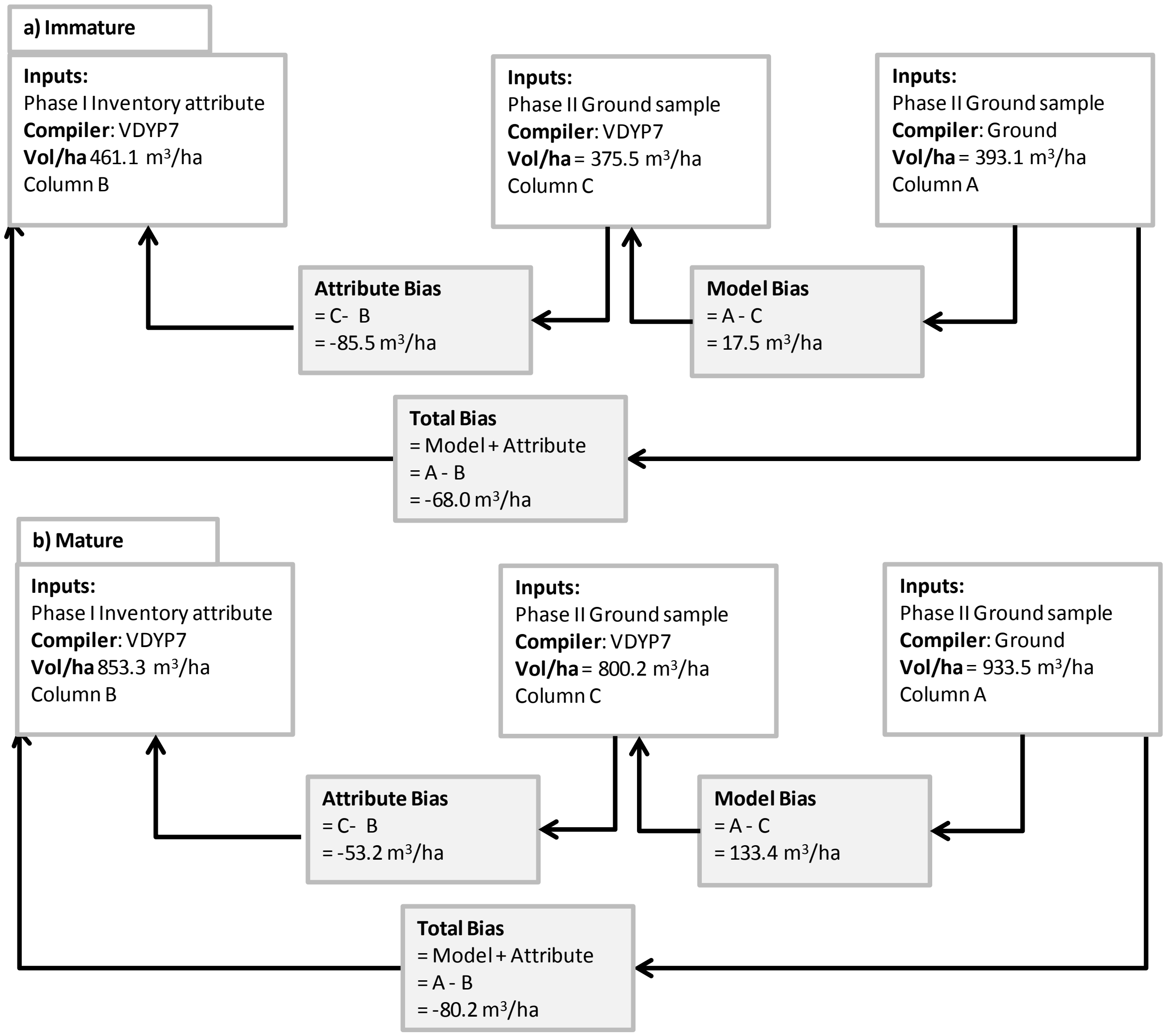

Figure 2. The relationship between the volume and bias estimates is given for the immature stratum (a) and mature stratum (b). A negative bias indicates overestimation and a positive bias indicates underestimation.

The model bias for the mature stratum is high and dominates the total bias. In previous VRI analyses, the total bias was generally dominated by the attribute-related bias. Therefore, volume bias was further investigated by undertaking the same bias analysis using whole stem volume rather than volume net of decay, waste and breakage. For whole stem volume, the model-related bias is generally less than the model-related bias associated with volume net of decay, waste and breakage indicating some of the differences in the in volume are due to different net down algorithms in the ground compiler and in VDYP7. Although the model-related bias is lower for whole stem volume (compared to volume net of decay, waste and breakage), the attribute related bias is similar. And since the model related bias compensates to some extent for the attribute related bias, the total bias for whole stem volume is larger.

Table 7. Weighted mean whole stem volumes (Dbh ≥ 12.5 cm) are given by stratum for TFL 46. For the bias, the mean is followed by the mean expressed as a percentage of the Phase I volume (B). Shading indicates less reliable results that are given for information only.

Stratum	Leading species substratum	n	Weighted mean whole stem volume (m^3/ha) estimates for Dbh ≥ 12.5cm					
			Phase II ground A	VDYP7 Phase I (VRIStart) attributes) B	VDYP7 with Phase II attributes as input C	Model-related volume bias A-C	Attribute-related volume bias C-B	Total volume bias A-B
Immature	Fd	42	413.4	490.8	365.9	47.5 (10%)	-124.9 (-25%)	-77.4 (-16%)
	Hemlock	13	476.7	570.3	445.7	31.0 (5%)	-124.6 (-22%)	-93.6 (-16%)
	Other	3	561.6	695.8	669.5	-107.9 (-16%)	-26.3 (-4%)	-134.2 (-19%)
	Subtotal	58	436.0	520.3	400.8	35.2 (7%)	-119.4 (-23%)	-84.2 (-16%)
Mature	Fd	3	1215.3	1056.9	1251.5	-36.2 (-3%)	194.5 (18%)	158.4 (15%)
	Hemlock	15	1147.8	1137.9	1197.5	-49.8 (-4%)	59.6 (5%)	9.8 (1%)
	Other	8	887.1	1018.3	849.6	37.5 (4%)	-168.8 (-17%)	-131.3 (-13%)
	Subtotal	26	1063.7	1088.1	1081.6	-18.0 (-2%)	-6.5 (-1%)	-24.4 (-2%)
All		84	660.6	723.5	644.5	16.2 (2%)	-79.0(-11%)	-62.8 (-9%)

Table 8. The ratios of mean whole stem volumes (Dbh ≥ 12.5cm) representing total, model and attribute bias, with associated sampling error % at a 95% confidence level for TFL 46. Shading indicates less reliable results that are given for information only.

Stratum	Leading species substratum	n	Ratio of weighted mean whole stem volume/ha Dbh ≥ 12.5cm		
			Total bias: ground/Inventory (A/B)	Model bias: Ground/VDYP7(Ground attributes) (A/C)	Attribute bias: VDYP7 (Ground attributes)/Inventory (C/B)
Immature	Fd	42	0.842 (13.1%)	1.130 (6.1%)	0.745 (13.9%)
	Hemlock	13	0.836 (26.5%)	1.070 (11.7%)	0.781 (26.4%)
	Other	3	0.807 (57.3%)	0.839 (5.2%)	0.962 (54.6%)
	Subtotal	58	0.838 (11.9%)	1.298 (12.4%)	0.919 (5.1%)
Mature	Fd	3	1.15 (54.7%)	0.971 (11%)	1.184 (65.1%)
	Hemlock	15	1.009 (23.3%)	0.958 (8.5%)	1.052 (22.9%)
	Other	8	0.871 (33.7%)	1.044 (9.7%)	0.834 (25.2%)
	Subtotal	26	0.978 (19.0%)	1.006 (17.6%)	1.017 (6.2%)
All			0.913 (10.2%)	1.123 (10.0%)	0.976 (3.9%)

Basal area (m^2/ha) is an important driver of volume in VDYP7. In order to assess the contribution of errors in the Phase I basal area estimates to the volume bias, a number of additional VDYP7 projections were undertaken.

- VDYP7 was run using the Phase II ground measurements as input except the Phase II basal area was replaced with the Phase I basal area (projected to 2007) (column D in Table 9).
- VDYP7 was run using the Phase I attributes projected to 2007 as inputs except Phase I basal area was replaced with the Phase II basal area (column E in Table 9).

In Table 9, columns C and E use the same basal area as input (Phase II) but the remaining attributes are from Phase II for column C and Phase I for column E.

If most of the attribute-related bias was due to bias in basal area, one would expect predictions using the same basal area (i.e., columns C and E and columns B and D) to be close. They are not. For the immature stratum, all attributes except age and SI are overestimated. Correcting basal area only still leaves some attribute bias. For the mature stratum, there is almost no basal area bias at the stratum level so the contribution of basal area to attribute bias is small.

Table 9. The influence of basal area on attribute-related volume bias for TFL 46. Shading indicates less reliable results that are given for information only.

Stratum	Leading species substratum	n	Weighted mean volume/ha net DWB Dbh ≥ 12.5cm				
			Phase II ground A	VDYP7 Phase I (VRIStart) attributes) B	VDYP7 with Phase II attributes as input C	VDYP7 with Phase II attributes except BA is from VRIStart D	VDYP7 with Phase I attributes except BA from Phase II E
Immature	Fd	42	374.2	435.3	319.7	350.0	379.5
	Hemlock	13	425.3	504.2	386.2	388.5	468.6
	Other	3	504.9	618.4	600.8	653.2	532.8
	Subtotal	58	393.1	461.1	375.5	380.5	410.5
Mature	Fd	3	1047.2	883.4	938.2	846.4	906.2
	Hemlock	15	1014.8	890.7	950.8	861.6	913.2
	Other	8	772.4	785.5	636.7	689.7	720.5
	Subtotal	26	933.5	853.3	800.2	807.9	854.2

A comparison of Phase I and Phase II leading species (section 4.3) showed some disagreement, particularly for the mature stratum. The effect of leading species was tested in a manner similar to that of basal area. The Phase II attributes were input into VRYP7 except the species composition was taken from Phase I (column D, Table 10) and Phase I attributes were input into VDYP7 with the Phase II species composition (column E, Table 10). The difference between C and D are due only to leading species and, in general, they are close except for the mature – Fd substratum where for all three samples the Phase I leading species was hemlock (compared to Fd in Phase II). The difference between B and E is also due only to leading species but the differences are larger, particularly for the immature stratum.

Table 10. The influence of species composition on attribute-related volume bias for TFL 46. Shading indicates less reliable results that are given for information only.

Stratum	Leading species substratum	n	Weighted mean volume/ha net DWB Dbh ≥ 12.5cm				
			Phase II ground A	VDYP7 Phase I (VRIStart) attributes) B	VDYP7 with Phase II attributes as input C	VDYP7 with Phase II attributes except Species are from VRIStart D	VDYP7 with Phase I attributes except Species are from Phase II E
Immature	Fd	42	374.2	435.3	319.7	306.9	376.8
	Hemlock	13	425.3	504.2	386.2	397.4	444.1
	Other	3	504.9	618.4	600.8	697.8	604.7
	Subtotal	58	393.1	461.1	375.5	349.1	404.7
Mature	Fd	3	1047.2	883.4	938.2	839.7	909.2
	Hemlock	15	1014.8	890.7	950.8	943.7	869.4
	Other	8	772.4	785.5	636.7	656.8	749.6
	Subtotal	26	933.5	853.3	833.2	844.6	831.7

The effect of differences in leading species was further investigated by comparing Phase I inventory to Phase II ground volumes. The samples where the Phase I and Phase II leading species was different (the circled observations in Figure 3) are within the range of the samples where the Phase I and Phase II leading species are the same. Differences in Phase I and Phase II leading species may contribute to the volume error but much of the error remains unexplained.

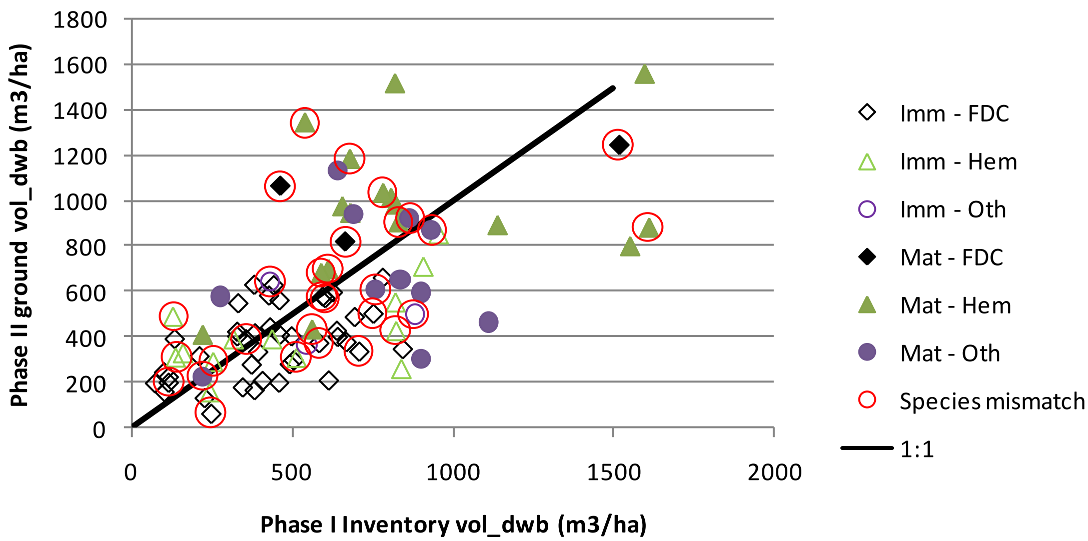

Figure 3. The Phase I inventory and Phase II ground volumes are compared. The circled observations are those samples where the leading species in Phase I is different from the leading species in Phase II.

4.3 Leading species comparison

Tables 8 to 10 summarize the correspondence between the leading species from the Phase I inventory and the leading species from the Phase II ground sample compilation. For the immature stratum, 74% (43 out of 58) of the inventory and the ground samples had the same leading species. For the mature stratum, 52% (16 out of 31) of the samples had the same leading species. For a further 17 samples, the Phase II leading species matched the Phase I second species.

For the mature stratum, the Phase I species composition tends to be mixed and the leading species comprises, on average, around 50% of the species composition (Table 15). Five out of 31 mature samples had a tie for leading species in Phase I. For three of these, the Phase I and Phase II leading and second species were reversed. In these mixed conditions, more differences between the Phase I and Phase II species might be expected, especially since the Phase II ground plot samples only a portion of the polygon.

Table 11. The Phase I and Phase II leading species are cross tabulated by maturity.

Maturity	Phase I	Phase II species							
	Species	Ba	Cw	Dr	Fd	Hm/Hw	Ss	Yc	Total
Immature	Ba					1			1
	Dr			1			1		2
	Fd		2		34	6			42
	Hw	1	1		3	8			13
	Subtotal	1	3	1	37	15	1	0	58
Mature	Ba	4	1			1			6
	Cw		3		1			1	5
	Fd					3			3
	H/Hw	4	4			9			17
	Subtotal	8	8	0	1	13	0	1	31
Grand total		9	11	1	38	28	1	1	89

Table 12. The Phase I and Phase II leading species are cross tabulated by maturity. Each cell is expressed as a percent of the row (Phase I) total.

Maturity	Phase I	Phase II species							
	Species	Ba	Cw	Dr	Fd	Hm/Hw	Ss	Yc	Total
Immature	Ba	0%	0%	0%	0%	100%	0%	0%	100%
	Dr	0%	0%	50%	0%	0%	50%	0%	100%
	Fd	0%	5%	0%	81%	14%	0%	0%	100%
	Hw	8%	8%	0%	23%	62%	0%	0%	100%
	Subtotal	2%	5%	2%	64%	26%	2%	0%	100%
Mature	Ba	67%	17%	0%	0%	17%	0%	0%	100%
	Cw	0%	60%	0%	20%	0%	0%	20%	100%
	Fd	0%	0%	0%	0%	100%	0%	0%	100%
	H/Hw	24%	24%	0%	0%	53%	0%	0%	100%
	Subtotal	26%	26%	0%	3%	42%	0%	3%	100%
Grand total		10%	12%	1%	43%	31%	1%	1%	100%

Table 13. The Phase I and Phase II leading species are cross tabulated by maturity. Each cell is expressed as a percent of the column (Phase II) subtotal. If the subtotal is zero, the cell is left blank.

Maturity	Phase I	Phase II species							
	Species	Ba	Cw	Dr	Fd	Hm/Hw	Ss	Yc	Total
Immature	Ba	0%	0%	0%	0%	7%	0%		2%
	Dr	0%	0%	100%	0%	0%	100%		3%
	Fd	0%	67%	0%	92%	40%	0%		72%
	Hw	100%	33%	0%	8%	53%	0%		22%
	Subtotal	100%	100%	100%	100%	100%	100%		100%
Mature	Ba	50%	13%		0%	8%		0%	19%
	Cw	0%	38%		100%	0%		100%	16%
	Fd	0%	0%		0%	23%		0%	10%
	H/Hw	50%	50%		0%	69%		0%	55%
	Subtotal	100%	100%		100%	100%		100%	100%
Grand total		100%	100%	100%	100%	100%	100%	100%	100%

4.4 Issues

No issues were identified.

4.5 Comparison to Timberline (2010)

The results are consistent with the findings of Timberline (2010). The NVAF sample data were not available for the Timberline study but were used here so the volume summaries are slightly different. That study also included an analysis of the impacts of adjusting the Phase I attributes age, height, basal area and trees per hectare and computing input- or attribute-adjusted estimates of volume and Lorey height. In that study, the unadjusted estimates of volume and Lorey height were closer to the Phase I means than the attribute adjusted estimates. Attribute adjustment was not undertaken here.

4.6 Comparison to Previous Timber Supply Review Ratios

In the 2007 annual allowable cut (AAC) determination, the height, age and volume were adjusted using the ratios in Table 14. The results here are consistent with the AAC ratios (within 5%) except for mature volume. The NVAF sample data were not available in 2007 but were used in the volume estimated in the current study.

Table 14. The 2007 AAC adjustment ratios are compared to the ratios computed in this study.

	Height		Age		Volume	
	AAC	Current Study	AAC	Current Study	AAC	Current Study
Immature	0.975	0.983	1.084	1.050	0.812	0.852
Mature	0.937	0.967	1.078	1.062	1.204	1.060

4.7 Limitations of the Approach

There are a number of limitations to the approach taken here.

Attribute definitions – The unprojected Phase I and Phase II have slightly different definitions of attributes. The Phase I basal area is the total cross sectional area, at breast height, of all living trees visible to the photo interpreter in the dominant, codominant and high intermediate crown positions for each tree layer in the polygon (FAIB 2010). For Phase II, it is the cross sectional area of all living trees with Dbh > 7.5 cm. The Phase I leading species height is the average height by layer, weighted by basal area, of the dominant, codominant and high intermediate trees for the leading species within each layer. Phase I density is the average number of living trees visible to the photo interpreter in the dominant, codominant and high intermediate crown positions in each tree layer in the polygon. The unprojected Phase I attributes are used as input to VDYP7 and projected to the year of ground sampling. These projected Phase I attributes have the same utilization definitions as Phase II. The differences in definitions of Phase I and Phase II attributes are expected to have a larger effect on the immature stratum where more trees are expected to be below the 7.5 cm Dbh utilization limit.

Some of the Phase I estimates for immature polygons may come from silvicultural records and may be collected to different standards, different levels of error checking and different definitions. In particular, the height and age may have been measured in the field while the site index may have been estimated from SIBEC[1] or the previous stand.

Sample Unit – In Phase I the sample unit is the polygon and in Phase II it is generally a five plot cluster within the polygon. Some of the differences between Phase I and Phase II may arise because Phase II is a subsample of the polygon and may not fully capture some of the within polygon variation considered by photo interpreters when assigning a VRI label to reflect the overall polygon.

VDYP7 – VDYP7 is used to project the Phase I inventory to the year of ground sampling. For very young polygons, VDYP7 uses VRIYoung which does not estimate a full suite of inventory attributes – rather it projects dominant height and basal area (and age) until the polygon meets the minimum criteria of breast height age ≥ 6 years, dominant height ≥ 6 m and basal area (7.5 cm+) ≥ 2 m^2. Basal area is then predicted from age and site height. VDYP7 may not be the most appropriate model for projecting young managed stands. This should not be an issue here as the polygons were all 30+ years.

Net merchantable volume – VDYP7 and the ground compiler use different methods of reducing the gross merchantable volume to merchantable net of decay waste and breakage. The ground compiler methods are considered more accurate and precise. However, the net factoring approach used in the ground compiler cannot be implemented in VDYP7 because of different resolutions (tree vs. stand summary).

5. Conclusions and recommendations

The VRI statistical analysis for TFL 46 suggests that the inventory age and height are generally well estimated with age slightly underestimated and height slightly overestimated. As a consequence, Lorey height and SI are also well estimated. For the immature stratum, basal area is overestimated by about 10% leading to an overestimation of volume. Overall, for the mature stratum, basal area was well

[1] Nigh, G.B. Nigh, G.D. and P.J. Martin. 2006. Selecting a method to estimate site index. B.C. Min. For. and Range, Res. Br. Land Manage. Handb. Field Guide Insert 12.
http://www.for.gov.bc.ca/hfd/pubs/Docs/Fgi/Fgi12.pdf

estimated with considerable variation by leading species substratum and the volume was relatively well estimated. Trees per hectare was generally poorly estimated.

For the leading species substrata, the sampling error for all ratios was generally larger than the target of 10%. The sampling errors for the mature strata were consistently higher than for the immature strata due in part to a smaller sample size.

Overall, all attribute estimates were within 10% of the mean and had a sampling error ≈ 10% or less except for trees/ha.

Based on the analysis, the following recommendation is made.

- The leading species substrata ratios are highly variable within strata and have high sampling errors and should be used with caution.

6. Literature cited

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FAIB. 2010. Vegetation Resources Inventory – Photo Interpretation Procedures Version 2.6. Dated April 2010. 98 p + appendices.

FAIB 2011. Vegetation Resources Inventory – VRI sample data analysis procedures and standards. Version 1, June 2011. Ministry of Forests and Range, Forest Analysis and Inventory Branch. 23p. + app.

J.S.Thrower and Associates. 2008. Teal Cedar Products Ltd. Tree Farm Licence 46 Vegetation Resources Inventory Phase II Project Implementation Plan updated for the NVAF Program Only. Version 3.2. Dated March 31, 2008. 13p + app.

Timberline. 2010. Tree Farm Licence 46 Vegetation Resources Inventory Statistical Adjustment Version 1.0. dated February 2010. 23p + app.

7. Appendix A: Phase I inventory attributes

Table 15. The Phase I input attributes (projected to 2011) are given.

SAMPLE	FEATURE_ID	BEC	Stratum 1	Leading species	Sample weight	inventory standard	Measurement year (for projections)	Reference Year	Age sp1	Height sp1	Age sp2	Height sp2	CC%	BA7.5	TPH7.5	sp01	pct1	sp02	pct2	sp03	pct3	sp04	pct4	sp05	pct5	sp06	pct6
2	6831165	CWH	Immature	FDC	577	V	2011	2005	44	31	44	30	55	44	709	FD	90	HW	10		.		.		.		.
7	6831767	CWH	Immature	FDC	577	V	2011	2005	44	38	39	36	55	60	632	FD	75	HW	20	BG	5		.		.		.
8	6830622	CWH	Immature	FDC	577	V	2011	2005	49	39	49	37	60	61	545	FD	60	HW	35	BA	5		.		.		.
11	6083703	CWH	Immature	FDC	577	V	2011	2005	64	20	64	20	45	27	1119	FD	80	HW	10	CW	10		.				
13	6087352	CWH	Immature	FDC	577	V	2011	2005	64	31	64	30	60	62	854	FD	70	HW	20	CW	5	DR	5				
14	6087523	CWH	Immature	FDC	577	V	2011	2005	49	37	49	37	65	66	657	FD	90	HW	5	DR	5		.				
18	7177509	CWH	Immature	FDC	577	V	2011	2005	49	32	49	32	60	47	644	FD	60	HW	30	DR	5	CW	5				
22	6830846	CWH	Immature	FDC	577	V	2011	2005	44	22	44	22	50	24	801	FD	90	HW	10		.		.				
25	6085319	CWH	Immature	FDC	577	V	2011	2005	49	32	49	30	70	55	582	FD	85	HW	10	DR	5		.				
27	6084348	CWH	Immature	FDC	577	V	2011	2005	49	28	49	26	70	64	1059	FD	50	HW	50		.		.				
28	6831476	CWH	Immature	FDC	577	V	2011	2005	39	26	39	26	55	38	927	FD	70	HW	20	BA	10		.				
29	6083911	CWH	Immature	FDC	577	V	2011	2005	37	16	34	13	55	44	3558	FD	85	HW	10	CW	5		.				
31	6830985	CWH	Immature	FDC	577	V	2011	2005	49	32	49	32	55	46	636	FD	70	HW	20	DR	5	CW	5				
32	6087101	CWH	Immature	FDC	577	V	2011	2005	49	32	49	32	60	56	759	FD	75	HW	25		.		.				
38	6831931	CWH	Immature	FDC	577	V	2011	2005	54	40	54	38	55	76	604	FD	70	HW	20	CW	5	DR	5				
39	6831678	CWH	Immature	FDC	577	V	2011	2005	44	40	44	39	55	58	507	FD	75	HW	20	DR	5		.				
44	6222069	CWH	Immature	FDC	577	V	2011	2005	64	31	64	32	55	56	752	FD	70	CW	15	HW	15		.				
51	6085565	CWH	Immature	FDC	577	V	2011	2005	49	30	49	29	60	59	478	FD	85	HW	10	CW	5		.				
54	6086819	CWH	Immature	FDC	577	V	2011	2005	59	32	59	32	55	49	679	FD	50	HW	50		.		.				
60	6084250	CWH	Immature	FDC	577	V	2011	2005	49	31	49	29	65	65	725	FD	65	HW	35		.		.				
61	6085195	CWH	Immature	FDC	577	V	2011	2005	69	21	69	14	45	29	310	FD	60	PL	30	HW	5	CW	5				
65	6831518	CWH	Immature	FDC	577	V	2011	2005	39	20	39	18	55	29	1365	FD	70	HW	20	CW	5	DR	5				
68	6831647	CWH	Immature	FDC	577	V	2011	2005	39	30	39	29	65	48	895	FD	60	HW	30	CW	5	DR	5				
70	6085082	CWH	Immature	FDC	577	V	2011	2005	39	26	39	23	65	64	1562	FD	85	HW	15		.		.				

SAMPLE	FEATURE_ID	BEC	Stratum 1	Leading species	Sample weight	inventory standard	Measurement year (for projections)	Reference Year	Age sp1	Height sp1	Age sp2	Height sp2	CC%	BA7.5	TPH7.5	sp01	pct1	sp02	pct2	sp03	pct3	sp04	pct4	sp05	pct5	sp06	pct6
73	6083838	CWH	Immature	FDC	577	V	2011	2005	79	38	79	37	55	73	621	FD	75	CW	15	HW	10		.				
74	6084059	CWH	Immature	FDC	577	V	2011	2005	37	17	34	14	65	51	3704	FD	60	HW	30	BA	5	CW	5				
77	6084946	CWH	Immature	FDC	577	V	2011	2005	44	25	44	21	55	46	769	FD	85	HW	10	CW	5		.				
78	6832241	CWH	Immature	FDC	577	V	2011	2005	59	36	59	36	60	71	709	FD	60	HW	40		.		.				
81	6087669	CWH	Immature	FDC	577	V	2011	2005	49	35	49	35	60	55	596	FD	85	HW	15		.		.				
82	6830997	CWH	Immature	FDC	577	V	2011	2005	49	32	49	32	55	46	628	FD	75	HW	20	DR	5		.				
85	6832234	CWH	Immature	FDC	577	V	2011	2005	54	32	54	32	55	45	601	FD	60	HW	30	CW	10		.				
86	6085671	CWH	Immature	FDC	577	V	2011	2005	39	30	39	24	60	57	799	FD	80	HW	20		.		.				
87	6083822	CWH	Immature	FDC	577	V	2011	2005	64	26	64	25	50	33	722	FD	75	CW	15	HW	5	RA	5				
90	6830051	CWH	Immature	FDC	577	V	2011	2005	49	24	49	24	70	56	1109	FD	50	HW	40	CW	5	BA	5				
99	6085311	CWH	Immature	FDC	577	V	2011	2005	79	43	79	40	60	64	324	FD	50	HW	50		.		.				
102	6830869	CWH	Immature	FDC	577	V	2011	2005	44	31	44	30	60	43	662	FD	75	HW	20	DR	5		.				
106	6087596	CWH	Immature	FDC	577	V	2011	2005	64	35	64	33	60	66	673	FD	75	HW	20	DR	5		.				
114	6831349	CWH	Immature	FDC	577	V	2011	2005	46	35	46	32	60	71	804	FD	45	HW	35	SS	10	DR	10				
117	7297881	CWH	Immature	FDC	577	V	2011	2005	84	43	84	41	60	74	257	FD	50	HW	50		.		.				
118	6087377	CWH	Immature	FDC	577	V	2011	2005	54	37	54	35	50	48	459	FD	75	HW	20	DR	5		.				
121	6829419	CWH	Immature	FDC	577	V	2011	2005	58	38	58	36	60	69	633	FD	65	HW	20	CW	10	DR	5				
124	6085387	CWH	Immature	FDC	577	V	2011	2005	74	37	74	37	60	60	319	FD	60	HW	35	CW	5		.				
4	6832060	CWH	Immature	Hem	591	V	2011	2005	39	22	39	23	60	31	1110	HW	60	FD	35	BA	5		.		.		.
15	6087597	CWH	Immature	Hem	591	V	2011	2005	64	42	64	42	55	73	520	HW	65	FD	30	DR	5		.				
17	6084550	CWH	Immature	Hem	591	V	2011	2005	49	30	49	32	70	60	835	HW	40	FD	30	BA	30		.				
20	6830749	CWH	Immature	Hem	591	V	2011	2005	44	28	44	28	60	41	839	HW	60	FD	30	CW	5	BA	5				
41	6087335	MH	Immature	Hem	591	V	2011	2005	64	20	64	21	55	28	1114	HW	65	BA	20	FD	10	CW	5				
47	6084298	CWH	Immature	Hem	591	V	2011	2005	44	26	44	28	70	66	1299	HW	70	FD	30		.		.				
55	6087042	CWH	Immature	Hem	591	V	2011	2005	49	26	49	26	55	36	841	HW	65	FD	15	CW	10	BA	10				
63	6084558	CWH	Immature	Hem	591	V	2011	2005	54	39	54	40	65	72	500	HW	60	FD	40		.		.				
79	6832434	CWH	Immature	Hem	591	V	2011	2005	44	21	44	21	60	25	849	HW	60	FD	30	BA	10		.				
93	6085361	CWH	Immature	Hem	591	V	2011	2005	39	22	39	25	60	48	1438	HW	70	FD	30		.		.				

SAMPLE	FEATURE_ID	BEC	Stratum 1	Leading species	Sample weight	inventory standard	Measurement year (for projections)	Reference Year	Age sp1	Height sp1	Age sp2	Height sp2	CC%	BA7.5	TPH7.5	sp01	pct1	sp02	pct2	sp03	pct3	sp04	pct4	sp05	pct5	sp06	pct6
101	6085344	CWH	Immature	Hem	591	V	2011	2005	79	43	79	44	60	64	339	HW	60	FD	40		.		.				
110	6087383	CWH	Immature	Hem	591	V	2011	2005	64	39	64	39	60	72	623	HW	65	FD	30	SS	5		.				
119	6829865	CWH	Immature	Hem	591	V	2011	2005	59	39	59	40	65	86	462	HW	70	FD	30		.		.				
23	6087755	CWH	Immature	Oth	830	V	2011	2005	54	31	54	31	60	50	640	DR	75	MB	10	SS	5	HW	5	CW	5		
62	6084245	CWH	Immature	Oth	830	V	2011	2005	59	37	59	38	65	76	615	BA	40	HW	40	DR	10	FD	10				
111	6829719	CWH	Immature	Oth	830	V	2011	2005	79	28	109	50	45	40	204	DR	70	SS	30		.		.				
26	6831782	CWH	Mature	FDC	631	V	2011	2005	306	55	306	50	55	107	450	FD	70	HW	30		.		.				
52	6085170	CWH	Mature	FDC	631	V	2011	2005	239	31	239	28	60	60	277	FD	60	HW	40		.		.				
83	6085327	CWH	Mature	FDC	631	V	2011	2005	259	37	259	35	60	80	300	FD	40	HW	40	CW	20		.				
12	6087703	CWH	Mature	Hem	610	V	2011	2005	309	49	309	50	50	85	443	HW	50	FD	30	CW	15	BA	5				
24	6085140	CWH	Mature	Hem	610	V	2011	2005	249	35	309	40	55	75	226	HW	50	CW	30	BA	10	YC	10				
42	6086384	CWH	Mature	Hem	610	V	2011	2005	209	29	189	27	65	75	417	HW	50	BA	30	CW	20		.				
48	6085136	CWH	Mature	Hem	610	V	2011	2005	269	45	309	49	55	80	150	HW	40	CW	30	BA	25	FD	5				
56	6084217	MH	Mature	Hem	610	V	2011	2005	259	39	209	37	55	75	225	HW	70	BA	20	CW	10		.				
58	6084434	MH	Mature	Hem	610	V	2011	2005	189	24	209	21	45	45	217	H	30	YC	30	CW	20	BA	20				
59	6085233	CWH	Mature	Hem	610	V	2011	2005	259	38	259	41	65	80	322	HW	50	FD	40	CW	5	BA	5				
64	6831127	CWH	Mature	Hem	610	V	2011	2005	309	51	309	52	55	112	542	HW	50	FD	40	BA	10		.				
66	6086028	CWH	Mature	Hem	610	V	2011	2005	109	38	109	38	65	78	288	HW	60	FD	40		.		.				
69	6831035	CWH	Mature	Hem	610	V	2011	2005	249	56	209	56	60	107	450	HW	50	BA	30	CW	15	YC	5				
71	7297964	CWH	Mature	Hem	610	V	2011	2005	249	30	259	30	60	85	302	HW	40	CW	40	BA	20		.				
88	6831051	CWH	Mature	Hem	610	V	2011	2005	309	52	209	49	55	117	550	HW	60	BA	30	CW	10		.				
92	6085393	CWH	Mature	Hem	610	V	2011	2005	259	37	229	37	60	80	275	HW	30	BA	25	CW	25	YC	20				
96	6832103	CWH	Mature	Hem	610	V	2011	2005	359	38	359	38	60	62	550	HW	70	CW	10	BA	10	FD	10				
105	6084053	CWH	Mature	Hem	610	V	2011	2005	89	30	84	29	65	69	534	HW	80	BA	10	CW	10		.				
107	6084857	CWH	Mature	Hem	610	V	2011	2005	259	39	309	42	60	85	250	HW	50	CW	35	BA	15		.				
108	6085538	CWH	Mature	Hem	610	V	2011	2005	259	45	269	46	55	75	200	HW	50	CW	20	FD	20	BA	10				
6	7176328	CWH	Mature	Oth	597	V	2011	2005	269	49	259	45	25	30	50	CW	50	HW	40	BA	10		.		.		.
10	6086184	CWH	Mature	Oth	597	V	2011	2005	309	40	249	36	60	100	175	CW	50	HW	35	FD	15		.		.		.

SAMPLE	FEATURE_ID	BEC	Stratum 1	Leading species	Sample weight	inventory standard	Measurement year (for projections)	Reference Year	Age sp1	Height sp1	Age sp2	Height sp2	CC%	BA7.5	TPH7.5	sp01	pct1	sp02	pct2	sp03	pct3	sp04	pct4	sp05	pct5	sp06	pct6
36	6085909	MH	Mature	Oth	597	V	2011	2005	259	34	259	33	60	75	300	BA	40	HW	40	CW	15	YC	5				
45	6085749	CWH	Mature	Oth	597	V	2011	2005	259	41	309	45	50	75	298	BA	40	HW	40	CW	20		.				
67	6830726	CWH	Mature	Oth	597	V	2011	2005	309	52	309	48	55	96	444	CW	45	HW	30	BA	25		.				
80	7177370	CWH	Mature	Oth	597	V	2011	2005	189	40	209	42	55	70	253	BA	70	HW	25	CW	5		.				
95	6086483	CWH	Mature	Oth	597	V	2011	2005	309	27	259	27	35	45	150	CW	40	HW	30	YC	30		.				
104	6085816	CWH	Mature	Oth	597	V	2011	2005	259	44	309	47	60	80	298	BA	40	CW	30	HW	30		.				
112	6829794	CWH	Mature	Oth	597	V	2011	2005	249	44	249	45	60	80	250	BA	40	HW	30	CW	25	FD	5				
122	6085684	CWH	Mature	Oth	597	V	2011	2005	259	41	309	45	60	75	324	BA	60	HW	30	CW	10		.		.		.
123	6085606	CWH	Mature	Oth	597	V	2011	2005	309	36	259	34	65	90	250	CW	40	HW	40	BA	10	FD	10		.		.

Table 16. The Phase I attributes are given (projected to the year of ground sampling using VDYP7).

Sample	Leading species Age	Leading species height	Second species Age	Second species height	(Dbh ≥ 7.5 cm) Basal area (m^2/ha)	Trees/ha	Lorey height (m)	Volume net DWB (m^3/ha)	(Dbh ≥ 12.5 cm) Volume net DWB (m^3/ha)
2	40	28.2	40	27.7	41.7	797	25.0	329	329
7	40	35	35	33.0	55.9	715	31.7	584	584
8	45	36.7	45	34.4	57.8	623	33.3	639	639
11	60	19.2	60	19.5	25.4	1151	16.2	117	116
13	60	29.8	60	28.9	59.2	918	26.1	499	498
14	45	34.3	45	34.1	62.2	733	30.9	614	614
18	45	30	45	29.5	44.2	725	26.9	394	394
22	40	20.4	40	20.6	22.1	868	17.8	116	116
25	45	30	45	27.3	51.3	655	26.7	432	431
27	45	26	45	24.3	60.6	1188	23.4	460	459
28	35	23.6	35	23.0	34.3	1039	20.7	229	228
29	33	14.2	30	11.2	36.1	3042	11.4	74.5	73.6
31	45	30	45	29.5	43.8	712	26.7	382	382
32	45	30	45	29.5	52.1	847	26.9	461	461
38	50	38.1	50	35.3	71.9	674	34.0	782	782
39	40	37.2	40	35.8	54.1	586	33.9	603	603
44	60	29.8	60	30.2	53.4	806	26.2	428	428
51	45	27.6	45	26.6	55.3	540	24.8	408	408
54	55	30.2	55	30.1	47.5	749	27.7	443	443
60	45	28.8	45	26.5	60.7	819	25.5	492	492
61	65	20.1	65	13.6	28.1	337	16.9	135	135
65	35	17.7	35	16.5	26.2	1423	14.9	104	103
68	35	26.8	35	26.3	44.3	1023	23.6	347	346
70	35	23.6	35	20.8	57.2	1713	20.1	357	357
73	75	36.5	75	35.7	70.2	658	33.0	695	694
74	33	14.7	30	11.8	43.0	3435	11.6	104	102
77	40	22.9	40	19.0	41.7	866	19.5	249	248
78	55	34.4	55	34.3	68.1	782	31.4	709	709
81	45	33.1	45	32.8	52.1	664	30.1	505	505
82	45	30	45	29.5	43.3	703	26.9	383	383
85	50	30.4	50	30.4	43.1	664	27.3	385	385
86	35	26.8	35	21.5	52.2	919	22.9	374	374
87	60	24.5	60	23.8	32.1	767	21.6	212	212
90	45	22.2	45	22.5	52.6	1227	19.7	333	332
99	75	41.7	75	38.6	63.0	351	38.4	753	753
102	40	28.2	40	27.7	39.7	754	25.2	329	329
106	60	34	60	32.0	64.0	728	30.4	626	626
114	42	32.4	42	29.9	66.9	918	28.5	642	642
117	80	41.4	80	39.5	72.5	278	39.4	844	844
118	50	34.4	50	33.2	45.5	514	31.3	462	462
121	54	36	54	34.1	66.3	700	31.6	669	669
124	70	35.7	70	35.8	58.5	347	33.6	595	595
4	35	19.9	35	20.5	28.9	1249	18.4	165	163
15	60	40.2	60	40.3	71.2	576	37.7	907	907
17	45	27.6	45	30.3	57.4	950	26.1	515	515
20	40	26	40	26.3	39.2	954	24.1	321	320
41	60	19.4	60	19.9	27.9	1199	17.3	140	140
47	40	23.8	40	26.3	61.7	1480	21.6	440	439

Sample	Leading species Age	Leading species height	Second species Age	Second species height	(Dbh ≥ 7.5 cm) Basal area (m^2/ha)	Trees/ha	Lorey height (m)	Volume net DWB (m^3/ha)	(Dbh ≥ 12.5 cm) Volume net DWB (m^3/ha)
55	45	24.5	45	24.5	34.5	947	21.9	257	256
63	50	37.1	50	38.5	69.3	564	36.0	821	821
79	40	19.3	40	19.3	23.6	962	17.9	133	132
93	35	19.9	35	22.5	44.1	1622	18.0	248	246
101	75	41.7	75	42.8	63.0	368	40.8	823	823
110	60	37.1	60	37.3	70.3	686	35.1	839	839
119	55	37.4	55	38.6	83.2	522	35.8	954	954
23	50	29.9	50	29.9	51.1	710	27.7	545	544
62	55	35.2	55	36.4	75.0	693	33.1	880	880
111	75	27.4	105	49.6	40.5	218	33.7	431	431
26	302	55.1	302	50.1	107.0	449	49.3	1519	1519
52	235	31.2	235	28.3	60.2	279	29.0	465	465
83	255	37.2	255	35.3	80.2	302	33.0	667	667
12	305	49.3	305	50.2	84.9	442	46.7	1139	1139
24	245	35.2	305	40.2	74.9	228	35.6	614	614
42	205	28.3	185	26.5	75.2	420	25.7	541	541
48	265	45.2	305	49.2	79.9	151	44.6	820	820
56	255	39.2	205	36.5	75.0	227	36.8	682	682
58	205	21.2	225	19.0	45.0	219	21.2	223	223
59	255	38.2	255	41.1	80.1	325	37.9	832	832
64	305	51.2	305	52.1	112.0	541	48.0	1597	1597
66	105	37	105	37.7	76.8	306	36.2	808	808
69	245	55.3	205	55.6	107	450	49.9	1552	1552
71	245	30.2	255	30.2	85.2	304	29.4	591	591
88	305	52.2	205	48.6	117	550	47.1	1611	1611
92	225	30.9	195	30.2	80.2	277	32.8	680	680
96	355	38.2	355	38.2	62.0	553	35.6	657	657
105	85	29.1	80	28.4	67.4	580	26.3	563	563
107	255	39.2	305	42.2	84.9	252	38.8	784	784
108	255	44.3	265	45.3	74.9	202	43.8	822	822
6	265	48.3	255	44.3	29.9	50.4	45.4	277	277
10	305	40.3	245	36.3	99.8	176	39.3	762	762
36	255	33.3	255	33.2	75.1	302	31.8	645	645
45	255	40.4	305	45.2	75.1	300	41.0	869	869
67	305	52.2	305	48.2	96.2	446	45.7	1114	1114
80	185	39.5	205	41.3	69.9	256	38.1	840	840
95	305	27.1	255	27.2	45.1	151	25.5	224	224
104	255	43.4	305	47.2	80.2	299	42.2	906	906
112	245	43.3	245	44.2	79.9	251	43.3	937	937
122	255	40.4	305	45.2	75.1	325	40.0	906	906
123	305	36.2	255	34.3	89.8	252	35.0	696	696

8. Appendix B: Phase II compiled ground attributes

Table 17. The Phase II compiled ground attributes are given.

Sample	Species composition At Dbh ≥ 4.0 cm	Dbh ≥ 7.5 cm						Dbh ≥ 12.5 cm
		Age tlxo trees (years)[2]	Height tlxo trees (m)	Basal area (m^2/ha)	Trees/ ha	Lorey height (m)	Live volume net DWB (m^3/ha)	Live volume net DWB (m^3/ha)
2	Fd 91 Hw 09	37	25.7	53.9	1042	24.4	427	427
7	Hw 69 Fd 31	34	30.2	44.8	573	27.8	377	377
8	Fd 77 Cw 09 Dr 09 Hw 05	44	32.4	53.9	1092	22.7	431	431
11	Hw 53 Fd 47	78	22.4	30.0	877	21.0	212	203
13	Fd 74 Hw 21 Dr 05	54	29.1	58.2	1469	19.8	421	406
14	Fd 60 Hw 13 Vb 13 Dr 14	50	28.9	27.0	576	26.8	221	213
18	Fd 78 Hw 22	40	30.8	40.5	445	23.9	338	338
22	Fd 55 Hw 38 Cw 03 Ba 04	40	25.6	29.0	444	21.0	228	228
25	Fd 71 Hw 29	39	31.1	51.5	749	23.7	446	446
27	Fd 50 Hw 28 Cw 22	48	23.1	30.6	654	16.5	212	203
28	Fd 60 Hw 30 Ba 10	21	16.8	20.8	443	15.4	136	136
29	Fd 86 Hw 05 Cw 05 S 04	32	22.7	27.5	371	17.9	201	201
31	Fd 76 Dr 17 Hw 07	41	29.4	71.1	829	28.9	632	632
32	Fd 62 Hw 19 Ba 19	41	27.8	67.2	846	21.9	564	564
38	Fd 55 Hw 36 Cw 09	49	33.6	67.4	618	31.6	663	663
39	Hw 71 Cw 14 Fd 15	80	37.6	56.0	397	35.6	574	574
44	Fd 91 Cw 09	67	35.8	70.4	1443	32.6	585	585
51	Fd 63 Cw 19 Hw 13 Ba 05	38	21.4	31.5	1133	18.2	211	211
54	Fd 68 Hw 32	54	34.7	67.4	658	33.1	630	630
60	Fd 50 Hw 44 Cw 06	50	37.0	28.8	362	33.0	284	284
61	Fd 64 Hw 21 Cw 15	162	30.4	42.0	787	39.2	395	395
65	Fd 59 Hw 24 Cw 06 Ba 06 Dr 05	31	21.1	27.0	1020	15.0	163	163
68	Fd 77 Cw 23	34	23.2	27.1	601	19.2	183	183
70	Hw 51 Fd 23 Cw 20 Dr 06	68	21.8	61.2	2733	18.5	414	394
73	Fd 81 Cw 11 Hw 08	58	38.7	48.6	160	34.6	491	491
74	Fd 95 Dr 05	31	22.6	34.2	615	19.7	249	249
77	Cw 75 Fd 17 Hw 08	36	12.6	12.5	418	15.7	76	67
78	Hw 45 Fd 36 Dr 19	54	36.7	33.0	549	31.7	339	339
81	Fd 86 Hw 05 Mb 05 Cw 04	49	27.4	37.8	512	24.7	301	301
82	Fd 100	39	26.8	22.4	310	23.4	171	171
85	Fd 56 Hw 32 Vb 09 Cw 03	48	32.4	47.6	717	28.3	420	420
86	Fd 80 Hw 10 Cw 05 Ba 05	37	21.9	45.0	1860	16.1	282	282
87	Fd 100	75	28.2	39.2	455	25.6	319	319
90	Fd 92 Hw 08	43	30.6	61.3	490	29.8	551	551
99	Cw 39 Hw 39 Ss 11 Fd 06 Ac 05	74	27.6	57.6	605	30.1	505	505
102	Fd 100	41	26.6	51.5	627	20.1	406	406
106	Fd 25 Hw 25 Dr 25 Cw 25	58	36.9	72.0	1721	26.2	599	599
114	Fd 90 Hw 10	45	29.6	46.7	536	28.4	404	404
117	Fd 100	64	34.6	33.7	183	38.6	351	351
118	Fd 43 Hw 39 Dr 13 Ss 05	57	42.3	41.4	282	31.8	413	413
121	Fd 82 Pw 07 Cw 07 Hw 04	100	27.9	50.4	1096	25.9	401	381
124	Hw 61 Fd 28 Cw 11	65	33.8	57.6	350	34.0	581	581
4	Hw 55 Ba 29 Fd 16	40	21.7	55.8	2499	22.3	365	334

[2] For some ground plots, no ages or heights were available for the leading species.

Sample	Species composition At Dbh ≥ 4.0 cm	Dbh ≥ 7.5 cm Age tlxo trees (years)[2]	Height tlxo trees (m)	Basal area (m^2/ha)	Trees/ ha	Lorey height (m)	Live volume net DWB (m^3/ha)	Dbh ≥ 12.5 cm Live volume net DWB (m^3/ha)
15	Hw 81 Cw 10 Tw 05 Mb 04	67	38.0	67.2	445	31.4	715	715
17	Fd 95 Dr 05	46	33.4	35.0	328	30.1	313	313
20	Hw 67 Ba 33	43	25.6	51.5	1412	24.2	399	395
41	Fd 47 Hm 26 Hw 27	45	17.1	57.0	1290	14.2	330	315
47	Hw 68 Fd 27 Ba 05	45	18.7	66.0	2514	17.6	395	395
55	Ba 62 Hw 34 Fd 04	42	19.9	50.4	2245	20.1	309	295
63	Hw 82 Fd 18	47	37.1	61.2	795	40.9	558	558
79	Fd 36 Hw 32 Ba 32	45	29.4	53.9	630	26.9	499	495
93	Hw 60 Dr 20 Fd 13 Cw 07	33	21.9	29.2	1022	18.5	174	161
101	Cw 46 Hw 38 Ss 16	77	27.3	53.1	712	24.4	431	431
110	Hw 100	59	29.2	24.0	158	32.6	264	264
119	Hw 64 Fd 21 Ss 15	80	41.9	74.7	412	36.0	858	858
23	Dr 92 Hw 08	66	31.6	36.0	404	24.9	365	365
62	Hw 50 Dr 30 Fd 13 Mb 07	55	37.4	54.0	742	26.8	502	502
111	Ss 52 Dr 39 Hw 09	49	44.3	56.4	418	39.8	647	647
26	Hw 91 Ba 04 Fd 05	275	47.2	93.2	172	47.3	1249	1249
52	Hw 48 Fd 30 Yc 13 Ba 04 Cw 05	261	44.2	93.2	365	44.2	1069	1069
83	Hw 63 Cw 19 Fd 18	354	34.2	86.4	569	30.5	823	823
12	Hw 100	120	45.4	60.0	153	43.5	898	898
24	Ba 40 Yc 24 Fd 20 Hw 12 Cw 04	300	29.5	100.0	3062	18.2	738	705
42	Ba 81 Hw 19	311	34.3	105.0	381	33.5	1350	1350
48	Hw 42 Fd 31 Cw 27	281	46.1	130.0	340	45.9	1521	1521
56	Hw 68 Hm 26 Fd 06	198	35.1	95.0	1089	27.8	952	952
58	Hm 37 Ba 32 Hw 16 Yc 15	211	17.8	57.6	1039	18.2	431	416
59	Cw 57 Hw 29 Fd 14	234	29.7	105.0	1166	33.3	910	910
64	Hw 67 Fd 25 Cw 08	197	55.3	120.0	557	44.1	1563	1563
66	Hw 76 Fd 14 Cw 10	104	45.5	92.8	556	46.0	1018	1018
69	Hw 62 Ba 25 Cw 13	273	41.7	64.8	323	29.8	805	805
71	Cw 80 Hw 20	.	.	67.5	226	28.8	688	688
88	Cw 65 Hw 18 Ba 12 Fd 05	480	43.7	86.1	468	46.6	887	887
92	Ba 59 Hm 31 Hw 07 Yc 03	289	30.5	117.5	901	25.2	1189	1189
96	Hw 69 Ba 31	300	46.8	69.3	171	45.6	981	981
105	Cw 44 Hw 31 Fd 25	163	.	48.0	258	25.7	439	439
107	Ba 42 Cw 33 Hw 25	286	35.7	97.2	709	27.7	1039	1039
108	Hw 91 Ba 09	384	43.7	85.1	1508	36.7	988	988
6	Cw 86 Hw 14	333	50.1	56.0	32	38.2	582	582
10	Yc 27 Hw 27 Ba 18 Fd 18 Cw 10	.	.	70.4	656	22.6	610	610
36	Ba 52 Hw 26 Yc 19 Hm 03	271	31.7	105.3	475	24.0	1133	1133
45	Hw 57 Ba 21 Cw 14 Tw 08	211	39.7	74.7	334	37.4	925	925
67	Cw 54 Hw 46	222	43.7	52.0	812	27.6	474	469
80	Ba 91 Hw 09	231	44.6	44.0	135	37.9	654	654
95	Fd 33 Yc 33 Cw 11 Ba 11 Hm 12	.	.	27.0	106	29.4	231	231
104	Ba 67 Hw 33	.	.	24.3	412	53.7	326	308
112	Cw 69 Hw 15 Ba 16	458	37.9	87.8	394	28.3	875	875
122	Ba 47 Hw 40 Cw 13	191	37.5	48.0	311	36.9	600	600
123	Cw 29 Hw 24 Yc 19 Ba 19 Fd 09	238	31.3	106.3	415	26.8	940	940

9. Appendix C: Scatterplots to find potential outliers

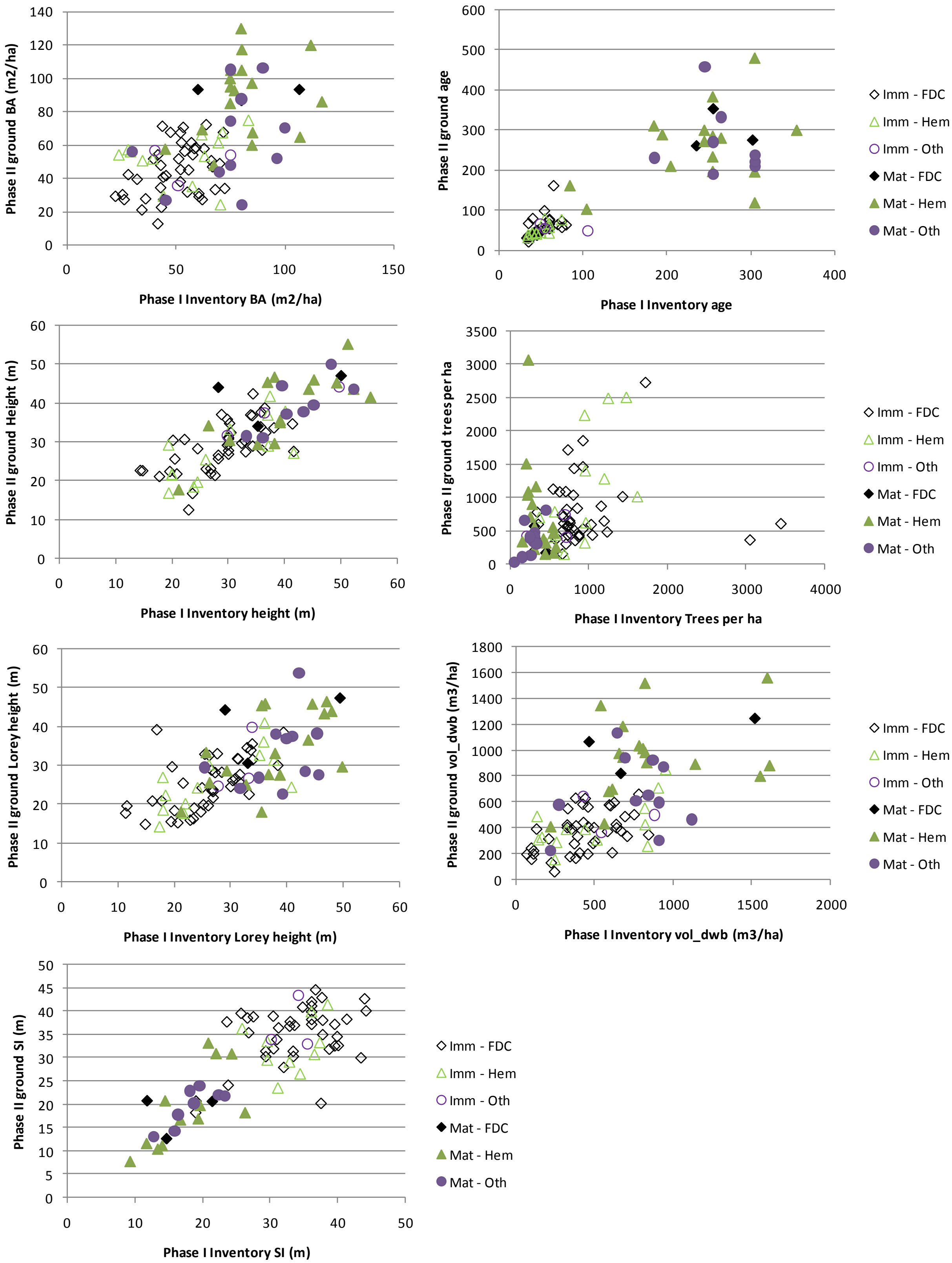

Figure 4. The Phase I inventory and Phase II Ground data are plotted for the seven attributes of interest.

10. APPENDIX D: HEIGHT AND AGE MATCHING

The current standard for Phase II ground age and height is based on the average of the T, L, X and O trees. The five possible matching cases are 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
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
Case 5: No match

Table 18. The Sp0 groupings are given.

Sp0 Code	Species	Description
AC	AC	Poplar
AT	AT	Trembling Aspen
B	B, BA, BG, BL	Fir
C	CW	Western Red Cedar
D	DR	Alder
E	E, EA, EP	Birch
F	FD	Douglas Fir
H	H, HM, HW	Hemlock
L	L, LA, LT, LW	Larch
MB	MB	Broadleaf Maple
PA	PA, PF	Whitebark & Limber Pine
PL	PJ, PL	Lodgepole & Jack Pine
PW	PW	Western White Pine
PY	PY	Yellow Pine
S	S, SB, SE, SS, SW, SX	Spruce
Y	Y	Yellow Cedar

Table 19. The results of matching the Phase I inventory and Phase II ground heights and ages.

	Phase II (ground) leading species attributes					Phase I (Inventory)				
Sample	Species @ 4cm Dbh	Mean Age[3]	Mean Height[4]	Sample size Age[5]	Sample size Height[6]	Leading species	Secondary species	Case of match	Age for match	Height for match
2	Fd	37	25.7	5	4	FD	HW	1	40	28.2
7	Hw	34	30.2	4	4	FD	HW	2	35	33.0
8	Fd	44	32.4	5	5	FD	HW	1	45	36.7
11	Hw	78	22.4	2	2	FD	HW	2	60	19.5
13	Fd	54	29.1	4	3	FD	HW	1	60	29.8
14	Fd	50	28.9	3	3	FD	HW	1	45	34.3
18	Fd	40	30.8	4	3	FD	HW	1	45	30.0
22	Fd	40	25.6	4	4	FD	HW	1	40	20.4
25	Fd	39	31.1	4	2	FD	HW	1	45	30.0
27	Fd	48	23.1	4	4	FD	HW	1	45	26.0
28	Fd	21	16.8	3	3	FD	HW	1	35	23.6
29	Fd	32	22.7	3	3	FD	HW	1	33	14.2
31	Fd	41	29.4	4	3	FD	HW	1	45	30.0

[3] Age = age_tlxo
[4] Height = ht_tlxo
[5] Sample size for age = n_age_tlxo
[6] Sample size for height = n_ht_tlxo

Sample	Phase II (ground) leading species attributes					Phase I (Inventory)				
	Species @ 4cm Dbh	Mean Age[3]	Mean Height[4]	Sample size Age[5]	Sample size Height[6]	Leading species	Secondary species	Case of match	Age for match	Height for match
32	Fd	41	27.8	4	4	FD	HW	1	45	30.0
38	Fd	49	33.6	4	4	FD	HW	1	50	38.1
39	Hw	80	37.6	2	2	FD	HW	2	40	35.8
44	Fd	67	35.8	5	5	FD	CW	1	60	29.8
51	Fd	38	21.4	3	3	FD	HW	1	45	27.6
54	Fd	54	34.7	4	4	FD	HW	1	55	30.2
60	Fd	50	37.0	3	3	FD	HW	1	45	28.8
61	Fd	162	30.4	3	3	FD	PL	1	65	20.1
65	Fd	31	21.1	4	4	FD	HW	1	35	17.7
68	Fd	34	23.2	2	2	FD	HW	1	35	26.8
70	Hw	68	21.8	5	4	FD	HW	2	35	20.8
73	Fd	58	38.7	4	3	FD	CW	1	75	36.5
74	Fd	31	22.6	4	4	FD	HW	1	33	14.7
77	Cw	36	12.6	3	3	FD	HW	3	40	22.9
78	Hw	54	36.7	1	1	FD	HW	2	55	34.3
81	Fd	49	27.4	3	3	FD	HW	1	45	33.1
82	Fd	39	26.8	3	3	FD	HW	1	45	30.0
85	Fd	48	32.4	4	4	FD	HW	1	50	30.4
86	Fd	37	21.9	4	3	FD	HW	1	35	26.8
87	Fd	75	28.2	5	5	FD	CW	1	60	24.5
90	Fd	43	30.6	5	5	FD	HW	1	45	22.2
99	Cw	74	27.6	4	4	FD	HW	3	75	41.7
102	Fd	41	26.6	5	5	FD	HW	1	40	28.2
106	Fd	58	36.9	1	1	FD	HW	1	60	34.0
114	Fd	45	29.6	3	3	FD	HW	1	42	32.4
117	Fd	64	34.6	3	2	FD	HW	1	80	41.4
118	Fd	57	42.3	2	1	FD	HW	1	50	34.4
121	Fd	100	27.9	5	5	FD	HW	1	54	36.0
124	Hw	65	33.8	4	3	FD	HW	2	70	35.8
4	Hw	40	21.7	5	5	HW	FD	1	35	19.9
15	Hw	67	38.0	4	4	HW	FD	1	60	40.2
17	Fd	46	33.4	4	3	HW	FD	2	45	30.3
20	Hw	43	25.6	5	5	HW	FD	1	40	26.0
41	Fd	45	17.1	4	3	HW	BA	3	60	19.4
47	Hw	45	18.7	3	3	HW	FD	1	40	23.8
55	Ba	42	19.9	5	5	HW	FD	3	45	24.5
63	Hw	47	37.1	4	4	HW	FD	1	50	37.1
79	Fd	45	29.4	4	4	HW	FD	2	40	19.3
93	Hw	33	21.9	2	2	HW	FD	1	35	19.9
101	Cw	77	27.3	2	1	HW	FD	3	75	41.7
110	Hw	59	29.2	2	2	HW	FD	1	60	37.1
119	Hw	80	41.9	3	3	HW	FD	1	55	37.4
23	Dr	66	31.6	3	3	DR	MB	1	50	29.9
62	Hw	55	37.4	3	3	BA	HW	2	55	36.4
111	Ss	49	44.3	2	2	DR	SS	2	105	49.6
26	Hw	275	47.2	4	3	FD	HW	2	302	50.1
52	Hw	261	44.2	2	1	FD	HW	2	235	28.3
83	Hw	354	34.2	2	1	FD	HW	2	255	35.3
12	Hw	120	45.4	3	2	HW	FD	1	305	49.3

Sample	Phase II (ground) leading species attributes					Phase I (Inventory)				
	Species @ 4cm Dbh	Mean Age[3]	Mean Height[4]	Sample size Age[5]	Sample size Height[6]	Leading species	Secondary species	Case of match	Age for match	Height for match
24	Ba	300	29.5	2	2	HW	CW	3	245	35.2
42	Ba	311	34.3	5	5	HW	BA	2	185	26.5
48	Hw	281	46.1	4	4	HW	CW	1	265	45.2
56	Hw	198	35.1	2	2	HW	BA	1	255	39.2
58	Hm	211	17.8	3	3	H	YC	1	205	21.2
59	Cw	234	29.7	3	3	HW	FD	3	255	38.2
64	Hw	197	55.3	4	3	HW	FD	1	305	51.2
66	Hw	104	45.5	5	4	HW	FD	1	105	37.0
69	Hw	273	41.7	3	2	HW	BA	1	245	55.3
71	Cw					HW	CW	2		
88	Cw	480	43.7	1	1	HW	BA	3	305	52.2
92	Ba	289	30.5	5	5	HW	BA	2	195	30.2
96	Hw	300	46.8	2	1	HW	CW	1	355	38.2
105	Cw	163		2	0	HW	BA	3	85	
107	Ba	286	35.7	1	1	HW	CW	3	255	39.2
108	Hw	384	43.7	5	5	HW	CW	1	255	44.3
6	Cw	333	50.1	1	1	CW	HW	1	265	48.3
10	Yc					CW	HW	3		
36	Ba	271	31.7	2	1	BA	HW	1	255	33.3
45	Hw	211	39.7	3	3	BA	HW	2	305	45.2
67	Cw	222	43.7	1	1	CW	HW	1	305	52.2
80	Ba	231	44.6	2	2	BA	HW	1	185	39.5
95	Fd					CW	HW	3		
104	Ba					BA	CW	1		
112	Cw	458	37.9	1	1	BA	HW	3	245	43.3
122	Ba	191	37.5	2	2	BA	HW	1	255	40.4
123	Cw	238	31.3	3	1	CW	HW	1	305	36.2

11. Appendix E: Scatterplots and residuals

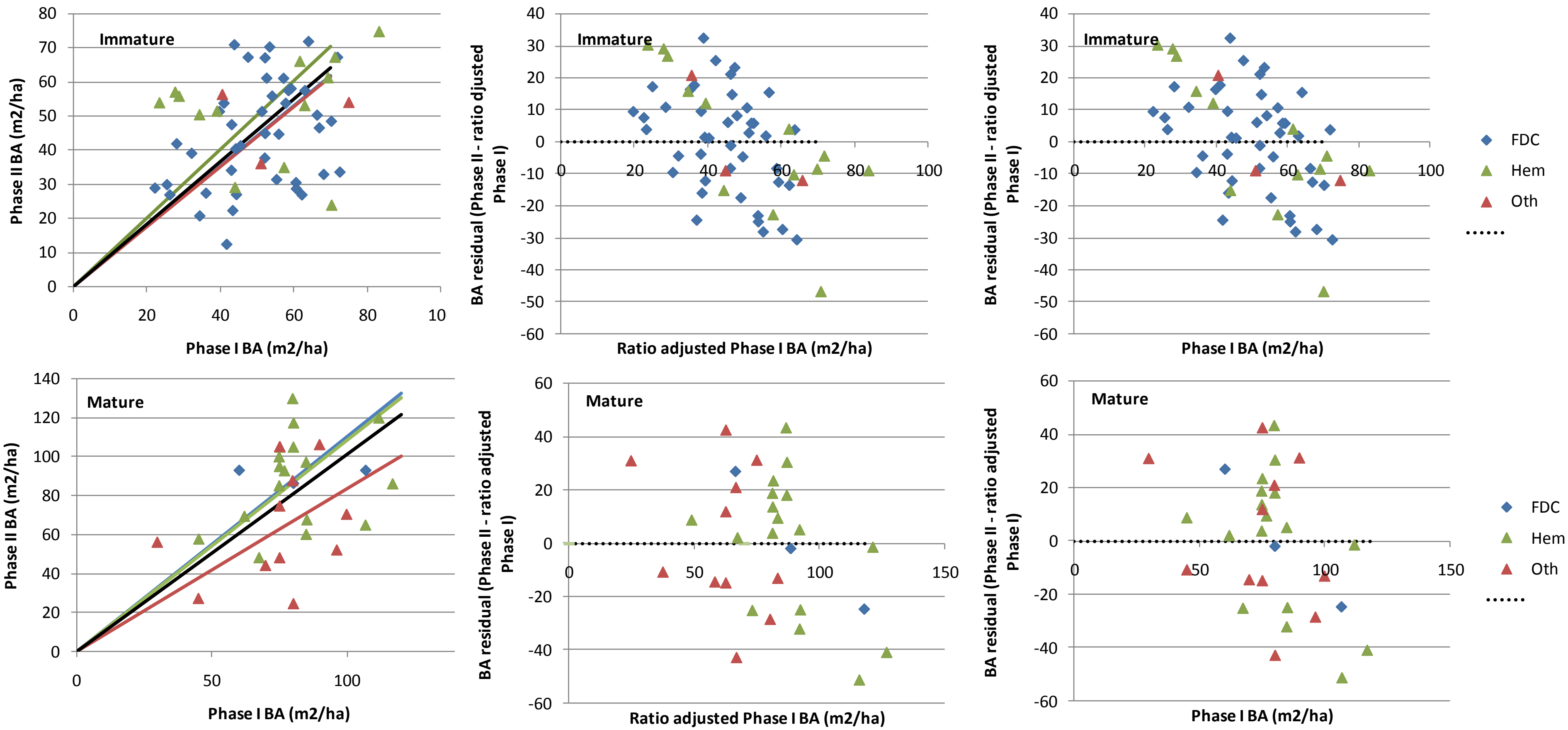

Figure 5. The scatterplots for BA are given (Dbh ≥ 7.5cm). The top left graph gives the Phase I photo and Phase II ground estimates of basal area for the immature stratum with lines representing the ratios by leading species. The black line is the stratum ratio (all leading species combined). The top middle graph plots the residuals against the adjusted Phase I BA. The top right graph plots the residuals against the Phase I BA. Ideally the residuals would be scattered uniformly around the x-axis. The slight downward trend is not uncommon and may indicate the need for a regression estimator rather than a ratio (i.e., the need for an intercept). The bottom graphs are similar but are for the mature stratum.

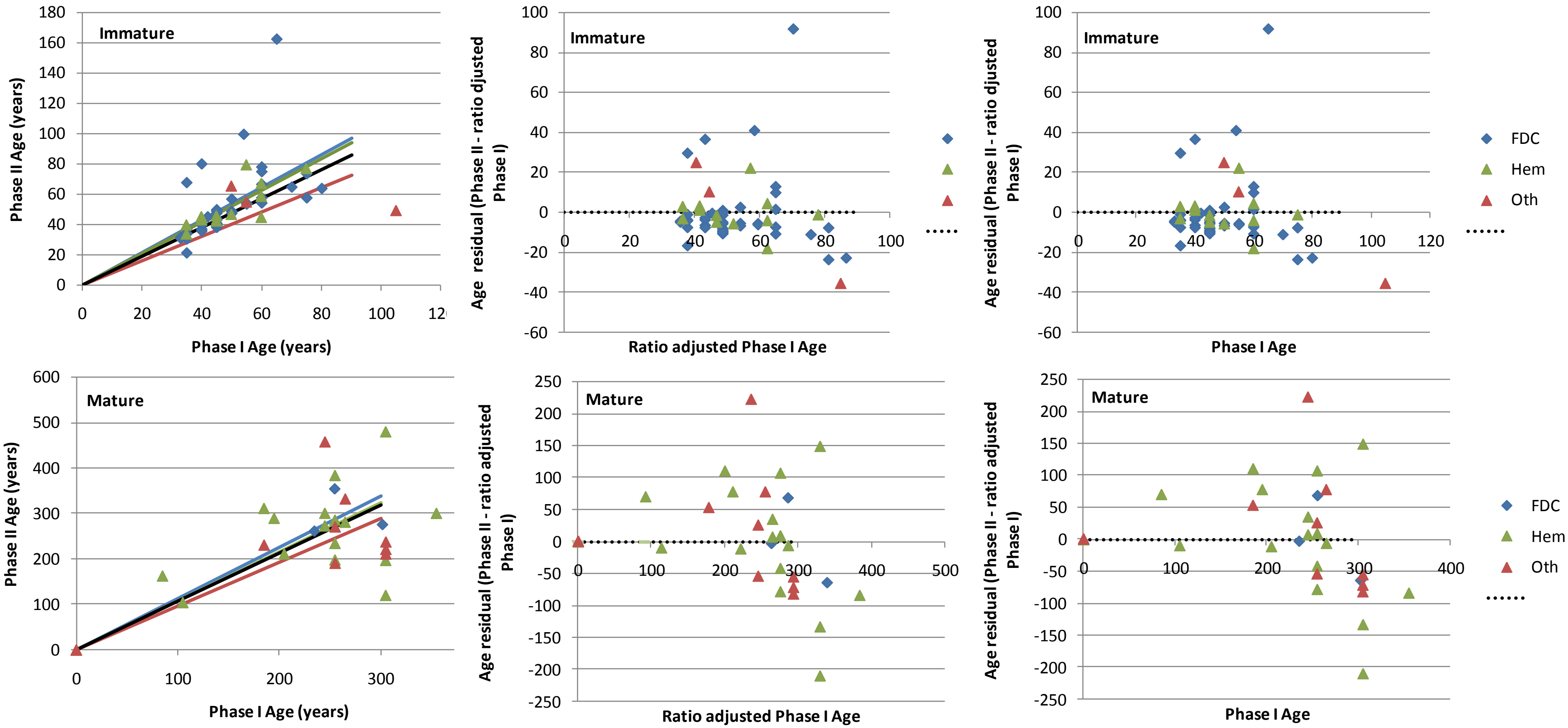

Figure 6. The scatterplots for Age are given (Dbh ≥ 7.5cm).

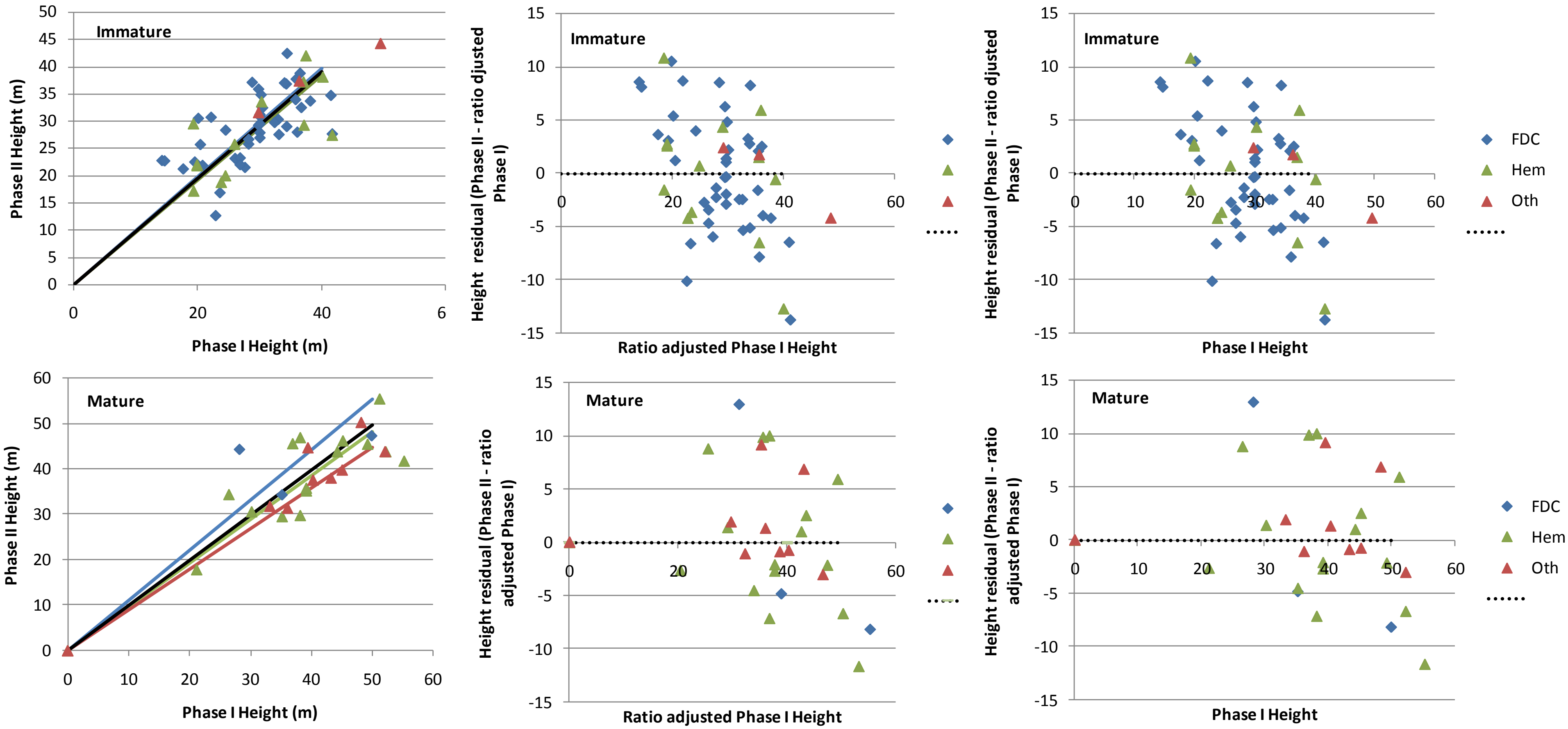

Figure 7. The scatterplots for Height are given (Dbh ≥ 7.5cm).

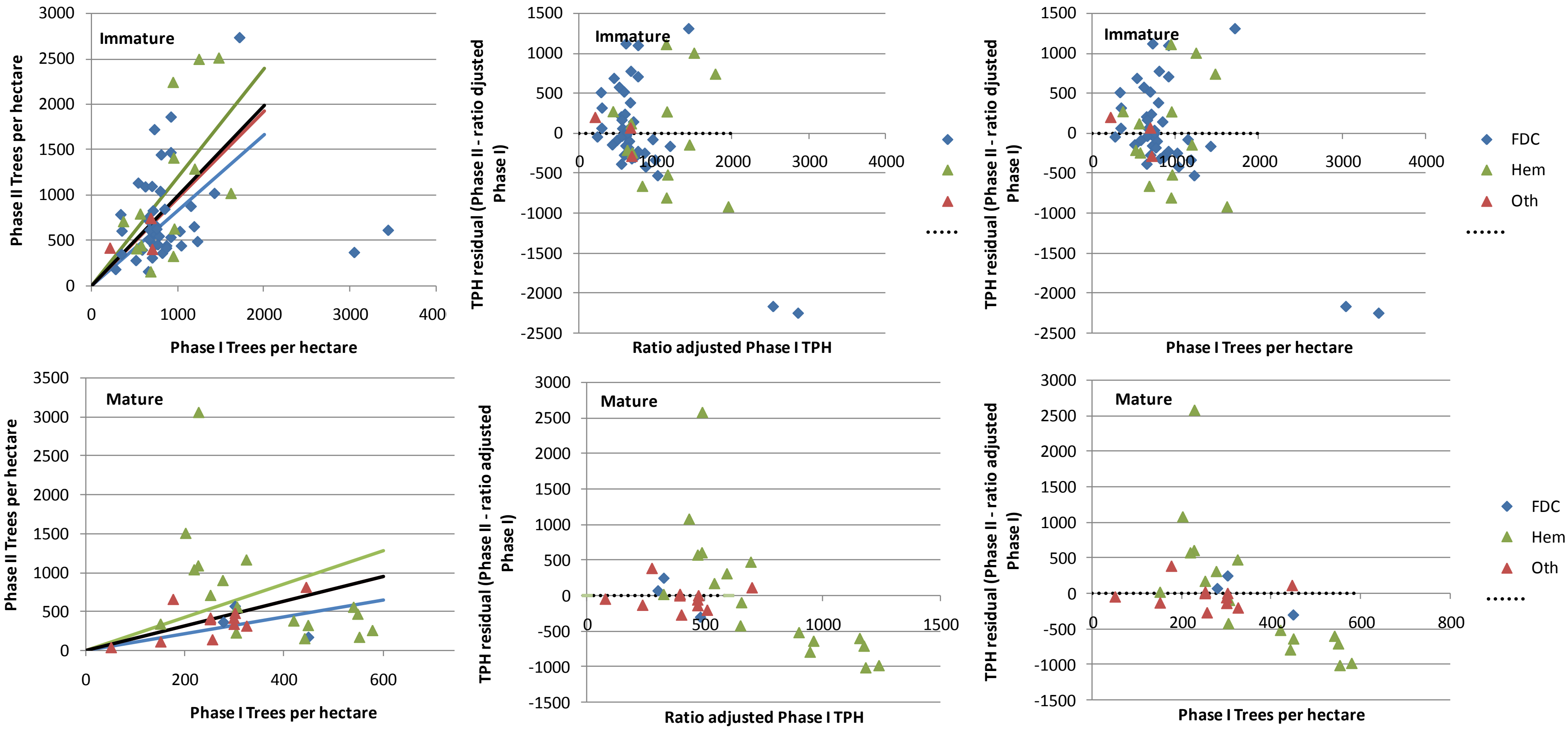

Figure 8. The scatterplots for Trees/ha are given (Dbh ≥ 7.5cm).

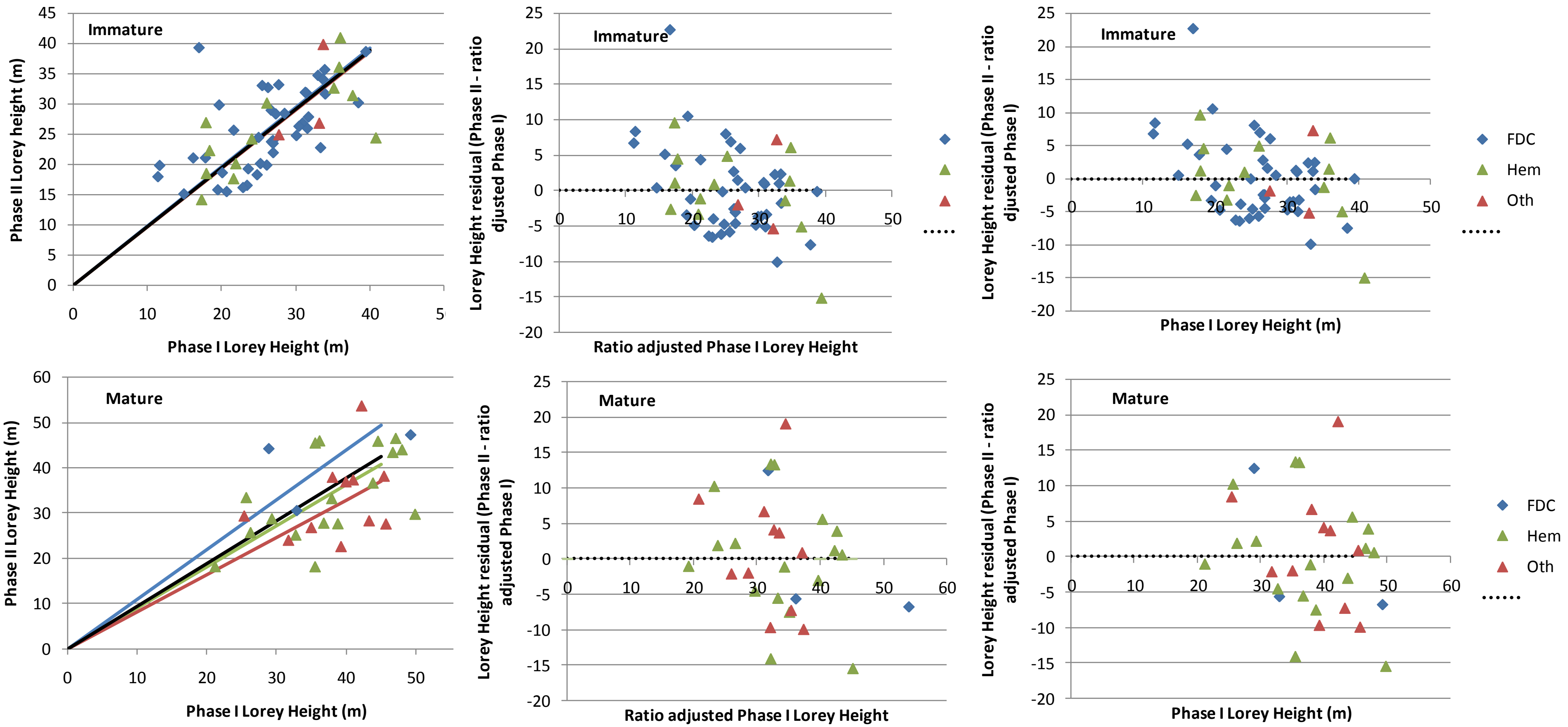

Figure 9. The scatterplots for Lorey height are given (Dbh ≥ 7.5cm).

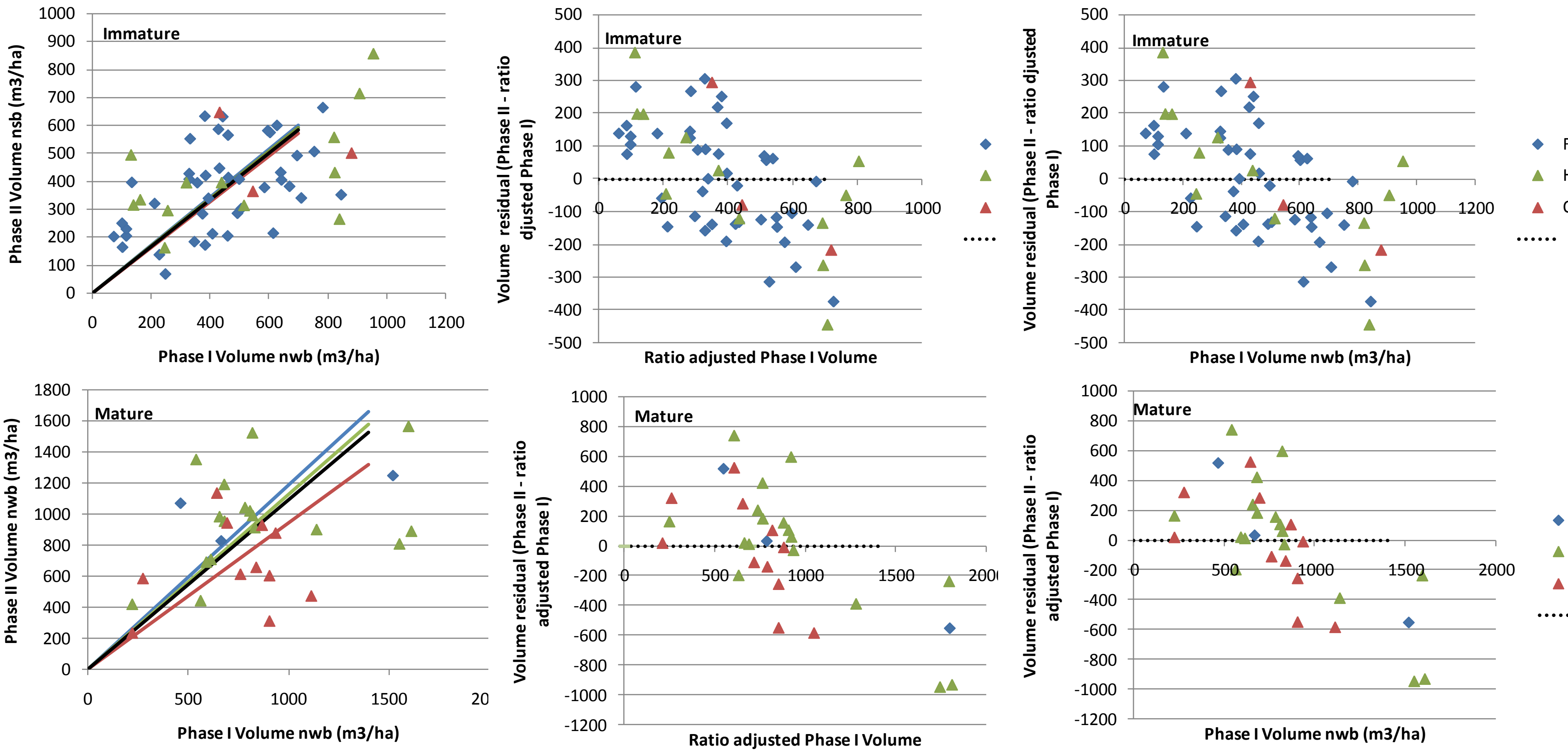

Figure 10. The scatterplots for Volume net of decay waste and breakage are given (Dbh ≥ 12.5cm).

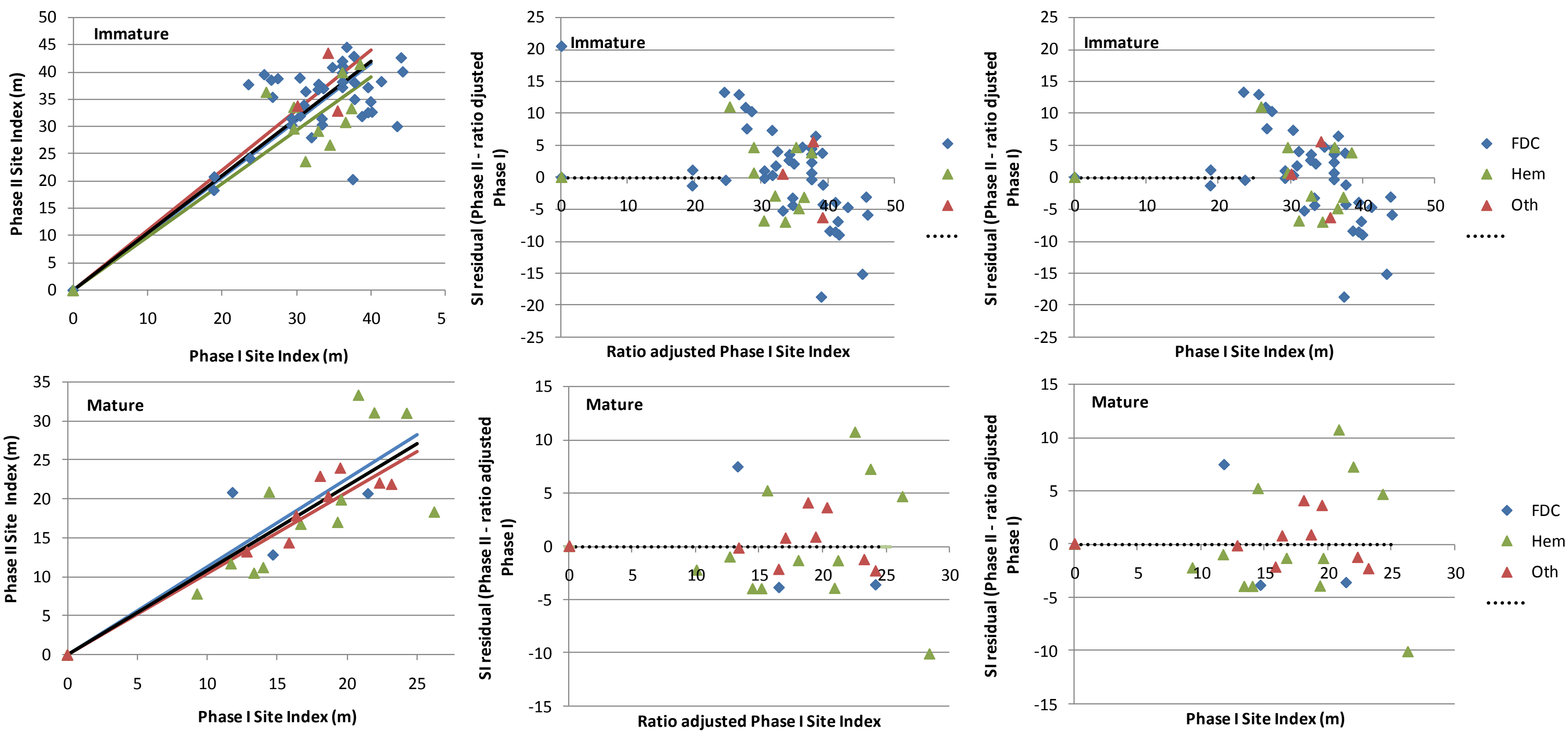

Figure 11. The scatterplots for Site index are given.

12. Appendix F: Scatterplots of total volume bias, model bias and attribute bias.

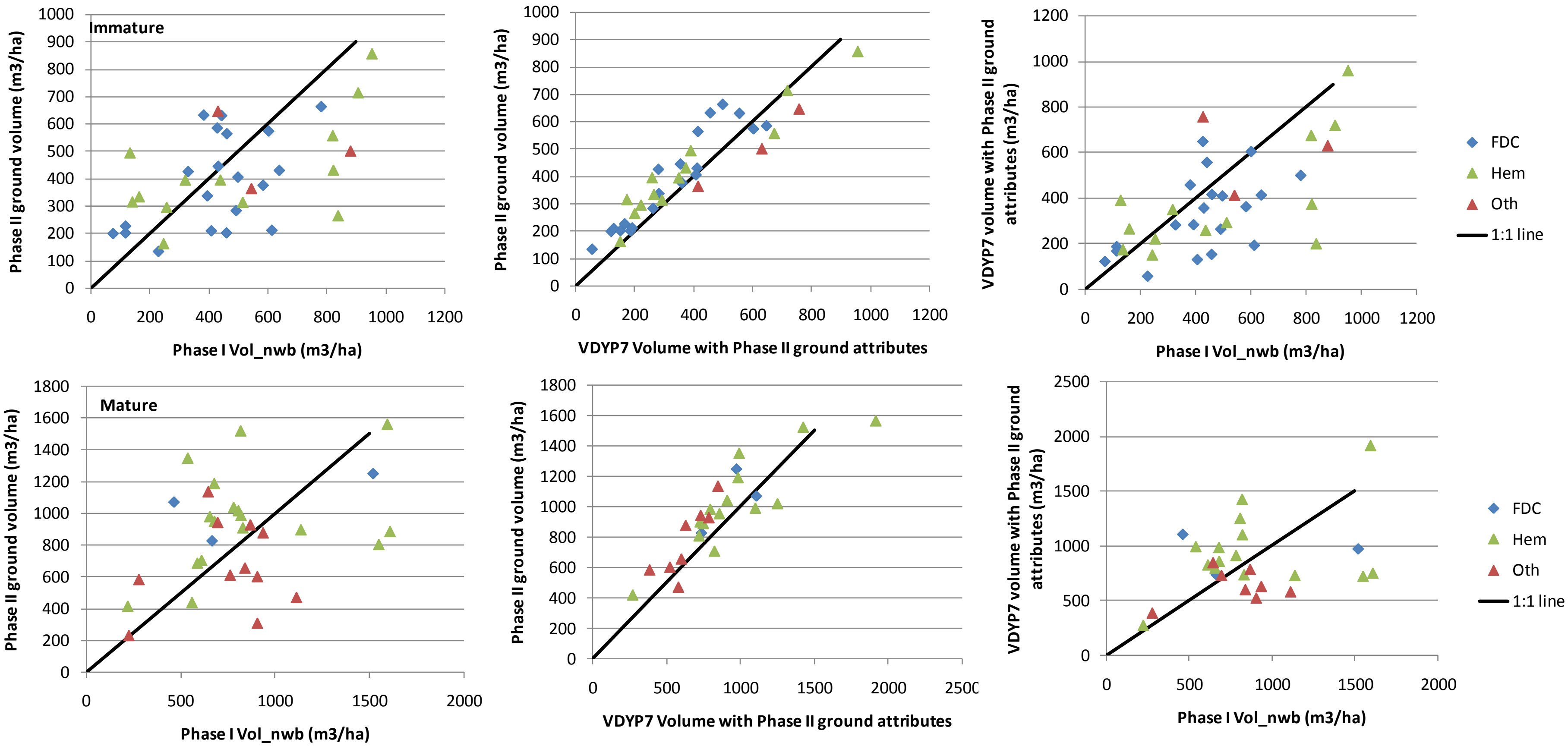

Figure 12. The left column of graphs illustrates the total volume error (Phase I vs. Phase II volume, Dbh ≥ 12.5cm). There are two potential sources of volume error in Phase I. First, the attributes fed into VDYP7 could be incorrect (attributed-related volume error). Second, the volume estimation routines in VDYP7 could be biased (model-related volume error). Total volume error = attribute-related volume error + model-related volume error. The centre column of graphs illustrates model-related volume error (VDYP7 volume using Phase II inputs vs. Phase II volume). The points are generally above the line indicating a positive bias. The points are generally clustered tightly around the line indicating a small sampling error. The right column of graphs illustrates the attribute-related volume error (Phase I volume vs. VDYP7 volume using Phase II inputs). The attribute-related volume error dominates the total volume error indicating that most of the differences in volume between Phase I and Phase II are due to differences in the input values to VDYP7.