Kamloops TSA

Documentation of

Vegetation Resources Inventory Analysis

Prepared For:
Forest Analysis and Inventory Branch
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Executive Summary

The objective of this project was to assess the accuracy of the Phase I inventory of the Kamloops TSA by completing a VRI statistical analysis of selected Phase I inventory attributes in the target population of interest. The analysis was based on current standards.

Table 1. The sample size (N), mean, ratio of means (Phase II Ground/Phase I Inventory) and standard error of the ratio expressed as a percent of the ratio (SE of ratio (%)) are given by strata and attribute for the Kamloops TSA. Only Ratios that differ from 1.0 by more than 10% are shaded.

		Stratum				
Attribute	Statistic	Balsam	Fd	Other	Spruce	All
Leading species age (years)	N	13	29	13	17	72
	Mean Phase II Ground	141	127	122	138	131
	Mean Phase I inventory	153	125	151	156	142
	Ratio (Phase II/Phase I)	0.921	1.018	0.806	0.883	0.926
	SE of Ratio (%)	(19.4%)	(14.7%)	(24.6%)	(15.4%)	(9.2%)
Leading species height (m)	N	13	29	13	17	72
	Mean Phase II Ground	19.7	21.1	22.0	23.9	21.7
	Mean Phase I inventory	19.0	23.6	25.0	27.2	23.8
	Ratio (Phase II/Phase I)	1.036	0.897	0.880	0.880	0.909
	SE of Ratio (%)	(17.1%)	(7.3%)	(10.6%)	(7.6%)	(5%)
Basal area (m^2/ha) 7.5 cm+	N	13	29	13	17	72
	Mean Phase II Ground	28.8	27.7	38.0	30.9	30.3
	Mean Phase I inventory	22.9	26.5	38.8	32.6	29.3
	Ratio (Phase II/Phase I)	1.256	1.043	0.979	0.949	1.034
	SE of Ratio (%)	(40.9%)	(21.5%)	(16.6%)	(20.9%)	(12.1%)
Trees/ha 7.5 cm+	N	13	29	13	17	72
	Mean Phase II Ground	940	953	984	779	914
	Mean Phase I inventory	309	332	364	345	336
	Ratio (Phase II/Phase I)	3.045	2.873	2.706	2.255	2.720
	SE of Ratio (%)	(69.7%)	(32.4%)	(40.7%)	(40.6%)	(21.9%)
Lorey height (m)	N	12	29	13	17	71
	Mean Phase II Ground	17.1	19.3	19.8	19.7	19.1
	Mean Phase I inventory	19.4	21.3	24.3	23.9	22.1
	Ratio (Phase II/Phase I)	0.885	0.906	0.813	0.825	0.865
	SE of Ratio (%)	(18.5%)	(10.3%)	(15.7%)	(9.9%)	(6.5%)
Volume Net dwb (m^3/ha) 12.5 cm+	N	13	29	13	17	72
	Mean Phase II Ground	182	164	227	220	191
	Mean Phase I inventory	135	176	247	247	197
	Ratio (Phase II/Phase I)	1.353	0.930	0.919	0.889	0.967
	SE of Ratio (%)	(33.3%)	(23.7%)	(22.9%)	(21.9%)	(12.9%)
Leading species Site index (m)	N	13	29	13	17	72
	Mean Phase II Ground	11.0	14.5	14.5	13.5	13.6
	Mean Phase I inventory	9.3	14.9	14.7	14.7	13.8
	Ratio (Phase II/Phase I)	1.192	0.976	0.986	0.919	0.990
	SE of Ratio (%)	(15.2%)	(10.9%)	(14.7%)	(12.8%)	(6.8%)
Site index (m)	N	10	26	11	15	62
	Mean Phase II Ground	11.2	14.1	14.6	13.3	13.5
	Mean Site prod layer	15.3	17.7	18.1	18.4	17.6
	Ratio (Phase II/site)	0.730	0.798	0.803	0.724	0.770
	SE of Ratio (%)	(12.4%)	(7.5%)	(14.3%)	(13.5%)	(5.7%)

The results for the main inventory attributes – basal area, height and volume – are good and within 10% of the ground mean at the population level. Trees per hectare is significantly underestimated but this has little effect on volume and is likely due to the photo interpreters basing their estimates on the larger trees. The site index (SI) estimates from the Provincial Site Productivity Layer (PSPL) are significantly higher than the ground or Phase I inventory estimates. The PSPL SI estimates potential site productivity and the actual site productivity, particularly of the unmanaged forest in the volume audit population, is expected to be lower.

Acknowledgements

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Table of Contents

1. Introduction

This report documents the statistical analysis of the Vegetation Resources Inventory (VRI) for the Kamloops Timber Supply Area (TSA).

1.1 Scope and Objectives

This project has two main objectives:

- Perform a VDYP7-based VRI analysis for the Kamloops TSA, based on current standards (FAIB 2011) for the Volume Audit (mature) population using 72 ground samples (71 VRI Phase 2 samples and one CMI sample), and
- Analyze the 100 air calls in terms of species composition and associated VRI polygon attributes.

This report addresses the first objective. The second objective is addressed in a separate report. Both reports are available from FAIB at: http://www.for.gov.bc.ca/hts/vri/planning_reports/tsa_analysis.html.

Dead layer information was interpreted for most of the Kamloops TSA, but was not available in a compiled form at the time of this analysis.

2. Background

The ground sampling plan for the Kamloops TSA is documented in "Kamloops Timber Supply Area TSA 11 – Vegetation resources inventory project implementation plan Including Volume Audit Sampling and Air Calls" (Nona Phillips Forestry Consulting 2014a) available from the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO).

2.1 Description of the Target Population Area

The description of the target population is taken from Nona Phillips Forestry Consulting (2014a). The Kamloops TSA covers almost 2.7 million ha (Table 2) and is located in south central British Columbia (Figure 1). The TSA boundary coincides with the Thompson Rivers Forest District boundary, administered from the Ministry of Forests, Lands and Natural Resource Operations' office in Kamloops. It is part of the Thompson/Okanagan Region.

The TSA ranges from Logan Lake in the south to Wells Gray Park in the northwest, including the Blue River area, and is bounded by the Columbia mountains to the east and the Cariboo Regional District to the west.

The topography of the Kamloops TSA is diverse, ranging from hot, dry grasslands in the valley bottoms in the south to wet rugged mountains in the north. It is bisected by the North Thompson River which joins the South Thompson River at Kamloops.

The dominant Biogeoclimatic (BEC) zones in the TSA include Interior Douglas-Fir (IDF) and Engelmann Spruce-Subalpine Fir (ESSF), followed by Interior Cedar-Hemlock (ICH) and Montane Spruce (MS). A recently completed Phase 1 inventory for the TSA shows the dominant species in stands greater than 50 years in the Timber Harvesting Land Base (THLB) are Douglas fir, spruce, balsam and pine.

Table 2. A summary of the land base (taken from Nona Phillips Forestry Consulting 2014a).

Land Classification	Area (ha)	% of TSA
Total TSA Area	**2,655,823**	**100.0%**
Net-downs	**836,432**	**31.5%**
Parks	624,691	23.5%
Private	177,715	6.7%
Federal	34,026	1.3%
Net Area	**1,819,391**	**68.5%**
Non-Vegetated	114,142	4.3%
Vegetated	1,705,249	64.2%

Land Classification	Area (ha)	% of TSA
Non-Treed	238,900	9.0%
Treed	1,466,349	55.2%

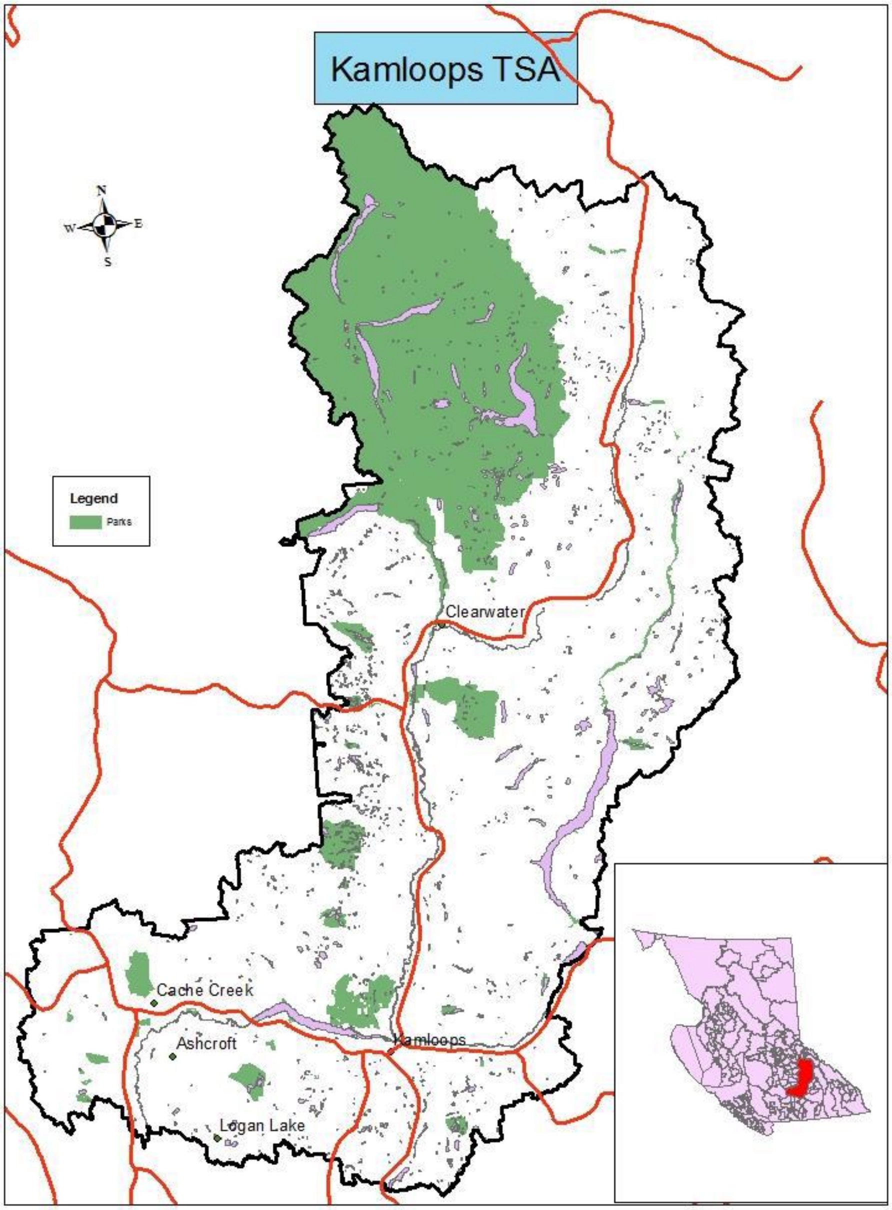

Figure 1. The location of the Kamloops TSA (from Nona Philips Forestry Consulting 2014a).

The ground sample locations are given in Figure 2.

The majority of the Kamloops TSA inventory is a VRI standard inventory with photography flown in the 2011 field season. The inventory for some of the parks is considerably older.

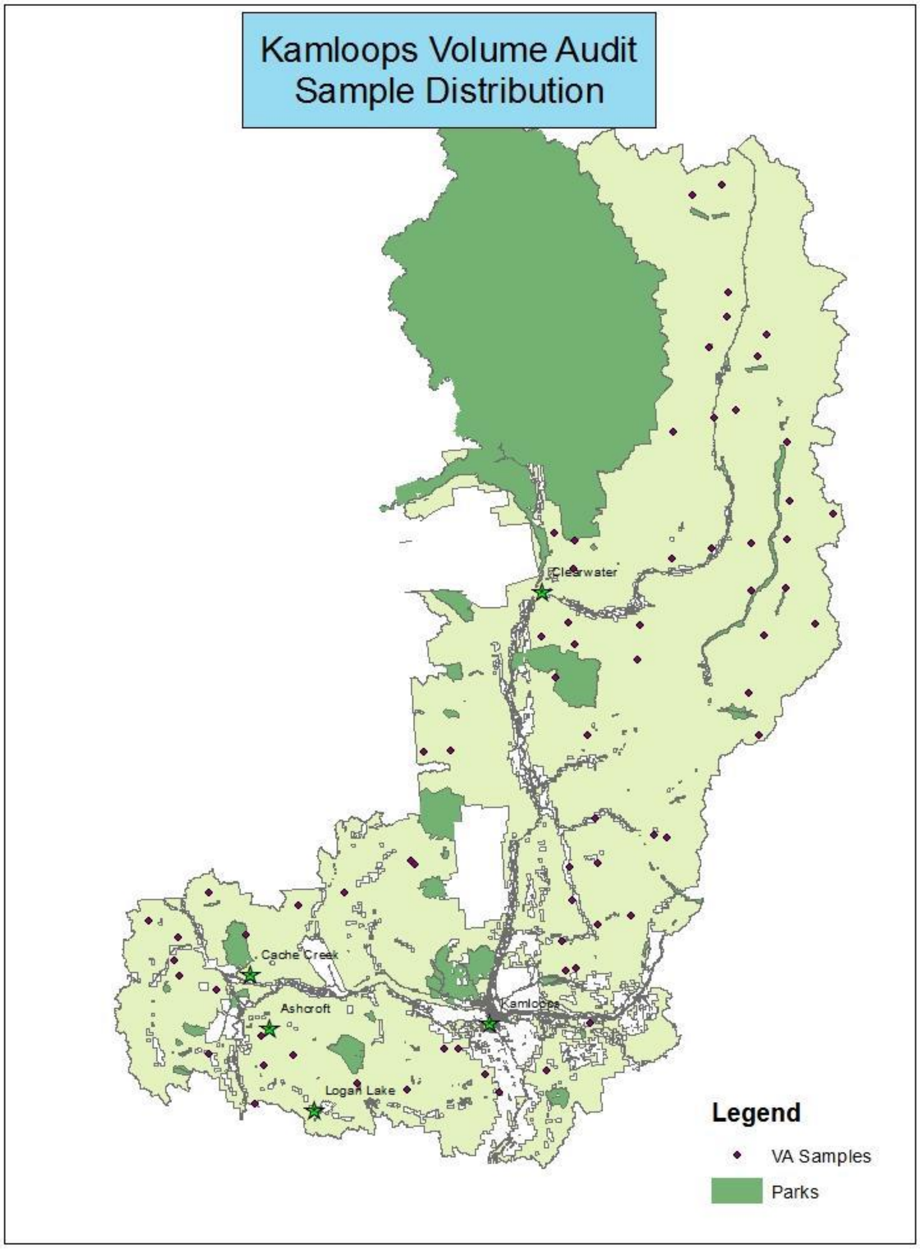

Figure 2. The locations of the Volume audit ground samples within the Kamloops East TSA are given (from Nona Philips Forestry Consulting 2014a).

The Vegetation Resources Inventory (VRI) project implementation plan (VPIP) for the Kamloops TSA identified two separate populations of interest for Phase II ground sampling:

1 Volume audit sampling occurred in stands aged 51 years and older.

2 The Air Call project population includes stands age 31 years and older.

The target population is the Vegetated Treed (VT) land base. Private land, parks and federal Lands (military reserves and Indian reserves) are excluded from the Volume Audit population. Community Forests and Woodlots have been retained.

The areas by inventory leading species for the Volume Audit population are given in Table 3.

Table 3. Kamloops TSA Volume Audit (Vegetated Treed, Age 51+) population is summarized by leading species. From Nona Phillips Forestry Consulting 2014a.

Inventory Leading Species	Area (ha)	% of Volume audit population
FD	484,012	42.2%
SX	262,084	22.8%
B	209,997	18.3%
P	72,081	6.3%
HW	49,944	4.4%
CW	35,244	3.1%
AT	22,799	2.0%
EP	11,855	1.0%
XC	14	0.0%
XH	10	0.0%
JR	3	0.0%
Total	1,148,043	100.0%

3. Data Sources

3.1 Phase I photo-interpreted inventory data

The Phase I data, projected to January 1, 2014, were provided. Ground sampling was completed in 2014, so the Phase I data for age, height and volume were used directly in the analysis. Lorey height (LH) at the 7.5cm+ DBH utilization was not provided in the Phase I file and was generated using VDYP7 Console version 7.10c.41. The Phase I data for the ground sampled polygons are given in Appendix A.

The Volume audit population is a VRI standard inventory based on photography flown from 2011 (Nona Phillips Forestry Consulting 2014a).

Generally, the Phase I inventory tree data come originally from photo interpretation, updated to the year of ground sampling. Volumes are estimated using VDYP7. Outputs from VDYP7 have a utilization level specified by the user – usually 7.5 cm for most attributes and 12.5 cm for volume. For stands less than 7m tall, VDYP will project the age and height until the height is 7m and then generate the remaining attributes. Until the projected height is 7m, the other attributes are not altered and the utilization limit is unchanged from the original data collection. This occurred in one ground sampled polygon (Table 4). The Dbhq calculated from BA and TPH is less than the utilization level 7.5 cm.

Table 4. One sample is given where the projected height is less than 7m. It appears only height and age have been projected. The calculated quadratic mean Dbh is less than the anticipated lower limit of 7.5 cm.

Sample	SI (m)	BA (m^2/ha)	Stems/ha	Projected Age (years)	Projected Ht (m)	Calculated Dbhq (cm)
47	5.3	1	550	54	3.3	4.8

The analysis here uses the VDYP7 projected inventory which may not be appropriate for stands less than 7m in height. This issue is expected to have little impact in the volume audit population.

The population, projected to 2014, was provided by the FAIB. This includes the projected primary layer but does not include projection of the residual layer.

For the ground sample polygons, the projected inventory was available (primary layer). The VDYP input files were also provided. This allowed projection of the residual layer for the ground sampled polygons. The projected height and age of the secondary species was not provided. Age was projected to the sample year. Height was projected using SiteTools.

3.2 Ground sample data

The ground sample data come from two sources - VRI ground samples and CMI samples. The compiled ground sample attributes are given in Appendix B. There were no substitutions or movements of plots.

In some cases, the ground sample had a different BEC zone than the zone assigned to the polygon. For instance, the CMI plot was in the ESSF BEC zone. The polygon contains a BEC zone boundary with most of the polygon falling in the ICH and the rest in the ESSF. The BEC zone is used by VDYP7 in projecting the inventory. In consultation with the MFLNRO, the decision was made to use the polygon BEC for both the polygon and the ground sample. Part of the justification is that the polygon BEC influencing the plot.

3.2.1 VRI ground samples

Nona Phillips Forestry Consulting Ltd. (2014a) documented the selection of the ground samples for the Kamloops TSA. One additional plot (sample 96) was established in the “Other” strata, basal area strata 1 One CMI plot (sample 86) was established in the population and falls within the Spruce strata.

The Phase II data were compiled by MFLNRO.

The Phase II site index (SI) value for each sample was computed as the average site index (SI) of the trees with suit_ht=”Y” and suit_tr=”Y” and of the leading species in the “trees_h” file.

3.3Phase II Sample Selection Pre-Stratification and Weights

The Volume Audit population was pre-stratified by leading species and further stratified by basal area classes to ensure adequate representation of the samples across the target population. Polygons were selected with Probability Proportional to Size (polygon area) With Replacement (PPSWR).

The original Sample weights (Table 5) were taken from *“Kamloops TSA Sample Selection Report”* (Nona Phillips Forestry Consulting 2014a). The combined sample weights were calculated as described in section 4.2 and used in the analysis.

Table 5. The sample weights for the Kamloops TSA are given. The combined sample weights are discussed in section 4.2.

						Planned		Actual	
Strata	Strata	Basal area strata	Basal area Criteria (m^2/ha)	Area (A) (ha)	Area %	n	Weight (hectares represented by each sample) = A/n	n	Combined sample weights
Volume audit (mature)	Douglas-fir (Fd)	1	0-16	148,981	31%	9	16,553	9	16,324
		2	17-30	159,047	33%	10	15,905	10	15,684
		3	31+	175,985	36%	10	17,599	10	17,354
		Total		484,013	100%	29		29	
	Spruce (S)	1	0-20	65,517	25%	4	16,379	4	16,152
		2	23-36	87,741	33%	5	17,548	5	17,304
		3	37+	108,827	42%	7	15,547	7	15,331
		Total		262,085	100%	16		16	
	Balsam (B)	1	0-14	50,878	24%	3	16,959	3	16,724
		2	15-29	66,438	32%	4	16,610	4	16,379
		3	30+	92,682	44%	6	15,447	6	15,232
		Total		209,998	100%	13		13	
	Other (O)	1	0-15	51,619	27%	4	12,905	4	12,726
		2	16-38	55,944	29%	4	13,986	4	13,792
		3	39+	84,387	44%	5	16,877	5	16,643
		Total		191,950	100%	12		13	
	Total			1,148,046		70		71	
CMI		Total		1,148,046	100%	1	1,148,046	1	15,945

4. METHODS

4.1 Overview of VRI Sample Data Analysis

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

1 Project the inventory attributes using VDYP7 in accordance with the most recent Ministry standards and procedures.
2 Identify any outliers and data issues with the Phase I and Phase II data files supplied by the Ministry.
3 Identify analysis strata in consultation with Ministry staff.
4 Calculate sample selection probability weights.
5 Compute ratio of means and related statistics for each stratum for both the mature and immature population and the overall unit for the attributes of interest. These ratios of means form the basis of the inventory assessment. The sampling errors for these ratios can be used to assess the risk and uncertainty associated with the sampling process.
6 Produce an analysis of the comparison of leading species.
7 Provide separate tables, graphs and ratios for all key attributes for the immature and the mature components.

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

- Age of the leading species (AGE_PROJ_1),
- Height of the leading species (HEIGHT_PROJ_1),
- Basal area at 7.5cm+ DBH utilization (BASAL_AREA),
- Trees per hectare at 7.5cm+ DBH utilization (VRI_LIVE_STEMS_PER_HA),
- Lorey height1 (LH) at 7.5cm+ DBH utilization (LH7.5, generated by VDYP7),
- Volume net top, stump (CU), decay, waste and breakage at 12.5cm+ DBH utilization (LIVE_STAND_VOLUME_125), and
- Site index (SITE_INDEX).

For the Kamloops TSA, two data sources are available – the 71 VRI Phase II samples and 1 CMI sample. These were combined as described in section 4.2.

4.2 Combining data

Ott (2013[1]) described combining data from different sources, using an example very similar to the current situation. In this case, the data sources to be combined are the volume audit and CMI plots. These all sample the same population (vegetated-treed polygons with age > 50). The volume audit sample was selected with probability proportional to polygon size resulting in the weights given in Table 5. The CMI is grid-based so the weight for each sample is the population area divided by the sample size. Ott's procedure was used to calculate new weights (Table 5). Essentially, each weight was scaled by the data source sample size divided by the total sample size. The resulting weights are relatively constant across strata and data sources. This is reassuring since both sampling designs were based on the premise that each hectare in the population had an equal probability of being sampled.

4.3 Data issues related to the statistical adjustment

Scatterplots comparing the Phase I and Phase II attributes were examined for potential outliers (Figure 4). Large differences between the ground sample and photo-based estimates, particularly for basal area, tree/ha and volume, were noted for a number of samples.

[1] Ott, P. Combining samples from two (or more) sampling designs – a saimple example using both VRI ground and 20km grid-samples. B.C. FAIB.memo dated Nov 11, 2013. 3p.

Sample 52 had a number of issues. The projected leading species (BL) was taken from the R1 layer while the projected attributes (BA, TPH, etc.) were taken from the RS layer. The R1 layer appeared to be the primary layer (RS_BASAL_AREA = 1 m^2/ha compared to R1_BASAL_AREA = 17 m^2/ha). This polygon was projected manually with the R1 layer as the primary layer.

The Phase II age for sample 64 is almost three times the Phase I age. The Phase II age is based on two trees. The other three cedar trees that were cored were rotten.

Sample 35 has a much higher Phase I volume than Phase II due to more BA and taller trees. Sample 15 has more Phase II volume due to more Phase II BA.

Sample 1 has 3,110 stems/ha in Phase II and 89 stems/ha in Phase I (Figure 4). This illustrates an issue that occurs for most attributes but is most acute for TPH. When the Phase I attributes are projected by VDYP, the original photo attributes are assumed to be at the 7.5 cm utilization. For the volume audit population, it is likely the photo attributes are based on the larger, older trees and small trees are not included. For Sample 1, the ground TPH at the 12.5 cm utilization is 152 trees/ha (much closer to the Phase I estimate) compared to the 3,110 at the 7.5 cm utilization.

Sample 5 has a much higher Phase II SI due in part to using Pw as the leading species (see Table 6).

Two samples (Table 6) had a tie for leading species based on the ground basal area at the 7.5 cm utilization level. The ground compiler determines the leading species using BA at the 4.0 cm utilization level and, in the case of ties, using Dbh. For sample 31, the ground compiler leading species was FD and for sample 5 the leading species was PW.

For sample 31, the ground crews did not sample the leading species (FD) for age and height. The Phase I leading species is SE. The ground leading species for sample 31 was manually set to SX.

For sample 5, using PW as the leading species leads to a relatively high SI estimate (Figure 4).

Table 6. Two samples with ties for leading species (in terms of basal area) at the 7.5 cm utilization are given. Both plots have dead PL trees but no live PL trees.

Sample	Util (cm)	species	vha_wsv (m^3/ha)	BA (m^2/ha)	Stems/ha	QMD (cm)	AGET_TLS (years)	HT_TLS (m)	SI_M_TLS (m)
31	4.0	BL	4.2	1.8	786	5.4			
31	4.0	FD	22.6	3.6	20	47.7			
31	4.0	PL	0	0	0	0			
31	4.0	SX	38.0	3.6	20	47.4	126.5	27.4	15.1
31	7.5	BL	0	0	0	0			
31	7.5	FD	22.6	3.6	20	47.7			
31	7.5	PL	0	0	0	0			
31	7.5	SX	38.0	3.6	20	47.4	126.5	27.4	15.1
5	4.0	CW	11.4	2	93	16.6			
5	4.0	HW	3.9	1	50	15.9			
5	4.0	PL	0	0	0	0			
5	4.0	PW	24.6	5	599	10.3	24.5	11.6	31.1
5	4.0	SX	24.5	4	143	18.9	57.5	10.3	11.7
5	7.5	CW	11.4	2	93	16.6			
5	7.5	HW	3.9	1	50.4	15.9			
5	7.5	PL	0	0	0	0			
5	7.5	PW	20.9	4	297	13.1	24.5	11.6	31.1
5	7.5	SX	24.5	4	143	18.9	57.5	10.3	11.7

4.4 Phase I Inventory – primary and combined L1 and L2 layers

Polygons in the Phase I Inventory can have one or two layers (L1 and L2). One of these is designated the primary, or R1, layer. Typically in VRI analysis, the ground plot summaries are compared to the Phase I Inventory summary for the primary layer. However, the ground plot data are not separated into layers. The analysis here includes the comparison of ground to Phase I inventory primary layer (the usual analysis) but the scope was expanded to include a comparison of ground to Phase I inventory combined L1 & L2 layers for volume and basal area.

Five of the 72 ground samples (4, 9, 48, 52, and 62) had two layers identified (Table 7).

Table 7. The Phase I (unprojected) data for the ground sampled polygons with two layers are given. R1 is generally considered the primary layer and RS is generally considered the residual layer. For sample 52, RS was designated the primary layer in the original projected inventory. R1 was designated the primary layer for this analysis.

	R1							RS						
Sample	CC	Spp1	Pct1	Age1	Ht1	BA	TPH	CC	Spp1	Pct1	Age1	Ht1	BA	TPH
4	15	FDI	100	70	9	5	300	10	FDI	100	160	25	5	100
9	25	FDI	100	40	10	10	280	10	FDI	100	150	19	8	120
48	20	BL	90	51	3	1	550	10	BL	55	125	10	1	75
52	55	BL	85	60	16	17	850	2	SE	100	185	28	1	15
62	60	EP	97	70	20	30	600	1	FDI	100	135	27	1	20

The Phase I inventory layers were combined using the protocol in section 12.7 of the photo interpretation procedures (FAIB 2014).

- Volume – the L1 and L2 volumes were summed.
- Basal area – the L1 and L2 basal areas were summed.

Two subsets of the inventory were used - ground sample and population. For both subsets, the primary layer was summarized as well as the sum of the L1 and L2 layers. The subsets are described in 0. Note the strata for the combined layers were based on the primary layer. In some cases, the combined age or species composition would have led to assignment to a different stratum.

As noted in section 3.1, the projected residual layer was only available for the sampled polygons.

Table 8. The data subsets are described.

Label	Sample	Layer
Sample Primary	Ground sampled polygons	Primary
Sample Combined	Ground sampled polygons	Combined
Population Primary	Inventory where age > 50 and year ≥ 2009	Primary
Population Combined	Inventory where age > 50 and year ≥ 2009	Combined

4.5 Height and Age data matching

Two height and age comparisons were undertaken – leading species and species matched. For the leading species comparison, the ground leading species age and height were compared to the Inventory leading species and height, regardless of whether the species were the same. For the species matched comparison, the MFLRNO data matching procedures (FAIB 2011) were followed to determine the appropriate Phase I and II heights and ages for the comparison ratios.

The ground heights and ages used in the analysis were based on the average values for the suitable trees for the ground leading species (by basal area at 4cm + DBH utilization) on the ground. The youngest tree had a breast height age = 13 years.

The objective of the species matching 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 sp0 (Table 18) level, conifer-to-conifer (or deciduous-to-deciduous) matches were allowed. However, conifer-deciduous matches were not considered acceptable. Appendix E provides the details for the height and age data matching.

4.6 Site Index from the VRI Phase I polygons

As with age and height, site index (SI) was compared at the leading species level and species matched. The only difference is that for the species matched site index comparison, only Case 1 samples where the Phase II and Phase I leading species were the same) and case 2 (Phase II leading species and Phase I secondary species were the same and there was a height and age available for the Phase I secondary species) were included. No other cases were considered acceptable matches for the ground plots. SI is the average SI of the SI of the leading species.

4.7 Site index from Provincial Site productivity layer

The provincial site productivity layer (PSPL, Cloverpoint 2014) provides an alternative source of site index estimates, which can be particularly useful for young polygons. This layer provides site index estimates for up to 22 species. The intersection of the provincial site productivity layer and the ground plots was provided by the FAIB in the volume audit sample.

The PSPL SI values are taken from the PSPL tile with the largest overlap with the ground plot. The sample size for the PSPL SI is greater than the VRI inventory SI because of the species matching – the PSPL has more species and more matches. As noted in the PSPL documentation (Cloverpoint 2014), the PSPL site indexes are more appropriately used for strategic, as opposed to operational, purposes. If used for site-specific applications, as is the case here, the site index estimates should be verified through a ground-based survey

Site index field data are collected by site series within the Biogeoclimatic Ecosystem Classification system (SIBEC). The SIBEC SI estimates are then averaged by species for each site series with sufficient field data and applied spatially through the Predictive Ecosystem Mapping (PEM) or Terrestrial Ecosystem Mapping (TEM) processes. The data are collected from a large number of sample points across the province using standard, documented methods.

The SI's in the PSPL are all estimates from models, either from PEM/TEM/SIBEC or a biophysical model when a PEM/TEM derived SI is not yet available. An approved PEM or TEM is not available for Kamloops. The Si estimates are from the biophysical model for this TSA.

The site index layer was designed to assist with strategic-level decision-making where the effects of the any errors in the site index estimate are reduced from the grouping and averaging of individual site index values for points across a broader area such as an analysis unit. The site index estimates are provided on a 1 ha grid, giving the user a lot of flexibility in grouping points for weighting and averaging.

The comparison of the Phase II site index estimates to the PSPL layer should be interpreted with caution. The PSPL is an estimate of potential productivity. The actual productivity for unmanaged stands is generally lower due to regeneration delays, suppression of site trees and, in some cases, removal of the overstorey pine layer by mountain pine beetle. VDYP7 uses SI from the inventory for projecting the inventory so the differences between the PSPL and Phase I inventory do not affect volume estimates for the mature stratum.

5. RESULTS AND DISCUSSION

5.1 Attribute bias

The ratios of the weighted mean Phase II ground sample attribute to the corresponding weighted mean Phase I inventory attribute were computed for each of the seven key attributes identified in Section 4.1. The analysis stratification for the Volume Audit population was based on Phase I inventory leading species groups from the primary layer. The means are given in Table 9 and the ratios in Table 10.

Table 9. Sample-estimated weighted means for the Phase I inventory and Phase II ground sample for seven key inventory attributes, for the Volume Audit population in the Kamloops TSA. The Phase I attributes are from the primary layer only.

		Weighted Means				
		Balsam	Fir	Other	Spruce	All
Leading	N	13	29	13	17	72
Species	Phase II Ground	141	127	122	138	131
Age	Phase I Sample	153	125	151	156	142
(years)	Phase I Population	138	123	137	160	136
Species	N	13	29	13	17	72
Matched	Phase II Ground	141	127	122	138	131
Age(years)	Phase I Sample	156	125	150	155	142
Leading	N	13	29	13	17	72
Species	Phase II Ground	19.7	21.1	22.0	23.9	21.7
Height	Phase I Sample	19.0	23.6	25.0	27.2	23.8
(m)	Phase I Population	18.6	23.4	23.6	26.8	23.4
Species	N	13	29	13	17	72
Matched	Phase II Ground	19.7	21.1	22.0	23.9	21.7
Height (m)	Phase I Sample	19.4	23.6	24.4	26.6	23.7
Basal area	N	13	29	13	17	72
(m^2/ha)	Phase II Ground	28.8	27.7	38.0	30.9	30.3
7.5 cm+	Phase I Sample	22.9	26.5	38.8	32.6	29.3
	Phase I Population	24.8	26.4	36.4	32.7	29.3
Trees/ha	N	13	29	13	17	72
7.5 cm+	Phase II Ground	940	953	984	779	914
	Phase I Sample	309	332	364	345	336
	Phase I Population	333	340	432	360	360
Lorey	N	12	29	13	17	71
Height	Phase II Ground	17.1	19.3	19.8	19.7	19.1
(m)	Phase I Sample	19.4	21.3	24.3	23.9	22.1
Volume net	N	13	29	13	17	72
Dwb (m^3/ha)	Phase II Ground	182	164	227	220	191
12.5 cm+	Phase I Sample	135	176	247	247	197
	Phase I Population	153	170	222	246	194
Leading	N	13	29	13	17	72
Species	Phase II Ground	11.0	14.5	14.5	13.5	13.6
Site index	Phase I Sample	9.3	14.9	14.7	14.7	13.8
(m)	Phase I Population	9.9	15.1	14.4	14.1	13.9
Species	N	13	26	10	13	62
Matched	Phase II Ground	11.0	14.0	14.3	13.0	13.2
Site index (m)	Phase I Sample	9.3	14.8	14.7	13.1	13.3
Site index	N	10	26	11	15	62
(m)	Phase II Ground	11.2	14.1	14.6	13.3	13.5
	PSPL	15.3	17.7	18.1	18.4	17.6

In general, the attribute means from the Phase I sample and the Phase I population are close for the volume audit population. The Volume Audit (mature) ratios for age, height, basal area, volume and site index are within 10% of the desired ratio of 1.0 (Table 10). These are important inventory attributes and the results are good.

Trees per hectare has the poorest estimates. As noted in section 4.3, VDYP7 is used to project the Phase I inventory and assumes the photo interpreted attributes are at the 7.5 cm utilization. The Phase I attributes for the volume audit population are likely at a higher utilization. The effect of going from 7.5

cm to 12.5 cm for most attributes is relatively minor. However, it is significant for Tree per hectare. The Phase II average TPH at the 7.5 cm utilization is 914 stems/ha while at the 12.5 cm utilization it is 514 stems/ha and much closer to the Phase I sample average of 349 stems/ha.

The Phase II SI comparison with PSPL layer also shows poorer agreement than the other attributes. As noted in section 4.7, the PSPL gives the potential SI. For the Volume audit population, most of the polygons are unmanaged and the SI may be lower than the potential for a number of reasons including regeneration delay, early height suppression, and disturbances such as mountain pine beetle.

The results for the leading species substrata within the Volume audit stratum show more variability. The Phase I inventory underestimates most attributes for Fir and overestimates most attributes for the other species strata

Some of the trees in the Phase II sample are very old and may not be representative SI trees since site index data is less reliable from trees older than age 150. Older trees frequently have hidden pathology or other damage as well as an earlier history of suppression, etc. The Kamloops TSA has had significant pine mortality from mountain pine beetle. Some of the polygons may be residual stands and the current overstorey may have originally been an understorey under a pine overstorey. There were two spruce trees with breast height ages > 300 years and 72 trees (of all species) with a breast height age > 150 years.

Table 10. Ratio of means comparisons (and sampling error % at a 95% confidence level) for seven attributes, for the target populations in the Kamloops TSA. The ratios are based on the Phase I primary layer.

Attribute	Ratio of weighted means (with 95% sampling error shown as % of ratio)				
	Balsam	Fir	Other	Spruce	All
Leading Species Age (years)	0.921 (19.4%)	1.018 (14.7%)	0.806 (24.6%)	0.883 (15.4%)	0.926 (9.2%)
Species matched Age (years)	0.905 (18%)	1.018 (14.7%)	0.811 (25.4%)	0.89 (15.6%)	0.926 (9.1%)
Leading Species Height (m)	1.036 (17.1%)	0.897 (7.3%)	0.880 (10.6%)	0.880 (7.6%)	0.909 (5%)
Species matched Height (m)	1.014 (16.6%)	0.897 (7.3%)	0.903 (9.5%)	0.899 (7.8%)	0.916 (4.8%)
Basal area (m^2/ha) 7.5 cm+	1.256 (40.9%)	1.043 (21.5%)	0.979 (16.6%)	0.949 (20.9%)	1.034 (12.1%)
Trees/ha 7.5 cm+	3.045 (69.7%)	2.873 (32.4%)	2.706 (40.7%)	2.255 (40.6%)	2.720 (21.9%)
Lorey Height (m)	0.885 (18.5%)	0.906 (10.3%)	0.813 (15.7%)	0.825 (9.9%)	0.865 (6.5%)
Volume net Dwb (m^3/ha) 12.5 cm+	1.353 (33.3%)	0.930 (23.7%)	0.919 (22.9%)	0.889 (21.9%)	0.967 (12.9%)
Leading Species Site index (m)	1.192 (15.2%)	0.976 (10.9%)	0.986 (14.7%)	0.919 (12.8%)	0.990 (6.8%)
Species matched Site index (m)	1.192 (15.2%)	0.976 (10.9%)	0.986 (14.7%)	0.919 (12.8%)	0.990 (6.8%)
Site index (m) Site prod (PSPL)	0.730 (12.4%)	0.798 (7.5%)	0.803 (14.3%)	0.724 (13.5%)	0.770 (5.7%)

5.2 Primary versus combined layers

The ground plots do not distinguish layers (other than the potential identification of veteran or residual trees). The expectation was that rather than comparing the ground summaries to the Phase I primary layer, the ground summaries should be compared to the Phase I combined layers. In practice, this introduced a number of complications.

Table 11. Sample-estimated weighted means for the Phase I inventory and Phase II ground sample for seven key inventory attributes, for the target population in the Kamloops TSA.

Attribute		Weighted Means				
		Balsam	Fir	Other	Spruce	All
Basal area	N	13	29	13	17	72
(m^2/ha)	Phase II Ground	28.8	27.7	38.0	30.9	30.3
7.5 cm+	Phase I Sample – Primary	24.4	26.5	38.8	32.6	29.6
	Phase I Sample – Combined	24.6	27.0	38.8	32.6	29.9
	Phase I Population – Primary	24.8	26.4	36.4	32.7	29.3
Volume net	N	13	29	13	17	72
Dwb (m^3/ha)	Phase II Ground	182	164	227	220	191
12.5 cm+	Phase I Sample - Primary	135	176	247	247	197
	Phase I Sample – Combined	136	179	247	247	199
	Phase I Population - Primary	153	170	222	246	194

Several of the samples in Table 7 have relatively low crown closure. Polygons with two layers may be more heterogeneous, in general, than single layer polygons. This may exacerbate the issues that arise when comparing a ground sample, which covers a limited area, to photo estimates that cover the entire polygon. Multi-layer stands are a challenge for ground sampling, particularly for selecting height, age and site trees. The ideal solution is to identify layers in the ground sample and compare layers. This may not be feasible. However, if field crews are told which samples were identified as multi-layer, the ground crews could assign the sampled trees to layer 1 or layer 2. These results show that there is only a very small difference between volume calculations for combined versus uncombined layers.

5.3 Model-Related and Attribute-Related Components of Volume Bias

The difference between the mean Phase I inventory volume and the mean Phase II ground sample volume is an estimate of the total volume bias. The Phase I inventory estimates of volume for a polygon are generated by VDYP7. Generally, photo interpreted estimates of species composition, age, height, basal area and trees/ha are input into VDYP7. These are projected to the year of ground sampling and various volumes estimated. There are two potential sources of bias that contribute to the volume bias.

1 Attribute-related volume bias: This is the bias associated with providing VDYP7 with incorrect input attributes i.e. species composition, height, age, basal area, trees/ha) as well as errors associated with projecting these attributes to the year of ground sampling. In addition, the bias includes sampling error – comparing the Phase I polygon to the Phase II sample plot.

2 Model-related volume bias: This is bias associated with predicting volume from projected species composition, height, age, basal area, trees/ha using the VDYP7 yield model. Depending on the volume, it can include errors in estimation of decay, waste and breakage.

Estimates of the relative contribution of each of these bias components to the total inventory volume bias can be obtained by estimating a new volume using the attributes from the ground sample as inputs to VDYP7. The model-related bias is evaluated by comparing this third volume to the ground volume. The total bias minus model bias is considered attribute bias.

VOL A – Phase II ground volume – assumed to be correct.

VOL B – Phase I inventory – uses the photo interpreted attributes, projected to the year of ground sampling, using VDYP7. It includes errors in original attributes, projection errors, and volume estimation errors.

VOL C– VDYP7 volume using the ground attributes. It includes only VDYP7 volume estimation errors.

Total bias = VOL A – VOL B

Model bias = VOL A – VOL C. Includes VDYP7 volume estimation errors but not errors in input attributes.

Attribute bias = VOL C - VOL B. Does not include VDYP7 volume estimation errors but includes errors in original attributes, errors in attribute projection and sampling errors.

Overall, the results are good (Table 12). Overall, and for the stratum except Balsam, the total bias was less than 10% (Figure 3, Table 12 and Table 13). Generally the model bias is positive and the attribute bias is negative. The exception was the Balsam strata which has the largest overall bias. The large volume bias in the Balsam stratum appears to be due to an overestimate of the Phase I BA and SI.

Table 12. Volumes for model-related and attribute-related bias comparison.

Stratum	N	Weighted mean Live Volume (m^3/ha) net Dwb at 12.5cm DBH						Dead Volume	
		Phase II Ground	VDYP7 Phase I Inventory	VDYP7 volume with Phase II attributes as input	Model-related volume bias	Attribute-related volume bias	Total volume bias	Phase II Ground	Phase I Inventory
		A	B	C	A-C	C-B	A-B		
Balsam	13	182.0	134.5	155.3	26.6	20.8	47.4	67.0	n.a.
Fir	29	163.8	176.1	133.6	30.2	-42.5	-12.3	42.8	n.a.
Other	13	226.6	246.5	218.6	8.0	-27.9	-19.9	91.2	n.a.
Spruce	17	219.6	247.2	201.1	18.6	-46.1	-27.5	127.4	n.a.
Total	72	190.8	197.2	167.6	23.1	-29.5	-6.4	75.4	n.a.

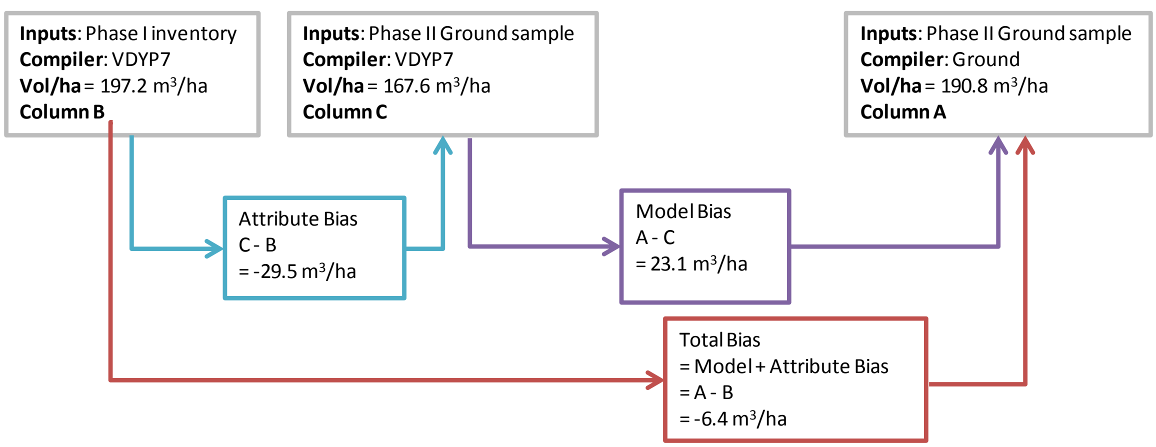

Figure 3. The relationship between the model and attribute components of total volume bias for the mature target population in the Kamloops TSA (from Table 12). A negative bias indicates Phase I overestimation whereas a positive bias indicates underestimation.

Table 13. Ratios of mean volumes (12.5cm+ DBH net Dwb) representing total, model and attribute bias, with associated sampling error (expressed as a % of the mean bias) at a 95% confidence level.

		Ratio of Weighted Mean Volume/ha net dwb at 12.5cm+ DBH (and sampling error at a 95% confidence level)		
		Total bias: Ground/Inventory	Model bias: Ground/VDYP7 (ground attributes)	Attribute bias: VDYP7 (Ground attributes)/Inventory
Stratum	N	(Table 12 A/B)	(Table 12 A/C)	(Table 12 C/B)
Balsam	13	1.353 (±33.3%)	1.172 (±7.3%)	1.155 (±33.7%)
Fir	29	0.930 (±23.7%)	1.226 (±9.3%)	0.759 (±20.8%)
Other	13	0.919 (±22.9%)	1.037 (±9.7%)	0.887 (±26%)
Spruce	17	0.889 (±21.9%)	1.092 (±10.4%)	0.814 (±23.5%)
Total	72	0.967 (±12.9%)	1.138 (±5.3%)	0.85 (±12.9%)

5.4 Leading species comparison

Table 14 summarizes the agreement between the leading species in the Phase I inventory and the leading species from the Phase II ground sample compilation for the sampled polygons. For the Volume audit, 50 out of 72 (69%) were correctly classified.

Table 14. The Phase II ground vs. Phase I inventory leading species cross-tabulation for the Volume Audit (mature) target population in the Kamloops TSA. The shaded cells are correct classifications. The overall correct classification rate is 69%.

Phase I Inventory	Volume Audit Phase II Ground Leading Species @ 4cm DBH utilization									
leading spp	A	B	C	E	F	H	P	S	Total	% agreement
A	1				1				2	50%
B		10						3	13	77%
C						1			1	0%
E				2					2	100%
F					26		1	2	29	90%
H			4					1	5	0%
P							2	1	3	67%
S		5	1		1	1		9	17	53%
Total	1	15	5	2	28	2	3	16	72	
% agreement	100%	67%	0%	100%	93%	0%	67%	56%	100%	69%

5.5 Limitations of the approach

Sample unit – The Phase I sample unit is the polygon while the Phase II sample unit is a fixed area plot (YSM) or a cluster of 5-variable radius plots (Volume audit). In highly variable polygons (polygons with small openings, rock, multi-layered stands, mixes of immature and mature, etc.), a photo-interpreter may reflect this within-polygon variability in the Phase I attribute values that are assigned. However, the Phase II plot may not be as effective in capturing such variability.

VDYP7 – VDYP7 is used to project the Phase I attributes to the year of ground sampling. For very young stands, VDYP7 uses a module called VRIYoung which does not estimate the full suite of inventory attributes until the polygon meets the minimum criteria of breast height age ≥ 6 years, dominant height ≥ 6 m and basal area (7.5cm+ DBH) ≥2 m^2/ha. Hence VDYP7 may not be the most appropriate model for projecting young managed stands. In the timber supply analysis process, the table interpolation program for stand yields (TIPSY) is generally used instead of VDYP7 for estimating yields of young managed stands.

Net volume – VDYP7 and the Phase II ground compiler use different methods to reduce whole stem merchantable volume to volume net of decay, waste and breakage (DWB). Net factoring, in combination with the net volume adjustment factor (NVAF), is used in the ground compiler and is generally considered more accurate and precise. VDYP7 was developed from TSP and PSP data and net volumes were estimated using BEC-based loss factors. Any net volume estimation bias associated with the BEC-based loss factors is built into the VDYP7 model.

Sample sizes – The sample sizes for the leading species substrata within the volume audit (mature) population are small, resulting in estimates with high standard errors.

Target population - THLB – The target population for the volume audit (mature) stratum was the vegetated trees portion of the land base. The Timber Harvesting Land Base (THLB) is a subset of this area. If the THLB differs substantially from the larger population (e.g., more productive, less pine), the results may not be appropriate for the THLB.

6. Conclusions and recommendations

The results of the VRI analysis are good, particularly for age, height, basal area and volume. This may be due in part to the relatively recent aerial photography and ground sampling. The results for the Douglas-fir substrata (the largest substrata with 29 samples) are also good. The results for the remaining substrata (Balsam, Other and Spruce) are more variable and should be used with caution. The model- and attribute-related volume bias generally compensate somewhat for one another, resulting in an overall low total volume bias. The model bias (+23.1m^3 /ha) was smaller but similar in magnitude to the attribute bias (-29.5m^3 /ha), resulting in low overall bias. When looking at the components of total error, it is important to look at the combined effects as well. Reducing the model bias through refinement or localization of components such as net volume adjustment factoring, in this TSA, may lead to a larger overall or total error.

The agreement between the Phase I and Phase II leading species is 69%.

The secondary layer contributes about 1% to both basal area and volume. It is important to identify multi-layer stands during photo interpretation, not because of the effect on volume but the residual layer generally differs considerably in terms of age and height. Multi-layer stands are a challenge for ground sampling, particularly for selecting height, age and site trees. The ideal solution is to identify layers in the ground sample and compare layers. This may not be feasible. However, if field crews are told which samples were identified as multi-layer, the ground crews could assign the sampled trees to layer 1 or layer 2.

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8. Appendix A: Phase I inventory attributes

Table 15. The Phase I inventory projected attributes are given.

Strata	Sample weight	SAMPLE	FEATURE_ID	BEC	inventory standard	Polygon area (ha)	Reference year	Projected Age sp1	Projected Height sp1	Projected Age sp2	Projected Height sp2	Input CC%	Projected BA7.5	Projected TPH7.5	Lorey height (m)	Volume NWB 12.5 (m^3/ha)	sp01	pct1	sp02	pct2	sp03	pct3	sp04	pct4	sp05	pct5	sp06	pct6	Dead Volume (m^3/ha)
Balsam	16724	47	9510434	ESSF	V	4.1	2011	223	23.2	267	29.1	15	10.0	70	23.0	73	BL	55	SE	45									
Balsam	16724	48	9975383	ESSF	V	21.7	2011	54	3.3	53	3.3	20	1.0	550			BL	90	SE	10									
Balsam	16379	49	9973604	ESSF	V	59.3	2011	203	22.2	242	24.1	40	23.0	417	20.1	137	BL	85	SE	15									
Balsam	16379	50	9505815	ESSF	V	13.1	2011	53	11.9	42	11.1	35	21.0	443	11.8	72	BL	40	SE	30	PLI	30							
Balsam	16379	51	9826695	ESSF	V	23.7	2011	183	17.2	227	23.1	30	19.8	206	16.2	92	BL	90	SE	10									
Balsam	16379	52	9998124	ESSF	V	17.7	2011	62	16.6	188	28.2	55	20.0	924	14.0	82	BL	85	SE	15									
Balsam	15232	53	9484993	ESSF	V	5.2	2011	143	15.3	147	18.2	45	34.5	532	13.4	135	BL	90	SE	10									
Balsam	15232	54	9525676	ESSF	V	34.7	2011	223	24.2	222	25.1	45	44.9	288	23.3	295	BL	60	SE	40									
Balsam	15232	55	9822574	ESSF	V	122.5	2011	203	22.2	227	25.1	50	34.9	281	21.2	218	BL	70	SE	30									
Balsam	15232	56	9975285	ESSF	V	4.6	2011	153	18.3	252	29.1	50	40.0	383	16.5	200	BL	90	SE	10									
Balsam	15232	57	9503223	ESSF	V	32.9	2011	183	22.2	222	25.1	55	39.3	509	20.9	259	BL	60	SE	40									
Balsam	15232	58	9513067	ESSF	V	1.0	2011	103	22.5	102	24.4	35	30.3	253	21.5	196	BL	70	SE	30									
Balsam	16724	91	9512781	ESSF	V	101.5	2011	83	17.1	102	22.3	15	5.2	99	16.3	31	BL	50	SE	35	HW	10	CW	5					
Fir	16324	1	9970317	IDF	V	7.1	2011	143	22.2			15	10.0	89	21.9	56	FDI	100											
Fir	16324	2	9560578	IDF	V	11.1	2011	153	20.2			30	14.7	201	19.1	73	FDI	100											
Fir	16324	3	9544123	PP	V	12.6	2011	173	16.1	212	18.1	10	1.7	54	15.9	8	FDI	90	PY	10									
Fir	16324	4	9781939	IDF	V	14.7	2011	73	9.3			15	4.3	152	9.0	10	FDI	100											
Fir	16324	5	9518747	ICH	V	4.7	2011	83	18.5	82	18.4	30	15.5	231	17.2	78	FDI	70	SX	20	PLI	10							
Fir	16324	6	9791319	IDF	V	9.2	2011	123	25.3	122	24.2	35	15.2	261	22.6	95	FDI	60	AT	40									
Fir	16324	7	10030133	PP	V	23.6	2011	93	16.3			55	15.6	362	14.8	65	FDI	100											
Fir	16324	8	9623680	IDF	V	14.7	2011	153	25.2			35	7.9	147	24.3	56	FDI	100											
Fir	16324	9	10017076	IDF	V	23.8	2011	43	10.8			25	11.0	217	10.2	28	FDI	100											
Fir	15684	10	9833639	IDF	V	6.0	2011	113	21.3	82	14.2	15	25.1	263	19.9	123	FDI	90	PLI	10									
Fir	15684	11	9781870	IDF	V	9.8	2011	153	24.2			35	24.8	258	22.5	147	FDI	100											
Fir	15684	12	9553011	IDF	V	21.9	2011	113	18.3	92	14.2	60	21.1	446	16.2	95	FDI	99	AT	1									
Fir	15684	13	9564051	IDF	V	8.9	2011	113	20.3	82	16.2	30	17.9	280	18.9	93	FDI	90	PLI	10									
Fir	15684	14	9564052	IDF	V	24.0	2011	93	15.3			30	17.8	300	14.1	64	FDI	100											
Fir	15684	15	10039186	IDF	V	3.1	2011	128	28.3	127	29.3	50	20.1	248	26.5	160	FDI	95	PY	5									
Fir	15684	16	10052867	IDF	V	4.2	2011	113	23.3	92	21.4	45	29.7	474	20.6	178	FDI	80	SX	15	AT	5							
Fir	15684	17	9960899	IDF	V	0.6	2008	166	36.4			40	23.1	216	34.3	230	FDI	100											

Strata	Sample weight	SAMPLE	FEATURE_ID	BEC	inventory standard	Polygon area (ha)	Reference year	Projected Age sp1	Projected Height sp1	Projected Age sp2	Projected Height sp2	Input CC%	Projected BA7.5	Projected TPH7.5	Lorey height (m)	Volume NWB 12.5 (m^3/ha)	sp01	pct1	sp02	pct2	sp03	pct3	sp04	pct4	sp05	pct5	sp06	pct6	Dead Volume (m^3/ha)
Fir	15684	18	9993149	IDF	V	6.6	2011	153	26.2			50	27.8	299	24.1	187	FDI	100											
Fir	15684	19	9775535	ICH	V	32.1	2011	138	30.3	137	28.2	55	30.2	332	25.4	243	FDI	40	SX	40	CW	10	BL	10					
Fir	17354	20	10037417	IDF	V	7.1	2011	73	23.7	62	21.6	70	35.4	704	20.0	219	FDI	50	SX	20	EP	20	AT	10					
Fir	17354	21	9998349	IDF	V	7.2	2011	138	32.3	132	30.2	60	55.0	408	28.8	471	FDI	90	SX	10									
Fir	17354	22	9557378	IDF	V	20.0	2011	133	20.2			55	31.4	467	17.8	152	FDI	100											
Fir	17354	23	9940128	IDF	V	21.0	2011	122	28.1	98	25.2	40	40.0	390	25.1	277	FDI	95	AT	5									
Fir	17354	24	10051632	ICH	V	11.4	2011	153	30.3	122	31.3	55	44.9	426	26.9	360	FDI	75	PW	15	EP	5	CW	5					
Fir	17354	25	9552501	IDF	V	33.7	2011	133	24.3			75	35.5	511	21.1	218	FDI	100											
Fir	17354	26	9519834	ICH	V	15.2	2011	103	30.5	102	26.3	65	70.7	531	24.6	496	FDI	60	CW	20	HW	10	PLI	5	SX	5			
Fir	17354	27	9961470	IDF	V	0.3	2011	173	35.2			65	41.8	319	32.1	395	FDI	100											
Fir	17354	28	9557366	IDF	V	10.3	2011	78	20.6	77	21.3	50	30.9	627	17.8	170	FDI	50	AT	30	SX	20							
Fir	17354	29	9940184	IDF	V	1.4	2011	203	28.1			55	38.8	315	25.7	271	FDI	100											
Other	12726	59	9583171	MS	V	1.7	2011	138	23.2	137	23.2	25	15.1	243	21.5	120	PLI	75	SX	20	FDI	5							
Other	12726	60	9856513	MS	V	17.5	2011	138	18.2	142	21.2	15	10.0	194	17.3	59	PLI	85	FDI	15									
Other	12726	61	9617715	IDF	I	1.5	2004	90	13.0	119	18.6	20	7.6	336	12.8	21	AT	80	PLI	20									
Other	13792	62	9948864	IDF	V	68.1	2013	71	20.2	70	19.0	60	30.0	573	18.4	160	EP	97	CW	2	SX	1							
Other	13792	63	9991135	IDF	V	6.6	2011	93	24.4	92	23.4	45	22.7	374	22.6	128	AT	85	SX	5	BL	5	EP	5					
Other	13792	64	9715379	ICH	V	8.1	2011	303	35.1	302	32.1	35	30.0	144	34.6	209	HW	50	CW	30	SX	20							
Other	13792	65	9514769	ICH	V	10.4	2011	93	16.5	92	18.3	55	35.3	468	16.9	156	HW	35	FDI	25	SX	20	CW	10	BL	5	AT	5	
Other	16643	66	9526241	ICH	V	67.8	2012	72	23.3	71	30.3	65	40.7	529	23.8	311	EP	50	FDI	25	AT	15	SX	10					
Other	16643	68	9715116	ICH	V	4.3	2011	228	33.1	252	26.1	60	70.0	269	32.9	450	HW	40	CW	30	SX	20	ACT	10					
Other	16643	69	9511525	ICH	V	12.8	2011	278	37.1	247	35.1	65	60.0	271	34.8	378	HW	80	CW	20									
Other	16643	70	9889488	ICH	V	6.8	2011	253	30.2	227	30.1	65	70.0	291	30.5	444	CW	40	HW	30	SX	25	FDI	5					
Other	12726	96	9553903	MS	V	13.6	2011	93	17.3			35	14.9	450	16.0	85	PLI	100											
Other	16643	99	9520574	ICH	V	17.2	2011	73	26.7	72	26.5	70	66.0	551	26.1	461	HW	40	FDI	20	AT	20	EP	10	CW	10			
Spruce	16152	30	9807314	MS	V	4.6	2011	133	21.4	122	20.2	20	11.0	199	19.8	69	SX	85	BL	15									
Spruce	16152	31	9587069	ESSF	V	4.3	2011	163	22.2	122	17.2	35	14.6	258	19.9	90	SE	70	BL	30									
Spruce	16152	33	9516099	ESSF	V	19.5	2012	82	24.5	91	26.2	15	5.2	47	22.9	38	SE	40	FDI	30	BL	20	PLI	10					
Spruce	17304	34	9812669	MS	V	18.2	2011	133	22.3	117	18.3	50	31.8	526	19.4	194	SE	95	BL	5									
Spruce	17304	35	9587760	MS	V	5.4	2011	163	31.2	122	25.2	45	24.9	306	28.1	234	SX	90	BL	10									
Spruce	17304	36	9822212	ICH	V	6.2	2011	203	32.2	182	24.1	55	34.8	191	28.3	276	SX	70	BL	25	CW	5							
Spruce	17304	37	9540660	ESSF	V	9.5	2011	83	26.7	82	26.4	50	30.4	267	24.5	229	SX	50	FDI	30	BL	20							
Spruce	17304	38	9554029	MS	V	2.7	2011	178	26.3	137	23.1	30	24.8	269	24.4	179	SX	95	PLI	5									
Spruce	15331	39	9522074	ESSF	V	54.1	2012	72	14.5	71	12.2	60	39.8	681	12.5	150	SE	80	BL	20									

Strata	Sample weight	SAMPLE	FEATURE_ID	BEC	inventory standard	Polygon area (ha)	Reference year	Projected Age sp1	Projected Height sp1	Projected Age sp2	Projected Height sp2	Input CC%	Projected BA7.5	Projected TPH7.5	Lorey height (m)	Volume NWB 12.5 (m^3/ha)	sp01	pct1	sp02	pct2	sp03	pct3	sp04	pct4	sp05	pct5	sp06	pct6	Dead Volume (m^3/ha)
Spruce	15331	40	9521480	ICH	V	44.9	2011	83	24.7	77	22.4	60	45.5	527	21.3	322	SX	60	BL	30	PLI	10							
Spruce	15331	41	9889930	ICH	V	3.9	2011	253	28.2	222	23.1	55	49.8	372	23.8	329	SX	65	BL	20	HW	10	CW	5					
Spruce	15331	42	9520925	ICH	V	15.0	2011	83	24.7	82	24.4	60	45.6	593	19.5	286	SX	40	HW	30	CW	20	AT	10					
Spruce	15331	43	9992796	ESSF	V	16.9	2011	213	31.1	172	27.2	65	41.8	432	27.2	383	SE	90	BL	10									
Spruce	15331	44	9701891	ESSF	V	25.3	2011	233	33.1	162	28.1	60	54.9	387	28.7	507	SE	80	BL	20									
Spruce	16152	84	9514025	ESSF	V	5.9	2011	253	28.1	252	25.1	35	14.9	134	24.4	114	SE	60	BL	25	HW	15							
Spruce	15945	86	9822212	ICH	V	6.2	2011	203	32.2			55	34.8	191	28.3	276	SX	70	BL	25	CW	5							
Spruce	15331	88	9496812	ICH	V	13.4	2010	129	38.4	123	26.3	55	55.5	559	32.4	577	SX	75	BL	20	FDI	5							

9. Appendix B: Phase II compiled ground attributes

Table 16. The Phase II compiled ground attributes are given.

Strata	Sample	BEC	Species composition At DBH ≥ 4.0 cm	Basal area (m^2/ha) DBH ≥ 7.5 cm	Trees/ha DBH ≥ 7.5 cm	Lorey height (m) DBH ≥ 7.5 cm	Live volume net DWB (m^3/ha) DBH ≥ 12.5 cm	Dead WSV (m^3/ha) DBH ≥ 7.5 cm
16724	47	ESS	Bl 57 Sx 43	50.4	2772	13.8	254	232
16724	48	ESS	Bl 89 S 11	3.8	340	2.6	10	9
16379	49	ESS	Bl 69 S 31	28.8	524	19.1	243	215
16379	50	ESS	Bl 42 Pl 33 Sx 25	12.0	497	8.3	76	67
16379	51	ESS	Bl 94 S 06	25.2	527	13.8	190	170
16379	52	ESS	Bl 96 Sx 04	41.4	1592	15.4	257	223
15232	53	ESS	Bl 90 S 10	37.8	720	16.2	309	264
15232	54	ESS	S 67 Bl 33	16.8	130	23.3	164	150
15232	55	ESS	Bl 72 S 28	32.4	675	18.6	268	236
15232	56	ESS	Bl 100	28.8	829	17.1	197	170
15232	57	ESS	S 55 Bl 45	36.0	372	32.4	374	340
15232	58	ESS	Sx 50 Bl 40 Pl 10	35.0	2693	14.9	128	110
16724	91	ESS	Bl 79 Sx 21	26.6	520	14.3	217	194
16324	1	IDF	Fd 100	35.0	3110	4.6	116	106
16324	2	IDF	Fd 100	40.5	1153	15.0	249	223
16324	3	PP	Fd 100	1.0	2	15.8	5	4
16324	4	IDF	Fd 100	19.2	488	17.9	139	126
16324	5	ICH	Sx 36 Pw 36 Cw 18 Hw 10	11.0	583	10.3	56	44
16324	6	IDF	Fd 40 Sx 40 At 20	14.0	452	16.1	103	94
16324	7	PP	Fd 95 Py 05	20.0	981	18.3	99	91
16324	8	IDF	Fd 100	31.3	1552	13.3	166	150
16324	9	IDF	Fd 100	14.0	693	16.3	71	62
15684	10	IDF	Sx 63 Fd 21 Pl 16	26.6	2560	15.1	64	59
15684	11	IDF	Fd 100	34.2	1019	19.5	229	205
15684	12	IDF	Fd 100	23.8	592	17.9	156	136
15684	13	IDF	Fd 77 Pl 23	18.2	1253	15.1	70	63
15684	14	IDF	Fd 100	23.8	313	14.6	154	139
15684	15	IDF	Fd 100	55.8	367	23.2	232	128
15684	16	IDF	Fd 100	14.4	764	15.7	9	0
15684	17	IDF	Fd 71 Sx 29	16.3	165	33.7	215	151
15684	18	IDF	Fd 100	14.4	121	32.1	67	9
15684	19	ICH	Fd 55 Cw 32 S 09 Bl 04	52.8	1872	19.4	170	19
17354	20	IDF	Fd 65 Cw 19 Ep 08 Pl 04 At 04	36.4	2622	16.4	223	17
17354	21	IDF	Fd 88 Sx 12	36.4	481	31.1	264	135
17354	22	IDF	Fd 100	27.5	677	17.3	150	60
17354	23	IDF	Sx 59 Fd 32 Bl 09	30.8	1172	21.5	236	162
17354	24	ICH	Fd 48 Cw 45 Pw 03 Sx 04	52.2	787	18.1	170	37
17354	25	IDF	Fd 100	37.5	566	23.7	340	145
17354	26	ICH	Fd 56 Cw 25 Hw 19	28.8	250	27.7	110	11
17354	27	IDF	Fd 100	17.5	187	25.2	194	8
17354	28	IDF	Sx 44 Fd 38 At 18	28.8	1491	22.6	106	22
17354	29	IDF	Fd 81 Sx 15 At 04	36.4	1354	22.0	223	26
12726	59	MS	Sx 100	1.4	69	16.7	4	12

Strata	Sample	BEC	Species composition At DBH ≥ 4.0 cm	Basal area (m^2/ha) DBH ≥ 7.5 cm	Trees/ha DBH ≥ 7.5 cm	Lorey height (m) DBH ≥ 7.5 cm	Live volume net DWB (m^3/ha) DBH ≥ 12.5 cm	Dead WSV (m^3/ha) DBH ≥ 7.5 cm
12726	60	MS	Pl 60 Sx 40	9.0	1099	8.8	126	2
12726	61	IDF	Fd 100	1.0	12	18.2	44	23
13792	62	IDF	Ep 56 Cw 22 Fd 17 Sx 05	25.2	527	19.5	94	6
13792	63	IDF	At 65 Ep 30 Pl 05	20.0	495	20.7	91	29
13792	64	ICH	Cw 42 Bl 21 Hw 16 S 11 Ep 10	45.6	755	15.4	150	108
13792	65	ICH	S 56 Cw 32 Hw 12	45.0	2246	11.9	62	57
16643	66	ICH	Ep 29 Fd 25 Cw 21 At 13 S 08 Pl 04	43.2	725	25.8	59	80
16643	68	ICH	Cw 71 Ep 12 Hw 12 Sx 05	54.4	532	19.3	205	17
16643	69	ICH	Cw 52 Hw 43 Fd 05	73.6	1018	32.3	136	49
16643	70	ICH	Hw 62 Fd 15 Cw 15 Pw 08	83.2	1882	26.5	63	11
12726	96	MS	Pl 100	14.4	511	17.7	139	21
16643	99	ICH	Cw 60 Hw 28 Fd 08 Ep 04	45.0	2415	18.0	430	30
16152	30	MS	Sx 60 Bl 20 Pl 20	7.0	375	19.4	76	63
16152	31	ESSF	Fd 50 Sx 50	7.2	41	20.1	136	32
16152	33	ESSF	Bl 63 Sx 21 Fd 16	34.2	2196	11.2	106	52
17304	34	MS	Bl 63 Sx 37	22.4	1115	11.8	346	85
17304	35	MS	Sx 100	1.8	52	21.9	161	44
17304	36	ICH	S 45 Bl 27 Hw 18 Cw 10	35.2	175	24.1	313	19
17304	37	ESSF	Bl 54 Fd 31 Sx 12 Cw 03	46.8	874	19.3	146	0
17304	38	MS	Sx 100	26.6	432	20.4	192	41
15331	39	ESSF	Bl 57 S 39 Pl 04	41.4	2176	14.4	314	91
15331	40	ICH	Sx 56 Bl 41 At 03	48.6	1764	20.1	272	3
15331	41	ICH	S 44 Bl 28 Hw 22 Cw 06	43.2	785	22.3	202	72
15331	42	ICH	Hw 53 Cw 32 Sx 15	34.2	598	21.6	144	116
15331	43	ESSF	Sx 67 Bl 33	28.8	598	17.8	163	0
15331	44	ESSF	S 50 Cw 40 Bl 10	24.0	156	27.1	219	127
16152	84	ESSF	Bl 42 S 33 Hw 25	21.6	480	19.8	7	225
15945	86	ICH	Cw 33 S 30 Bl 29 Hw 08	44.9	801	14.3	8	187
15331	88	ICH	Fd 46 Sx 31 Cw 19 Bl 04	62.4	779	30.1	6	45

10. Appendix C: Site index

Table 17. Site index (SI) estimates are given by species and source. The ground SI potentially includes old (> 120 years) trees.

		Ground		Phase I															
	sample	Spp1	SI1	Spp1	Spp2	SI1	SI2	AT	BL	CW	EP	FD	HM	HW	PL	PY	SE	SX	YC
Balsam	47	BL	10.3	BL	SE	7.6	11.2		14			17			15		14	14	
Balsam	48	BL	9.6	BL	SE	5.3	5.9												
Balsam	49	BL	7.1	BL	SE	7.8	8.8		13						14		15	15	
Balsam	50	BL	15.3	BL	SE	14.5	19.0		17			19			18		19	19	
Balsam	51	BL	11.0	BL	SE	5.9	8.6										17	17	
Balsam	52	BL	10.2	BL	SE	17.2	13.0		16			18			18		18	18	
Balsam	53	BL	8.5	BL	SE	6.7	8.6		13								14	14	
Balsam	54	S	8.2	BL	SE	8.3	9.8		13						15		14	14	
Balsam	55	BL	11.7	BL	SE	7.8	9.7		17						17		21	21	
Balsam	56	BL	11.1	BL	SE	7.7	11.4												
Balsam	57	S	13.5	BL	SE	8.6	9.8		15			19			16		15	15	
Balsam	58	SX	11.0	BL	SE	14.6	15.9		17			20			19		19	19	
Balsam	91	BL	16.0	BL	SE	13.0	14.4		17			19			18		18	18	
Fir	1	FD	9.1	FDI		12.7						15			17			17	
Fir	2	FD	9.5	FDI		11.2					18	14				13			
Fir	3	FD	9.8	FDI	PY	8.6	5.9									15			
Fir	4	FD	10.4	FDI		8.4					18	15				13			
Fir	5	PW	30.7	FDI	SX	14.4	13.7	21	20	17	19	24	18	18	22			22	17
Fir	6	FD	17.6	FDI	AT	15.7	15.5	17			20	17			19			19	
Fir	7	FD	12.9	FDI		12.0										15			
Fir	8	FD	8.9	FDI		14.1		14				15			17			16	
Fir	9	FD	14.8	FDI		14.7		16				17			18	15		18	
Fir	10	SX	13.6	FDI	PLI	13.8	11.1	16				16			18			17	
Fir	11	FD	12.5	FDI		13.5						15			16	14			
Fir	12	FD	12.6	FDI	AT	11.9	9.9	15			19	16			17			17	
Fir	13	FD	9.0	FDI	PLI	13.2	12.8	13				15			16	13		16	
Fir	14	FD	8.4	FDI		11.3						14				13			
Fir	15	FD	10.2	FDI	PY	17.1	15.8	17		17	19	18			19	15		19	17
Fir	16	FD	15.6	FDI	SX	15.1	14.4	21		16	20	20			21	16			16
Fir	17	FD	19.2	FDI		19.8		17			20	18			19	15		19	
Fir	18	FD	21.9	FDI		14.6				16	20	22			22	18			16
Fir	19	FD	13.2	FDI	SX	17.7	14.7		18	18		21			19			20	18
Fir	20	FD	18.6	FDI	SX	19.9	20.7	19			18	20			20	15			
Fir	21	FD	20.7	FDI	SX	18.9	16.8	16				18			18	15		17	
Fir	22	FD	12.8	FDI		12.0					20	18			20	15			
Fir	23	SX	11.0	FDI	AT	17.4	18.3	16			20	17			19			18	
Fir	24	FD	17.7	FDI	PW	16.9	16.0	23	16	16	21	24			23			25	16
Fir	25	FD	13.5	FDI		14.4					21	16				15			
Fir	26	FD	23.1	FDI	CW	20.7	16.3	25	21	17	20	27	21	21	25			25	17
Fir	27	FD	14.1	FDI		18.8						17			18	16		18	
Fir	28	FD	13.4	FDI	AT	16.6	17.1				21	17			19	15			
Fir	29	FD	14.4	FDI		14.1		18				17			19			18	
Other	59	SX	18.4	PLI	SX	15.2	11.0		16						17			18	
Other	60	PL	10.3	PLI	FDI	11.1	12.2		16			17			17			17	
Other	61	FD	12.7	AT	PLI	9.1	12.3				20	16			18			18	
Other	62	EP	17.7	EP	CW	17.2	16.0	18			19	19			19	15			
Other	63	AT	15.4	AT	SX	18.0	16.1	18			18	19			19	14		19	

		Ground		Phase I															
	sample	Spp1	SI1	Spp1	Spp2	SI1	SI2	AT	BL	CW	EP	FD	HM	HW	PL	PY	SE	SX	YC
Other	64	CW	14.4	HW	CW	14.1	7.7		20		16		19	19					
Other	65	S	19.5	HW	FDI	11.1	13.4		19	20		24			21			22	20
Other	66	EP	21.0	EP	FDI	20.3	25.7	22	21	17	18	26	20	20	23			23	17
Other	68	CW	10.7	HW	CW	14.4	6.5		23	18	19	27	22	22	25			26	18
Other	69	CW	14.5	HW	CW	16.4	11.6	21	20	17	19	24	18	18	22			22	17
Other	70	HW	10.5	CW	HW	8.3	12.1		21	18	18	24	20	20				25	18
Other	96	PL	9.4	PLI		12.8									16				
Other	99	CW	13.7	HW	FDI	21.6	22.5		22		18	26	21	21				25	
Spruce	30	SX	12.9	SX	BL	10.1	11.1		18						18			18	
Spruce	31	SX	9.7	SE	BL	10.1	9.1		16			17			16		18	18	
Spruce	33	BL	9.4	SE	FDI	19.0	19.1		16			18			17		17	17	
Spruce	34	BL	8.7	SE	BL	11.7	10.1		17						18			18	
Spruce	35	SX	10.5	SX	BL	15.2	14.9		19			19			18			19	
Spruce	36	S	15.7	SX	BL	13.5	10.0		20						21				
Spruce	37	BL	16.5	SX	FDI	20.4	20.5		16			17			17		18	18	
Spruce	38	SX	13.5	SX	PLI	10.2	15.2		15			17			17			17	
Spruce	39	BL	13.3	SE	BL	13.0	11.2		14						15		16	16	
Spruce	40	SX	18.9	SX	BL	18.7	18.4		18	19		23			20			21	19
Spruce	41	S	15.3	SX	BL	8.0	7.6		21	18	18	24	20	20				24	18
Spruce	42	HW	19.9	SX	HW	18.7	18.2		21	18	18	25	20	20	23			24	18
Spruce	43	SX	8.7	SE	BL	13.7	12.9		17			18			18		19	19	
Spruce	44	S	11.0	SE	BL	14.4	14.3		17						18		22	22	
Spruce	84	BL	11.4	SE	BL	10.9	8.0		15						16		18	18	
Spruce	86	CW	13.7	SX	BL	13.5			20						21				
Spruce	88	FD	20.9	SX	BL	24.8	15.6	17	19	17	18	21			20				17

11. Appendix D: Scatterplots to find potential outliers

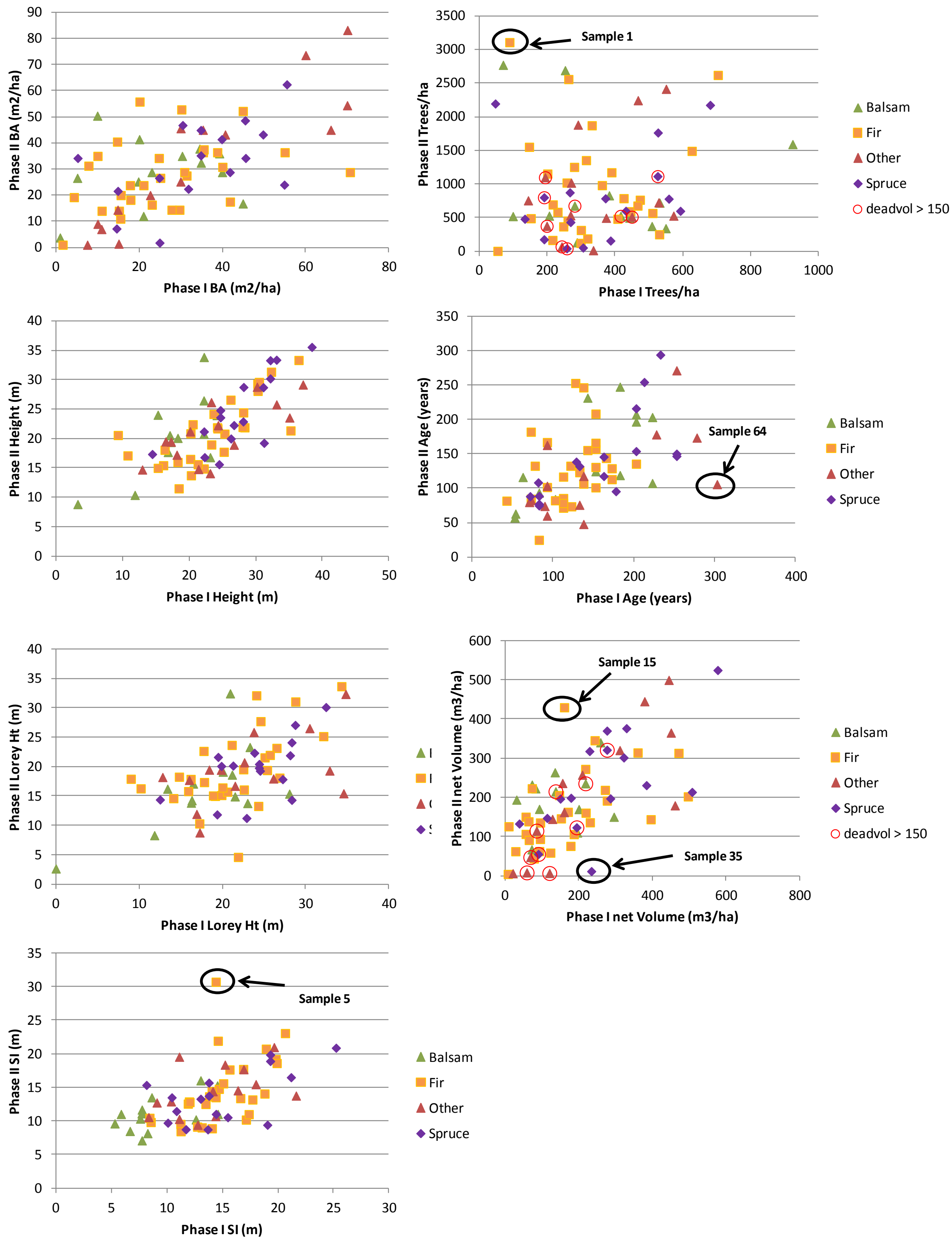


Figure 4. The Phase I inventory and Phase II Ground data are plotted for the seven attributes of interest. Potential outliers are identified in section 4.3.

12. APPENDIX E: HEIGHT AND AGE MATCHING

The current standard for Phase II ground age and height is based on the average of the T, L, 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.

Strata	sample	Phase II (ground) leading species attributes					Phase I (Inventory)				
		Species @ 4cm DBH	Mean		Sample size		Leading species	Second species	Case of match	Age for match	Height for match
			Age[2]	Height[3]	Age[4]	Height[5]					
Balsam	47	BL	107	16.8	5	5	BL	SE	1	223	23.2
Balsam	48	BL	63	8.8	5	5	BL	SE	1	54	3.27
Balsam	49	BL	207	20.8	6	6	BL	SE	1	203	22.2
Balsam	50	BL	57	10.4	5	5	BL	SE	1	53	11.9
Balsam	51	BL	119	19.4	5	5	BL	SE	1	183	17.2
Balsam	52	BL	116	17.7	5	5	BL	SE	1	63	16.8
Balsam	53	BL	232	24.0	5	5	BL	SE	1	143	15.3
Balsam	54	S			5	5	BL	SE	2	222	25.1
Balsam	55	BL	197	26.5	5	5	BL	SE	1	203	22.2

[2] Age = age_tlxo

[3] Height = ht_tlxo

[4]Sample size for age = n_age_tlxo

[5] Sample size for height = n_ht_tlxo

Strata	sample	Phase II (ground) leading species attributes					Phase I (Inventory)				
		Species @ 4cm DBH	Mean		Sample size		Leading species	Second species	Case of match	Age for match	Height for match
			Age[2]	Height[3]	Age[4]	Height[5]					
Balsam	56	BL	125	20.1	5	5	BL	SE	1	153	18.3
Balsam	57	S			5	5	BL	SE	2	222	25.1
Balsam	58	SX			2	2	BL	SE	2	102	24.4
Balsam	91	BL	93	20.5	5	5	BL	SE	1	83	17.1
Fir	1	FD	155	14.9	5	5	FDI		1	143	22.2
Fir	2	FD	157	16.5	5	5	FDI		1	153	20.2
Fir	3	FD	129	15.4	3	3	FDI	PY	1	173	16.1
Fir	4	FD	182	20.6	4	3	FDI		1	73	9.32
Fir	5	PW	25	11.5	4	4	FDI	SX	3	83	18.5
Fir	6	FD	74	20.8	1	1	FDI	AT	1	123	25.3
Fir	7	FD	102	18.1	6	5	FDI		1	93	16.3
Fir	8	FD	208	17.7	6	6	FDI		1	153	25.2
Fir	9	FD	82	17.1	5	5	FDI		1	43	10.8
Fir	10	SX	72	15.6	5	5	FDI	PLI	3	113	21.3
Fir	11	FD	166	21.9	5	5	FDI		1	153	24.2
Fir	12	FD	86	16.0	5	5	FDI	AT	1	113	18.3
Fir	13	FD	117	13.7	5	5	FDI	PLI	1	113	20.3
Fir	14	FD	167	15.0	5	6	FDI		1	93	15.3
Fir	15	FD	253	21.9	5	5	FDI	PY	1	128	28.3
Fir	16	FD	78	19.0	5	5	FDI	SX	1	113	23.3
Fir	17	FD	144	33.3	3	3	FDI		1	166	36.4
Fir	18	FD	101	26.6	5	5	FDI		1	153	26.2
Fir	19	FD	247	28.1	5	5	FDI	SX	1	138	30.3
Fir	20	FD	85	24.2	5	5	FDI	SX	1	73	23.7
Fir	21	FD	107	31.3	5	5	FDI	SX	1	138	32.3
Fir	22	FD	126	20.9	5	5	FDI		1	133	20.2
Fir	23	SX	133	21.9	5	5	FDI	AT	3	122	28.1
Fir	24	FD	131	29.3	5	5	FDI	PW	1	153	30.3
Fir	25	FD	123	21.7	5	5	FDI		1	133	24.3
Fir	26	FD	82	29.6	5	5	FDI	CW	1	103	30.5
Fir	27	FD	113	21.4	2	2	FDI		1	173	35.2
Fir	28	FD	133	22.4	1	1	FDI	AT	1	78	20.6
Fir	29	FD	136	24.4	5	5	FDI		1	203	28.1
Other	59	SX			4	4	PLI	SX	2	137	23.2
Other	60	PL	118	17.2	5	5	PLI	FDI	1	138	18.2
Other	61	FD			4	4	AT	PLI	4	119	18.6
Other	62	EP	80	21.2	5	5	EP	CW	1	71	20.2
Other	63	AT	103	22.2	5	5	AT	SX	1	93	24.4
Other	64	CW			5	4	HW	CW	2	302	32.1
Other	65	S	60	19.5	5	5	HW	FDI	3	93	16.5
Other	66	EP	83	26.2	5	5	EP	FDI	1	72	23.3
Other	68	CW			5	5	HW	CW	2	252	26.1
Other	69	CW			5	5	HW	CW	2	247	35.1
Other	70	HW			5	5	CW	HW	2	227	30.1
Other	96	PL	163	19.4	5	5	PLI		1	93	17.3
Other	99	CW	83	18.9	5	5	HW	FDI	3	73	26.7
Spruce	30	SX	76	14.8	5	5	SX	BL	1	133	21.4

Strata	sample	Phase II (ground) leading species attributes					Phase I (Inventory)				
		Species @ 4cm DBH	Mean		Sample size		Leading species	Second species	Case of match	Age for match	Height for match
			Age[2]	Height[3]	Age[4]	Height[5]					
Spruce	31	SX	146	21.2	5	5	SE	BL	1	163	22.2
Spruce	33	BL	108	15.6	5	5	SE	FDI	3	82	24.5
Spruce	34	BL			5	5	SE	BL	2	117	18.3
Spruce	35	SX	118	19.2	10	10	SX	BL	1	163	31.2
Spruce	36	S	216	33.3	4	4	SX	BL	1	203	32.2
Spruce	37	BL	89	22.3	5	5	SX	FDI	3	83	26.7
Spruce	38	SX	96	20.0	5	5	SX	PLI	1	178	26.3
Spruce	39	BL			5	5	SE	BL	2	71	12.2
Spruce	40	SX	77	23.6	5	5	SX	BL	1	83	24.7
Spruce	41	S	147	28.7	5	5	SX	BL	1	253	28.2
Spruce	42	HW			4	4	SX	HW	2	82	24.4
Spruce	43	SX	254	28.7	5	5	SE	BL	1	213	31.1
Spruce	44	S	294	33.4	5	5	SE	BL	1	233	33.1
Spruce	84	BL			5	5	SE	BL	2	252	25.1
Spruce	86	CW	154	30.2	1	1	SX	BL	3	203	32.2
Spruce	88	FD	139	35.6	5	5	SX	BL	3	129	38.4

13. Appendix F: Scatterplots and residuals

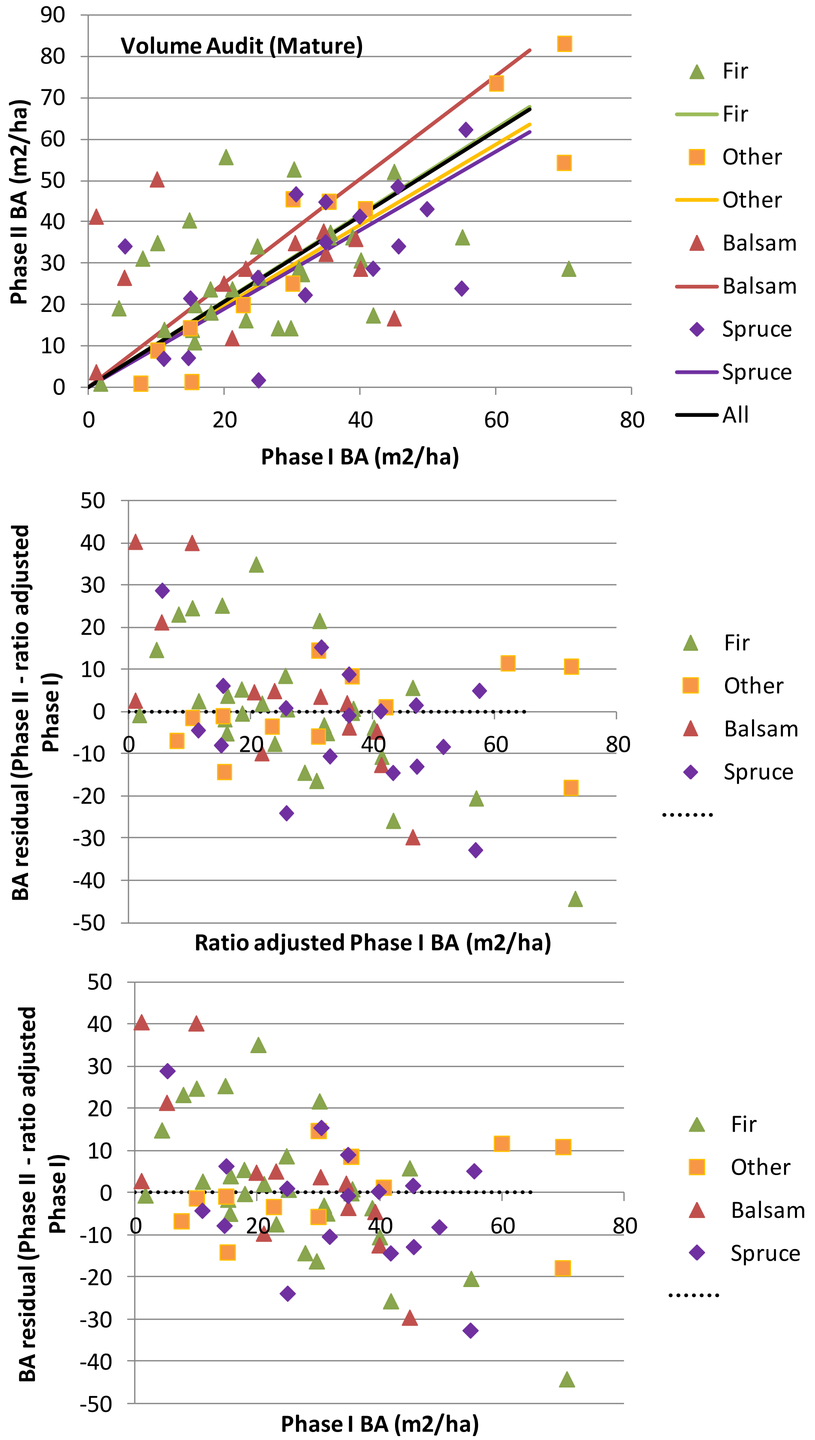


Figure 5. The scatterplots for BA are given. The top graph gives the Phase I photo and Phase II ground estimates of basal, by stratum, with a line representing the ratio. The middle graph plots the residuals against the adjusted Phase I BA. The bottom graph plots the residuals against the Phase I BA. 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 black line is the ratio for all samples.

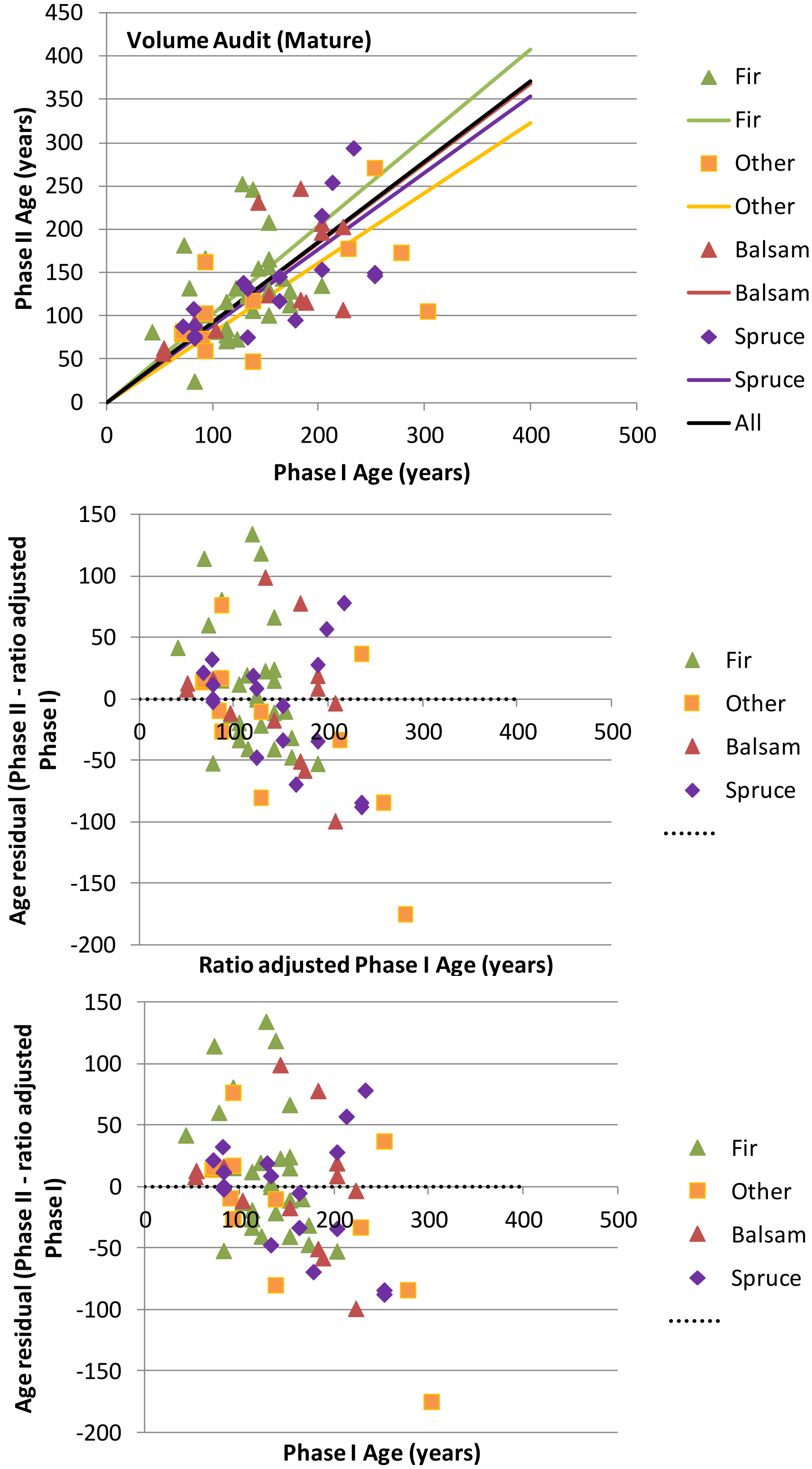


Figure 6. The scatterplots for Age are given.

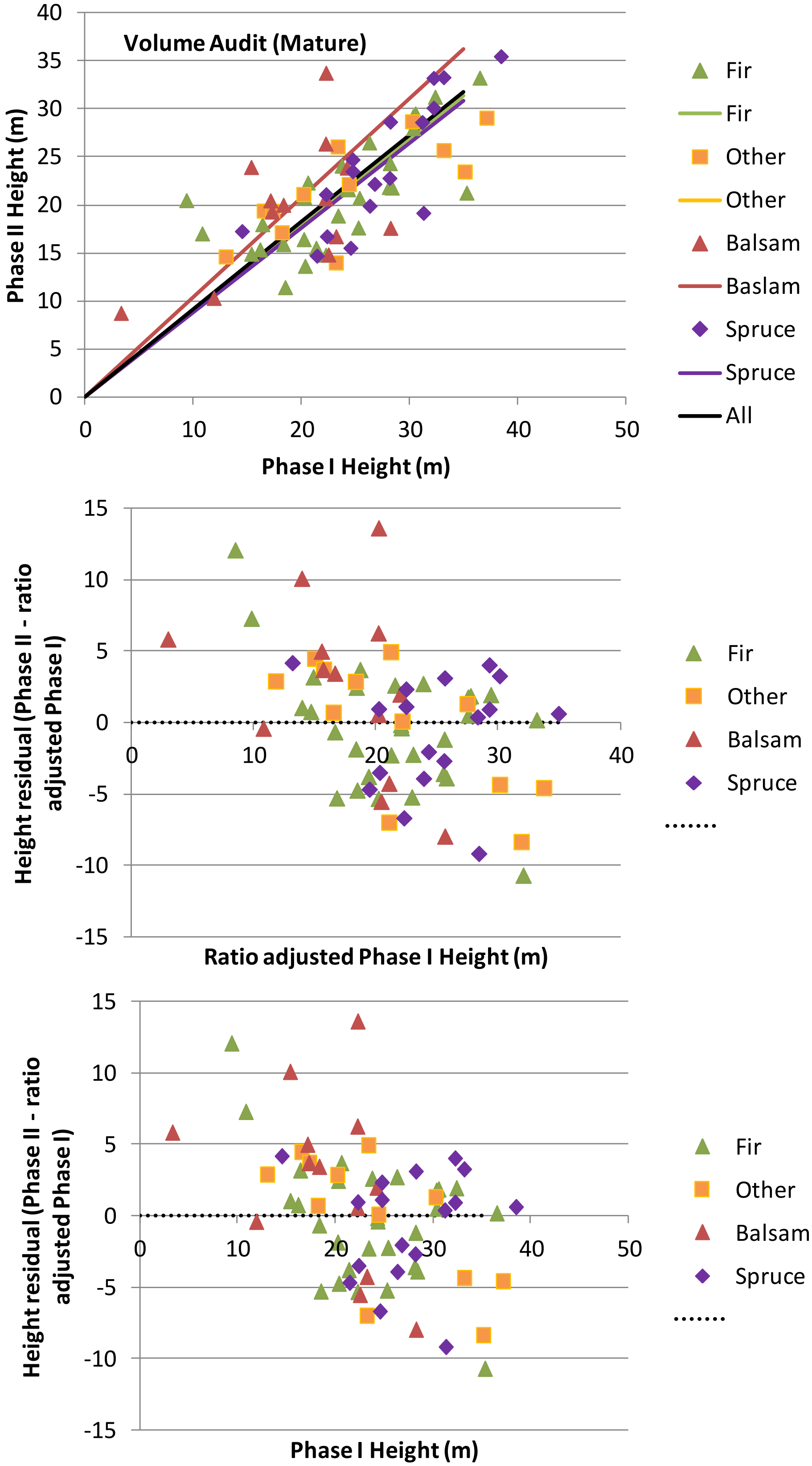


Figure 7. The scatterplots for Height are given.

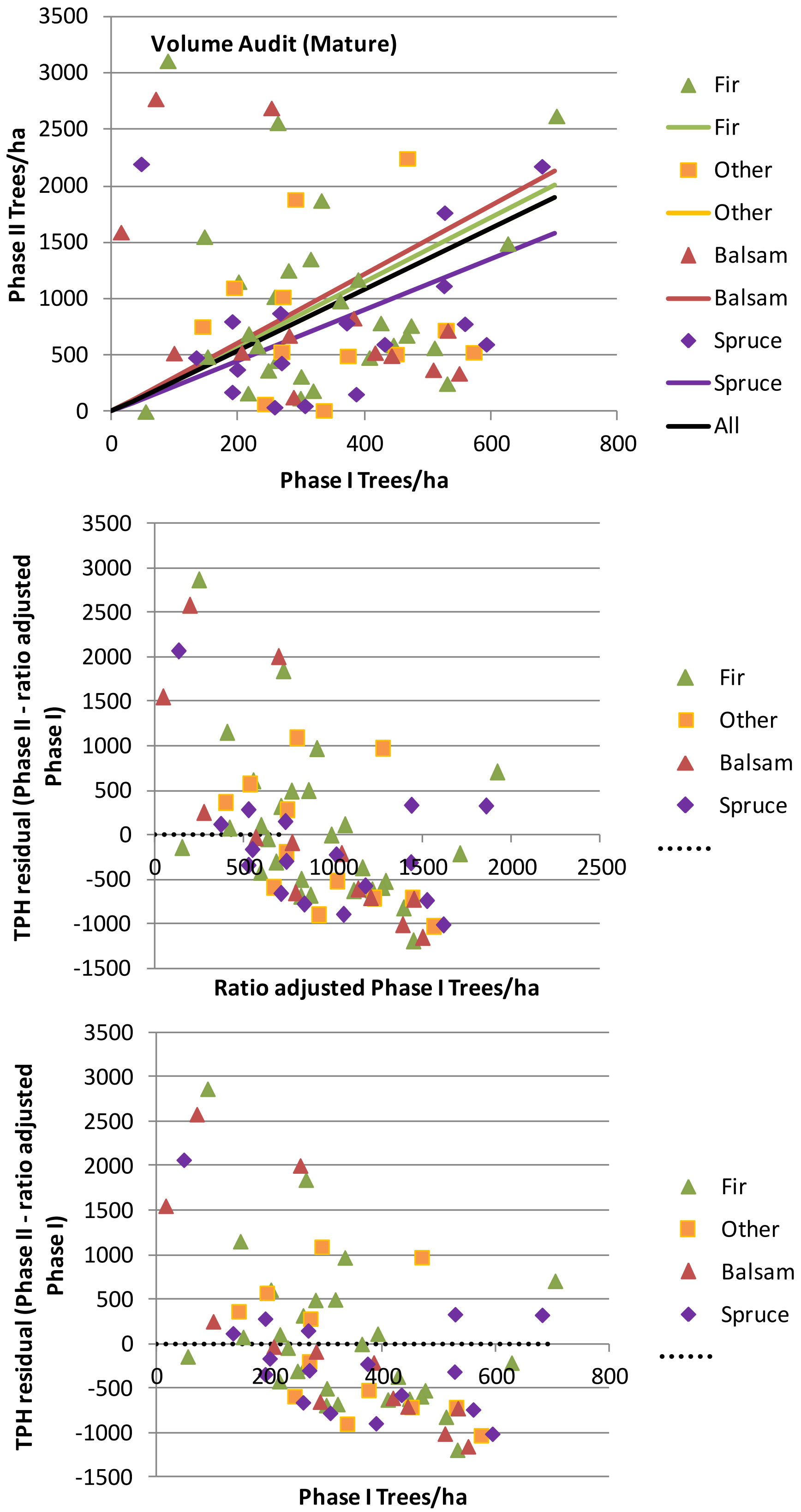


Figure 8. The scatterplots for Trees/ha are given.

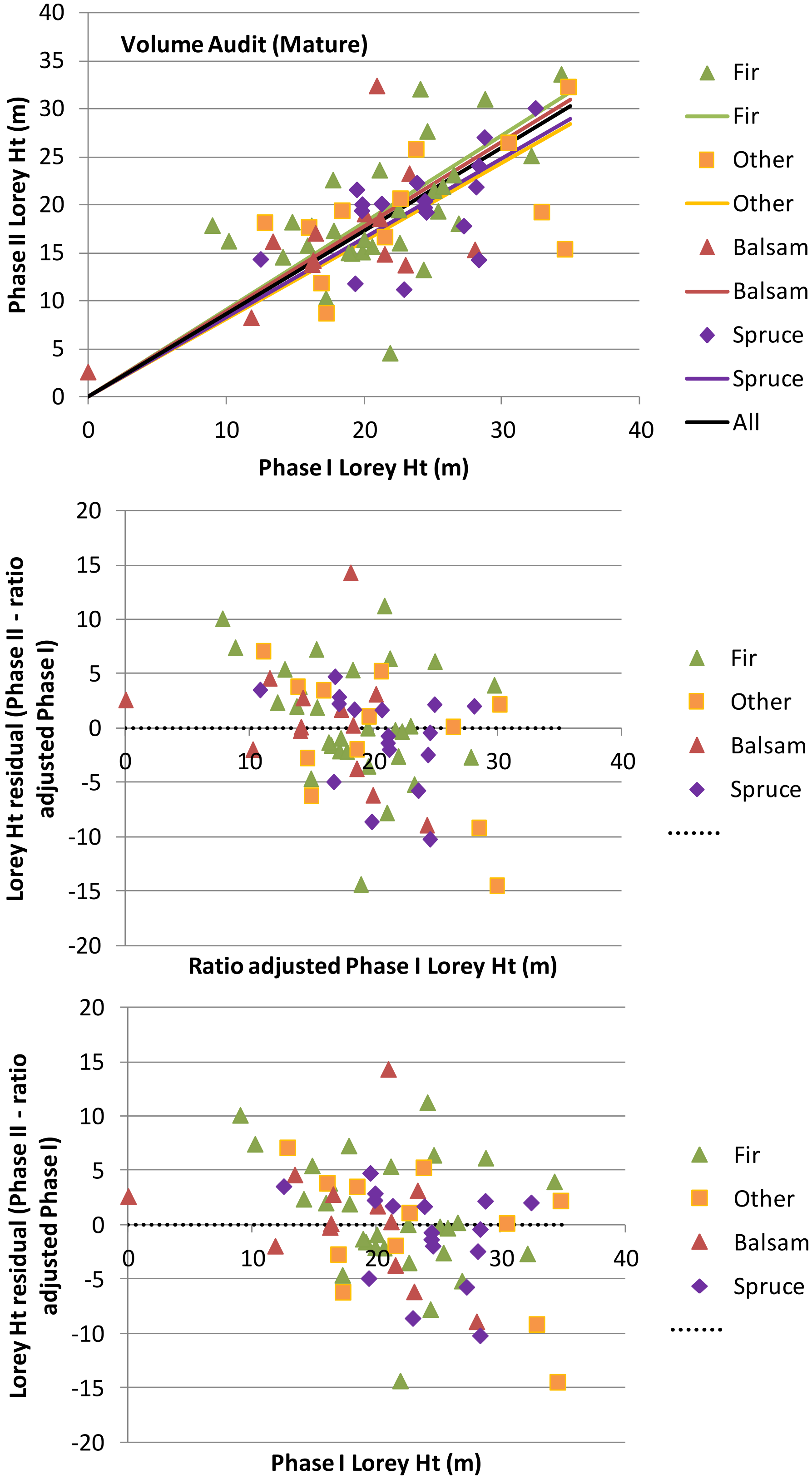


Figure 9. The scatterplots for Lorey height are given.

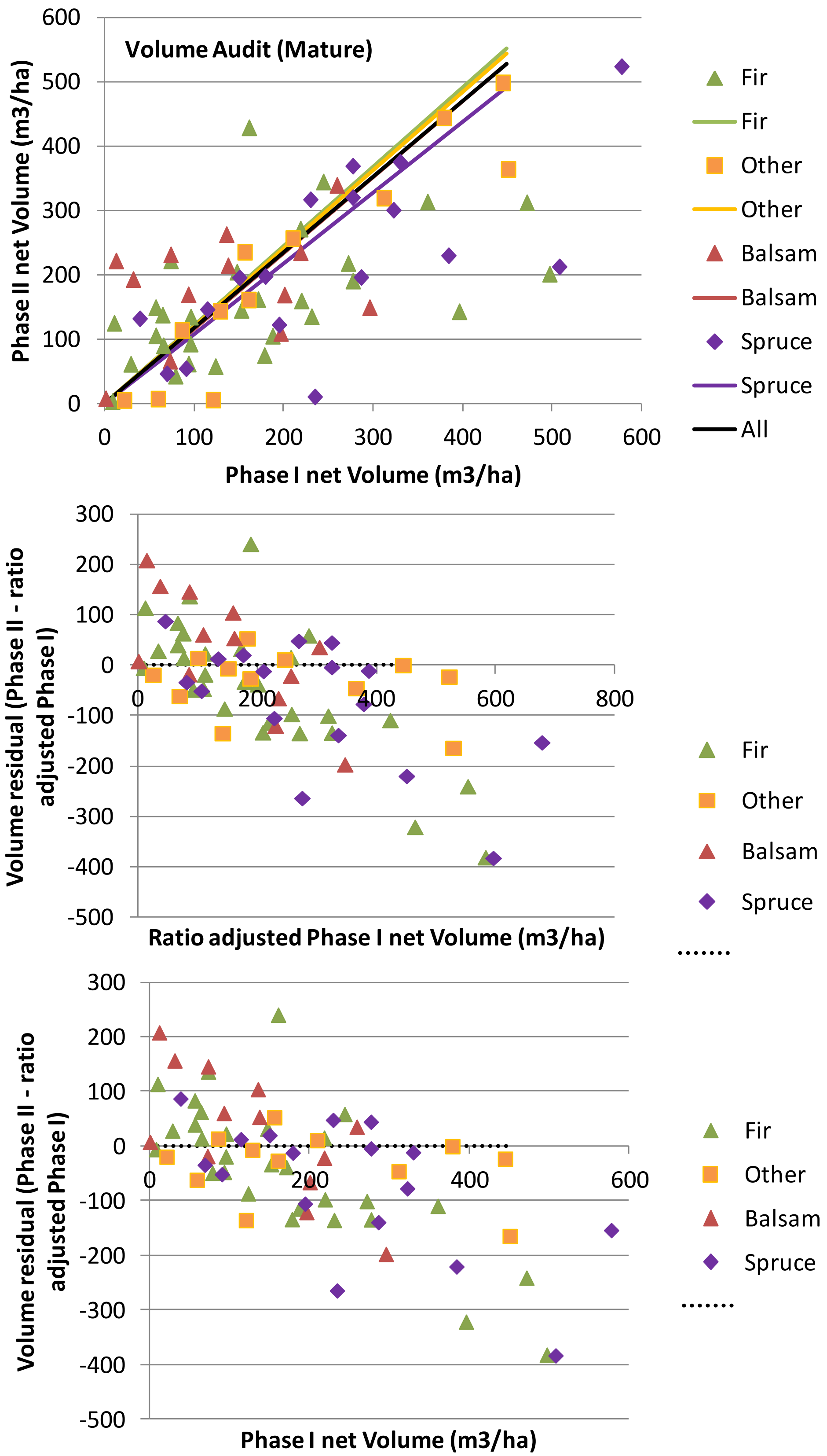
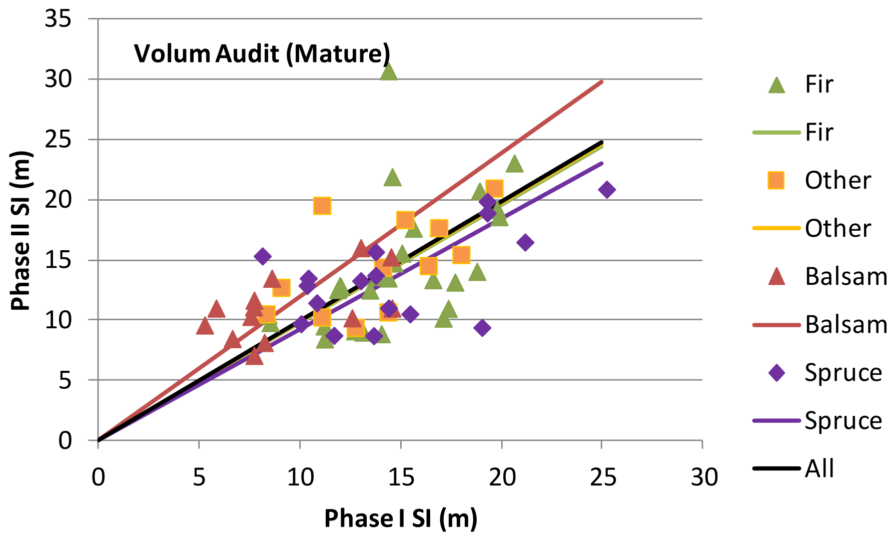
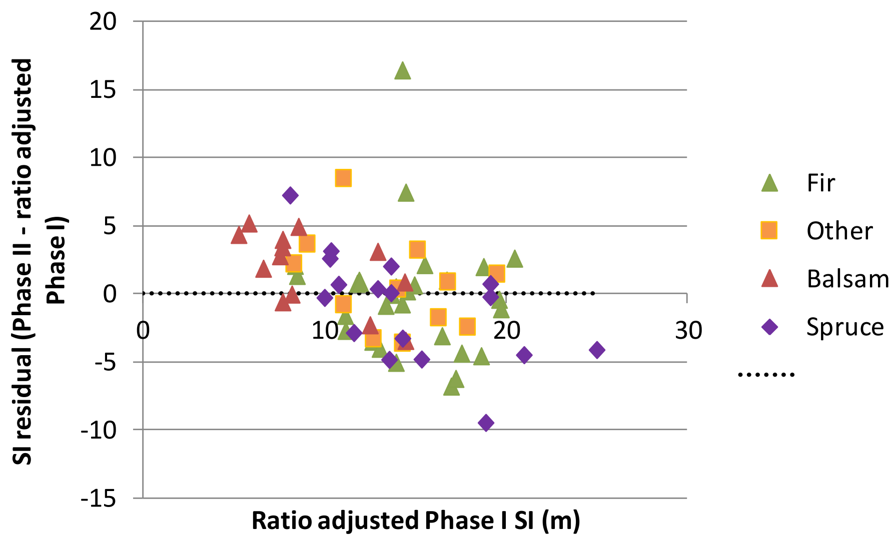


Figure 10. The scatterplots for Volume net of decay, waste and breakage are given.





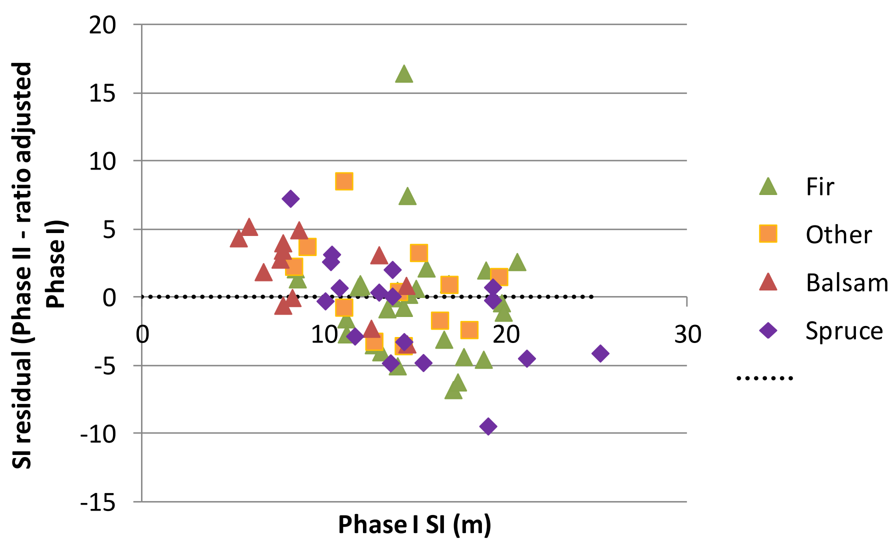
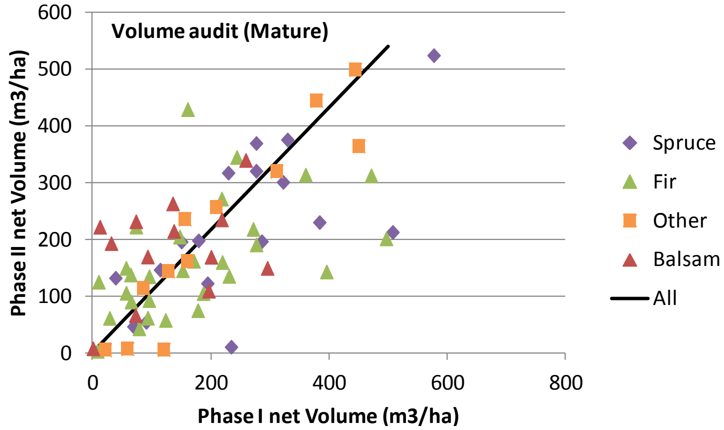
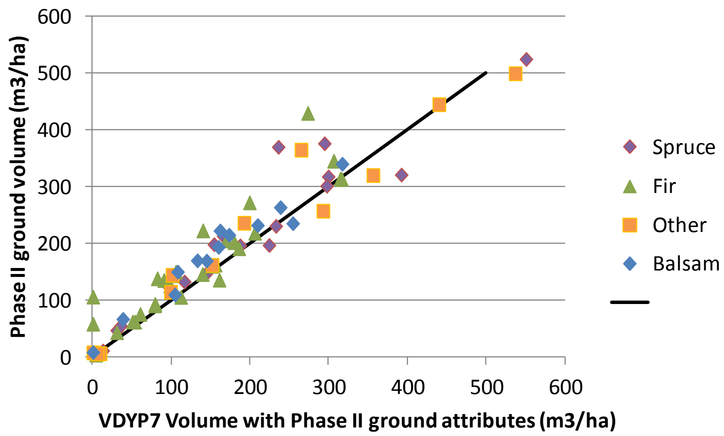
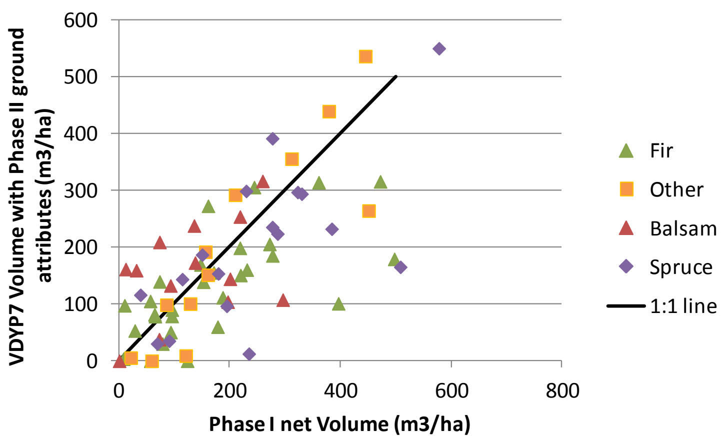


Figure 11. The scatterplots for Site index are given.

14. Appendix G: Graphs of total volume bias, model bias and attribute bias.







The top graph illustrates the total volume error (Phase I vs. Phase II volume). 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 middle graph illustrates model-related volume error (VDYP7 volume using Phase II inputs vs. Phase II volume). The model-related volume error is small indicating the VDYP7 volume estimates are similar to those from the ground compiler. The bottom graph 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.

15. Appendix I – Stand and Stock tables

Kamloops TSA

ADDENDUM: Stand and Stock Tables from VRI Phase II Ground Samples

Prepared for:
Ministry of Forests, Lands and Natural Resource Operations
Forest Analysis and Inventory Branch
Victoria, BC

Prepared by:
Forest Analysis Ltd.

FEBRUARY 2, 2015

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1. Introduction and Notes to Tables

This set of stand and stock tables and accompanying graphs was produced as an addendum to the report "Kamloops TSA: Documentation of Vegetation Resources Inventory Analysis"[6]. That report includes information on the definition of the population of interest, the ground sampling and weights. In addition, that report also compares the VRI Phase I inventory to the Phase II ground sampling in terms of the ratio of means and associated standard errors.

The stand and stock tables give here are based on the Phase II ground sampling although the population definition is based on the Phase I inventory. The volume audit population includes stands 51 years and older in the Vegetated Treed portion of the landbase. Private land, parks and federal Lands (military reserves and Indian reserves) are excluded from the Volume Audit population. Community Forests and Woodlots have been retained.

Seventy-two ground samples were established. The samples were stratified by BEC based on the Phase I (Inventory) BEC.

- The strata used to summarize the results are defined.

Stratification	Strata	Definition	N
BEC	ESSF	ESSF	20
	ICH	ICH	17
	IDF	IDF	26
	Other	MS, PP	9
Total			72

The Phase II ground samples trees with DBH ≥ 4cm. Hence the lower bound of the 4 cm DBH class is 4 cm rather than 2.5 cm.

All volumes/ha reported in the stock tables are merchantable volume (10cm minimum top diameter and 30cm high stump) net of decay, waste and breakage. Volumes have been net factored and have had net volume adjustment factors (NVAF) applied. As a result of the merchantability limits, there is no volume reported in the lowest DBH class.

In the tables, a "." In a cell indicates there were no trees with that combination of species, Dbh class and live/dead status. A zero indicates trees were present but represented fewer than 0.5 trees/ha for the stand tables and less than 0.05 m^3/ha for the stock table.

[6] *"Kamloops TSA: Documentation of Vegetation Resources Inventory Analysis",* prepared by Forest Analysis Ltd.

2. Live Mature

Most of the live, mature trees are Douglas-fir and most are in the smallest Dbh class.

Table 1. *Stand Table: Distribution of Mean Trees/ha by DBH class Mature samples (51+ years of age), LIVE trees*

Trees /ha															
	DBH Class (cm)														
Sp0	5	10	15	20	25	30	35	40	45	50	55	60	65	70+	*Subtotal*
AT	4	2	2	1	2	2	0	.	0	.	.	.	.	.	15
B	38	79	79	33	16	13	4	5	1	0	1	0	0	.	269
C	24	62	25	11	9	2	2	1	2	1	1	1	0	1	142
E	14	.	4	3	2	2	2	0	.	.	.	.	.	0	28
F	120	147	39	30	17	10	16	10	4	4	3	2	1	1	403
H	46	18	17	8	2	2	7	2	1	1	.	0	0	0	103
PL	.	17	7	6	1	1	.	.	.	.	.	.	.	.	32
PW	4	1	3	.	.	.	0	.	.	.	.	.	.	0	9
PY	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
S	63	72	30	16	16	6	8	6	3	2	1	1	1	0	224
Subtotal	312	400	206	109	64	39	39	24	12	8	5	4	2	3	1226

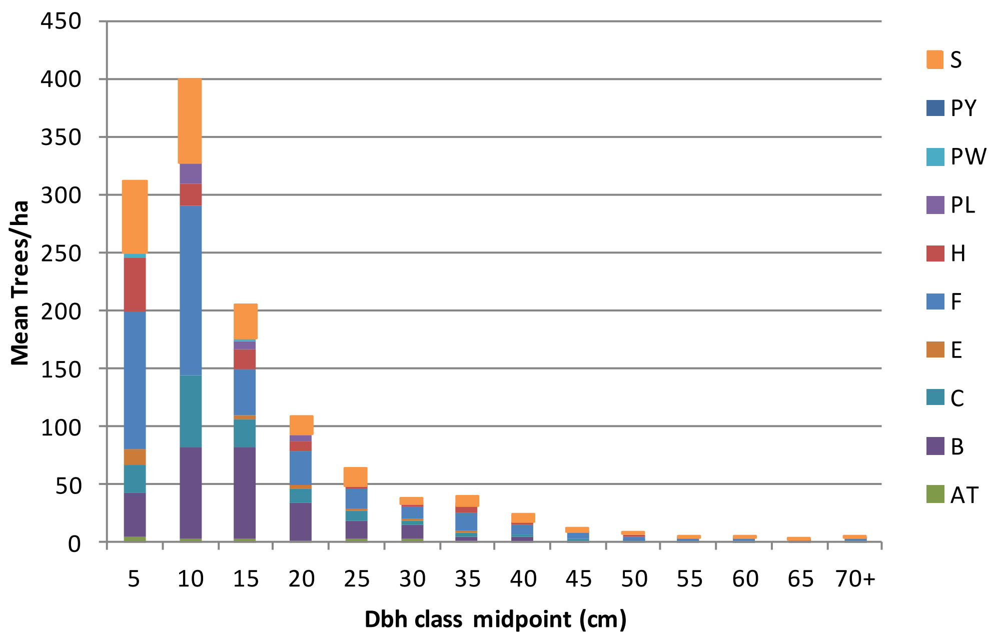


Figure 1. *Mean trees/ha by DBH class and species for mature samples (51+ years of age), LIVE trees.*

Approximately one third of the live, mature volume is Douglas-fir with approximately 25% of the volume (all species) in trees with Dbh > 52.2 cm.

Table 2. *Stock Table: Distribution of Mean Volume m^3/ha) by DBH class Mature samples (51+ years of age), LIVE trees*

	Volume (m^3/ha)														
	DBH Class (cm)														
Sp0	5	10	15	20	25	30	35	40	45	50	55	60	65	70+	*Subtotal*
AT	0.0	0.0	0.3	0.4	0.7	1.4	0.3	.	0.1	.	.	.	.	.	3.1
B	0.0	0.7	5.8	5.6	4.5	6.1	3.2	5.3	1.6	1.0	1.8	0.3	0.9	.	36.9
C	0.0	0.4	1.5	1.5	2.3	0.8	1.3	0.6	1.4	1.3	0.8	1.4	0.7	5.6	19.7
E	0.0	.	0.3	0.6	0.6	1.0	1.0	0.3	.	.	.	.	.	0.5	4.4
F	0.0	1.4	2.9	4.5	4.9	4.4	9.8	8.8	5.4	5.8	5.4	4.5	2.6	5.7	66.0
H	0.0	0.0	0.9	0.9	0.3	0.7	3.7	1.4	1.5	1.3	.	0.4	0.4	0.4	12.0
PL	.	0.5	0.7	1.5	0.4	0.4	.	.	.	.	.	.	.	.	3.5
PW	0.0	0.0	0.2	.	.	.	0.2	.	.	.	.	.	.	1.0	1.4
PY	.	0.0	.	.	.	.	.	.	.	.	.	.	.	.	0.0
S	0.0	0.9	2.4	2.9	5.3	3.1	6.3	7.0	5.2	4.1	2.1	2.7	3.2	2.4	47.7
Subtotal	0.0	3.9	15.1	18.0	19.0	17.9	25.8	23.4	15.2	13.5	10.2	9.2	7.9	15.6	194.7

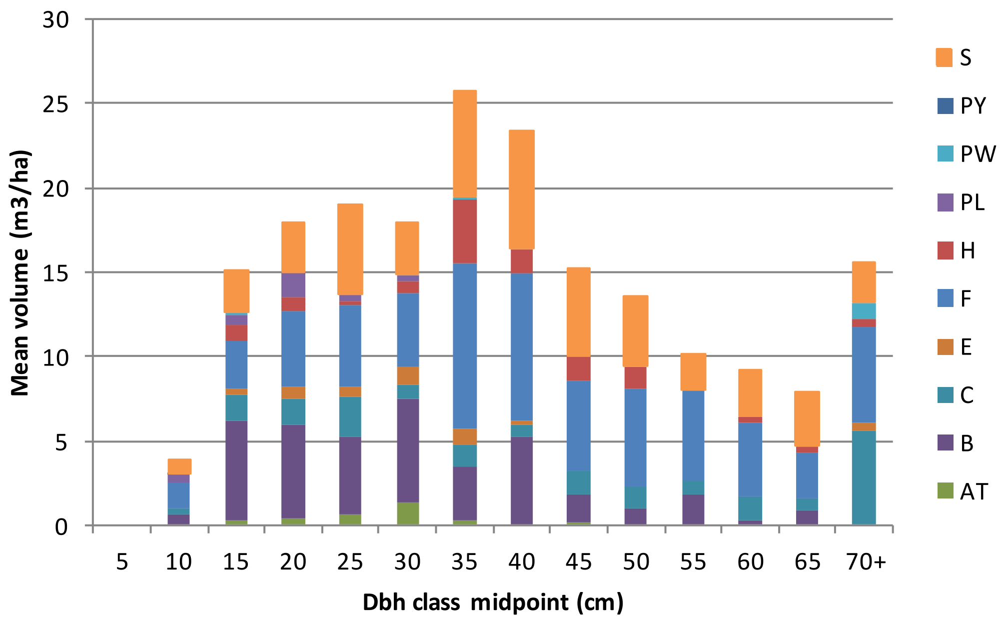


Figure 2. *Mean volume (m^3/ha) by DBH class and species for mature samples (51+ years of age), LIVE trees.*

3. Dead Mature

Most of the dead, mature trees are lodgepole pine in the 10-20 cm Dbh classes.

Table 3. *Stand Table: Distribution of Mean Trees/ha by DBH class Mature samples (51+ years of age), DEAD trees*

Trees /ha															
	DBH Class (cm)														
Sp0	5	10	15	20	25	30	35	40	45	50	55	60	65	70+	*Subtotal*
AT	.	.	1	1	2	.	.	0	.	.	.	.	.	.	4
B	.	33	8	6	9	7	2	3	2	1	0	0	0	.	71
C	.	.	1	.	1	.	0	0	0	0	0	.	0	0	4
E	5	6	3	3	0	.	.	.	0	.	.	.	.	.	18
F	15	9	6	10	3	3	1	1	1	0	0	0	.	0	52
H	.	.	1	2	.	1	.	.	.	0	.	0	.	.	5
PL	13	34	32	29	18	9	5	1	0	0	0	.	.	.	143
PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PY	.	.	.	1	.	0	.	0	0	0	.	.	.	.	2
S	.	16	1	3	1	1	1	1	0	0	0	0	0	0	26
Subtotal	34	98	54	54	35	22	9	7	5	3	1	1	1	1	323

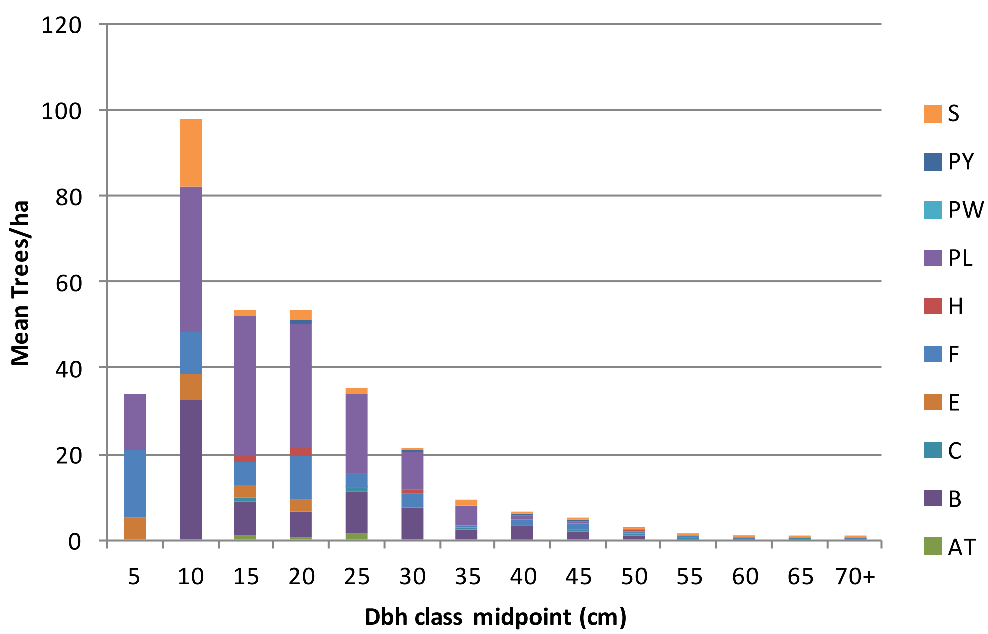


Figure 3. *Mean trees/ha by DBH class and species for mature samples (51+ years of age), DEAD trees.*

Most of the dead, mature volume is lodgepole pine, followed by balsam. The majority of the large, dead trees are spruce, cedar and Douglas-fir.

Table 4. *Stock Table: Distribution of Mean Volume m^3/ha) by DBH class Mature samples (51+ years of age), DEAD trees*

	Volume (m^3/ha)														
	DBH Class (cm)														
Sp0	5	10	15	20	25	30	35	40	45	50	55	60	65	70+	*Subtotal*
AT	.	.	0.0	0.0	0.1	.	.	0.0	.	.	.	.	.	.	0.2
B	.	0.1	0.4	0.6	1.6	2.4	1.1	2.0	1.8	1.3	0.2	0.2	0.1	.	11.9
C	.	.	0.1	.	0.0	.	0.1	0.1	0.1	0.3	0.0	.	0.2	0.3	1.2
E	0.0	0.0	0.0	0.0	0.0	.	.	.	0.0	.	.	.	.	.	0.1
F	0.0	0.1	0.0	0.6	0.4	0.6	0.0	0.3	0.3	0.2	0.6	0.1	.	0.0	3.1
H	.	.	0.0	0.1	.	0.0	.	.	.	0.0	.	0.1	.	.	0.2
PL	0.0	1.1	3.2	6.3	6.7	4.7	3.7	1.4	0.3	0.5	0.2	.	.	.	28.0
PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PY	.	.	.	0.0	.	0.1	.	0.1	0.2	0.0	.	.	.	.	0.4
S	.	0.1	0.1	0.3	0.3	0.4	0.7	0.3	0.2	0.6	0.4	0.4	1.4	2.0	7.0
Subtotal	0.0	1.4	3.9	7.9	9.0	8.1	5.5	4.2	2.9	3.1	1.3	0.6	1.8	2.3	52.1

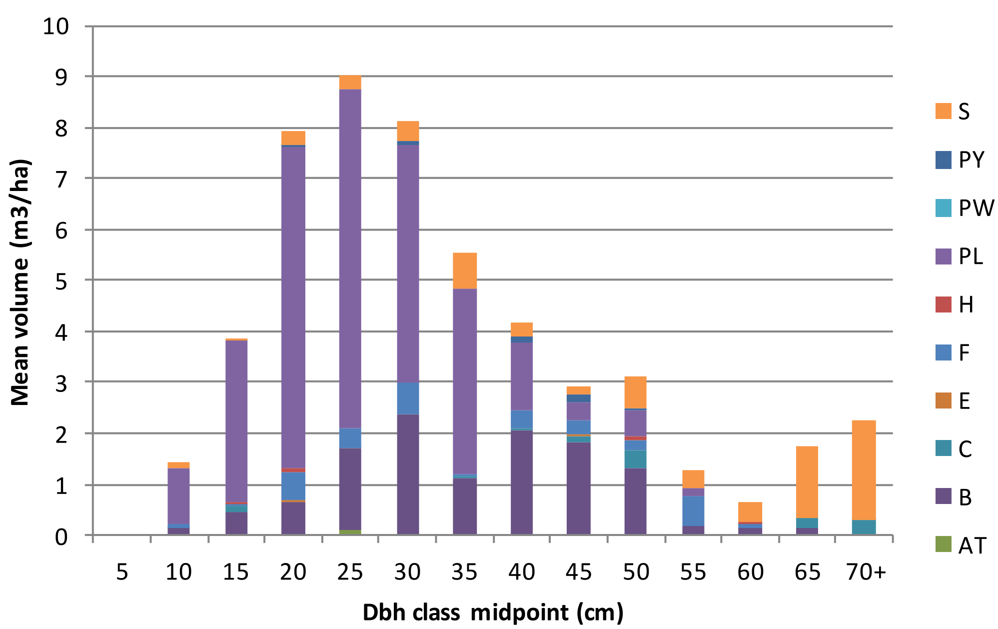


Figure 4. *Mean volume (m^3/ha) by DBH class and species for mature samples (51+ years of age), DEAD trees.*

4. Live, mature, by BEC

The ESSF is dominated by balsam and spruce, the ICH by cedar and hemlock, the IDF by Douglas-fir and the “Other” BEC zones are dominated by spruce.

Table 5. *Stand Table: Distribution of Mean Trees/ha by DBH class for live, mature samples by BEC zone.*

	Trees /ha															
		DBH Class (cm)														
	Sp0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70+**	***Subtotal***
ESSF	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	B	136	214	226	85	49	42	13	13	4	2	1	0	1	.	786
	C	.	.	.	.	2	2	1	.	.	.	.	0	.	0	6
	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	F	.	.	4	4	.	1	1	2	1	2	.	0	.	.	15
	H	.	.	11	2	.	.	.	.	.	.	.	.	.	.	13
	PL	.	.	7	4	3	1	.	.	.	.	.	.	.	.	15
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	S	106	124	40	15	20	10	9	9	2	3	2	1	2	1	343
	Subtotal	241	338	288	110	74	56	25	24	7	7	3	2	3	1	1178
ICH	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	B	.	26	49	25	7	4	3	5	.	.	1	.	1	.	122
	C	74	209	98	44	36	7	8	4	6	4	2	3	2	6	503
	E	59	.	12	7	7	3	3	1	.	.	.	.	.	0	92
	F	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	H	192	74	59	31	7	8	29	9	6	4	.	1	1	0	420
	PL	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2
	PW	18	5	13	.	.	.	1	.	.	.	.	.	.	1	38
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	S	.	24	33	22	17	7	14	11	6	5	1	1	1	0	143
	Subtotal	343	339	264	130	74	31	57	30	18	12	5	5	4	7	1320
IDF	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	B	.	20	.	.	.	.	.	.	.	.	.	.	.	.	20
	C	17	33	4	2	.	.	1	.	0	0	.	.	.	.	57
	E	.	.	3	5	1	4	3	0	.	.	.	.	.	.	16
	F	311	395	88	70	41	23	36	20	7	5	4	3	1	2	1006
	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	PL	.	20	8	2	.	.	.	.	.	.	.	.	.	.	31
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	S	34	69	22	13	11	1	2	2	2	0	0	0	.	.	156
	Subtotal	362	537	125	92	53	28	41	22	9	5	4	3	1	2	1286
Other	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	B	.	51	35	24	4	2	.	.	.	.	.	.	.	.	116
	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	F	.	30	50	12	10	.	1	2	.	.	.	.	.	0	106
	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PL	.	82	18	37	.	.	.	.	.	.	.	.	.	.	137
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	10	.	.	.	.	.	.	.	.	.	.	.	.	

	Trees /ha															
		DBH Class (cm)														
	Sp0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70+**	***Subtotal***
	S	173	59	21	16	17	9	9	6	6	.	.	1	.	.	316
	Subtotal	173	233	123	89	31	12	10	8	6	0	0	1	0	0	685

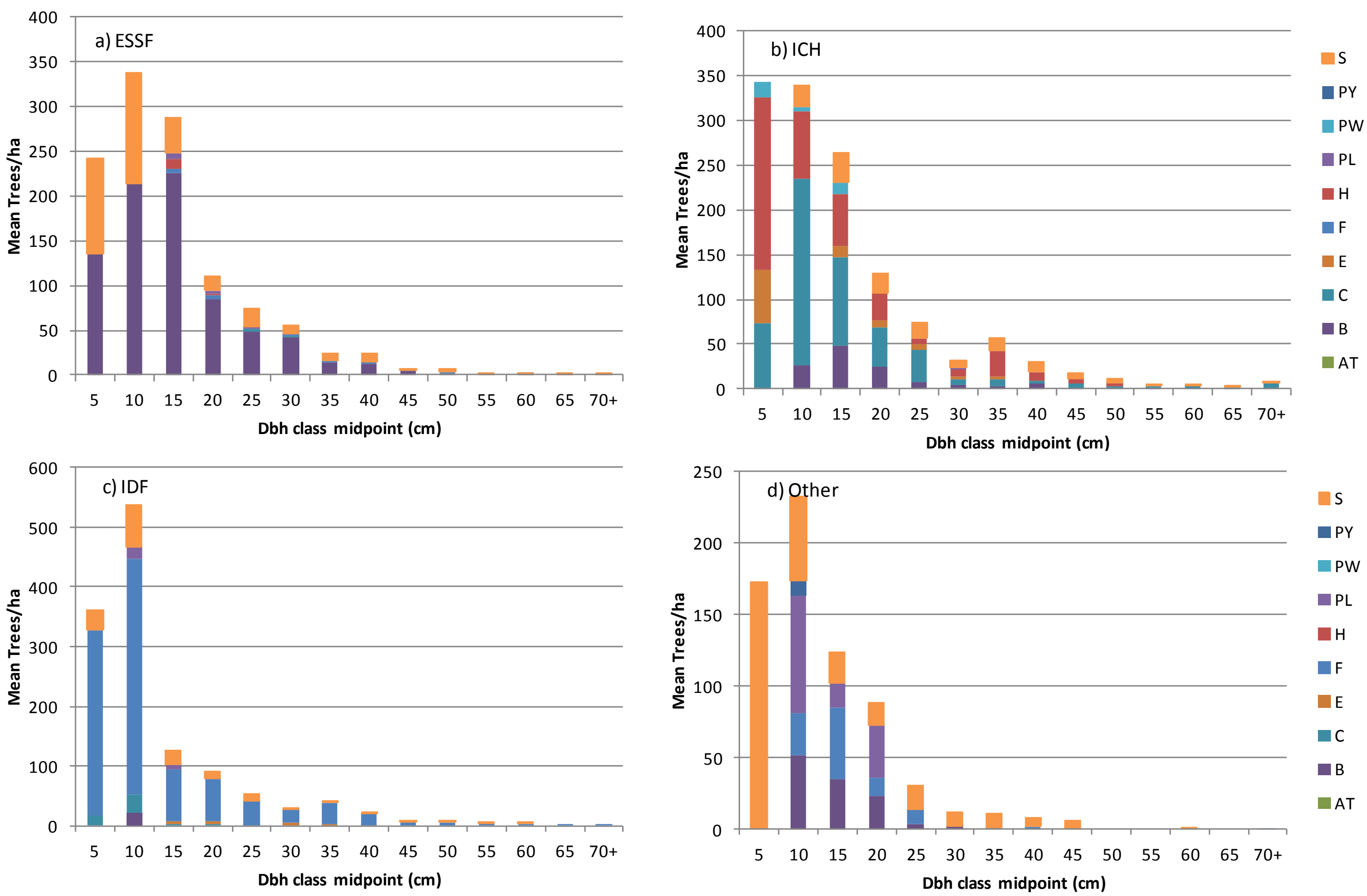


Figure 5. *Mean trees/ha by DBH class and species for live, mature samples by BEC zone.*

The IDF and "Other" BEC zones have the lowest volumes.

Table 6. *Stock Table: Distribution of Mean volume/ha by DBH class for live, mature samples by BEC zone.*

		Volume m^3/ha														
		DBH Class (cm)														
	Sp0	5	10	15	20	25	30	35	40	45	50	55	60	65	70+	*Subtotal*
ESSF	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	B	0.0	2.2	17.2	14.0	13.9	19.5	9.6	13.8	5.9	3.5	3.0	1.0	0.7	.	104.3
	C	.	.	.	.	0.4	0.6	0.6	.	.	.	.	0.7	.	0.7	2.9
	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	F	.	.	0.4	0.2	.	0.6	0.3	2.1	0.8	2.6	.	0.9	.	.	7.9
	H	.	.	0.5	0.2	.	.	.	.	.	.	.	.	.	.	0.7
	PL	.	.	0.4	0.8	1.5	0.5	.	.	.	.	.	.	.	.	3.2
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	S	0.0	1.2	2.9	2.8	5.6	5.2	7.5	9.9	3.1	5.3	4.3	4.7	9.4	5.8	67.6
	Subtotal	0.0	3.4	21.4	17.9	21.3	26.5	18.1	25.8	9.7	11.4	7.2	7.3	10.1	6.5	186.6
ICH	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	B	.	0.2	3.2	5.2	2.2	2.1	2.2	6.1	.	.	4.2	.	2.9	.	28.4
	C	0.0	1.6	6.2	5.9	9.4	2.7	4.3	2.7	5.6	4.6	3.4	5.0	3.1	22.9	77.3
	E	0.0	.	1.1	1.6	2.2	1.1	1.5	0.7	.	.	.	.	.	2.0	10.2
	F	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	H	0.0	0.0	3.4	3.6	1.2	2.9	5.8	5.8	6.4	5.5	.	1.5	1.7	1.7	39.6
	PL	.	.	.	.	.	1.2	.	.	.	.	.	.	.	.	1.2
	PW	0.0	0.2	0.7	.	.	.	0.6	.	.	.	.	.	.	4.4	5.9
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	S	.	0.8	3.0	4.2	6.2	3.8	1.9	12.7	9.9	10.3	3.1	3.2	2.6	3.4	65.1
	Subtotal	0.0	2.8	17.6	20.5	21.3	13.7	16.4	28.0	21.9	20.4	10.7	9.8	10.3	34.4	227.7
IDF	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	B	.	0.0	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	C	0.0	0.0	0.2	0.3	.	.	0.3	.	0.3	0.6	.	.	.	.	1.6
	E	.	.	0.2	0.7	0.3	2.1	1.7	0.4	.	.	.	.	.	.	5.4
	F	0.0	3.8	6.3	11.0	12.1	9.8	2.2	18.0	7.9	7.4	7.8	8.0	4.8	10.5	109.5
	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	PL	.	1.1	0.7	0.5	.	.	.	.	.	.	.	.	.	.	2.3
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	S	0.0	0.8	1.9	2.1	4.1	0.4	1.6	1.8	2.8	0.6	0.5	1.0	.	.	17.8
	Subtotal	0.0	5.7	9.4	14.7	16.5	12.3	5.8	20.1	11.0	8.6	8.4	9.0	4.8	10.5	136.7
Other	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	B	.	0.0	2.4	4.4	1.3	1.6	.	.	.	.	.	.	.	.	9.7
	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	F	.	0.4	3.6	1.8	2.6	.	0.9	1.8	.	.	.	.	.	0.5	11.6
	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PL	.	0.9	2.5	8.8	.	.	.	.	.	.	.	.	.	.	12.2
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	
	S	0.0	0.7	1.8	3.2	6.1	4.8	6.8	5.1	8.0	.	.	2.0	.	.	38.7
	Subtotal	0.0	2.2	10.3	18.3	10.1	6.4	7.7	6.9	8.0	0.0	0.0	2.0	0.0	0.5	72.3

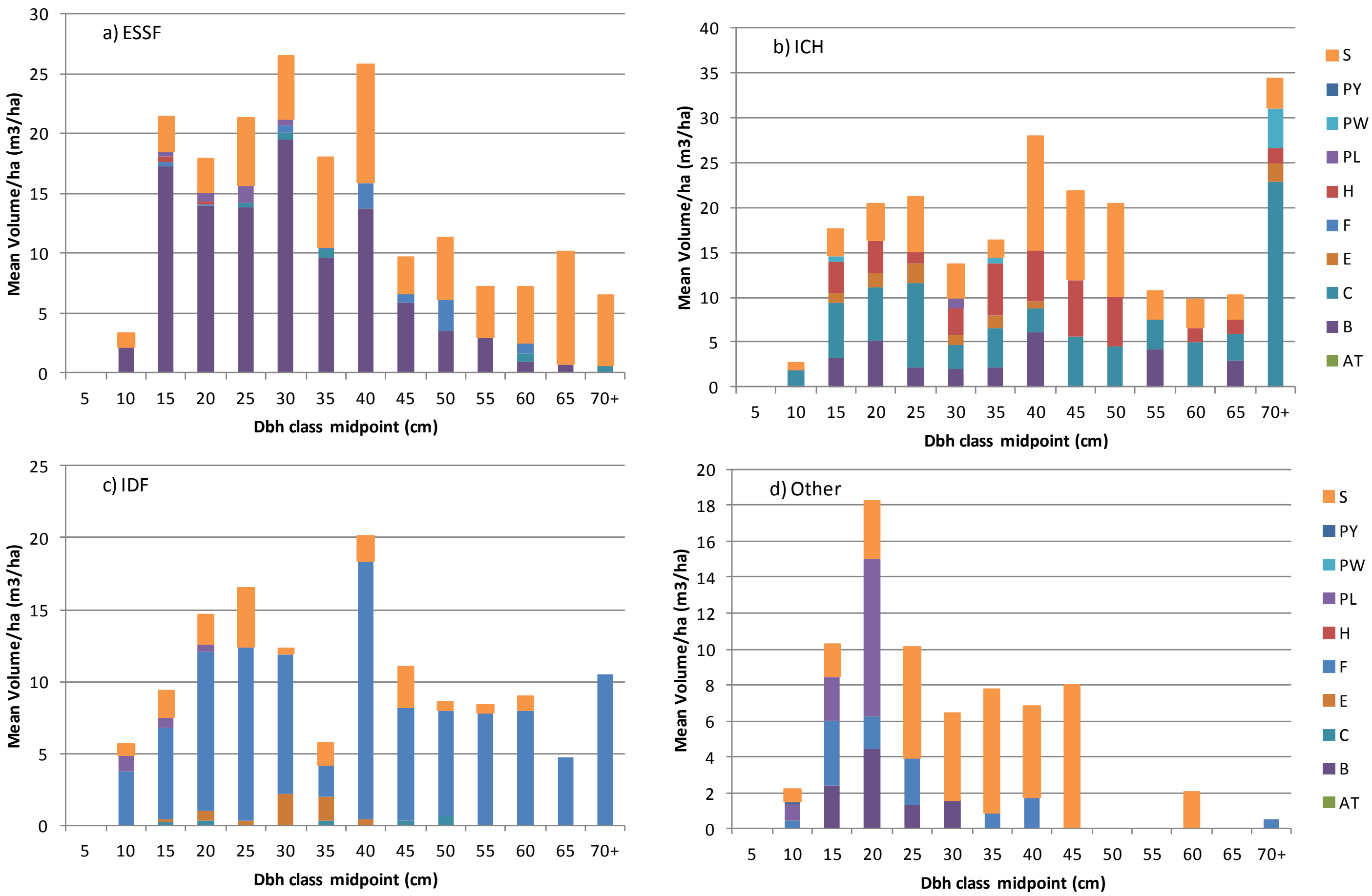


Figure 6. *Mean volume/ha by DBH class and species for live, mature samples by BEC zone.*

5. Dead, mature, by BEC

The “Other” BEC zones have considerable pine mortality.

Table 7. *Stand Table: Distribution of Mean Trees/ha by DBH class for dead, mature samples by BEC zone.*

	Trees /ha															
		DBH Class (cm)														
	Sp0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70+**	***Subtotal***
ESSF	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	B	.	117	27	15	29	18	7	11	6	2	1	.	0	.	232
	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	F	.	.	6	10	2	5	.	.	.	.	.	.	.	.	24
	H	.	.	5	3	.	.	.	.	.	.	.	.	.	.	7
	PL	.	.	4	15	11	13	9	2	1	.	.	.	.	.	54
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	S	.	.	.	3	2	.	1	.	1	1	1	0	.	.	10
	Subtotal	0	117	43	45	43	36	18	13	7	3	2	0	0	0	327
ICH	AT	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2
	B	.	.	.	.	6	11	1	.	2	2	.	0	.	.	23
	C	.	.	5	.	3	.	1	1	2	2	1	.	1	0	16
	E	.	.	5	8	.	.	.	.	1	.	.	.	.	.	14
	F	.	18	.	9	2	3	1	1	4	1	1	0	.	0	41
	H	.	.	.	4	.	4	.	.	.	1	.	1	.	.	11
	PL	.	.	6	3	4	.	2	2	.	1	.	.	.	.	18
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	S	.	39	6	4	.	3	1	.	.	1	.	.	2	2	58
	Subtotal	0	58	22	28	18	21	7	4	8	7	2	2	3	3	182
IDF	AT	.	.	3	2	2	.	.	0	.	.	.	.	.	.	8
	B	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	E	15	17	4	2	1	.	.	.	.	.	.	.	.	.	39
	F	42	14	.	15	6	3	1	2	1	1	1	0	.	0	87
	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	PL	23	26	42	17	16	4	2	0	.	.	.	.	.	.	129
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	.	.	.	.	1	.	0	0	0	.	.	.	.	1
	S	.	5	.	2	2	.	1	.	.	.	.	0	.	0	11
	Subtotal	80	63	50	38	28	7	3	3	2	1	1	0	0	0	276
Other	AT	.	.	.	.	3	.	.	.	.	.	.	.	.	.	3
	B	.	.	.	12	.	.	.	.	.	.	.	.	.	.	12
	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	F	.	.	32	.	.	.	.	1	.	.	.	.	.	0	34
	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	PL	42	205	120	150	69	31	9	2	1	1	1	.	.	.	631
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	PY	.	.	.	4	.	2	.	1	2	.	.	.	.	.	
	S	.	35	.	.	.	.	3	4	.	.	.	.	.	.	42

	Trees /ha														
		DBH Class (cm)													
	Sp0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70+**	***Subtotal***
	Subtotal	42	240	152	167	73	33	12	9	2	1	1	0	0	0	731

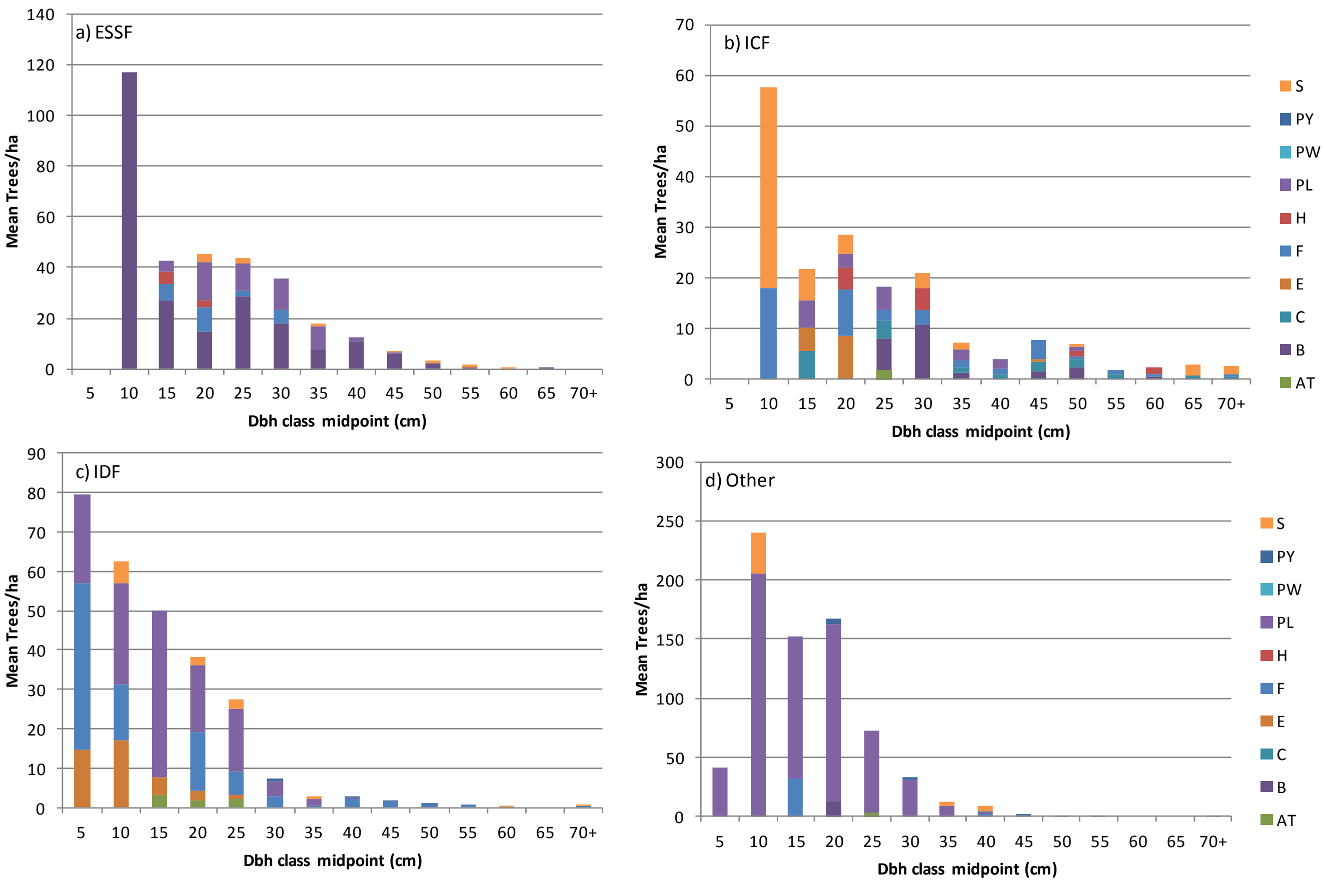


Figure 7. *Mean trees/ha by DBH class and species for dead, mature samples by BEC zone.*

Table 8. *Stock Table: Distribution of Mean Volume/ha by DBH class for dead, mature samples by BEC zone.*

	Volume m^3/ha															
		DBH Class (cm)														
	Sp0	5	10	15	20	25	30	35	40	45	50	55	60	65	70+	*Subtotal*
ESSF	AT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	B	.	0.5	1.5	1.5	5.0	5.6	3.5	7.3	4.8	2.3	0.6	.	0.5	.	33.2
	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	F	.	.	0.0	0.3	0.0	0.3	.	.	.	.	.	.	.	.	0.6
	H	.	.	0.1	0.1	.	.	.	.	.	.	.	.	.	.	0.2
	PL	.	.	0.3	3.8	4.0	7.0	7.2	1.8	0.7	.	.	.	.	.	24.9
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	S	.	.	.	0.4	0.3	.	1.2	.	0.6	1.2	1.3	0.9	.	.	5.9
	Subtotal	0.0	0.5	2.0	6.0	9.2	12.9	11.9	9.1	6.1	3.5	1.9	0.9	0.5	0.0	64.6
ICH	AT	.	.	.	.	0.1	.	.	.	.	.	.	.	.	.	0.1
	B	.	.	.	.	0.9	3.5	0.6	.	2.0	2.9	.	0.6	.	.	10.6
	C	.	.	0.5	.	0.0	.	0.2	0.3	0.6	1.5	0.0	.	0.8	1.2	5.1
	E	.	.	0.1	0.1	.	.	.	.	0.2	.	.	.	.	.	0.3
	F	.	0.0	.	0.4	0.2	0.9	0.0	0.9	0.5	0.2	1.4	0.2	.	0.0	4.6
	H	.	.	.	0.2	.	0.1	.	.	.	0.2	.	0.2	.	.	0.7
	PL	.	.	0.6	0.7	2.1	.	1.2	1.7	.	1.4	.	.	.	.	7.6
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	S	.	0.2	0.2	0.5	.	1.5	0.4	.	.	1.2	.	.	6.0	7.8	17.9
	Subtotal	0.0	0.2	1.4	1.8	3.2	6.0	2.4	3.0	3.3	7.3	1.4	1.0	6.8	9.0	47.0
IDF	AT	.	.	0.1	0.1	0.2	.	.	0.1	.	.	.	.	.	.	0.3
	B	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	E	0.0	0.0	0.0	0.0	0.0	.	.	.	.	.	.	.	.	.	0.1
	F	0.0	0.2	.	1.1	0.9	0.9	0.1	0.3	0.4	0.4	0.7	0.1	.	0.0	5.1
	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	PL	0.0	0.6	3.9	3.3	6.7	2.0	1.3	0.5	.	.	.	.	.	.	18.3
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PY	.	.	.	.	.	0.1	.	0.2	0.1	0.1	.	.	.	.	0.6
	S	.	0.1	.	0.2	0.6	.	0.2	.	.	.	.	0.3	.	0.3	1.8
	Subtotal	0.0	0.9	4.0	4.8	8.4	3.0	1.6	1.0	0.5	0.6	0.7	0.4	0.0	0.4	26.2
Other	AT	.	.	.	.	0.2	.	.	.	.	.	.	.	.	.	0.2
	B	.	.	.	1.5	.	.	.	.	.	.	.	.	.	.	1.5
	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	F	.	.	0.3	.	.	.	.	0.0	.	.	.	.	.	0.0	0.3
	H	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	PL	0.0	7.3	12.4	32.2	21.7	16.3	7.5	2.2	1.2	1.7	1.4	.	.	.	104.1
	PW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
	PY	.	.	.	0.2	.	0.2	.	0.2	1.0	.	.	.	.	.	
	S	.	0.0	.	.	.	.	1.5	2.3	.	.	.	.	.	.	3.7
	Subtotal	0.0	7.3	12.7	33.9	22.0	16.5	9.0	4.7	2.2	1.7	1.4	0.0	0.0	0.0	111.5

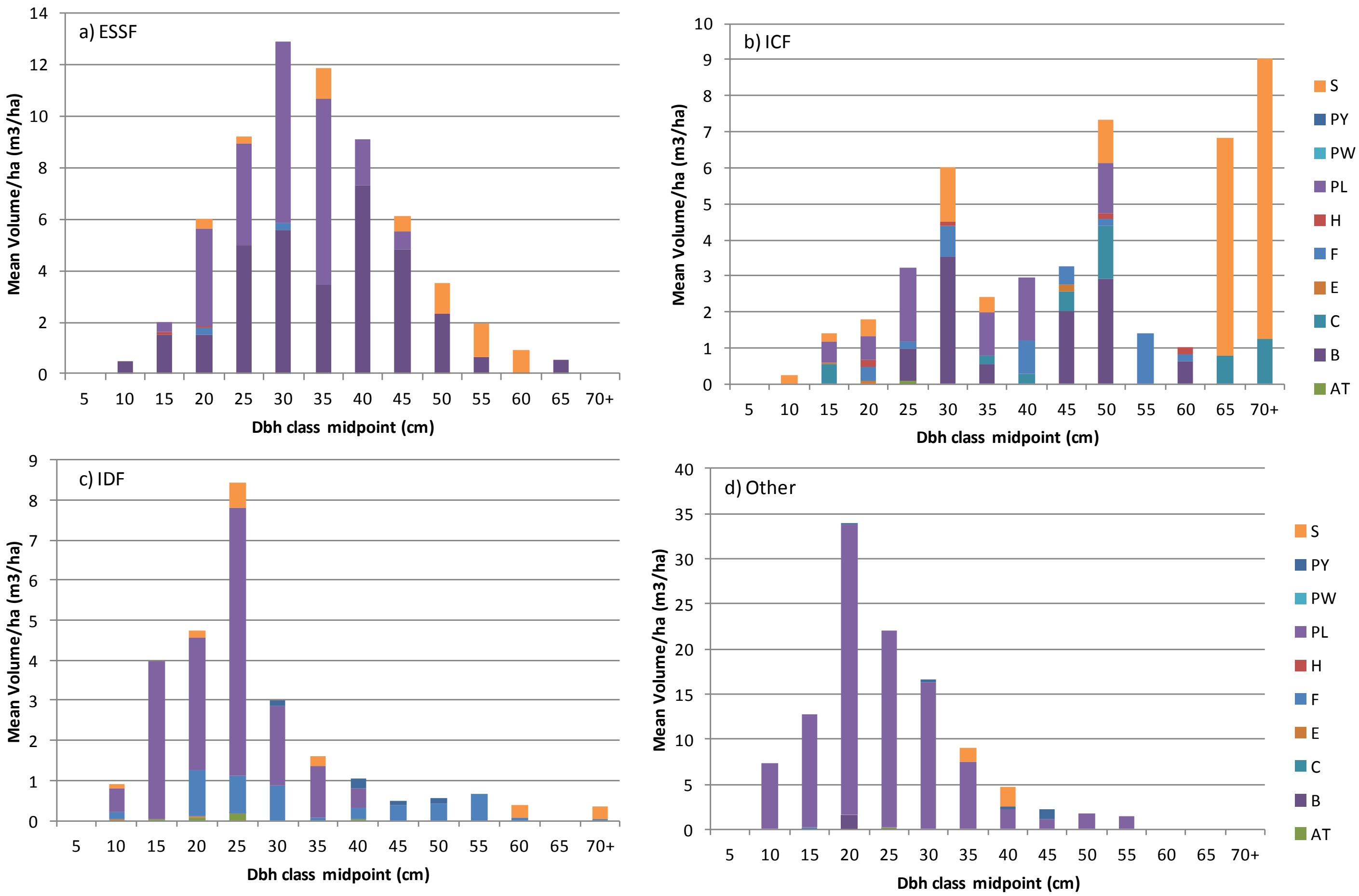


Figure 8. *Mean volume/ha by DBH class and species for dead, mature samples by BEC zone.*