Tree Farm Licence 52 Vegetation Resources Inventory
Statistical Adjustment Update

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Executive Summary

In December 2006 West Fraser Mills Ltd. (West Fraser) merged Tree Farm Licence (TFL) 5 and TFL 52 into a single TFL (TFL 52) with two blocks: A (formerly TFL 52) and B (formerly TFL 5). An updated statistical adjustment of the Vegetation Resources Inventory (VRI) is now therefore needed for TFL 52.

The target population for this project was 149,154 ha. It included Vegetated Treed stands, 40 years and older, and outside the ESSF biogeoclimatic zone on Block A or with a lodgepole pine component less than 35% or established after 1925 on Block B. Stands less than 40 years old are covered by the Change Monitoring Inventory (CMI) program.

Ninety-seven (97) VRI Phase II plots, established between 2002 and 2005, as well as 100 NVAF trees, sampled between 2004 and 2007, were used to develop adjustment ratios for height, age, basal area, trees/ha, and net merchantable volume 12.5 cm+ (live all species and dead lodgepole pine [Pl]). The newest version of VDYP7 and the most recent VRI statistical adjustment standards were used to complete the adjustment.

In 2008, the average volume in the target population was 275 m^3/ha, before adjustment. After adjustment, the live volume was 322 m^3/ha, an increase of 17% over the pre-adjustment estimate. Dead Pl volume represented an extra 10 m^3/ha.

The live volume estimate, however, is most likely over-estimating the true live volume in 2008 because most the Phase II plots were established before the TFL was severely hit by the Mountain Pine Beetle (MPB) infestation. For timber supply analysis purposes, all live Pl volume should be considered at risk of being killed in the short term. According to Phase I estimates, Pl represented approximately 21% of the 322 m^3/ha live volume. Preliminary analysis, however, indicated, that the proportion of Pl live volume is probably closer to 14%. This difference highlights the need to complete a species composition adjustment when adjusting the VRI.

The TFL 52 adjusted VRI should be used in the next Timber Supply Review as it represents the most accurate inventory information for the TFL.

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1. INTRODUCTION

1.1 BACKGROUND

1.1.1 Vegetation Resources Inventory Overview

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

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

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

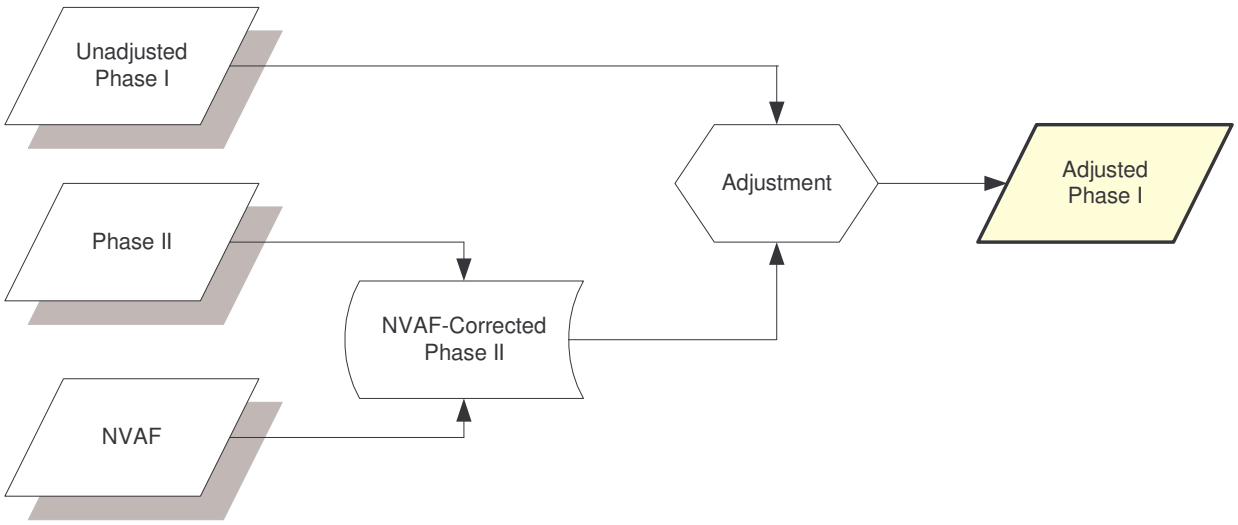

Figure 1. VRI flow-chart.

1.1.2 Tree Farm Licence 52 VRI Program

1.1.2.1 Block A

West Fraser Mills Ltd (West Fraser) initiated a VRI program on Block A in 1997. The Phase I was completed in 2001. The Phase II was completed over two field seasons (2002 and 2003). [1,2] The

[1] J.S. Thrower & Associates Ltd. 2002. West Fraser Mills Ltd. TFL 52 Vegetation Resources Inventory Project Implementation Plan. Unpublished report, Contract no. WFQ-029, August 12, 2002. 15 pp.

sampling component of the NVAF program was completed in two batches (2004 and 2007) and the analysis presented to the MoFR in 2008.[3] An initial VRI adjustment was completed in 2006.[4] A Change Monitoring Inventory (CMI) program was also initiated on Block A in 2002 to complement the VRI.[5]

1.1.2.2 Block B

The Phase I was completed in 2002. The Phase II was completed over a single field season (2005).[6] The NVAF was initiated and completed in 2008, at the same time as the second NVAF batch on Block A. No VRI adjustment has been done for Block B. A CMI program was initiated in 2004 on Block B.[7]

1.2 PROJECT OBJECTIVES

The objective of the project was to update the TFL 52 VRI statistical adjustment using NVAF-corrected Phase II data and Phase I inventory projection based on VDYP7, the new MoFR growth and yield model for natural stands. This updated VRI adjustment replaces the previous VRI adjustment completed for Block A in 2006.[4]

1.3 REPORT OBJECTIVES

The objective of this report was to provide information on the data preparation and the statistical analysis performed to complete the VRI statistical adjustment on TFL 52. MoFR staff provided technical support to ensure the adjustment followed the most recent VRI adjustment standards and provided the inventory information needed for the next TSR.

1.4 TERMS OF REFERENCE

This report was prepared for Earl Spielman, *RPF* (West Fraser). Guillaume Thérien, *PhD* completed the analysis and prepared the report. Darryl Klassen, *BNRSc* (TNRG) prepared the Geographic Information System (GIS) data. The project was funded through West Fraser's Forest Investment Account (FIA). Technical help from the MoFR staff is gratefully acknowledged.

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[2] J.S. Thrower & Associates Ltd. 2003. Sample plan amendment to accommodate Bl-leading sampling. Unpublished memo to Earl Spielman, June 19, 2003. 3 pp.

[3] Timberline Natural Resource Group. 2008. Net Volume Adjustment Factor analysis for Tree Farm Licence 52 – Blocks A and B. Unpublished report, Contract no. BC0108804, March 31, 2008. 16 pp + app.

[4] J.S. Thrower & Associates Ltd. 2006. West Fraser Mills Limited Tree Farm Licence 52 Vegetation Resource Inventory statistical adjustment Version 2.0. Unpublished report, Contract no. WFQ-047, February 2. 2006. 33 pp.

[5] J.S. Thrower & Associates Ltd. 2002. West Fraser Mills Ltd. Pilot Change Monitoring Inventory sample plan. Unpublished report, Contract no. WFQ-025, 13 July 2001. 13 pp.

[6] J.S. Thrower & Associates Ltd. 2005. West Fraser Mills Ltd. TFL 5 Vegetation Resources Inventory Project Implementation Plan Version 3.0. Unpublished report, Contract no. WFQ-046, May 17, 2005. 16 pp.

[7] J.S. Thrower & Associates Ltd. 2003. TFL 5 Change monitoring inventory sample plan. Unpublished report, Contract no. WWQ-036, Oct 28, 2003. 14 pp.

2. METHODS

2.1 LANDBASE

TFL 52 is located in the BC Central Interior, between Quesnel and Prince George and covers approximately 300,000 ha. The most common biogeoclimatic zones are Sub-Boreal Spruce (SBS) and Engelmann Spruce-Subalpine Fir (ESSF), with a minor component in Interior Cedar Hemlock (ICH). The most common species are lodgepole pine (Pl), interior spruce (Sx), and balsam (Bl). Douglas-fir (Fd) is an important species on Block B, but relatively marginal overall for the entire TFL.

2.2 TARGET POPULATION

The target population was defined using different criteria in Blocks A and B. In Block A, the target population was defined as Vegetated Treed stands established before 1960, outside the ESSFwc3 and ESSFwcp3. In Block B, the target population was defined as Vegetated Treed stands established before 1965, and either with less than 35% Pl or established after 1925. The total area of the target population in 2008 was 149,154 ha (Table 1). This area was smaller than the original target populations combined (164,682 ha) due to harvesting since 2002 (approximately 15,000 ha). The target population represented approximately 50% of the total TFL area.

Table 1. Target population net down.

Land Class	Block A (ha)	Block A (%)	Block B (ha)	Block B (%)	Total (ha)	Total (%)
Not TFL	6,484	2%	0	0%	6,484	2%
ESSFwc3 and ESSFwcp3	36,663	14%	0	0%	36,663	12%
Pl%>=35 and age > 80 yrs	0	0%	1,814	5%	1,814	1%
CMI	29,561	11%	5,629	16%	35,191	12%
Young Stands	58,187	22%	11,378	33%	69,565	23%
Target Population	133,476	50%	15,679	45%	149,154	50%
Total	*264,371*	*100%*	*34,500*	*100%*	*298,871*	*100%*

2.3 POST-STRATIFICATION

The original stratification was also defined using different criteria in Blocks A and B. In Block A, the target population was stratified using leading species and volume. In Block B, age class and proportion of Pl were used as stratification criteria. For the 2008 adjustment, the target population was post-stratified using a common definition in both Blocks. Block and leading species were used to define the post-strata with minor species in Block A being grouped with Sx while non-Fd species in Block B were grouped together (Table 2). Sub-strata were based on stand establishment year. Stands established before 1888 were labeled Mature, or Immature otherwise.

Table 2. TFL 52 VRI target population post-stratification area.

stratum	Immature Area (ha)	Immature (% Stratum)	Mature Area (ha)	Mature (% Stratum)	Total Area (ha)	Total (% Total)
A-Others	21,550	29%	52,592	71%	74,142	50%
A-Bl	15,954	52%	14,552	48%	30,506	20%
A-Pl	16,038	56%	12,789	44%	28,828	19%
B-Others	4,293	53%	3,742	47%	8,034	5%
B-Fd	3,537	46%	4,107	54%	7,644	5%

2.4 PHASE I INVENTORY

2.4.1 Update and Projection

The inventory database provided by West Fraser included depletion update to 2007. For adjustment ratio computations, the Phase I sample data was projected to the year of ground sampling using the most recent version of the VDYP7 Console module (version 7.5c.27). For population adjustment purposes, the Phase I target population was projected to 2008. The adjustment ratios were applied to the 2008 projected target population to obtain the 2008 adjusted target population.

The Phase I estimates used in the ratio computations were based on the projection to the year of ground sampling of each sample polygon rather than the median year of all sample polygons. This unusual approach was preferred in this specific case given the distribution of ground sampling years (which varied between 2002 and 2005). Projecting Phase I to the median year (2003) would have caused too much bias for Block B polygons which were all sampled in 2005.

2.4.2 Phase I Inventory Statistics

2.4.2.1 2008 Target Population

On average, the different strata in 2008 were relatively similar, with the average age varying between 117 and 159 years of age and the basal area varying between 27.7 and 47.6 m2/ha (Table 3). The B-Fd and A-Bl strata were the most and the least productive strata, respectively. Other statistics such as quadratic mean diameter, average volume to basal area ratio, and mean annual increment were also relatively similar across all strata.

Table 3. TFL 52 2008 Phase I inventory statistics for the VRI target population.

Stratum	Area (ha)	Height (m)	Age (yrs)	Basal Area (m^2/ha)	Trees/ha	Volume[a] (m^3/ha)
A-Others	74,142	28.9	159	34.1	516	292.2
A-Bl	30,506	19.1	124	27.7	546	169.0
A-Pl	28,828	25.4	122	33.0	733	291.3
B-Others	8,034	27.6	117	37.9	733	321.1
B-Fd	7,644	31.5	129	47.6	862	410.6
Total	*149,154*	*26.3*	*141*	*33.4*	*593*	*274.5*

a: Volume is live whole-stem volume less top, stump, decay, waste, and breakage at the 12.5 cm+ utilization level.

2.4.2.2 Sample

The sampled polygons were also projected to the year of ground sampling (Table 4, Appendix I). The differences observed between Table 3 and Table 4, are due to two factors. First Table 3 is based on all 21,086 polygons in the target population while Table 4 is based on the 97 sampled polygons. Second, Table 3 show numbers projected to 2008 while numbers in Table 4 are projected to the year of ground sampling.

Table 4. TFL 52 Phase I inventory statistics for the sampled polygons at time of sampling.

Stratum	Area (ha)	Sample Size	Height (m)	Age (yrs)	Basal Area (m^2/ha)	Trees/ha	Volume (m^3/ha)
A-Others	74,142	28	27.9	157	33.9	538	283.5
A-Bl	30,506	20	18.2	132	23.6	481	140.9
A-Pl	28,828	12	25.0	115	31.7	702	267.3
B-Others	8,034	19	28.5	112	41.5	783	354.4
B-Fd	7,644	18	31.8	119	47.1	835	410.9
Total	*149,154*	*97*	*25.6*	*139*	*32.5*	*587*	*261.5*

2.5 PHASE II GROUND SAMPLING

2.5.1 Sample Size and Sample Selection

Sixty-four (64) and 38 Phase II samples were selected in Block A and Block B, respectively, for a total of 102 plots. The sample selection was done in both Blocks using the sampling with probability proportional to size with replacement (PPSWR) method. Samples in Block A were selected in three batches. In the first two batches (40 and 14 samples, respectively), the samples were selected with equal probability across the Block A original target population. In the third batch, 10 plots were selected from Bl-leading stands only. Samples in Block B were all selected from the same batch with equal probability across the Block B original target population.

Since 2002, the first year of ground sampling on TFL 52, harvesting has removed approximately 6% of the original target population. Five of the 102 Phase II plots (5%) are now located in harvested stands and were removed from the 2008 analysis (Appendix II). This left 97 Phase II plots for analysis. The geographic location of valid plots is given in Appendix III. One plot (project 4771, sample 70) was established in the wrong polygon according to the recorded Global Positioning System (GPS) location. However, based on the data collected, the Phase I stand inventory at the intended location and at the GPS location, the plot appeared to be in the right polygon. The GPS location was assumed to have been mislabeled and the intended sample polygon was considered to be the right plot location.

2.5.2 Sampling Weight

The TFL 52 Phase II plots were originally selected with three different sampling intensities (Block A batch 1 and 2, Block A batch 3, and Block B). These plots, however, were re-assigned to new strata for the 2008 statistical adjustment. The sampling weights needed to be re-computed following post-stratification. While the actual sampling weights were re-computed, the original relative sampling weights among plots were maintained. The sampling weight for individual plots varied between 376 ha/plot to 5,244 ha/plot (a relative ratio of 14 to 1) (Appendix IV). On average, Phase II plots in Block B were almost equal probability plots (about 424 ha/plot) while the plots

Table 5. Average Phase II sampling weight based on post-stratification.

Stratum	Substratum	Area (ha)	No Plots	Avg. Weight
A-Others	Immature	21,550	7	3,079
	Mature	52,592	21	2,504
A-Bl	Immature	15,954	12	1,329
	Mature	14,552	8	1,819
A-Pl	Immature	16,038	8	2,005
	Mature	12,789	4	3,197
B-Others	Immature	4,293	10	429
	Mature	3,742	9	416
B-Fd	Immature	3,537	9	393
	Mature	4,107	9	456

in Bl-leading stands in Block A had a higher sampling intensity than the remaining plots in Block A (about 1,524 ha/plot versus an average of 2,574 ha/plot) (Table 5).

2.6 NVAF RATIOS

The NVAF ratios used to correct the Phase II net merchantable volume were computed by live/dead status, maturity class, and species group under a separate project (Table 6).[3] The ratios were applied to the Phase II net merchantable volume computed from the taper equations and cruiser-called decay.

Table 6. TFL 52 NVAF ratios.

Live/Dead	Maturity	Species	NVAF Ratio
Live	Immature	All	0.955
	Mature	Sx & Deciduous	1.028
		Pl	1.035
		Bl & Minor Conifers	1.094
		Fd	1.010
Dead	All	All	0.949

2.7 PHASE II DATA COMPILATION AND STATISTICS

2.7.1 Non-Standard Compilation

West Fraser collected additional information that was not part of the VRI standard at the time of sampling. First, dead trees were measured at all points in a sample plot. Second, sample plots in Bl- and Sx-leading stands on Block A had eight auxiliary plots instead of the standard four plots. The additional plots were located 50 m for the sample point in the following cardinal directions: Northeast, Southeast, Southwest, and Northwest. The MoFR staff compiled the Phase II ground data using both standard and non-standard data.

2.7.2 MPB Impact

TFL 52 is currently under-going a severe Mountain Pine Beetle (MPB) infestation. Most of the Phase II ground data was collected before the MPB became a serious problem on TFL 52. Therefore, the Phase II data showed little mortality. The adjusted proportion of Pl volume was investigated but cannot be part of the standard adjustment because the methodology has not been approved by the MoFR yet.

2.7.3 Phase II Inventory statistics

The Phase II ground data statistics were relatively similar across strata (Table 7, Appendix V). When compared to the Phase I sample data (Table 4), all attributes except for height were slightly larger on average in the ground data. The difference was particularly large for trees/ha where the average ratio ground:inventory is almost 2:1. Dead Pl volume represented only 7.5 m^3/ha on average.

Table 7. TFL 52 Phase II ground data statistics.

Stratum	Area (ha)	Sample Size	Height (m)	Age (yrs)	Basal Area (m^2/ha)	Trees/ha	Live Vol. (m^3/ha)	Dead Pl Vol. (m^3/ha)
A-Others	74,142	28	24.7	152	38.8	899	327.2	4.4
A-Bl	30,506	20	22.0	152	31.9	962	238.9	4.5
A-Pl	28,828	12	24.1	118	37.7	996	287.6	14.1
B-Others	8,034	19	28.7	102	37.7	830	346.7	19.9
B-Fd	7,644	18	29.3	113	39.5	1,001	346.3	10.2
Total	*149,154*	*97*	*24.6*	*141*	*37.1*	*932*	*303.5*	*7.5*

Note: Live volume is based on all species while dead volume is based on Pl only.

2.8 ADJUSTMENT METHODOLOGY

The new adjustment procedures for VDYP7 were used in this project.[8] With this methodology, the following variables were adjusted first:

1. Height of the leading species – rank 1 layer
2. Total age of the leading species – rank 1 layer
3. Basal area 7.5 cm+ – all species combined
4. Number of trees/ha 7.5 cm+ – all species combined

The adjustment was performed using the ratio of means method. The adjusted attributes were then used as VDYP7 input for a second run, and in a second stage, the variable

5. Whole-stem volume less top, stump, decay, waste, and breakage 12.5 cm+

was adjusted.

For this project, both live volume (all species) and dead Pl volume were adjusted. Dead Pl volume is not a Phase I attribute. Instead, the Phase I proportion of Pl live volume (estimated by the multiplication of the live volume all species and the proportion of Pl in the polygon) was used in the ratio computations. Dead Pl volume was a minor volume component and the proposed approach was considered adequate for this analysis.

[8] Ministry of Forests and Range. 2008. Vegetation Resources Inventory – Interim Procedures and Standards for Statistical Adjustment of Baseline VRI Timber Attributes Version 1.1 January 2008. Unpublished report, Victoria. 36 pp.

3. RESULTS

3.1 HEIGHT

Eight observations were dropped because the leading species on the ground had no valid height observation, leaving 89 plots for analysis (Appendix VI). One stratum (A-Bl) showed a very nonlinear trend that could not be explained on a theoretical basis. After discussion with the MoFR biometrician, it was decided to use a ROM based on the log of Phase I height. This transformation ensured a good fit through the sample points but raised issues for points outside the sampled range. It was decided that when the A-Bl height ratio is applied to the population stratum, any Phase I height outside the sampled range ([10.13 m – 26.78 m]) will be left unadjusted. Adjustment ratios in the strata outside A-Bl were close to 1 and the sampling error was relatively small across all strata (Table 8, Figure 2, and Figure 3). This indicated a high confidence in the height adjustment.

Table 8. Height adjustment statistics by stratum.

Stratum	n	Phase II Avg. (m)	Phase I Avg. (m)	ROM	95% Sampling Err. (m)	Relative Error
A-Others	25	24.9	26.7	0.931	0.097	10.4%
A-Bl	16	21.9	19.5	7.496[a]	0.609	8.1%
A-Pl	12	24.1	23.5	1.025	0.132	12.9%
B-Others	18	28.9	28.8	1.005	0.123	12.2%
B-Fd	18	29.3	30.5	0.959	0.082	8.6%

a: This ratio is based on the equation Phase II Height = ROM x log(Phase I Height).

3.2 AGE

Four observations were dropped, leaving 93 plots for analysis (Appendix VI). The bias was usually small as indicated by the ROM values close to 1 (Table 9, Figure 4, and Figure 5). The ROM in Bl-leading stands on Block A was an exception to this trend with a bias close to 18%. This result was expected since it is more difficult to estimate age in Bl-leading stands due to suppression. The 95% sampling error was usually around 15% except for Pl-leading stands at 25%.

Table 9. Age adjustment statistics by stratum.

Stratum	n	Phase II Avg. (yrs)	Phase I Avg. (yrs)	ROM	95% Sampling Err. (yrs)	Relative Error
A-Others	27	153	155	0.991	0.130	13.1%
A-Bl	18	153	130	1.181	0.133	11.3%
A-Pl	12	118	117	1.009	0.254	25.1%
B-Others	18	104	104	0.994	0.180	18.1%
B-Fd	18	113	119	0.948	0.153	16.2%

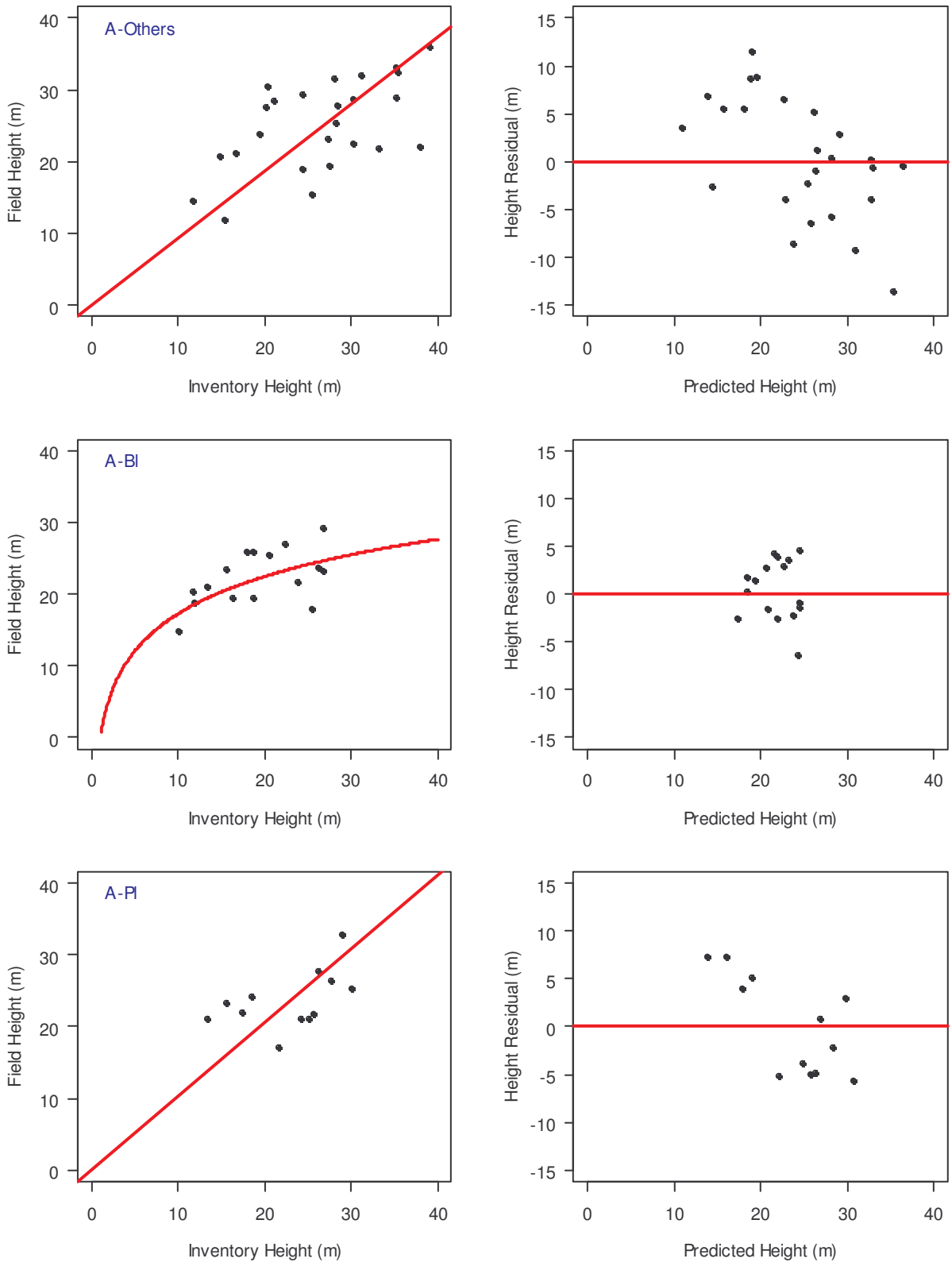

Figure 2. Field vs. inventory height in TFL 52 Block A.

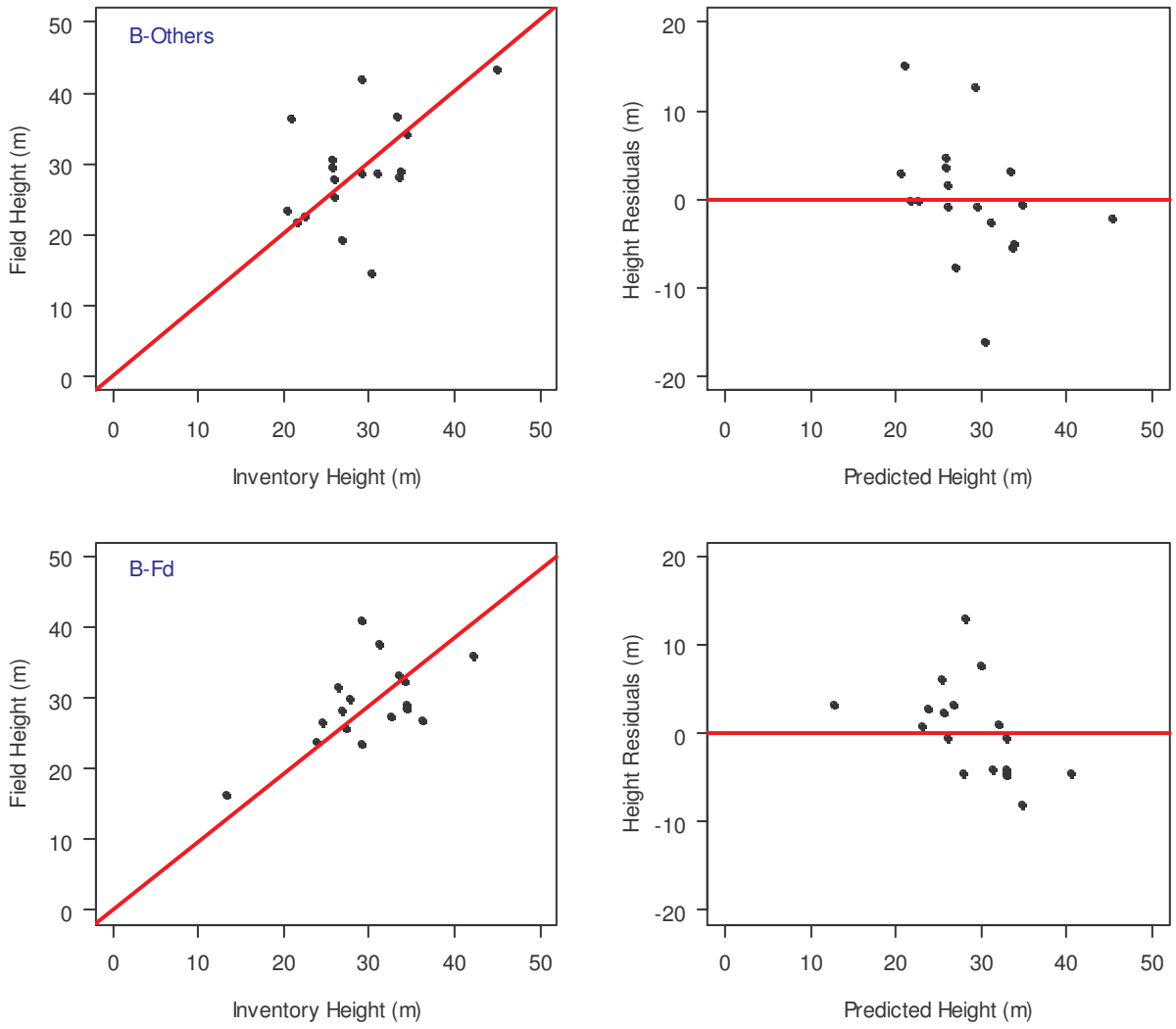

Figure 3. Field vs. inventory height in TFL 52 Block B.

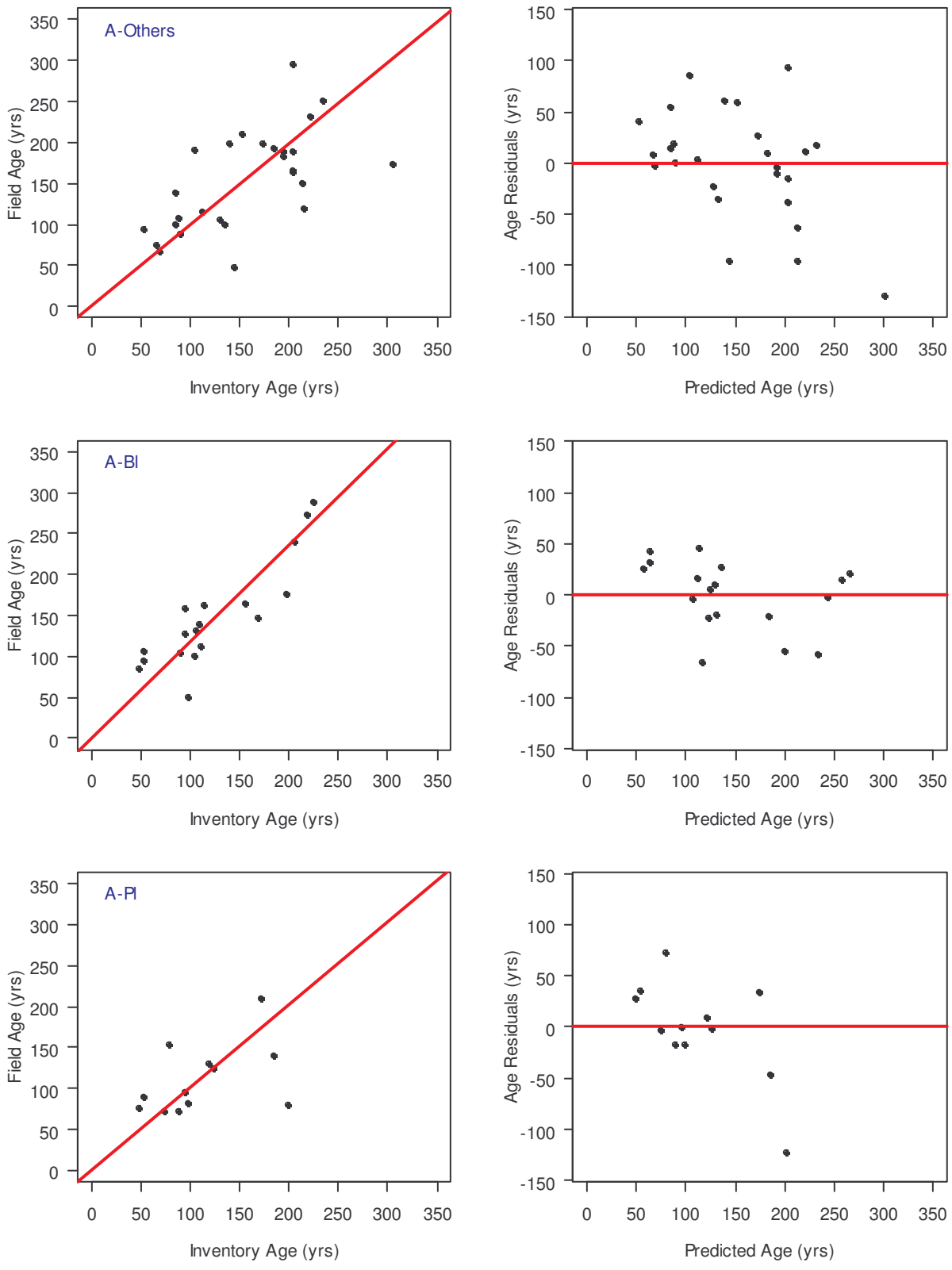

Figure 4. Field vs. inventory age in TFL 52 Block A.

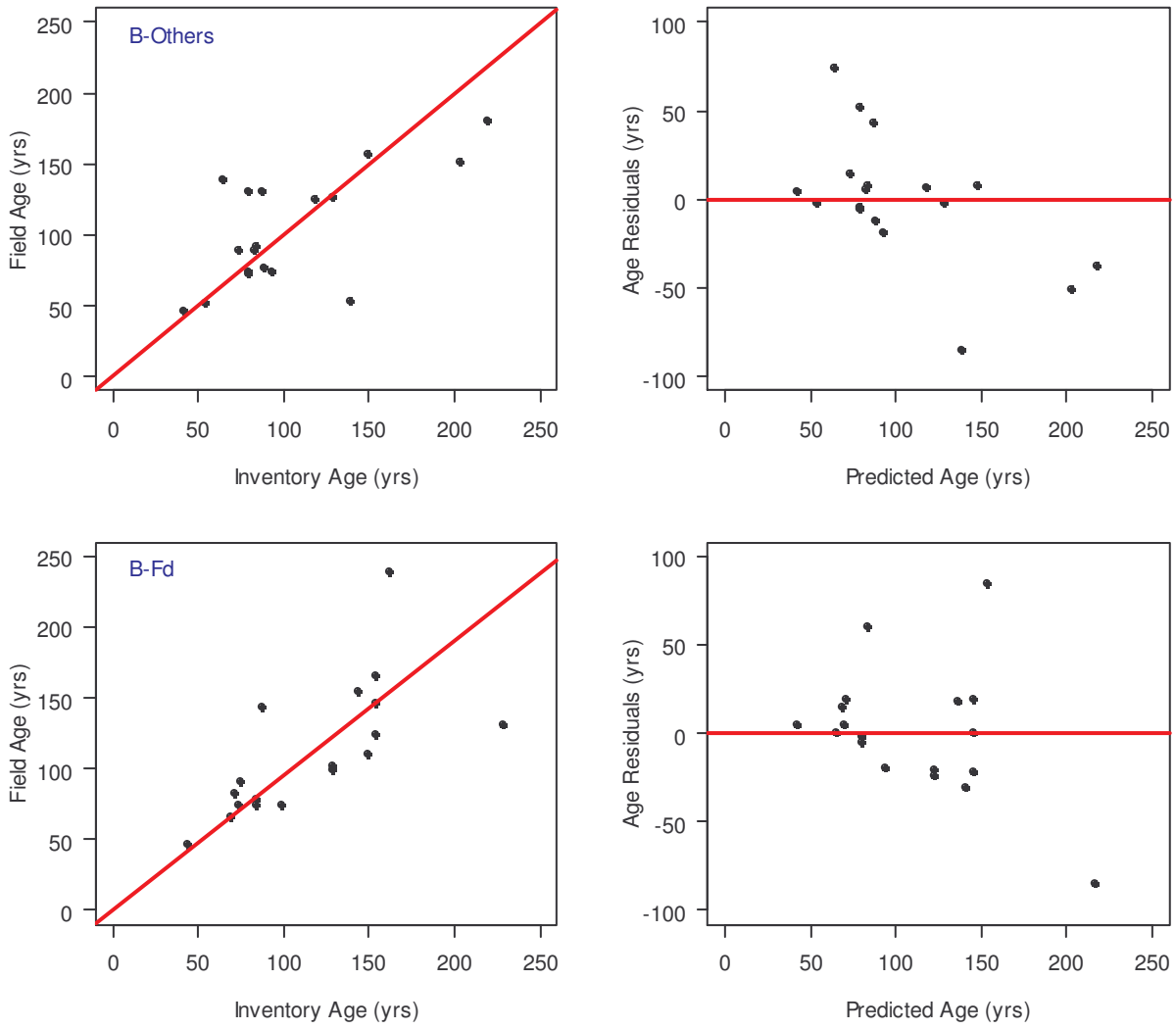

Figure 5. Field vs. inventory age in TFL 52 Block B.

3.3 BASAL AREA

All 97 observations were used to compute the basal area adjustment ratios. There was both a large bias (varying between -16% to 35%) and large sampling error (varying between 11% and 34%) across most strata (Table 10, Figure 6, and Figure 7). This was particularly true in the A-Bl and A-Pl strata where the sampling error was over 30%. One observation in the A-Pl stratum showed a large residual (project 4771 sample 68). This plot was established in a stand classified as "residual" indicating a certain level of patchiness. It is therefore likely that the plot was established in a dense area of the stand.

Table 10. Basal area adjustment statistics by stratum.

Stratum	n	Phase II Avg. (m^2/ha)	Phase I Avg. (m^2/ha)	ROM	95% Sampling Err. (m^2/ha)	Relative Error
A-Others	28	38.8	33.9	1.144	0.156	13.7%
A-Bl	20	31.9	23.6	1.349	0.404	30.0%
A-Pl	12	37.7	31.7	1.189	0.403	33.9%
B-Others	19	37.7	41.5	0.908	0.100	11.0%
B-Fd	18	39.5	47.1	0.840	0.125	14.9%

3.4 TREES/HA

All 97 observations were used to compute the trees/ha adjustment ratios. Photo-interpreters under-estimated the Phase II number of trees/ha with bias varying from 6% to 100% (Table 11, Figure 8, and Figure 9). The sampling errors were relatively large across all strata, indicating a lack of consistency in the Phase I estimates of trees/ha.

Table 11. Trees/ha adjustment statistics by stratum.

Stratum	n	Phase II Avg.	Phase I Avg.	ROM	95% Sampling Err.	Relative Error
A-Others	28	899	538	1.669	0.306	18.3%
A-Bl	20	962	481	2.001	0.844	42.2%
A-Pl	12	996	702	1.419	0.647	45.6%
B-Others	19	830	783	1.060	0.270	25.5%
B-Fd	18	1,001	835	1.199	0.318	26.5%

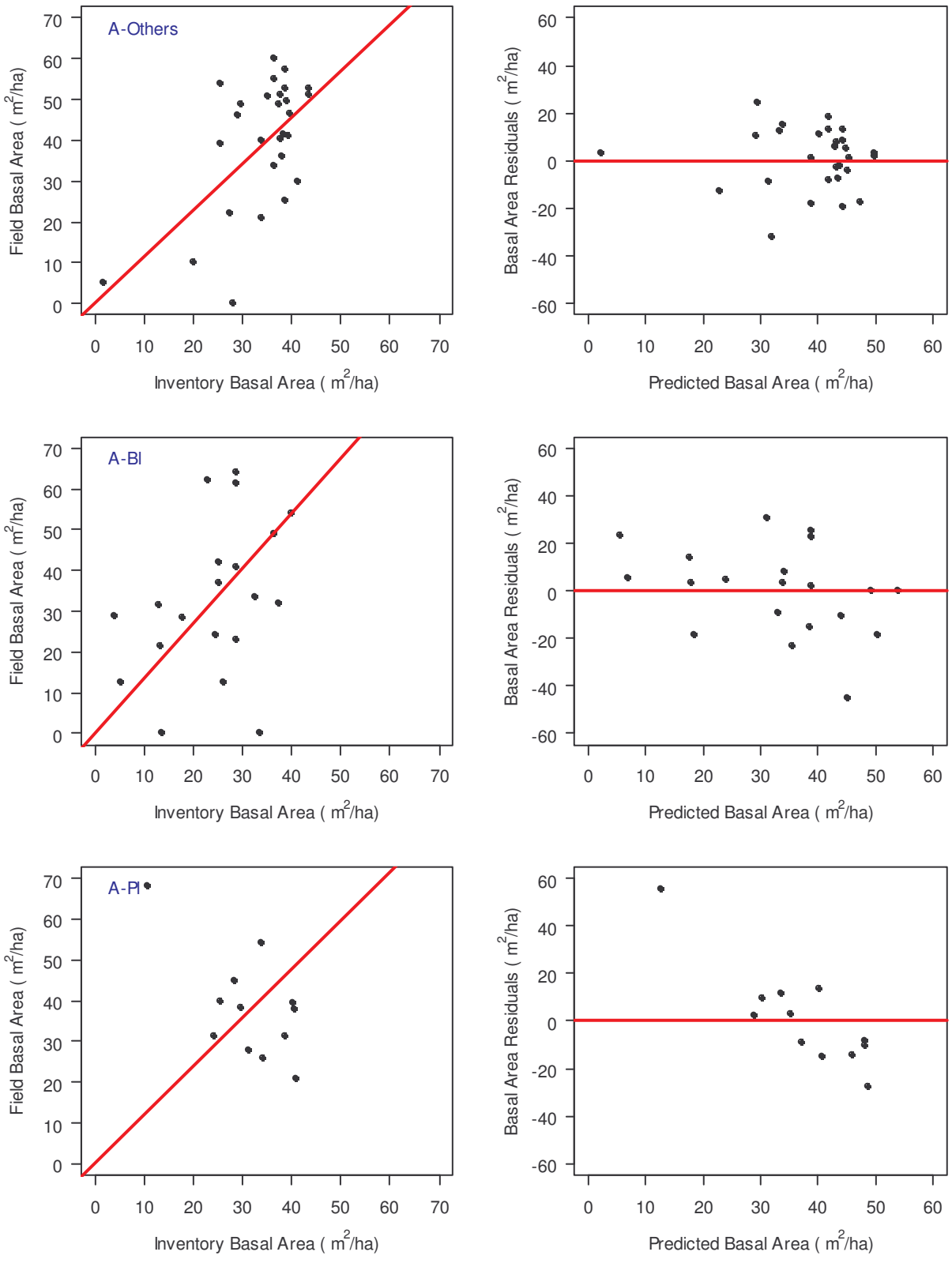

Figure 6. Field vs. inventory basal area in TFL 52 Block A.

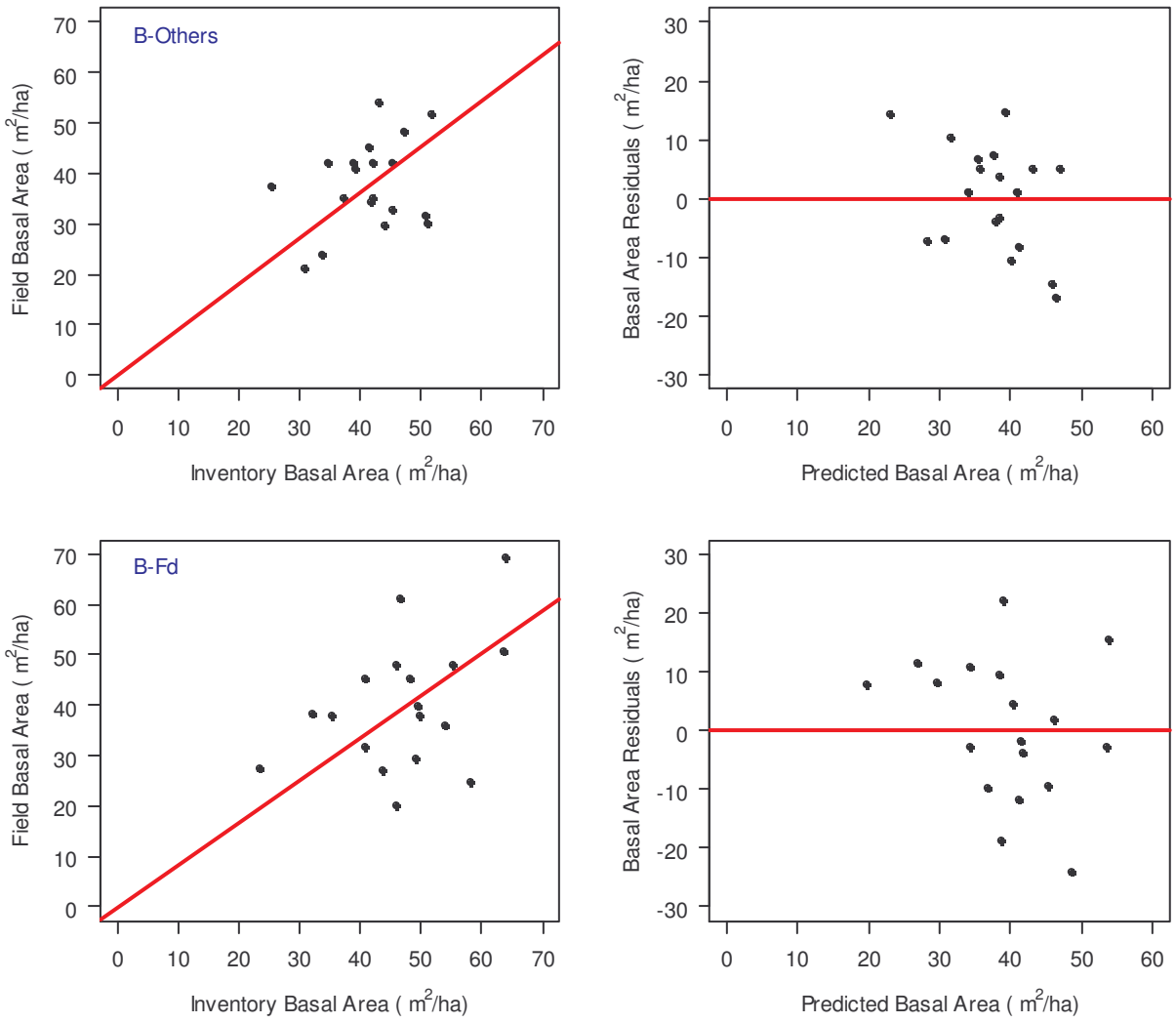

Figure 7. Field vs. inventory basal area in TFL 52 Block B.

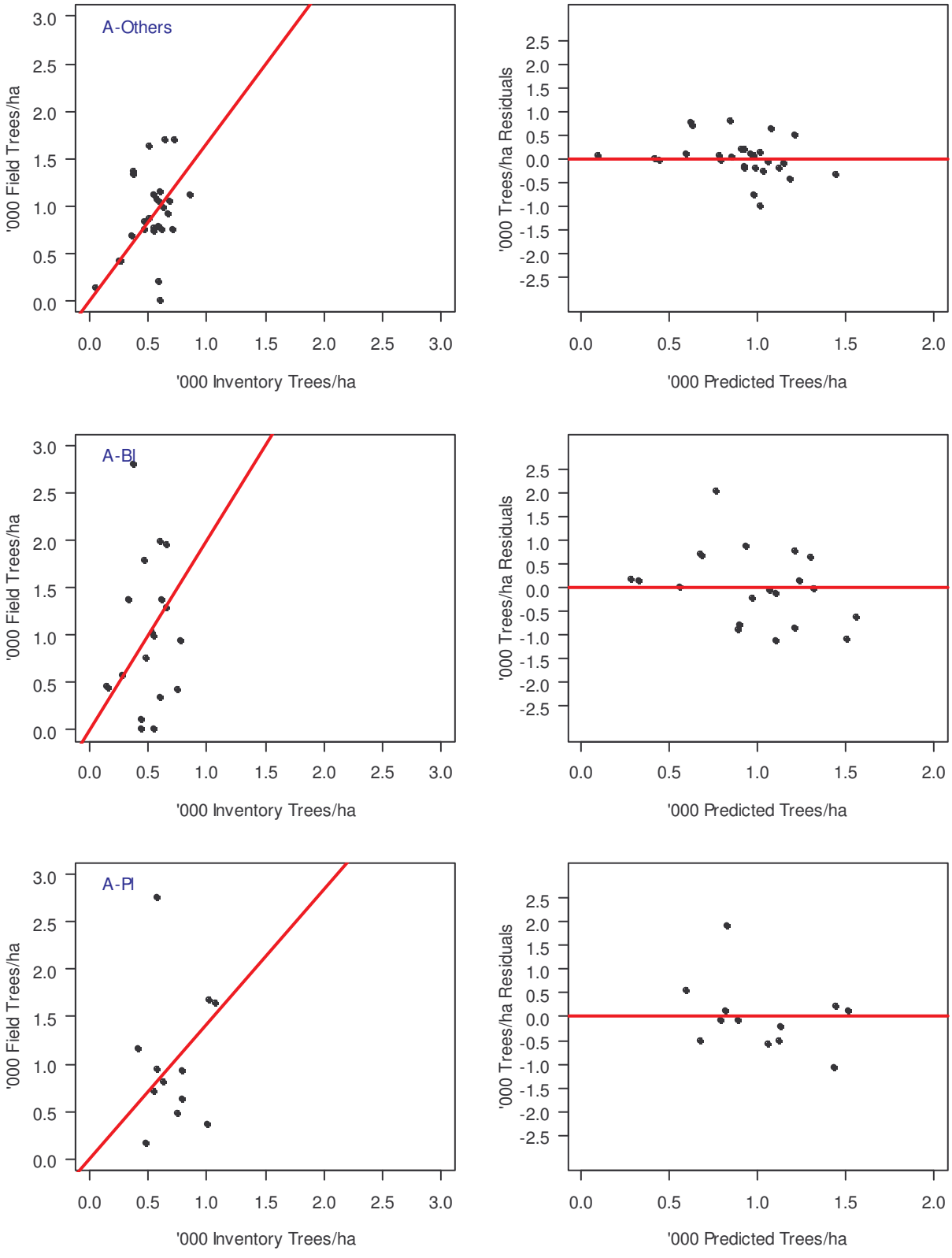

Figure 8. Field vs. inventory trees/ha in TFL 52 Block A.

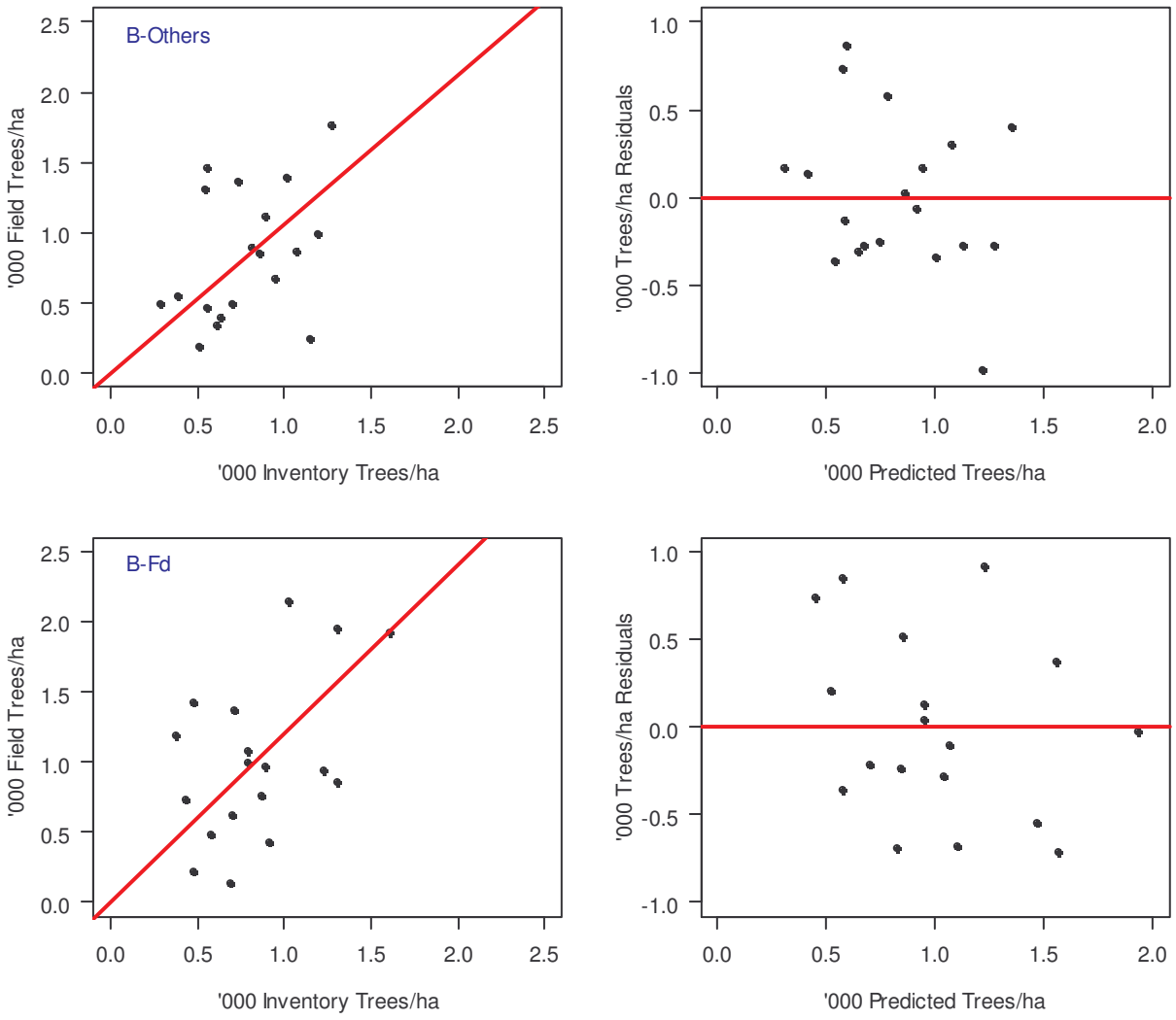

Figure 9. Field vs. inventory trees/ha in TFL 52 Block B.

3.5 ATTRIBUTE-ADJUSTED VOLUME

After adjusting height, age, basal area, and trees/ha, new VDYP7 volumes were generated for the 97 sampled polygons. These attribute-adjusted volumes are free from the input-variable bias associated with photo-interpretation. There was an increase in Block A between10% and 19% and a 9%-16% decrease in Block B (Table 12). These attribute-adjusted volumes are only an intermediate step and have no meaning for forest management purposes.

Table 12. Volume change in sampled polygons due to VDYP7 input variables adjustment.

Stratum	Sample Size	Phase I (m^3/ha)	Attr.-Adj. (m^3/ha)	Change (m^3/ha)	Change %
A-Others	28	283.5	312.6	29.1	10%
A-Bl	20	140.9	167.5	26.6	19%
A-Pl	12	267.3	308.1	40.8	15%
B-Others	19	354.4	323.4	-31.0	-9%
B-Fd	18	410.9	346.0	-64.9	-16%

3.6 NET MERCHANTABLE VOLUME

3.6.1 Live Volume

All 97 observations were used to compute the live volume adjustment ratios. Ratios were generally close to 1 except for the Bl-leading stands in Block A, indicating a relatively small bias due to VDYP7 (Table 13, Figure 10, and Figure 11). In the A-Bl stratum, however, the bias was almost 43%. The 95% sampling error was generally less than 25%, except in the A-Pl stratum where the error was 36%. One observation (project 4771, sample 68) had a large residual, but its impact on the sampling error was minimal. Without this observation, the relative sampling error would have been 34%.

Table 13. Live volume adjustment statistics by stratum.

Stratum	n	Phase II Avg. (m^3/ha)	Attr.Adj. Vol. (m^3/ha)	ROM	95% Sampling Err. (m^3/ha)	Relative Error
A-Others	28	327.2	312.6	1.047	0.167	16.0%
A-Bl	20	238.9	167.5	1.427	0.374	26.2%
A-Pl	12	287.6	308.1	0.933	0.338	36.2%
B-Others	19	346.7	323.4	1.072	0.150	14.0%
B-Fd	18	346.3	346.0	1.001	0.139	13.9%

Note: Attr.Adj. Vol is live attribute-adjusted volume.

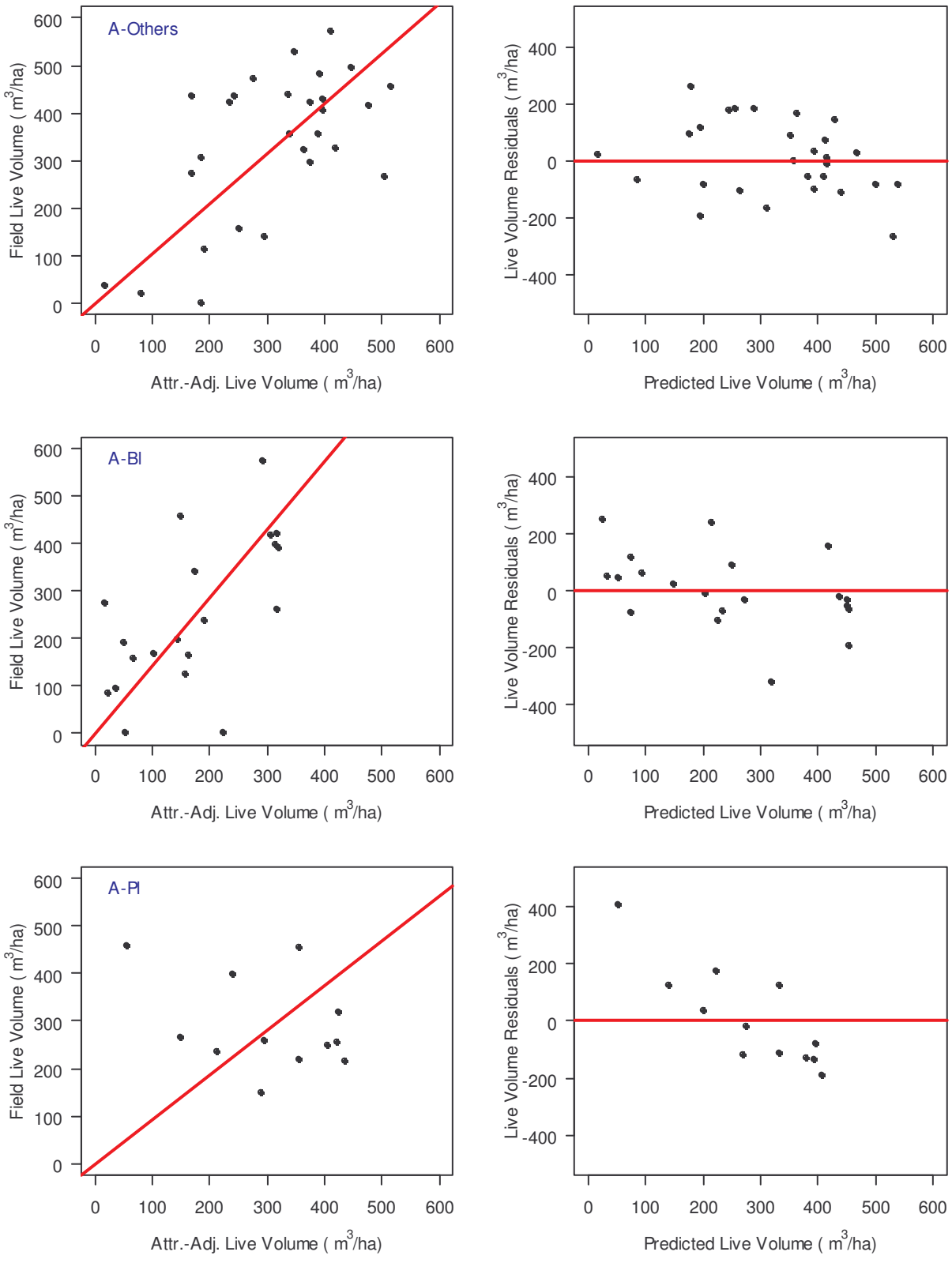

Figure 10. Field vs. attribute-adjusted VDYP7 live net merchantable volume in TFL 52 Block A.

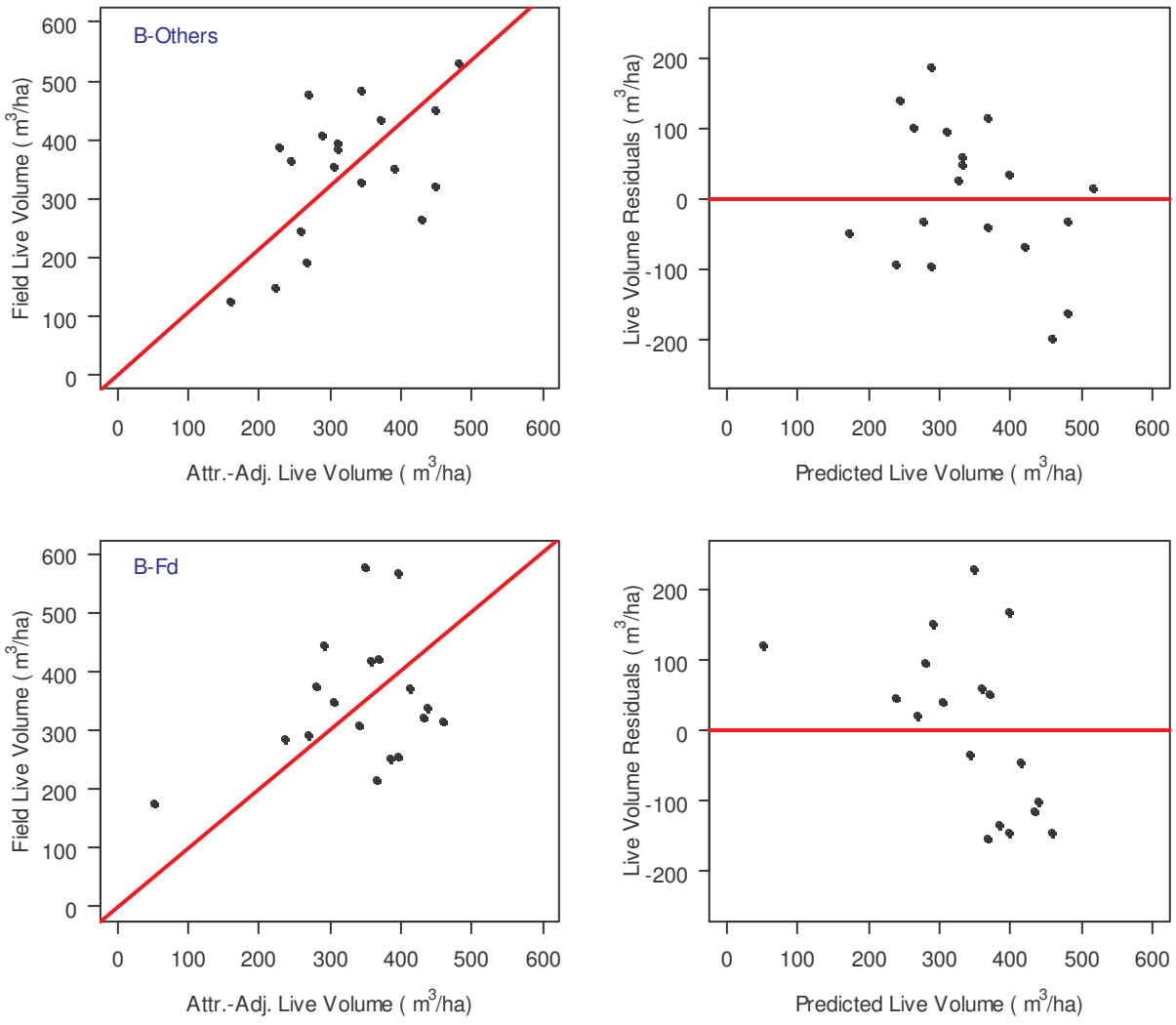

Figure 11. Field vs. attribute-adjusted VDYP7 live net merchantable volume in TFL 52 Block B.

3.6.2 Dead Pl Volume

All 97 observations were used to compute the dead Pl volume adjustment ratios. There was little dead Pl volume at the time of sampling (Table 13, Figure 12, and Figure 13). In two strata, A-Bl and B-Others, the average dead Pl volume on the ground was actually larger than the average live Pl volume predicted by VDYP7. The relative errors were extremely large indicating that predicting dead Pl volume from Phase I live Pl volume is not a precise method. More work is needed to identify a Phase I variable that would be better correlated with Phase II dead Pl volume.

Table 14. Dead Pl volume adjustment statistics by stratum.

Stratum	n	Phase II Avg. (m^3/ha)	Attr.Adj. Vol. (m^3/ha)	ROM	95% Sampling Err. (m^3/ha)	Relative Error
A-Others	28	4.4	21.0	0.207	0.283	136.8%
A-Bl	20	4.5	2.7	1.661	3.140	189.0%
A-Pl	12	14.1	229.1	0.062	0.049	78.7%
B-Others	19	19.9	15.5	1.288	2.214	171.8%
B-Fd	18	10.2	20.7	0.492	0.781	158.8%

Note: Attr.Adj. Vol is Pl live attribute-adjusted volume.

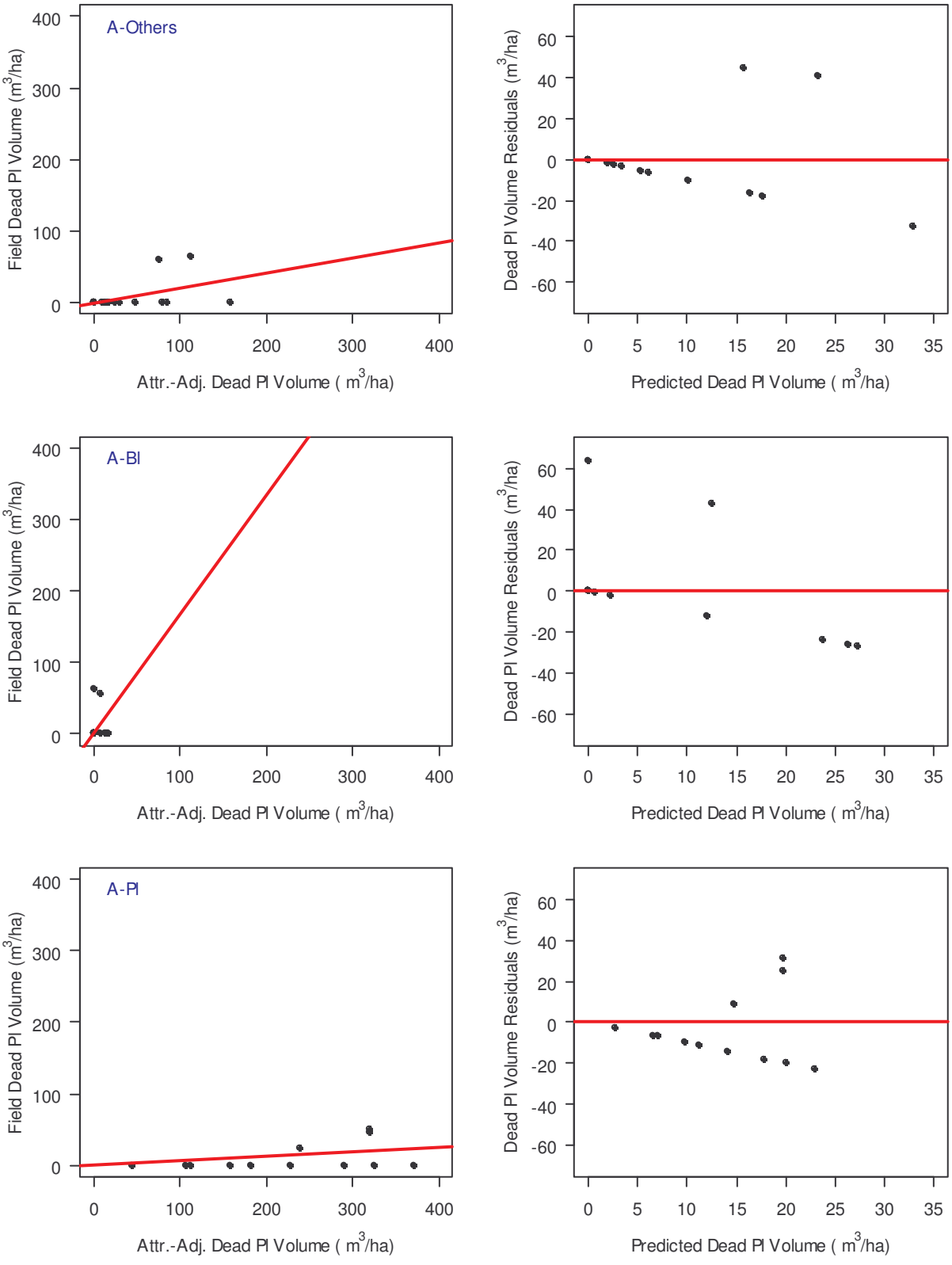

Figure 12. Field vs. attribute-adjusted VDYP7 dead Pl volume in TFL 52 Block A.

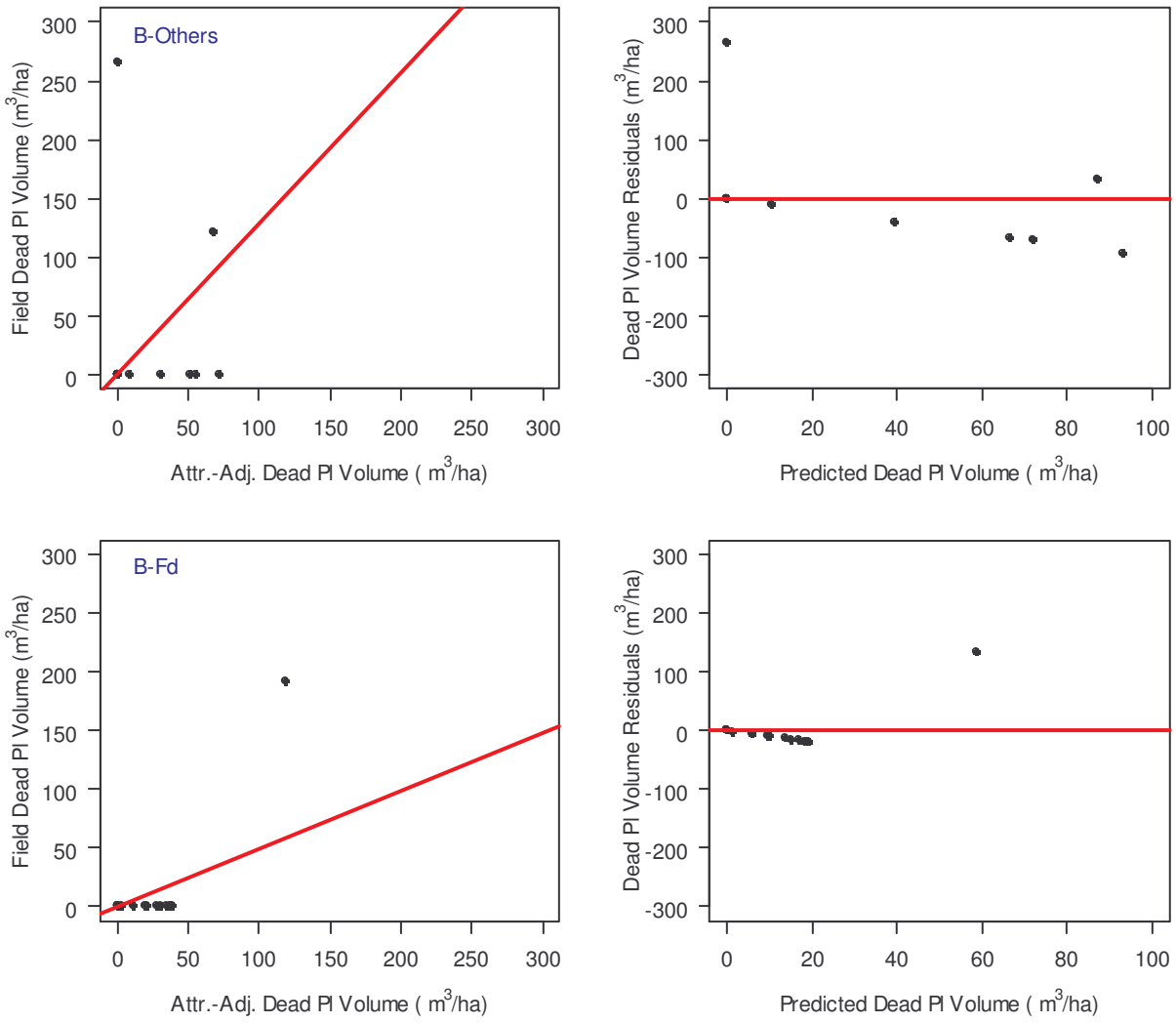

Figure 13. Field vs. attributed-adjusted VDYP7 dead Pl volume in TFL 52 Block B.

3.7 2008 ADJUSTED POPULATION

The height, age, basal area, and trees/ha adjustment ratios (Table 8, Table 9, Table 10, and Table 11) were applied to all 21,086 polygons in the 2008 target population. After these adjustments, new attribute-adjusted VDYP7 volumes were generated and live and dead Pl volumes were estimated using the adjustment ratios from Table 13 and Table 14 (Table 15). The overall live volume increased was approximately 17% (Table 16). The most important change occurred in the A-Bl stratum where the initial Phase I inventory volume increased by about 63% after adjustment. The overall sampling error was 11.6%, slightly larger than the targeted 10%. Dead Pl volume contributed very little to the overall volume (10 m^3/ha) and estimates showed large variability (over 80% sampling error overall) (Table 17). Because the actual dead Phase I volume was unknown and a surrogate attribute (live Pl volume) was used, no estimate of change is provided in Table 17.

Table 15. TFL 52 2008 adjusted Phase I inventory statistics for the VRI target population.

Stratum	Area (ha)	Height (m)	Age (yrs)	Basal Area (m^2/ha)	Trees/ha	Attr.Adj. Vol. (m^3/ha)	Live Vol. (m^3/ha)	Dead Pl Vol. (m^3/ha)
A-Others	74,142	28.9	158	38.0	762	326.3	341.5	6.1
A-Bl	30,506	18.8	144	32.7	815	193.2	275.7	6.1
A-Pl	28,828	25.4	123	38.5	987	337.0	314..6	15.1
B-Others	8,034	27.6	116	34.0	737	293.8	315.0	33.9
B-Fd	7,644	31.6	123	38.9	907	345.5	345.9	14.7
Total	*149,154*	*26.2*	*144*	*36.8*	*823*	*300.4*	*321.6*	*9.8*

Table 16. TFL 52 2008 adjusted live volume statistics for the VRI target population.

Stratum	Area	Phase I Volume (m^3/ha)	Attr.-Adj. Live Volume (m^3/ha)	Adjusted Live Volume (m^3/ha)	E Live Volume (m^3/ha)	E% Live Volume	Change Volume (m^3/ha)	%Change Volume
A-Others	74,142	292.2	326.3	341.5	54.6	16.0%	49.2	17%
A-Bl	30,506	169.0	193.2	275.7	72.2	26.2%	106.7	63%
A-Pl	28,828	291.3	337.0	314.6	113.7	36.2%	23.3	8%
B-Others	8,034	321.1	293.8	315.0	44.0	14.0%	-6.1	-2%
B-Fd	7,644	410.6	345.5	345.9	48.2	13.9%	-64.8	-16%
Total	*149,154*	*274.5*	*300.4*	*321.6*	*37.5*	*11.6%*	*47.2*	*17%*

Note: E is the 95% sampling error.

Table 17. TFL 52 2008 adjusted dead volume statistics for the VRI target population.

stratum	Area	Phase I Pl Volume (m^3/ha)	Attr.-Adj. Pl Volume (m^3/ha)	Adjusted Dead Pl Volume (m^3/ha)	E Dead Pl Volume (m^3/ha)	E% Dead Pl Volume
A-Others	74,142	26.0	29.3	6.1	8.3	136.8%
A-Bl	30,506	3.3	3.7	6.1	11.6	189.0%
A-Pl	28,828	212.3	245.3	15.1	11.9	78.7%
B-Others	8,034	29.2	26.3	33.9	58.2	171.8%
B-Fd	7,644	35.8	29.9	14.7	23.4	158.8%
Total	*149,154*	*58.0*	*65.7*	*9.8*	*8.1*	*82.5%*

Note: Phase I Pl Volume is the Phase I live Pl volume. Attr-Adj. Pl Volume is the attribute-adjusted live Pl volume.

4. DISCUSSION

4.1 95% SAMPLING ERROR

While the overall 95% sampling error achieved in this project (11.6%) was slightly larger than the target (10%), the sampling error within most strata was reasonable. Only in the A-Pl stratum was the sampling error (36%) larger than anticipated. One unusual plot had a very large residual but was not the main cause of the observed variability. Without the observation, the sampling error decreased to 34%. Fitting a ratio of means with the sum of live and Pl dead volume as the variable of interest did not help either, reducing the sampling error to 35%. There was simply a poor correlation between the Phase II ground and VDYP7 volumes. The correlation between the two attributes was actually negative (-0.37). This could be an artifact of the small sample size in this stratum (only 12 valid plots); it also could be indicative of a problem with VDYP7. The MoFR should investigate this potential VDYP7 issue using other management units with a large Phase II sample in Pl-leading stands.

4.2 DEAD PL VOLUME

The dead Pl volume showed in this report was only marginal but most likely does not reflect the 2008 reality on TFL 52. One can argue that the best estimate of the available dead Pl volume on TFL 52 would be to assume that all Pl volume in the target population is now dead. This would require an accurate estimate of the proportion of Pl volume in the target population. The proportion of Pl volume was not adjusted in this project, only the biased Phase I Pl proportion was available. On average, approximately 21% of the live volume in the 2008 target population was live Pl. We investigated the impact of a Pl proportion adjustment and estimate that the Pl proportion is closer to 14% than the indicated 21%. Therefore, using the indicated 21% as the proportion of Pl volume might over-estimate the dead Pl volume, and consequently under-estimate the live volume if used in a timber supply analysis scenario. A species composition adjustment standard has yet to be approved by the MoFR. Such standard has not been a priority so far. The impact that dead Pl volume will have in the next TSR, however, should change the importance that the MoFR gives to knowing the species composition with accuracy at the management unit level.

4.3 IMPACT OF CHANGE

4.3.1 Site Index

Site index is an important variable to predict the growth and yield of immature stands. Projection of immature stands is highly influenced by site index. On the other hand, the volume in mature stands is generally assumed to be constant over time, and is independent of site index. The impact of the height/age, and therefore site index, adjustment was investigated for immature stands (61,372 ha, or 41% of the target population). Site index marginally increased on average (approximately 3%) (Table 18). The largest increase was in the A-Bl stratum where the increase was about 25%. In other strata, the change in site index will have little impact on volume projections.

Table 18. Site index change due to statistical adjustment in immature stands.

	Area		Site Index (m)		Difference	
Stratum	(ha)	(% stratum)	Phase I	Adjusted	(m)	(%)
A-Others	21,550	29%	17.4	16.1	-1.3	-7%
A-Bl	15,954	52%	12.7	15.8	3.1	25%
A-Pl	16,038	56%	18.3	18.8	0.5	3%
B-Others	4,293	53%	19.8	19.9	0.1	0%
B-Fd	3,537	46%	22.1	21.2	-0.9	-4%
Total	*61,372*	*41%*	*16.9*	*17.3*	*0.5*	*3%*

4.3.2 Volume vs. Age

Mean annual increment (MAI) is an indicator of the short-term growth in many stands. The mean annual increment on TFL 52 increased slightly in the 3 and 4 m^3/ha/yr classes and decreased mainly in the 1 m^3/ha/yr class (Figure 14). There was no unrealistic MAI created by the adjustment of volume and age, which provides a level of comfort that the adjustment did not distort the stand dynamics in the target population.

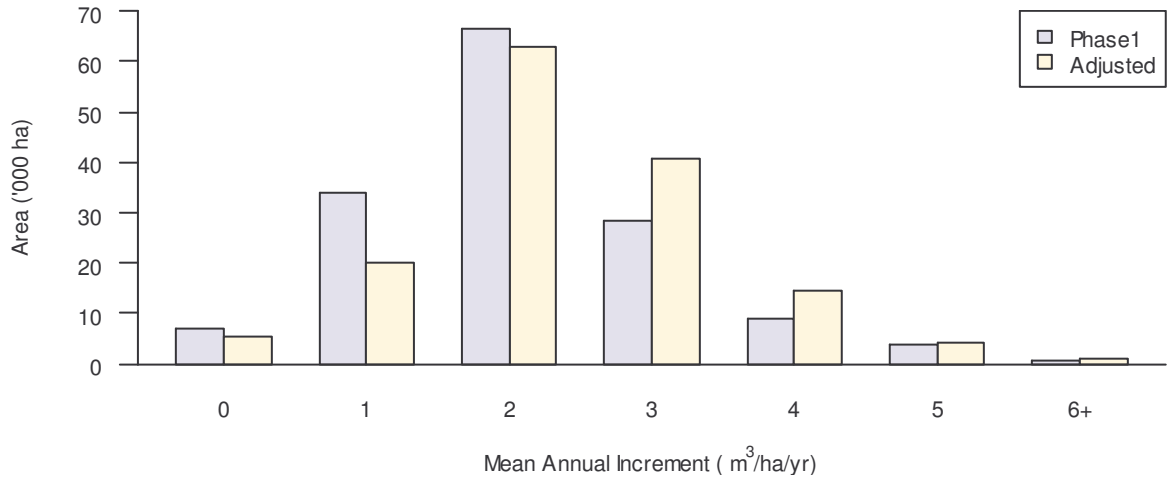

Figure 14. Distribution of mean annual increment before and after adjustment.

4.4 Risks and Uncertainties

4.4.1 Dead Pl Volume

The proportion of dead Pl volume in the MPB-impacted TFL is difficult to estimate because that proportion keeps changing on a daily basis. This introduces a high degree of uncertainty on both the growing stock and the dead Pl volume available. Dead Pl volume is the most important contributor to timber supply uncertainty on TFL 52 in the next five years. The uncertainty can be mitigated in the timber supply analysis using a series of assumptions and sensitivity analysis runs, but it is inevitable that the next TFL 52 AAC will be set with a higher degree of uncertainty. The AAC uncertainty however should return to a more normal level by the following AAC determination.

4.4.2 Shelf-Life of Dead Pl Volume

The economic merchantability of dead Pl volume, and its change over time, is an important question that was not solved with the VRI statistical adjustment. Since dead Pl volume will be a key component of West Fraser's wood basket for the next five to ten years, gathering more information about the economic merchantability of dead Pl volume should become a high priority.

4.4.3 Age Trend

The MoFR timber supply analysts are always concerned that the inventory adjustment may distort the volume/age relationships if the adjustment ratios are not constant over age. The residuals of each attribute (height, age, basal area, trees/ha, live volume, and dead volume) were graphed against photo-interpreted age of the leading species. No age-related trend could be detected indicating that the adjustment ratios used in this project were independent of stand age.

5. CONCLUSIONS

The TFL 52 VRI Phase I was adjusted using the Phase II plots established between 2002 and 2005 and the NVAF information collected between 2004 and 2007. The adjustment was completed using the newest version of VDYP7 and the most recent VRI statistical adjustment standards. Hence, the updated VRI adjustment for TFL 52 represents the best information available for TSR. Therefore, we recommend that

The updated VRI statistical adjustment is used in the next TSR on TFL 52.

A poor correlation was observed between Phase II volume and the VDYP7 prediction in Pl-leading stands in Block A. This result was unexpected and could be due to a problem with VDYP7 for these stands. The MoFR has access to a large database of Phase II plots in Pl-leading stands that can be used to confirm VDYP7 volume predictions for Pl-leading stands. Therefore, we recommend that

The MoFR investigates VDYP7 volume predictions in Pl-leading stands.

The proportion of live Pl volume was left unadjusted but a preliminary analysis showed that proportion could be over-estimating the true proportion. In preparation for the next TSR, it is imperative that this issue be resolved. This will require a new standard method from the MoFR. Therefore, we recommend that

The MoFR approves a method to adjust volume at the species group level within a management unit.

Adjusting dead Pl volume will become more and more critical in the next few years. The Fraser Method for this attribute cannot be applied because dead Pl volume is not a Phase I attribute. A new method that can estimate dead Pl volume with accuracy and precision is needed. Therefore, we recommend that

The MoFR tests new Phase I attributes and methods that can reliably estimate dead Pl volume.

The future economic merchantability of dead Pl volume is still a large unknown quantity in timber supply analysis. The short-term economic stability of many forest companies and communities in BC will depend heavily on dead Pl volume. More work is needed to predict with accuracy the economic merchantability of MPB-killed Pl trees. Therefore, we recommend

The MoFR invests a larger proportion of its research money into studies investigating the change in economic merchantability of dead Pl volume over time.

APPENDIX I - PHASE I SAMPLE ATTRIBUTES

Table 19. TFL 52 Phase I attributes for the 97 sampled polygons.

Project	Sample	Leading			Second			Basal Area (m^2/ha)	Trees/ha	Volume (m^3/ha)	Match Case[a]
		Spp	Height (m)	Age (yrs)	Spp	Height (m)	Age (yrs)				
0046	0001	SX	32.4	154	BL	22.1	69	39.0	544	338.9	3
0046	0002	SX	29.3	219	BL	32.4	144	42.0	702	319.1	1
0046	0004	FD	34.4	144	SX	22.5	54	32.1	485	316.7	1
0046	0005	AT	20.5	84	FD	30.4	139	34.0	743	178.7	2
0046	0006	FD	35.5	139	SX	31.4	154	58.2	695	535.6	2
0046	0007	FD	39.4	154	SX	24.7	88	43.9	585	461.7	2
0046	0008	FD	29.2	84	EP	27.3	75	40.8	708	330.0	2
0046	0009	FD	34.5	129	EP	32.5	119	55.2	1,029	520.8	1
0046	0010	EP	26.5	99	FD	21.0	88	50.7	1,281	474.7	2
0046	0011	SX	25.8	83	FD	24.3	73	43.3	1,153	306.1	1
0046	0012	ACT	34.6	89	SX	27.7	99	51.3	513	422.7	1
0046	0013	SX	35.2	194	FD	29.3	65	47.5	564	489.1	2
0046	0014	FD	34.4	154	EP	22.7	70	46.1	480	422.4	1
0046	0015	SX	32.4	154	BL	33.4	149	39.4	635	375.0	3
0046	0016	BL	33.9	129	EP	27.2	154	25.4	294	246.0	1
0046	0017	EP	25.2	149	SX	45.2	204	37.4	612	334.4	4
0046	0018	FD	42.2	229	SX	32.4	154	35.3	440	412.7	3
0046	0019	FD	26.8	84	PL	27.0	79	64.1	1,617	443.0	1
0046	0020	FD	27.9	84	SX	24.7	69	54.2	1,313	430.9	1
0046	0021	SX	33.5	119	PL	28.3	119	51.7	892	527.2	1
0046	0022	SX	30.4	139	FD	31.1	79	41.5	816	408.4	2
0046	0023	FD	31.7	104	SX	29.3	162	40.9	798	366.0	2
0046	0024	FD	34.4	149	SX	29.3	144	49.1	895	459.2	1
0046	0025	FD	33.5	129	SX	28.9	84	49.6	869	498.7	1
0046	0026	FD	36.4	154	SX	38.4	154	45.9	378	412.5	1
0046	0027	FD	32.8	99	PL	19.3	113	46.6	715	465.6	3
0046	0028	SX	36.3	154	FD	20.4	93	42.3	391	485.8	2
0046	0029	SX	26.8	54	BL	25.6	54	31.1	557	242.5	1
0046	0030	EP	24.0	54	FD	25.7	84	34.8	1,072	278.8	2
0046	0031	EP	22.6	74	AT	26.8	84	44.2	1,201	300.2	1
0046	0032	SX	26.0	79	FD	31.2	129	42.3	864	337.5	1
0046	0033	FD	24.0	69	PL	12.8	44	49.9	1,230	301.6	1
0046	0034	FD	13.4	44	SX	25.8	83	23.5	797	74.2	3
0046	0035	SX	21.7	42	EP	32.4	149	45.3	950	282.4	1
0046	0036	SX	26.0	79	FD	34.5	129	45.3	1,018	382.1	1
0046	0037	FD	29.1	72	SX	20.0	42	63.8	1,307	526.1	1
0046	0038	FD	26.5	74	SX	30.4	99	48.3	923	350.2	1
4771	0003	BL	15.6	99	SX	10.5	53	4.0	143	20.7	1
4771	0004	SX	39.2	223	BL	34.2	265	39.1	375	419.4	1
4771	0005	PL	24.3	120		15.2	113	31.1	1,072	259.4	1
4771	0006	BL	18.9	95	SX	26.0	95	23.1	653	140.3	2
4771	0007	BL	26.3	198	SX	20.5	140	28.7	383	246.4	1
4771	0008	BL	23.9	170	SX	20.3	218	37.3	607	262.1	1
4771	0009	BL	15.7	105	SX			13.0	467	57.4	1
4771	0012	SX	32.2	235	BL	19.0	95	38.1	589	357.2	1
4771	0013	SX	19.5	67	PL	26.5	74	25.5	688	163.0	1
4771	0014	SX	33.3	211	BL	27.3	205	36.6	511	370.2	2
4771	0016	SX	20.5	140	BL	30.9	163	38.6	467	304.6	1
4771	0017	BL	12.6	125	SX	25.6	115	5.1	161	23.5	2
4771	0018	BL	18.7	110	SX	15.4	225	24.5	536	139.6	1
4771	0019	BL	13.4	49	SX	21.2	106	17.6	779	67.3	1
4771	0021	SX	28.2	85	PL	17.0	90	33.8	558	305.3	1
4771	0022	PL	26.3	125	AT	26.4	130	34.2	792	308.6	1

Project	Sample	Leading			Second			Basal Area (m^2/ha)	Trees/ha	Volume (m^3/ha)	Match Case[a]
		Spp	Height (m)	Age (yrs)	Spp	Height (m)	Age (yrs)				
4771	0024	SX	27.6	130	BL	30.3	215	37.7	587	307.4	2
4771	0025	SX	35.3	205	BL	18.5	170	39.7	267	384.4	1
4771	0026	SX	22.9	159	BL	16.8	105	29.0	646	179.3	2
4771	0027	SX	35.3	205	BL	27.2	180	39.4	376	371.6	1
4771	0028	SX	31.3	153		24.2	71	36.5	359	338.9	3
4771	0030	SX	21.1	85	EP	20.5	155	25.6	505	153.7	1
4771	0031	PL	25.8	75	SX	10.4	145	40.4	1,017	368.1	1
4771	0032	BL	25.3	208	SX	18.9	67	28.8	338	225.4	2
4771	0033	PL	24.6	88	SX	25.3	200	29.6	630	254.3	2
4771	0034	AT	27.7	89	ACT	26.4	75	33.9	619	232.2	3
4771	0035	SX	30.3	174	PL	22.5	155	38.6	593	354.1	1
4771	0036	SX	36.3	190	BL	28.3	185	43.5	546	465.2	2
4771	0038	PL	27.4	107	SX	18.6	54	38.7	798	350.9	2
4771	0039	SX	33.3	205	BL	25.4	155	37.7	556	334.2	1
4771	0040	SX	24.6	70	PL	35.1	116	38.7	865	278.8	1
4771	0041	SX	24.4	195	BL	19.0	134	29.6	709	228.5	1
4771	0043	PL	25.8	72	SX	27.8	89	40.5	1,013	369.6	2
4771	0044	BL	16.9	90	SX	26.8	111	26.2	449	132.4	2
4771	0046	PL	30.1	185	SX	26.5	90	40.9	480	368.2	1
4771	0047	SX	32.3	210	BL	27.4	195	38.3	556	361.6	2
4771	0048	SX	22.5	224	BL	38.0	216	36.4	727	220.5	2
4771	0049	FD	28.5	130	PL	24.3	130	43.5	637	356.6	3
4771	0053	PL	23.4	100	BL	15.7	99	28.3	557	204.7	2
4771	0054	SX	25.6	145				1.8	55	17.6	1
4771	0056	SX	21.1	90	BL	15.0	90	28.0	610	175.7	1
4771	0058	PL	17.5	95	SX	20.7	110	24.3	750	133.3	1
4771	0060	SX	35.5	135	PL	30.4	155	41.3	252	442.9	1
4771	0061	PL	29.2	173	BL	27.5	170	33.7	420	301.2	1
4771	0063	SX	28.3	305	BL	20.3	305	35.0	475	250.2	2
4771	0065	SX	28.4	180	PL	32.3	135	37.4	608	328.0	1
4771	0068	PL	18.9	57	SX	13.5	49	10.6	585	65.6	2
4771	0069	PL	21.7	80	SX	24.0	169	25.4	576	186.2	3
4771	0070	SB	15.5	113	PL	22.2	80	19.9	673	88.6	1
4771	0071	SX	20.7	110	BL	11.8	53	27.3	576	180.3	2
4772	0001	BL	26.8	226	SX	23.9	116	28.8	280	242.9	2
4772	0002	BL	22.4	206	SX	28.4	160	33.4	554	183.9	1
4772	0003	BL	20.6	156	SX	16.8	95	36.5	661	259.7	1
4772	0004	BL	24.0	96	SX	18.1	96	40.0	341	261.3	2
4772	0005	BL	11.9	54	SX	26.5	186	28.5	753	98.3	1
4772	0006	BL	11.9	91	SX	20.2	96	13.7	444	54.4	1
4772	0007	BL	10.1	54	SX	28.2	175	13.1	619	38.9	1
4772	0008	BL	18.9	106	SX	29.4	171	25.3	487	150.3	2
4772	0009	BL	17.1	91	SX			25.0	605	127.7	2
4772	0010	BL	16.4	219	SX	25.3	89	32.7	554	154.9	1

a: Match case corresponds to the MoFR rules for matching Phase I and Phase II height and age. With Case 1or 3, the Phase I height/age of the leading species is matched to the Phase II height/age. With Case 2 or 4, the Phase I height/age of the second species is matched to the Phase II height/age. With Case 5, the observation is dropped from analysis.

APPENDIX II – REJECTED PHASE II PLOTS

Table 20. TFL 52 Phase II plots rejected for analysis.

				UTM			
Project	Sample	Map	Stand	Zone	Easting	Northing	Cause
0046	0003	093G017	397	10	522825	5891490	Logged stand
4771	0002	093A081	1117	10	575885	5854922	Logged stand
4771	0010	093H004	831	10	618050	5878763	Logged stand
4771	0050	093A092	419	10	581942	5866161	Logged stand
4771	0052	093B100	29	10	564375	5872558	Logged stand

APPENDIX III – PHASE II PLOT LOCATIONS

Table 21. TFL 52 Phase II sample plot locations.

Project	Sample	Map	Polygon	UTM Zone	UTM Easting	UTM Northing
0046	0001	093G017	143	10	521396	5893552
0046	0002	093G017	245	10	524463	5892518
0046	0004	093G017	605	10	519501	5889107
0046	0005	093G017	637	10	519701	5888913
0046	0006	093G017	689	10	524202	5888513
0046	0007	093G018	173	10	528710	5891228
0046	0008	093G018	244	10	527159	5889897
0046	0009	093G027	415	10	514860	5900040
0046	0010	093G027	512	10	515977	5897608
0046	0011	093G027	763	10	519293	5894592
0046	0012	093G036	818	10	508879	5910019
0046	0013	093G036	1120	10	506282	5907629
0046	0014	093G037	63	10	515633	5915643
0046	0015	093G037	135	10	518479	5914214
0046	0016	093G037	150	10	519571	5913969
0046	0017	093G037	243	10	515710	5912736
0046	0018	093G037	799	10	516781	5906778
0046	0019	093G026	4	10	512619	5903746
0046	0020	093G026	68	10	511640	5904289
0046	0021	093G027	112	10	518464	5904691
0046	0022	093G036	588	10	502937	5911682
0046	0023	093G036	916	10	512164	5909650
0046	0024	093G036	855	10	508643	5909232
0046	0025	093G036	1004	10	503517	5908845
0046	0026	093G037	87	10	513806	5915120
0046	0027	093G046	58	10	511368	5919033
0046	0028	093G046	66	10	512157	5918697
0046	0029	093G017	61	10	521331	5894248
0046	0030	093G017	617	10	520323	5889387
0046	0031	093G026	28	10	509735	5904736
0046	0032	093G026	58	10	512699	5904959
0046	0033	093G027	364	10	516213	5901087
0046	0034	093G027	423	10	516656	5899760
0046	0035	093G036	798	10	511800	5910192
0046	0036	093G036	1167	10	512733	5906549
0046	0037	093G036	1168	10	509054	5907105
0046	0038	093G037	853	10	517029	5906261
4771	0003	093H013	567	10	594095	5892328
4771	0004	093A092	973	10	590598	5862122
4771	0005	093A072	669	10	582801	5846123
4771	0006	093H012	1010	10	588352	5884425
4771	0007	093A092	725	10	588570	5863698
4771	0008	093A082	263	10	590324	5860441
4771	0009	093H023	963	10	595437	5898591
4771	0012	093A093	682	10	604274	5865529
4771	0013	093G020	89	10	554410	5894328
4771	0014	093A093	522	10	605051	5867115
4771	0016	093A092	892	10	592620	5862645
4771	0017	093A091	705	10	577947	5868477
4771	0018	093H003	1050	10	603042	5878629
4771	0019	093G009	621	10	550687	5875349
4771	0021	093H023	210	10	604263	5904628
4771	0022	093A071	56	10	569556	5850299
4771	0024	093A092	655	10	591494	5864182
4771	0025	093A091	420	10	576119	5870347

				UTM		
Project	Sample	Map	Polygon	Zone	Easting	Northing
4771	0026	093H023	59	10	594792	5905930
4771	0027	093A091	1316	10	577671	5864283
4771	0028	093G020	743	10	562745	5887861
4771	0030	093G030	106	10	561248	5904262
4771	0031	093G019	455	10	549070	5888787
4771	0032	093G020	640	10	564283	5888609
4771	0033	093A082	701	10	582678	5857339
4771	0034	093G019	441	10	541663	5889081
4771	0035	093H022	1097	10	589337	5897946
4771	0036	093A093	334	10	606422	5868756
4771	0038	093B100	105	10	566367	5871774
4771	0039	093A082	84	10	590080	5861947
4771	0040	093G030	144	10	563120	5903597
4771	0041	093H022	112	10	592372	5905639
4771	0043	093G019	152	10	541585	5892179
4771	0044	093A093	943	10	604715	5864021
4771	0046	093H022	1105	10	586226	5897886
4771	0047	093H011	21	10	567462	5890067
4771	0048	093G030	604	10	561874	5895728
4771	0049	093A072	647	10	589118	5845751
4771	0053	093H013	1426	10	607048	5885565
4771	0054	093H034	290	10	613355	5908849
4771	0056	093H003	1315	10	606459	5876570
4771	0058	093H013	528	10	600918	5892469
4771	0060	093A091	1647	10	570469	5862382
4771	0061	093G020	578	10	561623	5887723
4771	0063	093A082	618	10	588431	5858097
4771	0065	093A091	164	10	577587	5871798
4771	0068	093G009	296	10	550635	5881175
4771	0069	093A082	192	10	581731	5860899
4771	0070*	093A081	1405	10	574959	5852559
4771	0071	093H013	949	10	595864	5889051
4772	0001	093A093	1008	10	597172	5863440
4772	0002	093H003	1586	10	605954	5874091
4772	0003	093H012	479	10	589500	5890026
4772	0004	093H013	1230	10	606507	5887292
4772	0005	093H014	521	10	612255	5888167
4772	0006	093H004	603	10	608550	5880693
4772	0007	093H014	292	10	611784	5890964
4772	0008	093A093	262	10	605968	5869874
4772	0009	093H023	756	10	594838	5900016
4772	0010	093A082	619	10	587113	5857962

*: the UTM location of this plot is uncertain.

APPENDIX IV – PHASE II SAMPLING WEIGHTS

Table 22. TFL 52 Phase II sample plot sampling weights.

Project	Sample	Stratum	Substratum	Selection Weight Actual	Selection Weight Relative	Area/ Rel. Wgt	Sampling Weight
0046	0001	B-Others	Mature	392.3	1.000	405.8	405.8
0046	0010	B-Others	Immature	392.3	1.000	421.4	421.4
0046	0011	B-Others	Immature	392.3	1.000	421.4	421.4
0046	0012	B-Others	Immature	392.3	1.000	421.4	421.4
0046	0013	B-Others	Mature	392.3	1.000	405.8	405.8
0046	0014	B-Fd	Mature	392.3	1.000	445.4	445.4
0046	0015	B-Others	Mature	392.3	1.000	405.8	405.8
0046	0016	B-Others	Mature	392.3	1.000	405.8	405.8
0046	0017	B-Others	Mature	392.3	1.000	405.8	405.8
0046	0018	B-Fd	Mature	392.3	1.000	445.4	445.4
0046	0019	B-Fd	Immature	421.2	1.074	375.6	403.2
0046	0002	B-Others	Mature	392.3	1.000	405.8	405.8
0046	0020	B-Fd	Immature	421.2	1.074	375.6	403.2
0046	0021	B-Others	Mature	421.2	1.074	405.8	435.7
0046	0022	B-Others	Mature	421.2	1.074	405.8	435.7
0046	0023	B-Fd	Immature	421.2	1.074	375.6	403.2
0046	0024	B-Fd	Mature	421.2	1.074	445.4	478.2
0046	0025	B-Fd	Mature	421.2	1.074	445.4	478.2
0046	0026	B-Fd	Mature	421.2	1.074	445.4	478.2
0046	0027	B-Fd	Immature	421.2	1.074	375.6	403.2
0046	0028	B-Others	Mature	421.2	1.074	405.8	435.7
0046	0029	B-Others	Immature	404.5	1.031	421.4	434.5
0046	0030	B-Others	Immature	404.5	1.031	421.4	434.5
0046	0031	B-Others	Immature	404.5	1.031	421.4	434.5
0046	0032	B-Others	Immature	404.5	1.031	421.4	434.5
0046	0033	B-Fd	Immature	404.5	1.031	375.6	387.3
0046	0034	B-Fd	Immature	404.5	1.031	375.6	387.3
0046	0035	B-Others	Immature	404.5	1.031	421.4	434.5
0046	0036	B-Others	Immature	404.5	1.031	421.4	434.5
0046	0037	B-Fd	Immature	404.5	1.031	375.6	387.3
0046	0038	B-Fd	Immature	404.5	1.031	375.6	387.3
0046	0004	B-Fd	Mature	392.3	1.000	445.4	445.4
0046	0005	B-Others	Immature	392.3	1.000	421.4	421.4
0046	0006	B-Fd	Mature	392.3	1.000	445.4	445.4
0046	0007	B-Fd	Mature	392.3	1.000	445.4	445.4
0046	0008	B-Fd	Immature	392.3	1.000	375.6	375.6
0046	0009	B-Fd	Mature	392.3	1.000	445.4	445.4
4771	0012	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0013	A-Others	Immature	2,748.0	7.005	393.6	2,757.2
4771	0014	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0016	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0017	A-Bl	Mature	4,503.3	11.479	262.6	3,014.4
4771	0018	A-Bl	Immature	2,863.6	7.300	173.5	1,266.4
4771	0019	A-Bl	Immature	4,503.3	11.479	173.5	1,991.6
4771	0021	A-Others	Immature	2,578.5	6.573	393.6	2,587.0
4771	0022	A-Pl	Mature	3,243.5	8.268	411.6	3,402.8
4771	0024	A-Others	Mature	2,578.5	6.573	348.8	2,292.5
4771	0025	A-Others	Mature	2,748.0	7.005	348.8	2,443.2
4771	0026	A-Others	Mature	2,578.5	6.573	348.8	2,292.5
4771	0027	A-Others	Mature	2,748.0	7.005	348.8	2,443.2
4771	0028	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0003	A-Bl	Immature	2,748.0	7.005	173.5	1,215.3
4771	0030	A-Others	Immature	2,748.0	7.005	393.6	2,757.2
4771	0031	A-Pl	Immature	2,460.0	6.271	269.1	1,687.7
4771	0032	A-Bl	Mature	2,396.8	6.110	262.6	1,604.4
4771	0033	A-Pl	Immature	2,460.0	6.271	269.1	1,687.7

Project	Sample	Stratum	Substratum	Selection Weight Actual	Relative	Area/ Rel. Wgt	Sampling Weight
4771	0034	A-Others	Immature	5,226.9	13.324	393.6	5,244.3
4771	0035	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0036	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0038	A-Pl	Immature	3,243.5	8.268	269.1	2,225.2
4771	0039	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0004	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0040	A-Others	Immature	2,578.5	6.573	393.6	2,587.0
4771	0041	A-Others	Mature	2,578.5	6.573	348.8	2,292.5
4771	0043	A-Pl	Immature	2,460.0	6.271	269.1	1,687.7
4771	0044	A-Bl	Immature	3,134.1	7.989	173.5	1,386.1
4771	0046	A-Pl	Mature	3,243.5	8.268	411.6	3,402.8
4771	0047	A-Others	Mature	3,134.1	7.989	348.8	2,786.5
4771	0048	A-Others	Mature	2,578.5	6.573	348.8	2,292.5
4771	0049	A-Others	Mature	1,735.6	4.424	348.8	1,543.0
4771	0005	A-Pl	Mature	2,460.0	6.271	411.6	2,580.9
4771	0053	A-Pl	Immature	2,460.0	6.271	269.1	1,687.7
4771	0054	A-Others	Mature	2,578.5	6.573	348.8	2,292.5
4771	0056	A-Others	Immature	2,578.5	6.573	393.6	2,587.0
4771	0058	A-Pl	Immature	3,431.4	8.747	269.1	2,354.1
4771	0006	A-Bl	Immature	2,863.6	7.300	173.5	1,266.4
4771	0060	A-Others	Mature	2,748.0	7.005	348.8	2,443.2
4771	0061	A-Pl	Mature	3,243.5	8.268	411.6	3,402.8
4771	0063	A-Others	Mature	2,578.5	6.573	348.8	2,292.5
4771	0065	A-Others	Mature	2,748.0	7.005	348.8	2,443.2
4771	0068	A-Pl	Immature	3,431.4	8.747	269.1	2,354.1
4771	0069	A-Pl	Immature	3,431.4	8.747	269.1	2,354.1
4771	0007	A-Bl	Mature	2,396.8	6.110	262.6	1,604.4
4771	0070	A-Others	Immature	3,020.0	7.698	393.6	3,030.0
4771	0071	A-Others	Mature	2,748.0	7.005	348.8	2,443.2
4771	0008	A-Bl	Mature	2,396.8	6.110	262.6	1,604.4
4771	0009	A-Bl	Immature	2,863.6	7.300	173.5	1,266.4
4772	0001	A-Bl	Mature	2,396.1	6.108	262.6	1,603.9
4772	0010	A-Bl	Mature	2,857.4	7.284	262.6	1,912.7
4772	0002	A-Bl	Mature	2,396.1	6.108	262.6	1,603.9
4772	0003	A-Bl	Mature	2,396.1	6.108	262.6	1,603.9
4772	0004	A-Bl	Immature	2,396.1	6.108	173.5	1,059.7
4772	0005	A-Bl	Immature	2,995.4	7.636	173.5	1,324.8
4772	0006	A-Bl	Immature	2,995.4	7.636	173.5	1,324.8
4772	0007	A-Bl	Immature	2,995.4	7.636	173.5	1,324.8
4772	0008	A-Bl	Immature	2,857.4	7.284	173.5	1,263.7
4772	0009	A-Bl	Immature	2,857.4	7.284	173.5	1,263.7

APPENDIX V – PHASE II ATTRIBUTES

Table 23. TFL 52 Phase II attributes for the 97 plots.

Project	Sample	Species	Height (m)	Age (yrs)	Basal Area (m^2/ha)	Trees/ha	Live Volume (m^3/ha)	Pl Volume (m^3/ha)	Dead Volume (m^3/ha)
0046	0001	FD			42.0	1,309.2	390.8	0.0	0.0
0046	0002	SX	42.0	180	34.2	490.5	405.6	77.4	265.2
0046	0004	FD	28.5	154	38.3	1,419.6	291.6	0.0	0.0
0046	0005	FD	14.4	52	23.8	1,358.4	124.6	0.0	0.0
0046	0006	SX	37.6	124	24.8	135.3	313.3	0.0	0.0
0046	0007	SX	26.4	144	27.0	482.4	252.5	0.0	0.0
0046	0008	EP	25.6	90	45.0	610.2	374.9	0.0	0.0
0046	0009	FD	28.3	98	48.0	2,139.1	336.8	0.0	0.0
0046	0010	FD	36.2	131	31.5	1,758.1	261.3	0.0	0.0
0046	0011	SX	29.5	88	54.0	233.5	475.1	0.0	0.0
0046	0012	ACT	34.1	77	29.8	177.3	349.0	0.0	0.0
0046	0013	FD	28.6	138	48.0	1,456.0	449.5	0.0	0.0
0046	0014	FD	32.3	146	19.8	210.9	214.2	0.0	0.0
0046	0015	BL	36.5	156	40.6	393.3	483.1	0.0	0.0
0046	0016	BL	28.9	126	37.3	480.8	384.2	0.0	0.0
0046	0017	FD	43.1	151	35.0	334.5	381.1	0.0	0.0
0046	0018	BL	35.9	131	37.8	729.1	417.5	0.0	0.0
0046	0019	FD	28.0	78	69.0	1,911.2	576.1	159.8	0.0
0046	0020	FD	29.8	75	36.0	850.9	308.2	0.0	0.0
0046	0021	SX	28.1	125	51.8	1,111.4	530.2	0.0	0.0
0046	0022	FD	28.5	130	45.0	889.8	431.9	83.3	0.0
0046	0023	SX	40.9	238	31.5	990.5	345.9	0.0	0.0
0046	0024	FD	28.9	110	29.4	961.3	249.7	15.4	0.0
0046	0025	FD	33.1	102	39.7	756.3	368.8	0.0	0.0
0046	0026	FD	26.8	165	48.0	1,189.6	421.2	0.0	0.0
0046	0027	SX	27.3	74	61.2	1,367.7	565.9	176.3	192.5
0046	0028	FD	23.3	73	35.0	543.0	319.5	88.5	120.8
0046	0029	SX	19.2	51	21.0	460.5	145.0	11.4	0.0
0046	0030	FD	30.4	91	42.0	854.9	364.0	0.0	0.0
0046	0031	EP	22.5	88	29.4	989.6	190.8	0.0	0.0
0046	0032	SX	27.8	73	42.0	852.6	353.1	0.0	0.0
0046	0033	FD	23.7	65	37.8	927.2	284.7	0.0	0.0
0046	0034	BL	16.1	46	27.5	1,073.9	173.0	0.0	0.0
0046	0035	SX	21.6	46	32.7	667.0	243.5	0.0	0.0
0046	0036	SX	25.3	74	42.0	1,380.3	327.3	104.9	0.0
0046	0037	FD	23.3	82	50.8	1,937.7	319.0	0.0	0.0
0046	0038	FD	31.4	74	45.0	421.3	442.1	0.0	0.0
4771	0003	BL		50	28.8	455.9	273.7	0.0	0.0
4771	0004	SX	36.0	231	49.8	1,367.6	417.0	0.0	0.0
4771	0005	PL	21.0	130	28.0	1,634.2	149.6	149.6	0.0
4771	0006	BL	25.9	127	62.0	1,955.3	455.0	77.6	55.5
4771	0007	BL	23.5	175	61.3	2,800.0	396.7	0.0	0.0
4771	0008	BL	21.5	146	32.0	343.3	261.3	0.0	0.0
4771	0009	BL	23.4	100	31.5	1,790.0	191.0	0.0	0.0
4771	0012	SX		250	36.0	209.9	354.6	0.0	0.0
4771	0013	SX	23.7	73	39.4	1,052.4	272.1	105.2	60.4
4771	0014	BL		164	60.0	868.7	570.9	0.0	0.0
4771	0016	SX	30.5	199	57.3	832.9	527.9	0.0	0.0
4771	0017	SX	17.8	162	12.6	446.3	84.3	36.8	0.0
4771	0018	BL	19.4	139	24.1	1,024.5	165.3	7.6	0.0
4771	0019	BL	20.9	84	28.3	939.6	157.7	0.0	0.0
4771	0021	SX	31.4	138	40.0	763.4	356.7	140.9	0.0
4771	0022	PL	27.7	123	26.0	623.1	218.0	190.4	45.1

Project	Sample	Species	Height (m)	Age (yrs)	Basal Area (m^2/ha)	Trees/ha	Live Volume (m^3/ha)	Pl Volume (m^3/ha)	Dead Volume (m^3/ha)
4771	0024	BL	22.5	149	51.2	1,051.8	439.0	0.0	0.0
4771	0025	SX	33.0	164	46.7	412.3	495.4	0.0	0.0
4771	0026	BL	21.2	189	46.0	1,704.4	307.2	0.0	0.0
4771	0027	SX	28.8	296	41.0	1,331.5	326.5	0.0	0.0
4771	0028	SX	31.9	210	33.6	681.6	295.1	0.0	0.0
4771	0030	SX	28.4	98	54.0	1,638.0	434.2	0.0	0.0
4771	0031	PL	21.6	72	39.6	1,673.6	256.2	241.6	0.0
4771	0032	BL			64.0	1,362.3	571.5	0.0	0.0
4771	0033	SX	20.9	79	38.3	818.1	257.3	0.0	0.0
4771	0034	EP	19.3	107	21.0	754.4	155.3	68.7	0.0
4771	0035	SX	28.6	199	52.9	782.4	481.9	57.7	0.0
4771	0036	BL	25.3	193	51.3	1,119.8	454.6	0.0	0.0
4771	0038	SX	24.2	89	31.5	926.6	248.1	33.5	0.0
4771	0039	SX	21.7	188	40.3	1,106.9	323.9	0.0	0.0
4771	0040	SX	18.9	66	25.2	1,117.7	141.3	45.6	0.0
4771	0041	SX	29.2	182	49.0	753.1	436.4	104.2	0.0
4771	0043	SX	26.3	71	38.0	362.0	317.0	19.6	0.0
4771	0044	SX	23.2	111	12.5	115.8	124.7	0.0	0.0
4771	0046	PL	25.2	139	21.0	164.8	215.8	215.8	23.7
4771	0047	BL	23.1	188	41.6	734.5	406.1	0.0	0.0
4771	0048	BL	21.9	118	55.2	1,690.2	422.1	0.0	0.0
4771	0049	SX	27.7	106	52.8	986.1	427.8	0.0	0.0
4771	0053	BL	23.3	82	45.0	702.7	397.7	141.8	0.0
4771	0054	SX	15.2	48	5.0	137.5	36.7	0.0	0.0
4771	0056	BL	20.7	88	0.0	0.0	0.0	0.0	0.0
4771	0058	PL	21.8	95	31.5	481.1	265.3	257.4	0.0
4771	0060	SX	32.4	98	30.0	416.4	264.7	0.0	0.0
4771	0061	PL	32.8	208	54.0	1,151.3	455.1	272.6	50.9
4771	0063	BL	27.5	173	51.0	744.9	471.7	0.0	0.0
4771	0065	SX			48.9	1,145.9	422.8	13.2	64.0
4771	0068	SX	21.0	76	68.0	2,750.8	456.6	245.7	0.0
4771	0069	BL	17.0	153	40.0	941.1	235.5	60.2	0.0
4771	0070	SB	11.7	114	10.0	908.2	19.1	0.0	0.0
4771	0071	BL	14.5	93	22.2	1,070.6	114.7	0.0	0.0
4772	0001	BL	29.1	287	41.0	569.6	389.0	0.0	0.0
4772	0002	BL	26.8	240	0.0	0.0	0.0	0.0	0.0
4772	0003	BL	25.5	163	49.0	1,288.2	415.4	0.0	0.0
4772	0004	SX	25.9	158	54.0	1,365.5	420.1	0.0	63.7
4772	0005	BL	20.2	106	23.0	425.7	169.2	0.0	0.0
4772	0006	BL	18.8	103	0.0	0.0	0.0	0.0	0.0
4772	0007	BL	14.8	95	21.4	1,371.3	93.2	15.0	0.0
4772	0008	BL		130	42.0	761.9	340.1	0.0	0.0
4772	0009	BL			37.0	1,978.6	195.9	0.0	0.0
4772	0010	BL	19.4	273	33.4	979.8	237.8	0.0	0.0

Note: Live volume includes all species while Pl volume includes only the live Pl volume.

APPENDIX VI – DROPPED HEIGHT AND AGE OBSERVATIONS

Table 24. List of height observations dropped for analysis.

Project	Sample	Stratum	Phase II Spp	Phase II Ht (m)	Phase I 1st Spp	Phase I 1st Ht (m)	Phase I 2nd Spp	Phase I 2nd Ht (m)	Rejection Cause
0046	0001	B-Others	FD		SX	32.4	BL	22.1	No Phase II height
4771	0003	A-Bl	BL		BL	15.6	SX	10.5	No Phase II height
4771	0012	A-Others	SX		SX	32.2	BL	19.0	No Phase II height
4771	0014	A-Others	BL		SX	33.3	BL	27.3	No Phase II height
4771	0032	A-Bl	BL		BL	25.3	SX	18.9	No Phase II height
4771	0065	A-Others	SX		SX	28.4	PL	32.3	No Phase II height
4772	0008	A-Bl	BL		BL	18.9	SX	29.4	No Phase II height
4772	0009	A-Bl	BL		BL	17.1	SX		No Phase II height

Table 25. List of age observations dropped for analysis.

Project	Sample	Stratum	Phase II Spp	Phase II Age (yrs)	Phase I 1st Spp	Phase I 1st Age (yrs)	Phase I 2nd Spp	Phase I 2nd Age (yrs)	Rejection Cause
0046	0001	B-Others	FD		SX	154	BL	69	No Phase II age
4771	0032	A-Bl	BL		BL	208	SX	67	No Phase II age
4771	0065	A-Others	SX		SX	180	PL	135	No Phase II age
4772	0009	A-Bl	BL		BL	91	SX		No Phase II age