Vanderhoof Forest District

Documentation of Analysis for
Vegetation Resources Inventory Statistical Adjustment

DRAFT

EXECUTIVE SUMMARY

Timberline Natural Resource Group recently completed a VDYP6 VRI statistical adjustment analysis of the Prince George TSA. The analysis was done separately for each of the three forest districts within the TSA: Prince George, Vanderhoof and Fort St. James.

The objective of this project was to provide a VDYP7 adjustment for the Vanderhoof Forest District of the Prince George TSA which followed the same approach as the Timberline VDYP6 adjustment for this unit. Hence analysis strata, sampling weights, target population, compiled VRI Phase II data, etc. were provided by Timberline.

This adjustment was to be carried out according to the interim procedures for a VDYP7 adjustment which allows for adjustment of age, height, basal area/ha at 7.5cm+ dbh utilization, trees/ha at 7.5cm+ dbh utilization and volume/ha net dw2 at 12.5cm+ dbh utilization.

Because of the heavy MPB infestation in this area and how MPB mortality is dealt with in a timber supply context, timber supply staff requested that all dead pine be included in the adjustment. Hence the basal area/ha, trees/ha, and volume adjustment factors are all based on live (all species) plus dead lodgepole pine.

The NVAF destructive sampling for this unit was carried out after the 2005 remeasurement of the Phase II VRI samples. The destructive sampling data was compiled and NVAF values for live/dead in three species strata were calculated. These NVAF values, shown in Table 1 below, were then applied as a multiplier to the compiled volumes for each species present within a sample.

Table 1: NVAF values applied in the volume compilation for the Vanderhoof Forest District

Vanderhoof Forest District Net Volume Adjustment Factors		
Species Stratum	NVAF – Live trees	NVAF – Dead trees
Spruce	1.0491	0.98813
Lodgepole pine	1.0012	1.0392
All other species	0.92606	0.98813

The target population was stratified into 3 groups based on the Pl proportion in the stand. These groups formed the strata for the development of the adjustment factors:

- Polygons where the forest inventory indicated at least 80% Pl
- Polygons that were leading in lodgepole pine but contained less than 80% Pl
- Polygons where lodgepole pine was not the leading species.

The resulting VDYP7 adjustment factors for age, height, basal area, trees per hectare and volume are shown in Table 2.

Timber supply analyses are typically done on a net decay, waste and breakage volume basis. Hence, a special unadjusted run of VDYP7 was done to provide unadjusted volumes net decay, waste & breakage so that the estimated volume impact of the VDYP7 adjustment and its associated sampling error could be computed. The estimated volume impacts of the adjustment were computed as ratios of the ground (Phase II) volume to the unadjusted VDYP7 (Phase I) volume, with appropriate sample weights applied. The results, by stratum, are shown in Table 3.

Table 2: VDYP7 Adjustment Factors for age, height, trees/ha (at 7.5cm+dbh utilization), basal area/ha (at 7.5cm+dbh utilization) and volume/ha (net DW2 at 12.5cm+ dbh utilization). Note that the basal area/ha, trees/ha & volume/ha adjustment factors are based on Phase II per hectare values that include live trees for all species plus dead trees for lodgepole pine.

| Stratum | n | VDYP7 Adjustment Factors | | | | |
| | | Stage 1 | | | | Stage 2 |
		Age	Height	Basal area/ha @7.5cm+dbh	Trees/ha @7.5cm+ dbh	Volume/ha net DW2 @12.5cm+ dbh
Pl leading, Pl%<80%	12	0.897	1.026	1.048	1.364	1.020
Pl leading, Pl%>=80%	35	0.960	0.937	1.193	1.603	1.175
Non-Pl leading	17	1.053	0.946	0.951	1.378	1.185

Table 3: Volume Impact of VDYP7 adjustment, by stratum

| Stratum | n | Volume/ha @12.5cm+ dbh utilization net DWB: Estimated VDYP7 Adjustment Impact | | | |
		Wt'd Mean Phase II Vol/ha (LIVE + Dead PL)	Wt'd Mean Phase I Unadjusted vol/ha	Estimated volume impact ratio	SE % for volume impact (at 95%)
Pl leading, Pl%<80%	12	231	220	1.051	39%
Pl leading, Pl%>=80%	35	239	204	1.171	16%
Non-Pl leading	17	177	184	0.958	30%

It is estimated that the VDYP7 statistical adjustment based on this sample will increase current VDYP7 volume by about 5% in stands pine leading stands with less than 80% pine and will increase volume by about 17% in pure (>=80%) pine stands. In non-pine leading stands, it is estimated that the adjustment will decrease VDYP7 volume by about 4%. Overall, the adjustment was estimated to increase total VDYP7 volume by about 9.8%. The sampling error for this estimated adjustment impact was ±13.4% (at the 95% confidence level) or ±11.2% (at the 90% confidence level). This sampling error was slightly higher than the target specified in the VPIP. When the adjustment was applied to the target population, the calculated impact of the adjustment was about 11%, which is reasonably close to what was expected based on the sample.

The Mountain Pine Beetle infestation is widespread in this unit. To facilitate the current TSR approach for representing the effect of Mountain Pine Beetle on the inventory and to ensure consistency with that approach, timber supply requested that dead pine volume be included with live volume in the adjustment. Hence the Phase II compiled values for all per hectare-based adjustments (i.e. basal area/ha, trees/ha, volume/ha) included dead pine. The magnitude of the dead pine component in the resulting total volumes (and basal areas etc.) was significant. In the samples where the inventory indicates at least 80% pine, dead pine accounts for about 60% of the total volume for live trees (all species) plus dead pine. The impact of including dead pine volume in the analysis should be considered in terms of degradation of volume and value in the pine component and therefore pine volumes should not continue to be projected. A process is currently being developed for dealing with the dead pine component of the inventory in a more systematic and consistent manner.

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1. INTRODUCTION

1.1 Background

Timberline Natural Resource Group recently completed a VDYP6 VRI statistical adjustment analysis of the Prince George TSA. The analysis was done separately for each of the three forest districts (Prince George, Vanderhoof and Fort St. James) within the TSA. A VDYP7 statistical adjustment was also completed for each of these districts, based on the same approach and assumptions used by Timberline in their VDYP6 analysis. The VDYP7 statistical adjustment for the Vanderhoof and Fort St. James Forest Districts were completed in-house by Ministry of Forests & Range (MFR) staff and the Prince George Forest District was completed by Churlish Consulting Ltd.[1]. This report documents the VDYP7 statistical adjustment for the Vanderhoof forest district.

VRI Phase II sampling in the Vanderhoof Forest District was initiated in 2001. Details can be found in the document: "Vanderhoof IFPA: Vegetation Resources Inventory Project Implementation Plan Version 2", prepared by J.S. Thrower & Associates Ltd. in September 2001. In total, 70 Phase II ground samples were established[2]. A subsequent remeasurement of all samples was carried out in 2005[3]. The NVAF sampling in this unit was completed following the 2005 remeasurement. It was decided that the more recent 2005 remeasurement data was to be the basis for the VRI statistical adjustment.

In 2007 a re-inventory (FIP to VRI retrofit) was completed in the Vanderhoof Forest District. It was determined that 96% of the 2007 population had been sampled (the sample selection for 2005 sampling was done based on the FIP inventory).

To ensure that the VDYP6 and VDYP7 adjustments were comparable, strata assignments, sample weights, identification of the target population etc. were provided by Timberline.

1.2 Description of the Inventory Unit

Along with Fort St. James and Prince George, the Vanderhoof Forest District is one of three forest districts that comprise the Prince George TSA (see Figure 1).

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[1] Jahraus &Associates Consulting Inc. was a subcontractor on this project.

[2] There were 21 samples established under project IFPA and 49 samples established under project DVA1.

[3] Remeasured sample data was recorded as type N02 (to differentiate it from the NVAF sample data which was recorded as type N01).
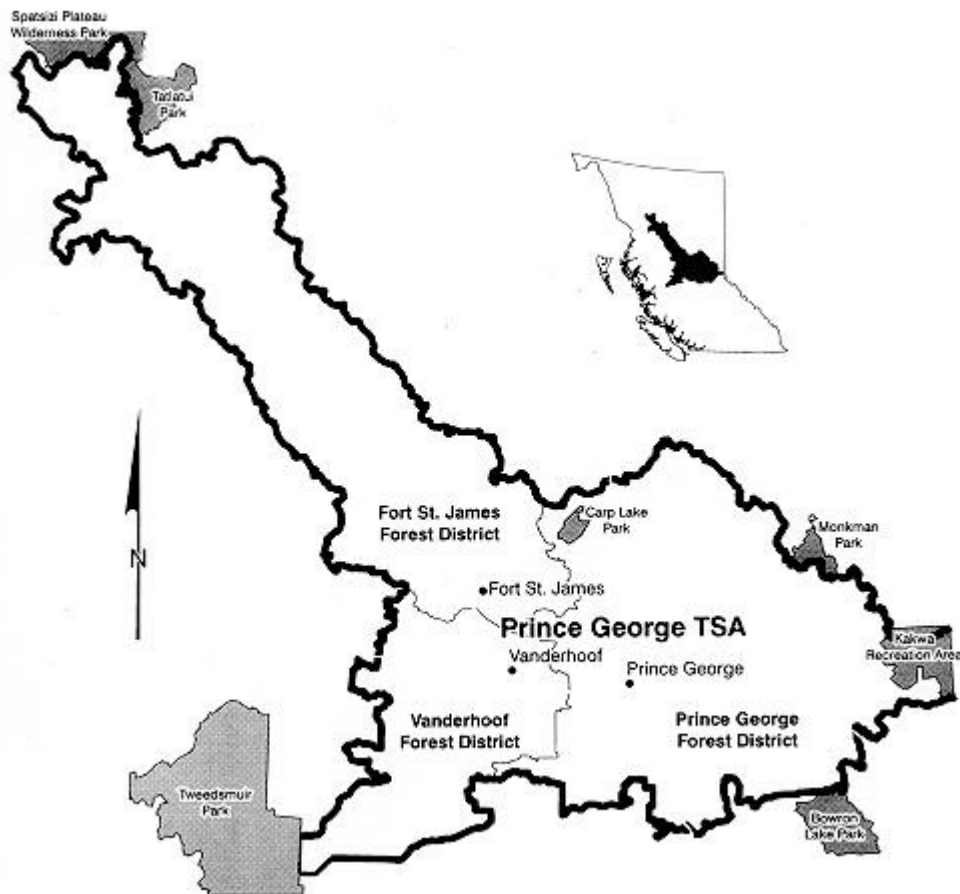
Figure 1: Map of the Prince George TSA showing the Vanderhoof Forest District [4]

1.3 Scope and Objectives

The objective of this project was to provide a VDYP7 adjustment for the Vanderhoof Forest District of the Prince George TSA which followed the same approach as the Timberline VDYP6 adjustment for this unit. Hence analysis strata, sampling weights, target population, compiled VRI Phase II data, etc. were provided by Timberline. Phase II plots were established in the Vanderhoof Forest District in 2001 and were subsequently remeasured in 2005. It was agreed that the adjustment analysis would be based solely on the latest data collected.

This adjustment was to be carried out according to the interim procedures for a VDYP7 adjustment which allows for adjustment of age, height, basal area/ha at 7.5cm+ dbh utilization, trees/ha at 7.5cm+ dbh utilization and volume/ha net dw2 at 12.5cm+ dbh utilization. Lorey height was not adjusted (an adjustment factor of 1.0 was applied for this attribute). The single volume adjustment computed was applied to all other volume utilizations.

Because of the heavy MPB infestation in this area and how MPB mortality is dealt with in a timber supply context, timber supply staff requested that all dead pine be included in the adjustment. Hence the basal area/ha, trees/ha, and volume adjustment factors are all based on live (all species) plus dead pine.

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[4] http://www.for.gov.bc.ca/hts/tsa/tsa24/map.gif

2. METHODS

2.1 Overview of NVAF analysis

The NVAF destructive sampling for this unit was carried out after the 2005 remeasurement of the Phase II VRI samples. The destructive sampling data was compiled and NVAF values for live/dead in three species strata were calculated. These NVAF values, shown in Table 1 below, were then applied as a multiplier to the compiled volumes for each species present within a sample.

Table 1: NVAF values applied in the volume compilation for the Vanderhoof Forest District

Vanderhoof Forest District Net Volume Adjustment Factors		
Species Stratum	*NVAF – Live trees*	*NVAF – Dead trees*
Spruce	1.0491	0.98813
Lodgepole pine	1.0012	1.0392
All other species	0.92606	0.98813

2.2 Population for Adjustment

According to the Vanderhoof Forest District VRI Project Implementation Plan (VPIP) prepared in 2001, the ground sampling objective was:

> *To achieve an overall precision of ±10% (at a 90% probability) in the High Priority stratum for net merchantable volume at a 12.5 cm+ utilization level.*

The VPIP defined the "high priority stratum" as the vegetated treed landbase minus private lands, small woodlots, and protected areas. There was no age-related restriction for the target population of interest that was specified in 2001.

The Phase II VRI ground sample selection completed in 2001 was based on Forest Inventory Planning (FIP) information. However, the inventory in the Vanderhoof Forest District subsequently underwent a VRI retrofit and was also updated for depletion. This resulted in differences between the 2001 sample selection population of interest and the 2007 adjustment population of interest[5]. In addition, the target population of interest in 2007 was further restricted to polygons that were at least 30 years of age in 2005[6].

Timberline overlaid the two populations and compared the areas (see Appendix A). It was determined that, based on the original FIP inventory and the 2001 sample selection population definition, 96% of the 2007 population of interest was sampled. It was proposed that the adjustment be applied only to the area that was common to both populations. The remaining 4% of the population of interest area was not adjusted since it was not originally sampled.

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[5] For example, polygons that may have been VT in the old FIP inventory might have been classified as VN in the new VRI inventory (and vice versa).

[6] Restricting the population of interest to polygons at least 30 years of age is recommended in the current VRI adjustment standards and procedures. The Phase II ground sample remeasurement was done in 2005 and this data forms the basis of the current adjustment.

The target population for adjustment and the stratum assignment for each polygon in the target population for adjustment were specified by the file target_population.csv provided by Timberline[7]. Only polygons listed in the target population file provided by Timberline were adjusted.

2.3 Data Sources

The Phase I & II data were largely provided as a series of linked files from Timberline.

2.3.1 Phase I photo-interpreted inventory data

The Phase I attribute files from Timberline represented a subset of the inventory data that was relevant to VDYP6. To enable the analysis based on VDYP7, a more complete set of Phase I data was obtained from FAIB (Tim Salkeld). The Phase I data was projected to the year of ground sampling (i.e. 2005).

Timberline supplied several other files that provided the only means of identifying sample status (i.e. established, replaced, etc.), stratum assignments and sampling weights[8]. In some cases, assumptions were required where there was inconsistency among these files. A total of 64 of the original 70 polygons met the new population of interest criteria and were included in the statistical adjustment analysis described herein. Samples that were excluded are documented as Data Issues in Appendix B.

2.3.2 Phase II ground sample data

The Phase II ground sample data was compiled by Timberline based on ascii data. The data had not been loaded onto the Ministry of Forests and Range (MFR) Oracle database and as such it did not go through the MFR error checking process.

The compiled data (as smy_c and smy_cs files) used in this analysis was received from Timberline[9] at the beginning of November 2007. The Phase II volumes were subsequently adjusted with the NVAF values provided by the MFR.

2.3.3 Data matching

The data matching used to determine the appropriate heights and ages upon which to base the adjustment ratios followed the standard procedures outlined by the MFR. The results have been included in the Appendix C cut of the analysis spreadsheet.

For each VRI sample polygon, the ground sample data was matched with the corresponding inventory data for the same polygon. The ground heights and ages used in the adjustment were based on the average values for the T, S & L[10] trees for the leading species (by basal area at 4cm + dbh utilization) on the ground. Since the Vanderhoof Forest District was all VRI (V-type) inventory data, height and age was available for both the leading and second species. The objective in the matching process was to choose an inventory height and age

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[7] In combination with a file indicating inventory update depleted areas.

[8] Vanderhoof_plot_location.csv (sampling status); vanderhoof_phase2_data.csv (sample weights; sample inclusion); samples.csv (sample identifiers); target_population.csv (stratum assignment) and depleted areas file (population inclusions)

[9] Timberline used the VRI compiler distributed by MFR.

[10] T or "top height" tree is the largest DBH in 0.01 ha plot, regardless of species; L or "leading species" tree is the largest DBH in 0.01 ha plot, of leading species; S or "second species" is the largest DBH in 0.01 ha plot, of second species. T and S trees are selected and measured at the IPC only whereas L trees are selected at the IPC and all auxiliary plots. For details, refer to the MFR document "Vegetation Resources Inventory Procedures and Standards for Data Analysis Attribute Adjustment and Implementation of Adjustment in a Corporate Database Version 2.0", March 2004.

(i.e. for either the leading or second species) so that the ground and inventory species "matched". If a match could not be made at the sp0[11] level, conifer-to-conifer matches were allowed. However, conifer-deciduous matches were not considered acceptable. Note that where second species inventory ages and heights were required and were available, these attributes were also projected to the year of ground sampling.

For 37 of the 64 samples, the inventory leading species matched the ground leading species at 4cm+ dbh utilization. For a further 14 samples, the ground leading species matched the inventory second species. Eleven samples were matched based on conifer-to-conifer or deciduous-to-deciduous. The remaining 2 samples could not be matched or did not have ground age & height data and were excluded from the development of the age and height adjustment factors.

2.4 Data issues related to the statistical adjustment

In the course of the analysis, issues and questions arose for some samples. The resolution of these issues or the assumptions that were made is summarized in the Data Issues table in Appendix B.

2.5 Stratification and weights

The analysis herein followed the same stratification used by Timberline in their VDYP6 adjustment analysis. The stratification for the adjustment analysis was determined in consultation with timber supply analysts. The target population was stratified into 3 groups based on the lodgepole pine (Pl) proportion in the stand to form the strata for the development of the adjustment factors:

- Polygons where the forest inventory indicated at least 80% Pl
- Polygons that were leading in lodgepole pine but contained less than 80% Pl
- Polygons where lodgepole pine was not the leading species.

All strata assignments and sampling weights were provided by Timberline to ensure consistency between the VDYP6 and the VDYP7 adjustment in this management unit. Table 2 provides the sampling weights that were applied in the analysis.

Table 2: Sampling weights for the 2007 adjustment analysis.

Stratum	Sample selection sub-stratum	n	Weight
Pl leading, <80%	0-200 m3/ha	3	17658.4
	200.1-250 m3/ha	3	9721.1
	250.1+ m3/ha	6	15191.0
Pl 80%+	0-125 m3/ha	9	10091.1
	125.1-250 m3/ha	12	16341.1
	250.1+ m3/ha	14	13538.8
Non-Pl leading	0-125 m3/ha	5	13686.3
	125.1-250 m3/ha	6	12085.8
	250.1+ m3/ha	6	11284.0

2.6 Overview of statistical adjustment

The VDYP7 statistical adjustment process is similar to the VDYP6 process in that it is sequential and involves two stages. However, for VDYP7 additional attributes are adjusted at the first stage: age, height,

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

basal area at 7.5cm+ dbh utilization (BA7.5), and trees per hectare at 7.5cm+ dbh utilization (TPH7.5). Although the process has the flexibility to adjust multiple attributes at the second stage, only volume net decay and waste at the 12.5cm+ dbh utilization will be adjusted at the current time. Within the VDYP7 context, various internal modules of VDYP7 are used to project the polygons, generate additional attributes, and adjust attributes. Hence the VDYP7 model itself takes a much larger role in the statistical adjustment process than did VDYP6.

3. RESULTS AND DISCUSSION

3.1 First stage VDYP7 adjustment: Height, age, basal area & trees per hectare

When the samples without a suitable inventory species match and/or there were no suitable ground ages or heights were considered, there were 61 samples for age and 59 samples for height that were available for the development of the age and height adjustment factors respectively.

Adjustment factors were computed as the ratio of the weighted mean ground i.e. Phase II (ground) value over the weighted mean inventory i.e. Phase I value, using the sample weights provided by Timberline.

The resulting VDYP7 adjustment factors for age, height, basal area and trees per hectare are shown in Tables 3 through 6 respectively. Scatterplots of the Phase I and II relationships for these attributes are provided in Appendices D & E.

Table 3: Stage 1 VDYP7 Adjustment Factors for age

Age: VDYP7 Adjustment Factors				
Stratum	n	Wt'd Mean Phase II Age	Wt'd Mean Phase I Age	Ratio of Wt'd Means
Pl leading, Pl%<80%	11	112	125	0.897
Pl leading, Pl%>=80%	33	110	114	0.960
Non-Pl leading	17	119	113	1.053

Table 4: Stage 1 VDYP7 Adjustment Factors for height

Height: VDYP7 Adjustment Factors				
Stratum	n	Wt'd Mean Phase II Height	Wt'd Mean Phase I Height	Ratio of Wt'd Means
Pl leading, Pl%<80%	11	21.9	21.3	1.026
Pl leading, Pl%>=80%	32	17.8	19.0	0.937
Non-Pl leading	16	18.5	19.6	0.946

Table 5: Stage 1 VDYP7 Adjustment Factors for basal area/ha at 7.5cm+ dbh utilization (note that the Phase II basal area/ha includes live trees for all species plus dead trees for lodgepole pine only)

Basal Area/ha @7.5cm+ dbh utilization: VDYP7 Adjustment Factors				
Stratum	n	Wt'd Mean Phase II BA/ha (LIVE + Dead PL)	Wt'd Mean Phase I BA/ha	Ratio of Wt'd Means
Pl leading, Pl%<80%	12	33.0	31.5	1.048
Pl leading, Pl%>=80%	35	36.3	30.5	1.193
Non-Pl leading	17	26.9	28.3	0.951

Table 6: Stage 1 VDYP7 Adjustment Factors for trees/ha at 7.5cm+ dbh utilization (note that the Phase II tree/ha includes live trees for all species plus dead trees for lodgepole pine only).

Trees/ha @7.5cm+ dbh utilization: VDYP7 Adjustment Factors				
Stratum	n	Wt'd Mean Phase II TPH (LIVE + Dead PL)	Wt'd Mean Phase I TPH	Ratio of Wt'd Means
Pl leading, Pl%<80%	12	1308	959	1.364
Pl leading, Pl%>=80%	34	1635	1020	1.603
Non-Pl leading	17	1034	750	1.378

The sample suggests that the bias is age estimation is not consistent among the three strata and ranges from an age overestimation of about 10% in stands where pine is leading but comprises <80%, to an age underestimation of about 5% in stands where species other than pine are leading. The sample also suggests that there is a 5-6% overestimation in height in both "pure" (i.e. ≥ 80%) pine stands as well as stands where pine is not the leading species. Where pine is leading but mixed with other species, height is typically underestimated by about 3%.

In general, Phase I basal area/ha is underestimated in "pure" (i.e. ≥ 80%) pine stands by about 19%. Note, however, that this underestimation of basal area is based on including the contribution of dead lodgepole pine. This basal area underestimation is less where pine is a smaller proportion of the stand. For stands where pine is not the leading species, basal area is typically overestimated by the inventory. As is typical with most Phase I photo-inventories, the trees per hectare attribute is underestimated by at least 35%.

3.2 Second stage VDYP7 adjustment: Volume

The adjustment factors for height, age, BA and TPH were input into the VDYP7 model which then produced an expanded output set of inventory attributes. Only one adjustment factor, for volume net decay & waste2 at the 12.5cm+dbh utilization level, was directly developed from the available attributes produced by VDYP7 at this stage. The ratios developed for this particular volume were applied to volumes at other utilizations[12].

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[12] VDYP7 produces volumes at numerous utilization levels. Any adjustments input into VDYP7 must be harmonized, that is, care must be taken to ensure that the utilization relationships (e.g. volume at 12.5cm+ always less than or equal to volume at 7.5cm+) are not contorted by the adjustment ratios. As a simple approach to ensure harmonization, only one volume adjustment factor was computed and this factor was applied to all of the other volumes. This approach was approved by Sam Otukol, Forest Biometrician, MFR.

Although the VDYP7 software has been designed to also accept second stage adjustment factors for other attributes, including Lorey height and basal area at 12.5cm+ dbh, adjustment factors for these additional attributes were not computed at this time[13].

Table 7 below shows the VDYP7 volume adjustment factors by strata for the Vanderhoof Forest District population of interest. The ground volumes used to compute the adjustment ratio of means were based on net factored volumes to which the NVAF values had been applied in the compilation. All volumes are net decay and waste2 only, at the 12.5cm+ dbh utilization level for all polygons. The Phase II volumes include dead lodgepole pine.

Table 7: Stage 2 VDYP7 Adjustment Factors for volume (note that the Phase II volume includes live volume (all species) plus dead volume for lodgepole pine only).

Volume/ha @12.5cm+ dbh utilization net DW2: VDYP7 Adjustment Factors				
Stratum	n	Wt'd Mean Phase II Vol/ha (LIVE + Dead PL)	Wt'd Mean Phase I Attribute-adjusted vol/ha	Ratio of Wt'd Means
Pl leading, Pl%<80%	12	236	231	1.020
Pl leading, Pl%>=80%	35	244	208	1.175
Non-Pl leading	17	181	153	1.185

3.3 Estimated volume impact for the VDYP7 statistical adjustment

Timber supply analyses are typically done on a net decay, waste and breakage volume basis. Hence, a special unadjusted run of VDYP7 was done to provide unadjusted volumes net decay, waste & breakage so that the estimated volume impact of the VDYP7 adjustment and its associated sampling error could be computed. The estimated volume impacts of the adjustment were computed as ratios of the ground (Phase II) volume to the unadjusted VDYP7 (Phase I) volume, with appropriate sample weights applied. The results, by stratum, are shown in Table 8.

Table 8: Volume impact estimated from the sample, by stratum

Volume/ha @12.5cm+ dbh utilization net DWB: Estimated VDYP7 Adjustment Impact					
Stratum	n	Wt'd Mean Phase II Vol/ha (LIVE + Dead PL)	Wt'd Mean Phase I Unadjusted vol/ha	Estimated volume impact ratio	SE % for volume impact (at 95%)
Pl leading, Pl%<80%	12	231	220	1.051	39%
Pl leading, Pl%>=80%	35	239	204	1.171	16%
Non-Pl leading	17	177	184	0.958	30%

This sample suggests that where pine is not the leading species, VDYP7 overestimates volume by about 4%. However, where pine is leading and comprises up to 80% of the basal area, VDYP7 underestimates volume by

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[13] The VDYP7 adjustment procedures are still under development and are being tested. At the recommendation of Sam Otukol (Forest Biometrician, MFR), Lorey height and BA at 12.5cm+ dbh were assigned an adjustment factor of 1.0. That is, no adjustment was made for these attributes.

about 5%. This volume underestimation becomes more pronounced, rising to over 15%, in pure pine polygons (i.e. 80%+ pine). Note that the *adjusted* VDYP7 inventory volume will include volume associated with dead pine.

The impact of including dead pine in the adjustment is shown for volume in Table 7. In the VT polygons greater than 30 years of age, where the inventory indicates that at least 80% of the polygon basal area/ha is pine, the volume of dead pine comprises 60% of the total volume for LIVE (all species) + dead pine. In polygons where the inventory indicates a non-pine leading species, the volume of dead pine comprises 28% of the total volume for LIVE (all species) + dead pine. Note that the live volume in these polygons includes non-pine species hence this does NOT suggest that 28% of the pine is dead, rather 28% of the total volume (live all species plus dead pine) is represented by dead pine. The mean volumes are provided so that alternative %'s can be computed.

Table 9: Impact of including dead Pl volume, by stratum

Volume/ha @12.5cm+ dbh utilization net DWB: Estimated VDYP7 Adjustment Impact and Dead Pine %						
Stratum	n	Wt'd Mean Phase II Vol/ha (LIVE + Dead PL)	Wt'd Mean Phase II Vol/ha (LIVE all spp only)	Wt'd Mean Phase II DEAD PL vol/ha	Wt'd Mean Phase I Unadjusted vol/ha	Estimated volume impact ratio based on LIVE all spp volume only	Dead pine vol/ha as a % of LIVE (all spp)+ dead Pl
Pl leading, Pl%<80%	12	231	110	121	220	0.501	52%
Pl leading, Pl%>=80%	35	239	94	145	204	0.463	60%
Non-Pl leading	17	177	127	50	184	0.689	28%

3.4 Sampling error

The VPIP for the Vanderhoof Forest District specified a target sampling error of ±10% (at a 90% probability level) for total volume for VT polygons in the target population. To provide an indication of the sampling error achieved in the VDYP7 adjustment process, a comparison of the overall estimated adjusted inventory volume and the overall estimated VDYP7 unadjusted sample inventory volume was made. The overall ratio of these values and its standard error were computed using the formula for a separate ratio estimate after a pre-stratified PPSWR sample.

The overall impact of a VDYP7 adjustment was estimated to be 1.098 with a 13.4% sampling error (at the 95% confidence level). This translates into a sampling error of ±11.2% at a 90% confidence level. This level of sampling error did not meet the target of ±10% at a 90% confidence level set in the project VPIP. The implications of not meeting the sampling error objective for volume must be considered in the context of how this adjusted inventory data will be used.

3.5 Inventory file adjustment for the VDYP7 statistical adjustment

The adjustment was applied to the target population specified by Timberline and the population volume impact was computed. The ratio of adjusted volume to unadjusted volume in the population was 1.111. Impacts on the population by age class and stratum are shown in Appendix F. The actual volume impact on the population was reasonably close to the estimated impact (1.111 vs. 1.098). Adjusted yield curves were produced for the target population in support of the timber supply analysis for this unit.

Note that Timberline's target population covered 96% of the population of interest defined for this adjustment analysis. The remaining 4% of the population of interest was not adjusted but unadjusted yield curves were produced for timber supply purposes. For example, unadjusted yield curves were produced for VT polygons that were outside of the population of interest for the adjustment (i.e. polygons less than 30 years of age).

4. CONCLUSIONS AND RECOMMENDATIONS

The VDYP7 statistical adjustment analysis of the Vanderhoof Forest District was completed as an adjunct to the work done by Timberline in their VDYP6 adjustment analysis of this management unit. The target population of interest, stratification, sampling weights, sample status, the compilation of the Phase II ground samples and the NVAF values were all provided by Timberline in correspondence with their VDYP6 analysis.

The VDYP7 analysis of this sample suggests that both age and height are slightly underestimated (by 4% and 6% respectively) in pure lodgepole pine stands. Age is overestimated by about 10% in pine leading stands with less than 80% pine whereas height is slightly underestimated in this stratum. For the non-pine leading stratum, the sample suggests that age is underestimated by about 5% whereas height is overestimated by about 5%. The analysis also suggests that basal area/ha is underestimated in both of the pine leading strata, but underestimated in the non-pine leading stratum.

After the adjustment of age, height, basal area and trees/ha, the VDYP7 still underestimated volume in all strata, as reflected by the Stage 2 volume adjustment factors.

When the scatterplots of the data were examined some potential trends in the residuals plots were observed, particularly for the non-pine leading stratum which may have been age-related. However, since the VDYP7 adjustment was intended to directly follow the VDYP6 work done by Timberline, further post-stratification was outside the scope of this analysis. In addition the stratum sample sizes would have made further post-stratification difficult.

The VDYP7 statistical adjustment based on this sample will increase current VDYP7 volume by about 17% in pure pine stands (stands with at least 80% pine), on average. For pine leading stands with less than 80% pine the adjustment is expected to increase volume by about 5% on average. For non-pine leading stands, the adjustment will decrease the volume by about 4%. Overall, the adjustment was estimated to increase total VDYP7 volume by about 10%. The sampling error for this estimated adjustment impact was ±9.8% (at the 90% confidence level) which was slightly higher than the target specified in the VPIP. When the adjustment was applied to the target population, the calculated impact of the adjustment was about 11%, which is reasonably close to what was expected based on the sample.

The Mountain Pine Beetle infestation is widespread in this unit. To facilitate the current TSR approach for representing the effect of Mountain Pine Beetle on the inventory and to ensure consistency with that approach, timber supply requested that dead pine volume be included with live volume in the adjustment. Hence the Phase II compiled values for all per hectare-based adjustments (i.e. basal area/ha, trees/ha, volume/ha) included dead pine. The magnitude of the dead pine component in the resulting total volumes (and basal areas etc.) was significant. In the samples where the inventory indicates at least 80% pine, dead pine accounts for 60% of the total volume for live trees (all species) plus dead pine. *The impact of including dead pine volume in the analysis should be considered in terms of degradation of volume and value in the pine component and therefore pine volumes should not continue to be projected. A process is currently being developed for dealing with the dead pine component of the inventory in a more systematic and consistent manner.*

5. APPENDIX A: BACKGROUND DOCUMENTS

The following memo from Guillaume Thérien (Timberline) describes the population differences between the 2001 sample selection and the 2007 adjustment analysis.

This PDF memo to be merged into final PDF of this document

6. APPENDIX B: DATA ISSUES

This table documents questions and responses regarding the Prince George District VRI data that were made during the course of the analysis.

Sample	Issue	Action
16	Vegetated, non-treed.	Excluded from analysis.
64	Vegetated, non-treed.	Excluded from analysis.
66	Vegetated, non-treed.	Excluded from analysis.
22	JST adjustment analysis was missing this sample.	This sample was included in this adjustment analysis.
32	Sample weight missing.	Used average strata weight = 12185.2638
36	Missing Phase II NVAF volume, age, and height. Phase I data present.	Although there was no live Phase II volume, there was some dead Phase II Pl volume. This sample will be INCLUDED in the analysis.
46	Missing Phase I and Phase II volumes. Age and height data present.	This was a young stand hence no Phase 1 volume at our utilization levels. Although there was no live Phase II volume, there was some dead Phase II Pl volume. This sample will be INCLUDED in the analysis.
56	Missing Phase II NVAF volume, age, and height data.	Excluded from analysis. Sample had no Phase II spp comp or ba at 4cm+ dbh nor any dead volume. Assume has been logged.
5	Missing Phase I data from Tim.	Excluded.

7. APPENDIX C: INVENTORY AND GROUND ATTRIBUTES USED IN THE ADJUSTMENT

PDF version of spreadsheet to be merged into final PDF of this document

8. APPENDIX D: VDYP7 SCATTERPLOTS & RESIDUALS FOR AGE & HEIGHT (STAGE 1 ADJUSTMENT FOR VDYP7)
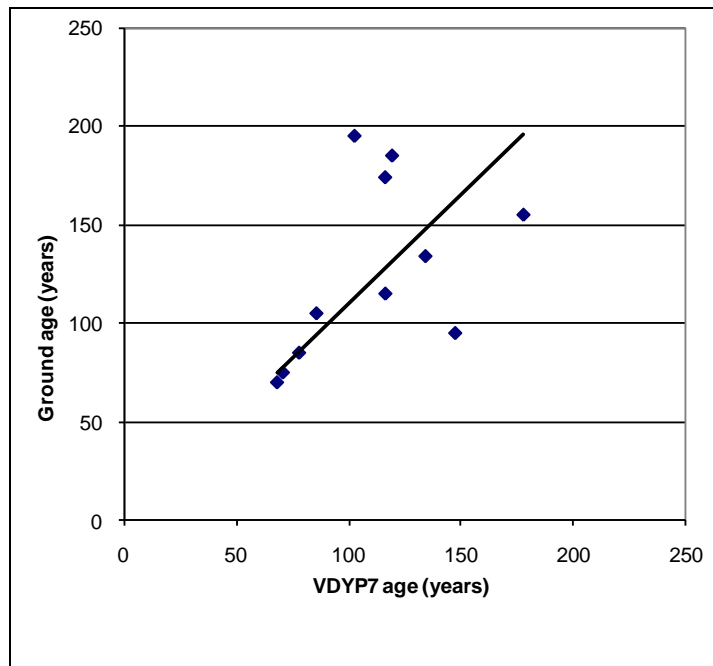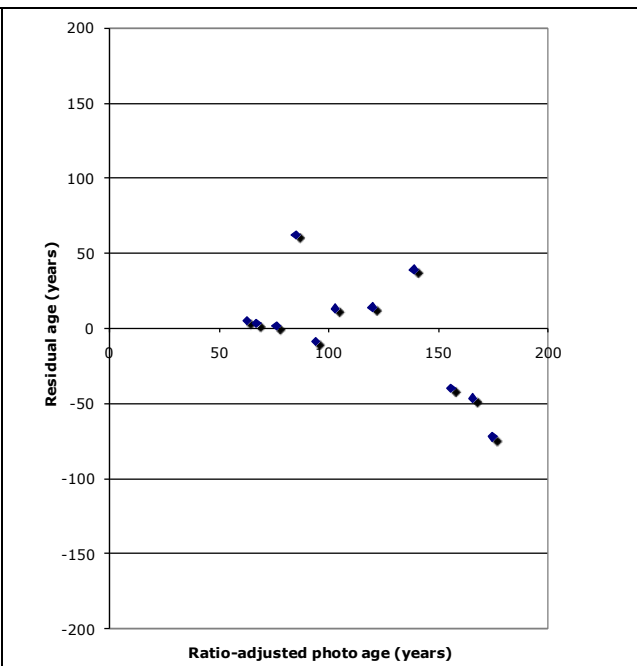
Fig. 1: Pl leading, Pl%<80%. Phase 1 and Phase 2 age relationship.

Fig. 2: Pl leading, Pl%<80%. Age residuals (Phase 2 age – adjusted Phase 1 age) vs. unadjusted Phase 1 age.
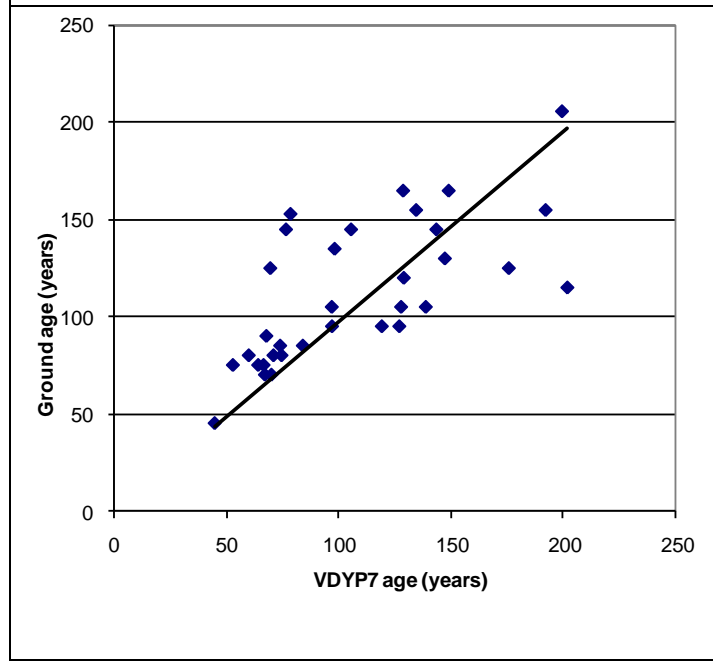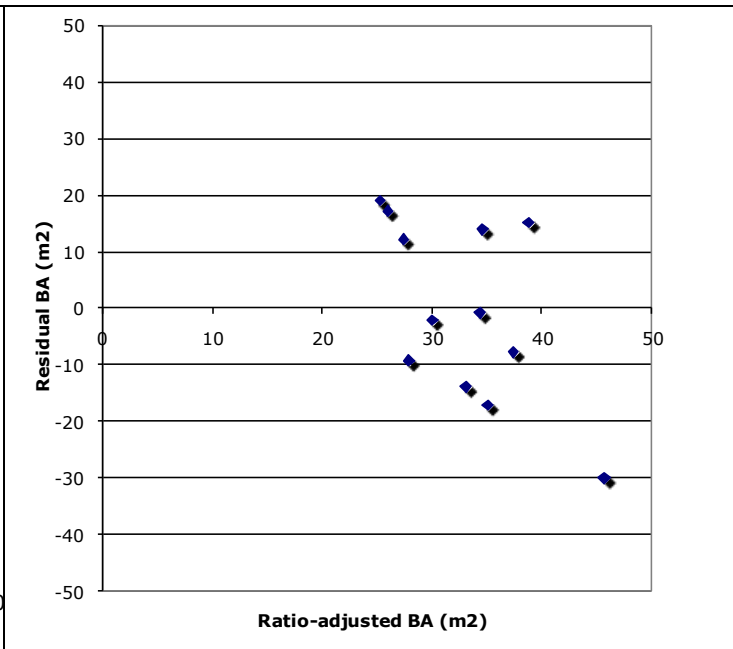
Fig. 3: Pl leading, Pl%>=80%. Phase 1 and Phase 2 age relationship.
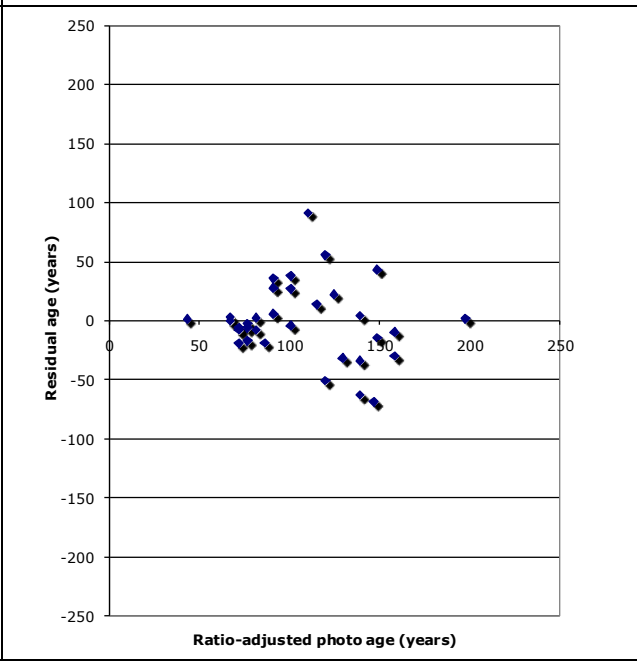
Fig. 4: Pl leading, Pl%>=80%. Age residuals (Phase 2 age – adjusted Phase 1 age) vs. unadjusted Phase 1 age.
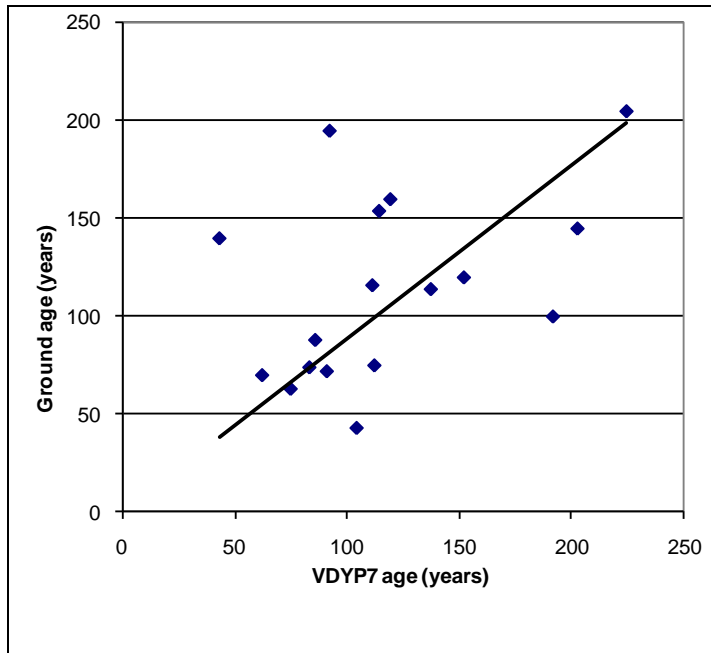
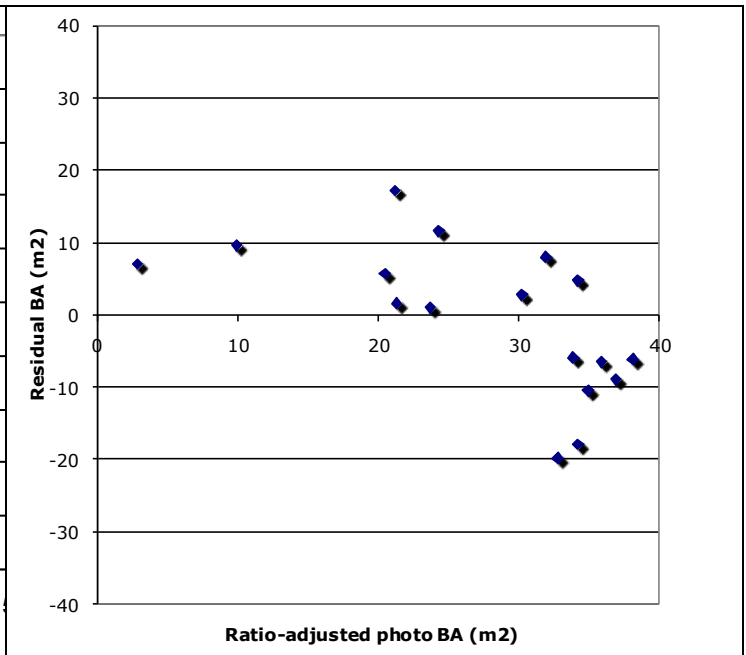Fig. 5: Non-Pl leading. Phase 1 and Phase 2 age relationship.
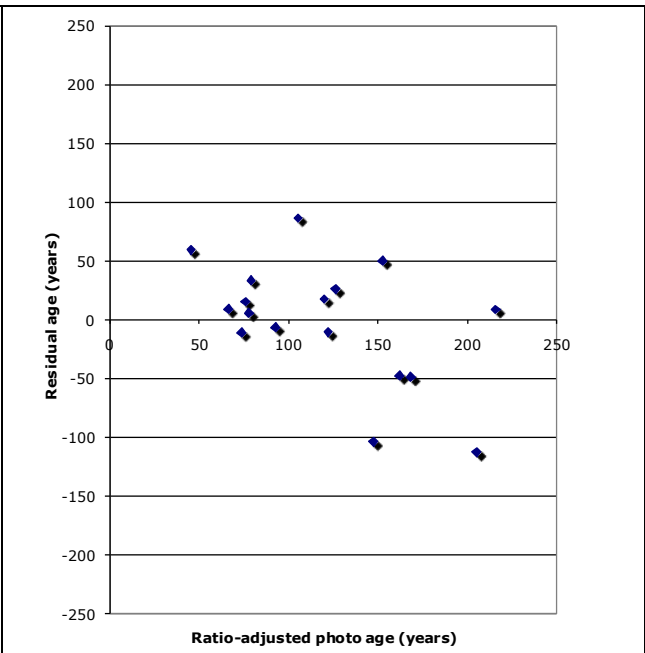
Fig. 6: Non-Pl leading. Age residuals (Phase 2 age – adjusted Phase 1 age) vs. unadjusted Phase 1 age.
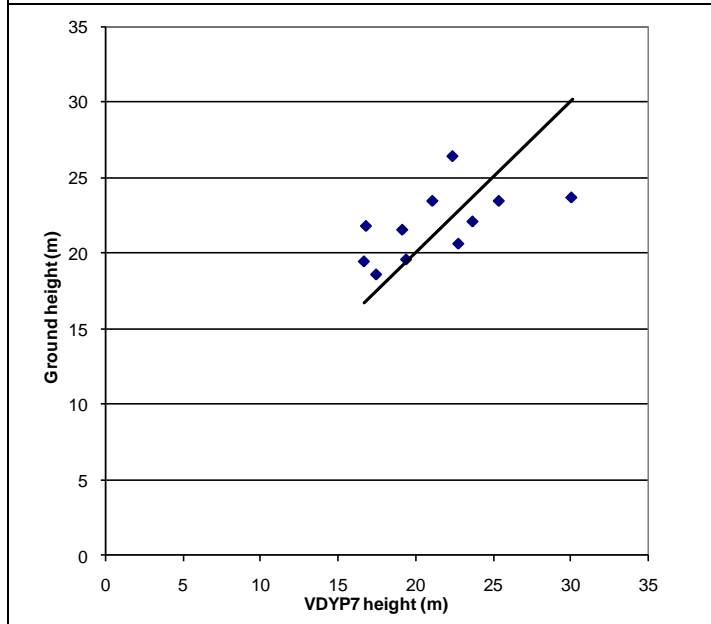
Fig. 7: Pl leading, Pl%<80%. Phase 1 and Phase 2 height relationship.
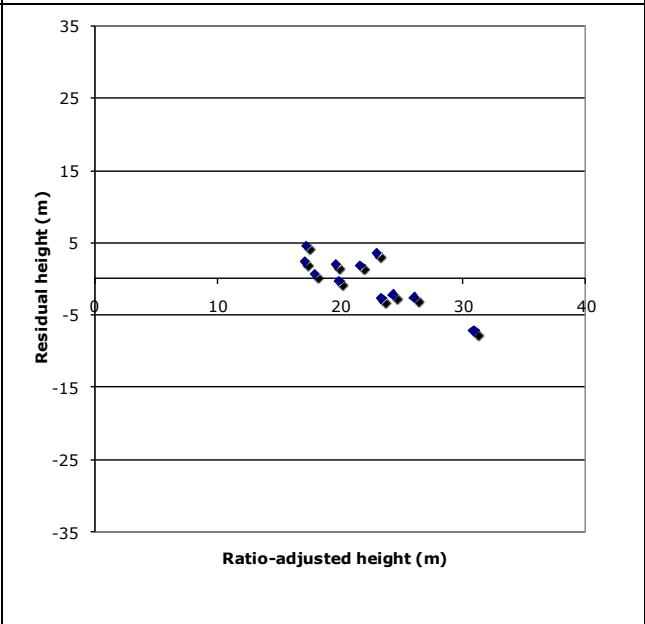
Fig. 8: Pl leading, Pl%<80%. Height residuals (Phase 2 height – adjusted Phase 1 height) vs. unadjusted Phase 1 height.
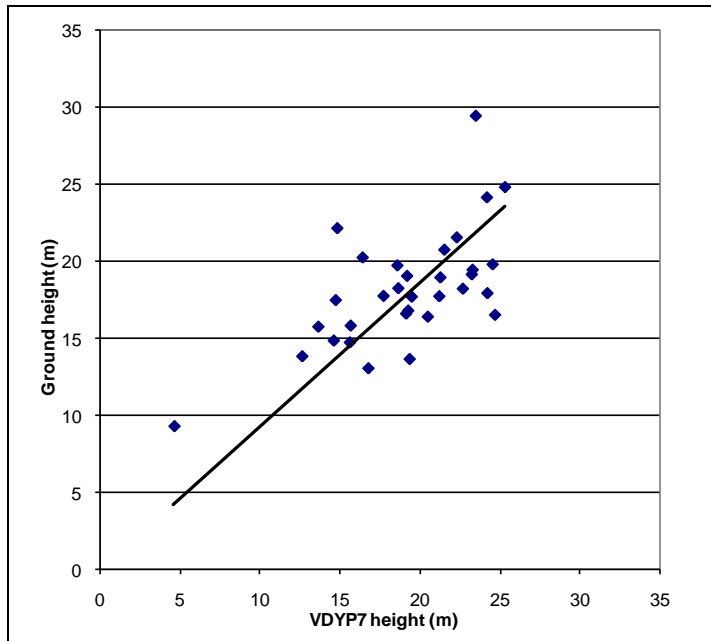
Fig. 9: Pl leading, Pl%>=80%. Phase 1 and Phase 2 height relationship.
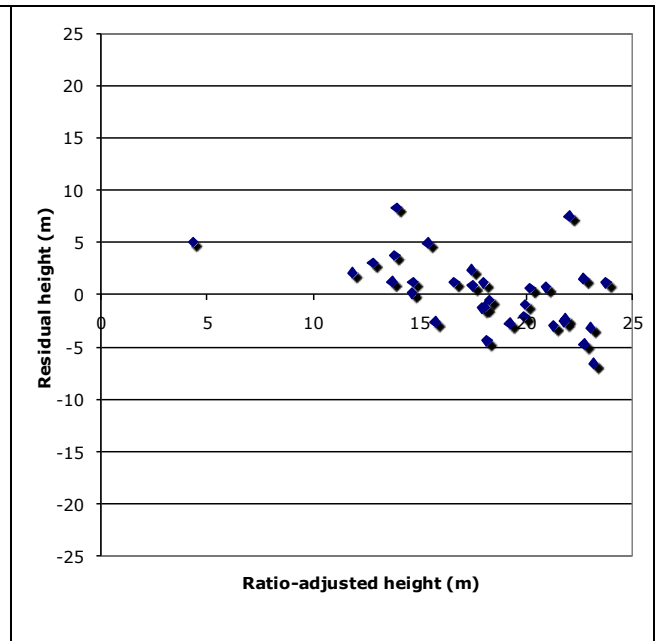
Fig. 10: Pl leading, Pl%>=80%. Height residuals (Phase 2 height – adjusted Phase 1 height) vs. unadjusted Phase 1 height.
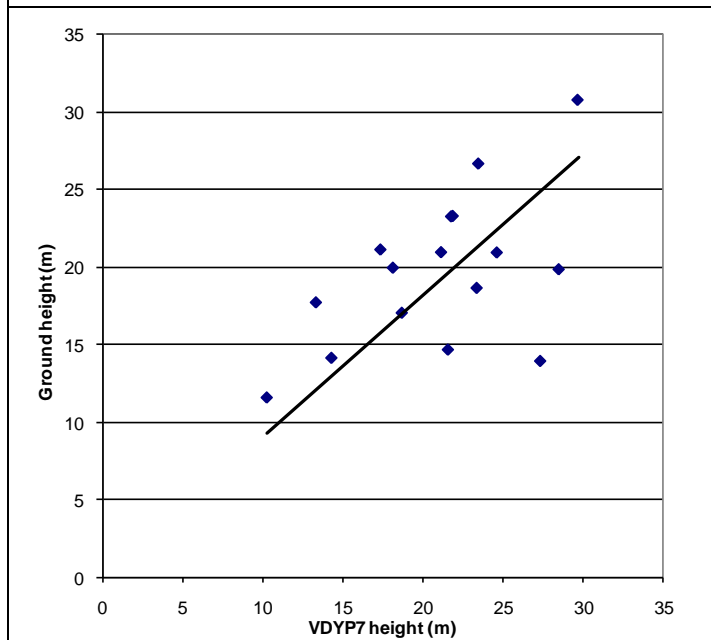
Fig. 11: Non-Pl leading. Phase 1 and Phase 2 height relationship.
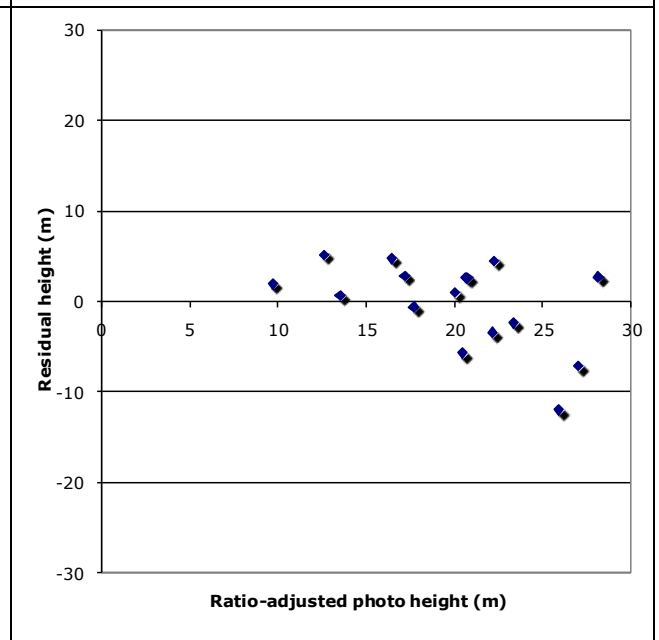
Fig. 12: Non-Pl leading. Height residuals (Phase 2 height – adjusted Phase 1 height) vs. unadjusted Phase 1 height.

9. APPENDIX E: VDYP7 SCATTERPLOTS & RESIDUALS FOR BA & TPH (STAGE 1 ADJUSTMENT FOR VDYP7)
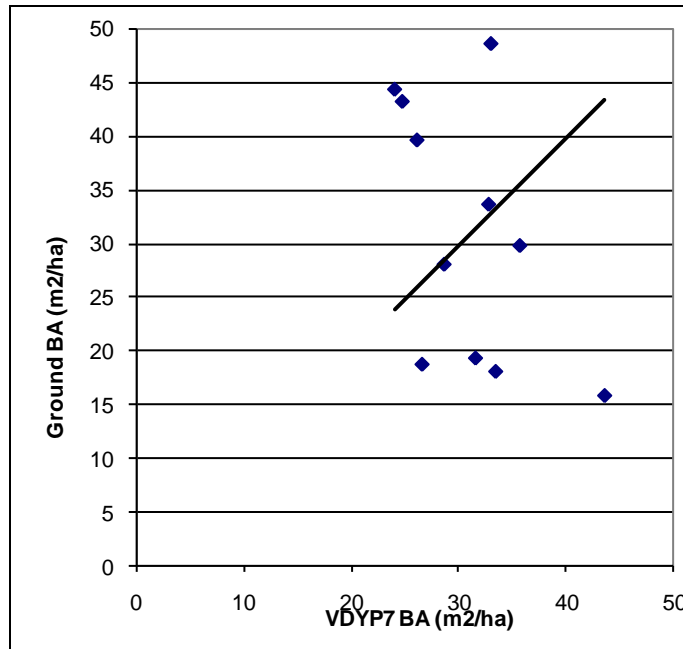
Fig. 1: Pl leading, Pl%<80%. Phase 1 and Phase 2 basal area/ha (BA) relationship. The line on the graph corresponds to the adjustment ratio.

Fig. 2: Pl leading, Pl%<80%. Age residuals (Phase 2 BA – adjusted Phase 1 BA) vs. unadjusted Phase 1 BA.
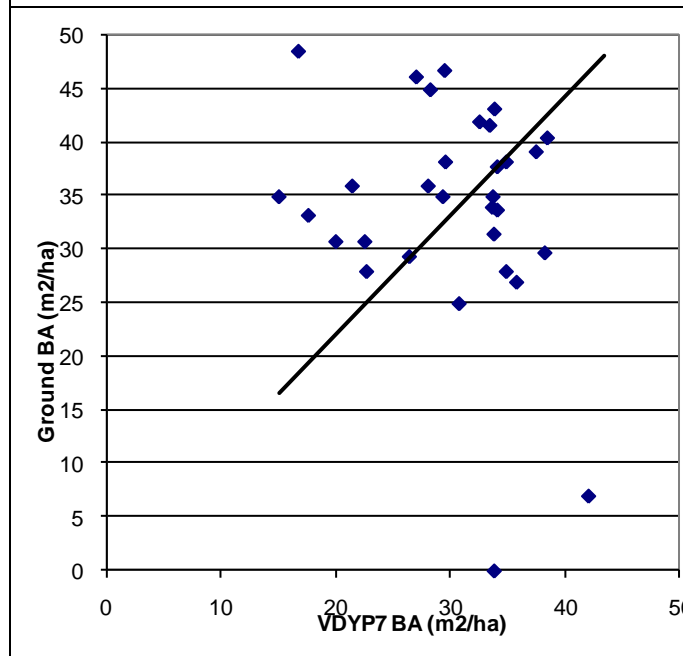
Fig. 3: Pl leading, Pl%>=80%. Phase 1 and Phase 2 basal area/ha relationship. The line on the graph corresponds to the adjustment ratio.
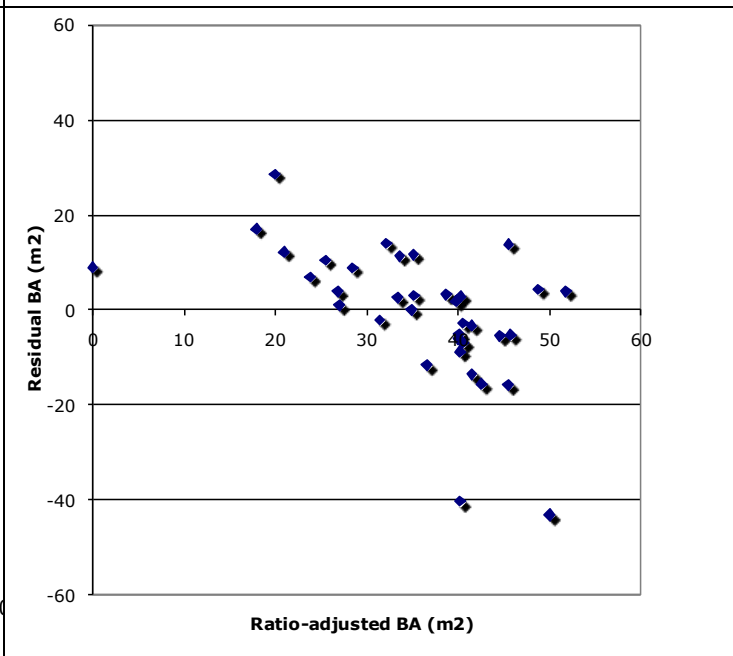
Fig. 4: Pl leading, Pl%>=80%. Age residuals (Phase 2 BA – adjusted Phase 1 BA) vs. unadjusted Phase 1 BA.
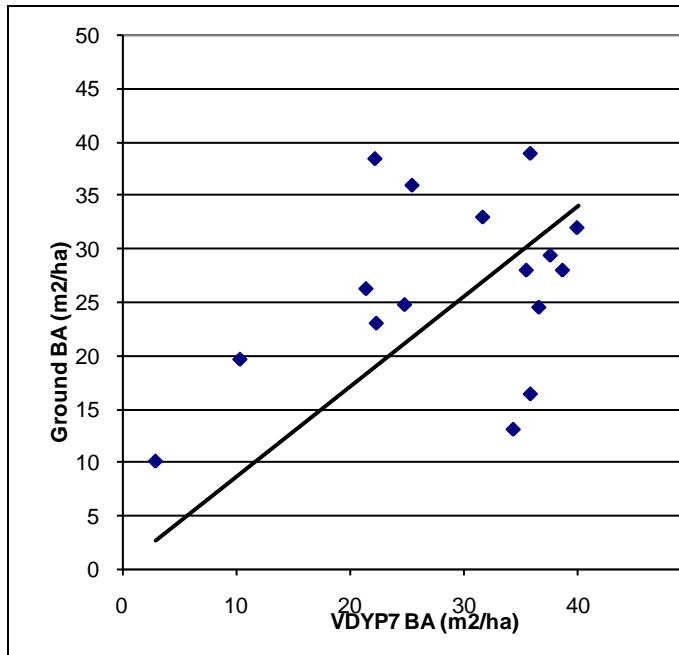
Fig. 5: Non-Pl leading. Phase 1 and Phase 2 basal area/ha relationship. The line on the graph corresponds to the adjustment ratio.

Fig. 6: Non-Pl leading. Age residuals (Phase 2 BA – adjusted Phase 1 BA) vs. unadjusted Phase 1 BA.
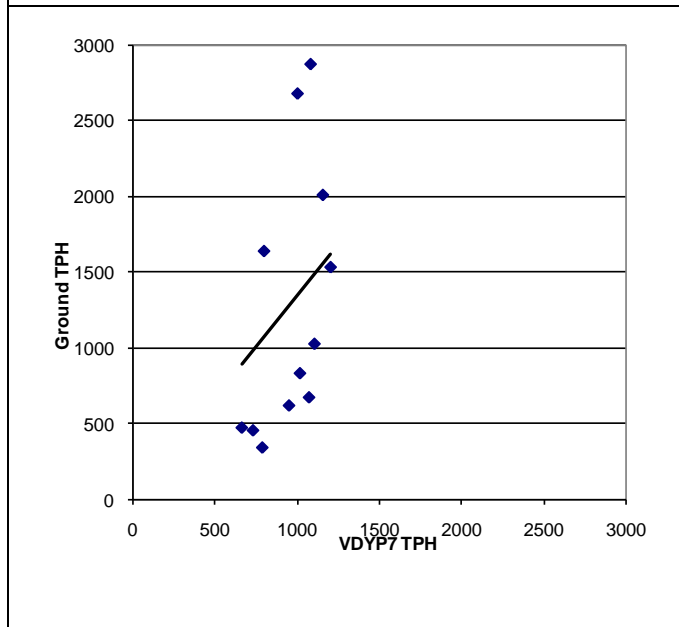
Fig. 7: Pl leading, Pl%<80%. Phase 1 and Phase 2 trees/ha (TPH) relationship. The line on the graph corresponds to the adjustment ratio.
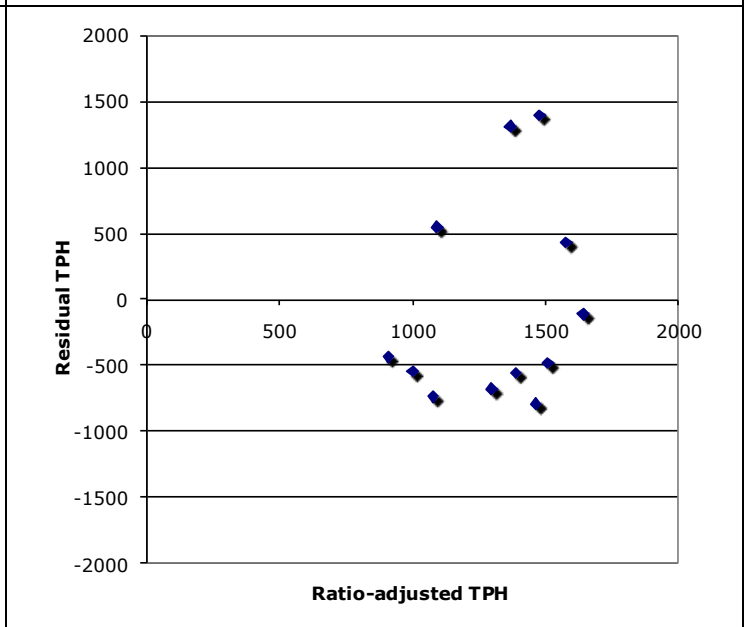
Fig. 8: Pl leading, Pl%<80%. TPH residuals (Phase 2 TPH – adjusted Phase 1 TPH) vs. unadjusted Phase 1 TPH.
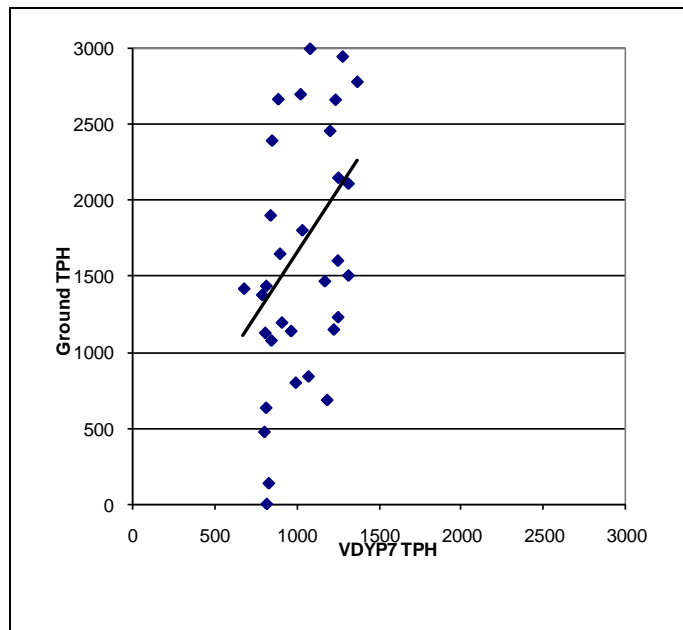
Fig. 9: Pl leading, Pl%>=80%. Phase 1 and Phase 2 TPH relationship. The line on the graph corresponds to the adjustment ratio.
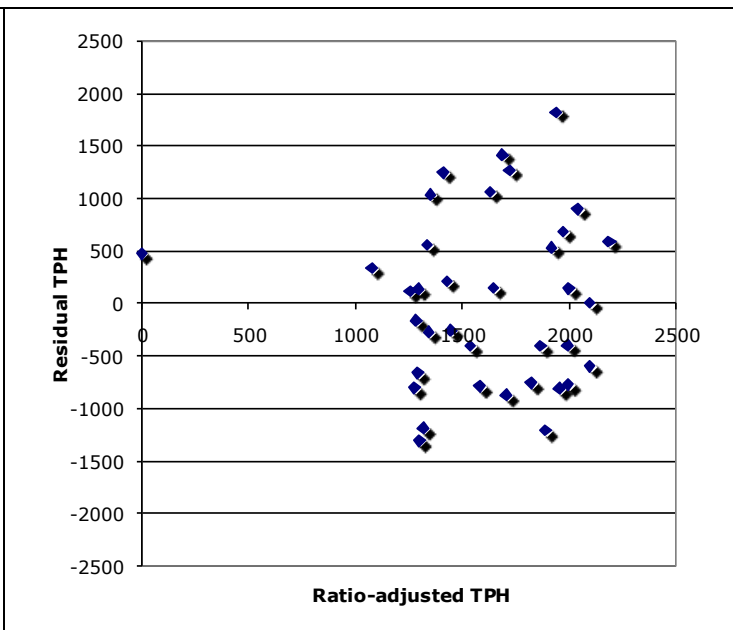
Fig. 10: Pl leading, Pl%>=80%. TPH residuals (Phase 2 TPH – adjusted Phase 1 TPH) vs. unadjusted Phase 1 TPH.
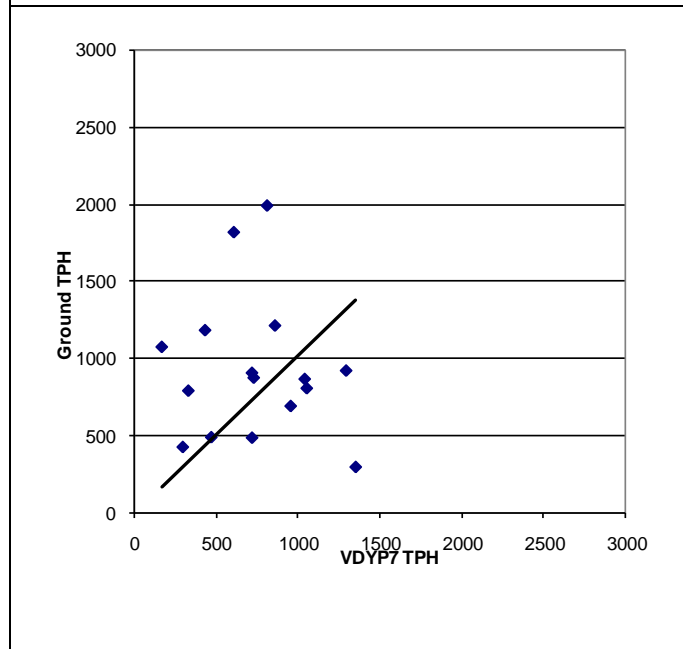
Fig. 11: Non-Pl leading. Phase 1 and Phase 2 TPH relationship. The line on the graph corresponds to the adjustment ratio.
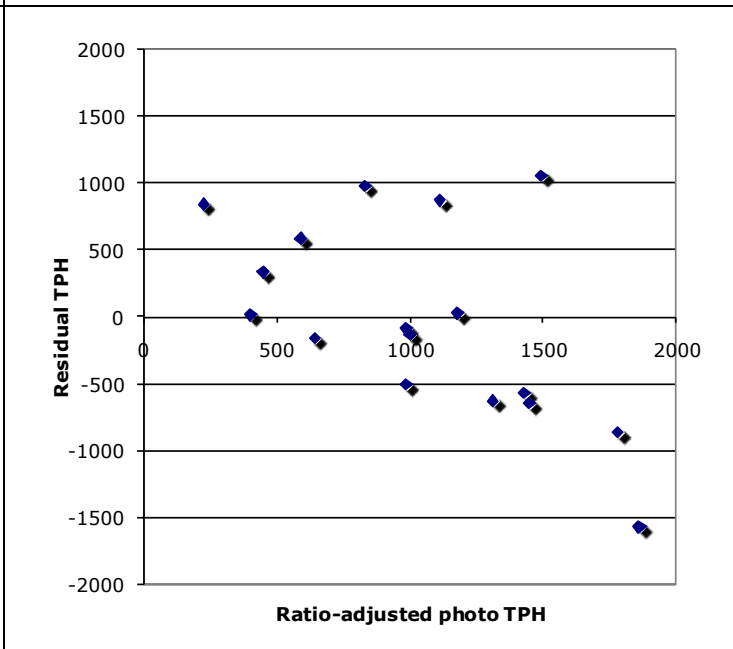
Fig. 12: Non-Pl leading. TPH residuals (Phase 2 TPH – adjusted Phase 1 TPH) vs. unadjusted Phase 1 TPH.

10. APPENDIX F: POPULATION DISTRIBUTIONS PRE- AND POST-ADJUSTMENT

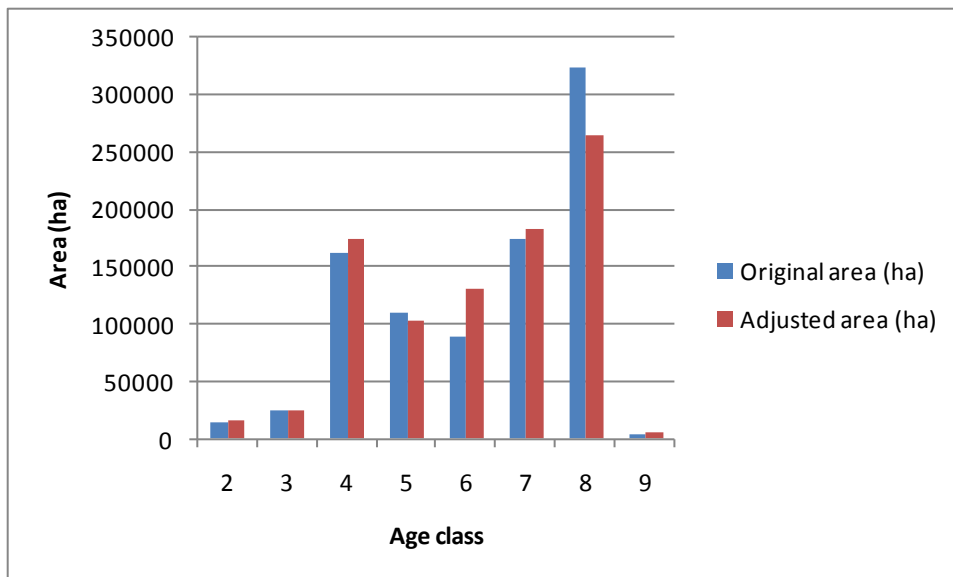*Figure 1: Age class distribution of Vanderhoof Forest District population of interest, pre- and post-adjustment.*

Figure 2: Average vol/ha by age class for population of interest, pre- and post-adjustment.
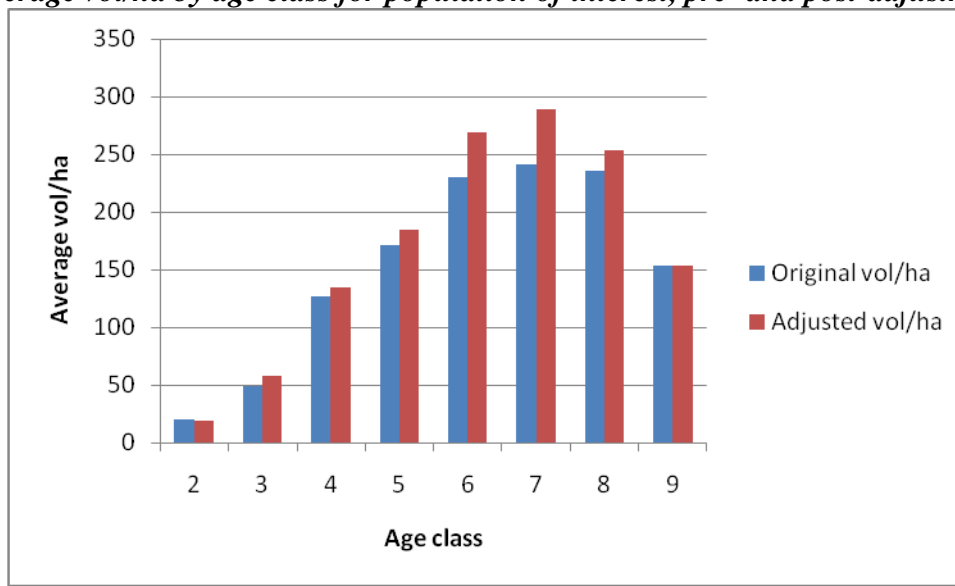
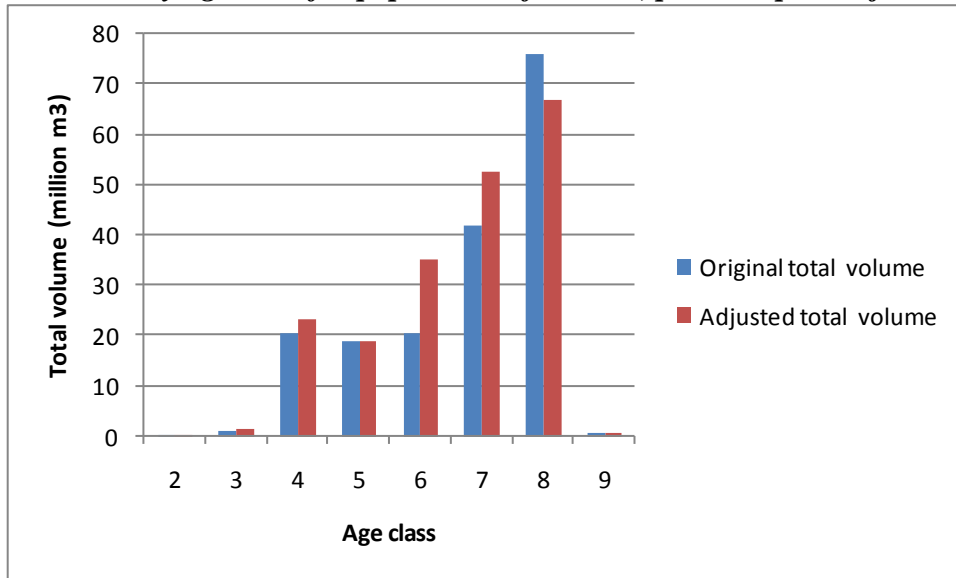*Figure 3: Total volume by age class for population of interest, pre- and post-adjustment.*

Figure 4: Average vol/ha by stratum for population of interest, pre- and post-adjustment.