TFL 3

Documentation of Analysis for Vegetation Resources Inventory Statistical Adjustment and Net Volume Adjustment Factor Development

ADDENDUM

PREPARED FOR:

CANADIAN FOREST PRODUCTS LTD.
SLOCAN DIVISION

PREPARED BY:

Jahraus & Associates Consulting Inc.
Maple Ridge BC

&

Churlish Consulting Ltd.
Victoria BC

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EXECUTIVE SUMMARY

A Vegetation Resources Inventory (VRI) retrofit was completed for TFL 3 in 1998. VRI Phase II ground sampling was carried out in 2001 and a VRI statistical inventory adjustment factors were developed in 2002. After 2002, shortcomings in the VRI retrofit data were identified and a plan was undertaken to remedy these problems with the inventory. Upon completion of the inventory corrections in June of 2004, a new analysis for the VRI statistical adjustment (which also incorporated an updated compilation of the Phase II data) was undertaken. During the 2004 field season, destructive sampling for Net Volume Adjustment Factor (NVAF) was undertaken and the data was available for analysis in 2005.

The objectives of this project were to:

- compile the destructive sampling data;
- determine the NVAF values with appropriate weighting;
- to produce new compiled Phase II volumes that incorporated the NVAF values;
- revise the statistical adjustment factors based on the new NVAF information; and,
- adjust the inventory files with the new adjustment factors.

A total of 58 trees were selected according to current Ministry of Sustainable Resource Management (MSRM) procedures. Analysis of the destructively sampled NVAF tree data yielded the following NVAF values.

Table 1: Net volume adjustment factors for TFL 3.

NVAF stratum	*n* *(number of NVAF sample trees)*	*NVAF value*	*Sampling error %* *(at 95% confidence level)*
Dead trees	3	0.918	1%
Immature	10	0.926	7.2%
Mat – BCHD	20	0.900	8.8%
Mat - FPLS	25	0.966	6.2%

The NVAF strata were determined based on the sample selection pre-stratification. Alternative strata were examined but were not considered acceptable mostly because of small sample sizes and high associated sampling errors. There was a discrepancy between the planned strata sample allocation and the actual distribution of the samples. In developing the NVAF values, samples were allocated to the strata as per the plan.

Based on these NVAF values, new VRI volumes were compiled and new volume adjustment factors based on net factored volumes with NVAF were determined.

The strata for the VRI statistical adjustment factor analysis did not change compared with the preliminary analysis. Similarly, the age and height adjustment factors remained the same. Only the volume adjustment factors were affected by the new NVAF information.

The adjustment factors used in the final file adjustment, shown in the table below, were applied to the inventory files for the population of interest defined as all vegetated treed polygons in the TFL greater than 20 years of age. The adjustment factors were developed using the interim "Fraser Protocol" according to current MSRM standards. Age, height and volume adjustment ratios were provided for each of five strata, which corresponded to the sample selection pre-stratification and included age-related post-stratification for balsam leading samples.

Table 2: Height, age and volume adjustment factors (based on NVAF volumes) for vegetated treed, greater than 20 years of age in TFL 3.

Inventory leading species stratum	***Height adjustment ratio of means***	***Age adjustment ratio of means***	***"Attribute-adjusted" volume adjustment ratio of means***
Fir, pine, larch, deciduous (FPLD)	0.905	1.032	1.265
Cedar, hemlock	0.965	1.034	1.041
Balsam, <121 years	1.053	1.300	1.026
Balsam, >120 years	0.960	0.844	1.105
Spruce	0.974	1. 081	0.977

This study suggests that, overall, volume in the new TFL 3 inventory is close to being unbiased. The sampling error for the overall impact ratio of 1.007 was ± 11%[1]. This volume bias estimate is based on a comparison of the unadjusted inventory volumes with the compiled net factored ground volumes with NVAF values applied.

Although volume was unbiased overall, the estimated volume bias varied by leading species stratum. Volume in the fir/pine/larch/deciduous leading stratum was underestimated by about 5%

[1] Based on the formula for separate variance estimation and a 95% confidence level. This is slightly higher than the target sampling error of ±10% in this unit. It is not unexpected since the sample size was reduced to 83 from 90 when the corrections to the VRI Retrofit of the inventory showed that 7 samples were not longer in the population of interest. Given that the overall volume impact is close to 1, this sampling error should not be of concern.

whereas spruce leading volumes were overestimated by about 6%. Volume in balsam leading <121 years was underestimated by about 10% whereas volume in balsam leading >120 years was underestimated by only about 5%. Spruce volume was overestimated by about 6%. Volume in cedar/hemlock leading was virtually unbiased.

The scope of this project also included applying the adjustment factors to the inventory files for TFL 3. The adjustment was limited to VT polygons greater than 20 years of age. Analysis of the impact of the adjustment on the population showed that the age class distribution was somewhat smoothed. After the height, age and volume adjustments were applied to the VT, greater than 20 years population, the overall volume impact (adjusted total volume compared with unadjusted total volume) was calculated as 1.012[2] which compares well with the volume impact estimated from the sample.

[2] This impact ratio was calculated as the ratio of the adjusted total inventory volume (projected to 2004) to the unadjusted total inventory volume (projected to 2004). The inventory volumes in this ratio were at the 12.5cm+ dbh net dwb utilization which appears standard on the inventory file.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

1.1 Background

A Vegetation Resources Inventory (VRI) retrofit was completed for TFL 3 in 1998. VRI Phase II ground sampling was carried out in 2001 and a VRI statistical inventory adjustment was completed in 2002. After 2002, shortcomings in the inventory data were identified and a plan was undertaken to remedy problems identified with the VRI retrofit data[3]. In addition to improvements in the inventory data, changes to the VRI compiler[4] were made subsequent to the initial statistical adjustment in 2001/2002. These changes to the inventory data and the Phase II compiled results required new analysis of the VRI to provide an updated set of statistical adjustment factors. An interim analysis was completed in 2004 with plans to update the adjustment factors once NVAF sampling had been completed.

Destructive sampling for NVAF was carried out in the 2004 field season. The data became available for analysis in spring of 2005.

1.2 Scope and Objectives

The objective of this analysis was to analyze the destructively sampled data and compute Net Volume Adjustment Factors (NVAF) for TFL 3 based on the current[5] Ministry of Sustainable Resource Management (MSRM) methodological standards. The NVAF values were then applied in the compilation of the Phase II ground sample volumes and the VRI statistical adjustment factors were revised based on the new Phase II volumes. The inventory files were adjusted using these final adjustment factors and current MSRM protocols. All inventory file adjustments were completed using VDYP6 and the "Fraser Protocol" methodology.

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[3] *"Timber Emphasis VRI Photo Retrofit Improvement Project Implementation Plan"*, Slocan Forest Products, Slocan BC, November 2003.

[4] Since 2002, the VRI compiler has changed to using BEC-based taper equations and a regression based approach to VBAR calculation has also been implemented.

[5] VRI statistical adjustment standards and procedures are continually evolving. This analysis met all standards in place as of July 2004.

2. METHODS

2.1 Overview of NVAF analysis

Destructive sampling for the NVAF analysis was completed in the 2004 field season and data was made available for analysis in the spring of 2005. The NVAF compilation was completed with input and review from Will Smith, Volume and Decay Sampling Officer, Resource Information Branch, MSRM. The summary description of the NVAF analysis methodology provided below is based on the current MSRM documentation of standards and procedures for NVAF analysis[6].

In general, the first step of the NVAF analysis involves compilation of the actual volume of each NVAF sample tree based on the stem analysis data collected in the destructive sampling process. This was done using the SAS-based TIB volume and decay tree compiler. In the second step, the estimated volume of each NVAF sample tree is compiled using the VRI plot compiler[7]. Checks for errors and inconsistencies between the data collected in the NVAF sampling and the data collected in the VRI sampling are an important part of this process. The third step in the process is the calculation of a model-based sample weight for each tree. The optimal tree sample weight is derived to minimize the variance of the ratio. Once the model weights are computed for each sample tree, the weighted ratio of actual sample tree volume (from destructive sampling) over the estimated sample tree volume (from taper equation and net factoring) is computed. This ratio is the NVAF value that is used to adjust the net merchantable net factored volume of the VRI ground sample volume. The NVAF value is applied at the species level in the VRI compiler, where it acts as a multiplier of the volume per hectare based on the strata defined for the NVAF values.

In determining the most appropriate post-stratification for the development of the NVAF values, factors such as age and species are most commonly tested. The objective of the post-stratification is to find logical groupings that provide consistent NVAF relationships and reasonable sampling error values for the NVAF ratios.

2.2 Data issues related to the NVAF analysis

A listing of specific data issues encountered in the analysis of the NVAF data is provided in Appendix B. The most serious issue was associated with a discrepancy related to planned versus actual sample allocation. Based on input from Will Smith and Sam Otukol, a weighting scheme to correct for this issue was devised and applied to the NVAF tree data. In general, the approach was to determine a model-based NVAF with the samples allocated to strata as per the sampling plan.

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[6] Net Volume Adjustment Factor: Sampling Standards and Procedures. Version 4.0. MSRM. March 2004.

[7] Based on species, dbh, height (to provide gross merchantable volume) and the cruiser-called net factor (to provide volumes net of decay and waste).

2.3 Overview of statistical adjustment

The population of interest for the TFL 3 adjustment was defined as: vegetated, treed (VT) polygons greater than 20 years of age.

The post-stratification for the adjustment factors did not change from the preliminary analysis completed in 2004. Results, based on these strata, are presented in the sections that follow. As before, the five strata were identified as:

- Polygons leading in Douglas-fir, pine, larch or deciduous (FPLD)
- Polygons leading in Cedar or Hemlock
- Polygons leading in Balsam and <121 years of age
- Polygons leading in Balsam and >120 years of age
- Polygons leading in Spruce

The completion of the NVAF sampling had no effect on the height and age adjustment factors produced in the preliminary analysis. However, new volume adjustment factors were produced. The resulting adjustment factors are shown in section 3. Please refer to the documentation for the preliminary analysis “TFL 3: Documentation of Analysis for Vegetation Resources Inventory Statistical Adjustment”, August 2004 for details on the adjustment methodology.

2.4 Data issues related to the statistical adjustment

There were a number of data issues identified in the preliminary analysis of the VRI Phase II data. These are documented in the August 2004 report referenced above.

2.5 Computation of adjustment ratios and sampling error

When analyzing the data it is important that the formulae used to derive the adjustment factors correspond with the sample design. Since the TFL 3 sample was selected using PPSWR the ratio of means formulae outlined in the Ministry’s Procedures and Standards were applied. For the computation of sampling error values, formulae for separate ratio estimation were applied.

2.6 Overview of inventory file adjustment process

The TFL 3 inventory files (13 mapsheets) were adjusted based on an interim process recommended by MSRM that allows adjusted VIF format values to be read by VDYP 6.6. The inventory file adjustment included a final projection of the inventory files to 2005.

3. RESULTS AND DISCUSSION

3.1 NVAF analysis

The NVAF sampling plan selected 60 trees for destructive sampling. Two of the trees in the “dead” stratum were not sampled. Hence a total of 58 trees (3 dead, 55 live) were included in the analysis. Details on the data issues and inconsistencies associated with the NVAF sample selection and the implications that these had on the NVAF analysis are provided in Appendix B.

In the “NVAF Sample Tree List” document, four strata were recommended for calculating the NVAF values, based on the distribution of trees that were selected for sampling. These strata included:

- Live mature FPLS (>100 years polygon age, fir/pine/larch/spruce)
- Live mature BCHD (>100 years polygon age, balsam/cedar/hemlock/deciduous)
- Live immature (<101 years)
- Dead trees

The NVAF data was reviewed for potential outliers and it was determined that no changes to the data were warranted. The resulting NVAF values and sampling errors by stratum are shown in Table 1 below.

Table 1: NVAF values and 95% sampling errors by stratum for TFL 3

NVAF stratum	*n* *(number of NVAF sample trees)*	*NVAF value*	*Sampling error %* *(at 95% confidence level)*
Dead trees	3	0.918	1%
Immature	10	0.926	7.2%
Mat – BCHD	20	0.900	8.8%
Mat - FPLS	25	0.966	6.2%

These NVAF values suggest that the net factored volumes from the compiler are overestimating the net merchantable volume by as much as 10% for mature balsam/cedar/hemlock/deciduous and as little as about 3% for mature fir/pine/larch/spruce. Further examination of the NVAF data showed that most of this volume overestimation was associated with bias in the taper function. In general, there was relatively little bias associated with the net factored decay estimates. The exception to these general trends was in mature cedar, where the taper equation tended to *under*estimate volume and net factoring overestimated volume[8].

The NVAF values in Table 1 were applied in the VRI compiler to produce new Phase II ground sample volumes based on net factoring adjusted with the NVAF values. The new Phase II volumes with NVAF applied are shown in Appendix A.

3.2 Age and height adjustment

Age and height adjustment factors did not change compared with the preliminary analysis completed in August of 2004. For reference, the height and age adjustment factors for the population of interest defined as VT, greater than 20 years of age, are provided in Tables 2 and 3 below:

Table 2: Mean heights and ratio of means adjustment factors, by stratum, for the VT, greater than 20 years population of interest.

Strata (inventory leading species[9])	n	Mean ground height (m)	Mean inventory height[10] (m)	Height adjustment Ratio of means
FPLD[11]	25	22.132	24.452	0.905
Cedar/Hemlock	11	21.036	21.791	0.965
Balsam <121 yrs	14	16.321	15.500	1.053
Balsam >120 yrs	8	20.825	21.688	0.960
Spruce	22	24.459	25.105	0.974

[8] That is, net factoring appeared to underestimate decay in mature cedar and hence the volume was overestimated. Net factoring also appeared to underestimate decay (and hence overestimate volume) in hemlock but there were two few trees of this species and too much variability to get a clear indication of the bias source.

[9] Stratum assignment is based on the inventory leading species at the time of the original sample selection.

[10] Mean inventory heights and ages are based on the set of values used to develop the adjustment ratios. These may have included second species heights and ages where the second species provided a better "match" with the ground species.

[11] Douglas-fir, pine, larch or deciduous leading in the inventory (based on leading species values in the inventory at time of original sample selection).

Table 3: Mean ages and ratio of means adjustment factors, by stratum, for the VT, greater than 20 years population of interest.

Strata (inventory leading species)	n	Mean ground age (yrs)	Mean inventory age (yrs)	Age adjustment Ratio of means
FPLD	25	85.132	82.52	1.032
Cedar/Hemlock	11	100.558	97.273	1.034
Balsam <121 yrs	14	104.093	80.071	1.300
Balsam >120 yrs	8	153.775	182.125	0.844
Spruce	22	183.923	170.136	1.081

3.3 Volume adjustment based on NVAF volumes

The compiled ground volumes used to develop the volume adjustment ratios were net factored volumes adjusted with the NVAF values in Table 1. The volume utilization used in the analysis was live stems 17.5cm + dbh for all polygons except for polygons where the inventory indicated lodgepole pine as the leading species; for these polygons the utilization was 12.5cm + dbh. Volumes were calculated net of decay, waste and breakage (dwb). This utilization applied to both inventory and ground volumes and was determined by the inventory leading species for a particular sample.

Table 4 below shows volume adjustment factors by strata for the VT, greater than 20 years population of interest. In addition to the volume adjustment factors based on net factoring and NVAF, the adjustment ratios for net factoring (without NVAF) are shown for comparison. Without the NVAF adjustment for bias due to taper and hidden decay, net factoring tends to over-estimate volume in all strata.

Table 4: Mean volumes and volume adjustment ratios for VT, greater than 20 years of age population of interest.

Leading Species Strata	*n*	*Mean ground vol/ha (12.5 cm+ dbh net dwb for Pl leading; else 17.5cm+dbh)*		*Mean attribute-adj'd inventory vol/ha*	*Volume adjustment Ratio of means*	
		Net factoring (NF)	*Net factoring with NVAF*		*NF*	*NF with NVAF*
FPLD	26	225.47	210.287	166.177	1.357	1.265
Cedar/Hemlock	12	233.868	215.165	206.683	1.132	1.041
Balsam <121 yrs	15	121.137	112.119	109.233	1.109	1.026
Balsam >120 yrs	8	185.983	172.974	156.575	1.188	1.105
Spruce	22	262.637	244.546	250.345	1.049	0.977

In the ground sample data set, the "attribute-adjusted" inventory volumes were adjusted using the net factoring with NVAF ratio of means shown in table 4. The resulting "final" adjusted inventory volumes were then compared with the actual ground volumes in each stratum. The plots of the "residual" values (i.e. ground value minus adjusted value) were used to evaluate the volume adjustments. Graphs showing the volume residuals are provided in Appendix C. There were no apparent trends in bias in the residual plots for volume.

3.4 Estimated volume impact

The volume factors in Table 4 represent adjustments to volumes based on inventory heights and ages that have already been adjusted (i.e. "attribute-adjusted" volumes). To determine the estimated overall volume *impact* of the *set of adjustments* (age, height and volume), the ground volumes were compared with the unadjusted inventory volumes (i.e. inventory volumes prior to any age or height adjustment) for the Phase II samples. These volume impact ratios are shown for both net factored volumes and net factored volumes with NVAF, by stratum. The volume impact for the VT, greater than 20 years population is shown in Table 5.

Table 5: Estimated volume impact by stratum for VT, >20 years, based on the Phase II samples. Utilization: 17.5cm + dbh except 12.5cm + dbh for lodgepole pine leading, net dwb.

Leading Species Strata	*n*	*Mean ground vol/ha (12.5 cm+ dbh net dwb for Pl leading; else 17.5cm+dbh)*		*Mean unadjusted inventory vol/ha*	*Volume impact ratio*	
		Net factor (NF)	*Net factor with NVAF*		*NF*	*NF with NVAF*
FPLD	26	225.47	210.287	200.742	1.123	1.048
Cedar/Hemlock	12	233.868	215.165	216.117	1.082	0.996
Balsam <121 yrs	15	121.137	112.119	101.44	1.194	1.105
Balsam >120 yrs	8	185.983	172.974	164.913	1.128	1.049
Spruce	22	262.637	244.546	260.491	1.008	0.939

The overall estimated volume impact (where the estimated strata means were weighted by the strata areas) was 1.007.

3.5 Sampling error

The MSRM standards for computing sampling error are currently under revision. However, based on a PPSWR sampling design, and separate ratio estimation formulae, the estimated sampling error of the overall ratio was 11% based on a 95% confidence level. According to the VPIP, the main objective of the timber emphasis inventory was to:

> *"Install an adequate number of VRI sample clusters to adjust the timber emphasis inventory in the TFL 3 Vegetated Treed (VT) areas greater than 20 years of age, to achieve a sampling error of ±10% (95% probability) for overall net timber volume."*

Hence, the achieved sampling error was slightly higher than the targeted sampling error of 10%. Note that not all of the originally planned samples could be used in the analysis. The original sample size of 90 was reduced to 83 when the corrections to the VRI Retrofit Inventory data showed 7 samples were outside of the population of interest. Although the target sampling error was not achieved, the magnitude of the overall volume impact was such that a slightly higher sampling error should not be of concern.

3.6 Inventory file adjustment

The scope of this project included applying the adjustment factors to the inventory files for TFL 3. Adjustment factors were applied only to *VT polygons greater than 20 years of age*. The inventory files were adjusted using the factors in Tables 2 and 3 for height and age respectively and Table 4 for net factored volume with NVAF. The adjustment procedure followed the current MSRM protocol for inventory file adjustment. The adjustment was applied to 13 mapsheets.

Appendix D shows population distributions of inventory age before and after the adjustment. Analysis of the inventory files post-adjustment show that some of the area in age class 8 has moved to adjacent age classes (i.e. age classes 6, 7 and 9). This has resulted in a slightly smoother post-adjustment age class distribution compared with the unadjusted inventory file.

The unadjusted total population volume[12] was compared with the adjusted total population volume, after the height, age and "attribute-adjusted" volume factors had been applied to all of the VT polygons greater than 20 years of age. The ratio of the adjusted to unadjusted volume in the population[13] was 1.012, which was very close to the 1.007 volume impact ratio estimated from the sample.

4. CONCLUSIONS

This study suggests that volumes in the VT greater than 20 years population of the unadjusted TFL 3 inventory are being underestimated by less than 1% overall. This underestimation is based on a

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[12] Sum of the polygon volumes/ha times the polygon areas. The population volumes in this comparison were based on 12.5cm+ dbh utilization.

[13] Based on a projection to 2004 for both the adjusted and unadjusted inventory volumes.

comparison with net factored ground volumes with NVAF. However, the volume bias varies by leading species stratum. The VRI ground sample indicates that volume underestimation appears to be more prominent in balsam leading stands. In particular, immature balsam leading stands were underestimated by about 10%. The volume in mature balsam leading stands and in Douglas-fir/pine/larch/deciduous (FPLD) leading stands was underestimated by about 5%. For spruce leading polygons, the sample suggests that volumes are overestimated by about 6%. The volume bias in Cedar/Hemlock leading stands was minimal. The VRI sample indicated that on average, height was overestimated in all strata except immature balsam.

The NVAF analysis in TFL 3 suggests that net factored volumes from the compiler are overestimating volume. With the exception of mature cedar[14], most of the volume bias appears to be associated with the taper functions. For cedar, the taper functions appear to *under*estimates volume but this is compensated for by a volume overestimation associated with bias in the net factored estimates of hidden decay[15].

The scope of this analysis also included the adjustment of the inventory files for TFL 3. The adjusted population was limited to VT polygons, greater than 20 years of age. Analysis of the inventory files post-adjustment indicated that the age class distribution appears to have been “smoothed” somewhat. However the overall mature versus immature area remains very similar. The implications of these changes in the age class distribution on timber supply and other management issues in this unit should be considered. Overall, total volume increased by just over 1% with the adjusted inventory, but the impact varied on a polygon leading species basis.

[14] and possibly hemlock

[15] For cedar, net factoring appears to be underestimating hidden decay.

5. APPENDIX A: INVENTORY AND GROUND ATTRIBUTES USED IN THE ADJUSTMENT

Phase I Inventory Attributes

VRI Sample number	Mapsheet	Polygon	Inventory species composition	Analysis stratum	Utiln based on lead spp	2nd spp proj'd age 2001	2nd spp proj'd ht 2001	Proj'd age 2001	Proj'd height 2001	Crown closure	Proj'd stocking class	Projected unadjusted inventory volumes (VDYP 6.6d) "mixed" utiln-dwb
0001	082F051	2238	BL 70 SE 30	B >120	17.5			139	14.7	20	2	39.4
0002	082F061	1902	BL 60 SE 30 HW 10	B <121	17.5			99	19.4	50	0	165.2
0003	082F071	2011	PL 100	FPLD	12.5			74	20.5	70	0	212.6
0006	082F062	1846	FD 40 PL 30 LW 30	FPLD	17.5			104	27.4	55	0	225.1
0007	082F062	1796	SE 40 EP 30 LW 20 CW 10	S	17.5			79	22.3	30	0	132.8
0008	082F062	2642	BL 80 SE 20	B <121	17.5			109	20.3	45	0	181.2
0010	082F051	1571	HW 40 SE 30 BL 20 CW 10	CH	17.5			49	12.8	60	0	69.8
0011	082F061	2427	LW 50 CW 30 FD 10 SE 10	FPLD	17.5	74	22.4	74	22.2	70	0	159.5
0012	082F072	1783	CW 50 SE 30 BL 15 HW 5	CH	17.5			209	33.5	40	1	452.3
0013	082F062	1611	LW 80 FD 20	FPLD	17.5	259	33.1	279	36.1	40	1	263.1
0014	082F062	2311	LW 60 PL 20 FD 15 EP 5	FPLD	17.5			74	24.2	70	0	163.7
0015	082F071	2173	LW 50 FD 40 PW 10	FPLD	17.5			74	25.3	75	0	181.5
0016	082F061	1863	SE 60 BL 40	S	17.5			69	17.6	20	0	111.4
0017	082F062	1864	FD 80 CW 10 LW 5 HW 5	FPLD	17.5	109	28.6	139	32	65	1	329.1
0020	082F073	1526	AC 30 EP 30 PL 20 SE 20	FPLD	17.5			59	19.4	30	0	43.5
0021	082F071	2011	PL 100	FPLD	12.5			74	20.5	70	0	212.6
0022	082F051	1901	SE 50 BL 50	S	17.5	159	20.8	189	24.8	15	2	82.3
0023	082F072	1727	SE 90 BL 10	S	17.5			209	31.5	45	1	364.1
0024	082F061	2561	SE 50 BL 30 LW 10 HW 10	S	17.5	129	21.0	149	24	40	1	206
0025	082F052	1768	SE 50 BL 50	S	17.5	189	22.6	229	26.6	40	1	242.6
0027	082F051	1905	SE 50 BL 50	S	17.5	149	20.9	189	25.8	30	1	220.1
0028	082F062	2442	FD 60 PL 30 SE 10	FPLD	17.5			99	25.4	60	0	233.5
0029	082F061	1894	BL 60 PL 3 SE 10	B <121	17.5	69	14.3	69	13	10	0	61.7
0030	082F081	1589	BL 80 SE 20	B >120	17.5			220	25.1	35	1	245.7
0031	082F071	2094	BL 60 SE 40	**S**	17.5			189	21.6	25	1	170.7
0032	082F063	1505	PL 40 SE 30 BL 30	**B <121**	12.5			79	20.3	50	0	200.4
0034	082F061	2465	LW 60 BL 30 SE 10	FPLD	17.5			74	24.2	70	0	186.4
0035	082F051	2036	BL 60 SE 35 PW 5	B >120	17.5			189	20.6	30	1	160.1

0037	082F061	2019	BL 90 SE 10	B >120	17.5			179	19.6	40	1	165
0038	082F063	1556	SE 70 LW 20 BL 10	S	17.5			99	29.7	60	0	345.2
0039	082F072	2166	SE 55 BL 3 PL 15	S	17.5	209	26.5	256	30.7	50	1	322
0040	082F071	1690	SE 70 BL 30	S	17.5	129	20.0	149	25	30	1	220.6
0041	082F072	2295	SE 60 BL 40	S	17.5	239	25.4	269	32.4	50	1	340.9
0042	082F052	1558	LW 60 FD 40	FPLD	17.5			109	23.3	50	0	136.4
0043	082F061	1762	HW 50 CW 40 SE 10	CH	17.5	49	17.4	49	17.3	70	0	132.4
0044	082F082	1506	BL 70 SE 30	B >120	17.5			169	18.7	25	1	133.4
0045	082F071	1611	BL 90 SE 10	B <121	17.5			109	15	10	0	90.2
0046	082F052	1937	HW 60 CW 30 FD 10	CH	17.5	39	17.3	39	17.4	75	0	68.8
0047	082F061	1909	BL 70 SE 30	B <121	17.5			79	13.5	25	0	73.3
0048	082F052	1599	LW 50 FD 30 HW 20	FPLD	17.5			89	21.7	70	0	141.5
0049	082F052	1910	HW 60 CW 30 PW 10	CH	17.5			89	24.8	65	0	288.5
0051	082F052	1574	LW 60 FD 30 PW 5 CW 5	FPLD	17.5	89	29.8	89	28.8	70	0	236.2
0052	082F072	44	BL 70 SE 30	B <121	17.5			89	7.8	5	0	4.9
0053	082F071	1982	LW 55 FD 25 SE 15 HW 5	FPLD	17.5			74	24.2	70	0	168.3
0055	082F061	1505	SE 50 BL 50	S	17.5	229	24.5	249	29.5	45	1	288.7
0057	082F071	1647	FD 50 SE 20 HW 20 CW 10	FPLD	17.5			79	19.7	30	0	154.8
0058	082F072	1963	SE 50 BL 50	S	17.5	184	21.7	209	24.7	30	1	206.7
0059	082F062	2238	BL 70 SE 30	B <121	17.5			104	22.5	50	0	200.7
0060	082F051	1926	HW 60 SE 20 CW 20	CH	17.5			259	29.3	55	1	476.9
0061	082F072	1586	BL 60 SE 40	B >120	17.5			129	16.9	20	2	51.6
0062	082F051	1534	SE 60 CW 20 HW 10 BL 10	S	17.5	259	37.5	155	39.7	60	1	563.6
0063	082F061	1524	LW 50 HW 40 BL 10	FPLD	17.5			73	19.5	65	0	133.9
0064	082F071	1511	BL 70 SE 30	B >120	17.5	209	29.6	179	25.8	50	1	246.4
0065	082F061	1592	BL 60 SE 20 PL 20	B <121	17.5			69	15.2	10	0	85.8
0066	082F072	1704	BL 90 SE 10	B <121	17.5			44	5.7	30	0	0
0067	082F061	2106	FD 35 HW 35 CW 20 LW 10	FPLD	17.5	89	27.8	144	30.9	50	1	373.3
0068	082F071	2139	SE 80 BL 20	S	17.5			219	33.5	45	1	375.4
0069	082F051	2062	SE 70 BL 30	S	17.5			239	25.6	55	1	257.3
0070	082F062	1740	EP 55 FD 20 PL 10 LW 10 SE 5	FPLD	17.5			69	21.1	65	0	104.2
0071	082F071	2158	HW 40 LW 30 PL 10 FD 10 CW 10	CH	17.5			74	23.2	70	0	241.1
0072	082F061	1523	LW 50 FD 25 CW 10 HW 10 PW 5	FPLD	17.5	74	27.3	83	25.3	80	0	206.3
0073	082F071	1664	FD 50 PL 30 LW 10 SE 10	FPLD	17.5	84	18.1	84	19.5	30	0	110.1
0076	082F072	1683	BL 60 SE 40	**S**	17.5			99	17.3	40	0	126
0077	082F071	1783	SE 60 BL 30 PL 10	S	17.5	149	24.8	189	27.7	50	1	279.7
0078	082F062	2241	SE 70 BL 30	S	17.5			139	26.1	40	1	245.9
0079	082F052	1511	SE 60 BL 40	S	17.5			169	25.9	40	1	236.8

0080	082F072	1966	SE 70 BL 20 HW 10	S	17.5			209	35.5	35	1	392
0081	082F062	2368	FD 45 LW 25 PL 15 PY 15	FPLD	17.5			100	33.3	70	0	352.8
0082	082F061	1924	HW 40 CW 30 LW 20 FD 10	CH	17.5			54	13.6	65	0	54.2
0083	082F062	1687	FD 89 CW 11	FPLD	17.5			97	34.9	70	0	405.5
0084	082F061	1919	HW 40 LW 30 FD 20 CW 10	CH	17.5	69	20.1	74	22.2	65	0	216.1
0086	082F072	1868	BL 60 PL 30 SE 10	B <121	17.5			69	11.9	20	0	51.1
0087	082F062	2242	SE 50 BL 40 PL 10	**B <121**	17.5	84	24.9	84	26.2	60	0	252.9
0088	082F061	1929	PW 50 LW 30 HW 10 CW 10	FPLD	17.5			69	24.2	70	0	209.8
0089	082F062	2330	FD 90 EP 10	FPLD	17.5			84	25.9	60	0	199.7
0090	082F061	2472	LW 80 CW 10 FD 10	FPLD	17.5			59	18.6	70	0	75.9
0091	082F061	2213	BL 60 PL 30 FD 10	B <121	17.5			69	19.5	45	0	146.8
0092	082F072	1689	BL 100	B <121	17.5			49	6.7	30	0	7.4
0093	082F081	1590	BL 76 SE 24	B >120	17.5			223	28.3	40	1	277.7
0105	082F062	2556	HW 50 FD 20 CW 20 LW 10	CH	17.5			104	29.4	65	0	370.4
0501	082F051	12	BL 50 SE 40 HW 10	B <121	17.5			31	3.7	25	0	0
0503	082F052	79	CW 60 EP 10 AT 10 HW 10 FD 10	CH	17.5			89	22.6	50	0	211.9
0504	082F052	43	HW 37 CW 32 SE 15 BL 12 FD 4	CH	17.5	35	13.1	35	10.5	30	0	11

Phase II Ground (compiled) Attributes

Compiled volumes (Spring 2005)

VRI Samp #	**SPECIES % by BA** *4 cm+ dbh utilization*	**Mean total age (TSL trees)**	**Mean top height (TSL trees)**	**Map lead spp.**	**Map 2nd spp.**	**Case # for match**	**Map age for match**	**Map ht for match**	**Net factored vol/ha (vht_nwb) with NVAF (nvl_nwb)** *Live trees,CLSGRS less dwb "mixed" utilization*
0001	Bl 97 Pa 03	98	6.2	BL	SE	1	139	14.7	0
0002	Hw 61 Se 22 Fd 11 Bl 06	212	20.6	BL	SE	3	99	19.4	276
0003	Pl 100	72	22.1	PL		1	74	20.5	252
0006	Fd 78 Cw 10 Pl 10 Py 02	72	26.1	FD	PL	1	104	27.4	412
0007	Cw 75 S 13 Pw 12	149	14.6	SE	EP	3	79	22.3	70
0008	Bl 73 S 27	205	16.4	BL	SE	1	109	20.3	119
0010	Hw 44 Bl 31 Cw 19 S 06	52	10.3	HW	SE	1	49	12.8	107
0011	Cw 39 Lw 24 Bl 20 Hw 12 Sx 05	57	15.5	LW	CW	2	74	22.4	249
0012	Cw 88 S 12	188	30.5	CW	SE	1	209	33.5	662
0013	Fd 81 Bl 08 Lw 04 S 04 Cw 03	72	22.0	FD		1	69	23.4	379
0014	Cw 46 Hw 38 Fd 08 Lw 08	71	11.0	LW	PL	3	74	24.2	62
0015	Hw 57 Fd 19 Cw 11 Se 05 Lw 05 Pw 03	72	15.3	LW	FD	3	74	25.3	66
0016	Se 56 Bl 44	46	17.4	SE	BL	1	69	17.6	101
0017	Cw 40 Fd 27 Hw 27 S 06	198	30.2	FD	CW	2	109	28.6	458
0020	Fd 60 Ep 20 Pl 20	58	24.7	AC	EP	7	.	.	45
0021	Pl 100	76	20.3	PL		1	74	20.5	229
0022	Bl 100	135	18.9	SE	BL	2	159	20.8	111
0023	Se 53 Bl 47	217	32.8	SE	BL	1	209	31.5	181
0024	Bl 47 Se 41 Hw 06 Fd 06	232	22.6	SE	BL	2	129	21.0	173
0025	Bl 92 Se 08	147	16.3	SE	BL	2	189	22.6	100
0027	Bl 85 Se 15	169	26.3	SE	BL	2	149	20.9	125
0028	Se 31 Lw 25 Fd 19 Bl 13 Pw 06 Cw 06	64	17.3	FD	PL	3	99	25.4	112
0029	Pl 56 Fd 33 S 11	31	10.8	BL	PL	2	69	14.3	48
0030	Bl 67 Se 33	176	21.5	BL	SE	1	220	25.1	333
0031	Bl 79 Se 14 Pa 07	250	20.2	BL	SE	1	189	21.6	122
0032	Bl 74 S 22 Lw 04	106	24.5	PL	SE	3	79	20.3	223
0034	Cw 42 Lw 27 Bl 19 Hw 08 Fd 04	53	20.2	LW	BL	3	74	24.2	202
0035	Bl 74 Se 16 Pa 05 Hm 05	179	17.1	BL	SE	1	189	20.6	123

0037	Bl 57 Se 38 Pa 05	144	20.7	BL	SE	1	179	19.6	231
0038	Cw 26 Hw 26 Bl 21 S 18 Lw 09	343	28.0	SE	LW	3	99	29.7	476
0039	Bl 55 S 31 Pl 14	132	21.2	SE	BL	2	209	26.5	380
0040	Bl 39 Pl 36 Se 25	133	22.6	SE	BL	2	129	20.0	142
0041	Bl 74 Se 26	147	23.1	SE	BL	2	239	25.4	224
0042	Cw 39 Fd 18 Se 12 Lw 12 Pw 06 Bl 06 Hw 07	170	23.1	LW	FD	3	109	23.3	452
0043	Cw 48 Hw 42 Fd 06 Lw 04	.	.	HW	CW	2	. .		152
0044	Bl 87 Se 13	142	19.5	BL	SE	1	169	18.7	87
0045	Bl 73 P 14 Se 13	103	18.6	BL	SE	1	109	15	137
0046	Cw 51 Hw 46 S 03	54	21.3	HW	CW	2	39	17.3	321
0047	Bl 60 Se 40	88	20.7	BL	SE	1	79	13.5	131
0048	Hw 35 Lw 20 Fd 15 Pl 15 Ep 05 Cw 05 Pw 05	99	22.6	LW	FD	3	89	21.7	203
0049	Hw 59 Cw 37 Pw 04	114	28.7	HW	CW	1	89	24.8	291
0051	Fd 58 Cw 29 Lw 08 Hw 05	100	30.3	LW	FD	2	89	29.8	232
0052	Bl 92 S 08	64	8.4	BL	SE	1	89	7.8	5
0053	Lw 33 Fd 29 Hw 19 Cw 19	70	25.8	LW	FD	1	74	24.2	166
0055	Bl 70 Se 30	141	26.5	SE	BL	2	229	24.5	325
0057	Fd 67 Pl 25 Pw 04 S 04	74	17.9	FD	SE	1	79	19.7	168
0058	Bl 67 Se 33	164	23.0	SE	BL	2	184	21.7	114
0059	Bl 79 S 21	116	22.3	BL	SE	1	104	22.5	207
0060	Hw 75 S 12 Cw 08 Bl 05	265	29.6	HW	SE	1	259	29.3	328
0061	Bl 50 Se 30 Tw 20	83	12.7	BL	SE	1	129	16.9	107
0062	Cw 45 Hw 30 Se 20 Bl 05	232	31.1	SE	CW	2	259	37.5	571
0063	Bl 37 Hw 23 Se 23 Lw 10 Pl 03 Fd 04	69	18.1	LW	HW	3	73	19.5	157
0064	Se 57 Bl 43	210	26.5	BL	SE	2	209	29.6	312
0065	Bl 52 Se 48	51	9.8	BL	SE	1	69	15.2	37
0066	Bl 100	77	7.3	BL	SE	1	44	5.7	0
0067	Hw 68 Cw 32	112	27.3	FD	HW	2	89	27.8	296
0068	Se 67 Bl 33	275	40.8	SE	BL	1	219	33.5	504
0069	Se 50 Bl 44 P 06	269	31.3	SE	BL	1	239	25.6	308
0070	Ep 35 Hw 17 Pl 17 Lw 13 Cw 09 Fd 09	69	18.9	EP	FD	1	69	21.1	113
0071	Hw 40 Fd 32 Se 16 Cw 08 Lw 04	86	14.8	HW	LW	1	74	23.2	66
0072	Fd 44 Hw 22 Cw 15 Lw 15 Sx 04	71	24.0	LW	FD	2	74	27.3	156
0073	Pl 38 Cw 19 Fd 19 Se 19 Ac 05	64	17.3	FD	PL	2	84	18.1	94
0076	Bl 76 S 24	116	15.1	BL	SE	1	99	17.3	80
0077	Bl 58 Se 35 Cw 07	126.7	16.8	SE	BL	2	149	24.8	103
0078	S 65 Bl 35	103.5	25.2	SE	BL	1	139	26.1	465
0079	Se 76 Hw 20 Bl 04	325.2	25.0	SE	BL	1	169	25.9	260

0080	Se 41 Hw 36 Bl 14 Pw 05 Cw 04	193.9	39.3	SE	BL	1	209	35.5	445
0081	Cw 62 Fd 23 Lw 08 Hw 07	107.4	30.1	FD	LW	3	100	33.3	145
0082	Hw 71 Sx 19 Fd 06 Cw 04	66.1	16.9	HW	CW	1	54	13.6	97
0083	Fd 70 Cw 17 Ep 09 Py 04	94.3	34.3	FD	CW	1	97	34.9	303
0084	Lw 31 Hw 21 Fd 17 Se 14 Cw 14 Bl 03	67.5	24.0	HW	LW	2	69	20.1	214
0086	S 57 Bl 43	142.9	17.0	BL	PL	3	69	11.9	87
0087	Bl 83 S 17	101.1	24.5	SE	BL	2	84	24.9	200
0088	Hw 68 Lw 32	76.2	11.4	PW	LW	3	69	24.2	94
0089	Fd 39 Ep 28 Cw 22 Pw 06 Lw 05	76.5	27.4	FD	EP	1	84	25.9	261
0090	Lw 55 Cw 36 Hw 05 Bl 04	68.9	24.8	LW	CW	1	59	18.6	163
0091	Bl 68 Se 26 Pl 06	103.0	22.0	BL	PL	1	69	19.5	160
0092	Bl 100	57.3	5.6	BL		1	49	6.7	0
0093	Bl 74 Se 26	198.2	42.4	BL	SE	1	223	28.3	191
0105	Cw 44 Hw 20 Ep 12 Lw 12 Fd 08 Pw 04	76.1	27.8	HW	FD	3	104	29.4	218
0501	Cw 43 Bl 39 Hw 12 Se 06	.	.	BL	SE	3	.	.	51
0503	Cw 64 At 23 Hw 13	95.3	20.3	CW	EP	1	89	22.6	112
0504	Cw 50 Bl 38 Hw 09 S 03	42.14	7.2	HW	CW	2	35	13.1	14

6. APPENDIX B: DATA ISSUES RELATED TO NVAF

When the NVAF tree data was examined, there appeared to be a discrepancy in stratum allocation between the distribution of sample trees identified in the original sampling plan and the actual trees that were sampled. It was determined that some of the trees that were selected as being mature were actually immature. The source of this error was traced to using polygon age from the incorrect layer in multi-layered stands. In NVAF and VRI sampling, the rank 1 layer is used as the basis for determining the attributes of the sample (i.e. age) for sample selection purposes. In multi-layered stands the inventory will *always* indicate one layer as rank 1 but non-rank 1 layers may indicate a "blank" rank value. In the case of the three samples where the discrepancy occurred, "layer 2" was the rank 1 layer and "layer 1" had a "blank" rank value. In these cases, the attributes that should have been correctly used were those for layer 2 (the rank 1 layer).

The incorrect stratum assignment complicated determining the "correct" weights to use in the computation of the NVAF. After discussions with Will Smith and Sam Otukol of MSRM, three options were tested:

- allocating the trees to strata based on the "correct" ages
- allocating the trees to strata as per the sampling plan
- using a "mixed model[16]" to compute sampling weights.

After review, comparison of the results, and discussions with MSRM staff, it was decided that the trees would be allocated to strata based on the sampling plan. Using the "correct" ages assigned far too many trees to the immature stratum (16 instead of the planned 10) and the "mixed model" was a new approach and there was not sufficient time to test this method.

When the NVAF was applied to the compiled volumes, again the inventory ages from the sample selection report (rather than the "correct" ages) were used to assign the sample to mature or immature stratum.

The approach described herein was approved by Will Smith, MSRM.

[16] Mixture of design and model-based weights.

7. APPENDIX C: VOLUME RESIDUALS

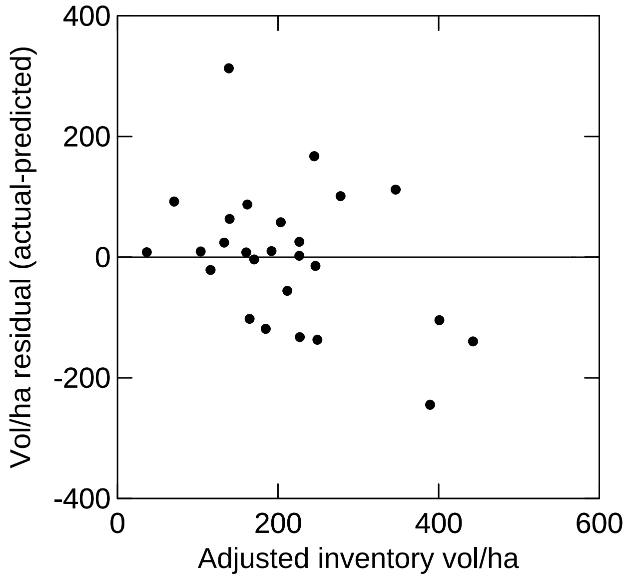

Fig. C-1. FPLD leading. Volume residuals as a function of ratio adjusted inventory vol/ha.

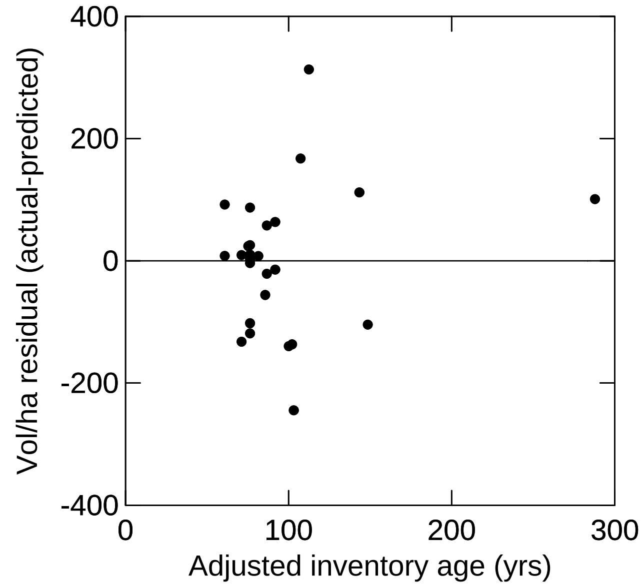

Fig. C-2: FPLD leading. Volume residuals as a function of adjusted inventory age.

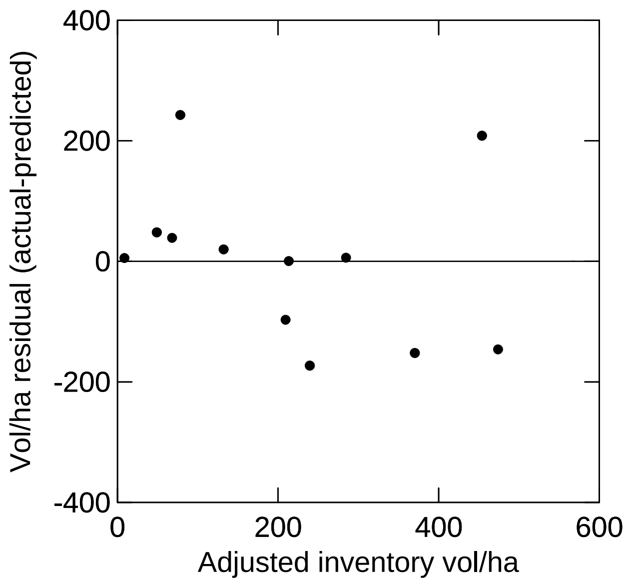

Fig. C-3. Cedar/hemlock leading. Volume residuals as a function of ratio adjusted inventory vol/ha.

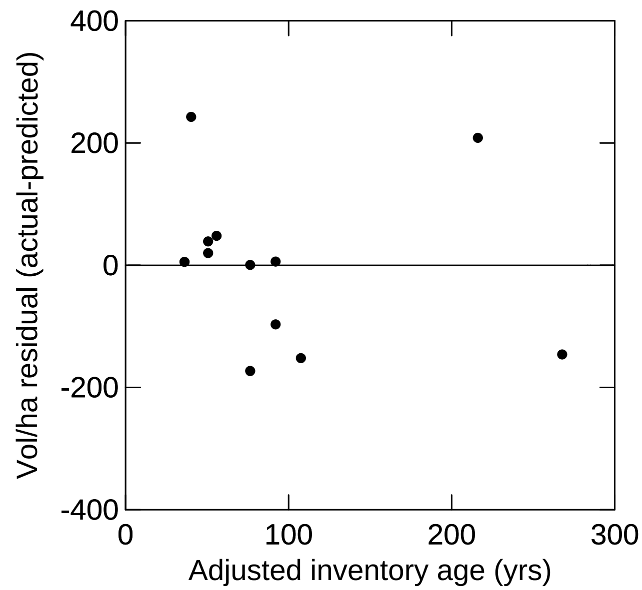

Fig. C-4: Cedar/hemlock leading. Volume residuals as a function of adjusted inventory age.

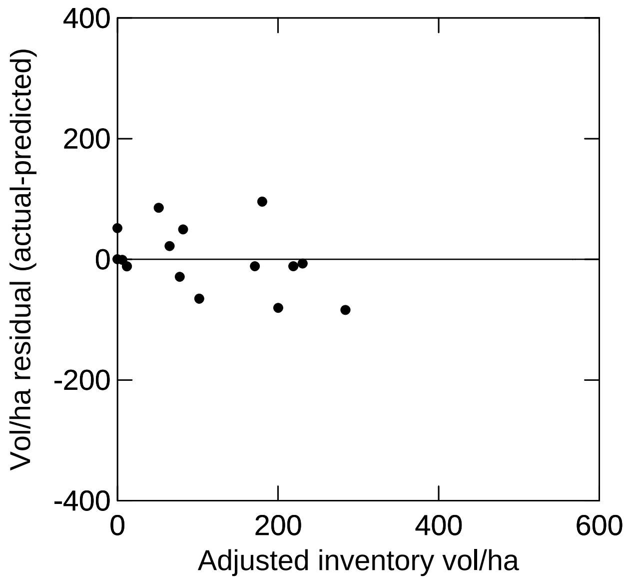

Fig. C-5. Balsam leading <121 yrs. Volume residuals as a function of ratio adjusted inventory vol/ha.

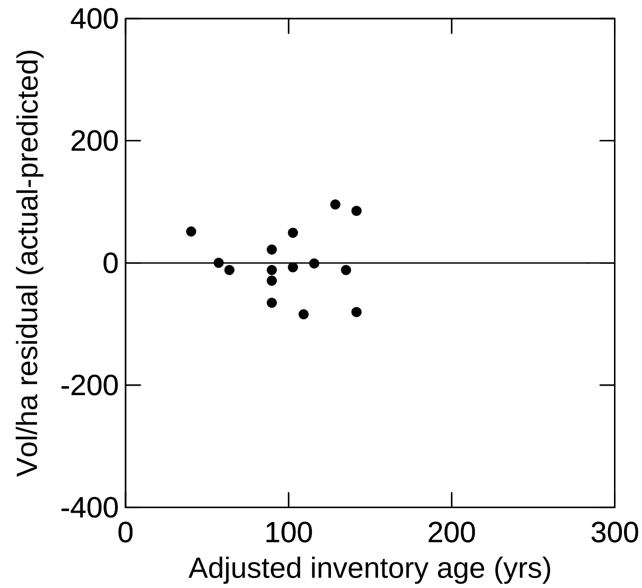

Fig. C-6: Balsam leading <121 yrs. Volume residuals as a function of adjusted inventory age.

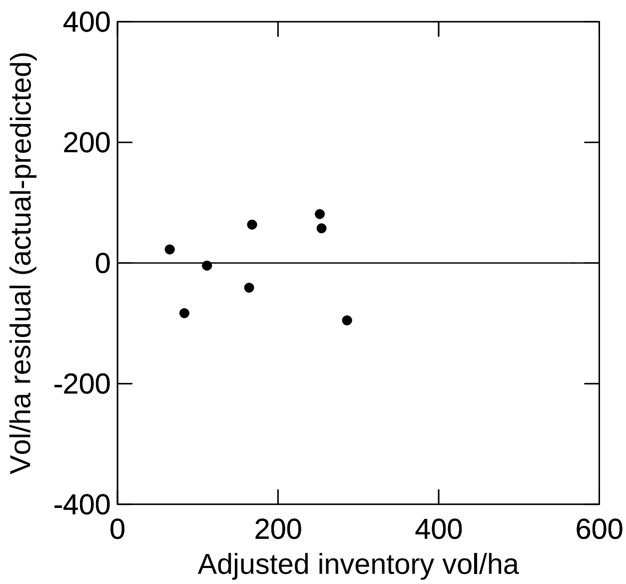

Fig. C-7. Balsam leading >120 yrs. Volume residuals as a function of ratio adjusted inventory vol/ha.

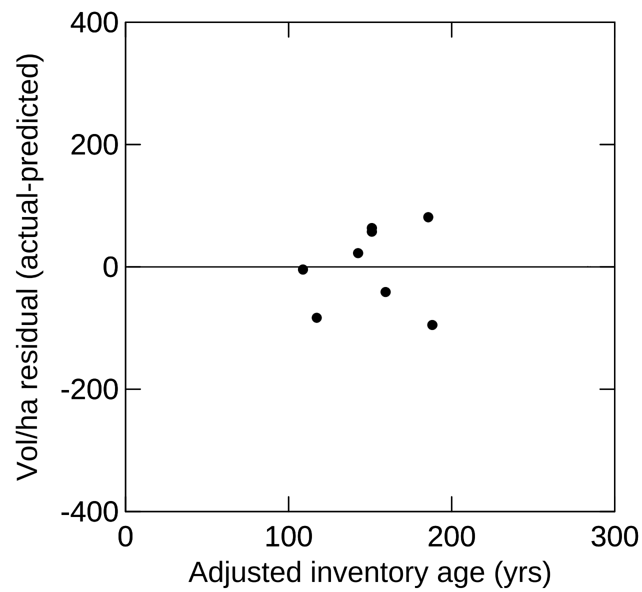

Fig. C-8: Balsam leading >120 yrs. Volume residuals as a function of adjusted inventory age.

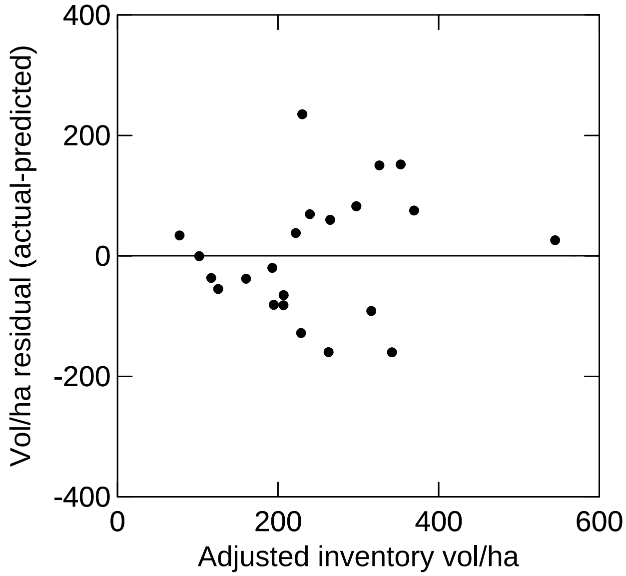

Fig. C-9. Spruce leading. Volume residuals as a function of ratio adjusted inventory vol/ha.

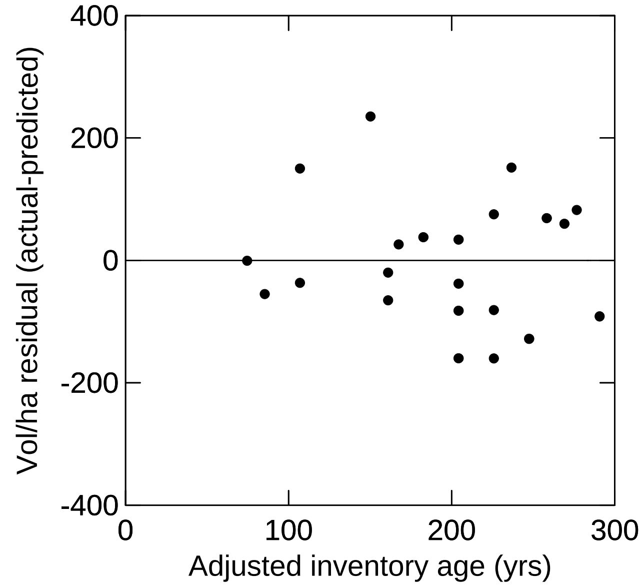

Fig. C-10: Spruce leading. Volume residuals as a function of adjusted inventory age.

8. APPENDIX D: POPULATION DISTRIBUTIONS PRE- AND POST-ADJUSTMENT

The pre-adjusted and post-adjusted age class distribution for TFL 3 population of polygons that are VT greater than 20 years is shown in Figure D-1 below. Area has shifted out of age class 8 and into the adjacent age classes (ages classes 6, 7 and 9), resulting in a slightly smoother age class distribution.

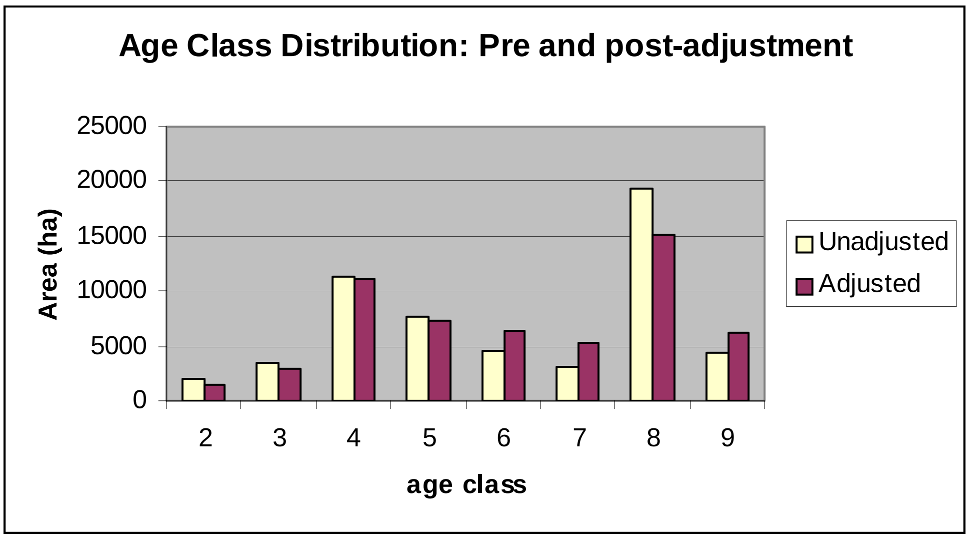

Figure D-1: Age class distribution in the VT greater than 20 years portion of TFL 3, pre- and post-adjustment.

The actual population volume impact of the adjustment (height, age and volume) for the VT, greater than 20 years population is shown in Table D-1.

Table D-1: Actual population volume impact after adjusting height, age and volume (for the VT, greater than 20 years population). Note that volume utilization in this table is 12.5cm+ dbh net dwb for all polygons regardless of leading species. All volumes in this table are projected to 2004[17].

Strata	*Total area (ha)*[18]	*Unadjusted total volume (m^3)*	*Adjusted total volume (m^3)*	*Population volume impact (adjusted/unadjusted)*
FPLD	17681	3944591	4243194	1.076
Cedar/Hemlock	7913	2445307	2432891	0.995
Balsam <121 yrs	7232	702822	735586	1.047
Balsam >120 yrs	9475	1471605	1516945	1.031
Spruce	13433	3713168	3495340	0.941
OVERALL	55734	12277492	12423956	1.012

Overall, the volume impact was 1.012, which is very close to the estimated impact of 1.007 (see Table 6 in the body of the report[19]).

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[17] The final adjusted file provided to the licencee was projected to 2005. This table was based on a 2004 projection so that values could be verified against the preliminary results produced last year.

[18] Areas in this table are based on the new inventory population file (after the new photo-interpretation and file corrections). These areas differ slightly from the sample selection population file.

[19] The estimated volume impact was based on a mixed utilization depending on the inventory species. Some differences between the estimated impact and the achieved impact can be attributed to these utilization differences.