Tree Farm Licence 47
Vegetation Resources Inventory

Statistical Adjustment

Version 1.1

PREPARED BY:

TECO NATURAL RESOURCE GROUP LTD.

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EXECUTIVE SUMMARY

TimberWest Forest Corp. (TimberWest) initiated a Vegetation Resources Inventory (VRI) program for Tree Farm License (TFL) 47 in 2006 to upgrade and adjust their existing inventory. The VRI Phase I was completed in March 2007 using 2006 1:15,000 aerial photos. The VRI Phase II project implementation plan (VPIP)[1] was prepared in 2007, with ground sampling carried out in 2007, 2008 and 2010. NVAF sampling was completed in March 2010. An adjustment of the Phase I was completed in 2010 using VDYP7. The objective of this project was to use the information from the VRI Phase II plots to adjust the inventory in preparation for timber supply review.

Height, age, basal area, stems per hectare, Lorey height and total live net merchantable volume were adjusted following Ministry of Forests and Range (MFR) VRI adjustment methods. The target population for the VRI Phase II was defined as all TFL 47 vegetated treed polygons where the main layer is treed and greater than 30 years of age (88,278 ha). The target population was stratified by leading species and age into the following four strata:

1. Hemlock[2] 30-100 years
2. Hemlock 100 + years
3. All other species 30-100 years
4. All other species 100 + years

After adjustment, **height and Lorey height were unchanged**. **Age, SPH and basal area increased by 39%, 114% and 31%** respectively. The increase in age resulted in a **16% decrease in site index**. The initial average Phase I **net merchantable volume** (12.5 cm+) was 389 m^3/ha. The attributed adjusted net merchantable volume estimate was 498 m^3/ha, **a 28% increase**. Following the Phase II adjustment the final net merchantable volume estimate was 512 m^3/ha, a **3% increase** over the attribute adjusted Phase I estimate and a **32% increase** over the unadjusted Phase I estimate. The sampling error for the volume adjustment was ±11% (95% probability).

A main source of uncertainty with this analysis is in the SPH estimations. Phase I SPH was under-estimated by approximately 114% with a sampling error of ±21% (95% probability). It is likely that this under-estimation is related to the layer estimate of SPH used for comparison. Phase II estimates will include all trees measured within the plot, and may include trees from intermediate or suppressed tree layers.

The recommendations from this project are:

1. TimberWest use the adjusted estimates of height, age, basal area, stems per hectare, and volume in the timber supply analysis base case.
2. TimberWest consider the forest health statistics provided in this report as a starting point for investigating specific forest health issues.
3. TimberWest use the adjusted inventory for forest management planning.
4. TimberWest explore other non-standard adjustment methods (e.g. regression) for attributes that showed a significant trend.

[1] Timberline Natural Resource Group Ltd. 2007. *TimberWest Forest Corp. Tree Farm License 47 Vegetation Resources Inventory Phase II Project Implementation Plan.* Unpublished Report, July 2007, amended February 15, 2008 and October 29, 2009. 28 pp.

[2] Hemlock includes both western hemlock and mountain hemlock.

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1.0 INTRODUCTION

1.1 Vegetation Resources Inventory Overview

The Vegetation Resources Inventory (VRI) is the Ministry of Forests and Range's (MFR) 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, usually 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. Statistical 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.

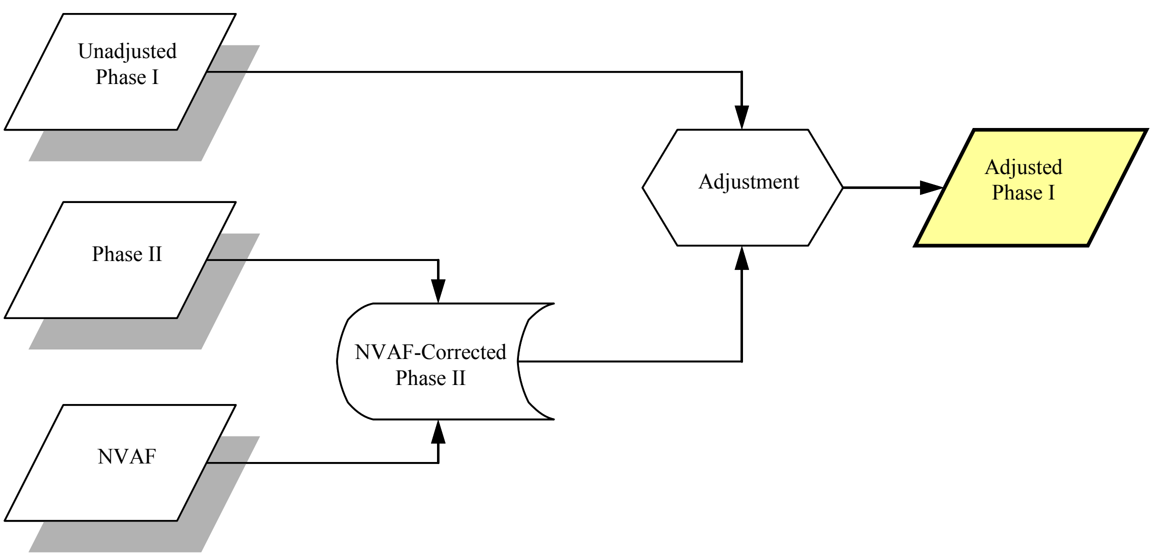

Figure 1. VRI Flow-chart.

1.2 TFL 47 VRI Program

TimberWest Forest Corp. (TimberWest) completed a VRI Phase I Strategic Inventory Plan[3] covering the Bonanza and Johnstone Strait Management Units of TFL 47 in 2006. Timberline Natural Resources Group Ltd. (Timberline) prepared a Phase II Vegetation Resources Inventory (VRI) Project Implementation Plan (VPIP)[1] to document the 2007 sample design and implementation of the ground program.

The sampling objective of the Phase II program is to estimate the net merchantable volume in the target population with a sampling error of ±10% (95% confidence interval). Mecredy Cruising & Forest Consulting Ltd. (Mecredy) completed the field work in November 2007 and November 2008. The initial intent of the field program was to establish 60 samples (including all of the Net Volume Adjustment Factor [NVAF] enhancement plots).

Timberline completed a preliminary analysis in March 2009, and the resulting sampling error did not achieve the target with 60 plots. In order to maintain cost efficiency, the target sampling error was modified to ±25% (95% confidence interval) for the estimate of net merchantable volume in three of the four strata[4]. The modified objective required an additional 9 samples to be established (which were established by Mecredy in 2010). A second preliminary analysis was completed by Timberline in March 2010.[5]

The NVAF destructive sampling was completed by Azmeth Forest Consultants in March 2010. This report documents the development of the NVAF ratios and their application in the final adjustment.

1.3 Project Objective

The TFL 47 Phase I inventory is based on photo-interpreted inventory attribute estimates using the current VRI procedures. The Provincial Chief Forester requires that the bias implicit in photo-interpretation be removed and the statistical precision of the inventory be known before the Annual Allowable Cut (AAC) is determined. The VRI is designed to provide the Chief Forester with a level of comfort in the inventory for TSR.

The project objective is to:

> *Upgrade and adjust the TFL 47 VRI Phase I forest inventory to MFR standards in preparation for the next Timber Supply Review.*

Forest management issues on TFL 47 that will benefit from an adjusted VRI inventory include:

1. *Timber supply analysis – will help to remove uncertainty in timber supply analysis projections.*

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[3] TimberWest Forest Corp. 2006. *TFL 47 Bonanza Lake and Johnstone Straits Management Units VRI Strategic Inventory Plan*. Prepared by Warren Nimchuk, RPF and Doug Reeve, RFT, on behalf of TimberWest Forest Corp.

[4] The three strata of interest include: H ≤ 100yrs, H > 100yrs & Other ≤ 100yrs. The Other > 100yrs stratum had high variability, and would have required an additional 28 plots to reach the target sampling error.

[5] Timberline Natural Resource Group. 2010. TFL 47 VRI preliminary adjustment 2 memo prepared for Timberwest Forest Corp.

2. *Operability mapping – will provide additional information to confirm distribution of merchantable timber. Better age and height data may also improve the identification and classification of problem forest types, sites with low growing potential, and deciduous stands.*
3. *Biodiversity – may aid in delineating wildlife tree patches, deer winter range, and seral stages.*
4. *Land use planning – will help identify areas of specific interest for the 'Central Coast Land Resource Management Plan', and 'Vancouver Island Land Use Plan'.*

1.4 Analysis and Reporting Objectives

The 2010 analysis objectives were to:

1. *Compile the 2006/2007/2010 VRI Phase II (ground data) to MFR standards;*
2. *Compute the NVAF ratios; and*
3. *Complete a statistical adjustment of the inventory using the most recent MFR standards.*[6]

The report objective is to:

1. *Document the statistical adjustment procedures used in this analysis;*
2. *Report on the results and make recommendations; and*
3. *Identify areas of uncertainty in the data.*

1.5 Terms of Reference

This final report for the TFL 47 VRI statistical adjustment was prepared for Timberwest and the MFR, Forest Analysis and Inventory Branch. Debora Soutar, *RPF*, of Madrone Environmental Services Ltd. was the Forest Investment Account (FIA) coordinator. Hugh Carter, *MSc, RFT*, (Timberline) was the project manager and provided technical support. Eleanor McWilliams, *MSc, RPF* and Stephanie Ewen, *RPF* completed the analysis and prepared the final report. The results from this report will be reviewed and approved by the MFR Forest Analysis and Inventory Branch (FAIB) prior to use in TSR.

[6] Ministry of Forests and Range, 2008. *Vegetation Resources Inventory Interim Procedures and Standards for Statistical Adjustment of Baseline VRI Timber Attributes*. Unpublished Report, January 2008. 36 p.

2.0 DATA

2.1 Land Base

TFL 47 comprises two[7] management units (MU) located on northern Vancouver Island near Port McNeill (Bonanza Lake MU) and parts of the coastal mainland and islands in the Johnstone Strait (Johnstone Strait MU) (Figure 2). The total TFL area is 123,034 ha. The total vegetated treed area of the TFL is 110,118 ha.

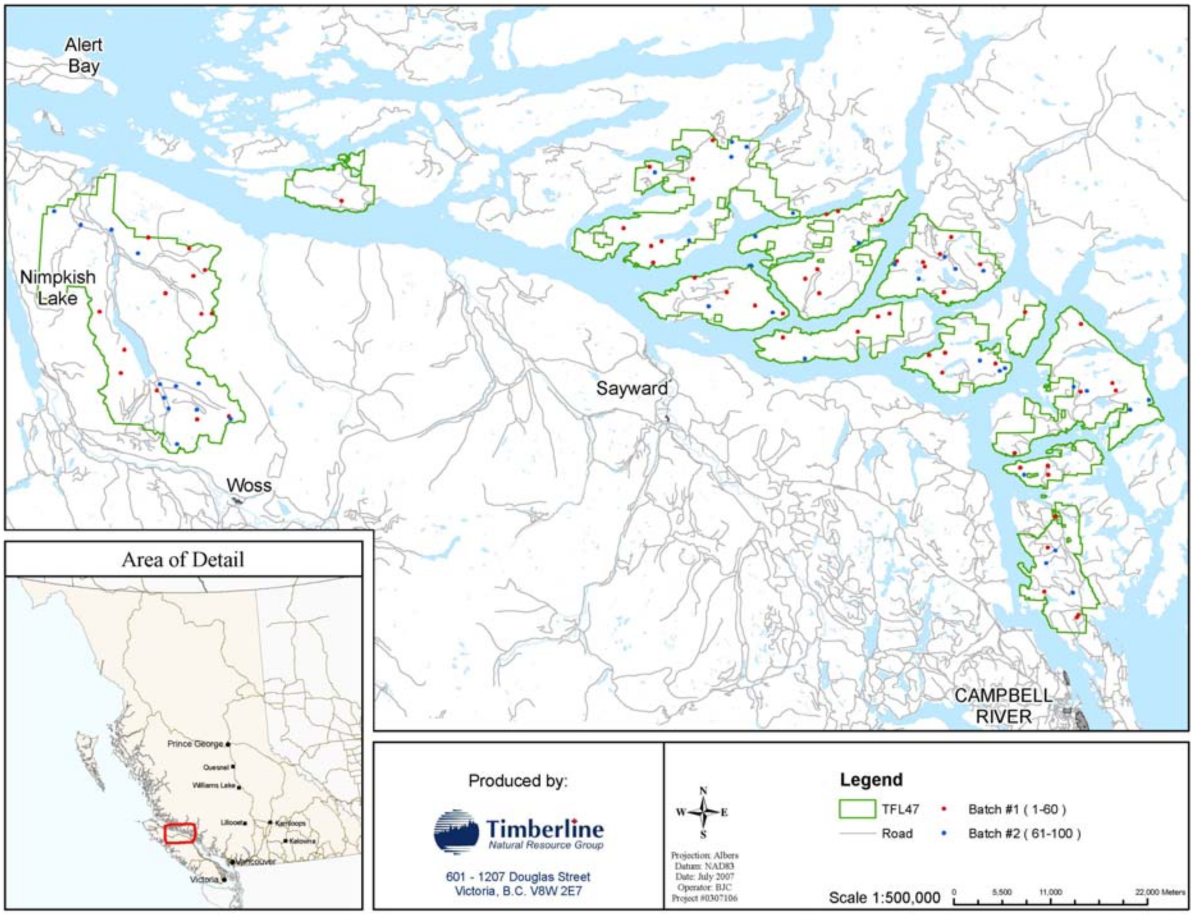

Figure 2. Geographic location of TFL 47, including sample locations (batch 1 and batch 2).

TFL 47 is located in the Coastal Western Hemlock (CWH) and Mountain Hemlock (MH) biogeoclimatic zones (Figure 3). The dominant species in both management units is western hemlock (Hw) comprising on average 63% of the area, followed (in decreasing area proportion) by Douglas-fir (Fdc), western redcedar (Cw), yellow cedar (Yc) mountain hemlock (Hm), and other species (Table 1 and Table 2). The majority (68%) of the area is in younger stands (< 80 years old) with 24% occurring in mature stands (>120 years old).

[7] A third unit (Moresby Island MU) is no longer part of TFL 47.

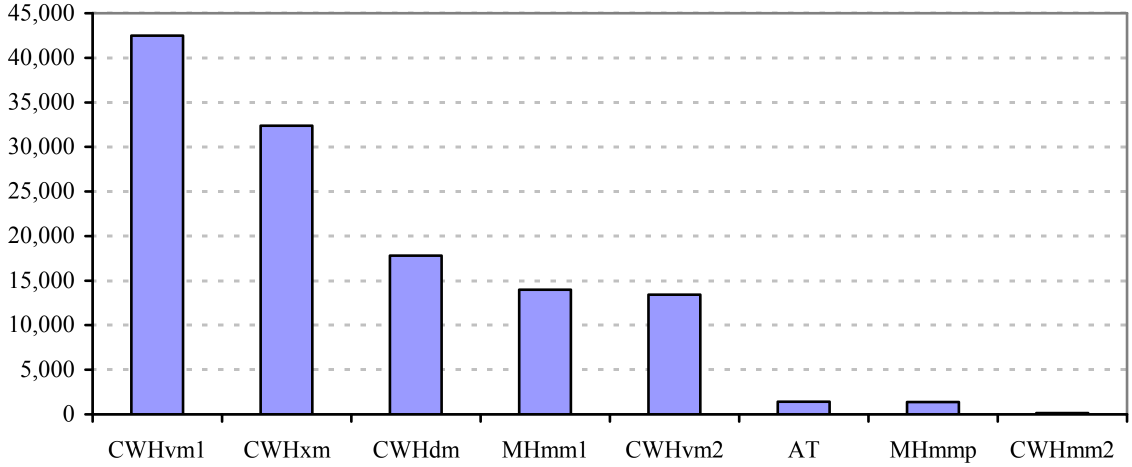

Figure 3. TFL 47 BGC subzone area distribution.

Table 1. TFL 47 species and age class distribution – Bonanza Management Unit.

Leading Species	MoFR Age Class									Total	
	1	2	3	4	5	6	7	8	9	***Ha***	**%**
BA	361	48	32	49	16		24	683	1,515	*2,727*	8%
CW	161	108	59				18	39	136	*520*	2%
DR	8	141	83						12	*245*	1%
FDC	723	1,324	14			4				*2,064*	6%
HM	104		14		21			1,002	2,641	*3,782*	12%
HW	5,608	5,713	2,131	582	95	47	25	896	3,266	*18,362*	56%
SS	24	127	64	6		5			13	*240*	1%
YC	232	9				5	19	2,178	2,390	*4,834*	15%
Total	*7,220*	*7,470*	*2,396*	*638*	*132*	*61*	*87*	*4,798*	*9,973*	*32,773*	100%
Total %	*22%*	*23%*	*7%*	*2%*	*0%*	*0%*	*0%*	*15%*	*30%*	*100%*	

Table 2. TFL 47 species and age class distribution – Johnstone Strait Management Unit.

Leading Species	MoFR Age Class									Total	
	1	2	3	4	5	6	7	8	9	***Ha***	**%**
BA	96	42						10	47	195	0%
BG	27		4							31	0%
CW	756	671	271	726	366	198	34	1,881	854	5,757	7%
DR	184	905	1,418	920	12					3,440	4%
FDC	1,978	2,655	756	5,501	2,211	725	39	978	176	15,017	19%
HM								172	119	291	0%
HW	7,769	9,772	7,159	14,768	3,500	886	316	4,619	2,002	50,790	66%
PL	4	128	129	766	303	11		9		1,349	2%
SS						16	4			20	0%
VB	213									213	0%
YC								296	16	312	0%
Total	*11,026*	*14,172*	*9,737*	*22,681*	*6,392*	*1,836*	*392*	*7,965*	*3,213*	*77,414*	100%
Total %	*14%*	*18%*	*13%*	*29%*	*8%*	*2%*	*1%*	*10%*	*4%*	*100%*	

All spatial GIS coverages used to define the TFL 47 landbase were obtained from TimberWest and Madrone staff (Table 3).

Table 3. TFL 47 Source coverages used in this project.

Coverage Name	Description	Date Received
TFL47.SHP	TFL 47 boundary coverage of Bonanza and Johnstone Strait MU's. Received as shape file from Ken Price, TimberWest.	2007-June-15
TFL47_DEPLETIONS06.SHP	Harvest depletions coverage occurring in 2006. Received from Ken Price, TimberWest.	2007-June-15
TEM_SUBZ.SHP	BGC subzone/variant linework, originating from the TFL 47 TEM coverage. Created by Ken Price, TimberWest.	2007-June-15
VRI.E00	VRI Phase I inventory of Bonanza and Johnstone Strait MU's. Originally created by IRC, March 31, 2007, and forwarded by Debora Soutar, Madrone. Note, this coverage has not yet gone through any data translation / conversion routines by the MoFR.	2007-June-05
	TFL 47 2006 1:15,000 air photo flight lines.	2007-June-05
Depletion2006_2010.shp	Depletion for areas harvested between 2006 and 2010. Received from Ken Price, TimberWest	2010-February-12

2.2 Target Population

The target population for the VRI Phase II was defined as all TFL 47 vegetated treed[8] (VT) polygons where the main layer is treed and greater than 30 years of age.[9] The main layer was

[8] Discussions with B.Storry, TimberWest that the majority of the forested landbase was operable, helped to confirm that the entire VT portion should be included in the target population (email corresp 21 June, 2007).

defined as the layer with the largest crown closure, and a layer was considered treed if the leading species was present with a minimum crown closure of 10%. The total area of the target population was 88,278 ha (Table 4; 72% of the total landbase or 80% of the VT landbase). All harvest depletions since the 2006 Phase I inventory mapping (up to January 1, 2010) were updated into the inventory.

Table 4. TFL 47 Phase II target population net down.

	Area removed (ha)	Area remaining (ha)	% of total	% of VT
Total Inventoried Area in 2006		126,654		
Area inside TFL in 2007	3,111	123,543		
Inventoried Area inside TFL in 2007	508	**123,034**	100%	
Vegetated Treed	12,847	110,188	90%	100%
Stands >30 years old	21,910	**88,278**	72%	80%
Bonanza MU	0	**24,559**	20%	22%
Johnstone Strait MU	0	**63,719**	52%	58%

2.3 Stratification

2.3.1 Ground Sampling

The target population was stratified by age and species using two age groups (30-100 years vs. 101+ years) and two species groups (Hw+Hm, vs. all others) (Table 1, Table 2). This stratification also reflects the two different MUs since Johnstone Strait is mainly composed of second-growth stands while Bonanza includes a larger component of mature stands.

While the leading species is dominated by Hw, both Hw and Hm were combined into one species group for consistency, separated from all other species. Each stratum was further sub-stratified into volume[10] classes (<=400m^3/ha, and >400m^3/ha) to ensure appropriate distribution of the ground samples across the range of possible values (Table 5).[11]

[9] Stand age definition criteria were based on the 2007 projected year.

[10] Polygon specific net merchantable volume estimates were generated with Batch VDYP ver. 6, at 17.5cm DBH utilization limit. Note, stocking class codes were not provided in the VRI Phase I inventory. Therefore, stocking class codes were estimated at 0 for VT stands 0-120 years old, and 1 for VT stands >120 years old. Age, height and volume were projected to 2007.

[11] While the Bonanza and Johnstone Strait MU's have somewhat different stand characteristics, we chose not to separate the two as part of the stratification. The main reason is that the Johnstone Strait MU is much larger than the Bonanza, plus the MU differences are already largely addressed in the proposed stratification criteria.

Table 5. Stratum and sub-stratum area distribution within the target population.

Sub-stratum Area (ha)	Stratum Area (ha)				
	H ≤ 100yrs	Other ≤ 100yrs	H > 100yrs	Other > 100yrs	Total (ha)
Low volume (<= 400m^3/ha)	21,107	11,270	5,048	6,596	44,021
High volume (> 400m^3/ha)	19,536	6,025	12,015	6,681	44,257
Total	*40,643*	*17,295*	*17,063*	*13,277*	*88,278*

2.3.2 NVAF

An assessment of the merchantable volume by species was completed using all established Phase II samples. The species groupings and sample sizes were determined and five (5) NVAF strata were defined as follows:

1. Dead
2. Immature
3. Mature – H
4. Mature – B
5. Mature – C

Due to funding constraints, only partial funding was available for NVAF sampling. In consultation with the MFR Volume and Decay Officer a batched approach was implemented for the sample selection. Three batches for sampling were determined as follows:

1. Batch 1 – 41 trees
2. Batch 2 – 20 trees
3. Batch 3 – 39 trees

Due to financial constraints, only Batch 1 was collected (Table 6, Appendix III).

Table 6. NVAF Batch 1 sample distribution.

Stratum	Species	Total Merch Volume		Number of trees	
		% Total	% Group	Total	% Group
Dead	H	32	32	1	50
	Cw	24	24	0	0
	Other	44	44	1	50
	Total	***100***	***100***	***2***	***100***
Immature	H	28	47	9	50
	Fd	17	29	5	28
	Cw	11	18	3	17
	Other	3	6	1	6
	Total	***59***	***100***	***18***	***100***
Mature – H	H	19	47	10	48
	Sub-Total	***19***	***47***	***10***	***48***
Mature – B	B	*11*	*26*	5	*24*
	Fd	*3*	*8*	*1*	*5*
	S	*0*	*0*	*0*	*0*
	P	*0*	*0*	*0*	*0*
	Sub-Total	***14***	***34***	***6***	***29***
Mature – C	Cw	*4*	*9*	*2*	*10*
	Yc	*4*	*9*	*3*	*14*
	Sub-Total	***8***	***18***	***5***	***24***
	Total	***41***	***100***	***21***	***100***
Grand Total		***100***	***100***	***41***	***100***

2.4 Phase I Data

In 2006 TimberWest completed a VRI Phase I Strategic Inventory Plan[3] covering the Bonanza and Johnstone Strait MU's. Subsequently, Inventory Resources Co-operative (IRC) completed the TFL 47 Phase I inventory on March 31, 2007 using 2006 1:15,000 aerial photos (Table 7).

Table 7. TFL 47 photo-interpreted inventory statistics.

Stratum	Area (ha)	Height (m)	Lorey Height (m)	Age (yrs)	BA 7.5cm+ (m^2/ha)	SPH 7.5cm+ (trees/ha)	SI (m)	Vol. 12.5cm+ (m^3/ha)	Vol. 17.5cm+ (m^3/ha)
H ≤ 100yrs	40,643	26.6	24.6	59	48.2	743	26.3	409.2	401.3
Other ≤ 100yrs	17,295	26.0	23.6	64	41.0	547	25.1	334.4	329.1
H > 100yrs	17,063	33.1	28.7	242	52.0	416	14.0	443.1	441.6
Other > 100yrs	13,277	28.6	26.2	229	40.6	363	14.6	325.6	323.7
Total	*88,278*	*28.0*	*25.4*	*121*	*46.4*	*584*	*21.9*	*388.5*	*383.3*

2.5 Phase II (Ground Sampling)

2.5.1 Actual Sample Size

In the 2007 Phase II VPIP, one-hundred (100) plots were selected and split into two batches. Batch one included sixty (60) samples while batch two included forty (40) samples. Upon completion of an interim analysis[12] of the batch one data, Timberline recommended that TimberWest concentrate further sampling in the H > 100 yrs and Other ≤ 100 yrs strata to bring the sampling error down to ±25% as these were seen as the most important strata for future TSR. To achieve this objective nine new samples were established: five (5) in the H > 100 yrs stratum, and four (4) in the Other ≤ 100 yrs stratum. The nine additional samples were chosen from the existing batch 2 sample list and were the next five and four samples in the list for the H > 100 yrs and Other ≤ 100 yrs strata respectively (Table 8). Therefore a total of sixty-nine (69) samples were visited in the Phase II sampling (Appendix I). Six samples were identified as being inaccessible, and were replaced with sample locations in similar stand types according to standard plot-replacement protocol. Sample 45 was harvested and was replaced with sample 97. All remaining samples were measured with no occurrences of logged or unsafe samples.

[12] Timberline, April 2009. *Memo – TFL 47 Preliminary Analysis April 8, 2009*. Unpublished. p. 15.

Table 8. Sample size distribution by stratum and sub-stratum.

Stratum	Sub-Stratum	Area (ha)	(%)	Batch 1 Sample Size	Batch 2 Sample Size	Total Sample Size	(%)	Ha/ Plot
H ≤ 100yrs	High_vol	19,536	22%	13	0	13	19%	1,503
	Low_vol	21,107	24%	11	0	11	16%	1,919
	Total	***40,643***	46%	***24***	***0***	24	35%	***1,693***
Other ≤ 100yrs	High_vol	6,025	7%	6	0	6	9%	1,004
	Low_vol	11,270	13%	6	4	10	14%	1,127
	Total	***17,295***	20%	***12***	***4***	16	23%	***1,081***
H > 100yrs	High_vol	12,015	14%	9	4	13	19%	924
	Low_vol	5,048	6%	5	1	6	9%	841
	Total	***17,063***	19%	***14***	***5***	19	28%	***898***
Other > 100yrs	High_vol	6,681	8%	5	0	5	7%	1,336
	Low_vol	6,596	7%	5	0	5	7%	1,319
	Total	***13,277***	15%	***10***	***0***	10	14%	***1,328***
Total		***88,278***	***100%***	***60***	***9***	***69***	***100%***	***1,279***

2.5.2 Sampling Weights

Plot weights were computed based on the distribution of the sample size within sub-strata, using 69 plots (Table 9). Sampling weights ranged from 841 ha to 1,919 ha. In general, plots are evenly distributed amongst the sub-strata, as each are of equal importance in timber supply. The average weight was 1,279 ha/plot. The sampling weight for each individual ground sample is provided in Appendix I.

Table 9. Phase II Sampling weights.

Stratum	Sub-Stratum	Area (ha)	No. Plots	Area/ Plot
H ≤ 100yrs	High_vol	19,536	13	1,503
	Low_vol	21,107	11	1,919
Other ≤ 100yrs	High_vol	6,025	6	1,004
	Low_vol	11,270	10	1,127
H > 100yrs	High_vol	12,015	13	924
	Low_vol	5,048	6	841
Other > 100yrs	High_vol	6,681	5	1,336
	Low_vol	6,596	5	1,319

2.5.3 Phase II Plot Statistics

The Phase II average plot statistics are provided in Table 10. Phase I and Phase II data is provided in Appendix II.

Table 10. Phase II plot statistics.

Stratum	n	Height (m)	Age (yrs)	BA (m^2/ha)	SPH (trees/ha)	SI (m)	Lorey Ht. (m)	Live Vol. 12.5+ cm (m^3/ha)	Live Vol. 17.5+ cm (m^3/ha)
H ≤ 100yrs	24	25.6	73	59.9	1,620	24.3	22.5	468.7	436.3
Other ≤ 100yrs	16	25.7	99	49.4	986	24.9	25.3	409.7	385.1
H > 100yrs	19	30.4	462	77.3	845	14.0	27.5	673.8	666.2
Other > 100yrs	10	33.7	346	73.7	783	16.5	30.0	760.3	757.3
Total	*69*	*27.7*	*191*	*63.3*	*1,220*	*21.4*	*25.1*	*540.6*	*519.0*

Note: Phase II (ground sampling) volume was whole-stem volume less tops, stumps, NVAF-corrected cruiser-called decay, waste, and breakage.

2.6 NVAF Data

The NVAF sampling program was completed in March 2010. Forty-one (41) trees were selected (39 live and 2 dead trees) (Table 11, Appendix III). All ratios were calculated by Timberline and approved by the MFR Volume and Decay Sampling Officer (September 2010). After the initial analysis the MFR Volume and Decay Sampling Officer asked that the original three Mature strata (Mature C, Mature H, Mature B) be combined into a single Mature stratum. Table 11 provides a summary of the cruiser called Phase II volumes for conifer trees compared to the destructively sampled volumes as supplied by the MFR. On average, the Phase II tree volumes were very close to the NVAF volumes. The complete NVAF sample tree list is provided in Appendix III.

Table 11. NVAF tree summary statistics.

Live/	Maturity		No.	Avg. Volume (m^3)		
Dead	Class	Spp	Trees	Phase II	NVAF	% Diff.
Live	Immature	All	18	1.317	1.378	4.68%
	Mature	All	21	3.288	3.290	0.06%
Dead	All	All	2	1.426	0.739	-48.18%
All	*All*	*All*	*41*	*2.332*	*2.326*	*-0.23%*

3.0 METHODS

3.1 Phase I Projection

Photo-interpretation was done using photos taken in 2006. For this analysis the photo-interpreted age was projected to 2008 by adding the required number of years.[13] The photo-interpreted height, BA, SPH, and corresponding net merchantable volume were also projected to 2008 using VDYP7 (version 7.5c.27). The model did not project BA, SPH, or volume where heights were less than 7.6m so these polygons were assumed to have no volume, BA, or SPH. All other critical VDYP7 inputs (species composition, crown closure, forest inventory zone, inventory standard, and BGC) were not modified.

3.2 NVAF

The NVAF ratios were generated by Timberline in September 2010 and approved by the MFR Volume and Decay Officer. Ratios were computed using the model-based method and applied to the Phase II net merchantable volume computed from the raw data.

3.3 Phase II Compilation

Timberline completed a preliminary compilation of Phase II data in March, 2009, and the resulting sampling error did not achieve the target with 60 plots. In order to maintain cost efficiency, the target sampling error was modified to ±25% (95% confidence interval) for the estimate of net merchantable volume in three of the four strata[14]. The modified objective required an additional 9 samples to be established (which were established by Mecredy in 2010). All 69 samples were used to complete this final analysis.

The standard five-point cluster was used in all stands. Height and net factors were used for all trees when available. Phase II net merchantable volume was the whole-stem volume less tops, stumps, cruiser-called decay, waste, and breakage. The Phase II data was NVAF adjusted. Volume was compiled to 12.5cm+ and 17.5cm+ for all strata.

The field-collected GPS points were analyzed to confirm that plots landed at the intended points. In all cases, the GPS point for the plot was within the polygon that the sample was intended to be located in. In all cases the intended polygon was used for analysis.

3.4 Statistical Adjustment

The most recent MFR VRI statistical adjustment standards were used to adjust height, age, BA (7.5+ cm), SPH (7.5+ cm), Lorey height (12.5+ cm) and live net merchantable volume (12.5+

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[13] The original 60 Phase II plots were sampled in 2008. As per MFR standards the data is projected to the year that the majority of sampling was completed.

[14] The three strata of interest include: H ≤ 100yrs, H > 100yrs & Other ≤ 100yrs. The Other > 100yrs stratum had high variability, and would have required an additional 28 plots to reach the target sampling error.

cm).[15] The MFR adjustment procedures assume that the unadjusted (Phase I) inventory volume is biased due to two sources of error:

1. An attribute bias associated with the photo-interpreted height, age, BA, and SPH; and
2. A model bias inherent to the growth and yield model used to estimate volume (VDYP7).

Three critical attributes needed for volume prediction are not adjusted in the process but are important for determination of other critical attributes. The "inventory standard" attribute determines how basal area and stems per hectare are either used or generated, BGC zones are important for estimating volume loss and are needed for every polygon, and species composition is used to distribute the volume. Leaving species composition unadjusted is assumed to create a negligible bias.

The interim attribute adjustment procedure is a two-step process (Figure 4) described as follows:

- Step 1: Phase I height, age, basal area (7.5cm+), and stems per hectare (7.5cm+) bias are corrected using an adjustment ratio of means (ROM) calculated from the Phase I and Phase II plots. An attribute-adjusted volume is then estimated using VDYP7 with the adjusted height and age.
- Step 2: An adjustment ratio estimated from the attribute-adjusted volume (12.5cm+) and the NVAF-corrected Phase II volume is calculated and this ratio is used to correct the model bias in the attribute-adjusted volume.
- Step 2b: An adjustment ratio estimated from the attribute-adjusted Lorey height (12.5cm+) and the Phase II Lorey height is calculated and this ratio is used to correct the model bias in the attribute-adjusted Lorey height.

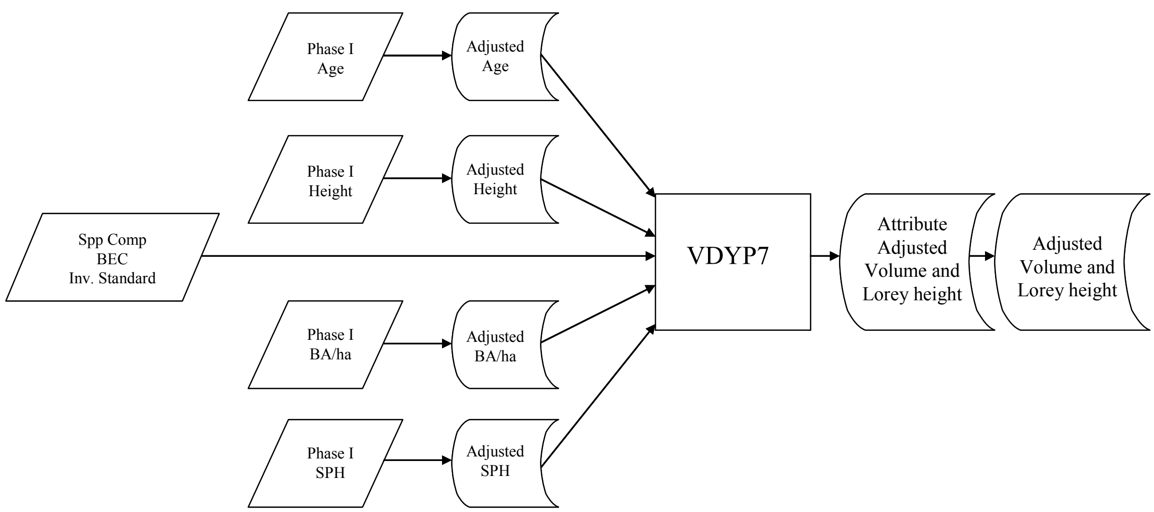

Figure 4. Interim procedures for adjustment of baseline VRI timber attributes.

[15] Ministry of Forests and Range. 2008. *Vegetation Resources Inventory Interim Procedures and Standards for Statistical Adjustment of Baseline VRI Timber Attributes*. Unpublished Report, January 2008. 36 pp.

4.0 RESULTS

4.1 NVAF

The average NVAF ratios for live immature and mature trees were 1.032 and 1.004 respectively (Table 12, Figure 5). The overall NVAF ratio for dead trees was 0.379 based on a sample size of two. This is obviously a small sample and could be improved by increasing the sample size, but it was approved for use by the MFR Volume and Decay Officer. The combined sampling error of all coniferous trees was 5.8% (95% confidence).

Table 12. TFL 47 NVAF ratios.

Live/ Dead	Maturity	Spp	No. Trees	Ratio	95% E%
Live	Immature	All	18	1.032	5.1
	Mature	All	21	1.004	10.3
Dead	All	All	2	0.379	352.9
All	*All*	*All*	*41*	*0.986*	*5.8*

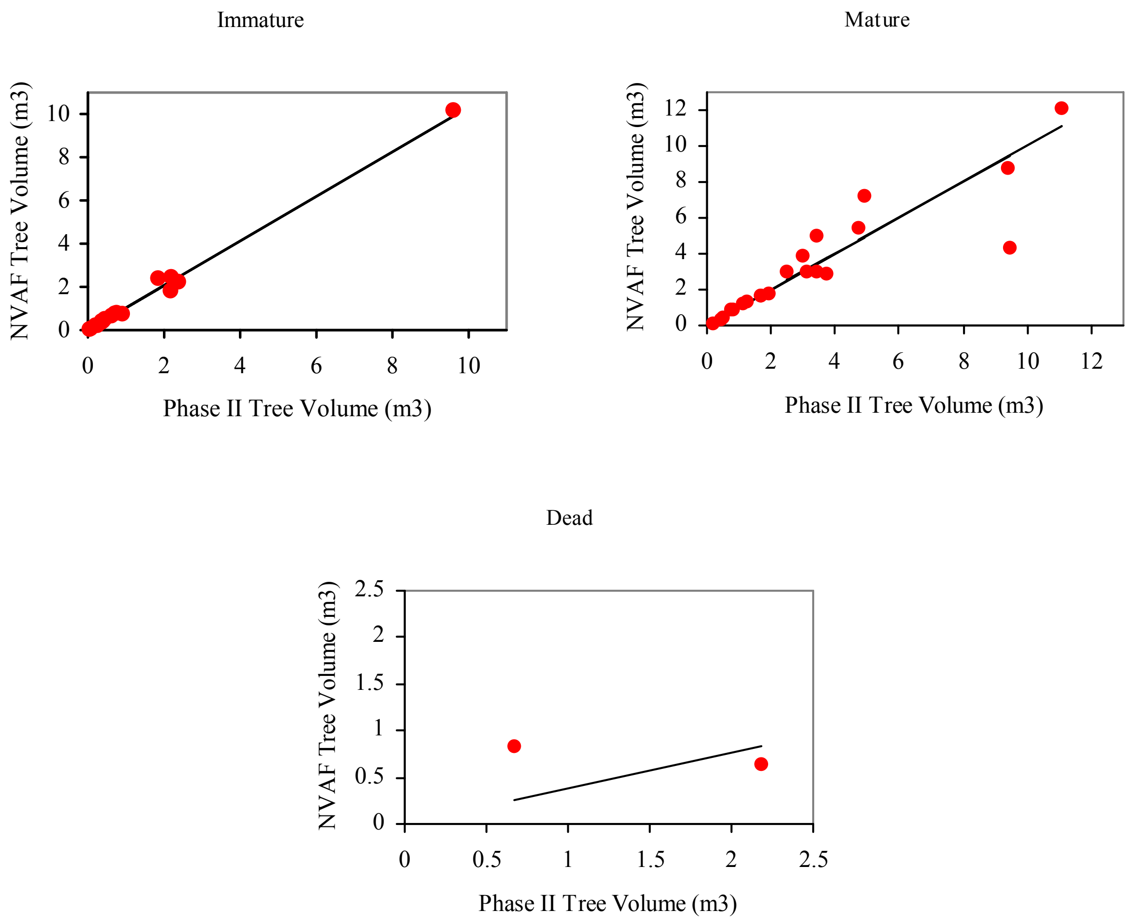

Figure 5. TFL 47 NVAF scatter plots.

4.2 Height

Two (2) plots[16] had no ground height observations, leaving 67 plots for height analysis. Overall, heights decreased by approximately 1% (Table 13, Figure 6) post-adjustment. The sampling error is relatively low at approximately ±6% (95% probability). The adjustment ratio was lowest (i.e., greatest decrease) in the "Other ≤ 100yrs" stratum at 0.910. Conversely, the adjustment ratio was highest (greatest increase) in the "Other > 100yrs" stratum at 1.130.

Table 13. Height adjustment statistics.

Stratum	Area (ha)	Pop. Avg. (m)	Sample Size	Sample Phase I Avg. (m)	Sample Phase II Avg. (m)	ROM	Predicted Avg. (m)	Error (m)	Error (%)
H ≤ 100yrs	40,643	26.6	24	26.4	25.6	0.969	25.7	1.7	6.4
Other ≤ 100yrs	17,295	26.0	16	28.3	25.7	0.910	23.6	3.5	14.7
H > 100yrs	17,063	33.1	17	30.8	30.4	0.989	32.7	5.4	16.4
Other > 100yrs	13,277	28.6	10	29.8	33.7	1.130	32.3	5.4	16.8
Total	*88,278*	*28.0*	*67*	*28.1*	*27.8*	*0.987*	*27.7*	*1.6*	*5.6*

Note: ROM is the ratio of means, error is the absolute 95% sampling error, and % error is the error relative to the predicted avg.

4.3 Age

One (1) plot[17] had no ground age observation, and 1 plot[18] was identified as an age outlier, and removed from the analysis. This left 67 plots for analysis. The potential outlier in the "Other ≤ 100" stratum (Phase II age was 514 years) was reviewed and it was confirmed that this sample was in an old growth stand. Overall, ages increased by approximately 39% post-adjustment (Table 14, Figure 7). The sampling error was large (approximately ±17%), mainly due to the age estimation in the "Other" strata. The adjustment ratio was highest (i.e., greatest increase) in the "Other > 100yrs" stratum at 1.671. Conversely, the adjustment ratio was lowest (i.e. smallest increase) in the "H ≤ 100yrs" stratum at 1.201.

[16] Sample 0055 did not have any site trees of the leading species (Yc) that had suitable height observations. Sample 0082 did not have any site trees corresponding to the leading species in the plot (Cw).

[17] Sample 0082 did not have any site trees corresponding to the leading species in the plot (Cw).

[18] Some ages in Sample 0021 for the leading species (Hw) were prorated ages, bringing the average total age for Hw to 2610 yrs.

Table 14. Age adjustment statistics.

Stratum	Area (ha)	Pop. Avg. (yrs)	Sample Size	Sample Phase I Avg. (yrs)	Sample Phase II Avg. (yrs)	ROM	Predicted Avg. (yrs)	Error (yrs)	Error (%)
H ≤ 100yrs	40,643	59	24	60	73	1.201	71	11	15.2
Other ≤ 100yrs	17,295	65	16	67	99	1.488	96	62	64.1
H > 100yrs	17,063	242	17	260	331	1.272	308	83	26.9
Other > 100yrs	13,277	229	10	207	346	1.671	382	150	39.3
Total	*88,278*	*121*	*67*	*122*	*169*	*1.392*	*168*	*28*	*16.6*

Note: ROM is the ratio of means, error is the absolute 95% sampling error, and % error is the error relative to the predicted avg.

4.4 Basal Area

All 69 observations were used for the basal area analysis. Overall, basal area increased by approximately 31% (Table 15, Figure 8) post-adjustment with a sampling error of ±9.4% (95% probability). The adjustment ratio was highest (i.e., greatest increase) in the “Other > 100yrs” stratum at 1.580. Conversely, the adjustment ratio was lowest (i.e., smallest increase) in the “Other ≤ 100yrs” stratum at 1.161.

Table 15. Basal area adjustment statistics.

Stratum	Area (ha)	Pop. Avg. (m^2/ha)	Sample Size	Sample Phase I Avg. (m^2/ha)	Sample Phase II Avg. (m^2/ha)	ROM	Predicted Avg. (m^2/ha)	Error (m^2/ha)	Error (%)
H ≤ 100yrs	40,643	48.2	24	46.6	59.9	1.286	61.9	8.8	14.3
Other ≤ 100yrs	17,295	41.0	16	42.5	49.4	1.161	47.6	11.7	24.5
H > 100yrs	17,063	52.0	19	58.2	77.3	1.328	69.0	13.3	19.3
Other > 100yrs	13,277	40.6	10	46.6	73.7	1.580	64.2	19.2	30.0
Total	*88,278*	*46.4*	*69*	*48.0*	*63.3*	*1.312*	*60.8*	*5.7*	*9.4*

Note: ROM is the ratio of means, error is the absolute 95% sampling error, and % error is the error relative to the predicted avg.

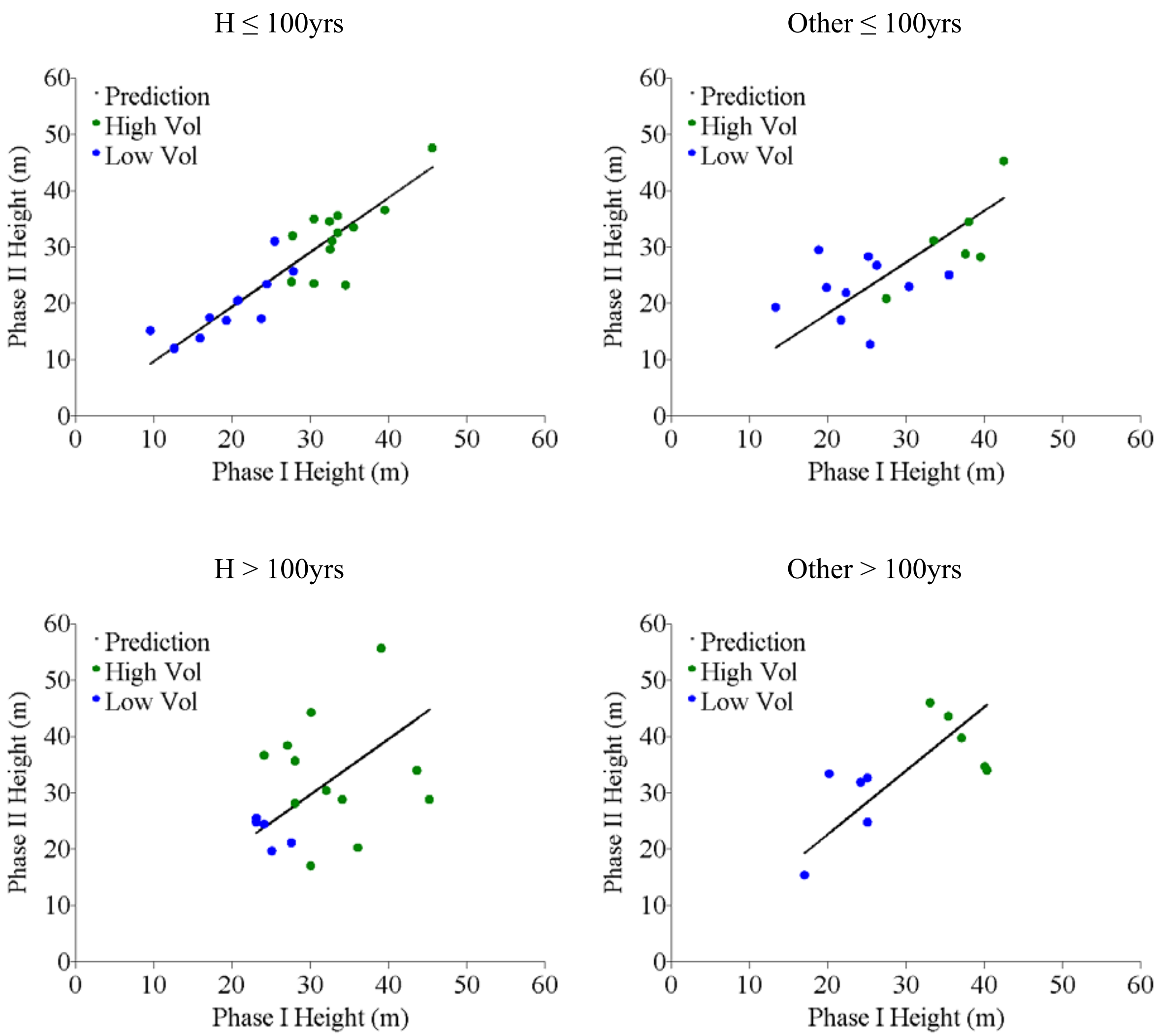

Figure 6. Height scatter plots by stratum.

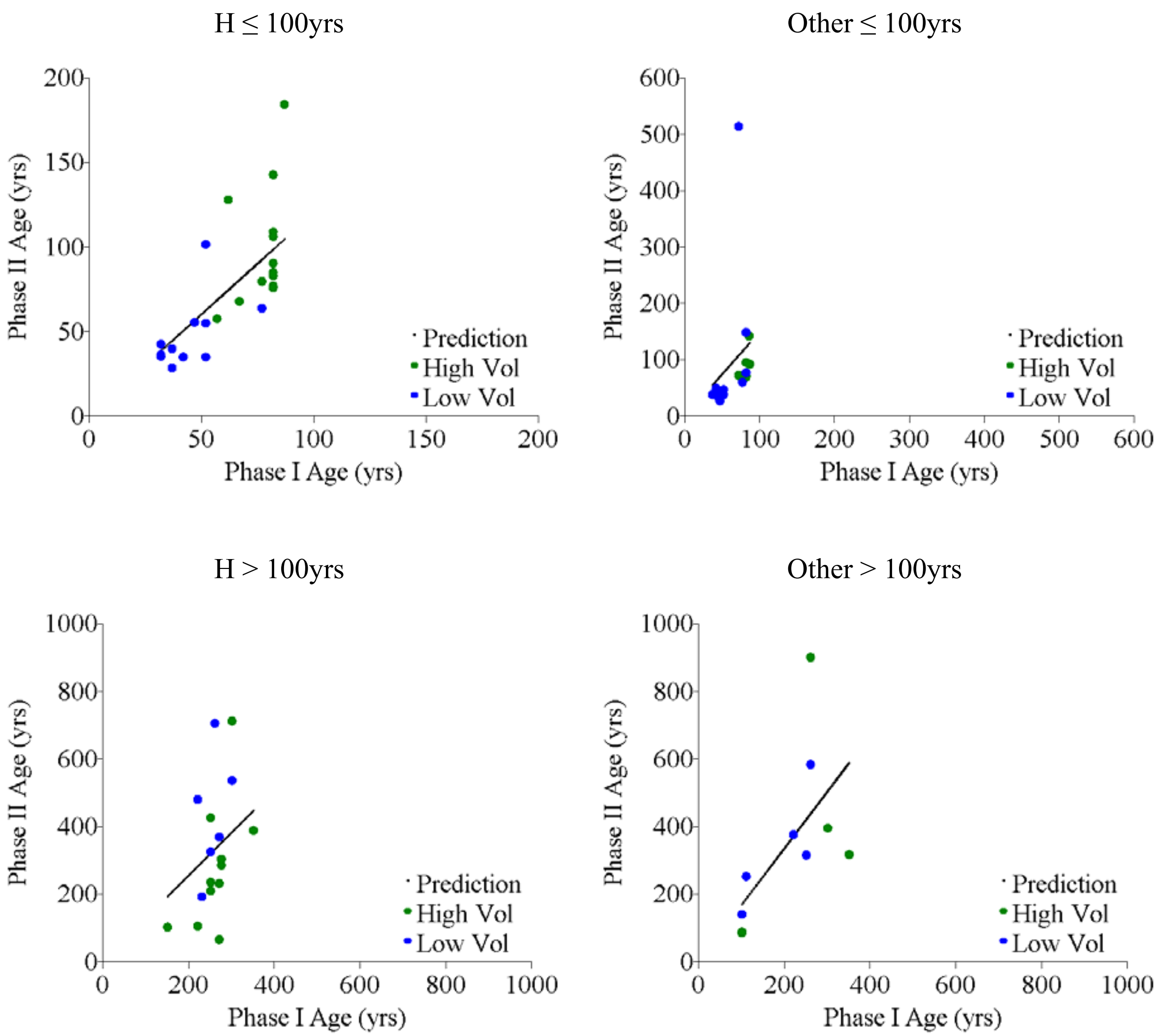

Figure 7. Age scatter plots by stratum.

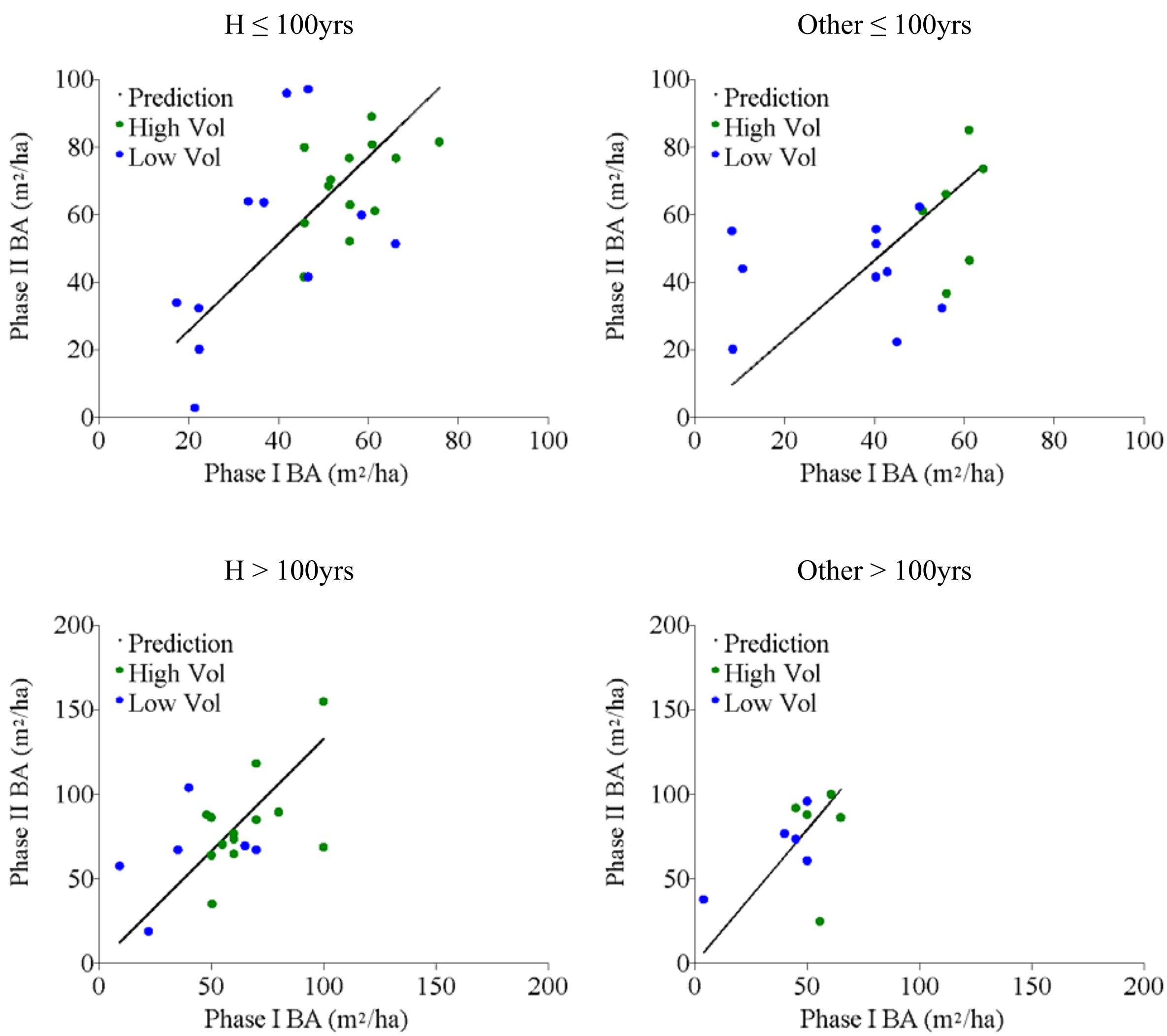

Figure 8. Basal area scatter plots by stratum.

4.5 Stem Per Hectare

All 69 observations were used for the stems per hectare analysis. The potential outlier in the "H > 100 years" stratum was reviewed (Phase II stems per ha estimate of 3,305). Two small trees (13.6 cm and 17.5 cm dbh) were selected with a BAF of 16. As a result these two trees contributed to approximately half the total stems per ha estimate. Overall, stems per hectare were approximately doubled (Table 16) with a sampling error of ±21% (95% probability). The adjustment ratio was highest (i.e., greatest increase) in the "H ≤ 100yrs" stratum at 2.320. Conversely, the adjustment ratio was lowest (i.e., smallest increase) in the "Other ≤ 100yrs" stratum at 1.664.

Table 16. Stems per hectare adjustment statistics.

Stratum	Area (ha)	Pop. Avg. (trees/ha)	Sample Size	Sample Phase I Avg. (trees/ha)	Sample Phase II Avg. (trees/ha)	ROM	Predicted Avg. (trees/ha)	Error (trees/ha)	Error (%)
H ≤ 100yrs	40,643	743	24	698	1,620	2.320	1725	496	28.7
Other ≤ 100yrs	17,295	547	16	592	986	1.664	910	531	58.3
H > 100yrs	17,063	416	19	423	845	1.996	831	411	49.5
Other > 100yrs	13,277	363	10	368	783	2.130	773	310	40.1
Total	*88,278*	*585*	*69*	*575*	*1220*	*2.137*	*1249*	*256*	*20.5*

Note: ROM is the ratio of means, error is the absolute 95% sampling error, and % error is the error relative to the predicted avg.

4.6 Site Index

Site index is not directly adjusted in the VRI standard statistical adjustment. Instead, an adjusted site index is derived from adjusted height and age. The overall inventory-site-index decreased by approximately 3.4 m after adjustment (15.6%; Table 17). The largest decrease was in the "Other ≤ 100 yrs" stratum at 6.4 m. This is consistent with the height in this stratum decreasing and the age increasing.

Table 17. Site index change after adjustment.

Stratum	Area (ha)	Phase I SI (m)	Adjusted SI (m)	Difference (m)	Difference (%)
H ≤ 100yrs	40,643	26.3	22.4	-3.9	-14.7%
Other ≤ 100yrs	17,295	25.1	18.7	-6.4	-25.5%
H > 100yrs	17,063	14.0	12.4	-1.6	-11.6%
Other > 100yrs	13,277	14.6	14.0	-0.5	-3.8%
Total	*88,278*	*21.9*	*18.5*	*-3.4*	*-15.6%*

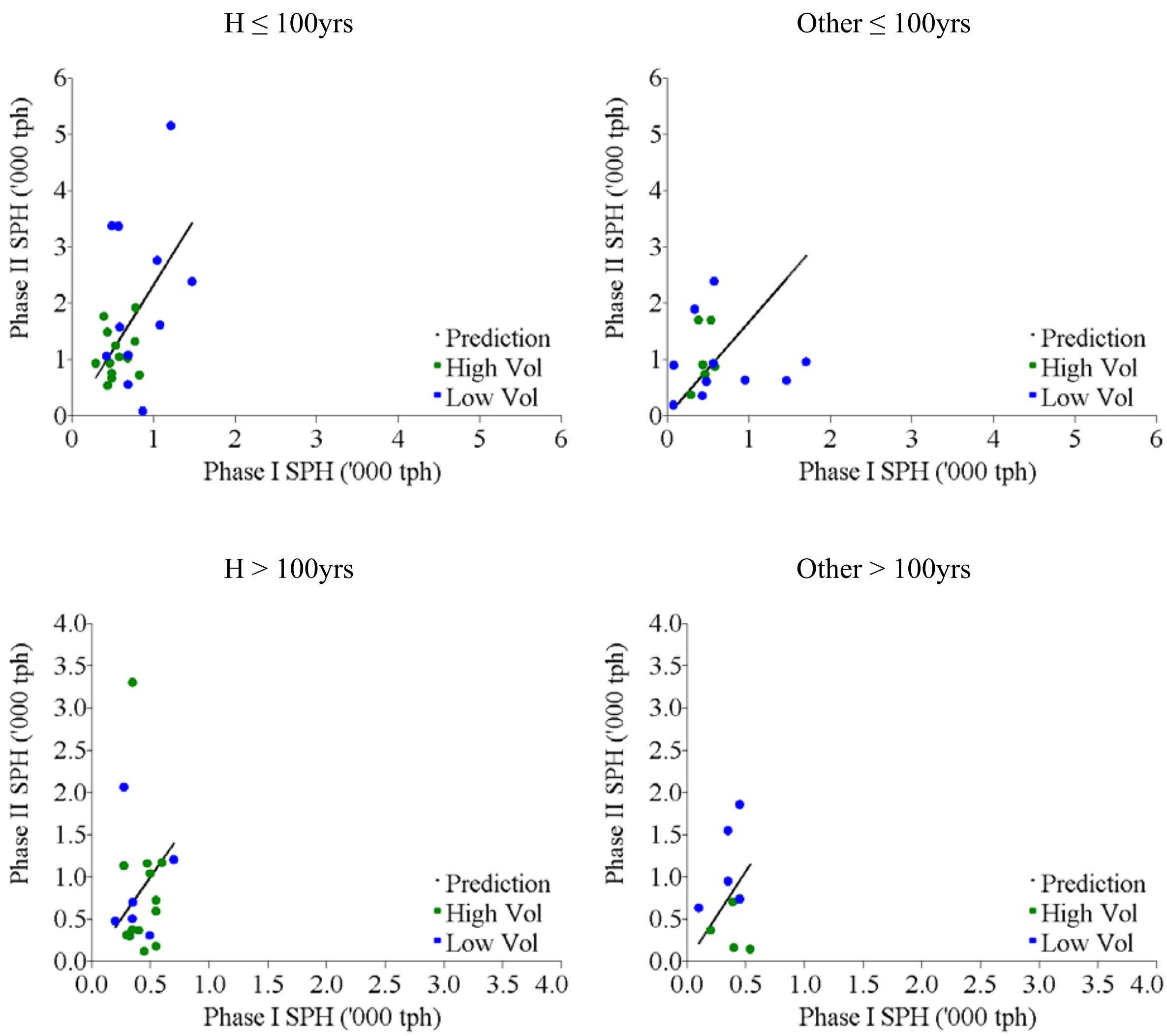

Figure 9. Stems per hectare (> 7.5 cm dbh) scatter plots by stratum.

4.7 Lorey Height

All 69 plots were used to compute the Lorey height adjustment ratio. Overall, the attribute-adjusted Lorey height stayed approximately the same (Table 18, Figure 10) post-adjustment with a sampling error of ±5% (95% probability). Before attribute-adjustment, the average Lorey height for the target population was 25.4 m. Therefore, the adjusted average Lorey height actually represents a 3% decrease over the original average Lorey height (from 25.4 to 24.6 m).

Table 18. Lorey height adjustment statistics.

Stratum	Area (ha)	AA[19] Pop. Avg. (m)	Sample Size	Sample AA[19] Phase I Avg. (m)	Sample Phase II Avg. (m)	ROM	Predicted Avg. (m)	Error (m)	Error (%)
H ≤ 100yrs	40,643	22.7	24	22.8	22.5	0.987	22.4	1.7	7.8
Other ≤ 100yrs	17,295	21.0	16	23.5	25.3	1.078	22.6	2.2	9.8
H > 100yrs	17,063	28.5	19	27.3	27.5	1.004	28.7	3.1	11
Other > 100yrs	13,277	29.2	10	30.8	30.0	0.974	28.4	5.6	19.8
Total	*88,278*	*24.5*	*69*	*25.0*	*25.1*	*1.004*	*24.6*	*1.3*	*5.2*

Note: ROM is the ratio of means, error is the absolute 95% sampling error, and % error is the error relative to the predicted avg.

4.8 Live Net Merchantable Volume

4.8.1 Volume 12.5 cm+

All 69 plots were used to compute the volume adjustment ratio. Overall, the attribute-adjusted volume stayed approximately the same (Table 19, Figure 11) post-adjustment with a sampling error of ±11% (95% probability). Before attribute-adjustment, the average volume for the target population was 389 m^3/ha. Therefore, the adjusted average volume actually represents a 32% increase over the original average volume (from 389 to 512 m^3/ha).

Table 19. Volume 12.5 cm+ adjustment statistics.

Stratum	Area (ha)	AA[19] Pop. Avg. (m^3/ha)	Sample Size	Sample AA[19] Phase I Avg. (m^3/ha)	Sample Phase II Avg. (m^3/ha)	ROM	Predicted Avg. (m^3/ha)	Error (m^3/ha)	Error (%)
H ≤ 100yrs	40,643	497	24	485	469	0.965	480	76	15.9
Other ≤ 100yrs	17,295	345	16	398	410	1.029	354	118	33.4
H > 100yrs	17,063	597	19	605	674	1.114	664	112	16.8
Other > 100yrs	13,277	575	10	707	760	1.076	619	264	42.5
Total	*88,278*	*498*	*69*	*525*	*541*	*1.027*	*512*	*57*	*11.2*

Note: ROM is the ratio of means, error is the absolute 95% sampling error, and % error is the error relative to the predicted avg.

[19] AA = attribute adjusted

4.8.2 Volume 17.5 cm +

Although not a standard adjustment, volume was also adjusted for a utilization limit of 17.5 cm+ as this is the standard utilization used for timber supply on the coast. Adjustment results for this utilization limit are similar to those for the 12.5 cm+ utilization limit (Table 20, Figure 12).

Table 20. Volume 17.5 cm+ adjustment statistics.

Stratum	Area (ha)	AA[19] Pop. Avg. (m^3/ha)	Sample Size	Sample AA[19] Phase I Avg. (m^3/ha)	Sample Phase II Avg. (m^3/ha)	ROM	Predicted Avg. (m^3/ha)	Error (m^3/ha)	Error (%)
H ≤ 100yrs	40,643	466	24	458	436	0.953	444	69	15.6
Other ≤ 100yrs	17,295	334	16	382	385	1.007	336	115	34.2
H > 100yrs	17,063	590	19	600	666	1.111	655	112	17.1
Other > 100yrs	13,277	568	10	701	757	1.080	613	261	42.6
Total	*88,278*	*479*	*69*	*507*	*519*	*1.021*	*489*	*55*	*11.2*

Note: ROM is the ratio of means, error is the absolute 95% sampling error, and % error is the error relative to the predicted avg.

4.9 Forest Health

The occurrence of pest[20] and damage agents are summarized and expressed as a percent of the total number of stems[21] affected by species groups[22] (standardized to SPH) (Table 21).

Table 21. Pest incidence as a percentage of all measured trees.

Damage Agent	Species Group							
	H	C	Fdc	B	P	S	Deciduous	Other
Animal	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Stem Rot	0.7	0.0	0.6	1.2	0.0	0.0	0.0	0.0
Mistletoe	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stem Disease	0.0	0.0	0.0	0.0	23.6	0.0	0.0	0.0
Abiotic	4.6	4.0	0.7	2.4	0.0	0.0	9.6	0.0
Treatment	1.5	0.1	0.6	0.0	0.0	0.0	0.0	0.0
Other	39.4	34.1	36.9	8.4	47.8	75.0	51.4	3.3

[20] Some pest codes were grouped. Pest codes for each "pest" are as follows: Animal = AX; Stem Rot = DD & DDF; Mistletoe = DMH; Stem Disease = DSB; Abiotic = N, NB, NGC, NW, NWS, NWT & NX; Treatment = TT, TL & TM; Other = U.

[21] An individual stem may have more than one pest.

[22] "Species Groups" are defined as follows: H = H, Hw & Hm; C = Yc & Cw; Fdc = Fdc & Fd; B = Ba & Bl; P = Pl, Plc & Pw; S = S & Ss; Deciduous = Dr, Mb & Kc; Other = Xh & Xc.

The key results from the VRI target population are that:

1. Unidentified pests ('U' or 'D') have the greatest prevalence among all species, followed by abiotic damage;
2. Mistletoe was prevalent in 5.9% of all hemlock stems; and
3. 23.6% of pines had stem disease.

Forest health data provides a broad indication of the occurrence of forest health indicators on the landbase. Each sample is a random point (not weighted by strata areas) within the target population and together the samples cover a range of variability in the TFL.

The associated incidence of damage indicators[23] is generally related to the pest incidence.[24] The most significant findings for damage indicators on TFL 47 from the tree data is that (Table 22):

1. Broken Tops are observed at a rate of 3 – 54% of all trees of all species; and
2. Scarring, dead tops, and forks are present in most species.

Table 22. Damage incidence as a percentage of all measured trees**.**

Damage Indicator	Species Group							
	H	C	Fdc	B	P	S	Deciduous	Other
Broken Top	8.8	7.0	7.3	3.4	18.1	54.3	21.3	3.3
Conk	0.0	0.0	0.2	0.5	0.0	0.0	0.0	0.0
Crook	13.3	2.0	4.8	3.5	0.0	0.0	17.1	0.0
Decay	0.6	0.0	0.4	0.9	0.0	0.0	0.0	0.0
Dead Top	7.3	11.1	14.6	3.1	43.5	0.0	15.0	3.3
Fork	5.7	4.3	2.3	0.6	5.5	14.2	17.2	0.0
Frost Crack	1.9	0.1	0.0	0.1	0.0	0.0	0.0	0.0
Scar	12.1	9.2	3.3	2.2	0.0	54.3	18.5	0.0
Other	0.1	0.3	0.0	0.2	0.0	0.0	0.0	0.0

[23] Some damage indicators were grouped. Damage indicators are grouped as follows: Broken Top = BTP & BYP; Conk = CNK; Crook = CRO; Decay = BNK, DD, DDF & DDP; Dead Top = DTP; Fork = FRK; Frost Crack = NGC; Scar = SCA & CSA; Other = AFC & SNG.

[24] The damage indicators are not always associated with pests, as the cause of the underlying damage was often recorded as unknown by field crews.

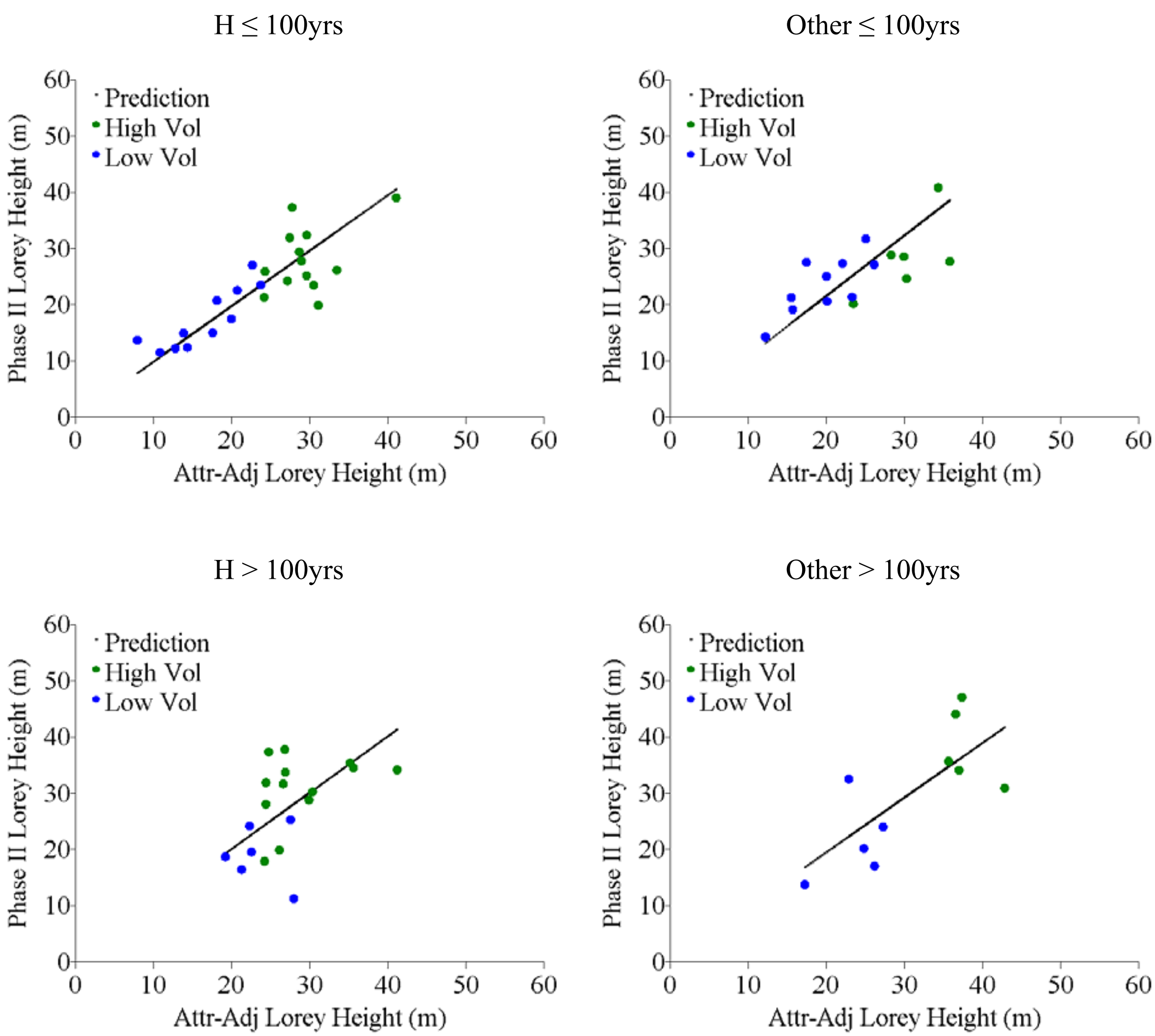

Figure 10. Lorey Height scatter plots by stratum.

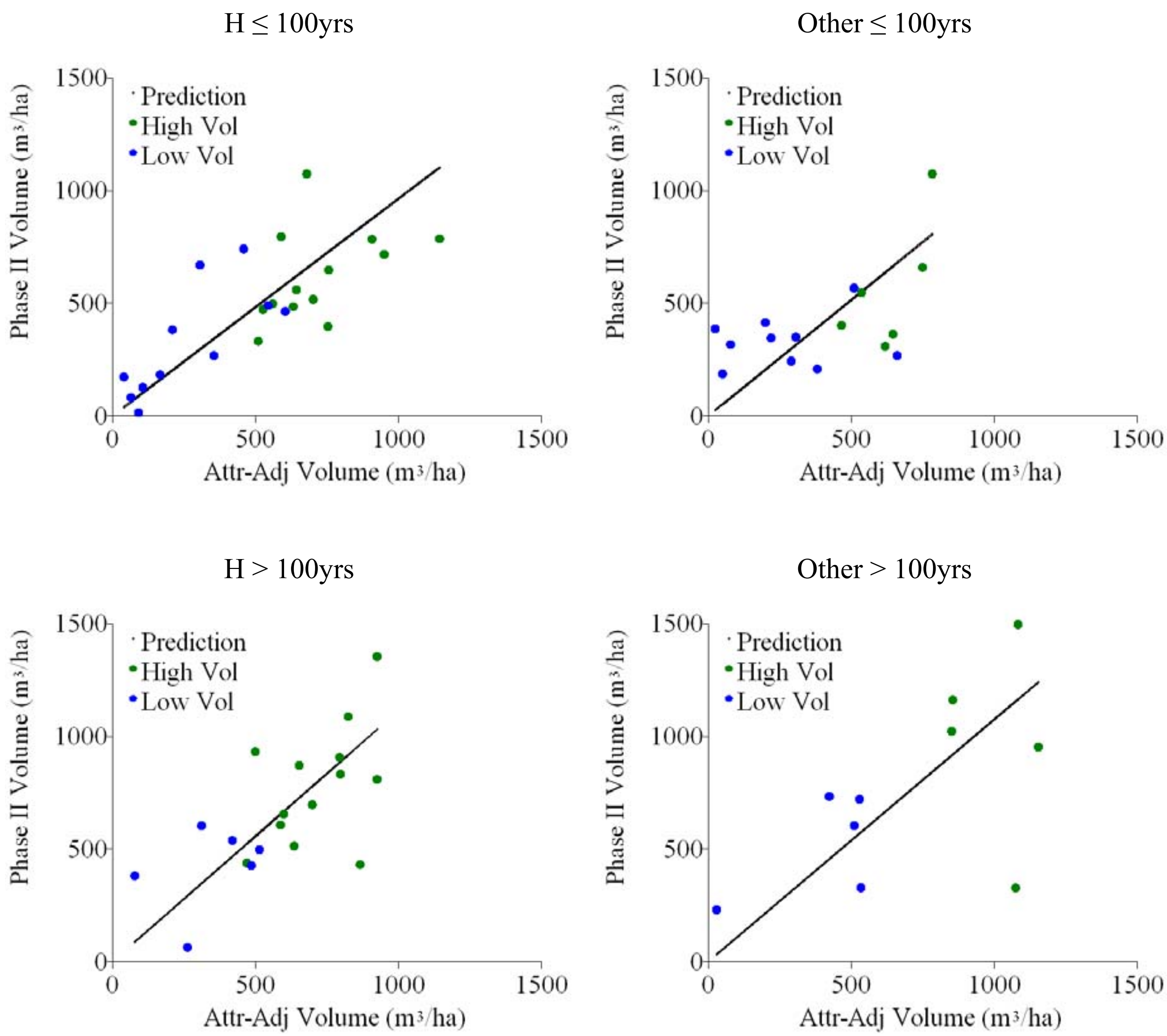

Figure 11. Net merchantable volume (12.5 cm+) scatter plots by stratum.

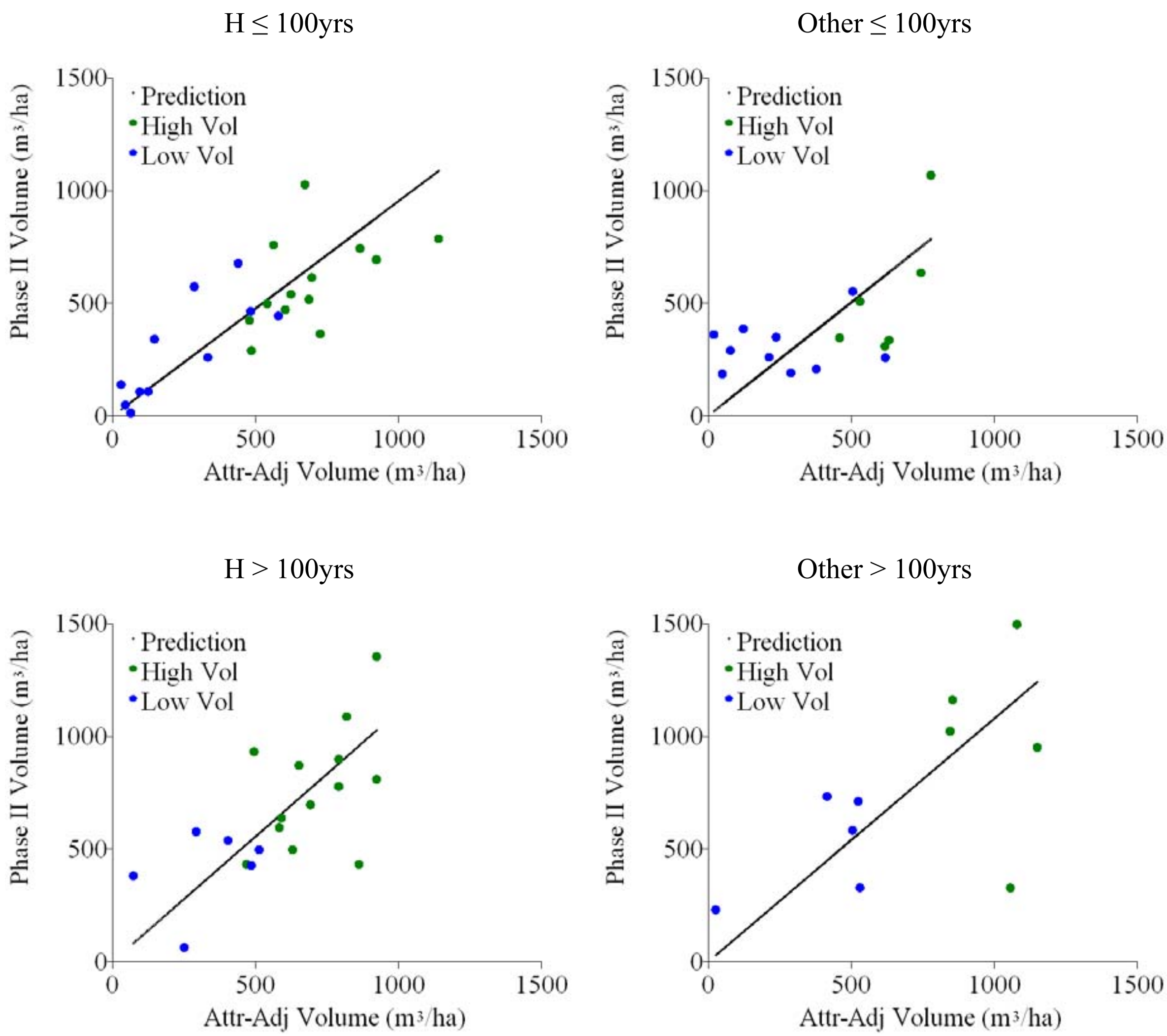

Figure 12. Net merchantable volume (17.5 cm+) scatter plots by stratum.

5.0 DISCUSSION

5.1 Accuracy and Precision

The statistical adjustment provides unbiased estimates for the scale at which the ratios were computed. In the case of TFL 47, unbiased estimates will be at the stratum level. There is always a possibility that local bias exists within a stratum. It would be inappropriate to estimate sub-stratum bias given the small sample size provided at a smaller scale.

The MFR-recommended precision for adjusted average volume at the management unit level is a sampling error of ±10% (95% probability). The overall sampling error achieved in this project was ±11% (95% probability). After the first preliminary analysis, TimberWest modified its sampling targets to maintain cost efficiency, and set a target sampling error of ±25% per stratum in 3 strata. This target has been reached for strata "H ≤ 100yrs" and "H > 100yrs" (15.9% and 16.8%, respectively). However, the sampling error increased in the "Other ≤ 100yrs" stratum, despite adding 4 plots (to 33.4%). Sampling error in this stratum decreased for all attributes, except volume. All four new plots are typed as red alder (Dr) leading in the Phase I inventory. The results suggest that VDYP7 doesn't predict volumes in Dr-leading stands well, or stands are incorrectly labelled.

It should be recognized that a higher sampling error represents uncertainty in the overall volume estimates.

5.2 Impact of Change

5.2.1 Live Volume

The overall live volume (12.5 cm+) increased by approximately 32% following adjustment (Table 23). The overall change in volume is reflective of volume increases in all strata, with the largest increase in the "Other > 100yrs" stratum (90%). There were relatively large increases in SPH and BA in all strata, which is strongly associated with volume estimates derived from VDYP7. The impact of change between the Phase II ground volumes and the attribute-adjusted volume is negligible with an increase in attribute-adjusted volume of approximately 3%, indicating that in general, VDYP7 adequately predicted volume in the target population with the adjusted input attributes. Table 24 shows the difference in volumes when volumes were estimated at 17.5 cm+ utilization.

Table 23. Volume change after adjustment (12.5 cm+).

Stratum	Area (ha)	Phase I	Attribute-Adjusted	Adjusted	Difference	
					(m^3/ha)	(%)
H ≤ 100yrs	40,643	409	497	480	71	17.4%
Other ≤ 100yrs	17,295	334	345	354	20	6.1%
H > 100yrs	17,063	443	597	664	221	50.0%
Other > 100yrs	13,277	326	575	619	293	89.8%
Total	*88,278*	*389*	*498*	*512*	*123*	*31.6%*

Table 24. Volume change after adjustment (17.5 cm+).

Stratum	Area (ha)	Phase I	Attribute-Adjusted	Adjusted	Difference	
					(m^3/ha)	(%)
H ≤ 100yrs	40,643	401	466	431	29.4	7.3%
Other ≤ 100yrs	17,295	329	334	326	-3.5	-1.1%
H > 100yrs	17,063	442	590	653	211.1	47.8%
Other > 100yrs	13,277	324	568	607	283.3	87.5%
Total	*88,278*	*383*	*479*	*480*	*96.3*	*25.1%*

5.2.2 Age

The age adjustment had a considerable impact on the age class distribution (Figure 13). The result was more area in age classes 5, 6, 7 and 9 and less area in age classes 2, 3, 4 and 8. However, the general shape of the age class distribution was maintained, with age classes 6, 7 & 8 having less representation than other age classes. The general trends observed can be attributed to ages increasing over the entire target population. Age class 2 covers the range of 21-50 and this figure only includes area for ages 30 and above as defined in the target population.

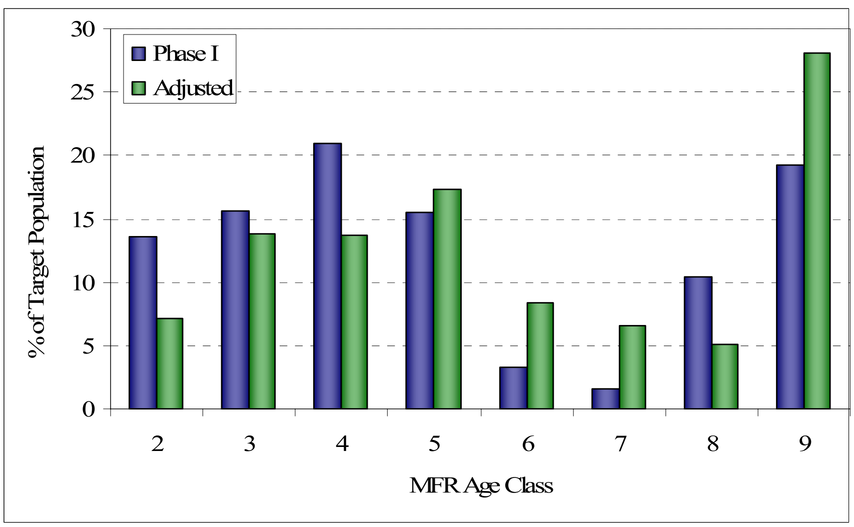

Figure 13. Change in MFR age class.

5.2.3 Lorey Height

The overall Lorey height decreased by about 3% following adjustment (Table 25). The small overall change in Lorey height is reflective of an increase in the "Other > 100yrs" stratum (+8.4%), and decreases in the "H ≤ 100yrs" and "Other ≤ 100yrs" strata (-8.8% & -4.4%, respectively). The impact of change between the Phase II and the attribute-adjusted Lorey height is negligible with an increase in attribute-adjusted Lorey height of less than 1%, indicating that in general, VDYP7 adequately predicted Lorey height in the target population with the adjusted input attributes.

Table 25. Lorey height change after adjustment.

Stratum	Area (ha)	Phase I (m)	Attribute-Adjusted (m)	Adjusted (m)	Difference	
					(m)	(%)
H ≤ 100yrs	40,643	24.6	22.7	22.4	-2.2	-8.8%
Other ≤ 100yrs	17,295	23.6	21.0	22.6	-1.0	-4.4%
H > 100yrs	17,063	28.7	28.5	28.7	0.0	0.0%
Other > 100yrs	13,277	26.2	29.2	28.4	2.2	8.4%
Total	*88,278*	*25.4*	*24.5*	*24.6*	*-0.9*	*-3.4%*

5.3 Risks and Uncertainties

5.3.1 Age Trend

The statistical adjustment removes the bias in each stratum. However, it is possible that an age-related trend exists within each stratum. All residuals were plotted against stand age to detect any age-related trend. None of the residuals had a significant relationship to age. Volume is the most important attribute and had no age correlations.

5.3.2 Residual Trend

In SPH and BA, a significant relationship existed between the residuals and the initial predicted values in some strata. This relationship is particularly noticeable in the "Other ≤ 100yrs" stratum for BA and SPH. MFR standards require attribute adjustment using a ratio of means. The observed trend indicates that perhaps a ratio of means is not the best estimator in this case. However, on average, estimates should be accurate on a stratum-level.

5.3.3 Volume Sampling Errors

While the overall volume sampling error achieved was 11% (95% probability), the sampling error in the "Other ≤ 100 yrs" and "Other > 100 yrs" strata were 33.4% and 42.5% respectively. This uncertainty should be acknowledged in the timber supply process.

6.0 CONCLUSIONS

After adjustment, live, net merchantable volume increased by 3% over the attributed adjusted net merchantable volume and 32% over the initial Phase I volumes. Height and Lorey height were largely unchanged. The biggest adjustment was to SPH with a 114% increase (from 585 to 1249). Basal area also increased by 31% (14.4 m2) and age increased by 39% (47 years). The increase in age resulted in a 16% decrease (3.4 m) in site index.

The overall sampling error volume was ±11% (95% probability); slightly greater than the target sampling error of ±10% (95% probability). This is largely due to the sampling error in the "Other ≤ 100yrs" stratum, where despite increasing the sample size the sampling error increased. The additional plots are typed as red alder (Dr) leading in the Phase I inventory suggesting that either VDYP7 doesn't predict volumes well in Dr-leading stands, or stands are incorrectly labelled.

A main source of uncertainty with this analysis is in the SPH estimations. Phase I SPH was under-estimated by approximately 114% with a sampling error of ±21% (95% probability). It is likely that this high sampling error and under-estimation may be related to the layer estimate of SPH used for comparison. Phase II estimates will include all trees measured within the plot, and may include trees from intermediate or suppressed tree layers.

6.1 Recommendations

A statistical adjustment was completed for TFL 47 using the standard MFR methodology. Unbiased estimates of height, age, and volume were obtained using the VRI statistical adjustment methods. These estimates represent the best available inventory estimates. Therefore, we recommend that:

> *Timberwest use the adjusted estimates of height, age, basal area, stems per hectare, and volume in the timber supply analysis base case.*

The forest health information could provide insight to particular forest health issues with a presence within the TFL. Therefore, we recommend that:

> *Timberwest consider the forest health statistics provided in this report as a starting point for investigating specific forest health issues.*

The new inventory data provides a rich set of information that can be used for a variety of broad scale strategic planning. Therefore, we recommend that:

> *Timberwest use the adjusted inventory for forest management planning*

The residuals analysis exhibited a significant relationship with Phase I predicted values for SPH and BA. Therefore, we recommend that:

> *TimberWest explore other non-standard adjustment methods (e.g. regression) for attributes that showed a significant trend.*

APPENDIX I – PHASE II SAMPLING WEIGHTS & PLOT LOCATIONS

Table 26. Phase II sampling weights and actual plot locations.

Proj.	Plot	Stratum	Sub-stratum	Mapsheet	Poly.	Zone	Easting	Northing	Weight
4701	1	>100 H	Low vol	092L047	70	9	658237	5593134	841
4701	2	≤100 H	High vol	092K042	857	10	305195	5587015	1,503
4701	3	≤100 H	Low vol	092L037	451	9	661120	5576742	1,919
4701	4	≤100 H	High vol	092K041	249	10	721008	5594482	1,503
4701	5	≤100 H	Low vol	092L058	324	9	680266	5599925	1,919
4701	6	≤100 H	High vol	092K043	377	10	317308	5589723	1,503
4701	7	≤100 H	Low vol	092K033	44	10	323627	5585265	1,919
4701	8	>100 H	Low vol	092L047	261	9	661163	5587815	841
4701	9	≤100 Others	High vol	092K024	20	10	331561	5573841	1,004
4701	10	≤100 H	Low vol	092K043	567	10	327637	5595303	1,919
4701	11	>100 H	High vol	092K042	281	10	307767	5593712	924
4701	12	≤100 Others	Low vol	092L060	42	9	712508	5599436	1,127
4701	13	≤100 H	High vol	092K033	278	10	323339	5582976	1,503
4701	14	≤100 Others	Low vol	092K043	130	10	323085	5596489	1,127
4701	15	>100 Others	Low vol	092L037	244	9	666449	5584451	1,319
4701	16	>100 H	High vol	092K041	507	10	298799	5592160	924
4701	17	≤100 Others	High vol	092K014	383	10	338809	5555447	1,004
4701	18	≤100 Others	High vol	092K044	8	10	332717	5589894	1,004
4701	19	>100 H	High vol	092K044	163	10	339058	5588555	924
4701	20	≤100 H	Low vol	092K014	25	10	335322	5563088	1,919
4701	21	>100 H	High vol	092L036	47	9	653929	5585043	924
4701	22	≤100 H	High vol	092K043	23	10	318151	5595690	1,503
4701	23	≤100 H	High vol	092K042	560	10	302041	5590644	1,503
4701	24	≤100 H	High vol	092K041	98	10	290435	5595515	1,503
4701	25	>100 Others	High vol	092L047	331	9	664498	5590082	1,336
4701	26	≤100 H	Low vol	092K051	286	10	290084	5606441	1,919
4701	27	≤100 Others	Low vol	092L037	173	9	669515	5574480	1,127
4701	28	≤100 H	High vol	092K043	78	10	321147	5595568	1,503
4701	29	≤100 H	High vol	092K024	272	10	335361	5571386	1,503
4701	30	≤100 H	High vol	092K052	226	10	310161	5601015	1,503
4701	31	>100 H	High vol	092K053	88	10	316441	5600361	924
4701	32	>100 H	High vol	092L047	423	9	665451	5585811	924

Proj.	Plot	Stratum	Sub-stratum	Mapsheet	Poly.	Zone	Easting	Northing	Weight
4701	33	>100 H	Low vol	092L047	213	9	663449	5593138	841
4701	34	≤100 H	High vol	092K041	31	10	290212	5597425	1,503
4701	35	>100 Others	Low vol	092K042	707	10	313716	5587678	1,319
4701	36	≤100 Others	Low vol	092K014	480	10	338598	5555156	1,127
4701	37	>100 H	High vol	092K042	292	10	309110	5594758	924
4701	38	>100 H	Low vol	092K034	143	10	342685	5581798	841
4701	39	≤100 Others	High vol	092K043	280	10	323509	5592171	1,004
4701	40	>100 Others	High vol	092K051	252	10	294922	5605037	1,336
4701	41	≤100 H	Low vol	092K024	98	10	335302	5572388	1,919
4701	42	≤100 H	Low vol	092K034	321	10	339047	5580835	1,919
4701	43	>100 Others	High vol	092L037	280	9	657054	5581078	1,336
4701	44	≤100 H	High vol	092K052	216	10	311481	5601358	1,503
4701	46	>100 Others	High vol	092K043	77	10	321218	5595099	1,336
4701	47	>100 H	High vol	092K042	281	10	307508	5593652	924
4701	48	≤100 H	High vol	092K014	186	10	763519	5562070	1,503
4701	49	≤100 Others	Low vol	092K024	59	10	332195	5572215	1,127
4701	50	>100 Others	Low vol	092K053	202	10	325178	5597853	1,319
4701	51	≤100 H	Low vol	092K033	103	10	329377	5584030	1,919
4701	52	>100 Others	Low vol	092K042	637	10	305205	5589722	1,319
4701	53	≤100 H	Low vol	092K043	370	10	315983	5589375	1,919
4701	54	>100 Others	Low vol	092K034	368	10	343049	5580973	1,319
4701	55	>100 H	Low vol	092L047	71	9	658715	5594042	841
4701	56	>100 H	High vol	092L027	132	9	665943	5573838	924
4701	57	≤100 H	Low vol	092K061	41	10	297202	5609447	1,919
4701	58	>100 Others	High vol	092L037	311	9	656854	5578367	1,336
4701	59	≤100 Others	Low vol	092K033	39	10	321818	5585039	1,127
4701	60	≤100 Others	High vol	092K041	33	10	294922	5605037	1,004
4701	62	≤100 Others	Low vol	092K035	63	10	344659	5578805	1,127
4701	65	>100 H	High vol	092L037	22	9	665787	5577921	924
4701	69	≤100 Others	Low vol	092K052	120	10	306377	5601166	1,127
4701	70	≤100 Others	Low vol	092L046	167	9	647847	5596096	1,127
4701	74	>100 H	High vol	092K033	151	10	327608	5584395	924
4701	79	≤100 Others	Low vol	092K043	150	10	324829	5594807	1,127
4701	82	>100 H	High vol	092K034	328	10	339735	5580908	924
4701	92	>100 H	High vol	092L046	101	9	654489	5594571	924
4701	97	≤100 Others	High vol	092K061	48	10	299402	5609264	1,004
4701	98	>100 H	Low vol	092K034	310	10	338267	5581364	841

APPENDIX II – PHASE I & II DATA

Table 27. Phase I data from sampled polygons.

Sample	Map ID	Polygon ID	Phase I Area (ha)	Spp1	Ht1 (m)	Age1 (yrs)	SI1 (m)	SPH 7.5 (trees/ha)	BA 7.5 (m^2/ha)	Spp2	Ht2 (m)	Age2 (yrs)	SI2 (m)	Lorey height (m)	Vol. 12.5 (m^3/ha)	Vol. 17.5 (m^3/ha)	A.A. Lorey height (m)	A.A. Vol. 12.5 (m^3/ha)	A.A. Vol. 17.5 (m^3/ha)
1	092L047	70	18.5	Hm	36.2	302	9.6	495	35.2	Yc	23.1	262	10.9	22.5	238	234	27.6	420	405
2	092K042	857	17.9	Hw	45.6	82	35.4	294	66.2	Fdc	45.6	87	35.2	43.9	887	886	41.1	1144	1141
3	092L037	451	24.4	Hw	24.5	32	37.2	1081	58.5	Ba	26.6	32	40.2	22.7	472	459	20.7	545	484
4	092K041	249	9.9	Hw	32.8	62	32.5	436	51.6	Cw	32.8	62	31.2	33.9	534	532	30.5	644	625
5	092L058	324	22.0	Hw	17.2	32	28.0	869	21.4	Cw	12.9	32	23.5	15.1	99	84	13.9	92	64
6	092K043	377	66.0	Hw	39.6	82	30.4	582	60.9	Ba	39.5	82	30.7	36.4	773	771	33.5	951	923
7	092K033	44	52.1	Hw	20.7	52	22.0	1475	36.7	Cw	20.7	52	23.1	18.9	216	181	17.6	210	147
8	092L047	261	40.7	Hm	27.6	222	7.7	200	9.2	Yc	17.0	202	8.9	16.8	46	44	21.3	79	74
9	092K024	20	25.2	Fdc	42.5	87	33.2	465	61.1	Hw	40.5	87	30.1	39.1	757	756	34.3	783	779
10	092K043	567	45.0	Hw	19.3	32	31.1	1216	33.3	Cw	12.9	32	23.5	15.5	162	143	14.4	167	126
11	092K042	281	49.8	Hw	28.1	277	11.1	549	100.0	Ba	28.0	292	9.7	25.8	719	719	24.4	926	924
12	092L060	42	14.4	Dr	23.3	52	23.3	339	40.4	Hw	21.7	52	23.1	22.4	277	276	20.1	291	289
13	092K033	278	10.0	Hw	32.5	87	23.8	828	75.8	Fdc	36.3	92	27.8	30.2	741	735	27.8	908	866
14	092K043	130	19.5	Dr	19.3	42	20.6	1704	40.4	Hw	18.9	42	24.3	17.2	221	173	15.7	200	123
15	092L037	244	34.1	Yc	17.0	262	8.2	100	4.0	Hw	19.9	302	7.6	16.3	19	18	17.3	30	27
16	092K041	507	33.9	Hw	36.1	272	14.9	349	50.1	Yc	33.1	302	14.8	32.1	454	454	30.4	588	584
17	092K014	383	12.2	Fdc	37.6	72	32.5	291	56.0	Hw	35.7	72	29.6	33.5	577	577	30.3	619	618
18	092K044	8	21.1	Fdc	30.4	82	24.7	539	55.9	Hw	27.5	82	20.7	26.5	448	445	23.5	467	460
19	092K044	163	26.6	Hw	28.1	202	12.7	325	70.1	Cw	30.1	252	14.3	27.6	480	479	26.8	654	653
20	092K014	25	8.8	Hw	20.8	47	24.2	575	41.8	Fdc	21.6	47	25.9	19.9	254	250	18.1	307	287
21	092L036	47	13.1	Hw	39.1	302	15.8	349	55.0	Ba	41.2	302	15.4	37.0	617	617	35.2	795	792
22	092K043	23	88.7	Hw	35.5	82	27.0	775	55.8	Cw	33.6	82	26.3	32.3	622	612	29.6	756	698
23	092K042	560	36.9	Hw	27.6	67	24.1	783	51.2	Fdc	30.5	67	27.8	26.4	438	428	24.2	527	480
24	092K041	98	48.6	Hw	30.5	82	23.1	393	60.7	Fdc	33.5	82	27.2	29.4	532	531	27.4	680	673

			Phase I																	
Sample	Map ID	Polygon ID	Area (ha)	Spp1	Ht1 (m)	Age1 (yrs)	SI1 (m)	SPH 7.5 (trees/ha)	BA 7.5 (m^2/ha)	Spp2	Ht2 (m)	Age2 (yrs)	SI2 (m)	Lorey height (m)	Vol. 12.5 (m^3/ha)	Vol. 17.5 (m^3/ha)	A.A. Lorey height (m)	A.A. Vol. 12.5 (m^3/ha)	A.A. Vol. 17.5 (m^3/ha)
25	092L047	331	21.4	Ba	37.1	262	14.4	449	65.0	Hw	35.1	302	13.9	33.2	691	690	35.7	1155	1151
26	092K051	286	183.7	Hw	9.6	37	14.7	588	17.4	Cw	6.4	37	10.2	8.7	40	36	7.9	40	31
27	092L037	173	4.5	Ba	13.3	72	11.8	567	8.3	Hw	18.0	152	9.2	14.0	29	25	12.2	25	20
28	092K043	78	9.9	Hw	34.5	82	26.2	538	55.8	Fdc	38.6	82	30.9	33.9	606	602	31.1	754	727
29	092K024	272	46.8	Hw	27.8	57	27.0	686	61.5	Fdc	29.7	57	30.1	26.4	512	507	24.3	633	604
30	092K052	226	17.3	Hw	33.5	82	25.4	489	45.7	Fdc	37.5	82	30.1	32.1	474	470	29.6	591	564
31	092K053	88	7.8	Hw	45.2	152	25.1	298	50.4	Cw	42.1	232	20.7	43.0	648	648	41.2	866	862
32	092L047	423	11.8	Hw	32.1	352	11.9	400	48.0	Yc	29.0	302	13.0	28.4	381	381	26.9	500	496
33	092L047	213	14.0	Hm	23.1	272	8.4	699	40.0	Ba	23.0	272	8.1	19.8	243	237	19.2	312	293
34	092K041	31	12.4	Hw	30.5	82	23.1	489	45.7	Cw	35.2	152	20.0	29.7	415	412	27.2	510	487
35	092K042	707	48.4	Fdc	26.1	252	14.5	449	45.0	Hw	24.2	112	14.8	22.8	292	290	24.8	512	505
36	092K014	480	4.9	Fdc	22.4	77	19.0	77	8.5	Pl	16.2	77	13.3	19.7	48	48	17.5	50	50
37	092K042	292	57.3	Hw	30.1	272	12.1	474	60.0	Ba	30.0	272	10.9	27.5	494	493	26.1	636	631
38	092K034	143	6.3	Hw	24.1	202	10.8	350	70.1	Cw	24.1	252	11.5	23.0	370	370	22.3	514	514
39	092K043	280	13.8	Fdc	39.6	82	31.6	586	61.2	Cw	35.6	82	27.9	34.0	621	616	29.9	646	633
40	092K051	252	15.4	Fdc	38.4	102	27.9	391	60.7	Hw	35.4	102	23.6	34.3	616	615	36.6	1084	1080
41	092K024	98	15.3	Hw	13.8	37	20.4	426	22.4	Fdc	15.9	37	23.7	13.7	88	84	12.8	107	96
42	092K034	321	24.5	Hw	12.6	42	16.9	1047	22.3	Cw	11.6	42	16.1	11.7	71	58	10.8	65	45
43	092L037	280	16.9	Ba	33.1	302	11.6	399	50.0	Hm	42.9	302	13.0	30.2	458	457	37.4	852	846
44	092K052	216	19.6	Hw	33.5	82	25.4	440	45.8	Cw	30.6	82	24.1	31.0	442	440	28.7	561	542
46	092K043	77	29.0	Fdc	40.4	102	29.2	539	55.7	Hw	35.5	82	27.0	34.6	611	607	37.0	1076	1057
47	092K042	281	49.8	Hw	28.1	277	11.1	549	100.0	Ba	28.0	292	9.7	25.8	719	719	24.4	926	924
48	092K014	186	50.9	Hw	32.5	77	25.6	466	55.9	Fdc	34.6	77	28.9	31.4	563	561	28.9	702	688
49	092K024	59	1.4	Cw	25.4	82	20.0	82	10.7	Hw	27.5	82	20.7	26.0	77	77	23.3	79	78
50	092K053	202	36.4	Cw	25.1	222	12.5	350	50.1	Hw	27.1	202	12.2	24.2	306	306	26.2	534	531
51	092K033	103	1.7	Hw	23.8	52	24.8	692	46.6	Cw	21.7	52	24.2	21.8	297	293	20.0	355	334
52	092K042	637	9.0	Fdc	24.0	252	13.0	450	40.0	Hw	20.2	102	13.0	21.0	243	241	22.9	424	416

			Phase I																
Sample	Map ID	Polygon ID	Area (ha)	Spp1	Ht1 (m)	Age1 (yrs)	SI1 (m)	SPH 7.5 (trees/ha)	BA 7.5 (m^2/ha)	Spp2	Ht2 (m)	Age2 (yrs)	SI2 (m)	Lorey height (m)	Vol. 12.5 (m^3/ha)	Vol. 17.5 (m^3/ha)	A.A. Lorey height (m)	A.A. Vol. 12.5 (m^3/ha)	A.A. Vol. 17.5 (m^3/ha)
53	092K043	370	21.9	Hw	25.5	77	20.0	689	66.0	Fdc	28.5	77	24.0	24.6	486	483	22.7	605	581
54	092K034	368	18.4	Cw	25.1	252	12.0	350	50.1	Fdc	30.1	252	16.5	25.1	300	299	27.3	530	525
55	092L047	71	13.4	Hm	38.7	302	10.8	346	22.1	Yc	25.1	302	11.3	24.5	166	163	28.0	263	251
56	092L027	132	26.2	Hm	43.6	302	13.4	447	50.1	Yc	36.2	302	16.2	31.7	462	461	35.6	699	692
57	092K061	41	5.0	Hw	27.9	52	29.1	493	46.6	Cw	25.9	52	28.3	25.8	369	366	23.7	459	440
58	092L037	311	15.2	Ba	40.1	352	13.8	200	45.0	Hm	46.7	402	14.0	36.7	477	476	42.8	855	855
59	092K033	39	71.4	Fdc	27.6	37	38.1	1463	42.9	Hw	25.2	37	34.0	22.5	322	279	20.0	307	238
60	092K041	33	12.2	Cw	38.0	86	29.0	385	64.2	Fdc	52.2	77	42.3	40.3	706	704	35.8	750	744
62	092K035	63	11.7	Dr	26.3	52	26.2	432	45.0	Fdc	28.9	52	31.4	24.6	368	367	22.1	382	378
65	092L037	22	13.9	Hw	34.1	252	14.3	548	70.1	Yc	35.1	252	16.7	31.4	630	628	29.9	825	819
69	092K052	120	20.6	Dr	29.2	62	27.8	482	50.0	Fdc	35.5	82	28.7	28.0	491	490	25.1	510	506
70	092L046	167	22.0	Dr	30.4	47	31.1	958	55.1	Ba	40.7	67	36.0	28.9	638	626	26.1	661	619
74	092K033	151	4.5	Hw	32.1	252	13.4	499	60.1	Cw	24.1	252	11.5	27.8	455	453	26.6	599	591
79	092K043	150	16.2	Dr	18.3	42	19.5	577	40.4	Hw	19.9	42	25.0	17.2	211	209	15.5	220	213
82	092K034	328	49.6	Hw	26.1	232	11.5	275	60.1	Cw	26.1	232	12.8	25.1	344	344	24.2	470	469
92	092L046	101	45.2	Hw	27.1	222	11.7	599	80.1	Ba	30.2	202	13.0	25.8	613	612	24.8	797	792
97	092K061	48	7.7	Fdc	36.5	82	29.4	439	50.8	Hw	33.6	82	25.4	31.9	513	511	28.3	537	531
98	092K034	310	13.8	Hw	25.1	232	10.6	275	65.1	Yc	23.1	242	11.2	23.2	350	350	22.6	486	486

Note: A.A. is the VDYP7 attribute-adjusted volume.

Table 28. Phase II data from sampled polygons.

Proj. ID	Sample	Stratum	Sub-stratum	Phase II Spp	Case	Height (m)	Age (yrs)	SI (m)	BA 7.5	SPH 7.5	Lorey height (m)	Vol. 12.5 (m^3/ha)	Vol. 17.5 (m^3/ha)
4701	1	>100 H	Low vol	Yc	2	25.6	706	9.9	67.2	309	25.3	537	537
4701	2	≤100 H	High vol	Fdc	3	47.6	83	37.6	76.8	934	39.1	763	763
4701	3	≤100 H	Low vol	Hw	1	23.4	35	34.1	60.0	1617	22.6	476	451
4701	4	≤100 H	High vol	Hw	1	31.1	128	18.8	70.4	1491	23.5	543	524
4701	5	≤100 H	Low vol	Fdc	3	17.5	36	28.0	2.9	85	15.0	15	14
4701	6	≤100 H	High vol	Hw	1	36.6	85	27.5	80.9	1046	26.2	696	673
4701	7	≤100 H	Low vol	Hw	1	20.5	55	19.4	63.7	2389	15.0	371	331
4701	8	>100 H	Low vol	Hm	1	21.2	481	7.8	57.6	478	16.5	380	380
4701	9	≤100 Others	High vol	Fdc	3	45.3	92	34.1	85.1	736	40.8	1042	1036
4701	10	≤100 H	Low vol	Hw	1	17.0	43	22.0	64.0	5157	12.4	178	106
4701	11	>100 H	High vol	Hw	1	35.7	286	14.5	68.9	181	31.9	807	807
4701	12	≤100 Others	Low vol	Hw	2	17.0	47	21.6	41.7	1897	20.6	236	186
4701	13	≤100 H	High vol	Cw	3	34.6	185	18.3	81.6	727	37.3	761	721
4701	14	≤100 Others	Low vol	Hw	2	29.5	50	32.0	51.5	961	19.2	403	375
4701	15	>100 Others	Low vol	Hm	3	15.4	584	5.2	37.8	635	13.8	231	231
4701	16	>100 H	High vol	Hw	1	20.3	67	17.6	86.4	3305	30.3	605	594
4701	17	≤100 Others	High vol	Ss	3	28.8	73	19.6	36.8	376	24.7	300	300
4701	18	≤100 Others	High vol	Hw	2	20.9	95	14.2	66.2	1701	20.2	390	336
4701	19	>100 H	High vol	Cw	2	44.3	210	20.4	85.1	299	37.8	869	869
4701	20	≤100 H	Low vol	Hw	1	20.6	56	20.9	96.0	3369	20.8	650	557
4701	21	>100 H	High vol	Hw	1	55.7	2610	17.2	70.4	377	35.4	904	896
4701	22	≤100 H	High vol	Hw	1	33.5	76	27.0	76.8	1320	25.2	628	596
4701	23	≤100 H	High vol	Hw	1	23.8	68	20.6	68.6	1921	21.3	460	412
4701	24	≤100 H	High vol	Hw	1	35.0	91	25.4	89.1	1771	32.0	1042	995
4701	25	>100 Others	High vol	Ba	1	39.8	902	12.0	86.4	744	35.7	950	949
4701	26	≤100 H	Low vol	Hw	1	15.2	29	28.8	34.0	1577	13.7	168	135
4701	27	≤100 Others	Low vol	Hm	3	19.3	514	6.7	55.2	933	14.3	375	351
4701	28	≤100 H	High vol	Cw	3	23.3	77	19.4	52.2	1247	19.9	385	354
4701	29	≤100 H	High vol	Hw	1	32.0	58	31.0	61.3	1026	25.9	470	458
4701	30	≤100 H	High vol	Cw	3	35.6	143	24.3	80.0	669	32.4	772	736
4701	31	>100 H	High vol	Hw	1	28.8	103	20.5	35.2	314	34.2	430	430
4701	32	>100 H	High vol	H	3	30.5	389	11.1	88.0	368	33.8	930	930
4701	33	>100 H	Low vol	Hm	1	24.8	370	9.6	104.0	1207	18.7	602	576
4701	34	≤100 H	High vol	Hw	1	23.5	106	16.7	41.7	758	24.3	322	282
4701	35	>100 Others	Low vol	Hw	2	31.9	253	12.4	73.6	1858	20.2	602	582
4701	36	≤100 Others	Low vol	Fdc	3	21.9	60	22.3	20.3	194	27.6	181	181
4701	37	>100 H	High vol	Yc	3	17.1	232	11.2	76.8	1160	19.9	512	496
4701	38	>100 H	Low vol	Cw	2	24.5	326	10.9	67.2	701	24.2	496	496
4701	39	≤100 Others	High vol	Hw	3	28.3	72	29.3	46.6	878	28.6	353	327
4701	40	>100 Others	High vol	Hw	2	43.6	88	32.5	100.0	705	44.1	1452	1452
4701	41	≤100 H	Low vol	Fdc	2	13.9	40	20.4	20.2	1067	12.2	123	104

Proj.				Phase II									
ID	Sample	Stratum	Sub-stratum	Spp	Case	Height (m)	Age (yrs)	SI (m)	BA 7.5	SPH 7.5	Lorey height (m)	Vol. 12.5 (m^3/ha)	Vol. 17.5 (m^3/ha)
4701	42	≤100 H	Low vol	Hw	1	12.0	35	21.6	32.4	2761	11.5	79	47
4701	43	>100 Others	High vol	Hw	3	46.0	396	18.1	88.0	162	47.1	1020	1020
4701	44	≤100 H	High vol	Hw	1	32.6	109	21.8	57.6	539	29.4	483	483
4701	46	>100 Others	High vol	Cw	3	34.0	86	26.1	24.9	145	34.1	318	318
4701	47	>100 H	High vol	Hm	3	28.2	304	10.9	155.0	725	28.1	1350	1350
4701	48	≤100 H	High vol	Fdc	3	29.6	80	24.6	63.0	937	27.8	502	502
4701	49	≤100 Others	Low vol	Cw	1	12.8	149	12.0	44.1	903	21.4	308	283
4701	50	>100 Others	Low vol	Yc	3	24.8	377	10.5	60.8	1550	17.1	328	328
4701	51	≤100 H	Low vol	Hw	1	17.3	35	27.8	41.7	1082	17.5	260	252
4701	52	>100 Others	Low vol	Hw	2	33.4	140	18.6	76.8	737	32.6	731	731
4701	53	≤100 H	Low vol	Hw	1	31.1	64	28.3	51.5	557	27.1	451	431
4701	54	>100 Others	Low vol	Fdc	3	32.7	316	17.0	96.0	950	24.0	719	710
4701	55	>100 H	Low vol	Yc	2		537		19.0	506	11.2	64	64
4701	56	>100 H	High vol	Hm	1	34.0	713	12.3	64.0	124	34.5	695	695
4701	57	≤100 H	Low vol	Fdc	3	25.7	102	18.8	97.2	3378	23.6	719	657
4701	58	>100 Others	High vol	Ba	1	34.7	317	12.7	92.0	369	30.9	1158	1158
4701	59	≤100 Others	Low vol	Hw	2	28.3	39	37.3	43.2	627	25.1	340	340
4701	60	≤100 Others	High vol	Cw	1	34.5	142	23.8	73.6	1705	27.7	639	616
4701	62	≤100 Others	Low vol	Dr	1	26.8	38	33.3	22.4	361	27.4	202	202
4701	65	>100 H	High vol	Ba	3	28.8	427	8.5	118.4	596	28.8	1085	1085
4701	69	≤100 Others	Low vol	Cw	4	25.1	77	20.7	62.4	611	31.7	550	536
4701	70	≤100 Others	Low vol	Dr	1	23.0	27	33.1	32.4	635	27.2	260	251
4701	74	>100 H	High vol	Cw	2	36.7	236	18.4	73.6	1042	31.7	653	636
4701	79	≤100 Others	Low vol	Hw	2	22.8	37	32.5	55.8	2391	21.3	336	253
4701	82	>100 H	High vol	Cw	2				64.8	1134	17.9	437	431
4701	92	>100 H	High vol	Hw	1	38.4	106	25.4	89.6	1172	37.4	830	775
4701	97	≤100 Others	High vol	Hw	2	31.2	70	26.5	61.3	908	28.9	531	493
4701	98	>100 H	Low vol	Hw	1	19.7	193	9.0	69.6	2066	19.6	426	426

APPENDIX III – NVAF SAMPLES

Table 29. NVAF sample trees.

Sample Number	Batch	Species Group	Plot Maturity	Plot	Tree Number	Species	Live/ Dead	DBH (cm)	Age (yrs)
0003	1	Immature-H	Immature	S	001	H	L	18.9	32
0003	1	Immature-H	Immature	E	006	H	L	21.0	32
0003	1	Immature-O	Immature	E	004	B	L	48.4	32
0011	1	Mature-B	Mature	E	002	B	L	100.0	277
0011	1	Mature-H	Mature	E	004	H	L	74.0	277
0018	1	Immature-CW	Immature	N	001	Cw	L	73.5	82
0018	1	Immature-FD	Immature	S	007	Fd	L	27.2	82
0018	1	Immature-FD	Immature	W	008	Fd	L	36.2	82
0018	1	Immature-H	Immature	W	001	H	L	13.7	82
0018	1	Immature-H	Immature	S	010	H	L	21.5	82
0019	1	Dead	Mature	W	001	B	D	42.3	202
0019	1	Mature-B	Mature	N	010	Fd	L	91.0	202
0019	1	Mature-C	Mature	N	005	Cw	L	99.6	202
0019	1	Mature-H	Mature	W	002	H	L	44.9	202
0020	1	Immature-FD	Immature	N	006	Fd	L	27.9	47
0020	1	Immature-H	Immature	S	001	H	L	24.8	47
0031	1	Mature-C	Mature	N	005	Cw	L	56.1	152
0033	1	Mature-B	Mature	W	002	B	L	52.7	272
0033	1	Mature-C	Mature	N	003	Yc	L	29.4	272
0033	1	Mature-C	Mature	E	099	Yc	L	85.6	679
0033	1	Mature-H	Mature	E	003	H	L	72.9	272
0033	1	Mature-B	Mature	S	003	B	L	20.1	210
0033	1	Mature-B	Mature	E	001	B	L	42.3	723
0046	1	Immature-CW	Immature	E	004	Cw	L	26.8	102
0046	1	Immature-CW	Immature	N	003	Cw	L	48.1	102
0046	1	Immature-FD	Immature	W	004	Fd	L	96.4	102
0046	1	Immature-H	Immature	E	002	H	L	43.5	102
0047	1	Dead	Mature	N	003	H	D	42.1	272
0047	1	Mature-H	Mature	N	001	H	L	36.7	272
0047	1	Mature-H	Mature	S	003	H	L	55.5	272
0047	1	Mature-H	Mature	S	001	H	L	60.7	272
0047	1	Mature-H	Mature	S	004	H	L	66.6	272
0047	1	Mature-H	Mature	W	002	H	L	91.3	272
0050	1	Mature-B	Mature	W	005	B	L	33.5	222
0050	1	Mature-C	Mature	S	001	Yc	L	48.4	222
0050	1	Mature-H	Mature	W	008	H	L	32.8	222
0050	1	Mature-H	Mature	W	012	H	L	43.8	222
0051	1	Immature-FD	Immature	W	001	Fd	L	32.1	52
0051	1	Immature-H	Immature	W	003	H	L	12.8	52
0051	1	Immature-H	Immature	S	001	H	L	29.0	52
0051	1	Immature-H	Immature	E	001	H	L	31.1	52