Young Stand Monitoring in Haida Gwaii: Plot Establishment Report

A Technical Report

Ministry of Forests, Lands, and Natural Resource Operations

Forest Analysis and Inventory Branch

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EXECUTIVE SUMMARY

This report presents preliminary results of Young Stands Monitoring (YSM) in Haida Gwaii. The YSM population consists of 15-50 year old polygons covering approximately 100,000 ha. Fourty-three ground samples were established in 2016. The YSM population is dominated by hemlock followed by spruce (48% and 42% by basal area respectively) with minor amounts of alder, cedar, yellow cedar and pine. The highest volumes are found in the spruce stratum followed by the hemlock stratum.

The Phase I inventory attributes, including species composition and site index, are used to assign polygons to an analysis unit and project yields. Errors in these attributes will affect the accuracy of the yields.

The ground basal area is approximately 14% higher than the inventory estimates (Table 1). The bias is greatest in the younger age class (age 15 - 30). The bias in the older age class (age 31 – 50) is relatively smaller and not statistically significant. The lower inventory BA may be due in part to some polygons with short trees. VDYP7 does not project BA until the projected height is approximately 7m.

The species matched ground age was 18% higher than the inventory estimates with the largest differences in the younger age class. The ground heights were slightly lower than the inventory heights but the differences were not statistically significant.

The PSPL estimates of Site Index (SI) are 9% higher than the ground estimates. The range, by species, of the PSPL SI is quite narrow compared to the ground estimates.

Twenty-five (58%) of the samples had the same inventory and ground leading species.

Table 1. The results of comparing the ground plots to the inventory and to the YSM assumptions are summarized. A p-value < 0.05 is generally considered an indication of statistically significant differences (or bias). Residual trees are not included in the volume estimates. All attributes are at the 7.5 cm utilization level.

Attribute	N	Estimate	Ground mean	Inventory mean	Bias		
					Magnitude	% of ground mean	p-value
Basal area (m^2/ha)	43	VRI	31.4	27.0	4.4 ± 2.2	14%	0.053
Species matched age (years)	43	VRI	39.6	32.5	7.1 ± 2.7	18%	0.011
Species matched height (m)	43	VRI	15.4	16.3	-0.9 ± 0.7	-6%	0.208
Site index (m)	41	PSPL	23.3	25.4	-2.2 ± 1	-9%	0.042
Whole stem volume (m^3/ha)	40	TIPSY	219.6	189.9	29.7 ± 29.2	14%	0.314
Volume model bias (m^3/ha)	40	TIPSY			38.7 ± 13.2	18%	0.006
Volume attribute bias (m^3/ha)	40	TIPSY			-9 ± 22.1	-4%	0.687

The samples are young and current volumes are less important than the growth trajectories. The plots should be remeasured to compare actual growth against the growth projections used in timber supply analysis.

Inventory estimates of volume were generated using TIPSY and the inventory species composition, the PSPL SI and an assumed initial density. The ground volume is approximately 14% higher than the TIPSY estimates, similar to the basal area bias. The difference is not statistically significant. TASS generates the yield curves in the TIPSY database. TASS is based on growth trends observed in fully stocked research plots growing in a relatively pest-free environment. TASS yields will be very close to the potential of a specific site, species and management regime. Operational yields are expected to be lower.

The ground volumes were also compared to the analysis unit (AU) volumes. The AU volumes are based on the previous inventory and are approximately half of the ground volumes and less than the inventory volumes.

The analysis has a number of complications. These are young samples and the trees are small. Small changes in age and height can have relatively large effects on SI. The age, height, site index and basal area biases are smaller in the older age class (31 – 50) than the younger age class (15 – 30).

A VRI volume audit analysis of Haida Gwaii is documented in a separate report available from the Ministry of Forests, Lands and Natural Resource Operations.

Acknowledgements

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1 Introduction

The Forest Analysis and Inventory Branch (FAIB) of the British Columbia Ministry of Forests, Lands and Natural Resource Operations has developed a framework for a Young Stand Monitoring (YSM) program to monitor the performance of young forest stands, especially those in high risk forest management units. The primary focus of YSM is to check the accuracy of the growth and yield assumptions and predictions of key timber attributes in young stands for timber supply review. This monitoring program helps to identify opportunities to improve the accuracy of timber supply forecasting for a management unit.

2 Objective

This report summarizes YSM for Haida Gwaii. The intent of YSM is to monitor the performance of young forest stands. Specifically, the primary goals of FAIB's YSM are to:

1 Characterize the young stand population, including composition, structure, mortality, growth, yield, and health.
2 Assess the accuracy of some Phase I Vegetation Resources Inventory (VRI) photo-interpreted polygon attributes (e.g., age, height, density and site index) for young stands.
3 Assess the accuracy of site index estimates in the Provincial Site Productivity Layer (PSPL).
4 Compare observed stand yields (e.g., basal area/ha and trees/ha) to predictions generated from TIPSY.
5 Compare observed growth to forecasts from growth and yield models for the young stand population once remeasurements are available.

Remeasurements are not yet available for Haida Gwaii. This report covers YSM goals 1 – 4.

3 Sample Design

A program of inventory field plot measurement is a key component of BC's provincial forest inventory of which YSM sampling is a sub-component. This program includes:

- Monitoring plots on a 20 x 20 km grid. This includes all land types across BC, including young stands.
- For the YSM population, the monitoring plot grid is intensified and sampling occurs at the intersection of young stands on a 5 x 5 km grid.

The ground sample in Haida Gwaii includes both sampling components. This report is focused on the intensive young stand sample.

3.1 Population

The monitoring unit, the geographic area of interest, is Haida Gwaii which is an archipelago off the west coast of British Columbia (Figure 1). Haida Gwaii covers approximately 1 million hectares, about half of which is in the operating area (Table 2).

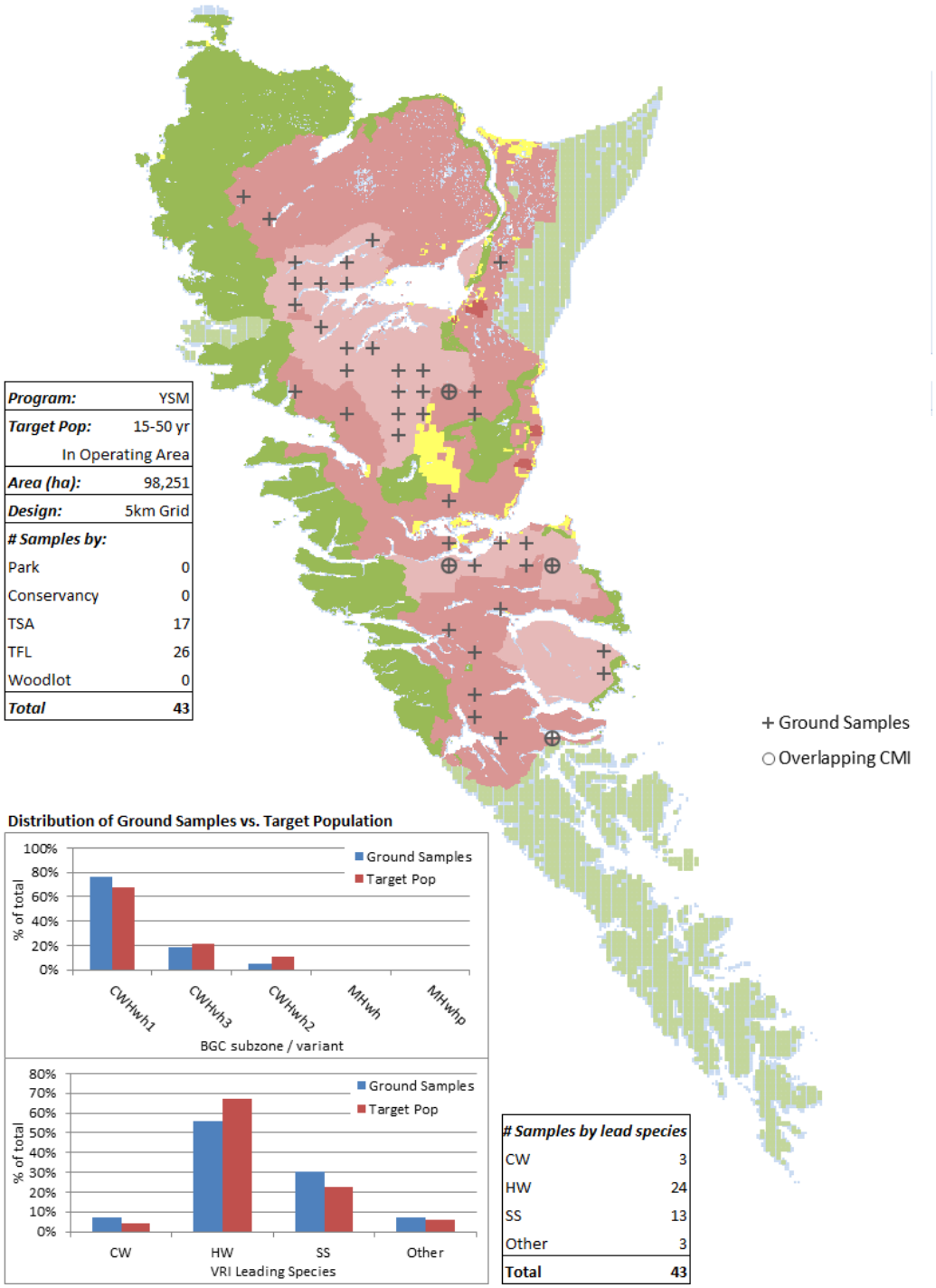

Figure 1. The location of the Haida Gwaii YSM samples (from FAIB 2016). The operating area is colour-coded (TFL – light pink, TSA – medium pink, Woodlot – dark pink). Parks and conservancy areas are shaded green. Private land is shaded yellow.

Table 2. A summary of the land base (taken from the Haida Gwaii Ground sampling plan (FAIB 2016).

Netdown Description	Area Deducted (ha)	Area Remaining (ha)	% of Haida Gwaii	% of Operating Area
Entire Haida Gwaii		***1,006,800***	***100%***	
Parks / Conservancy / Private	487,200	519,600	52%	
Lakes / Wetlands	55,291	464,309	46%	
Operating Area		***464,309***	***46%***	***100%***
< 15 yrs		15,936	2%	3%
15-50 yrs (target pop)		98,251	10%	21%
> 50 yrs: forested		336,511	33%	72%
> 50 yrs: non-forest		13,611	1%	3%

3.2 Target Population

The operating area for ground sampling is 464,309 ha representing 46% of Haida Gwaii (Table 2). The YSM target population is composed of 15- to 50-year-old young stands within Haida Gwaii. The population was not restricted to vegetated treed polygons. It includes all stands in the age range (including silvicultural openings with crown closure < 10%). The ground sampling plan is described in FAIB (2016).

3.3 Sample Selection

The YSM ground sample data come from two data sources – YSM and CMI ground plots. The samples were selected from various intensities of a grid (Table 3). Each ground sample has equal weight. There are 39 YSM plots and 4 CMI plots for a total of 43 ground plots in the YSM population.

Table 3. The data sources are defined. All are circular, 0.04 ha fixed area plots.

Abbreviation	Data Source	Description
CMI	Change monitoring inventory	Established on the 20 x 20 km NFI grid.
YSM	Young Stand Monitoring	Established on a 5 x 5 km grid superimposed on the 20 x 20 km grid, and within the YSM population.

The compiled ground attributes for the YSM samples are given in Appendix B. There were no substitutions or movements of plots.

3.4 Plot Design & Establishment

Ground samples are circular fixed-area (0.04 ha) permanent sample plots. Ground sample establishment and measurement followed provincial YSM standards and procedures[1]. The plot consists of three nested plots: a 400 m^2 (11.28 m radius) plot for measuring all trees with diameter at breast height (DBH) ≥ 9.0 cm; a 100 m^2 (5.64 m radius) for trees with DBH ≥ 4.0 cm; and a 19.6 m^2 (2.50 m radius) plot for all trees at least 1.3 m tall and DBH < 4.0 cm. The sample plots are centered at the grid intersection points.

[1] BC Ministry of Forests, Lands and Resource Management Operations. June 2015. Change Monitoring Inventory BC. Change Monitoring procedures for provincial reporting. Ver. 2.2. https://www.for.gov.bc.ca/hts/vri/standards/RISC/2015/cmi_ground_sampling_procedures_2015.pdf.

The walkthrough method (as specified in the CMI ground sampling standards) was assessed for all YSM ground samples in proximity to a potential out-of-population polygon boundary.

The sampling intensity, the proportion of the area sampled, was approximately 0.011% based on forty-three 0.04 ha samples and a population size of 98,251 ha.

4 Data Compilation

The attributes in Table 4 were taken or compiled from the FAIB files.

Table 4. The field names for the attributes are given.

Attribute	Utilization	Ground file	VDYP7 file
Age of leading species	7.5 cm	AGET_TXO	PRJ_TOTAL_AGE
Height of leading species	7.5 cm	HT_TXO	PRJ_DOM_HT
SI of leading species	7.5 cm	See section 4.4	PRJ_SITE_INDEX
Basal area	7.5 cm	BA_HA	PRJ_BA
Trees per hectare	7.5 cm	STEMS_HA	PRJ_TPH
Lorey height	N/A	Calculated	PRJ_LOREY_HT
Whole stem volume	7.5 cm	VHT_WSV	PRJ_WSV
Merchantable volume Dwb	12.5 cm	VHT_NWB	PRJ_VOL_DWB

For the ground measurements, Lorey height is calculated as the basal area weighted mean height for all live, standing, full measure trees, including broken top trees. Lorey height does not have a utilization level, it includes all trees that meet the criteria regardless of DBH.

Some additional screening of SI trees was undertaken (section 4.4) so the ground site index was calculated in a similar manner to SI_M_TXO, but based on fewer trees.

4.1 Ground plot attributes

The compiled summaries were used for most attributes (volume, BA, etc.). The attributes are defined in the data dictionary[2] and summarized in Table 7.

The ground volume compilations use DWB functions based on localized destructive sampling data collected in 1996[3].

4.2 Ground plot data screening

Samples 27, 51 and 58 were boundary plots and sampled using the walkthrough method (Ducey et al. 2004) and compiled accordingly.

Trees with a breast height age < 10 years or with breast height age > 120 are not considered suitable site index trees. None of the trees measured for age had a breast height age < 10 years. Four trees had breast height age > 120 and were not used for SI estimation.

[2] Data Dictionary for Vegetation Resrouces Inventory and National Forest Inventory Timber Data. Ministry of Sustatinable Resource Management. By Gitte Churlish. Dec. 2003. 8p.
[3] Decay-prediction Working Notes, Sample based adjustment – Volume and Decay for QCI. TDJF24.doc, dated May 2, 2001. 5p + app.

Residual trees are identified in the field. Unless otherwise indicated, these are included in summaries. There were 30 trees identified as residual, three of which were dead. Twenty-two were live and had DBH ≥ 7.5 cm. Live fallen trees are not included in the summaries

Plots with large, old trees and high volumes were also examined in more detail. The summaries are based on all live, measured trees. Sixteen plots have trees with a total age greater than 50 (Table 24). These ages may represent residual trees after selective disturbance. Seven were identified as residual trees in the field. All were retained in the analysis but not necessarily used in the height, age and SI calculations.

Twenty-two samples had ground basal area greater than 30 m^2/ha (Table 25). Based on the Phase I photo age, all are part of the YSM population.

4.3 Ground sampling year and projection year

The ground sampling occurred in June, August and September of 2016. Ground measurements in June 2016 were assumed to correspond to the 2015 measurement year and ground measurements in August and September 2016 were assumed to correspond to the 2016 measurement year. The Phase I data were projected to the ground measurement year for the purpose of Objective 2: assessing the accuracy of some Phase 1 Vegetation Resources Inventory (VRI) photo interpreted polygon attributes for young stands.

4.4 Ground SI and years to breast height

Age and height were measured on some trees on the ground plots. The trees used in site index assessment had a breast height or total age, a height, and the height and site index suitability flags = Y. Because of this screening, the trees used in the SI calculations are not necessarily the same as those used in the age and height calculations. The SIBEC standard (BC Ministry of Forests and Range, Research Branch 2009) of excluding trees with breast height age < 10 or > 120 was used here.

4.5 Phase I (Photo Interpreted Inventory) data

The Phase I inventory mapping was completed in 2013. Inventory information for recently disturbed polygons generally comes from the Reporting Silviculture Updates and Land status Tracking System (RESULTS) layer. These polygons are processed by VDYP7 to project them to the year of ground sampling. For stands less than 7 m tall, VDYP7 will project the age and height until the height is 7 m and then generate the remaining attributes. Until the projected height is 7 m, the other attributes are not altered and the utilization limit is unchanged from the original data collection. This is illustrated by sample 20 which, in the original inventory file, had a PROJ_HEIGHT_1 = 3.5 m and 2,125 trees/ha. The basal area estimate is 1.0 m^2/ha, implying the quadratic mean DBH is 2.5 cm (below any of the common utilization limits). For some young stands, the Phase I inventory utilization limit is not known.

The Phase I data were projected to the year of ground sampling. Seven samples (20, 26, 27, 35, 50, 51 and 56) were too short to project basal area and trees/ha. These attributes were copied from the input file. Volumes were set to zero. Ages and heights were projected.

None of the sampled YSM polygons have dead volume or more than one layer in the inventory.

4.6 Provincial Site Productivity Layer

The provincial site productivity layer (PSPL[4]), version 4.0, provides an alternative source of site index estimates, which is particularly useful for the YSM population. The PSPL is the prime source of SI information used in Timber Supply Review (TSR) for existing managed stands. This layer provides site index estimates for up to 22 species. The intersection of the provincial site productivity layer and the ground plots was provided by the FAIB.

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

As noted in the PSPL documentation[5], the PSPL site indexes are more appropriately used for strategic, as opposed to operational, purposes. If used for site-specific applications, as is the case here, the site index estimates should be verified through a ground-based survey. The PEM/TEM data for the site productivity layer are approved for about half the target area, indicating passing a third party accuracy assessment based on published standards and procedures.

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

Three samples had a Phase I leading species of DR. The PSPL did not have SI estimates for DR and site conversion equations are not available to estimate the DR SI from other species. The PSPL SI for these samples is missing.

4.7 Height and Age matching

The height and age data matching followed the FAIB (2011) VRI procedures. The ground plot data were matched with the corresponding VRI Phase I photo interpreted inventory data for the polygon. The ground plot heights and ages were based on the average values for the T, L, S, X and O trees by species. The objective was to match the ground leading species to the Inventory (Phase I) leading or secondary species and compare the ages and heights. If a match could not be made at the Sp0 (genus) level, conifer-to-conifer (or deciduous-to-deciduous) matches were allowed. However, conifer-deciduous matches were not acceptable. The five possible matching cases are given in Table 5.

Table 5. The height and age matching cases are described.

Case	Description
1	VRI polygon leading Sp0 matches the ground leading Sp0
2	VRI polygon second Sp0 matches the ground leading Sp0
3	VRI polygon leading species and the ground leading species are both coniferous or both deciduous.
4	VRI polygon second species and the ground leading species are both coniferous or both deciduous.
5	No match

[4] http://www.for.gov.bc.ca/hts/siteprod/download/FLNR_Provincial_Site_Productivity_Layer.pdf
[5] http://www.for.gov.bc.ca/hts/siteprod/provlayer.html

4.8 Stratification

The samples were stratified by BEC, leading species, leading species age and whether or not they are in the Timber Harvesting Land Base (THLB) (Table 6). The stratification was based on the Phase I data for age and leading species. The assignment to the THLB is based on the previous inventory and timber supply review in 2010. Note the small sample sizes for some strata.

Table 6. The strata used to summarize the results are defined.

Stratification	Strata	Definition	N
BEC	CWHwh1	CWHwh1	33
	Other	CWHwh2, CWHwh3	10
Leading species	C	CW	3
(Phase I inventory)	H	HM, HW	24
	Other	DR	3
	S	SS	13
Age	Young	ages 15-30	19
(Phase I Inventory)	Older	ages 31-50	24
THLB (Timber	nonTHLB	nonTHLB	8
Harvesting Land Base)	THLB	THLB	35

5 Stand structure and health

The ground data are summarized in Table 7. The ground data are compiled from 0.04 ha fixed area plots. The ranges and standard errors associated with small plots are considerably higher than what is expected for larger polygons.

Table 7. Haida Gwaii YSM ground plots are summarized. SE is the sampling error of the mean and SE% is sampling error expressed as a percent of the mean.

Attribute	Util (cm)	N	Statistic (includes residual trees)				
			Mean	Minimum	Maximum	SE	SE%
Basal area (m^2/ha)	4.0	43	34.1	1	96.8	3.6	11%
Trees per hectare (stems/ha)	4.0	43	2441	325	7930	281.9	12%
Gross volume live (m^3/ha)	4.0	43	244	3	1237	42	17%
Basal area (m^2/ha)	7.5	43	31.4	0	96.8	3.6	12%
Trees per hectare (stems/ha)	7.5	43	1338	0	3552	138.2	10%
Gross volume live (m^3/ha)	7.5	43	237	0	1237	42	18%
Gross volume dead (m^3/ha)	7.5	43	22	0	274	9	41%
Volume net of decay, waste & breakage (m^3/ha)	7.5	43	192	0	1112	39	20%
Dead trees per hectare (stems/ha)	7.5	43	93	0	1176	31.1	34%
Leading species age (years)	7.5	43	39.6	18.0	135.8	2.8	7%
Leading species height (m)	7.5	43	15.4	4.4	38.0	1.3	8%

The YSM subpopulation is dominated by hemlock and spruce (Figure 2 and Figure 3).

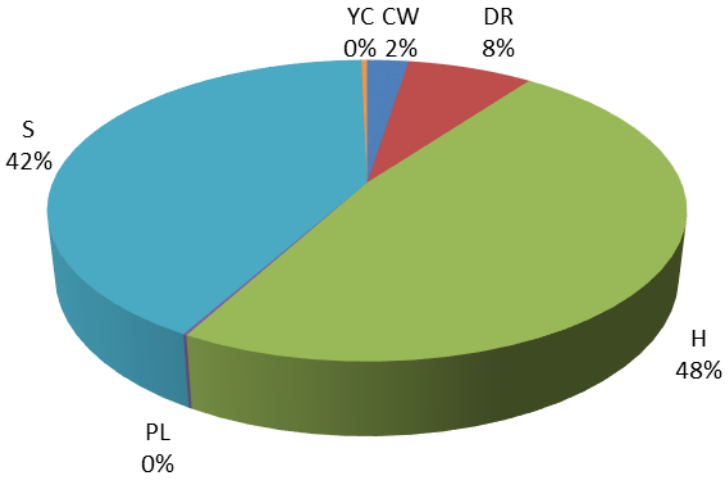

Figure 2. The percentage of live basal area is given by species based on the ground measurements. Residual trees are included.

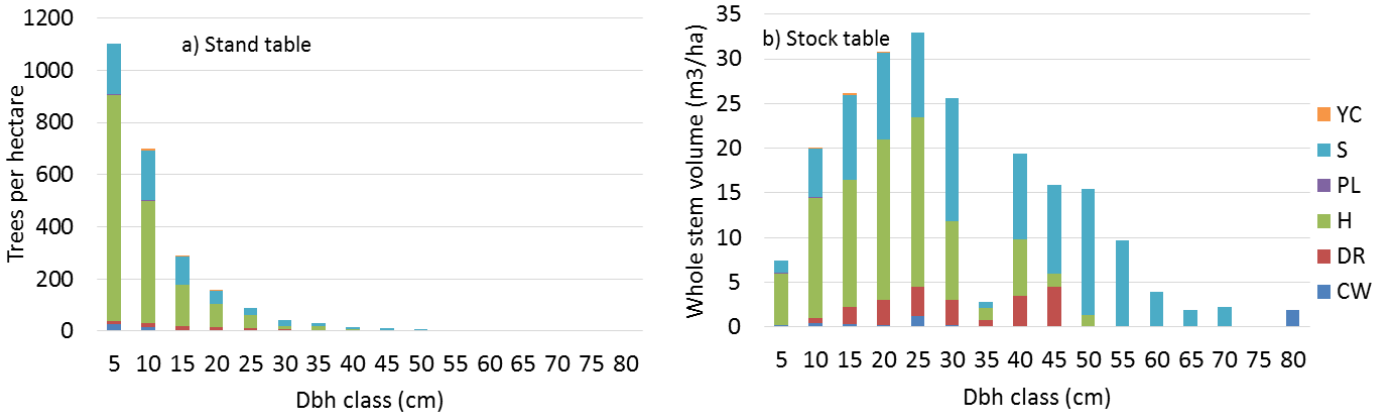

Figure 3. The stand and stock tables based on the ground measurements are given. Residual trees are included.

The average number of dead trees (DBH ≥ 4.0 cm) was 144 trees/ha (Table 8). About 2/3 of the dead trees have a DBH < 12.5 cm and almost half are hemlock. None of the Phase I samples had estimates of dead volume. Four samples (42, 55, 58 and 63) had ground estimates of dead whole stem volume > 50 m^3/ha. The average dead standing whole stem volume is 22 m^3/ha or about 9% of the live standing volume.

Table 8. The average number of dead trees/ha is given by species and DBH class. Zeroes indicate there were dead trees but the average was less than 0.5 trees/ha. Residual trees are included

Species	DBH Class (cm)											
Group	5	10	15	20	25	30	35	40	45	50+	Total	Percent

Species		DBH Class (cm)											
Group		5	10	15	20	25	30	35	40	45	50+	Total	Percent
CW	Cedar										1	1	1%
DR	Alder	2	8	5	2	1	1					19	13%
H	Hemlock	30	21	8	1	1	1	1	1	1	3	67	47%
PL	Pine	2										2	2%
S	Spruce	16	13	8	2			1			1	41	28%
XC	Unknown conifer		5	5	2			1			1	13	9%
YC	Yellow cedar										1	1	0%
Total		51	47	25	8	2	1	2	1	1	6	144	100%
Percent		36%	32%	17%	5%	1%	1%	2%	0%	1%	4%	100%	

There is a relatively high incidence of unknown damage agent in the Haida Gwaii inventory. Damage agent is coded as 'unknown' when the sampler cannot confirm the primary damage agent with any reasonable degree of certainty because the damage may be old or the damage agent not clear in terms of symptomology (characteristics of attack) and could be due to multiple causes. Samplers also record primary damage agent as "unknown" when there is indication of scars, forks or crooks which may affect wood quality. The level of severity, however, may vary and there may or may not be a significant impact on volume or growth. The trees where the primary damage agent = "Unknown" were split into those with form-related primary loss indicators (loss1_in = BTP, CRO, DTP, FRK, SCA) and those with non-form related primary loss indicators.

Approximately 40% of the live trees show signs of damage (Figure 4). The cause of most of the damage is unknown, form-related (85% of damaged trees or 33% of all trees). If the Unknown, form-related damage is excluded, 85% of the trees are damage-free. At this time, there is no separation of forks and crooks into minor and major. Minor crooks and forks generally have negligible consequences on volume.

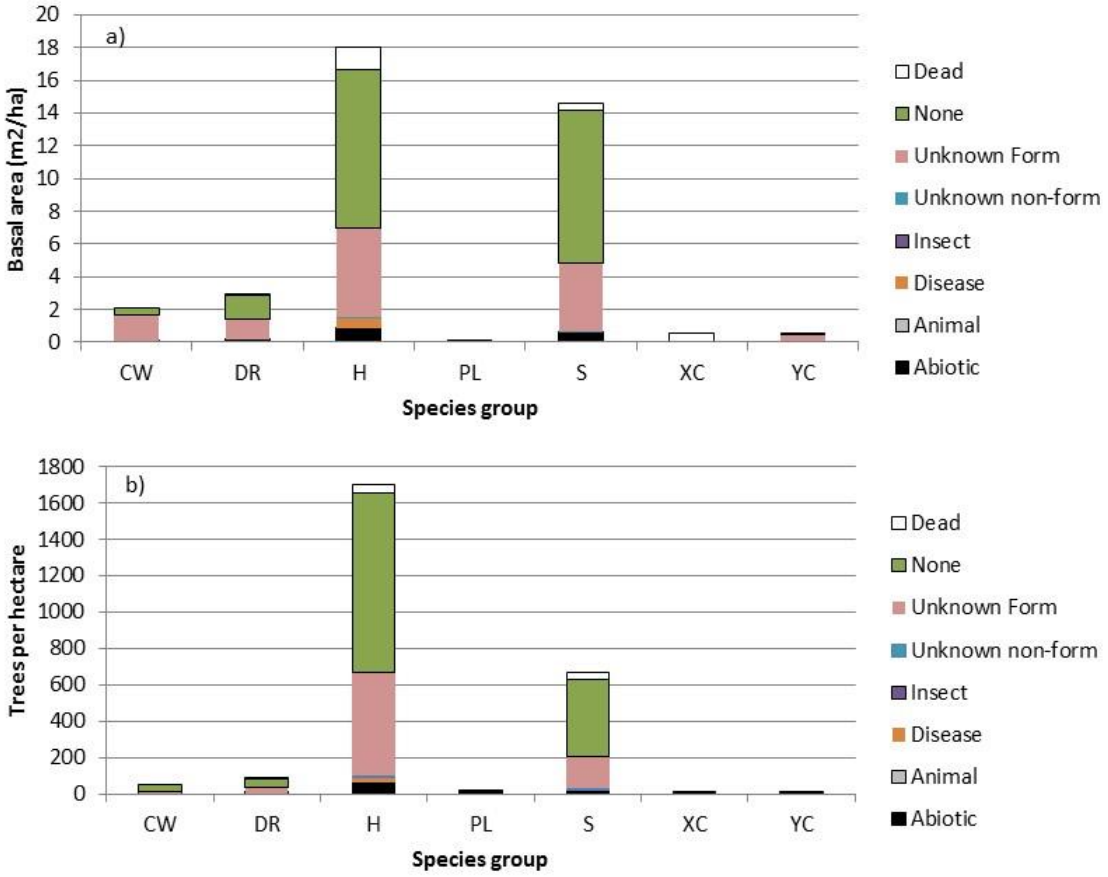

Figure 4. The basal area (a) and stems/ha (b) affected by each primary damage agent is given by species for live and dead trees, DBH ≥ 4.0 cm.

6 Ground vs. Inventory

6.1 Stand Age and Height

The leading species age, height and SI comparisons are based on a utilization level of 7.5 cm.

All 43 samples had acceptable age matches and acceptable height matches while 38 had acceptable SI matches (Table 9).

Table 9. The results of the age, height and SI matching are given.

Case	Number of plots	Age pairs	Height pairs	SI pairs
1	25	25	25	25
2	13	13	13	13
3	4	4	4	
4	1	1	1	
5				
All	43	43	43	38

The leading species height and age are compared in Table 10 and Figure 5 and the species- or case-matched height and age are given in Table 11. Overall, the ground age is approximately 17% higher than the VRI age while the height is slightly shorter. Age differences are greatest for the 15 – 30 year age range and for the C and H species strata. The differences are statistically significant for age but not height.

Table 10. The leading species ground plot and VRI Polygon ages and heights are compared. The mean bias is followed by the sampling error[6] at a 95% confidence level. Statistically significant differences (p-value < 0.05) are shaded. No residual trees were suitable age or height trees.

Phase I	Age (years)					Height (m)				
Strata	N	Ground	VRI	Bias	p-value[7]	N	Ground	VRI	Bias	p-value
CWHwh1	33	38.1	34	4.1 ± 1.2	0.002	33	15.9	16.2	-0.3 ± 0.9	0.736
Other	10	44.6	28.5	16.1 ± 10.7	0.166	10	13.6	13.8	-0.2 ± 1.2	0.846
C	3	32.6	24.3	8.3 ± 3.5	0.143	3	10.1	8.3	1.7 ± 3.1	0.641
H	24	39.1	29.6	9.6 ± 4.6	0.051	24	12.7	12.9	-0.2 ± 0.9	0.839
Other	3	47.1	47	0.1 ± 3.5	0.983	3	25.2	20.6	4.6 ± 2.6	0.223
S	13	40.3	37.1	3.2 ± 1.7	0.083	13	19.4	21.5	-2.1 ± 1.6	0.201
Age 15-30	19	34.9	22.4	12.5 ± 5.7	0.043	19	9.1	8.8	0.3 ± 0.6	0.561
Age 31-50	24	43.3	40.8	2.4 ± 1	0.028	24	20.4	21.2	-0.8 ± 1.3	0.533
nonTHLB	8	41	40.6	0.4 ± 1.4	0.779	8	24.0	21.9	2.1 ± 1.9	0.316
THLB	35	39.2	30.9	8.4 ± 3.2	0.014	35	13.4	14.3	-0.8 ± 0.8	0.293
All	43	39.6	32.7	6.9 ± 2.7	0.014	43	15.4	15.7	-0.3 ± 0.7	0.695

The differences in the case-matched ages and heights are slightly larger (Table 11).

Table 11. The case-matched ground plot and VRI Polygon ages and heights are compared. Statistically significant differences (p-value < 0.05) are shaded.

Phase I	Age (years)					Height (m)				
Strata	N	Ground	VRI	Bias	p-value	N	Ground	VRI	Bias	p-value
CWHwh1	33	38.1	33.7	4.3 ± 1.2	0.001	33	15.9	16.9	-1 ± 0.9	0.279
Other	10	44.6	28.5	16.1 ± 10.7	0.166	10	13.6	14.3	-0.7 ± 1	0.495
C	3	32.6	24.3	8.3 ± 3.5	0.143	3	10.1	10.6	-0.5 ± 1.7	0.783
H	24	39.1	29.2	9.9 ± 4.6	0.042	24	12.7	13.4	-0.7 ± 0.8	0.385
Other	3	47.1	47.3	-0.3 ± 3.2	0.944	3	25.2	24.7	0.6 ± 4.7	0.915
S	13	40.3	37.1	3.2 ± 1.7	0.083	13	19.4	21.1	-1.8 ± 1.7	0.308
Age 15-30	19	34.9	21.9	13 ± 5.7	0.035	19	9.1	9.5	-0.4 ± 0.5	0.450
Age 31-50	24	43.3	40.9	2.4 ± 1	0.029	24	20.4	21.7	-1.3 ± 1.2	0.290
nonTHLB	8	41	40.8	0.3 ± 1.3	0.836	8	24.0	23.1	0.9 ± 2.4	0.718
THLB	35	39.2	30.6	8.6 ± 3.2	0.011	35	13.4	14.8	-1.3 ± 0.7	0.070
All	43	39.6	32.5	7.1 ± 2.7	0.011	43	15.4	16.3	-0.9 ± 0.7	0.208

[6] The sampling error is the standard error multiplied by the two-sided t-value with df = n – 1 and α-value = 0.05.

[7] The p-value is the probability associated with the null hypothesis H_0: bias = 0 versus the alternative hypothesis H_1: bias ≠ 0. In this report, a p-value < 0.05 is considered grounds for rejecting H_0 and concluding the bias is statistically significant.

The relationship between ground and inventory age was strong with a few exceptions (Figure 5).

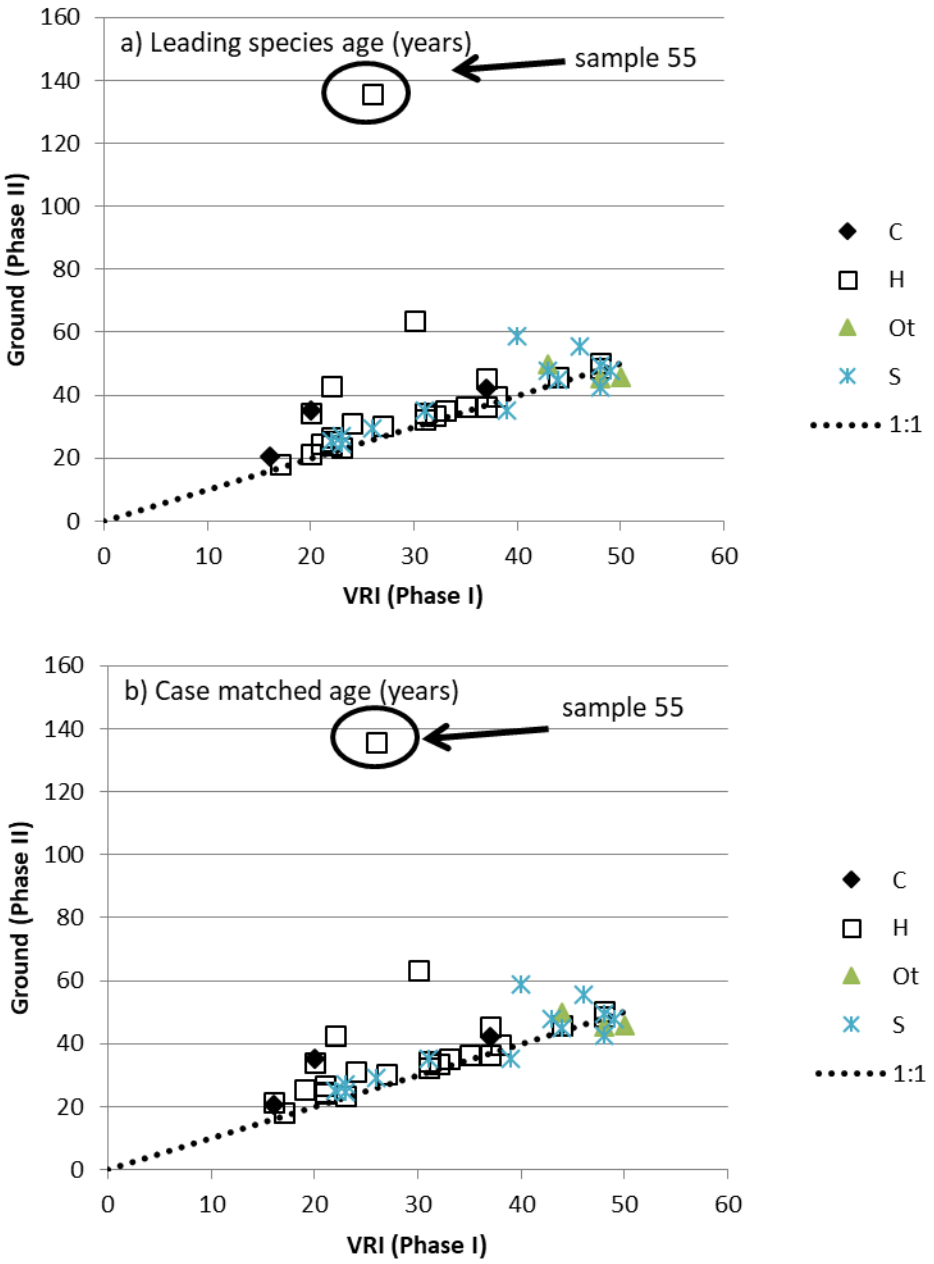

Figure 5. The VRI inventory (Phase I) and ground (Phase II) leading species ages are compared (a) and the case-matched ages are compared (b). Some ages for sample 55 are given in Table 24.

The relationship between ground and inventory height was relatively strong (Figure 6) and the relative bias is small (Table 11). The Phase I age is used in TSR but the Phase I height is not used directly. Phase I

age and height are used in the estimation of VRI SI. Another estimate of SI is available from the PSPL. The Phase I inventory is updated to the year of ground sampling using the Phase I age and SI (either from the VRI or the PSPL). If the SI is biased, it will have an impact on the projected height. The comparison here indicates the projected Phase I inventory slightly overpredicts height. However, it should be noted that the Phase I height does not directly affect TSR projections although indirectly affects TSR projections if it is used to estimate SI.

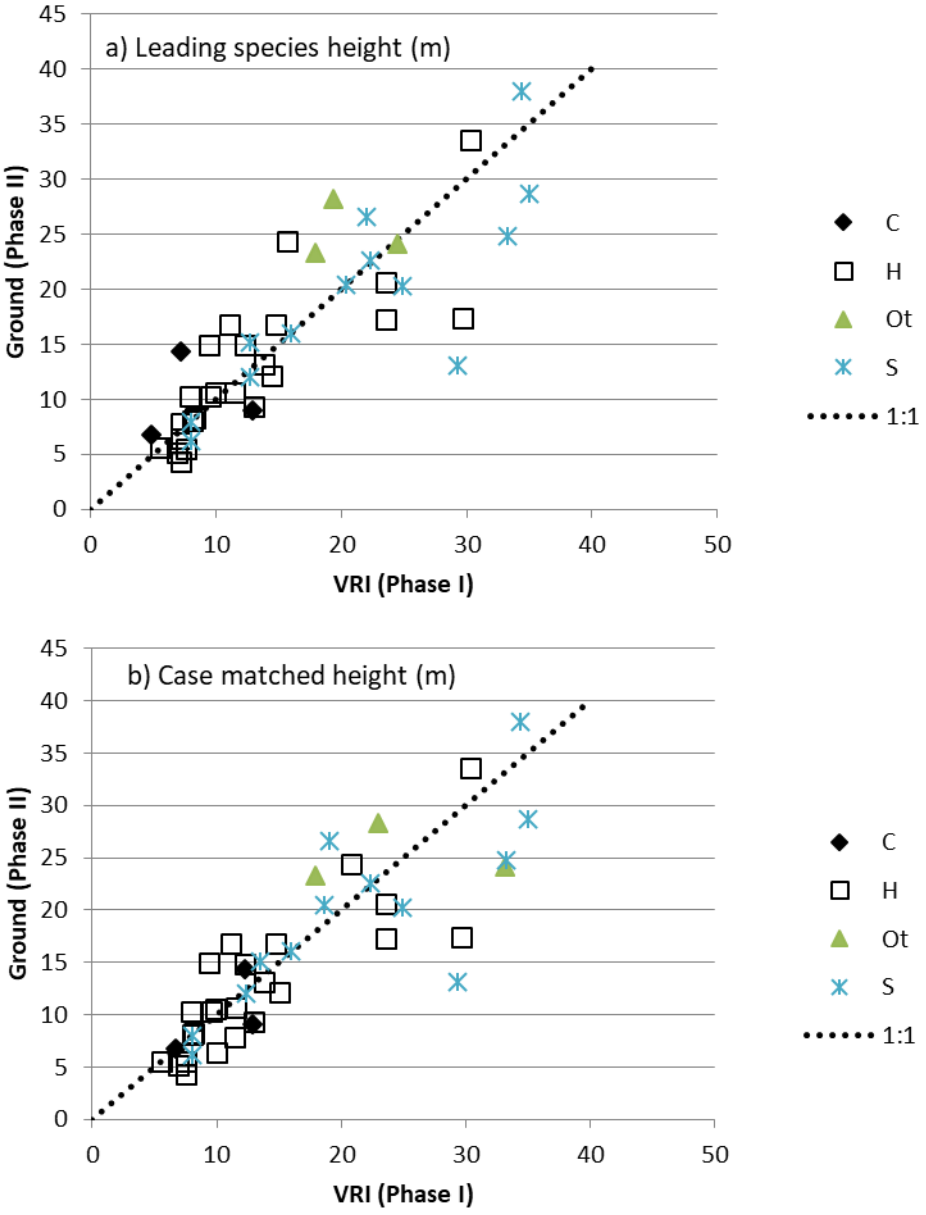

Figure 6. The VRI inventory (Phase I) and ground (Phase II) leading species heights are compared (a) and the case-matched heights are compared (b).

6.2 Site index

The ground, VRI and PSPL SI are compared in Figure 7 and Table 12. The sample size for the PSPL SI (n = 41) is greater than the VRI inventory SI (n = 38) because of species matching – the PSPL has more species and more matches.

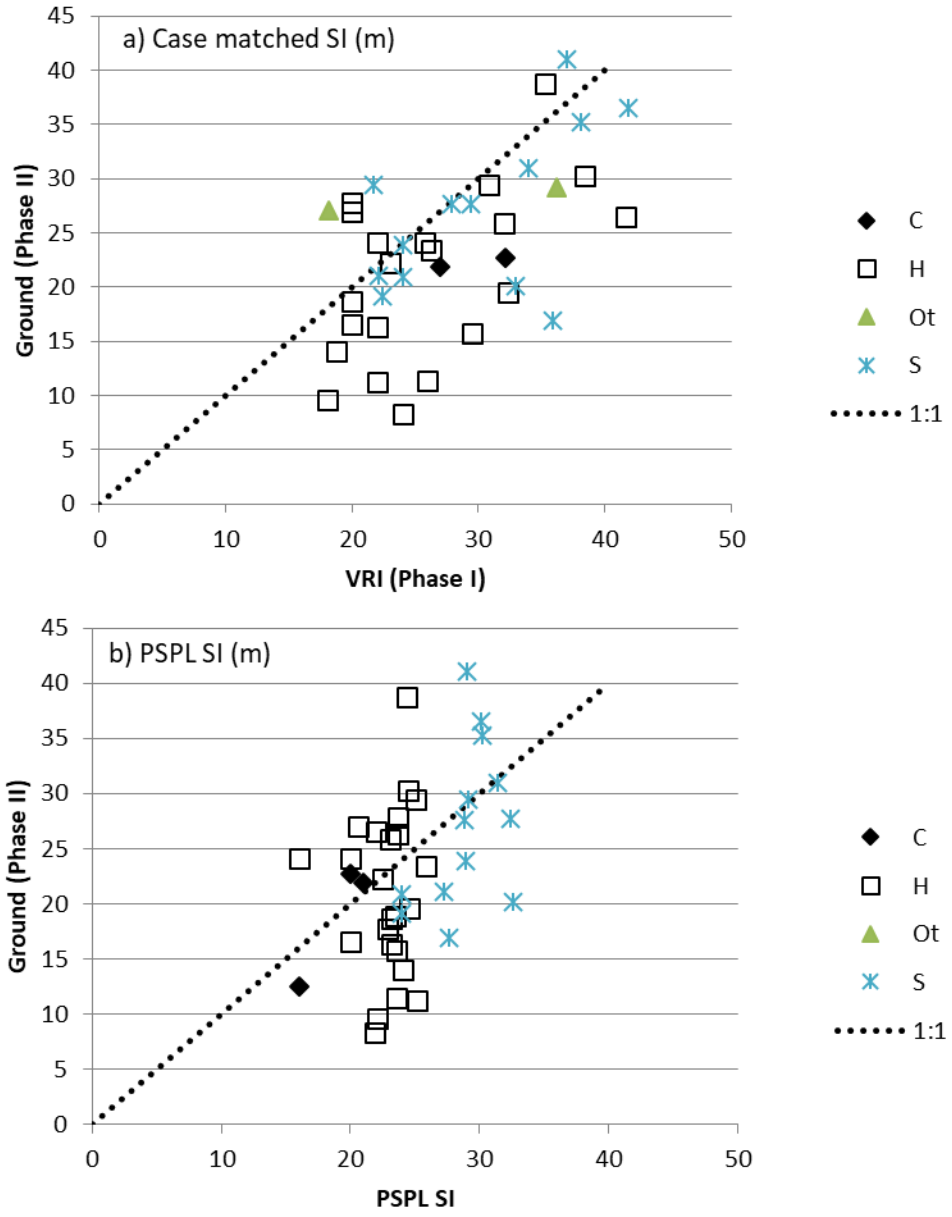

Figure 7. The ground SI and inventory SI (from Phase I) (a) and ground SI and PSPL SI (b) are compared. The Phase I and PSPL SI correspond to the ground leading species.

Both the Ground and VRI SI showed greater range than the PSPL (Figure 7). The PSPL SI range is particularly narrow by species. There is a tendency for the PSPL to overestimate SI (Table 12), particularly for the C and H strata. Note three samples in the C strata were hemlock leading on the ground (Table 13). Overall, the ground SI was 10% less than the PSPL SI. The differences were greater for the younger age class.

The ground leading species for sample 025Y-0049-YO1 was DR and did not have a PSPL SI estimate. The ground leading species for sample 025Y-0051-YO1 was PL and did not have a PSPL SI estimate.

Table 12. The ground plot and PSPL SI are compared. Statistically significant differences (p-value < 0.05) are shaded.

Phase I		SI (m)			
Strata	N	Ground	PSPL	Bias	p-value
CWHwh1	31	23.5	25.3	-1.7 ± 1.2	0.164
Other	10	22.5	26.0	-3.5 ± 1.9	0.104
C	3	19.0	24.7	-5.7 ± 2.9	0.192
H	23	21.1	24.1	-2.9 ± 1.4	0.049
Other	2	30.1	29.5	0.6 ± 0.8	0.584
S	13	27.0	27.4	-0.4 ± 1.9	0.828
Age 15-30	18	20.0	24.3	-4.3 ± 1.3	0.004
Age 31-50	23	25.9	26.3	-0.5 ± 1.5	0.747
nonTHLB	7	32.1	27.5	4.5 ± 1.6	0.031
THLB	34	21.5	25.0	-3.5 ± 1.1	0.002
All	41	23.3	25.4	-2.2 ± 1	0.042

The previous comparison looked only at the SI for the ground leading species. Some of the ground samples also include SI information for the secondary and tertiary species. The PSPL was compared to all species that had ground SI estimates, regardless of whether they were leading species. As with the leading species comparison, the ground SIs are generally lower than the PSPL SI (Table 13 and Figure 8). The biggest differences were for CW which is based on a small sample size (n = 4) and young trees.

Table 13. The ground and PSPL SI are compared by ground species group. Statistically significant differences (p-value < 0.05) are shaded.

Species		Breast	Height	Age	SI (m)			
Group	N	Mean	Min	Max	Ground	PSPL	Bias	p-value
CW	4	14.3	13	16	14.3	17.9	-3.6 ± 0.7	0.014
HW	38	31.5	14	55	21.3	23.4	-2 ± 1.1	0.07
SS	35	32.2	15	54	25.4	28.8	-3.3 ± 1	0.003

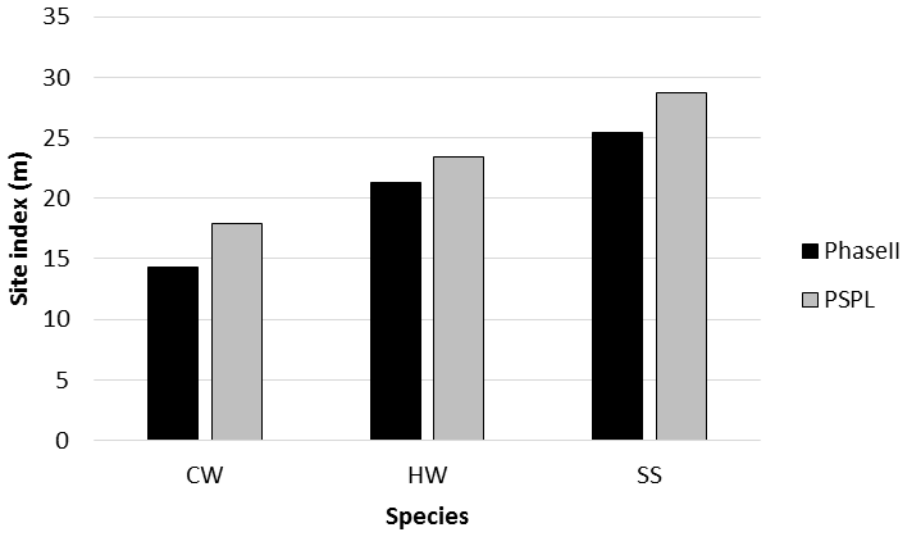

Figure 8. The ground and PSPL SI are compared by species. The data are given in Table 13.

6.3 Leading Species

Twenty-five (58%) of the plots had the same inventory and ground leading species. Much of the confusion was between HW and SS, the dominant species. The average leading species percentage in the Phase I inventory was 66% compared to 64% for the ground sample. For 11 samples (or about 25%), the ground leading species comprised 50% or less of the species composition.

Table 14. The Ground and Phase I (Inventory) leading species are compared (4.0 cm utilization level). Agreement cells are shaded gray.

Ground Plot	VRI polygon leading species					%
Leading Species	CW	DR	HW	SS	Total	Agreement
CW			2		2	0%
DR		1			1	100%
HW	3		15	4	22	68%
PL			1		1	
SS		2	6	9	17	53%
Total	3	3	24	13	43	
% agreement	0%	33%	63%	69%		58%

Eight samples had 5% or less difference between the leading and second species in terms of species composition on the ground or in the inventory (Table 15). If the leading and second species in the inventory composition were switched when the difference ≤ 5%, three additional samples would have become case 1 matches. The overall effect would be to increase the agreement for leading species from 58% to 65%. If the tolerance was increased to include differences ≤ 10%, the agreement would rise to 72%.

Table 15. The samples with 5% or less difference between the leading and second species in terms of species composition. "Approx Case" is the case matching if the leading and second species are switched.

	Ground								VRI									Approx
	Spp	Spp	Spp	Spp	Pct	Pct	Pct	Pct	Spp	Spp	Spp	Spp	Pct	Pct	Pct	Pct	Case	Case
Clstr_id	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		
025Y-0063-YO1	HW				100				HW	SS	DR		50	45	5		1	1
025Y-0055-YO1	HW	CW	SS	YC	31	30	22	17	HW	SS			50	50			1	1
025Y-0039-YO1	SS	HW			69	31			SS	HW	CW	HM	40	40	10	10	1	1
025Y-0027-YO1	HW	SS			51	49			CW	HW	DR		60	25	15		2	1
025Y-0052-YO1	SS	DR	HW	CW	33	28	23	15	DR	SS			75	25			2	1
0251-0018-MO1	SS	HW			52	48			HW	SS	CW		80	10	10		2	1
0251-0020-MO1	SS	HW	CW	DR	38	34	13	10	HW	CW	SS		60	30	10		3	3
025Y-0054-YO1	SS	DR	HW		41	36	23	.	SS	HW			80	20			1	1

6.4 Basal area and trees/ha

Phase I Inventory trees/ha (TPH) and basal area (BA) are compared to the YSM ground data in order to assess the accuracy of these Phase I polygon attributes for young stands. Note that the Phase I TPH and BA are not used in TSR. As noted in section 4.5, the original source of the Phase I TPH and BA may be photo interpretation or silviculture surveys provided by RESULTS. When the inventory is projected using VDYP7, the TPH and BA are modified to represent only trees with DBH ≥ 7.5 cm in the projection year. However, BA and TPH are only updated by VDYP7 once the projected height is 7 m. The samples where the Phase I inventory BA and TPH have not been modified likely represent a lower utilization limit.

The ground and Phase I (Inventory) BA and TPH are compared in Table 16. Seven samples (20, 26, 27, 35, 50, 51 and 56) were not projected by VDYP7 and the BA and TPH were copied over from the input file and likely have a lower utilization limit. The effect of differing utilization levels and lack of updating BA and TPH is expected to be greater for younger samples. This is confirmed by the larger relative biases for BA associated with the 15 - 30 year age class (compared to the 31 – 50 year age class) and, to a lesser extent, by TPH. The higher BA in the nonTHLB compared to the THLB is unexpected and likely due to the older average age (41 vs. 31 years old, Table 10). Overall, the differences are not statistically significant.

Table 16. The ground plot and VRI Polygon BA and TPH are compared. Statistically significant differences (p-value < 0.05) are shaded.

Phase I		BA (m^2/ha)				Trees/ha			
Strata	N	Ground	VRI	Bias	p-value	Ground	VRI	Bias	p-value
CWHwh1	33	33.4	28.2	5.2 ± 2.2	0.026	1326	1090	236 ± 297	0.434
Other	10	24.5	22.9	1.6 ± 6	0.803	1376	594	782 ± 312	0.033
C	3	17.9	10.7	7.2 ± 10.3	0.553	1434	1536	-101 ± 1017	0.930
H	24	24.7	17.1	7.6 ± 2.2	0.002	1327	1084	243 ± 389	0.539
Other	3	51	39.2	11.8 ± 8.4	0.298	959	795	164 ± 612	0.814
S	13	42.3	46.3	-4 ± 4.8	0.417	1422	686	736 ± 244	0.011
Young	19	14.2	7.2	7 ± 2.3	0.007	1205	1269	-64 ± 492	0.897
Older	24	45	42.7	2.3 ± 3.5	0.518	1443	742	700 ± 166	0.000
nonTHLB	8	49.9	43.7	6.2 ± 5.9	0.322	1295	697	598 ± 397	0.176
THLB	35	27.1	23.2	3.9 ± 2.4	0.106	1347	1039	309 ± 282	0.282
All	43	31.4	27.0	4.4 ± 2.2	0.053	1338	975	362 ± 240	0.139

7 Ground vs. TIPSY Volumes

The volumes associated with young stands are less important than the growth curves. Growth curves are generated by analysis units (AUs) for TSR. Remeasured ground plots are required to assess the accuracy of growth curves. Remeasured plots are not available for Haida Gwaii so the volume comparison is restricted to static volumes. Once remeasurement data are available, the AU curves should be evaluated. Two growth models are available for growth projections of managed stands – TASS and TIPSY. TASS generates the yield tables in the TIPSY database. TASS is based on growth trends observed in fully stocked research plots growing in a relatively pest-free environment. In addition, limited species and age mixtures are supported. When actual growing conditions depart from the ideal conditions, yields should be adjusted. TASS requires a stem-mapped tree list, not available here, so TIPSY was used to generate inventory volumes.

7.1 Residual trees

The following is taken from the CMI procedures (MSRM 2005, p.42)

> Classify all trees assessed on the larger tree plot as to whether it is a residual from a former stand. In making this assessment, refer to the general area around the plot. Trees are classed as residual if they are present in even aged stands, are living remnants of a former stand, and occur as the occasional (< 25 per ha) large stem of an older age class than the stand as a whole. Typically these trees have larger diameters, a higher incidence or indication of decay, thicker bark, larger branching and "ragged" or flat tops. These trees must be clearly residual. Uneven-aged stands do not generally have residual trees.

Residual trees identified by the ground crews were removed from this volume analysis.

7.2 Analysis Unit yield curves

The AU yield curves were provided by FAIB. They were part of a 2011 TSR analysis[8] and use the VRI that was current at that time. The AU yield curves were generated by the VRI information and VDYP7 or TIPSY. The VRI information is taken from the primary layer projected to 2012. Generally polygons with age < 30 use a TIPSY curve while older polygons use VDYP7. The reported volumes are net merchantable volumes (DBH ≥ 12.5 cm) with deciduous volumes excluded. The entire Haida Gwaii was re-inventoried in 2013 and the 2013 VRI is used elsewhere in this report.

Historically, in the absence of any better information, an OAF1 of 15% and an OAF2 of 5% have been applied to the managed stand yield curves. The rationale behind OAFs is to reduce the theoretical projected yields from those found in research plots to actual yields experience in managed stands. The standard OAFs were used for the AU TIPSY curves and for TIPSY runs used in this report.

7.3 Predicted (Projected) Yield Estimates

For each sample plot, ground measured volumes were compared against two separate sets of TIPSY yield curves to quantify the overall volume bias as well as to partition the total bias into model bias and attribute bias. In addition, two types of volume were compared. Whole stem volume is the total stem

[8] Haida Gwaii Timber Supply Review Data Package 2011, November 8, 2011. Submitted by: Joint Technical Working Group. Submited to: Haida Gwaii Management Council and Jim Snetsinger, Chief Forester.

volume of live trees with DBH ≥ 7.5 cm. Net volume is the stem volume minus stump, top and net downs for all live trees with a utilization of 12.5 cm.

VOL1: Ground based plot volume. VOL1 is identical to the ground compiled volume except for the removal of residual trees.

VOL2: TIPSY estimated volumes using a combination of ground plot and AU assumption inputs. TIPSY simulations start with initial stand conditions. The main input attributes are species composition, SI, initial density and regeneration type (N = natural or P = planted). The species composition and SI were taken from the ground plot summaries. The initial density and the regen method for the ground plots were not known. The AU curves modelled stands older than 30 years at the time of analysis (2010) were modeled as VDYP7 natural stands and stands 30 and younger were modeled as TIPSY managed stands using a planted regime. Stands with a harvest year ≥ 1980 were assumed to be planted with 1,000 stems/ha. Stands with a harvest year < 1980 were assumed to be natural origin with an initial density of 5,000 stems/ha. One sample, 025Y-0049-YO1, was deciduous leading. It had a harvest year of 1965 and was modeled as a natural stand.

Regeneration delay was set to zero as was used in the data package. Similarly, gain1 was set to zero.

For each species, the average site index was computed as described in section 4.4. SI was always available for the leading species.

TIPSY does not model mixed stands but outputs the weighted average of pure species stand where the weights reflect the species composition. Pure species curves were generated for up to the top four species on the ground plots. For each species, the yield curve was generated assuming 100% species composition and the ground SI for that species. The ground SI was not always available for species other than the leading species. Where possible, the SI for additional species was generated using SiteTools and the SI for the leading species and the SiteTools SI conversion equations. If that was not possible, the PSPL SI was used. A mixed species, composite yield curve was generated by the weighted average pure species yield curves with weights equal to the species composition fraction. Height, BA, TPH and volume were taken as the species composition weighted average of the curves. The species-weighted average height is consistent with TIPSY output for multiple species runs which is the weighted top height by species.

The TIPSY total age is the age since disturbance and not necessarily breast height age plus years to breast height. It includes a regen delay, years to breast height and assumes an initial stock height. As a consequence, when the TIPSY total age is equal to the ground age, the TIPSY height will not necessarily equal the ground height. And the heights should match since the ground compiler and TIPSY use the same SI (SiteTools) curves. Rather than matching the ground and TIPSY at the same total age, the ground and TIPSY heights were matched and the corresponding TIPSY volume extracted. This is equivalent to matching the ground and TIPSY volumes at the same breast height age. For mixed species stands, the species-weighted average height from the TIPSY curves was matched to the species-weighted average height from the ground sample.

VOL3: TIPSY estimated volumes using the PSPL site index estimates and the VRI Phase I species composition. As with VOL2, for samples with a harvest year < 1980, natural regeneration was assumed with, 5,000 tree/ha. For samples with a harvest year ≥ 1980 were modeled as plantations with 1,000 trees/ha. The three samples with hardwood leading species had harvest years < 1980 and were modeled as natural origin stands. The TIPSY runs were similar to those for VOL2 except the species composition was taken from the VRI Phase I layer and SI from the PSPL. The TIPSY age was matched to PROJ_AGE_1 (corresponding to the age of ground sampling).

For some samples, the PSPL SI for HM or HW was lower than the TIPSY lower limit of 10 m. For these samples, the SI was set to 10 m. The TIPSY allowed SI range for DR is 20 to 32 and a number of samples had were below or above this range. The DRI SI were restricted to the acceptable range.

The three samples in the "Other" strata were DR leading and did not have PSPL SI estimates so VOL3 was not available.

If SI estimates were not available for non-leading species, TIPSY curves were not generated for that species and the combined curve was generated for the remaining species. For example, sample 025Y-0027-YO1, the Phase I species composition is Cw 60 Hw 25 Dr 15. SI estimates were not available for Dr so the combined yield curve was estimated as (0.60 x Cw + 0.25 x Hw)/(0.60 + 0.25).

VOL4: The AU volumes are described in section 7.2. These volumes correspond to a utilization of 12.5 cm and are generated for 10 year age classes. Volumes were interpolated for additional ages using Peter Ott's spline interpolation algorithm. VOL4 is the volume from the AU yield curve corresponding to PROJ_AGE_1 (adjusted to the year of ground sampling).

The bias was defined a follows.

Total Bias = VOL1 – VOL3 = Model Bias + Attribute Bias
Model Bias = VOL1 – VOL2
Attribute Bias = VOL2 – VOL3

7.4 Total bias - Ground compiler vs. TIPSY Volume

The ground volumes (VOL1) versus the TIPSY volumes from Phase I species composition and the PSPL SI (VOL3) are relatively close (Figure 9) except for samples 43 and 58.

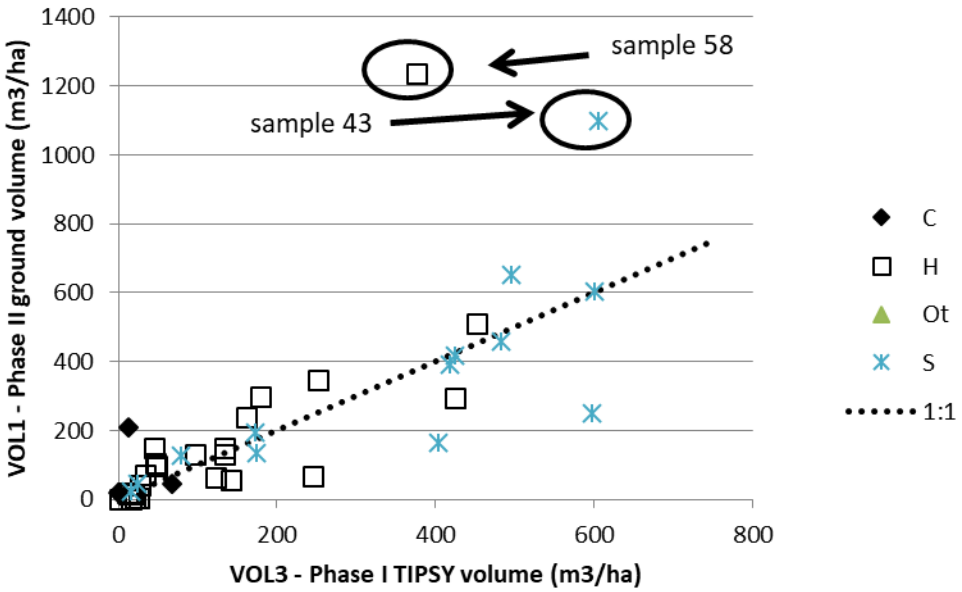

Figure 9. The ground volume is plotted against the TIPSY VOL3 predictions. Volumes are whole stem volume at the 7.5 cm utilization level.

7.5 Model bias - Ground vs. TIPSY Volume using ground attributes

The ground volumes (VOL1) were compared to the TIPSY volumes using the ground species composition and site index (VOL2) (Figure 10).

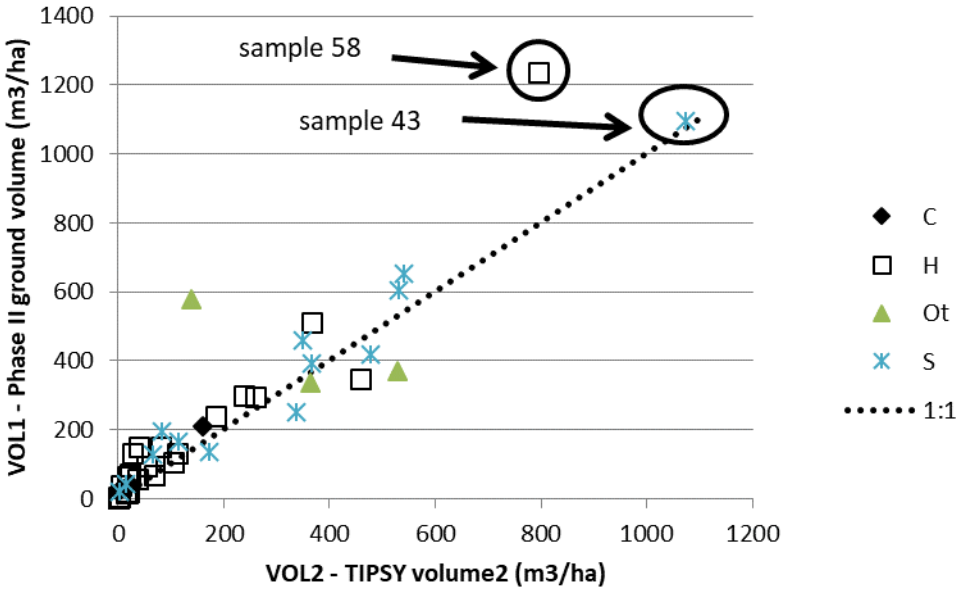

Figure 10. The ground volume is plotted against VOL2. Volumes are whole stem volume at the 7.5 cm utilization level.

7.6 Bias analysis

The differences between the ground attributes and the TIPSY estimates (e.g., VOL1 vs .VOL3) include errors from a number of sources. The initial density for the TIPSY runs is taken from the AU assumptions (based on the previous TSR) and are average values for the AU and may not reflect the individual sample. VOL3 is based on the Phase I species composition and PSPL site index while VOL1 is based on the ground measurements. The ground attributes represent a local 400 m^2 area while the Phase I attributes represent a larger polygon and the PSPL SI represents a 1 ha tile. The results of TIPSY whole stem volume comparisons are given in Table 17. The higher volumes in the nonTHLB relative to the THLB are likely due to the older ages associated with the polygons in the nonTHLB (Table 10).

Table 17. Ground and TIPSY whole stem volumes are compared. The utilization level is 7.5 cm. Statistically significant differences (p-value < 0.05) are shaded. Residual trees are excluded. The deciduous component is included.

Phase I	N	(m^3/ha)			Bias			p-value		
Strata		VOL1	VOL2	VOL3	Total	Model	Attribute	Total	Model	Attribute
Other	30	245.1	196.4	195.3	49.8 ± 35.4	48.8 ± 16.5	1.1 ± 26.9	0.170	0.006	0.968
SBS	10	143.1	134.6	173.7	-30.6 ± 45.9	8.5 ± 16.5	-39.1 ± 36.3	0.522	0.618	0.309
C	3	91.3	60.8	27.0	64.3 ± 68.4	30.5 ± 10.4	33.8 ± 58.4	0.446	0.099	0.621
H	24	164.9	121.9	126.0	38.9 ± 38.9	43 ± 20.1	-4.1 ± 24.5	0.327	0.043	0.867
Other	0									
S	13	350.2	317.6	345.4	4.8 ± 53.8	32.6 ± 17.7	-27.8 ± 50.7	0.930	0.090	0.594
Age 15-30	19	61.2	38.3	41.1	20.1 ± 13	22.9 ± 7.2	-2.9 ± 11.3	0.139	0.005	0.804
Age 31-50	21	362.9	309.9	324.5	38.5 ± 54.9	53 ± 24.2	-14.5 ± 41.3	0.491	0.041	0.729
nonTHLB	5	484.9	455.1	323.2	161.7 ± 86.7	29.8 ± 29.2	131.9 ± 84.6	0.136	0.365	0.194
THLB	35	181.7	141.7	170.8	10.9 ± 30.1	40 ± 14.7	-29.1 ± 20.6	0.720	0.010	0.167
All	40	219.6	180.9	189.9	29.7 ± 29.2	38.7 ± 13.2	-9 ± 22.1	0.314	0.006	0.687

The volumes net of decay, waste and breakage are given in Table 18. The samples are young and should not have much decay but the trees are small with a high fraction of non-merchantable volumes and stand level volumes are very sensitive to utilization level. Due to high variability, none of the differences are statistically significant.

Table 18. Ground and TIPSY volumes net of decay waste and breakage are compared. The utilization level is 12.5 cm. Statistically significant differences (p-value < 0.05) are shaded.

Phase I	N	(m^3/ha)			Bias			p-value		
Strata		VOL1	VOL2	VOL3	Total	Model	Attribute	Total	Model	Attribute
Other	30	195.8	169.7	164.5	31.3 ± 34	26.1 ± 13.9	5.2 ± 27.1	0.364	0.070	0.850
SBS	10	101.8	110.1	145.1	-43.2 ± 38.3	-8.2 ± 10.9	-35 ± 33.8	0.288	0.469	0.327
C	3	51.0	50.7	12.9	38.2 ± 44.5	0.3 ± 3.8	37.8 ± 48.1	0.482	0.935	0.515
H	24	123.0	100.3	99.9	23.1 ± 36.6	22.7 ± 16.9	0.4 ± 24.3	0.534	0.191	0.988
Other	0									
S	13	291.4	279.5	303.9	-12.5 ± 51.5	11.9 ± 13.5	-24.4 ± 50.7	0.812	0.395	0.639
Age 15-30	19	29.9	27.8	28.4	1.5 ± 8.2	2.1 ± 4	-0.6 ± 10.1	0.857	0.610	0.955
Age 31-50	21	301.1	269.6	278.4	22.8 ± 52.3	31.5 ± 20.3	-8.8 ± 41.3	0.668	0.137	0.834
nonTHLB	5	410.7	416.6	282.1	128.6 ± 85	-5.9 ± 19.5	134.5 ± 86.5	0.205	0.777	0.195
THLB	35	138.3	117.4	142.2	-3.9 ± 28.3	20.9 ± 12.2	-24.8 ± 20.4	0.892	0.096	0.232
All	40	172.3	154.8	159.7	12.7 ± 27.5	17.5 ± 11	-4.9 ± 22	0.647	0.118	0.826

The ground basal area (BA) and trees per hectare (TPH) were compared to those generated by TIPSY with the VOL3 scenario (Table 19). The Ground and TIPSY TPH both include all live trees with DBH ≥ 7.5 cm. TIPSY generates estimates of BA for all trees (DBH > 0cm). The closest equivalent in the ground compilation is BA for trees with DBH ≥ 4.0 cm. The contribution of trees with DBH < 4.0 to BA is likely to be small so the differences in ground and TIPSY BA due to utilization are anticipated to be small.

Table 19. The ground plot and TIPSY-generated trees/ha and basal area are compared. Statistically significant differences (p-value < 0.05) are shaded. The bias is total bias and includes both model and attribute bias, similar to the comparison of VOL1 vs. VOL3. The utilization level for BA is 4.0 so the numbers are slightly higher than in Table 16.

		Trees/ha				BA (m^2/ha)			
Phase I Strata	N	Ground DBH≥7.5cm	TIPSY DBH≥7.5cm	Bias	p-value	Ground DBH≥4.0cm	TIPSY DBH≥0cm	Bias	p-value
Other	29	1389	924	465 ± 157	0.006	34.9	23.6	11.2 ± 2.5	0.000
SBS	10	1373	868	506 ± 379	0.215	27.4	21.8	5.6 ± 5.8	0.359
C	3	1434	494	940 ± 608	0.262	21.2	2.6	18.6 ± 8.4	0.157
H	23	1360	857	503 ± 193	0.016	28.1	16.8	11.2 ± 3.2	0.002
Other	0								
S	13	1418	1099	319 ± 263	0.248	44.3	39.1	5.1 ± 3.7	0.187
Age 15-30	18	1248	478	770 ± 221	0.003	17.5	7.9	9.6 ± 2.6	0.002
Age 31-50	21	1502	1279	223 ± 189	0.252	46.2	36.2	9.9 ± 3.8	0.017
nonTHLB	5	1496	1115	381 ± 700	0.615	50.8	36.6	14.2 ± 4.5	0.035
THLB	34	1369	880	489 ± 143	0.002	30.3	21.2	9.1 ± 2.6	0.001
All	39	1385	910	475 ± 149	0.003	32.9	23.2	9.8 ± 2.4	0.000

7.7 Ground vs. AU volumes

The ground volumes are considerably higher than the AU volumes (Table 20). Note deciduous volumes are excluded from VOL4 and VOL1 in Table 20. The main deciduous species is DR with an average of 22.5 m^3/ha (whole stem volume DBH ≥ 7.5 cm) and 19.3 m^3/ha (net volume DBH ≥ 12.5 cm). The AU volumes are a combination of TIPSY (66%) and VDYP7 (34%) sources.

Table 20. Ground and AU volumes net of decay waste and breakage are compared. The utilization level is 12.5. Statistically significant differences (p-value < 0.05) are shaded. Note the AU volume (VOL4) does not include deciduous volume. The deciduous volume is removed from VOL1 in this comparison. Residual trees are excluded.

Phase I	N	(m^3/ha)			
Strata		VOL1	VOL4	Bias	p-value
Other	32	193.2	100.3	92.9 ± 38	0.020
SBS	10	94.8	46.6	48.2 ± 22.1	0.057
C	3	50.6	35.9	14.7 ± 63.3	0.838
H	23	122.4	36.6	85.8 ± 43.8	0.063
Other	3	204.9	314.7	-109.8 ± 75.8	0.284
S	13	273.1	137.2	135.9 ± 43.8	0.009
Age 15-30	18	29.0	5.1	23.9 ± 8.8	0.015
Age 31-50	24	275.4	149.4	126 ± 49.6	0.018
nonTHLB	7	354.8	259.9	94.8 ± 95.3	0.358
THLB	35	132.8	53.1	79.7 ± 30.5	0.013
All	42	169.8	87.6	82.2 ± 29.4	0.008

8 Discussion

The YSM population is dominated by hemlock followed by spruce (48% and 42% by basal area respectively) with minor amounts of alder, cedar, yellow cedar and pine. The highest volumes are found in the spruce stratum followed by the hemlock stratum. The ground average basal area is approximately 14% higher than the inventory estimates (Table 21). The bias is greatest in the younger age class (age 15 - 30). The bias in the older age class (age 31 – 50) is relatively smaller and not statistically significant. The lower inventory BA may be due in part to some polygons with short trees. VDYP7 does not project BA and volume until the projected height is approximately 7m.

The PSPL estimates of SI are 9% higher than the ground estimates. The PSPL is the potential SI and expected to be higher than the actual SI. The range, by species, of the PSPL SI is quite narrow compared to the ground estimates. The PSPL estimates are based on SIBEC Site series so the amplitude in the PSPL will always be less than any set of ground observations.

Twenty-five (58%) of the samples have the same inventory and ground leading species.

For young stands, the volume is not as important as the growth trajectory. Stands are assigned to growth curves based by AU. It is important stands get assigned to the correct AU and that the AU growth curves are correct. Stands are assigned to AUs based on inventory information including species composition and SI. The accuracy of the inventory species composition and SI are assessed here. The ground plots should be remeasured and the accuracy of the growth trajectories assessed.

Overall, the volume bias is not statistically significant. The volume bias is dominated by model bias (18%) rather than attribute bias (-4%). This is dependent on the assumptions used to generate VOL2 and VOL3. In mixed species stands, TIPSY does not account for species interactions. The model bias should be further examined to verify the ground compiler estimates are accurate and the taper models and net downs are appropriate. The VDYP7 volume models may require adjustment as well.

The AU volumes are based on the previous inventory. The AU volumes are approximately half of the ground volumes and less than the inventory volumes.

The analysis has a number of complications. These are young samples and the trees are small. Small errors in age (e.g., due to missing the pith) and height can have relatively large effects on SI. The compilations and projections are sensitive to the utilization standard.

Table 21. The results of comparing the ground plots to the inventory and to the YSM assumptions are summarized. A p-value < 0.05 is generally considered an indication of statistically significant differences (or bias).

Attribute	N	Estimate	Ground mean	Inventory mean	Bias		
					Magnitude	% of ground mean	p-value
Basal area (m^2/ha)	43	VRI	31.4	27.0	4.4 ± 2.2	14%	0.053
Species matched age (years)	43	VRI	39.6	32.5	7.1 ± 2.7	18%	0.011
Species matched height (m)	43	VRI	15.4	16.3	-0.9 ± 0.7	-6%	0.208
Site index (m)	41	PSPL	23.3	25.4	-2.2 ± 1	-9%	0.042
Whole stem volume (m^3/ha)	40	TIPSY	219.6	189.9	29.7 ± 29.2	14%	0.314
Volume model bias (m^3/ha)	40	TIPSY			38.7 ± 13.2	18%	0.006
Volume attribute bias (m^3/ha)	40	TIPSY			-9 ± 22.1	-4%	0.687

9 Recommendations

For young stands, a key question is whether the stands are growing as predicted. This can only be verified with remeasurement data. The ground plots should be remeasured.

The PSPL is an estimate of potential productivity and the TIPSY volumes are estimates of potential yield. Operational SI and yield may be lower than the potential due to many factors. Knowledge of these factors should be used to adjust yields.

10 List of References

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11 Appendix A – Plot Data Summaries

Table 22. The Plot data summaries are given.

		Phase II									Phase I							Site	Prod	Layer		
samp_no	Strata	BA 7.5	TPH 7.5	WSV 7.5	WSV dead	Vol dwb 12.5	Spp1	HT1	Age1	SI1	BA 7.5	TPH 7.5	WSV 7.5	Dead Vol	Spp1	HT1	Age1	CW	HM	HW	PL	SS
025Y-0027-YO1	C	35.4	2477	211	12	129	Hw	14.3	35.3	22.8	10.0	1100			CW	7.3	20	20	26.1	26.1		31.2
025Y-0028-YO1	C	11.9	1126	44	0	19	Hw	9.1	42.0	12.5	22.0	757	125		CW	12.9	37	16	24	24		24.0
025Y-0050-YO1	C	6.5	700	19	0	5	Hw	6.8	20.5	21.9	0.0	2750			CW	4.8	16	21	24.1	24.1		29.3
0251-0018-MO1	H	4.4	575	15	0	2	Ss	8.3	24.3	24.2	5.3	259	16		HW	8.3	22	12	16	16	16	31.6
0251-0020-MO1	H	2.0	275	5	3	1	Ss	5.2	23.5	18.9	1.0	2125			HW	6.9	23	17.3	23.5	23.5		26.2
0251-0021-MO1	H	66.3	2076	512	0	422	Hw	20.6	48.8	23.4	47.4	624	406		HW	23.5	48	19.6	25.9	25.9		29.6
025Y-0022-YO1	H	19.7	2377	72	2	17	Hw	10.3	42.8	16.4	2.6	125	8		HW	7.9	22	20.7	23.2	23.2		26.9
025Y-0023-YO1	H	16.8	725	67	0	48	Hw	9.4	39.5	14.0	13.7	616	71		HW	13.0	38	20.3	24.1	24.1		27.6
025Y-0024-YO1	H	20.4	1351	107	0	66	Hw	15.0	30.3	27.0	8.8	393	33		HW	9.4	27	20.3	20.6	20.6		28.6
025Y-0026-YO1	H	4.8	475	17	0	6	Ss	7.8	21.5	26.5	2.0	3000			HW	7.2	20	21	22	22		29.0
025Y-0029-YO1	H	13.0	876	57	0	35	Hw	10.7	33.5	18.7	15.5	626	68		HW	11.5	32	19.8	23.2	23.2		27.6
025Y-0030-YO1	H	38.3	1276	239	0	194	Ss	16.8	36.5	26.3	12.4	589	80		HW	14.8	35	21.2	23.7	23.7		29.3
025Y-0032-YO1	H	6.0	725	19	0	5	Hw	5.5	34.2	8.3	2.4	115	7		HW	7.6	20	19	21.9	21.9	18.7	29.1
025Y-0035-YO1	H	1.5	175	4	0	0	Cw	6.5	26.5	15.7	1.0	2700			HW	7.2	22	18.4	23.6	23.6	20	26.3
025Y-0036-YO1	H	45.2	1451	300	2	249	Hw	17.3	36.3	25.9	35.4	1015	318		HW	23.6	37	21.2	23.1	23.1	20	28.9
025Y-0038-YO1	H	20.8	1001	131	0	99	Hw	16.8	32.5	27.8	14.1	623	76		HW	11.1	31	21.2	23.7	23.7		29.3
025Y-0040-YO1	H	31.9	3552	151	0	42	Ss	12.1	24.5	30.2	18.8	765	104		HW	14.4	21	20.9	24.5	24.5		29.4
025Y-0042-YO1	H	20.9	1826	96	95	52	Hw	14.9	34.5	24.1	13.7	585	79		HW	12.3	31	15.2	20	20	16	27.9
025Y-0047-YO1	H	44.1	3027	294	6	181	Hw	17.4	50.2	19.6	58.6	534	650		HW	29.6	48	20.6	24.6	24.6		28.0
025Y-0048-YO1	H	42.2	776	347	0	307	Ss	24.4	45.3	29.5	32.2	966	181		HW	15.7	37	20.3	25.1	25.1		28.5
025Y-0051-YO1	H	0.5	50	1	0	0	Pl	5.6	18.0	17.8	3.0	2375			HW	5.6	17	21.4	22.9	22.9		29.2
025Y-0055-YO1	H	17.0	1001	66	270	41	Hw	10.6	135.8	11.3	8.2	386	30		HW	9.9	26	22.1	25.2	25.2		30.4
025Y-0056-YO1	H	0.0	0	0	0	0	Cw	4.4	25.5	11.4	1.0	5353			HW	7.2	22	16.9	23.6	23.6		26.8
025Y-0058-YO1	H	96.8	1751	1237	115	1110	Hw	33.6	45.8	38.8	64.4	552	694		HW	30.3	44	21	24.4	24.4		31.0
025Y-0061-YO1	H	12.8	1526	40	0	11	Hw	8.1	31.0	16.6	3.7	181	12		HW	8.1	24	16	20	20		24.0

		Phase II									Phase I							Site	Prod	Layer		
samp_no	Strata	BA 7.5	TPH 7.5	WSV 7.5	WSV dead	Vol dwb 12.5	Spp1	HT1	Age1	SI1	BA 7.5	TPH 7.5	WSV 7.5	Dead Vol	Spp1	HT1	Age1	CW	HM	HW	PL	SS
025Y-0062-YO1	H	33.9	2577	149	4	77	Hw	13.2	35.3	22.3	35.7	1112	171		HW	13.8	33	19.4	22.5	22.5		24.7
025Y-0063-YO1	H	33.4	2402	133	274	74	Hw	10.3	63.5	9.6	8.5	399	31		HW	9.6	30	18.7	22.1	22.1		24.3
025Y-0049-YO1	O	36.3	575	337	46	300	Dr	23.3	45.8	27.0	32.7	763	210		DR	17.9	50	21.1	26.5	26.5		31.6
025Y-0052-YO1	O	72.8	1976	577	26	481	Ss	24.2	45.5	29.2	44.2	621	432		DR	24.4	48	20.3	25.9	25.9		29.4
025Y-0053-YO1	O	43.8	325	369	29	332	Ss	28.3	50.0	31.0	40.7	1000	293		DR	19.4	43	23.3	25	25		29.6
0251-0019-MO1	S	62.4	1176	603	9	526	Ss	28.6	42.5	35.3	66.6	437	792		SS	34.9	48	19.7	26.3	26.3		30.2
025Y-0025-YO1	S	13.5	976	44	0	22	Ss	8.0	27.0	20.9	1.2	69	3		SS	8.0	23	14.4	8	18.4		24.0
025Y-0031-YO1	S	37.1	2201	193	1	126	Hw	15.1	35.3	23.9	28.4	1147	137		SS	12.8	31	21.2	23.1	23.1	20	28.9
025Y-0033-YO1	S	29.3	2752	129	0	52	Hw	12.0	24.8	27.6	16.1	656	75		SS	12.7	23	21	23.2	23.2	20	28.8
025Y-0034-YO1	S	46.8	375	418	0	379	Ss	24.8	35.3	36.6	76.2	701	884		SS	33.2	39	18.9	25.7	25.7		30.1
025Y-0037-YO1	S	67.4	1576	652	6	557	Hw	26.6	49.3	29.4	53.4	851	386		SS	22.0	48	20.6	24.7	24.7	20	29.1
025Y-0039-YO1	S	7.8	876	22	1	3	Ss	6.2	25.3	19.1	2.5	128	7		SS	8.1	22	14.4	8	18.4		24.0
025Y-0041-YO1	S	36.5	3202	165	2	80	Ss	13.1	47.8	16.9	71.8	761	731		SS	29.3	43	19.8	23.2	23.2		27.6
025Y-0043-YO1	S	79.9	625	1097	19	1009	Ss	38.0	47.8	41.1	74.6	482	866		SS	34.4	49	19.9	26.07	26.07		29.0
025Y-0054-YO1	S	30.8	926	252	0	209	Ss	22.6	45.0	27.7	57.3	875	427		SS	22.3	44	21.7	26.9	26.9		32.4
025Y-0057-YO1	S	51.1	1051	393	10	345	Hw	20.4	55.5	21.1	54.2	820	358		SS	20.4	46	19.7	24	24		27.2
025Y-0059-YO1	S	22.9	625	135	0	113	Ss	16	29.3	30.9	40.5	1235	230		SS	16.0	26	21.9	25.7	25.7		31.4
025Y-0060-YO1	S	64.0	2126	460	32	375	Ss	20.3	58.8	20.1	59.4	755	476		SS	24.9	40	20.3	26.2	26.2	20	32.6

12 Appendix B – Plot Data Summaries

Table 23. The volume predictions associated with each sample are given.

		Ground				VOL2 (ground leading species)				VOL3 (Phase I leading species)					
Sample	TH LB	Leading species	Leading species age	SI	WSV (m^3/ha)	BA (m^2/ha)	TPH	Top height (m)	WSV (m^3/ha)	Phase I Spp	PSPL SI	BA (m^2/ha)	TPH	Top height (m)	WSV (m^3/ha)
025Y-0027-YO1	1	Hw	35.3	22.8	211	26.5	764	14.5	160	CW	20	2.4	371	8.6	12
025Y-0028-YO1	1	Hw	42.0	12.5	44	3.6	212	6.2	22	CW	16	5.2	1067	11.3	68
025Y-0050-YO1	1	Hw	20.5	21.9	19	0.0	8.69	4.4	0	CW	21	0.1	43	6.6	0
0251-0018-MO1	1	Ss	24.3	24.2	15	3.8	387	8.9	14	HW	16	2.3	94	7.1	13
0251-0020-MO1	1	Ss	23.5	18.9	5	0.7	81.2	2.0	2	HW	23.5	5.0	530	9.7	25
0251-0021-MO1	1	Hw	48.8	23.4	512	39.1	1652	20.1	367	HW	25.9	46.0	1523	23.3	452
025Y-0022-YO1	1	Hw	42.8	16.4	72	5.1	604	10.1	23	HW	23.2	7.1	613	10.0	34
025Y-0023-YO1	1	Hw	39.5	14.0	67	5.2	1189	10.2	69	HW	24.1	22.8	1704	17.4	245
025Y-0024-YO1	0	Hw	30.3	27.0	107	20.0	770	14.4	104	HW	20.6	9.4	685	11.3	47
025Y-0026-YO1	1	Ss	21.5	26.5	17	3.7	540	7.8	17	HW	22	3.7	403	8.8	19
025Y-0029-YO1	1	Hw	33.5	18.7	57	4.6	369	7.0	36	HW	23.2	24.0	775	15.5	143
025Y-0030-YO1	1	Ss	36.5	26.3	239	28.2	759	16.3	184	HW	23.7	25.8	768	16.3	161
025Y-0032-YO1	1	Hw	34.2	8.3	19	1.1	190	2.9	19	HW	21.9	1.5	300	8.2	12
025Y-0035-YO1	1	Cw	26.5	15.7	4	0.0	21.8	6.7	1	HW	23.6	4.3	532	9.4	20
025Y-0036-YO1	1	Hw	36.3	25.9	300	22.1	1706	17.3	237	HW	23.1	16.3	1715	15.8	179
025Y-0038-YO1	1	Hw	32.5	27.8	131	18.4	737	14.9	112	HW	23.7	23.1	776	15.2	134
025Y-0040-YO1	0	Ss	24.5	30.2	151	16.0	760	11.9	79	HW	24.5	9.5	664	10.7	45
025Y-0042-YO1	1	Hw	34.5	24.1	96	12.0	744	11.9	55	HW	20	10.9	741	11.8	48
025Y-0047-YO1	1	Hw	50.2	19.6	294	25.4	1684	17.4	261	HW	24.6	46.7	1596	22.7	425
025Y-0048-YO1	1	Ss	45.3	29.5	347	46.2	1499	24.7	458	HW	25.1	23.3	1700	17.7	252
025Y-0051-YO1	1	Pl	18.0	17.8	1	0.0	4	4.8	0	HW	22.9	0.2	92	7.1	2
025Y-0055-YO1	1	Hw	135.8	11.3	66	3.6	246	6.6	18	HW	25.2	21.4	760	14.4	122
025Y-0056-YO1	1	Cw	25.5	11.4	0	0.0	0	4.7	0	HW	23.6	3.2	425	9.0	16
025Y-0058-YO1	1	Hw	45.8	38.8	1237	65.2	973	33.6	796	HW	24.4	36.3	1646	21.3	376
025Y-0061-YO1	1	Hw	31.0	16.6	40	0.9	251	7.8	6	HW	20	5.5	560	9.6	27

		Ground				VOL2 (ground leading species)				VOL3 (Phase I leading species)					
Sample	TH LB	Leading species	Leading species age	SI	WSV (m^3/ha)	BA (m^2/ha)	TPH	Top height (m)	WSV (m^3/ha)	Phase I Spp	PSPL SI	BA (m^2/ha)	TPH	Top height (m)	WSV (m^3/ha)
025Y-0062-YO1	1	Hw	35.3	22.3	149	8.4	684	10.9	40	HW	22.5	23.3	769	15.1	133
025Y-0063-YO1	1	Hw	63.5	9.6	133	5.7	622	10.4	26	HW	22.1	18.2	760	13.4	96
025Y-0049-YO1	0	Dr	45.8	27.0	337	33.3	927	24.6	363	DR					
025Y-0052-YO1	0	Ss	45.5	29.2	577	16.2	1293	13.4	139	DR					
025Y-0053-YO1	0	Ss	50.0	31.0	369	59.2	1060	26.6	529	DR					
0251-0019-MO1	1	Ss	42.5	35.3	603	51.0	1353	26.2	530	SS	30.2	63.4	1272	26.0	601
025Y-0025-YO1	1	Ss	27.0	20.9	44	3.8	540	8.0	16	SS	24.0	5.0	397	7.6	23
025Y-0031-YO1	1	Hw	35.3	23.9	193	16.5	778	13.8	83	SS	28.9	26.8	752	15.8	173
025Y-0033-YO1	1	Hw	24.8	27.6	129	13.5	744	11.7	66	SS	28.8	15.8	708	11.9	79
025Y-0034-YO1	0	Ss	35.3	36.6	418	53.4	1415	23.1	477	SS	30.1	47.9	1530	21.2	424
025Y-0037-YO1	0	Hw	49.3	29.4	652	53.9	1356	26.9	540	SS	29.1	51.5	1452	23.9	495
025Y-0039-YO1	1	Ss	25.3	19.1	22	0.4	136	6.2	3	SS	24.0	3.4	351	7.8	15
025Y-0041-YO1	1	Ss	47.8	16.9	165	10.8	1529	12.4	113	SS	27.6	44.7	1551	20.8	403
025Y-0043-YO1	0	Ss	47.8	41.1	1097	87.7	675	38.3	1075	SS	29.0	64.9	1242	25.8	605
025Y-0054-YO1	1	Ss	45.0	27.7	252	41.9	1331	19.0	338	SS	32.4	62.3	1288	25.9	597
025Y-0057-YO1	1	Hw	55.5	21.1	393	39.3	1631	19.8	365	SS	27.2	44.3	1554	21.7	418
025Y-0059-YO1	1	Ss	29.3	30.9	135	27.4	749	16.0	172	SS	31.4	27.5	747	15.6	174
025Y-0060-YO1	1	Ss	58.8	20.1	460	35.2	1613	19.4	349	SS	32.6	51.4	1447	23.2	483

13 Appendix C – Data Sreening

Some data screening was undertaken to identify potential issues.

The ground trees with ages > 50 are given in Table 24 and plots with ground basal area > 30 m^2/ha are given in Table 25.

Table 24. The age sample trees with age_tot > 50 are given. These are potential veteran trees.

Sample	Species	DBH	Height	Age_bh	Age_tot	resid	suit_tr	suit_ht	Comment
0251-0020-MO1	CW	9.8	6.1	57	69.5	R	Y	Y	Not a suitable tree
0251-0020-MO1	HW	9.4	5.8	49	57.5	R	N	Y	Not a suitable tree
025Y-0022-YO1	HW	14.3	10.5	66	74.5		Y	Y	
025Y-0025-YO1	SS	23	7	47	57.5	R	N	N	Not a suitable tree
025Y-0032-YO1	HW	9.6	5.2	46	54.5		N	N	Not a suitable tree
025Y-0035-YO1	HM	11.5	5.6	58	66.5	R	Y	N	Not a suitable tree
025Y-0037-YO1	HW	37.1	29.1	48	53.5		Y	Y	
025Y-0037-YO1	HW	38.3	22.9	45	50.5		Y	Y	
025Y-0037-YO1	SS	35.8	29.8	46	51.5		Y	Y	
025Y-0037-YO1	SS	26.2	19.9	48	55.5		Y	Y	
025Y-0038-YO1	HW	31.6	20.5	84	91.5	R	Y	N	Not a suitable tree
025Y-0038-YO1	SS	31.9	20.8	54	62.5		Y	Y	
025Y-0041-YO1	HW	24.9	14.5	186	194.5	R	N	N	Not a suitable tree
025Y-0041-YO1	HW	15.5	11.6	43	50.5		Y	Y	
025Y-0041-YO1	SS	16.5	11	49	58.5		Y	Y	
025Y-0047-YO1	HW	20.6	16.1	46	53.5		Y	Y	
025Y-0047-YO1	HW	19.1	18.5	44	50.5		Y	Y	
025Y-0047-YO1	HW	24.9	13.2	148	156.5	R	N	N	Not a suitable tree
025Y-0047-YO1	SS	27.5	20.8	45	52.5		Y	Y	
025Y-0047-YO1	SS	18.5	18.7	43	50.5		Y	Y	
025Y-0047-YO1	SS	35	21.6	47	54.5		Y	Y	
025Y-0047-YO1	SS	21.4	16.3	42	50.5		Y	Y	
025Y-0048-YO1	HW	23.5	21.4	45	51.5		Y	Y	
025Y-0049-YO1	DR	35.8	22.9	49	50.5		Y	Y	
025Y-0053-YO1	SS	65.9	28.5	45	51.5		Y	Y	
025Y-0055-YO1	CW	26.8	11	103	115.5		N	Y	Not a suitable tree
025Y-0055-YO1	CW	22.7	8.3	75	87.5		N	Y	Not a suitable tree
025Y-0055-YO1	CW	29.8	11.6	139	151.5		Y	Y	remove for SI - too old
025Y-0055-YO1	HW	18.5	8.6	81	89.5		Y	Y	
025Y-0055-YO1	HW	26.8	14.8	277	285.5		Y	Y	remove for SI - too old
025Y-0055-YO1	SS	12.2	6.5	46	56.5		Y	Y	
025Y-0057-YO1	HW	29.3	15.6	45	52.5		Y	Y	
025Y-0057-YO1	HW	28.3	20.2	48	54.5		Y	Y	
025Y-0057-YO1	HW	29	21.4	65	71.5		Y	Y	
025Y-0057-YO1	HW	39.2	24.8	45	50.5		Y	Y	
025Y-0060-YO1	HW	35.7	19.1	46	52.5		Y	Y	
025Y-0060-YO1	HW	22.4	18	48	54.5		Y	Y	
025Y-0060-YO1	HW	39.7	23.5	47	52.5		Y	Y	
025Y-0060-YO1	SS	32.4	22.4	48	55.5		Y	Y	

Sample	Species	DBH	Height	Age_bh	Age_tot	resid	suit_tr	suit_ht	Comment
025Y-0060-YO1	SS	56	20.4	58	66.5		Y	Y	
025Y-0060-YO1	SS	27.3	17.1	48	56.5		Y	Y	
025Y-0060-YO1	SS	35.8	21.2	49	56.5		Y	Y	
025Y-0063-YO1	HW	16.3	8	53	61.5		Y	Y	
025Y-0063-YO1	HW	23.7	11.5	63	71.5		Y	Y	
025Y-0063-YO1	HW	17	8.9	53	61.5		Y	Y	
025Y-0063-YO1	HW	24	12.8	52	59.5		Y	Y	

Table 25. The samples with ground basal area > 30 m^2/ha are given.

		YSM Ground					Phase I Photo			
Sample	Strata	Basal area (m^2/ha)	Stems /ha	Volume (m^3/ha)	Height (m)	Age (years)	Basal area (m^2/ha)	Volume (m^3/ha)	Age (years)	Height (m)
025Y-0027-YO1	C	35.4	2477	211	14.3	35	10.0		20	7.3
0251-0021-MO1	H	66.3	2076	512	20.6	49	48.1	408	48	23.5
025Y-0030-YO1	H	38.3	1276	239	16.8	37	23.9	136	35	14.8
025Y-0036-YO1	H	45.2	1451	300	17.3	36	40.6	345	37	23.6
025Y-0040-YO1	H	31.9	3552	151	12.1	25	27.1	138	21	14.4
025Y-0047-YO1	H	44.1	3027	294	17.4	50	58.8	651	48	29.6
025Y-0048-YO1	H	42.2	776	347	24.4	45	37.5	200	37	15.7
025Y-0058-YO1	H	96.8	1751	1237	33.6	46	64.7	694	44	30.3
025Y-0062-YO1	H	33.9	2577	149	13.2	35	41.8	190	33	13.8
025Y-0063-YO1	H	33.4	2402	133	10.3	64	15.2	49	30	9.6
025Y-0049-YO1	Ot	36.3	575	337	23.3	46	33.2	212	50	17.9
025Y-0052-YO1	Ot	72.8	1976	577	24.2	46	44.4	433	48	24.4
025Y-0053-YO1	Ot	43.8	325	369	28.3	50	41.7	297	43	19.4
0251-0019-MO1	S	62.4	1176	603	28.6	43	66.7	792	48	34.9
025Y-0031-YO1	S	37.1	2201	193	15.1	35	40.6	181	31	12.8
025Y-0034-YO1	S	46.8	375	418	24.8	35	76.4	885	39	33.2
025Y-0037-YO1	S	67.4	1576	652	26.6	49	54.7	390	48	22.0
025Y-0041-YO1	S	36.5	3202	165	13.1	48	72.1	733	43	29.3
025Y-0043-YO1	S	79.9	625	1097	38.0	48	74.7	866	49	34.4
025Y-0054-YO1	S	30.8	926	252	22.6	45	58.2	430	44	22.3
025Y-0057-YO1	S	51.1	1051	393	20.4	56	55.2	361	46	20.4
025Y-0060-YO1	S	64.0	2126	460	20.3	59	60.2	479	40	24.9