Haida Gwaii Timber Supply Review
Data Package Appendices

Timber Supply Review Technical Working Group report for the Haida Gwaii Management Council

2019

Contents

Appendix 1 Meta data on timber supply spatial inputs

Input	Source	Reference file (TSR Geodatabase)
Protected Areas (CHN/Federal, 51N)	GeoBC: WHSE_ADMIN_BOUNDARIES.CLAB_NATIONAL_PARKS	FEDPA_51N
Protected Areas (CHN/Provincial, 60N)	GeoBC: TA_CA_SVW_polygon TA_PEP_SVW_polygon	PROVPA_60N
Surface water (TRIM waterbodies)	GeoBC: TRIM	WATER
Current roads	GeoBC: FTEN_ROAD_SECTION_LINES_SVW CHN: road updates	ALLROADS MSROADS
Federal Reserves (IR, 52N)	GeoBC: WHSE_ADMIN_BOUNDARIES.CLAB_INDIAN_RESERVES	REDIR_52N
Federal Misc (Military/other, 53N, 54N)	GeoBC: WHSE_TANTALIS.TA_CROWN_TENURES_SVW	FEDBLOCK_54N FEDMILITARY_53N
Provincial Reserves/non-timber tenures (69N, 68U, 61C)	GeoBC: TA_CPR_SVW_polygon WHSE_TANTALIS.TA_CROWN_TENURES_SVW	PROVMISCRES_69N PROVRECRES_68U PROVUREP_61C
Private (crown grants-40N)	GeoBC: WHSE_CADASTRE.CBM_INTGD_CADASTRAL_FABRIC_SVW Integrated Cadastral Information Society layer	PRIVATE_40N
Municipal	GeoBC: MUN_NUM, CRWN_GRANTS	MUNBNDRY
Tree Farm Licence	WHSE_ADMIN_BOUNDARIES.FADM_TFL, WHSE_ADMIN_BOUNDARIES.FADM_TFL_ADDITION, WHSE_ADMIN_BOUNDARIES.FADM_TFL_DELETION, WHSE_ADMIN_BOUNDARIES.FADM_TFL_SCHED_A	PROVFMU_62c_update
Woodlot Licence	GeoBC: WHSE_FOREST_TENURE.FTEN_MANAGED_LICENCE_POLY_SVW	PROVFMU_62c_update
AFU	Taan Forest:AFU_8152017; Tlewis Mapping HGMC: afu_090814; Gowgaia: Riparian Fish Forest CWAPs	AFU_update

Input	Source	Reference file (TSR Geodatabase)
Type 1 Fish Habitat	HGMC: Sch04_TypeI_20101125 Gowlland: TypeI spatial model PECP_estuarypolys_with_ranking_March2007 est_bc_pt1 (LOS) herring_arc (CRIMS) Kelp_arc (CRIMS)	T1FISH_HAB
Type 2 Fish Habitat	HGMC: Sch04_TypeI_20101125 Gowlland: TypeII spatial model	T1FISH_HAB
Terrestrial Ecosystem Mapping	MFLNRORD: qci_ecp (Shikun Ran) TEM_jul5_10_v1 TEI_Long_tbl6469 (Madrone Louise) NEM_Long_tbl TSM_long_tbl RSLT_FCSLV_polygon Operational_Data_6519_2019.gdb	ECO_updated
Karst	Natural Resources Canada: Sutherland Brown	KARST
Forest Reserves (Marbled Murrelet, Rare Ecosystems)	HGMC: Sch08_FR_20170906	FRN
Marbled Murrelet reserves	HGLUOO annual submissions 2012-2016	MAMU
Northern Goshawk nesting	HGMC: Sch12_NOGO_20170905 Updates (draft reserves) to 2019	NOGO_update
Northern Goshawk predicted territories	HGMC: Technical Working Group	NOGOTERR_u pdate
Saw Whet Owl nesting	HGMC: Sch12_SAWO_20170905	SAWO
Black Bear denning	HGLUOO annual submissions 2012-2016	BEAR
Timber Harvesting Land Base	MoE: NOGO-6-001_ord NOGO-6-002_ord MAMU-6-041_ord MAMU-6-046_ord	THLB10000_Bas eCase_Oct31
	MFLNRORD: arch_sites_intersecting_Haida_Coastline_16May19 HGLUOO annual submissions 2012-2016 CHN: Haida Name Place CHN: CMT database	HERITAGE_up date

Input	Source	Reference file (TSR Geodatabase)
Cedar Stewardship Areas	HGMC: Sch03_Csa_20101125	CSA
Monumentals (current in-block)	HGLUOO annual submissions 2012-2016	MON
Haida Traditional Forest Features	HGLUOO annual submissions 2012-2016	HTFF
Yew	HGLUOO annual submissions 2012-2016	YEW
Trails	CHN: all-trails (Tlell Watershed Society- maintained trail map) Haida Mapping- traversed trails -maintained	TRAIL
Permanent Sample Plots	GeoBC: GRY_PSP_AL	PSP
Landslides	CHN	SLIDES
Class IV Terrain	terqci45; tert2545; tsm_qci; tsmqci45; tter_25_6; ssite (TFL39); fr82_pl3; Weiland2018	
Class V Terrain		TERRAIN
Vegetation Resource Inventory Phase I	GeoBC: veg_comp_lyr_r1_poly	-
RESULTS	GeoBC: RSLT_FCSLV_polygon	-
Visual Landscape Inventory	GeoBC: REC_VLND	VLIINV
Sensitive Watersheds	HGMC: Sch07_SensWS_20101125	SENSWSHDS
Upland Stream Areas	HGMC: Sch06_UpStrSubUnits_20101125	USAWSHDS
Community Watersheds	GeoBC: BC_COM_WTR	CWSHED1
Landscape Units	HGMC: Sch01_LU_20101124	LUNAME
Marbled Murrelet habitat	HGMC: Sch11_Mamu_20101125	MAMULU
Ecosections	MoE:	ECO_SECTIONS
2008-2017 harvest areas	GeoBC: RSLT_FCSLV_polygon Silvacare: 2017 depletion updates	MCBLOCKS_update
Community Forest Agreement (Proposed)		PROVFMU_CFA
First Nation Woodland Licence (Proposed)		PROVFMU_FNWL
Mosquito Lake watershed	LUP: Process Technical Team/CHN	MOSQLK_update
Operability Woodsheds	HGMC: Technical Working Group	OPWDSHEDS

Appendix 2 Enhanced SIBEC

An expert review coordinated by the TSR working group was conducted[1] to determine which of these previously unused plots could be used to provide updated site index estimates. These plots filled gaps in the SIBEC database; and provided additional information that needed to be compared to the SIBEC database and was assessed by the expert review group.

In proposing changes relative to the published SIBEC estimates, the review group based its recommendations on a combination of expert opinion and available data, considering the following:

- Confidence in site series calls or mensurational work of different plot sources. For example Site Index Adjustment studies explicitly reported that site series were not classified to SIBEC standards, and therefore these plots were not used for adjustments
- Expert experience with ecosystems on Haida Gwaii and along the coast in particular on the mainland adjacent to Haida Gwaii helped to assess the relative reasonableness of SI estimates from different sources based on knowledge of the growth of tree species on different ecosystem types and edatopes (moisture/nutrient) within site types, as well as experience with the comparative growth of different tree species on similar sites. This experience was used by the review team in assessing how and whether to apply data to override or use the existing SIBEC estimates in developing yield estimates.
- Sample sizes and standard error. For example, if the data set that contained a discrepancy relative to the existing SIBEC estimates was very small, less weight was placed on this additional information;

Generally, the expert review concluded that existing SIBEC estimates should be used in the analysis unless it was ecologically and statistically defensible to make a change. Of the approximate 73 forested site series on Haida Gwaii**Invalid source specified.**, SIs were re-assigned for 7 site series as a result of the review (See following table).

Table 2. Site series for which SI adjustments were made relative to the SIBEC database.

BG Zone/Var	Site Series	Species	2013 SIBEC Site index	Adjusted Site Index	No. Plots	St Dev of Site Index	Variance	SE
CWHwh1	101	Cw	21.4	20.08	30	3.56	12.67	0.65
CWHwh1	101	Hw	22.9	26.04	19	5.47	29.91	1.25
CWHwh1	102	Cw	20	18.16	8	3.79	14.33	1.34
CWHwh1	102	Hw	23.9	25.73	45	3.54	12.51	0.53
CWHwh1	102	Ss	27.9	25.37	57	6.06	36.76	0.80
CWHwh1	105	Ss	29.7	30.98	54	4.55	20.66	0.62
CWHwh1	110	Ss	16	22.97	8	4.52	20.41	1.60

[1] Dr. Sari Saunders, Provincial Regional Ecologist; Pam Dykstra, Research Leader forest ecologist interpretations; Dr. Allan Banner, Ecologist.

Appendix 3 Evaluating alternative sources of site index assignments

Evaluating site index assignment alternatives

Independent field plots from a Young Stand Monitoring project were used to evaluate site index assigned from various mapping projects including VRI (site tools), Ecosystem mapping, Provincial Site Productivity Layer and RESULTS silviculture records. Site index from the YSM program, in which SIBEC standards were used for choosing site index trees, can be used to evaluate the various potential site index assignment approaches. The purpose of the comparison was to evaluate which mapping system best represented site index relative to what was found in the field. In the end the ecosystem mapping (using primary deciles) matched with site index for each species component was chosen for the base case.

The 2016 Young Stand Monitoring project was implemented on Haida Gwaii by the Forest Analysis and Inventory Branch (deJong, 2017). A total of 43 ground samples were established in young stands (aged 15-50 years) in order to[2]:

- Characterize the stand species composition, structure, mortality and growth, yield[3] and health;
- Assess the accuracy of the Phase I (photo interpreted) Vegetation Resource Inventory;
- Assess the accuracy of site index estimates in the Provincial Site Productivity Layer;
- Compare observed stand yields to predictions generated from TIPSY, and;

Only two of the YSM plots were in cedar leading stands, which is expected given the short time over which cedar has been successfully regenerated after harvest on Haida Gwaii. Therefore no statistical inference could be made regarding cedar-leading site indices.

The following charts show comparisons of SI derived from YSM data to mapped SI approaches.

Five site index assignment approaches were evaluated against the YSM data: RESULTS[4]; Provincial Site Productivity Layer; VRI (Site Tools) ; and; SIBEC (both primary ecosystem and a separate multi-decile approach). In the following charts, green diamonds represent hemlock leading plots and the red triangles represent Sitka spruce leading plots.

[2] Excerpt from page 1 of (deJong 2017)

[3] Growth and yield comparisons will only be available when re-measurements become available (anticipated in 2021).

[4] On Haida Gwaii the majority of RESULTS standard units are assigned using SIBEC (52%), followed by SI assignments from 1998 rollover (18%), or SI from stand before harvest (12%). An issue is that SIBEC has been re-published over the years- so many of the records would be from 'older' (first-approximation) estimates

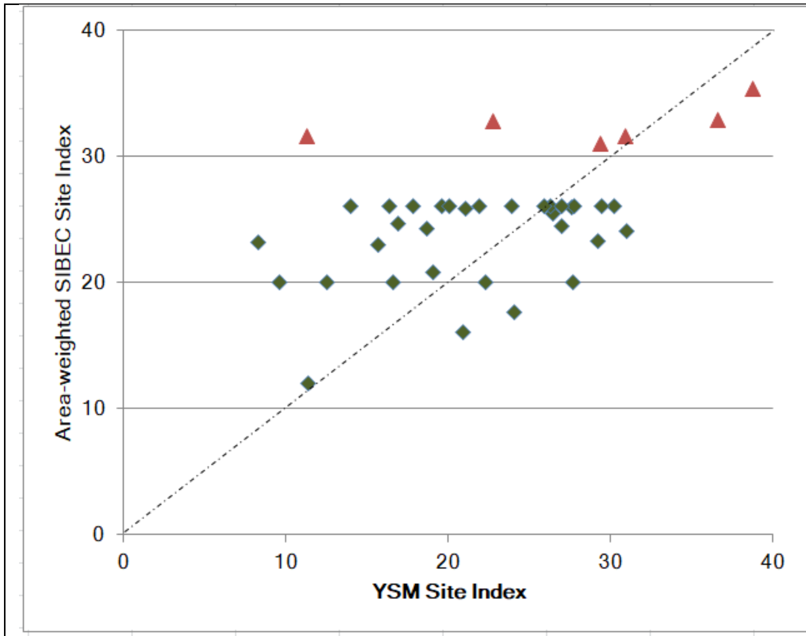


Figure 3.1 YSM site index compared to area-weighted site index from SIBEC and ecosystem mapping (green= hemlock, red=spruce)

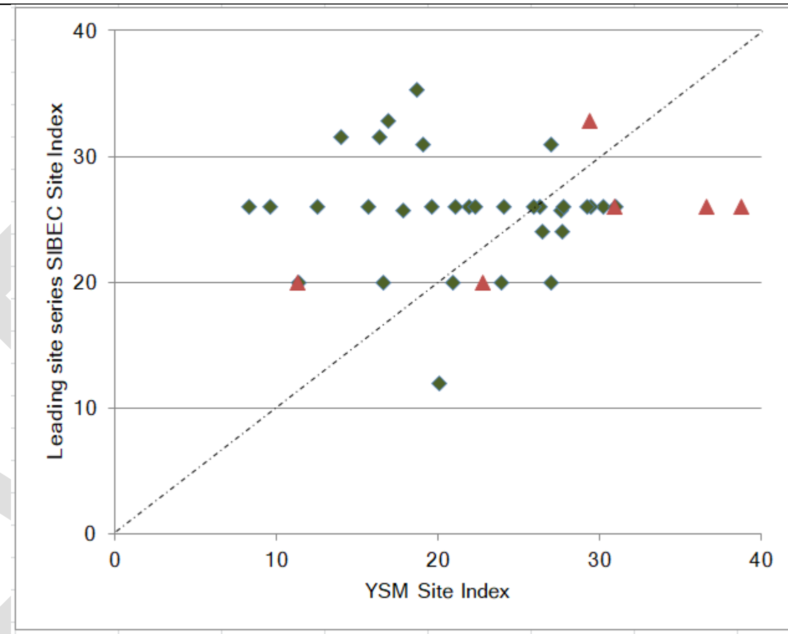
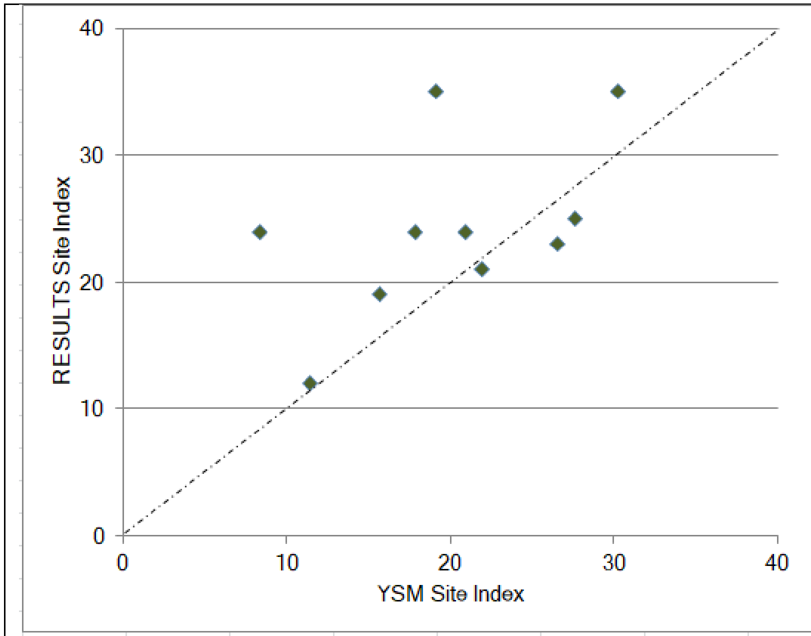


Figure 3.2 YSM site index compared to leading ecosystem site index from SIBEC and ecosystem mapping (green= hemlock, red=spruce)



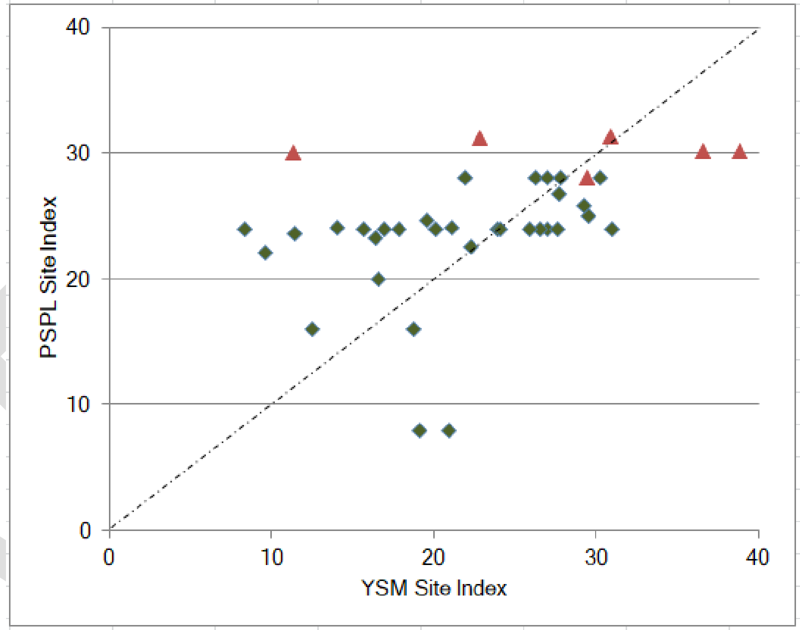


Figure 3.3 YSM site index compared to RESULTS site index (green= hemlock, red=spruce)	**Figure 3.4 YSM site index compared to the Provincial Site Productivity Site Index (green= hemlock, red=spruce)**

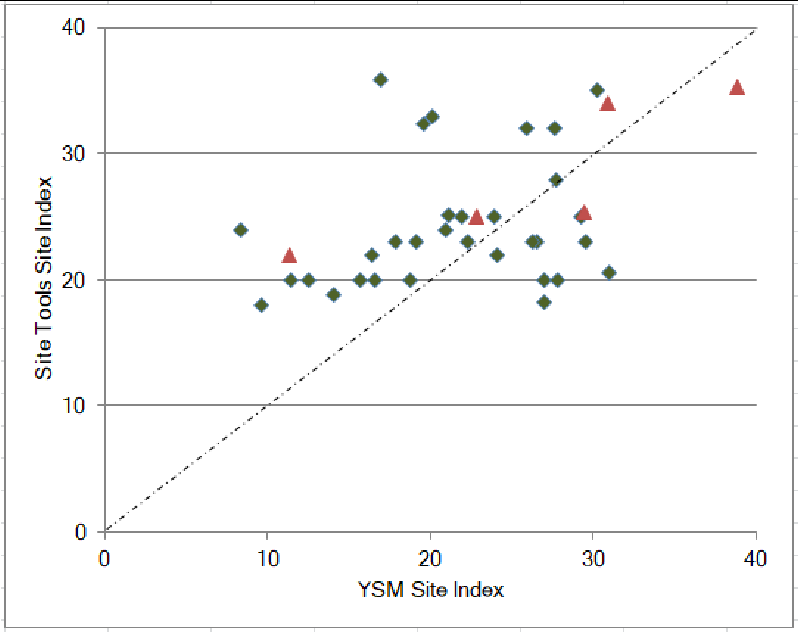


Figure 3.5 YSM site index compared to Site Tools site index (green= hemlock, red=spruce)

All of the mapping products over-estimated site index when compared with the YSM plots. The Provincial Site Productivity Layer was most closely aligned with the YSM site index (+5%, *SE 0.98*, table 4.3.4), however the dataset generalizes site index by species to the BEC variant level (e.g., CWHwh1) for the Timber Supply Area which was considered too coarse a scale for the variety of site types found in the TSA. The area-weighted site index (AWSI) approach, which uses all the deciles of the ecosystem mapping and species composition deciles, was closely aligned with the YSM site index (+9%, *SE 0.76*, table 4.3.1), however its application to growth curves would be impractical: weighting site index by the number of species per polygon (3 to 5) to the power of three (ecosystem mapping typically has three deciles). Therefore the primary decile ecosystem mapping (using SIBEC) was the next best mapping of site index when compared with the YSM plots (+11%, *SE 0.76* table 4.3.2). The following tables provides some descriptive statistics for this comparison:

Table 3.1 Area-weighted ecosystem mapping SIBEC compared to Young Stand Monitoring site index

	YSM	**AWSI SIBEC**	PERC_DIFF	*n*	SE
HW	21.5	23.4	1.09	32.0	0.63
SS	30.1	32.3	1.07	7.0	0.58
TOTAL	23.0	25.0	1.09	39.0	0.76

Table 3.2 Primary decile ecosystem mapping SIBEC compared to Young Stand Monitoring site index

	YSM	**Primary decile ECO SIBEC**	PERC_DIFF	*n*	SE
HW	21.5	25.7	1.20	32.0	0.79
SS	30.1	24.4	0.81	7.0	1.81
TOTAL	23.0	25.4	1.11	39.0	0.72

Table 3.3 RESULTS site index compared to Young Stand Monitoring site index

	YSM	**RESULTS SI**	PERC_DIFF	*n*	SE
HW	19.9	24.2	1.21	10.0	2.16
TOTAL	19.9	24.2	1.21	10.0	2.16

Table 3.4 Provincial Site Productivity Layer site index compared to Young Stand Monitoring site index

	YSM	**PSPL SI**	PERC_DIFF	*n*	SE
HW	21.5	23.1	1.07	32.0	0.86
SS	30.1	29.8	0.99	7.0	0.51
TOTAL	23.0	24.3	1.05	39.0	0.82

Table 3.5 VRI site index compared to Young Stand Monitoring site index

	YSM	**VRI SI**	PERC_DIFF	*n*	SE
HW	21.5	24.2	1.13	32.0	0.89

SS	30.1	31.5	1.05	7.0	2.80
TOTAL	23.0	25.5	1.11	39.0	0.98

Appendix 4 Qualifying managed stand growth and yield curves

Growth and Yield curves combine a variety of elements ranging from site index and stand volume models as well as stand table inputs (e.g. silviculture records, productivity estimates). It is therefore reasonable to question how well the G&Y curves compare to real-life independent measures. Using PSP data from Haida Gwaii, field plot measurements were grouped by field-assigned site series and quartiles of net merchantable volume per hectare[5] were calculated to compare or validate the TIPSY curves over time. While the following graphs do not represent all the site series found on Haida Gwaii, these do represent some of the most common growing sites within the THLB.

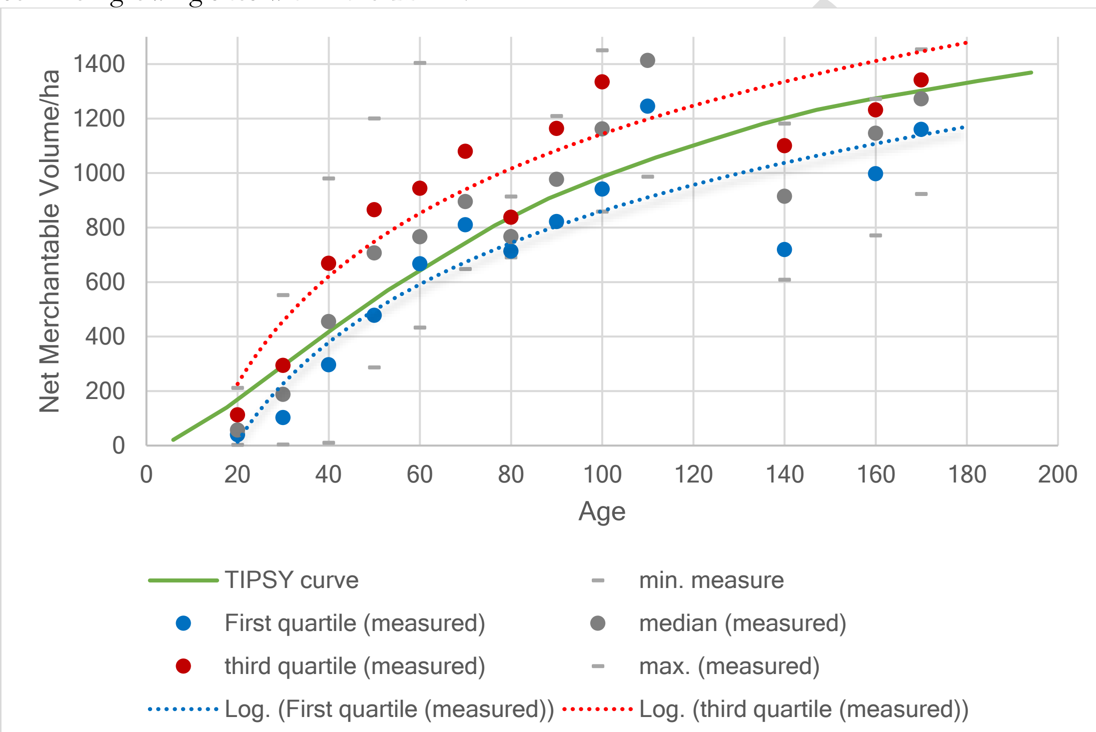


Figure 4.1 Net volume per hectare from measured PSPs (points and logarithmic curves) and TIPSY *future* managed stand curve for CWHwh1 01 site series from 46 plots and 426 re-measurements

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[5] Net merch volumes excluding 30cm stump height and 10cm top diameter-inside-bark at 12.5cm utilization (excluding veterans and ingrowth).

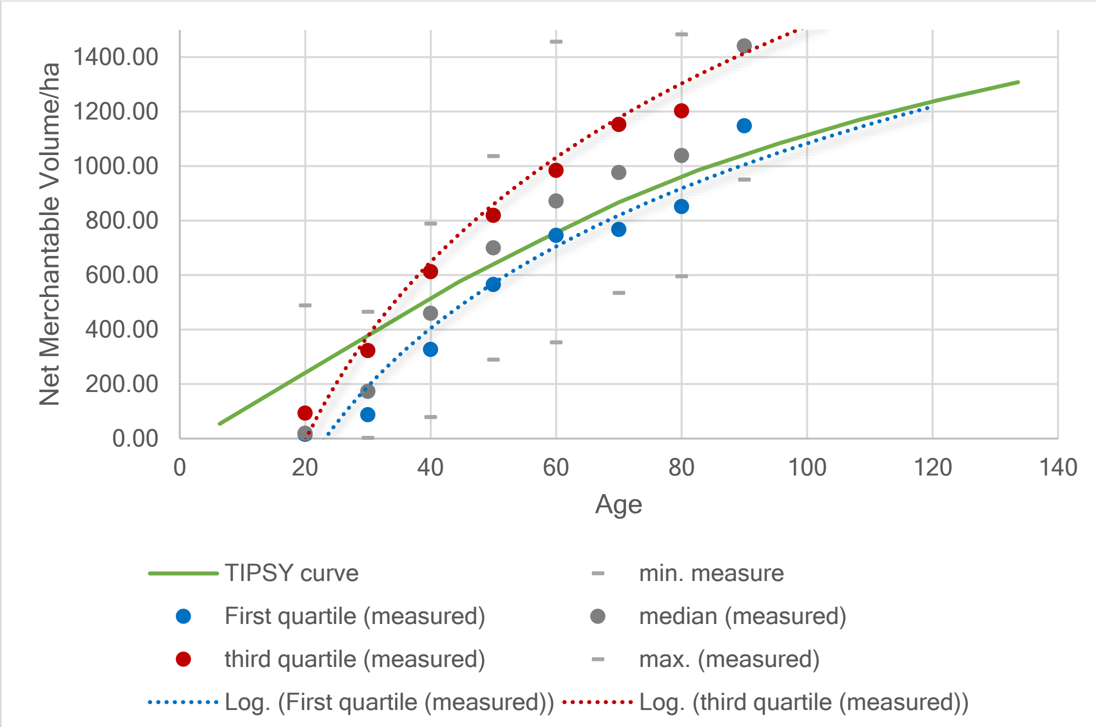


Figure 4.2 Net volume per hectare from measured PSPs (points and logarithmic curves) and TIPSY future managed stand curve f curve for CWHwh1 03 site series from 64 plots and 282 re-measurements

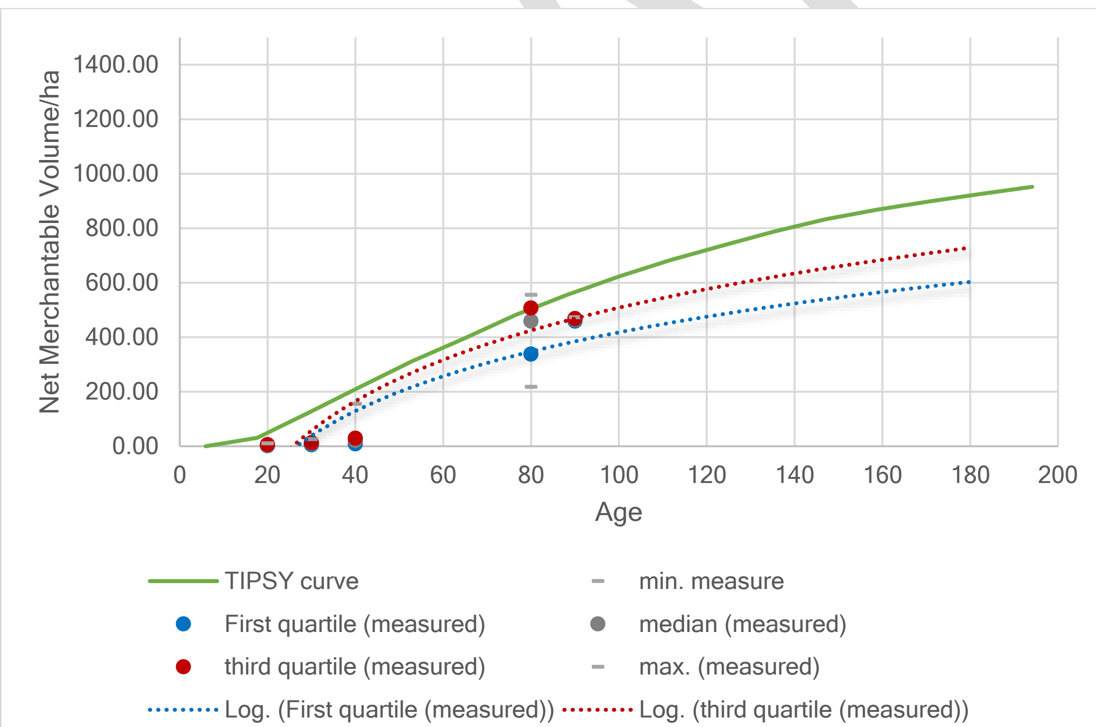


Figure 4.3 Net volume per hectare from measured PSPs (points and logarithmic curves) and TIPSY future managed stand curve f curve for CWHwh1 04 site series from 22 plots and 82 re-measurements

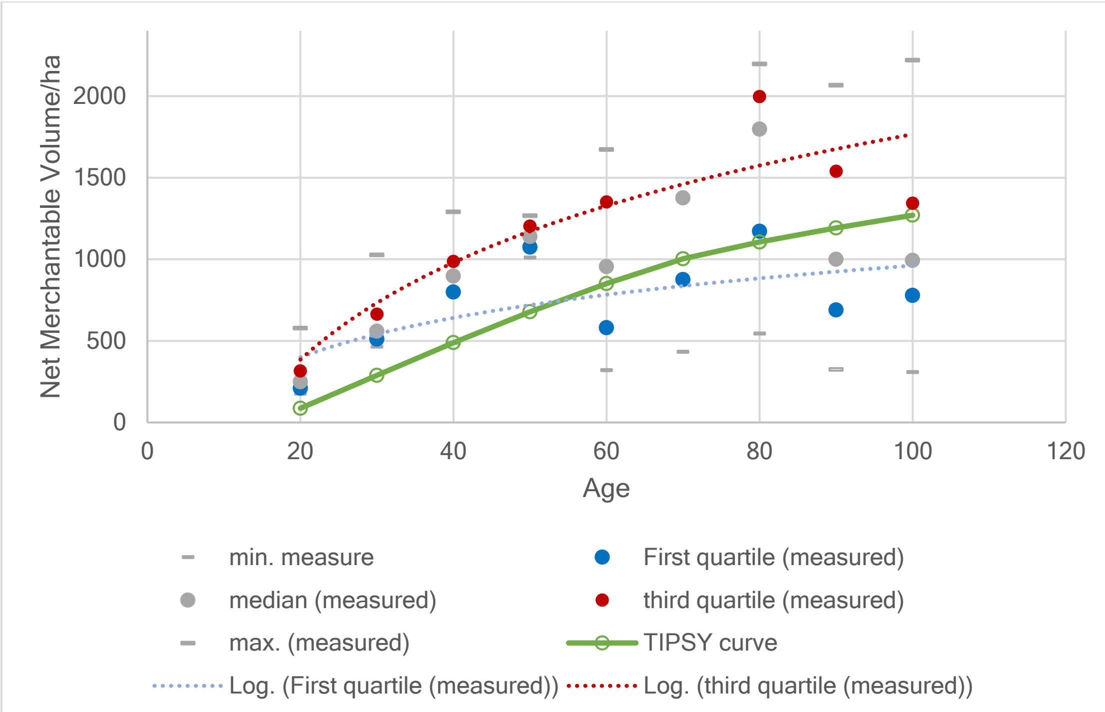


Figure 4.4 Net volume per hectare from measured PSPs (points and logarithmic curves) and TIPSY future managed stand curve f curve for CWHwh1 05 site series from 27 plots and 93 re-measurements

Existing managed stand curves comparisons with PSP data

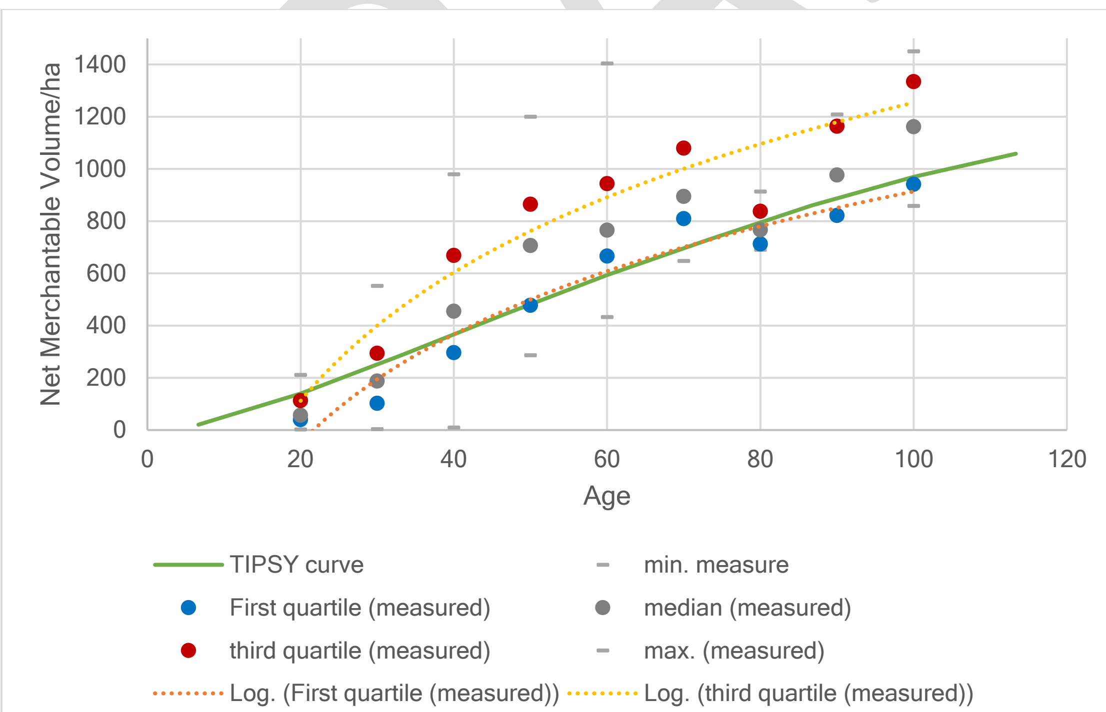


Figure 4.5 Net volume per hectare from measured PSPs (points and logarithmic curves) and TIPSY existing managed stand curve for CWHwh1 01 site series from 46 plots and 426 re-measurements

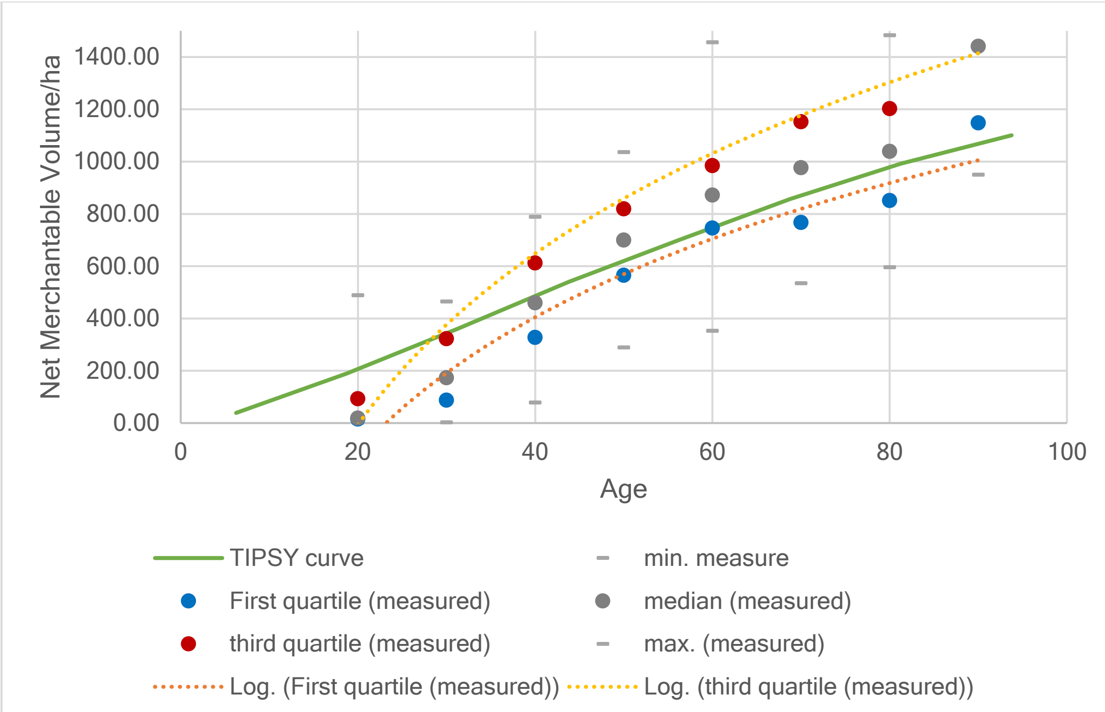


Figure 4.6 Net volume per hectare from measured PSPs (points and logarithmic curves) and TIPSY existing managed stand curve f curve for CWHwh1 03 site series from 64 plots and 282 re-measurements

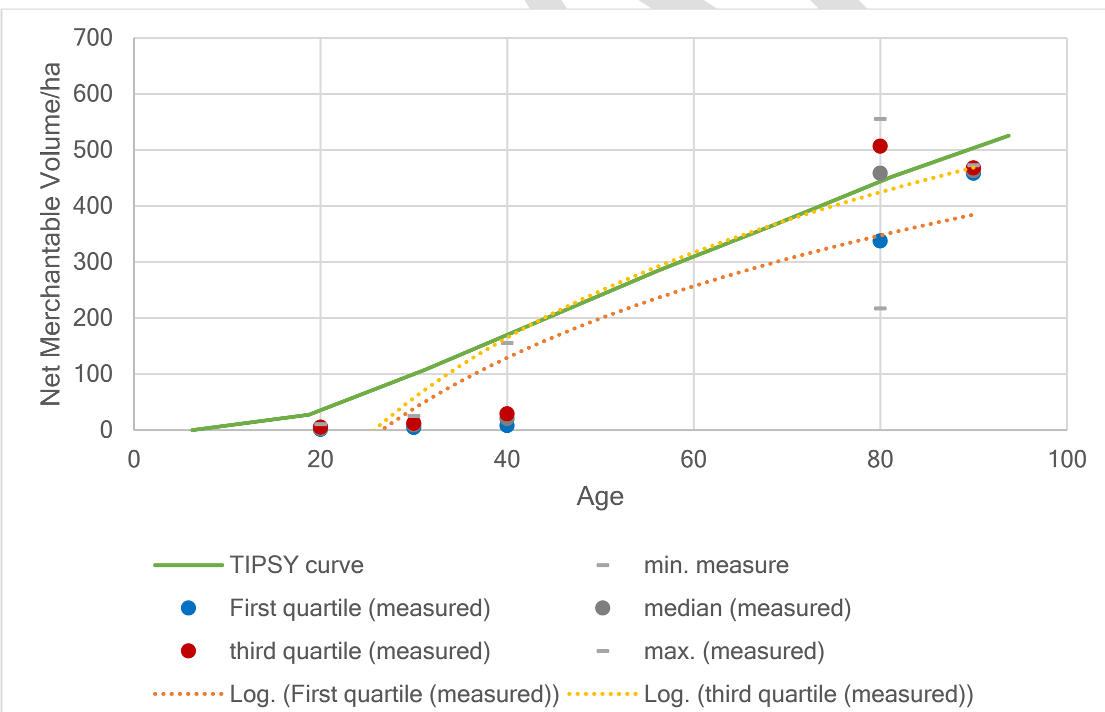


Figure 4.7 Net volume per hectare from measured PSPs (points and logarithmic curves) and TIPSY existing managed stand curve f curve for CWHwh1 04 site series from 22 plots and 82 re-measurements

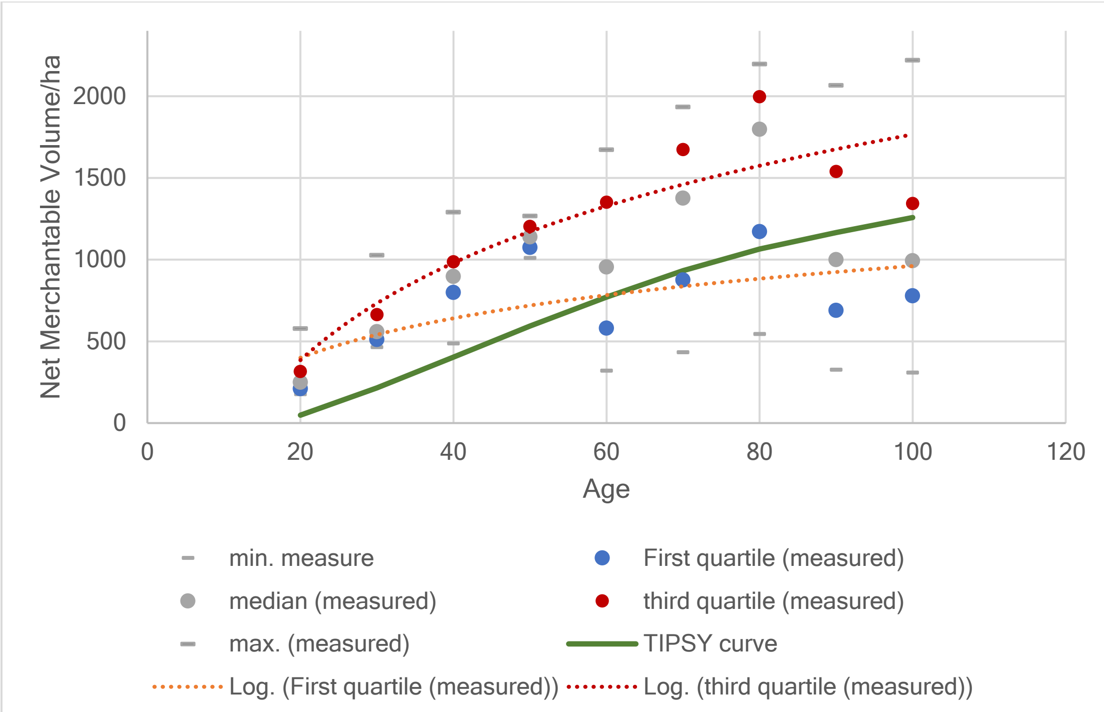


Figure 4.8 Net volume per hectare from measured PSPs (points and logarithmic curves) and TIPSY existing managed stand curve f curve for CWHwh1 05 site series from 27 plots and 93 re-measurements

A similar comparison was done using the 2016 Young Stand Monitoring (YSM) field plots, which are separate field plots then the Permanent Sample Data comparison listed above. The YSM to TIPSY compared ground plot volumes using net of decay, waste and breakage at a utilization level of 12.5cm (deJong, 2017). This comparison uses the ground/field attributes (e.g., species composition, site index) as inputs into TIPSY. As such it does not compare the timber supply analysis specific growth curves with the YSM, but rather a measure of how well TIPSY stand and volume interpolation is relative to field statistics. The results are similar as those found in the PSP to TIPSY comparison above: on average the ground measures are higher than TIPSY outputs, however not statistically significantly different.

Table 4.1 Ground and TIPSY volumes net of decay waste and breakage (utilization 12.5cm). Sourced from Table 18 in deJong (2017).

Strata	N	YSM ground volume	TIPSY volume	Total	p-value
Cw	3	51.0	50.7	0.3± 3.8	0.935
Hw	24	123	100.3	22.7±16.9	0.191
Ss	13	291	279.5	11.9± 13.5	0.395
Total	40	172.3	154.8	-17.5± 11	0.118

Appendix 5 Evaluation of LEFI volumes using re-compiled cruise data

Objective

The purpose of this analysis was to compare LiDAR Enhanced Forest Inventory (LEFI) net merch volumes with net merch volumes from cruise data. The LEFI volume model is a 20m raster grid whose volumes were area-weighted and aggregated up to match the polygonal net-area to be reforested of a block.

Tree level cruise data was ran through a Haida Gwaii volume compiler model that accounts for regionally specific taper equations for each species. These regionally specific taper equations were also used to derive volumes for the LEFI model, thereby minimizing taper function model error by using the same tree taper assumptions.

The results are a set of descriptive statistics of the observed samples and cannot be inferred to the rest of the population (THLB). While the samples are well distributed across the THLB (figure 1), the samples included in this evaluation were not randomly chosen, but rather incidentally occurring both within an area of overlap of LiDAR and within a specific timeframe (after cruising, after LiDAR acquisition, before logging). Therefore the results could never be used to adjust inventories or growth and yield curves, but can be used to examine trends between ground observations and the LEFI model.

Data inputs

Cutblocks

At the time of the analysis, 32 blocks from Taan Forest and BCTS overlapped with the geographic extent of the LEFI dataset. Cutblock boundaries were sourced from RESULTS, excluding retention area, reserves and management zones. The net area to be reforested (NAR) boundaries matched the cruise design and layout. The total cutblock area was 876 hectares.

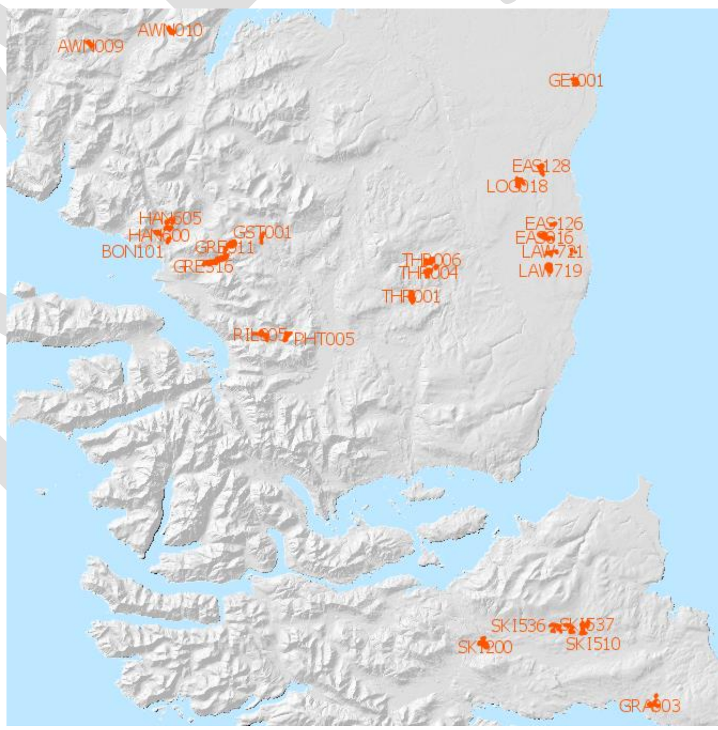


Figure 5.1. map of cutblocks used in the analysis

LEFI 20m grid

The Forest Analysis and Inventory Branch (FAIB) developed an area-based parametric prediction model that was based upon metrics sourced from the LiDAR canopy point cloud data and ground tree measurements (Yuan & Wang, 2017). A total of 84 ground plot tree measurements were used from the VRI audit inventory plots (35 Young Stand Monitoring, 3 Change Monitoring, 46 VRI audit plots). Final inventory parameters that were produced include top height, Lorey height, diameter, basal area, crown cover and whole stem/net volumes and delivered as a 20m x 20m raster product. Height (actual LiDAR output) and basal area/quadradic mean diameter (derived LiDAR outputs from parametric modelling) were computed through FAIB's ground compiler which utilizes the 2002 'QCI' decay, waste and taper equations to calculate volume.

Cruise data

Raw cruise data for the 32 blocks was submitted by licencees and compiled for tree-level data exports (.csv) by FLNRORDs Pricing, Tenures and Mines branch. A total of 754 plots were included within the study area. Dropped plots (as identified in cruise reports) were not used in this analysis.

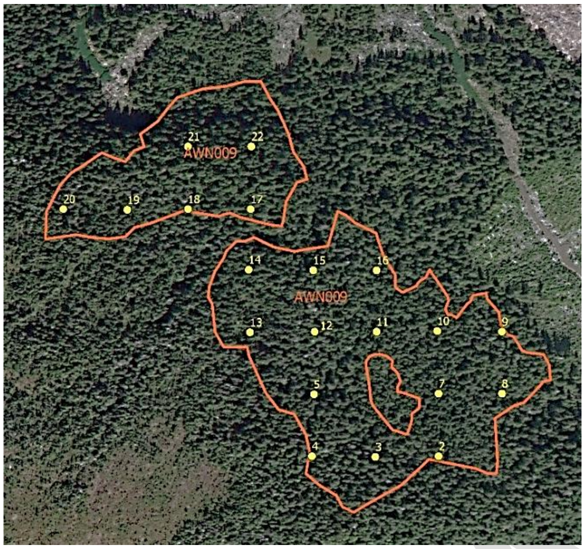


Figure 5.2. Example of one block, Awun09 used in the analysis along with cruise plots.

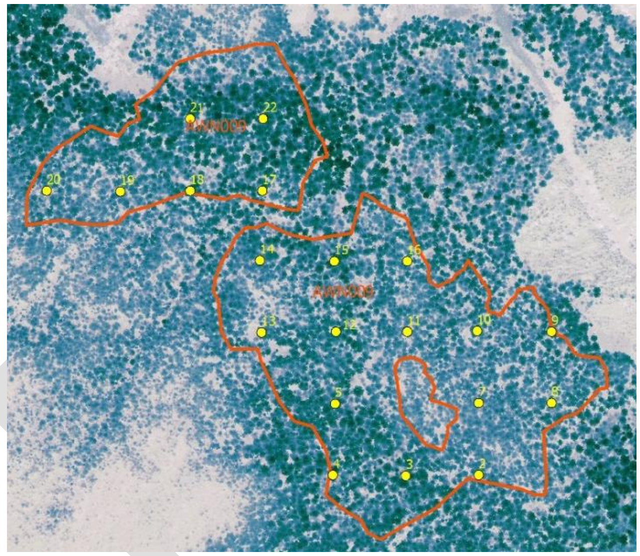


Figure 5.3. Awun09 with LiDAR derived Canopy Height Model (CHM). Height values range from light (0m) to dark (~50m)

Methods

All analysis was conducted in ArcGIS and R statistical program (RStudio Team, 2015).

HG Compiler

Volumes were defined based on close utilization volume net of decay, waste and breakage (DWB). Volume was calculated using local taper functions developed from destructive sampling of approximately 813 trees on Haida Gwaii in the 1990s (Flewelling, 2001), and subsequent Haida Gwaii specific taper equations developed by Kozak (2002). In total 200 red cedar, 323 hemlock, 184 spruce and 106 yellow cedar were analyzed through destructive sampling to fit taper equations. This regionally specific analysis amounted to a significantly smaller than average biases for DBH, inside bark diameter, height, total and merchantable volume than average biases obtained using general BEC Zone equations when originally fitted to the 1994 BEC taper equations (Kozak, 1997). Factor equations and coefficients (table 1) were supplied through Forest Analysis and Inventory Branch's Rene DeJong, RPF. The form of the 2002 BEC taper equation is:

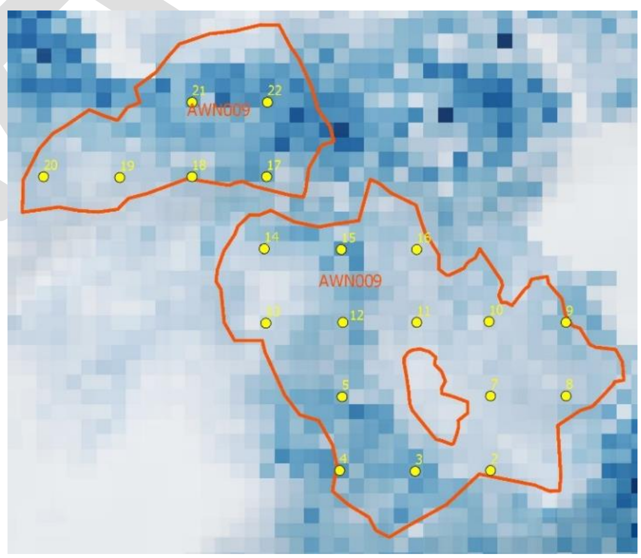


Figure 5.4. Awun09 with LiDAR derived net merchantable volume model (LEFI). Volume values range from light (0) to dark (~1500m^3/ha).

$$\hat{d}_i = a_0 D^{a_1} H^{a_2} X_i^{b_1 z_i^4 + b_2[1/e^{D/H}] + b_3 X_i^{0.1} + b_4[1/D] + b_5 H^{Q_i} + b_6 X_i}$$

Where:

$$X_i = [1.0 - (h_i / H)^{1/3}] / [1.0 - p^{1/3}]$$
$$Q_i = [1.0 - (h_i / H)^{1/3}]$$

$p = 1.3/H$
D = outside bark diameter at breast height (cm)
H = total tree height (m)
h_i = height from ground (m)
$z_i = h_i/H$, proportional height from ground
d_i = inside bark diameter at h_i height from ground (cm)
$\hat{d}_i$ = predicted inside bark diameter at h_i height from ground (cm)
a_0, a_1, a_2, b_1……b_6 = regression coefficients (parameters)

The coefficients from the Haida Gwaii taper and decay study are:

Table 5.1. Coefficients for use in the Haida Gwaii specific taper equations

species	_err	a_0	a_1	a_2	b_1	b_2	b_3	b_4	b_5	b_6
C	1.011184	0.943965	0.962949	0.054259	0.385844	-1.12617	0.693264	3.04716	0.063239	-0.355561
H	1.0103354	0.87323	0.983721	0.040875	0.41579	-0.487686	0.521597	3.06834	0.050408	-0.501109
PL	1.006966	0.936312	1.00412	0	0.323048	-0.941452	0.608207	2.16996	0.060198	-0.422735
S	1	1.055272	0.979499	0	0.261666	-0.643975	0.589574	2.69459	0.08509	-0.666734
Y	1	1.12594	0.972037	0	-0.144764	-0.578112	0.693395	6.50447	0.082599	-1.00605

Compiled volumes (gross, net and net less DWB) were quality checked and matched against HG compiler SAS volume outputs (sourced from FAIB), as well as compared against the original cruise-comp outputs to evaluate model performance.

Merchantable volume
Cruise volumes were compiled using the taper model described above. Trees were segmented into 0.1cm lengths and volume calculated (at diameter inside bark) using Smalian's formula. Utilization matched the Coast Appraisal Manual thresolds of 17.5cm at DBH, with a 0.3m stump height and a 15cm top for all live trees for the re-compiled cruise volumes.
Decay waste and breakage (DWB) factors were calculated by determining the DWB reduction factor for each tree and applying this on a tree-by-tree basis in the re-compilation. The DWB reduction factor is the difference between the gross merchantable volume and the lessDWB volume from the original cruise compilation, or GrossMerch – (lessDWB/GrossMerch). This DWB reduction factor was then applied on the re-compiled live merch volumes to come up with a final live net merch less DWB volume. While DWB was incorporated on a tree-by-tree basis, the following table illustrates the scale of the DWB reduction factors based on the Net Value Adjustment Factor (NVAF) sampling for the trees used in this study.

Species	*n*	DWB reduction factor
C	1208	10%
D	1	9%
H	837	10%
PL	120	3%
S	397	4%
Y	248	18%

Plot level cruise data were aggregated to the block level (as per the cruise design) to determine the m^3/hectare values and associated descriptive statistics.

LEFI volumes

The 20m LEFI net merchantable raster grid was extracted by mask in ArcGIS to match the 32 study area blocks. The rasters were then summed or aggregated by weighted area to the cutblock scale to determine the m^3/ hectare values per block.

Data check

A total of 9 trees within the original cruise were removed from the analysis as they had values considered data entry errors (ex. live tree height of 5 m and DBH 180, or height 381m). An additional 3 trees were missing either DBH or height values and were omitted from this analysis.

Results

The cruise data set that overlapped with the LEFI study area (32 blocks) included 754 plots. The total number of trees (live and dead) were 3462, with 2811 live trees. In the end 2798 live trees used to calculate volumes (minus missing or invalid measures).

Area weighted difference between the mean volumes suggest that the re-compiled volumes were 3% higher than the LEFI volumes.

Variances of the mean were evaluated using an F-test (F-test Two-Sample for Variances) that proved the variances as being equal (p= 0.426). A two sample t-test assuming equal variances was conducted with a null hypothesis that the re-compiled cruise volumes are no different than the LEFI volumes (figure 5.5).

	LEFI vol	*Re-Compiled Cruise*
Mean	538	549
Variance	30804	28810
Observations	32	32
df	62	
t Stat	-0.263	
P(T<=t) one-tail	0.397	
t Critical one-tail	1.670	

Figure 5.51. two sample t-test assuming equal variances

The results in figure 5.5 show that the null hypothesis cannot be rejected given the t statistic (-0.263) is less than the t critical one-tailed value (1.670) and the p value is greater than the alpha level chosen (0.05). In other words the mean volumes between the LEFI and the re-compiled cruise are statistically equal. Figure 6 illustrates the majority of the LEFI mean volumes fall either within the standard error (SE) of the mean for the cruise data or within a 95% confidence interval of the cruise data.

Figure 5.6. Mean volume comparisons between re-compiled cruise and LEFI volumes. Whiskers are the block-level Standard Error (SE) of the re-compiled cruise plots, dashed lines represent the upper and lower 95% Confidence Intervals of the cruise plots.

Figure 5.7 illustrates a line of best fit through origin equation and co-efficient of determination between both datasets.

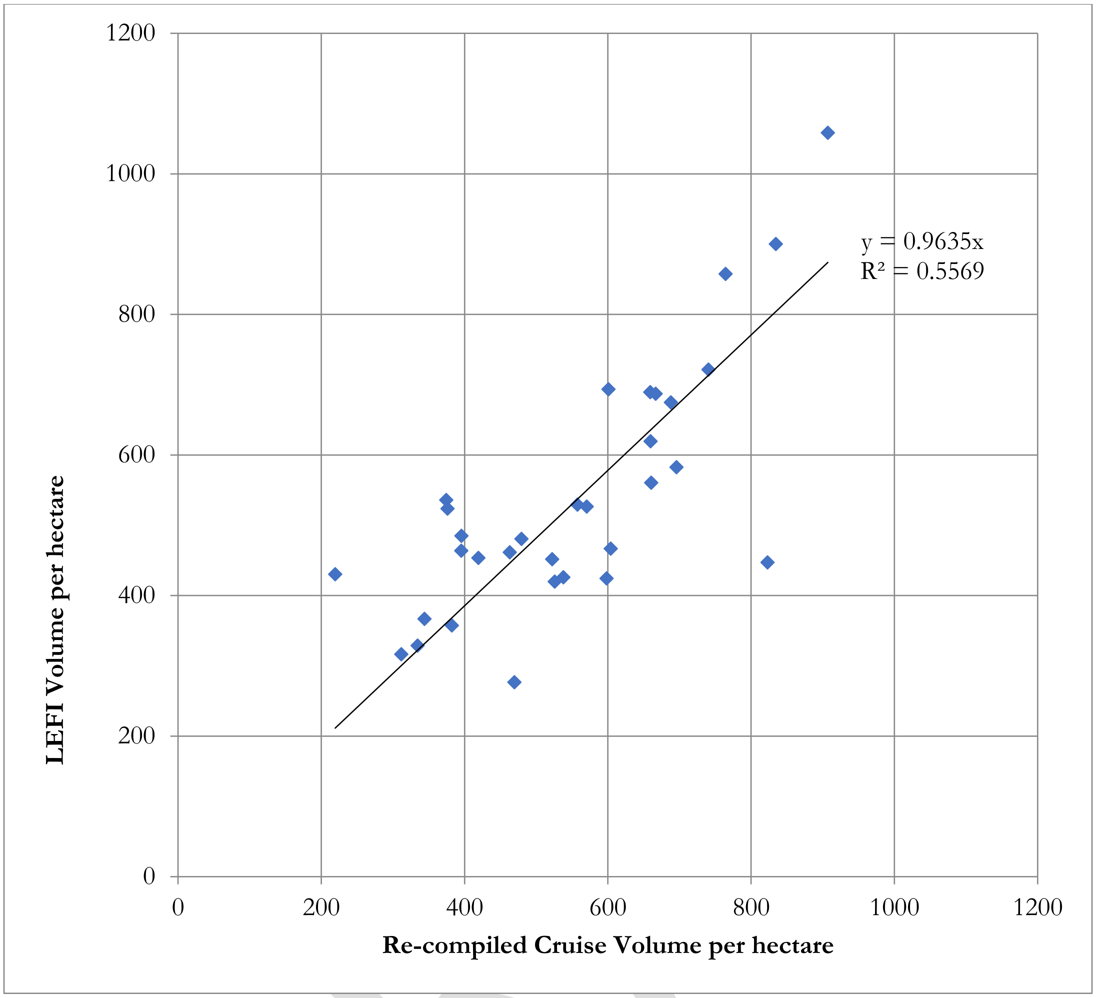


Figure 5.7. Comparison of LEFI and re-compiled cruise volumes, including the intercept (y) and coefficient of determination (R^2)

Cutblock	Area (hectares)	Area weighted LEFI volume	Re-compiled Cruise volume	SD	SE
SKI521	6.9	430.4	219.4	206.0	118.9
GRE316	46.0	316.6	311.6	148.8	38.4
LAW721	20.8	328.8	334.5	192.4	36.4
HAN600	20.1	366.8	344.0	147.4	29.5
BON101	12.8	535.9	374.4	154.4	39.9
SKI535	15.7	523.8	376.2	228.5	57.1
GRE313	65.9	357.5	382.2	213.6	43.6
EAS014	6.9	463.7	395.4	254.4	76.7
SKI506	11.0	484.9	395.6	346.8	104.6
SKI536	27.8	453.6	419.4	306.0	61.2
GEI001	24.1	461.5	463.0	228.4	44.0
GRE511	11.9	276.6	469.6	259.1	86.4
SKI537	33.9	480.7	479.4	388.6	86.9

Cutblock	Area (hectares)	Area weighted LEFI volume	Re-compiled Cruise volume	SD	SE
SKI510	15.3	451.8	522.3	106.8	40.4
EAS126	11.0	419.8	525.9	276.2	79.7
PHT005	28.8	425.9	538.0	332.0	78.2
GRE507	42.6	529.4	557.5	264.8	49.2
EAS016	34.7	526.7	570.5	280.2	34.8
EAS128	32.2	424.4	598.2	300.9	54.1
THR006	37.4	693.6	600.9	328.4	53.3
LAW719	38.8	466.8	604.1	323.6	58.1
THR004	39.3	689.5	659.2	328.7	54.0
GST001	16.7	619.6	659.6	379.1	105.2
AWN010	24.7	560.5	660.6	407.5	88.9
HAN601	20.8	687.1	666.7	339.8	66.6
LOG018	38.0	674.8	688.0	406.5	93.3
AWN009	19.4	582.6	695.9	379.6	87.1
RIL305	39.6	721.5	740.6	396.1	67.9
THR001	39.4	857.6	764.4	352.6	53.8
GRA003	26.7	447.2	822.9	404.3	77.8
HAN605	22.9	900.3	834.4	368.6	61.4
SKI200	43.4	1058.4	907.1	510.3	117.1

Figure 5.8. Block level results

Conclusion

Based upon the results, there are no statistically significant differences in the means of volume between the re-compiled cruise volumes and the LEFI volumes for the samples analyzed in this study.

Appendix 6 Description of the HG LUOO annual submission spatial dataset and Deriving exclusion factor estimates

HG LUOO annual submission spatial

Throughout the HGLUOO there are objectives for licencees to submit digital spatial data annually to the CHN and Province of BC that represent features and the areas retained to manage those features. Data were submitted in standardized geo-database formats either at the end of the calendar year, or on an application by application basis (for Road Permit, Cut Permit or Timber Sale Licence information sharing) to the Solutions Table.

Data were collated from all licencees and standardized for the purpose of the Timber Supply Review, specifically to determine the net downs on the harvesting land base by objective between the years 2012-2016.

A total of 362 development areas were utilized in the analysis totaling 14,092 hectares of development area between 2012 and 2016. The data set includes 97 development areas for BCTS, 121 for Husby, 104 for Taan, and 48 development areas for Teal Jones. Some descriptive statistics of the dataset include:

Table 6.1 Summary of Development area sizes within the HGLUOO 2012-2016 spatial dataset.

Licencee	Development area average size (ha)	Net Area to be Reforested average size (NAR) (ha)
BCTS	39.4	17.6
Husby Forest Products	38.4	19.3
Taan Forest Products	41.7	21.6
Teal Jones	29.1	13.7
Total	38.9	19.0

The total area logged was 6,889 hectares or 49% of the total Development Areas, the remaining 51% as areas retained to meet the HGLUOO,other legal requirements or operability considerations. 24% of all 'openings' (areas logged within a Development Area) were 2nd growth stands (stands originating after historic logging). All mapped retention areas from the 2012-2016 HGLUOO spatial dataset were excluded from the THLB.

The data set also included a total of 26,549 point features, divided into the following categories:

Table 6.2 Summary of features from the 2012-1026 HGLUOO annual spatial data

Type	Count
Bear Den	26
CMT	439
HTFF Class 1	141
HTFF Class 2[6]	8626
HTFF Class 3	142
HTHF	4
Monumental Cedar	1085
Yew Retention[2]	16226
Other	2

[6] HTFF Class 2 and yew features often include multiple plants/features per point.

In addition—a total of 360 km of mapped Type 1 and Type 2 fish habitat/streams were included in the dataset and utilized for stream modelling, as described in section 7.11.5 of the data package. The use of these data are described in the following sections.

Deriving exclusion factor estimates

The following section describes how an analysis, informed by empirical licencee data, was done to estimate or project an exclusion factor from the THLB for as-yet-to be identified values.

While the areas retained to meet specific LUO Objectives need to be documented and submitted, there was a general trend of grouping various objectives into singular retention polygons. For example, monumental cedar is often within a riparian management area (RMA) or a Wildlife Tree Retention Area (WTRA), and while the retention for the RMA or WTRA is documented, the specific retention area for the monumental cedar may not be delineated separately. This was common across most objectives throughout the data set. For the purposes of determining the total occurrence of a value for calculating net downs, quantifying the total (gross) area for management by objective was necessary.

Table 6.3 outlines the assumed management areas for those features where retention was established but not specifically delineated in the HGLUOO annual data. Note that these values were used only for the frequency of occurrence analysis for predicting future netdowns for yet-to-be identified features.

Table 6.3 Buffers applied to point features where retention was established but reserve/management zones not delineated

Monumental cedar:	60m	Based on minimum LUO retention assuming 40m tree heights
CMTs:	60m	
Type 1 Fish Habitat:	80m	
Type 2 Fish Habitat:	60m	
Yew features:	20m	Based on the average distance to openings for stand level retention for yew trees.
Haida Traditional Forest Features, Class 2:	20m	

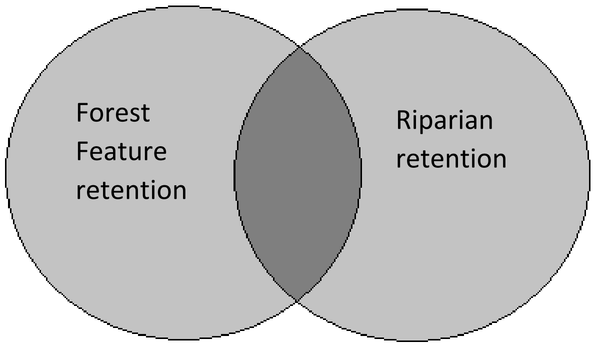
Within the HGLUO, the Development Area is the denominator where most retention objectives are measured. It is defined by areas on a site plan where timber harvesting is carried out and includes stand level retention, management zones, reserves zones, mapped reserves or other areas where timber harvesting is restricted or managed pursuant to the HGLUO or the Forest and Range Practices Act (FRPA). For the purposes of this analysis, retention areas that were outside of a Development Area, but associated (by block name identifier) with the Development Area, were assumed to be part of the Development Area. In other words, for this analysis no retention could be orphaned or outside of a Development Area.

Some features identified during the course of a Cultural Feature Identification survey or engineering, were submitted as digital spatial data, however were clearly outside of any development area and had no retention delineated around them. In these cases, these features were not included in the analysis.

Proportional retention

Many HG LUOO features spatially overlap with each other. As such it is necessary to determine what the total 'net' affect on the THLB is, but also of interest to determine what the 'gross' net effect is. This is done by assigning a 'rank' or spatial hierarchy to track the degree of overlap between values (note that this ranking is expressed in table 6.4, with the higher rows superseding lower rows).

The 'rank' is based on most legally constraining to least legally constraining to track the gross and net occurrences of retention for different values. If a more legally constraining feature is present, then other features would be incidentally retained. For example, where a Forest Feature (ex. Devil's club) retention area incidentally overlaps within a riparian retention area, there is no double counting of the riparian area retention:



In this example, if the riparian retention and forest feature retention both equal 1 hectare, with a 0.25 hectare overlap (dark grey), then the 'gross' riparian retention would be 1 hectare, and the 'net' riparian retention would be 0.75 hectares, and the forest feature netdown would be 1 hectare.
The following table summarizes the HGLUOO objectives found within the 2012-2016 dataset and the proportional retention for each objective.

Table 6.4 proportional retention within all development areas (across all tenures/licencees).

Type	Gross (ha)	Net (ha)	Gross % total	Net % total
Forest Reserves	142.8	142.8	1.0%	1.0%
CSA	88.6	88.6	0.6%	0.6%
HTHF	13.6	8.4	0.1%	0.1%
AFU	104.0	52.5	0.7%	0.4%
Type 1	2989	2898	21.2%	20.6%
Type 2	1557	1165	11.1%	8.3%
Forested swamp	0.2	0.2	0.0%	0.0%
Bear	17	13	0.1%	0.1%
CMT	168	139	1.2%	1.0%
HTFF 1	122	92	0.9%	0.7%
Monumental	459	267	3.3%	1.9%
Blue/Red	4	3	0.0%	0.0%
Yew	279	118	2.0%	0.8%
HTFF 2	254	112	1.8%	0.8%
MAMU	117	61	0.8%	0.4%
ECO	76	42	0.5%	0.3%
WTRA	2345	1145	16.6%	8.1%

Figure 6.1 indicates that some values significantly overlap each other, thereby reducing the net occurrence of retention for any one value.

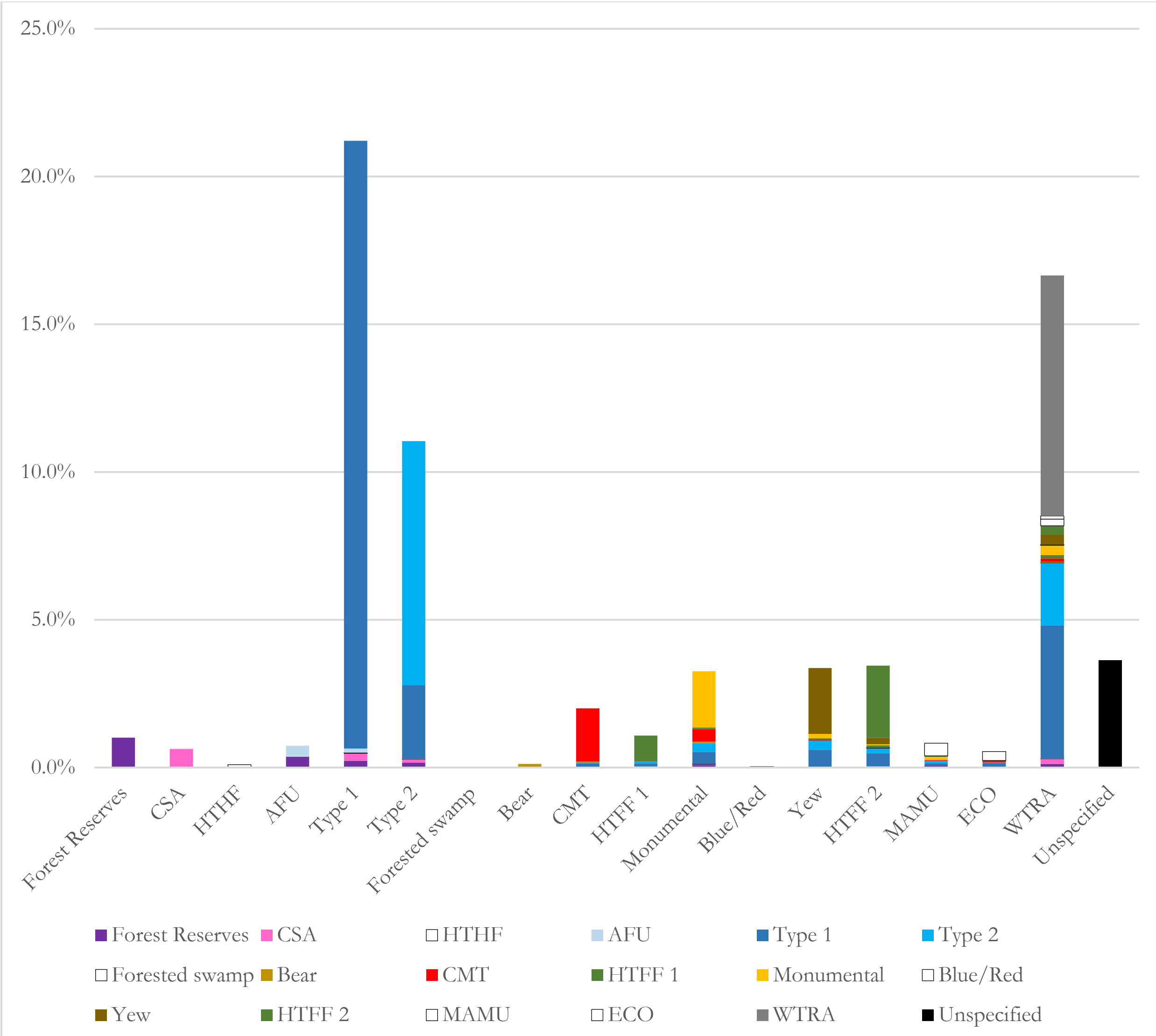


Figure 6.1 Proportional overlap between all values within the 2012-2016 HGLUOO spatial dataset.

Appendix 7 Concepts of hydrologic recovery relative to timber supply and recovery curves.

Timelines for hydrological recovery in hypermaritime environments are uncertain, and variables leading to recovery are incredibly complex. Timelines for each variable may vary between 25 to >250 years after disturbance before they can be considered functionally restored (Banner, LePage, J.Moran, & Groot, 2005) (CIT, 2004).

Post-disturbance watershed response, or hydrologic recovery, is normally associated with tree height (Hudson & Horel, 2007). Stand height is a good predictor for recovery because (i) wind speed experienced within a stand (controlling heat fluxes in Rain-on-snow events) is closely related to tree height, and (ii) shade affects radiation snowmelt (Hudson & Horel, 2007).
Equivalent Clearcut Area, or ECA, is common measure to quantify hydrologic recovery that uses tree heights as a surrogate for hydrologic recovery (B.C. Ministry of Forests, 2001). As cited from Hudson and Horel (2007), *"ECA provides us with an index of the hydrologic function of the post-disturbance canopy relative to that of the original canopy"*.

Forest harvesting in watersheds dominated by rain-on-snow events have a higher risk of increasing peak flow hazards than in watersheds dominated by either rain or snowmelt processes (Floyd W. , 2011). In these rain on snow zones small increases in melt have major implications to frequency of peak flows (Floyd W. , 2012).

Forests have a finite ability to intercept rain, thus removal of forest in watersheds generally has a minimal effect on the magnitude and frequency of flood producing rain events. In contrast, forest harvesting has the effect of increasing both snow depth and the energy available to melt that snow, thus rain falling on snow has the potential to have much greater impacts on the magnitude and frequency of floods than rain alone. Since all watersheds in Haida Gwaii have the potential to receive rain-on-snow through all elevation ranges, hydrologic recovery curves designed to represent rain on snow (ROS) dynamics should be used if available.

Relevant data exist for ROS hydrologic recovery from regenerating stands from the Russell Creek Experimental Watershed on Vancouver Island. Research at Russell Creek has attempted to validate these curves using data collected at different stand heights to determine if they represent hydrological recovery during ROS. Results of that research by MFLNR suggests that ROS recovery rates in that watershed are approximated by the snow-on-snow (SOS) recovery, however the recovery curve is slightly different, thus a new ROS curve was developed using the most up to date numbers.

Research results at Russell Creek suggest forests are fully recovered for ROS conditions when they reach a height between 13 and 14m. This level of recovery is based on a comparison of both the mean and frequency of energy available for melt during ROS and different forest types. The dataset was limited in that it did not capture any high melt energy ROS events, associated with warm temperatures and high winds. Based on the physical understanding of forests and snowmelt, trees 14m in height would have limited ability to attenuate high winds, thus the MFLNR Research Hydrologist recommended setting 14m as having an approximate recovery of 90%. He also recommended to allow for recovery past this 90% threshold to a 97.5% cap with the rationale that typical forest rotations of 60 to 100 years will never reach full hydrologic recovery compared to old growth forests.

Some uncertainties remain with modeling hydrologic recovery. With climate change increasing the frequency of storm events, the size and intensity of events amount to decreases in recovery (rates of recovery may change as events become larger) (Floyd W. , 2012). Small increases in intensity can have a 10-fold increase in large flow events.

Another uncertainty remains regarding the use of the entire drainage basin as a denominator for measuring hydrologic recovery for upland stream areas. Preliminary findings from the *Haikai Institute's* Kwakshua watershed program suggest that bog wetlands act similarly to areas without trees, insofar as bog wetlands don't attenuate flow, and therefore may influence hydrologic recovery differently then previously believed (pers. com W. Floyd). A specific sensitivity analysis is described in section 8 of the data package that explores the effect of these findings.

Table 7.1. Hydrologic recovery curve assumptions used in the TSR

Ht	Recovery	Ht	Recovery	Ht	Recovery	Ht	Recovery	Ht	Recovery	Ht	Recovery	Ht	Recovery
0.0	0.0	4.6	2.1	9.2	63.6	13.8	86.5	18.4	95.0	23.0	98.1	27.6	99.3
0.1	0.0	4.7	4.2	9.3	64.4	13.9	86.8	18.5	95.1	23.1	98.2	27.7	99.3
0.2	0.0	4.8	6.3	9.4	65.2	14.0	87.1	18.6	95.2	23.2	98.2	27.8	99.3
0.3	0.0	4.9	8.2	9.5	65.9	14.1	87.3	18.7	95.3	23.3	98.3	27.9	99.4
0.4	0.0	5.0	10.2	9.6	66.6	14.2	87.6	18.8	95.4	23.4	98.3	28.0	99.4
0.5	0.0	5.1	12.1	9.7	67.3	14.3	87.9	18.9	95.5	23.5	98.3	28.1	99.4
0.6	0.0	5.2	14.0	9.8	68.0	14.4	88.1	19.0	95.6	23.6	98.4	28.2	99.4
0.7	0.0	5.3	15.8	9.9	68.7	14.5	88.4	19.1	95.7	23.7	98.4	28.3	99.4
0.8	0.0	5.4	17.6	10.0	69.4	14.6	88.6	19.2	95.8	23.8	98.4	28.4	99.4
0.9	0.0	5.5	19.4	10.1	70.0	14.7	88.9	19.3	95.9	23.9	98.5	28.5	99.4
1.0	0.0	5.6	21.1	10.2	70.7	14.8	89.1	19.4	96.0	24.0	98.5	28.6	99.4
1.1	0.0	5.7	22.8	10.3	71.3	14.9	89.3	19.5	96.0	24.1	98.5	28.7	99.5
1.2	0.0	5.8	24.4	10.4	71.9	15.0	89.6	19.6	96.1	24.2	98.6	28.8	99.5
1.3	0.0	5.9	26.0	10.5	72.5	15.1	89.8	19.7	96.2	24.3	98.6	28.9	99.5
1.4	0.0	6.0	27.6	10.6	73.1	15.2	90.0	19.8	96.3	24.4	98.6	29.0	99.5
1.5	0.0	6.1	29.1	10.7	73.7	15.3	90.2	19.9	96.4	24.5	98.6	29.1	99.5
1.6	0.0	6.2	30.6	10.8	74.2	15.4	90.4	20.0	96.4	24.6	98.7	29.2	99.5
1.7	0.0	6.3	32.1	10.9	74.8	15.5	90.6	20.1	96.5	24.7	98.7	29.3	99.5
1.8	0.0	6.4	33.6	11.0	75.3	15.6	90.8	20.2	96.6	24.8	98.7	29.4	99.5
1.9	0.0	6.5	35.0	11.1	75.8	15.7	91.0	20.3	96.7	24.9	98.8	29.5	99.5
2.0	0.0	6.6	36.4	11.2	76.4	15.8	91.2	20.4	96.7	25.0	98.8	29.6	99.5
2.1	0.0	6.7	37.7	11.3	76.9	15.9	91.4	20.5	96.8	25.1	98.8	29.7	99.6
2.2	0.0	6.8	39.0	11.4	77.4	16.0	91.6	20.6	96.9	25.2	98.8	29.8	99.6
2.3	0.0	6.9	40.3	11.5	77.8	16.1	91.8	20.7	96.9	25.3	98.9	29.9	99.6
2.4	0.0	7.0	41.6	11.6	78.3	16.2	91.9	20.8	97.0	25.4	98.9	30.0	99.6
2.5	0.0	7.1	42.9	11.7	78.8	16.3	92.1	20.9	97.1	25.5	98.9		
2.6	0.0	7.2	44.1	11.8	79.2	16.4	92.3	21.0	97.1	25.6	98.9		
2.7	0.0	7.3	45.3	11.9	79.7	16.5	92.4	21.1	97.2	25.7	99.0		
2.8	0.0	7.4	46.4	12.0	80.1	16.6	92.6	21.2	97.3	25.8	99.0		
2.9	0.0	7.5	47.6	12.1	80.5	16.7	92.8	21.3	97.3	25.9	99.0		
3.0	0.0	7.6	48.7	12.2	80.9	16.8	92.9	21.4	97.4	26.0	99.0		
3.1	0.0	7.7	49.8	12.3	81.3	16.9	93.1	21.5	97.4	26.1	99.0		
3.2	0.0	7.8	50.9	12.4	81.7	17.0	93.2	21.6	97.5	26.2	99.1		

Ht	Recovery		Ht	Recovery		Ht	Recovery		Ht	Recovery		Ht	Recovery		Ht	Recovery		Ht	Recovery
3.3	0.0		7.9	51.9		12.5	82.1		17.1	93.4		21.7	97.5		26.3	99.1			
3.4	0.0		8.0	52.9		12.6	82.5		17.2	93.5		21.8	97.6		26.4	99.1			
3.5	0.0		8.1	53.9		12.7	82.9		17.3	93.6		21.9	97.6		26.5	99.1			
3.6	0.0		8.2	54.9		12.8	83.2		17.4	93.8		22.0	97.7		26.6	99.1			
3.7	0.0		8.3	55.9		12.9	83.6		17.5	93.9		22.1	97.7		26.7	99.2			
3.8	0.0		8.4	56.8		13.0	84.0		17.6	94.0		22.2	97.8		26.8	99.2			
3.9	0.0		8.5	57.7		13.1	84.3		17.7	94.2		22.3	97.8		26.9	99.2			
4.0	0.0		8.6	58.6		13.2	84.6		17.8	94.3		22.4	97.9		27.0	99.2			
4.1	0.0		8.7	59.5		13.3	85.0		17.9	94.4		22.5	97.9		27.1	99.2			
4.2	0.0		8.8	60.4		13.4	85.3		18.0	94.5		22.6	98.0		27.2	99.2			
4.3	0.0		8.9	61.2		13.5	85.6		18.1	94.6		22.7	98.0		27.3	99.3			
4.4	0.0		9.0	62.0		13.6	85.9		18.2	94.8		22.8	98.1		27.4	99.3			
4.5	0.0		9.1	62.8		13.7	86.2		18.3	94.9		22.9	98.1		27.5	99.3			

Appendix 8 Summary of TSR assumptions

THLB net downs	Description	Data package section
Water	Wetland and lakes defined by TRIM	3.1.2
Low productive forest	VRI- based exclusion of site index <5, and non-treed BC Land Classification units	3.1.2
Small islands	Islands <150 hectares excluded based on TRIM	3.1.2
Roads	TRIM, Licencees, RESULTS, new mapping. 10m (total) buffers on branchlines, 20m (total) buffers on mainlines/permanent roads.	3.1.2
Low volume stands (no MHV)	100% exclusion of stands <250m^3 per hectare (natural and managed stands)	7.1.2
Protected Areas CHN/Provincial	All areas designated as Provincial parks, Ecological reserves, Conservancies removed from THLB	3.1.4
Protected Areas CHN/Federal	Gwaii Haanas National Park and Heritage site removed from THLB	3.1.4
Federal reserves and miscellaneous	Indian Reserves, Military reserves removed from THLB	3.1.4
Provincial reserves (non-timber tenures)	Recreation sites and Land Act section 15/16 reserves 100% netdown. 100m buffers on known trails were 100% netdown.	3.1.4
Private land	Private land identified through the Land Title and Survey Authority	3.1.4
Municipal zonation	Forestry zonation identified in Official Community Plans under the Municipal Act.	3.1.4
Tree length buffers (applies to HGLUOO spatial objectives)	Based on LUOO Schedule 5 and ecosystem mapping	6.11.3
Active Fluvial Units	New LiDAR based mapping, terrain classification mapping, watershed assessment mapping. 1.5 tree length buffers applied. 100% of AFU net down and 90% of management zone net down.	6.11.4
Type 1 and Type 2 Fish Habitat	Enhanced LUOO schedule 4 data based on statistical modelling from empirical field data. 2 tree length (type 1) and 1.5 tree length (type 2) buffers applied. 95% of the type 1 reserves were net down, 80% of the type 2 management zones were net down.	6..1.5
FPPR Riparian buffers	Wetland, S5 and S6 (non-fish bearing streams) based on TRIM and FPPR requirements. FPPR prescribed retention configured to area-based netdowns.	6.13
Red and blue listed ecosystems	Based on LUOO schedule 13 and ecosystem mapping define units and 100% net down.	6.11.8
Common and rare ecosystems	Based on LUOO schedule 10 and ecosystem mapping to define units. Per site series deficit was calculated and used to exclude those units from the THLB proportional to their Landscape Unit occurrence and conservation targets. Net down occurred on a site-series polygon scale.	6.11.9

THLB net downs	Description	Data package section
Forested swamps	Ecosystem mapping to identify site series and 1.5 tree length buffer applied. 100% of the forested swamp units net down, 70% of the management zone net down	6.11.7
Karst	100% of the Sadler formation was net down	6.3
Forest Reserves	95% net down from each polygon of LUOO schedule 8 forest reserves	6.11.10
Marbled Murrelet reserves	100% net down from block-level LUOO annual submission data.	6.11.11
Northern Goshawk nesting	100% net down from current LUOO schedule 12	6.11.12
Saw whet owl nesting	100% net down from current LUOO schedule 12	6.11.13
Black bear denning	100% net down from block-level LUOO annual submission data.	6.11.21
Wildlife habitat areas	Two northern goshawk WHA's Orders- nesting reserves (6-001, 6-002) and two Marbled Murrelet WHA's Orders (6-041, 6-046) were 100% net down. Forest cover constraint applied to goshawk WHA's post-fledging area based on forest age requirements.	6.2
Haida Traditional Heritage Features (HTHFs), CMTS, Arch sites	100% netdown from 500m buffer around HTHF's; 100% netdown of current LUOO reserve/management zones, 1.5 tree length buffer for all other known CMTs; 1.8% netdown to old forest/natural stand THLB areas to account for unknown CMTs; 100% netdown of current Registered Archaeological Sites	6.11.16
Cedar Stewardship Areas	100% netdown of LUOO schedule 3 CSAs.	6.11.15
Monumental cedar	100% netdown of current LUOO reserve/management zones, 1.5 tree length buffer for all other known monumentals; and random predicted distribution netdown to old forest/natural stand within management unitsareas to account for unknown monumentals.	6.11.8
Haida Traditional Forest Features	100% netdown of current LUOO reserve/management zones, 2.3% per hectare netdown for all old forest and 0.1% netdown for young forest to account for unknown HTFFs.	6.11.19
Yew trees	100% netdown of current LUOO retention areas, 2.2% per hectare netdown for all old forest to account for unknown Yew.	6.11.20
Permanent Sample Plots	100% net down on 100m buffers around active PSPs.	6.6
Landslides	100% net down of mapped landslides	7.4.4
Class IV Terrain	Terrain stability preference ratio netdown of all class IV terrain by management unit. Terrain inclusion factors: TFL 60= 0.48; TFL 58=0.77, TSA=0.46) Areas previously logged post-1996 are included in the THLB.	6.8

THLB net downs	Description	Data package section
Class V Terrain	Terrain stability preference ratio netdown of all class V terrain by management unit. Terrain inclusion factors: TFL 60= 0.33; TFL 58=0.42, TSA=0.12) Areas previously logged post-1996 are included in the THLB.	6.8
LUOO in-block retention	Broad THLB netdowns described for CMT (1.8%), HTFFs (3.4%), Yew trees(2.3%), unspecified retention (3.6%), HTHF (0.1%), black bear (0.1%). Per hectare netdowns stratified by forest age (young=5.89%, old=10.94%).	App. 6
WTRAs	7% per hectare net down in 2nd growth stands, no netdown for old growth stands (>250 years) due to assumption of overlap with other stand-level retention objectives.	6.5
Roads, trails and landings	100% netdown for 20m and 10m buffers for mainlines and branches respectively. 6.4% per hectare net down for future roads.	6.9

Inventory	Description	Data package section
VRI, LEFI forest inventory and RESULTS	Vegetation Resource Inventory Phase I (species, age, site index for natural stands), LiDAR enhanced Forest Inventory (basal area, heights) for natural stands. RESULTS (silviculture records) updates and 2017 depletion (remotely sensed) data for existing managed stands.	4.1; 4.3
Ecosystem mapping	RESULTS-based site series classification where available, otherwise, TEM for TFL 60, TEM for TSA, PEM for TFL 58.	4.4

Growth and Yield	Description	Data package section
Site index sources	Site index sourced from VRI Phase I for natural stands; Site index sourced from Haida Gwaii enhanced SIBEC and Provincial Site Productivity Layer for managed stands.	5.1
Natural stand yield curves (unmanaged)	LEFI inputs for basal area, height, VRI Phase I inputs for species, age into VDYP7 growth and yield model. 66 Analysis units defined based on leading species, site index class and BEC zone. Data from LEFI-based areas applied to non-LEFI areas.	5.8
Existing stand yield curves (managed)	RESULTS standard-unit inputs (except site index) for TIPSY growth and yield model inputs.	5.6

Growth and Yield	Description	Data package section
Future managed stand yield curves (managed)	Area weighted averages for RESULTS by site series (except site index) for TIPSY growth and yield model inputs.	5.6

Resource Management (other than THLB)	Description	Data package section
Visual quality	Each polygon within the Haida Gwaii VLI was assigned the plan-view alteration limit for its VQO class. The plan-view alteration limit is also an area-weighted calculation. Each VLI cell within the STISM model based on the alteration limit and mean VEG height.	6.1
Community watersheds	Honna, Jervis, Slarkedus and Tarundl watersheds have 20% hydrologic effective green up constraint or 1% of the watershed per year. Entire watershed (treed/non-treed) forms basis of watershed denominator.	6.4
Upland stream areas	70% hydrologic effective green up on LUOO schedule 6 upland stream areas. Entire watershed (treed/non-treed) forms basis of watershed denominator.	6.11.6
Sensitive watersheds	80% hydrologic effective green up on LUOO schedule sensitive watersheds. Entire watershed (treed/non-treed) forms basis of watershed denominator.	6.11.6
Cedar partition	A maximum annual limit (scaled to 10 years for modelling) on red and yellow cedar was set as: 133,000m^3 for TFL 60 32,000m^3 for TFL 58 195,000m^3 for TSA 25	6.15

Other model parameters	Description	Data package section
Minimum harvest age	The age at which each stand reaches 95% of culmination mean annual increment volume.	7.1
Harvest preference	Relative highest value stand is harvested first.	7.1
Minimum harvest volume	250m^3 per hectare on natural and managed stands	7.1
Natural Disturbance	Natural disturbance was applied in a stochastic spatial model, stratified by disturbance type. Black-headed budworm amounts to a 59 hectare per year netdown for hemlock stands, Windthrow amounts to a 70 hectare per year netdown in the Skidegate plateau (SKP) and Queen Charlotte ranges (QCR); landslides amount to 26 hectares per year netdown in the SKP and QCR; and yellow cedar decline	7.4

	amount to 40 hectares per year netdown in the yellow cedar leading strata.	
Economic operability	Relative road cost (least cost spatial model) and stand value model (volume and market value indices) was developed and calibrated to empirical road and block inventories from the last 10 years harvest. Road length to stand value thresholds applied. Additional cover constraints applied to Sewell/Tasu and Louise operating areas, amounting to minimum volume availability of 330,000m^3 over 10-years for Sewell/Tasu and 250,000m^3 over 10-years for Louise Island.	7.5
Adjacency	400m 'soft' buffer between blocks with a preference set to not harvest buffers between blocks until green-up is met. Green-up height is 3m.	7.3
Maximum block size	Target between 20 to 40 hectare block sizes.	7.3

Sensitivity analyses	**Description**	**Data package section**
Cedar	Non-declining cedar timber flows by management units (TFL 58, TFL 60, TSA 25) and by woodsheds Analysis includes +/- 10% of long range average yield targets	8.2.1
Economic operability	High and low market value scenarios using the relative cost/value model. Additional analyses included: -No road operability constraints -No constraints on isolated planning units and exclusion of isolated planning units -exclusion of high cost access areas	8.2.7
Community Forest	Base case runs with proposed community forest tenure	8.2.2
First Nations Woodland Licence	Base case runs with proposed FNWL tenure	8.2.3
Minimum harvestable criteria	Economic rotation age (minimum 30cm diameter harvest criteria); extended rotation age (minimum 150 year rotation age); no minimum harvest age or volume constraint; 350m^3 minimum volume constraint; restrict old growth logging (maximum harvest age 250 years)	8.2.6
Harvest preferences	Prefer the highest relative volume Prefer the oldest stand relative to CMAI Randomized order of harvest	8.2.7
CHN policy	Removed Mosquito lake watershed from THLB and removed Slatechuck watershed from the THLB	8.2.4
Monumental cedar	Netdown projections based on 100% monumental protected with 1.5 tree length buffer (1)	8.2.3.3

	Netdown projections based on D, F, and H grade cedar protection in old (>250 year) forest Netdown projections including broader age and grade classes and retention levels	
Northern goshawk	200 ha nesting habitat netdown for 25, 38 and 67 predicted territories 5,564 hectares of suitable foraging habitat (65.5% target) retained for 22, 25, 38 and 67 territories. 4,672hectares of suitable foraging habitat (55% target) retained for 67 territories 3,823 hectares of suitable foraging habitat (45% target) retained for 67 territories	8.2.4
Hydrologic recovery	Only forested areas (BC land classification definition) contribute to hydrologic recovery (upland stream area)	8.2.9
Risk managed LUOO	Risk managed variances applied to LUOO objectives	8.2.8
Wildlife Tree Retention Areas	Increase in retention by 7.1% in the TSA and 11.3% in TFL 60 to reflect current practice	8.2.8
Roads	Assume red alder regeneration on branchlines	8.2.8
Terrain stability	Base access to unstable terrain from practices going back to 1996. Terrain inclusion factors for class IV terrain: TFL 60= 0.474; TFL 58=0.76, TSA=0.76. For class V terrain: TFL 60= 0.4; TFL 58=0.23, TSA=0.50	8.2.8
Harvest flow	allow short-term harvest level to increase such that steps to reach mid-term level cannot be more than 10% per decade.	8.2.10

Appendix 9 Natural Stand Volume adjustment analyses

The following text is sourced from section 5.8 of the TSR data package and the accompanying scatterplots are the primary purpose of this appendix.
LEFI net merchantable volumes, like the other LEFI attributes, are well founded predictions of ground attributes based on compiled forest field plot data and association with LiDAR. The TWG considers the LEFI volumes (which are net of decay waste and breakage at a utilization level of 12.5 cm) the best available information on the current volume of stands. These LEFI net volumes averaged to the VRI polygon are not yield curves. Instead, they represent current volumes. They are useful for adjusting the magnitude of the LEFI based VDYP curves for two reasons.

Firstly, the ground plot volume calculations on which the LEFI volumes are based are compiled using Haida Gwaii specific taper factors and Haida Gwaii specific loss factors for decay, waste and breakage. In contrast, the VDYP7 model uses taper factors and loss factors that are generalized to the entire area of the provincial BGC zones. The forests outside Haida Gwaii are not exactly the same even if in the same BGC zone and so the factors do not match. In this sense the LEFI net volumes are more specific to Haida Gwaii than the LEFI based VDYP curves.

Secondly, in attaining the LEFI net volumes, the LEFI model uses parametric equations to extrapolate from these ground measurements and locally specific compilations. This is a high resolution extension of the ground data that does not involve combining LEFI information with VRI information. In contrast, the LEFI based VDYP curves are produced using VDYP inputs from two very different sources; air photo interpretation and ground plot measurements distributed by the LEFI model. Using the two different sources of information is a creative and carefully considered approach intended to make the best use of the available information, and an improvement over Phase 2 adjustment . Using the detailed LEFI information provides a way of verifying the yield estimates based on LEFI and VRI inputs and the VDYP model.

With the above justification for making adjustments, the methods and magnitude of the adjustments are described next. The current volumes of stands on the LEFI based VDYP curves were compared to the LEFI net volumes in scatter plots created for each leading species (C, P, S, and Y, and for H younger than 250, and H at least 250). For each case, a line of best fit through the origin and a co-efficient of determination (R^2) were generated using MSExcel. The following graphs illustrate the volume comparisons between LEFI based VDYP curves and the LEFI net volumes.

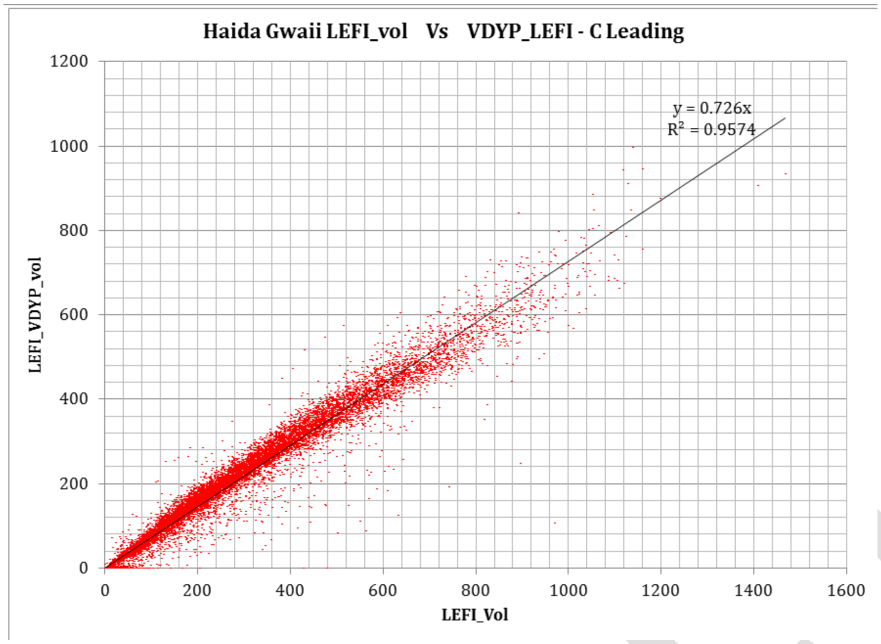


Figure 9.1. LEFI volume vs. LEFI-Based VDYP volume for Cedar leading stands.

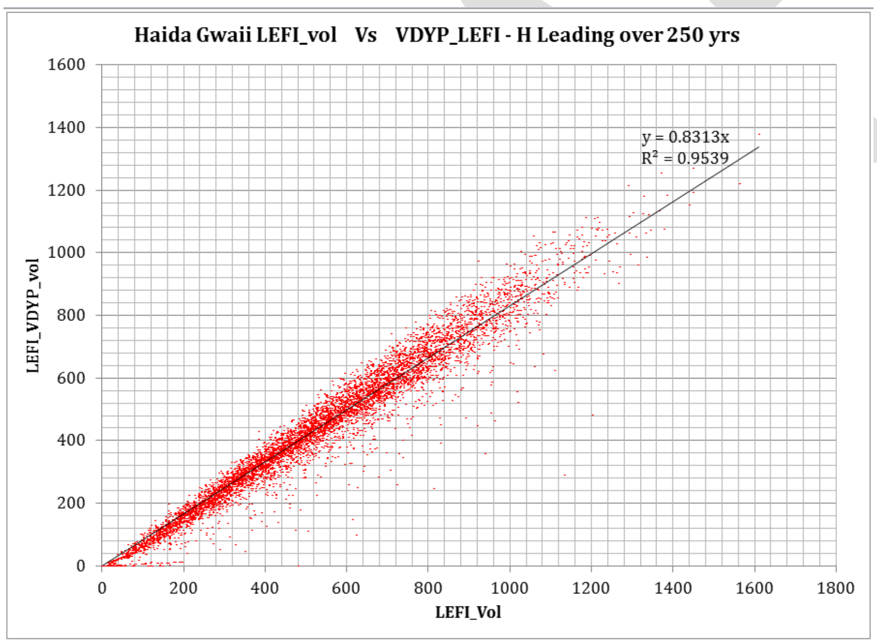


Figure 9.2. . LEFI volume vs. LEFI-Based VDYP volume for hemlock leading stands.

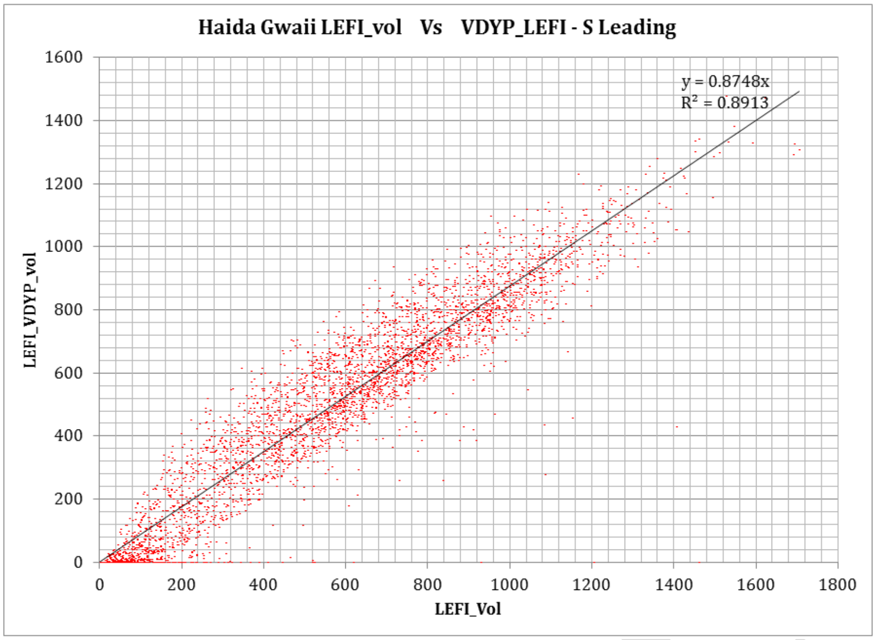


Figure9.3 LEFI volume vs. LEFI-Based VDYP volume for spruce leading stands.

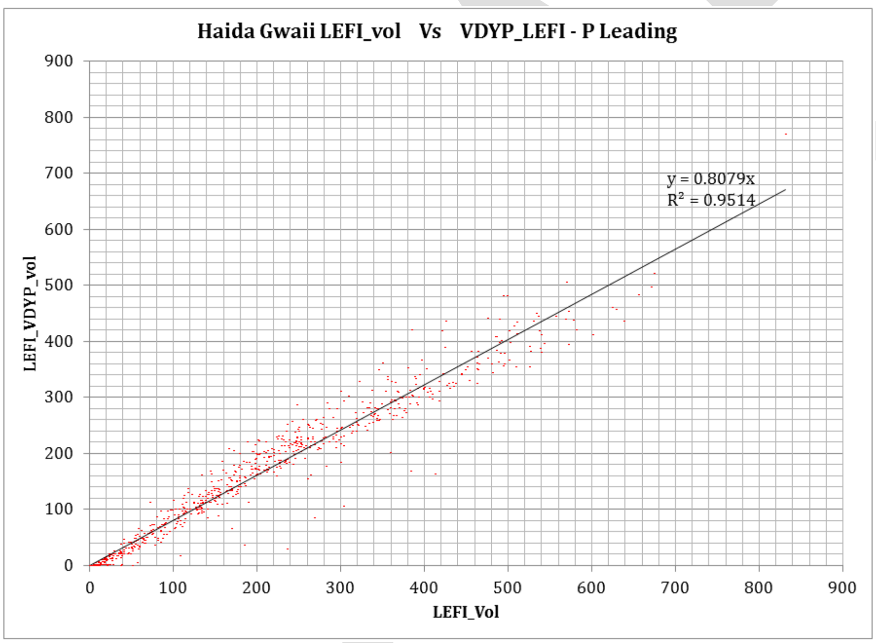


Figure 9.4 LEFI volume vs. LEFI-Based VDYP volume for pine leading stands.

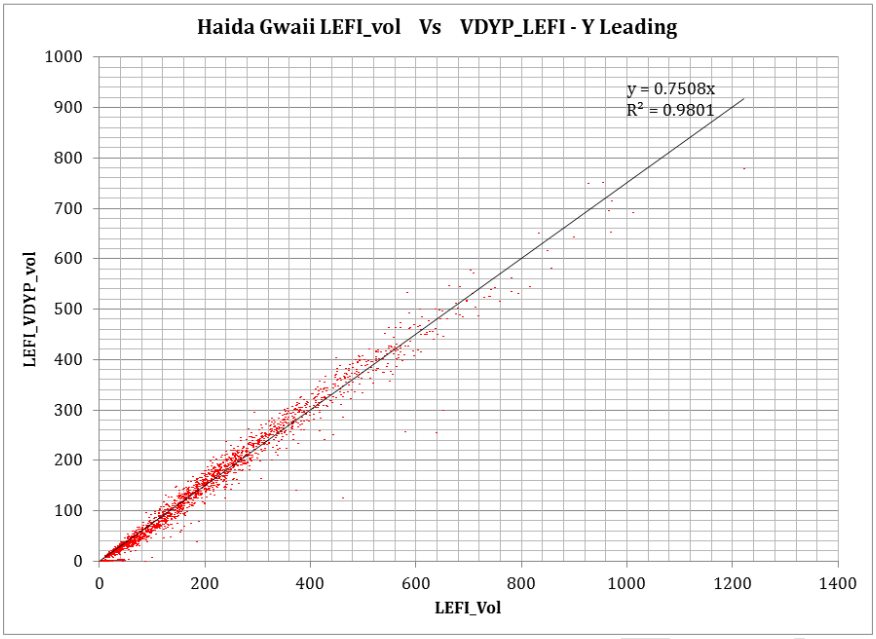


Figure 9.5. . LEFI volume vs. LEFI-Based VDYP volume for yellow cedar leading stands.

Appendix 10 'First Nation Reserves' under the *Indian Act* on Haida Gwaii

IR Name	Description	Hectares
AIN 6	QUEEN CHARLOTE DISTRICT, AT MOUTH OF THE AIN RIVER, NORTH SHORE OF MASSET INLET, GRAHAM ISLAND	66.4
COHOE POINT 20	QUEEN CHARLOTTE DIST., LOT 2079, ON DIBRELL BAY, EAST OF LANGARA ISLAND, OFF NORTHWEST TIP OF GRAHAM ISLAND	10.1
DANINGAY 12	QUEEN CHARLOTTE DIST., ON WEST SHORE OF VIRAGO SOUND, NORTH COAST OF GRAHAM ISLAND	8.5
EGERIA BAY 19	QUEEN CHARLOTTE DIST., LOT 2080, ON EGARIA BAY, EAST SHORE OF LANGARA ISLAND, NORTHWEST TIP OF GRAHAM ISLAND	10.1
GUOYSKUN 22	QUEEN CHARLOTTE DISTRICT, LOT 2078, AT RHODE4S POINT, WEST COAST OF LANGARA ISLAND	20.2
HIELLEN 2	QUEEN CHARLOTTE DIST. AT MOUTH OF HIELLEN RIVER E. OF TOW HILL PROVINCIAL PARK, MCINTYRE BAY N. COST OF GRAHAM ISLAND	27.4
JALUN 14	QUEEN CHARLOTTE DIST. SOUTHWEST OF NANKIVELL POINT AT MOUTH OF JALUN RIVER NORTH COAST OF GRAHAM ISLAND	7.1
KIOOSTA 15	QUEEN CHARLOTTE DISTRICT ON SOUTH SHORE OF PARRY PASSAGE NORTHWEST TIP OF GRAHAM ISLAND	40.9
KOSE 9	QUEEN CHARLOTTE DIST LEFT BANK OF THE NADEN RVR 4 MLS S. OF MOUTH ON NADEN HARBOUR, GRAHAM ISLAND	3.6
KUNG 11	QUEEN CHARLOTTE DISTRICT ON WEST SIDE OF ALEXANDRA NARROWS NODEN HARBOUR VIRAGO SOUND, GRAHAM ISLAND	28.7
LANAS 4	QUEEN CHARLOTTE DISTRICT AT MOUTH OF THE YAKOUN RIVER YAKOUN BAY SOUTHEAST SHORE OF MASSET INLET	78
MAMMIN RIVER 25	QUEEN CHARLOTTE DISTRICT LOT 2085, AT MOUTH OF THE MAMIN RIVER ON MAMMIN BAY, MASSET INLET, GRAHAM ISLAND	2.5
MASSET 1	QUEEN CHARLOEET DIST ON EAST SHORE OF MASSET HARBOUR BELOW ENTRY POINT NORTH COAST OF GRAHAM ISLAND	299.6
MEAGWAN 8	QUEEN CHARLOTTE DISTRICT AT WIAH POINT NORTH COAST OF GRAHAM ISLAND EAST OF VIRAGO SOUND	19.8
NADEN 10	QUEEN CHARLOTTE DISTRICT ON WEST SHORE AT MOUTH OF NADEN RIVER, NADEN HARBOUR, GRAHAM ISLAND	10.9

IR Name	Description	Hectares
NADEN 23	QUEEN CHARLOTTE DISTRICT LOT 2084, AT MOUTH OF STANDLY CREEK NADEN HARBOUR NORTH SHORE OF GRAHAM ISLAND	2.6
OWUN 24	QUEEN CHARLOTTE DISTRICT, AT THE MOUTH OF THE AWUN RIVER, AWUN BAY, SOUTH SHORE OF MASSET INLET, GRAHAM ISLAND	3
SAOUCHTEN 18	QUEEN CHARLOTTE DISTRICT, LOT 174, AT ROONEY POINT, WEST SIDE OF MASSET HARBOUR, GRAHAM ISLAND	11.4
SATUNQUIN 5	QUEEN CHARLOTTE DISTRICT, AT STRATHDANG KWUN, POINT ON WEST SIDE OF YAKOUN BAY OF MASSET INLET, GRAHAM ISLAND	3.6
SUSK 17	QUEEN CHARLOTTE DISTRICT, LOT 2083, AT PERIL BAY, EAST OF FREDERICK ISLAND, WEST SHORE OF GRAHAM ISLAND	63.1
TATENSE 16	QUEEN CHARLOTTE DISTRICT, ON S.W. TIP OF LANGARA ISLAND, N. OF PARRY PASSAGE, N.W. OF GRAHAM ISLAND	6.5
TIAHN 27	QUEEN CHARLOTTE DISTRICT, LOT 2082, AT TIAN BAY, W. SHOTE OF GRAHAM ISLAND	2.3
TLAA GAA AAWTLAAS 28		63.7
YAGAN 3	QUEEN CHARLOTTE DISTRICT, AT YAKAN PT. W. OF TOW HILL PROV. PARK, ON MCINTYRE BAY, SOUTH OF GRAHAM ISLAND	34.8
YAN 7	QUEEN CHARLOTTE DISTRICT, ON WEST SIDE OF ENTRANCE TO MASSET HARBOUR, NORTH COAST OF GRAHAM ISLAND	106.8
YASITKUN 21	QUEEN CHARLOTTE DISTRICT, LOT 2081, ON NORTHWEST COAST OF LANGARA ISLAND, NORTHWEST OF GRAHAM ISLAND	20.2
YATZE 13	QUEEN CHARLOTTE DISTRICT, SOUTHEAST OF KLASHWUN POINT, WEST OF VIRAGOSOUND, NORTH COAST OF GRAHAM ISLAND	18.2
BLACK SLATE 11	QUEEN CHARLOTTE DIST, BLK A, SEC. 23, TP 2, ON SLATECHUCK CREEK ABT 2 MLS WEST OF ITS MOUTH ON KAGAN BAY SKIDGATE INLT	17.7
CUMSHEWAS 7	QUEEN CHARLOTTE DIST. ON NORTH SHORE OF CUMSHEWAS INLET WEST OF MCCOY COVE, EAST SIDE OF MORESBY ISLAND	22.6
DEENA 3	QUEEN CHARLOTTE DISTRICT, ON SOUTH SHORE OF SKIDEGATE INLET ON NORTH SIDE OF SOUTH BAY NORTH END OF MORESBY ISLAND	48.2
KASTE 6	QUEEN CHARLOTTE DISTRICT, AT MOUTH OF COPPER CREEK, ON COPPER BAY, NORTHEAST COAST OF MORESBY ISLAND	15.4
KHRANA 4	QUEEN CHARLOTTE DISTRICT, ON THE EAST END OF MAUDE ISLAND IN SKIDEGATE INLET BTWN. GRAHAM & MORESBY ISLANDS	85

IR Name	Description	Hectares
LAGINS 5	QUEEN CHARLOTTE DISTRICT AT MOUTH OF LAGINS GREEK AT HEAD OF GRAHAM ISLAND, SKIDEGATE INLET	16.2
NEW CLEW 10	QUEEN CHARLOTTE DISTRICT LOT 175, ON NORTH SHORE OF LOUISE ISLAND IN THE QUEEN CHARLOTE GROUP	11.2
SKAIGHA 2	QUEEN CHARLOTTE DIST. ON EAST COAST OF GRAHAM ISLAND AT HALIBUT BAY, 7 MILES N. OF SKIDEGATE MISSION	25.1
SKEDANCE 8	QUEEN CHARLOTTE DISTRICT, ON EAST TIP OF LOUIS ISLAND OF THE QUEEN CHARLOTTE GROUP	68.4
SKIDEGATE 1	QUEEN CHARLOTTE DIST. AT SKIDEGATE MISSION, MOUTH OF SKIDE- GATE INLET, SOUTHEAST OF GRAHAM ISLAND	505.7
TANOO 9	QUEEN CHARLOTE DISTRICT, ON THE EAST SHORE OF TANOO ISLAND, QUEEN CHARLOTTE GROUP	26.3

Appendix 11 Timber Supply Review Spatial Input Atlas

See separate download document "*Appendix11.pdf*".

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