Western Forest Products Inc.

DEFINING A HIGHER STANDARD™

Tree Farm Licence 37

MANAGEMENT PLAN 10

August 2017

This Management Plan was prepared by and under the supervision of

REGISTERED PROFESSIONAL FORESTER
PROVINCE OF BRITISH COLUMBIA
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1 Introduction

This is the first Management Plan (MP) prepared by Western Forest Products for Tree Farm Licence (TFL) 37 to meet the requirements of the *Tree Farm Licence Management Plan Regulation* (B.C. Reg. 280/2009). This regulation, enacted by the provincial government in November 2009 (with associated amendments to the *Forest Act*), includes content requirements, submission timing and public review requirements for TFL Management Plans.

The regulation has replaced the content requirements specified in past TFL agreements. Management objectives and strategies that apply to operations within the TFL are specified in Forest Stewardship Plans (FSPs) consistent with the *Forest and Range Practices Act* (FRPA). These objectives and strategies are taken into account in the timber supply analysis that is included in this Management Plan. The timber supply analysis will provide information to the Chief Forester of BC for the determination of the next Allowable Annual Cut (AAC) for TFL 37.

2 Description of TFL 37

TFL 37 is located in the Nimpkish valley on northern Vancouver Island (see Figure 1). Communities within or near the TFL include Woss, Port McNeill, Alert Bay and Sayward.

Adjacent provincial parks include:

- Lower Nimpkish (200 ha),
- Nimpkish Lake (3,950 ha),
- Claud Elliot (328 ha),
- Schoen Lake (8,775 ha),
- Woss Lake (6,634 ha).

The total TFL area is nearly 160,000 hectares and approximately 132,200 hectares is considered productive forest land. Of this, 86,195 hectares is anticipated to be available for timber harvesting. TFL 37 is comprised of both 'Schedule A' lands (Timber Licences and Private land) and 'Schedule B' (Crown) land.

The Nimpkish Valley is the traditional territory of the 'Namgis First Nation. TFL 37 also overlaps to a lesser degree the traditional territories of the following First Nations:

- Kwakiutl
- Mowachaht-Muchalaht
- Quatsino
- K'ómoks
- Mamalilikulla
- Tlowitsis
- Wei Wai Kum
- We Wai Kai

The major tree species include western hemlock, western red cedar, balsam (amabilis fir), Douglas-fir and yellow cedar. The forests of TFL 37 predominantly lie within the Coastal Western Hemlock (CWH) biogeoclimatic zone. Annual precipitation levels reach 3,000 to 5,000 mm. At lower elevations the climate is characterized by short winters with intermittent wet snow storms; at the highest elevations a prolonged snow pack may persist. The summer period from July to September can be dry and warm. The topography of TFL 37 is varied with mountainous, steep formations surrounding the wide Nimpkish valley.

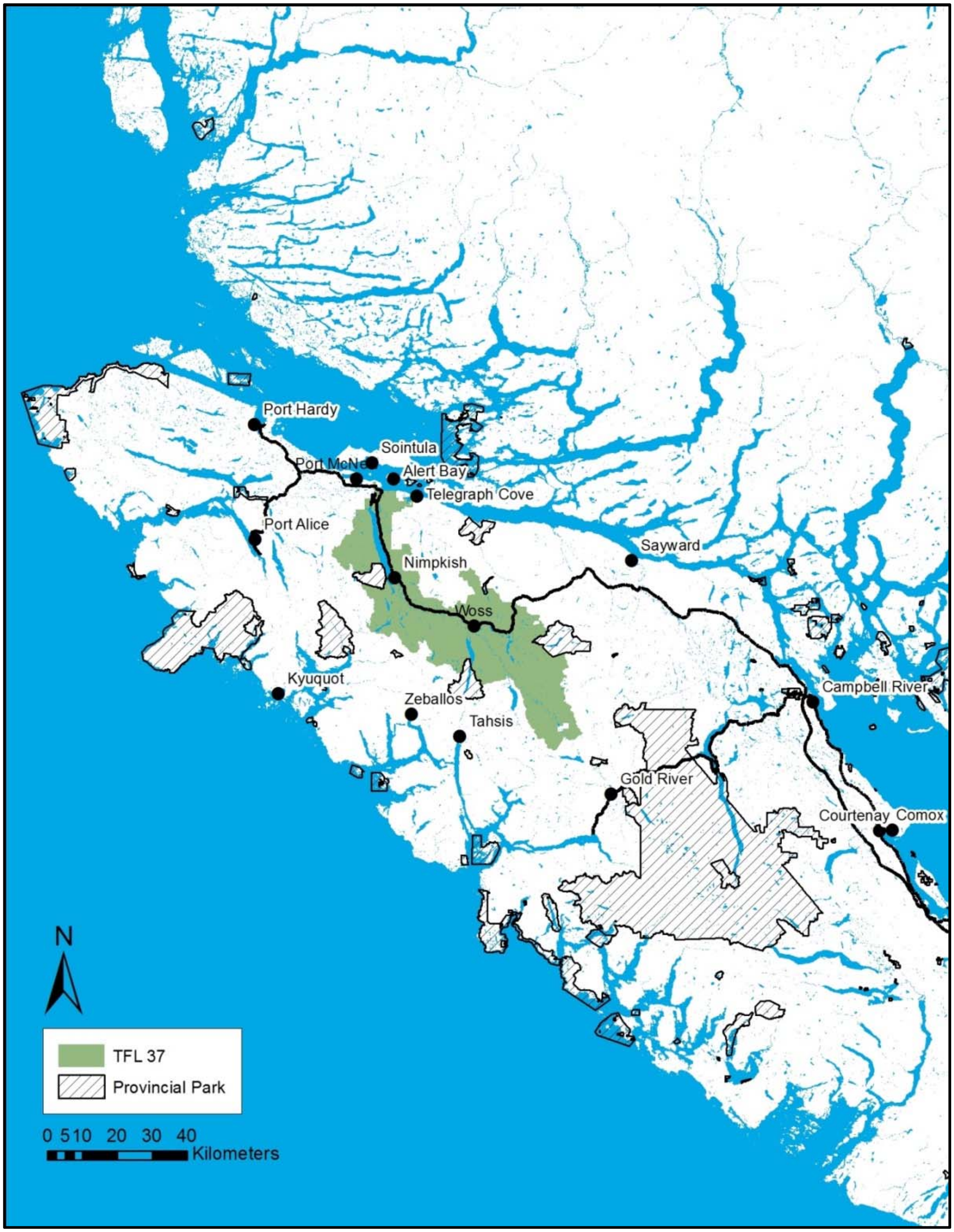

Figure 1 - TFL 37

3 TFL 37 Licence Holder History

TFL 37 was originally granted to Canadian Forest Products (Canfor) on December 28, 1960. In 2006 Western Forest Products purchased TFL 37 from Canfor (refer to Table 1).

Table 1 - TFL 37 Licence Holders

Date listed company became licence holder	Licence Holder	Description
December 28, 1960	Canadian Forest Products Ltd.	Original TFL
March 17, 2006	Western Forest Products Inc.	Purchase from Canfor

4 TFL 37 AAC History

Table 2 shows the history of the AAC for TFL 37. The large increases in the late 1960's were due to major changes in utilization standards, logging technology and timber values. Large scale inventory programs were conducted to establish more accurate estimates of standing timber volumes. Recent reductions are mainly due to landbase removals (see Section 6) and old forest conservation initiatives (e.g. Old Growth Management Areas, Wildlife Habitat Areas).

Table 2 - TFL 37 AAC History

Date From	Date To	Management Plan No.	TFL 37 AAC (m^3/year)
January 1, 1961	December 31, 1965	1	577,677
January 1, 1966	December 31, 1968	2	594,657
January 1, 1969	September 30, 1969	2	807,035
October 1, 1969	December 31, 1970	2	1,144,007
January 1, 1971	December 31, 1975	3	1,144,007
January 1, 1976	December 31, 1980	4	1,095,868
January 1, 1981	December 31, 1982	5	1,093,000
January 1, 1983	December 31, 1986	5	1,107,000
January 1, 1987	December 31, 1991	6	1,085,000
January 1, 1992	December 31, 1993	6	1,063,000
January 1, 1994	December 31, 1998	7	1,068,000
January 1, 1999	September 30, 2006	8	1,068,000
October 1, 2006	July 14, 2009	9	969,000
July 15, 2009	Present	9	889,415

5 TFL 37 Consolidations and Subdivisions

There have been no consolidations or subdivisions associated with TFL 37 since its issuance in 1960.

6 Significant TFL 37 Boundary Changes

Table 3 lists major changes to the TFL of record and the date of those changes. There have been multiple minor (< 200 ha) area revisions since 1961 to accommodate other land uses such as gravel pits, hydro-electric stations and road right-of ways. There have also been multiple amendments transferring areas from "Schedule A" to "Schedule B" that had no effect on the TFL boundaries.

Table 3 - TFL 37 Significant Boundary Changes

Date	Mechanism	Boundary Change
June 4 & October 27, 1971	Instruments 18 and 19	Deletion of roughly 176 ha for construction of Highway 19 along eastern side of Nimpkish Lake.
October 26, 1977	Instrument 30	Deletion of 1,940 ha to create Roderick Haig Brown Provincial Park (now known as Schoen Lake Park).
February 18, 1981	Instrument 33	Deletion of 90 ha by withdrawal of Lot 26 and portion of Lot 27 north of Highway 19 (near mouth of Nimpkish River).
June 10, 1983	Instrument 36	Addition of 2,168 ha of private land purchased by Canfor (Lots 240 and 1370 near Upper and Lower Klaklakama lakes).
April 14, 1986	Instrument 42	Deletion of 158 ha for Mt. Cain Regional Park.
December 23, 1987	Instrument 45	Deletion of 96 ha for Claud Elliot Creek Ecological Reserve
December 23, 1987	Instrument 46	Addition of 246 ha for eliminated portions of T0118.
March 24, 1988	Instrument 47	Deletion of 18 ha for Nimpkish River Ecological Reserve.
July 12, 1995	Park Act	Deletion of approximately 11,000 ha to create four provincial parks • Claud Elliot • Lower Nimpkish • Nimpkish Lake • Woss Lake and to expand Schoen Lake park by roughly 260 ha.
September 15, 1998	Instrument 51	Deletion of 144 ha to establish Woss as a public community.
November 8,2004	Instrument 56	Addition of 35 ha formerly within TFL 19.
July 15, 2009	Instrument 57	Deletion of 18,351 ha due *to Forestry Revitalization Act* to form part of Pacific TSA.

7 TFL 37 Planning Documents

The following are the publicly available planning documents used by WFP to guide forest management and operations within TFL 37.

7.1 Vancouver Island Land Use Plan Higher Level Plan Order

Under the *Forest Practices Code* and continued under FRPA government established a "higher level plan" (HLP) to declare forestry-related components of VISLUP as legal requirements. Effective December 1, 2000 the HLP established resource management objectives that vary from normal forest management standards. The HLP enables forest operations to be consistent with the intent of VILUP's special management and enhanced forestry zones.

Special Management Zones (SMZs) are areas where forest management emphasis is on protecting special resource values, including biodiversity, visual quality and wildlife values. Portions of 4 SMZ's are found within TFL 37:

- Woss-Zeballos (SMZ 6)
- Tsitika Woss (SMZ 9)
- Pinder-Atluck (SMZ 10)
- Schoen-Strathcona (SMZ 11)

Enhanced Forestry Zones (EFZs) are areas where forest management emphasis is on increasing the availability of timber while maintaining environmental stewardship. Part of TFL 37 is designated as EFZ 10 (Nimpkish).

As of July 2017, the Vancouver Island HLP order can be found at:
https://www.for.gov.bc.ca/tasb/slrp/lrmp/nanaimo/vancouver_island/docs/HLP_order_final.pdf

7.2 Upper and Lower Nimpkish Landscape Unit Plans

Landscape Unit Plans (LUPs) are intended to provide direction on biodiversity, old growth forest retention, wildlife habitat maintenance and timber harvesting. Biodiversity is defined as the diversity of plants, animals and other living organisms in all their forms and levels of organization, including genes, species, ecosystems and the evolutionary and functional processes that link them. Landscape Unit planning provides for the legal establishment of objectives to address landscape level biodiversity by planning for Old Growth Management Areas (OGMAs) and Wildlife Tree Retention (WTR).

In October 2005 orders were approved by government to establish the Upper and Lower Nimpkish Landscape Units and associated objectives for OGMAs and WTR. Accompanying maps indicated the location of OGMAs established at the time. Most OGMAs were designed to capture ecological values at a coarse scale without detailed knowledge of forest development challenges in the vicinity. The orders provide mechanisms to adjust the OGMA boundaries to accommodate forest development as more accurate fieldwork is completed.

As of July 2017, the LUPs and orders can be found at: https://www.for.gov.bc.ca/tasb/slrp/plan103.html

7.3 Forest Stewardship Plans

Forest Stewardship Plans (FSPs) indicate where a licensee may carry out forest development activities over a period of up to five or, if extended, up to ten years. The plan also states results, strategies or measures that the licensee will achieve or employ in order to be consistent with government objectives that apply to the area covered by the FSP. Once the FSP is approved the licensee may be issued a cutting permit or a road permit authorizing the harvest of timber or construction of roads.

As of July 2017 the FSP applicable to TFL 37 is *Central Island Forest Operation Forest Stewardship Plan: 2017 - 2022* (FSP #646). It can be found at http://www.westernforest.com/sustainability/environmental-stewardship/planning-and-practices/our-forests/.

7.4 Forestry Certification Plans

Operations within TFL 37 are certified to the Canadian Standards Association (CSA) Group Sustainable Forest Management System (SFM) standard. The CSA SFM standard is the leading forest certification standard in Canada and the first national sustainable forest management system in the world. First released in 1996, it is Canada's official national standard for sustainable forest management. For lands to be certified to the CSA SFM standard, forest managers must follow the six criteria developed by the Canadian Council of Forest Ministers as part of an international process to create global criteria and indicators for sustainable forest management.

The CSA SFM standard requires a significant level of public participation to assist in developing a Sustainable Forest Management Plan (SFMP) for certification. The SFMP contains Indicators and targets; the targets are set by the public advisory groups.

As of July 2017 the *Nimpkish Woodlands Sustainable Forest Management Plan* for TFL 37 can be found at http://www.northislandpag.com/sfm-planannual-reportsaudit-results.html

8 Public Review Strategy Summary

This section will be completed following the review period and be included in the final MP submission to the Ministry of Forests, Lands and Natural Resource Operations.

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Appendix 1: Timber Supply Analysis

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Version 1
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Executive Summary

This analysis examines timber supply projections for Tree Farm Licence 37 located on northern Vancouver Island. Woodstock, a pseudo-spatial harvest model, was used to model current management practices for protection and maintenance of ecological values and to estimate the timber supply potential through the year 2265.

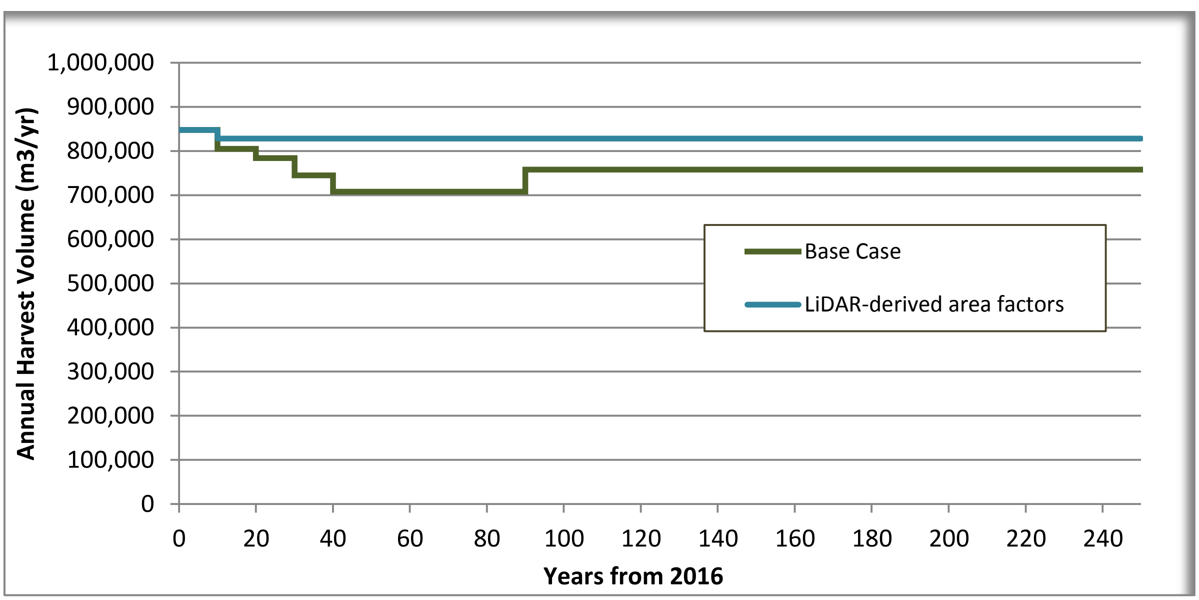
After allowances for non-recoverable losses, the modelling of current management practice as set out in the associated Information Package suggests an AAC of 847,400 m^3/year (a reduction of 4.7%). This represents a reasonable harvest level that accommodates ecological and social concerns in the short and longer terms.

The modelling indicates that a minimum of 33,750 ha (25%) of productive forest area will be maintained in old forests (>250 years old) and a minimum of 24,000,000 m^3 of growing stock will be maintained on the timber harvesting land base throughout the 250-year planning horizon. In the long-term, the extent of land base managed for timber and other resource values is 86,195 ha (65% of the productive forest) while 46,022 ha (35%) is conserved for non-timber values. These forests are expected to contribute significantly to biodiversity conservation and complement protected areas within and adjacent to the Tree Farm Licence.

Several assumptions are also reviewed using recently acquired LiDAR data for the TFL. This review looked at:

- growing site loss due to roads;
- average tree heights; and
- OAF1 (small non-productive areas within forest stands).

The net effect of reviewing the applied assumptions with TFL specific comprehensive data confirms that the Base Case assumptions are conservative and that mid and long-term timber supply is likely greater than indicated by the Base Case.



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1.1 Background

Tree Farm Licence (TFL) 37 is located on northern Vancouver Island in the Nimpkish Valley and is managed by Western Forest Products Inc. (WFP). Figure 1 indicates the current extent of TFL 37 for this analysis. Since the last timber supply analysis was completed some significant changes to the administration of the TFL have occurred:

- In 2006, WFP purchased TFL 37 from Canadian Forest Products (Canfor).
- In 2009, a portion of TFL 37 was deleted via Instrument Number 57 to form part of BCTS' Pacific Timber Supply Area.
- In 2012, potential treaty settlement lands for the 'Namgis First Nation were identified within TFL 37 (and elsewhere) as part of an Agreement in Principle (AIP) with the federal and provincial governments. 'Namgis members, in a March 2013 vote, did not approve the AIP. Ongoing negotiations resulted in the 2015 Forestry Fund Agreement that provides for continuation of timber harvesting within the proposed treaty settlement lands.

The TFL encompasses 159,982 ha of which 86,195 ha is expected to be available for timber production. The allowable annual cut (AAC) for this landbase is currently set at 889,415 m^3 per year. A history of the AAC is provided in the body of Management Plan #10.

1.2 Objective

The primary objective of this report is to estimate achievable timber flows for consideration by the Provincial Chief Forester in making the determination of the AAC for the term of Management Plan #10. More specifically:

- The management of non-timber values such as fish and wildlife habitat, biodiversity, visual quality, and terrain stability is accounted for. Protection of non-timber values will be satisfied by land base reserves, rate-of-harvest constraints and/or by maintaining a percentage of the landbase in older stands.
- Timber flow is estimated by considering harvestable inventory, growth potential of present and future stands, silvicultural treatments, potential timber losses, and operational and legislative constraints.
- Impacts of declining timber flow on community stability and employment are to be lessened by keeping rates of decline per decade as low as possible without inducing undue impacts on other values or long-term timber sustainability.

1.3 Timber Supply Model

Timber supply forecasts were completed with Woodstock software developed by Remsoft. Woodstock is a pseudo-spatial supply model and is described in more detail in the associated Information Package (IP) dated June 2017.

The inventory database was current to January 1, 2016 for harvesting depletion and silviculture treatments and assessments. The model was constructed using 50 5-year periods for a total planning horizon of 250 years. Since AAC's are now effective for up to 10 years, the model was constructed such that harvest volumes over successive pairs of 5-year periods had to be equal (i.e. harvest levels in Periods 1 and 2 had to be equal; harvest levels in Periods 3 and 4 had to be equal; etc.). This report presents results by 10-year intervals.

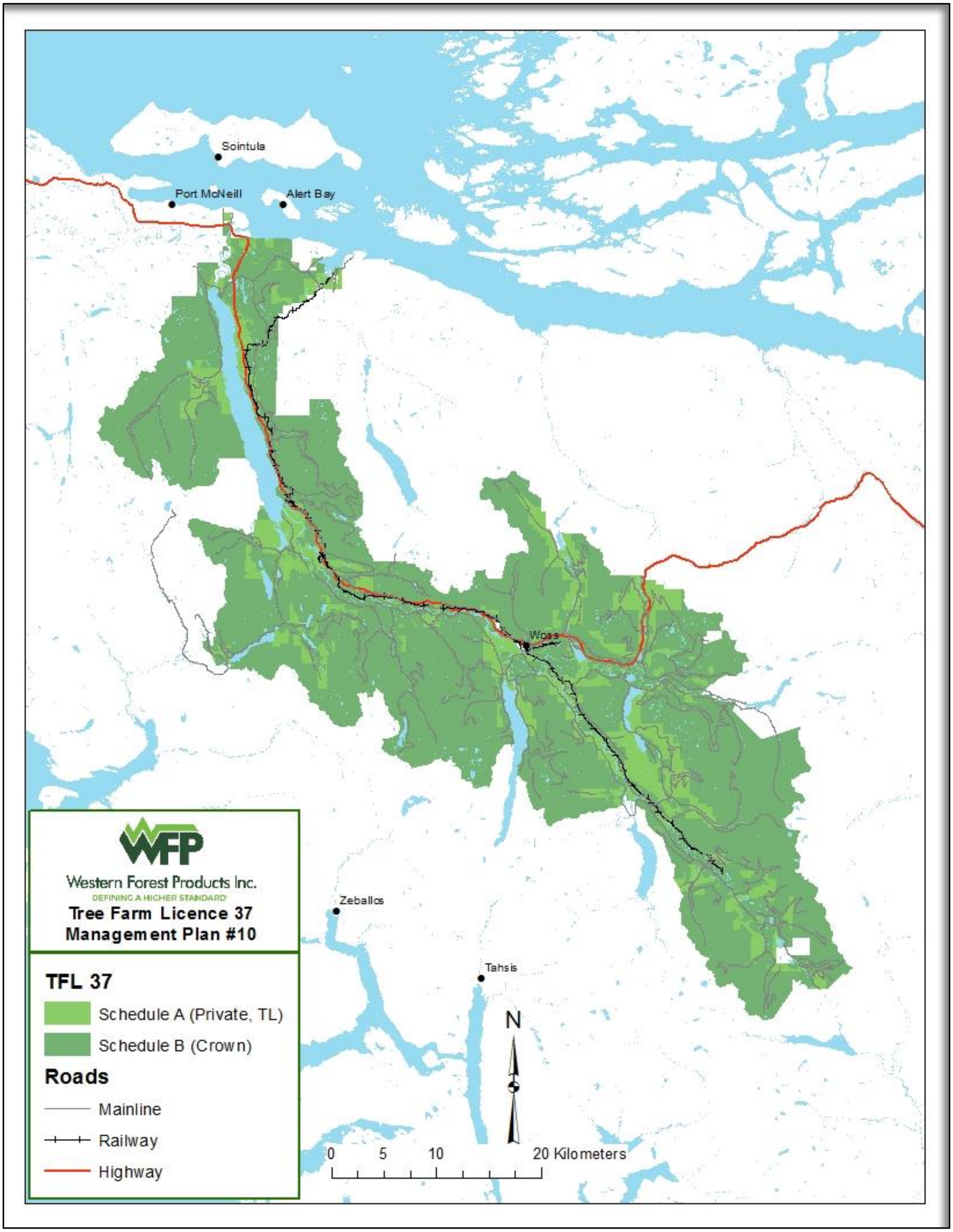

Figure 1 - TFL 37

2 Base Case (or Current Management Option)

The Base Case (or Current Management option) includes the following assumptions and modelling parameters that are described in more detail in the accompanying Information Package:

- The operable forested landbase accessible using conventional and non-conventional (helicopter) harvesting methods with controlled contribution from the non-conventional landbase.
- Exclusion of uneconomic forest stands.
- Harvesting of both mature and immature stands.
- Silviculture to meet free growing requirements is carried out on all regenerated stands. Known tree improvement gains are applied to existing stands ≤ 14 years old and future regenerated stands.
- Visual quality objectives (VQOs) are modelled based on the VQOs established and made effective through the *Government Actions Regulation*, with upper range disturbance assumed.
- Green-up heights for cutblock adjacency are assigned based on Resource Management Zones established in the Vancouver Island Higher Level Plan. Special and General zones have a 3m green-up requirement while Enhanced zones have a 1.3m green-up height.
- For initial forest conditions within Special and General Zones, areas within 200m of plantations 6-10 years old are not available in the first 5 years and NSR area plus plantations 1-5 years old are not available in the first 10 years.
- Future Wildlife Tree and other stand-level retention within the THLB are removed by a percentage area reduction.
- Established Old Growth Management Areas (OGMAs) in the Upper and Lower Nimpkish landscape units are removed from the THLB. Mature seral targets are incorporated for the portions of four Special Management Zones within TFL 37.
- Established Ungulate Winter Ranges (UWRs) and Wildlife Habitat Areas (WHAs) are removed from the THLB. As per the accepted Information Package (IP), an additional netdown is applied for presumed final WHAs for Marbled Murrelet and Northern Goshawk.
- Riparian management based on the FSP results/strategies and the results of a review of riparian management zone retention for cutblocks harvested between 1995 and 2015.
- Minimum harvest age criteria based on minimum average stand diameter-at-breast-height (DBH) that varies by harvest system and minimum volume per hectare. Both minimum diameter and minimum volume requirements must be met before a stand can be harvested.
- For initial forest conditions, harvesting patches of THLB less than 5 ha is delayed until at least 5 ha are available.
- Contribution from current old forest heli operable stands evenly-flowed over the first 30 years. This was done to align timing of harvesting of these stands with the remaining old conventionally operable stands.
- Harvesting of second growth beginning in the first decade.
- Woodstock was set up to maximize harvest volume for the first two decades subject to achieving the long-term harvest level achieved by requesting a non-declining even-flow (refer to Section 3.2) and maintaining a stable conventionally operable growing stock on the THLB over the final 125 years. This time frame was selected as this is when future stands contribute nearly all harvest volume. Through this time conventional harvest and growth are equal, ensuring long-term sustainability. No

growing stock constraint was applied to the heli-operable growing stock due to the harvest volume constraint applied to that portion of the landbase.

The Base Case harvest flow is presented in Table 1 and Figure 2. All harvest volume figures are net of non-recoverable losses of 1 % per year.

Table 1 - Base Case Harvest Levels

Period (Decade #)	Start Year	End Year	Annual Conventional Harvest Volume (m^3)	Annual Heli Harvest Volume (m^3)	Total Annual Harvest Volume (m^3)	% Change from Previous Period
1	2016	2025	770,600	76,800	847,400	-4.7%
2	2026	2035	728,300	76,800	805,100	-5.0%
3	2036	2045	707,400	76,800	784,200	-2.6%
4	2046	2055	707,400	37,600	745,000	-5.0%
5	2056	2065	707,400	400	707,800	-5.0%
6	2066	2075	707,400	200	707,600	< -0.1%
7 - 9	2076	2105	707,400	0	707,400	< -0.1%
10 - 25	2106	2265	707,400	50,500	757,900	+7.1%

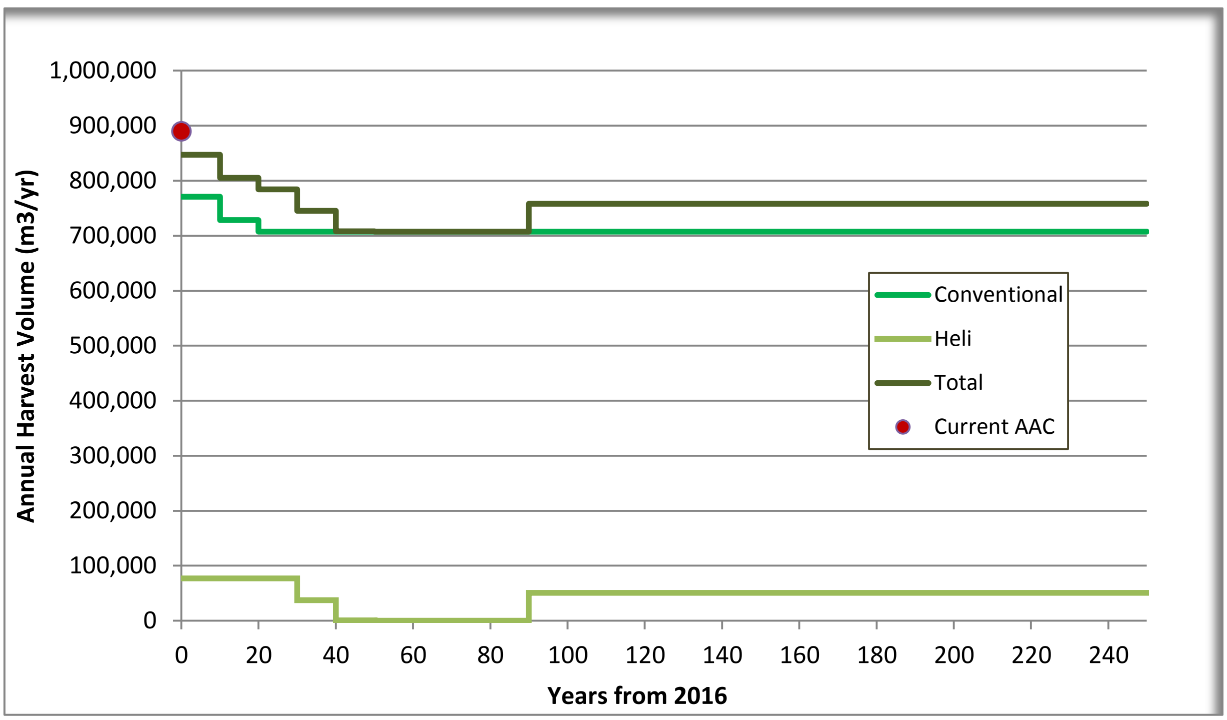

Figure 2 - Base Case Harvest Schedule 2016-2265

The initial harvest level of 847,400 m^3/year is a reduction of 42,015 m^3/year (4.7%) from the current AAC of 889,415 m^3/year. It is comprised of 770,600 m^3/year (91%) from conventionally operable stands and 76,800 m^3/year (9%) from heli operable stands. The projected harvest schedule declines 16.5% over the following 50 years to 707,400 m^3/year through to 2105 before increasing to the current long-term harvest level (LTHL) estimate of 757,900 m^3/year. The mid-term timber supply "dip" of 50,500 m^3/year occurs during the transition from unmanaged to managed heli operable stands. There is a 30 year period in which heli operable stands do not contribute to timber supply as there is insufficient merchantable inventory (i.e.

stands that have reached minimum harvest criteria) to sustain a non-declining contribution to long-term timber supply. As previously harvested heli operable stands age they are able to contribute to long-term timber supply beginning in 2106. The total volume harvested over the 250 years is roughly 188.5 million m^3.

Figure 3 compares the MP #10 Base Case to a pro-rated MP #9 schedule. The timber supply analysis for MP #9 was conducted prior to the deletion of the Vernon Lake block to form part of the Pacific TSA. When this landbase (18,351 ha) was removed from TFL 37 in July 2009 an AAC of 79,585 m^3/year was associated with the area. This equated to 8.21% of the total TFL AAC of 969,000 m^3/year in effect prior to the area deletion. The pro-rated MP #9 schedule in Figure 3 is based on an 8.21% reduction to the schedule associated with the AAC determined for MP #9. MP #9 indicated a 5% decline every 5 years to a pro-rated LTHL of 715,000 m^3/year. The most significant change between the MP #9 analysis and this analysis is in the treatment of the heli operable landbase. The MP #9 schedule was based on a HemBal heli partition that contributed 37,000 m^3/year throughout the projection; whereas this analysis even flows current old heli stands through the first 30 years and then relies on the minimum harvest criteria to determine possible timber supply contribution from heli operable stands. A sensitivity analysis was conducted that replicated the MP #9 HemBal heli partition – see Section 4.10.

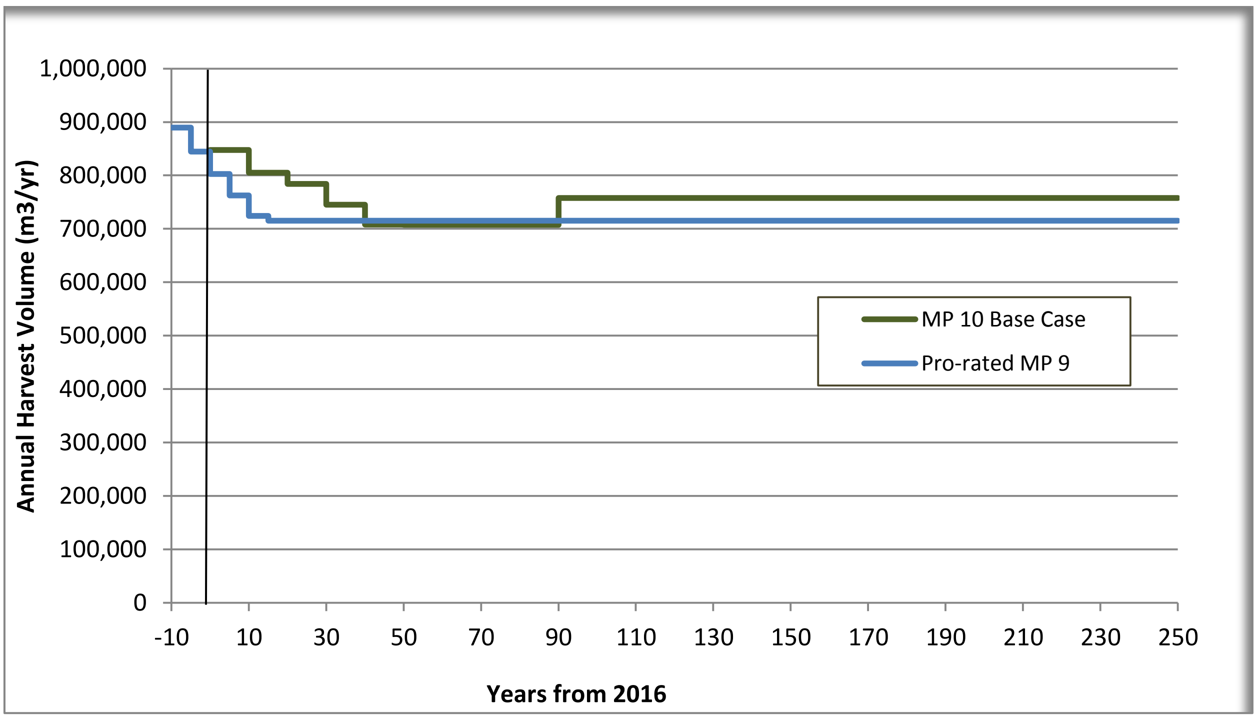

Figure 3 – Comparison to MP #9

Figure 4 indicates the contribution to the total harvest volume by period from each of the three broad stand eras used to define the analysis units. As expected, unmanaged stands (greater than 54 years old in 2016 and indicated in dark green) contribute the greatest proportion of volume in the first 15 years. In the subsequent 50 years current managed stands (indicated in medium green) provide the largest proportion of the volume as unmanaged stands harvest continues to decline. Future managed stands (indicated in light green) contribute some volume in the fifth decade (2056 – 2065) and provide the majority of the harvest volume as of the eighth decade (2086 – 2095).

The contribution from unmanaged stands 90 and 150 years into the future is from today's youngest unmanaged heli operable stands. The minimum harvest criteria applied results in some of these stands not being eligible for harvest until those periods.

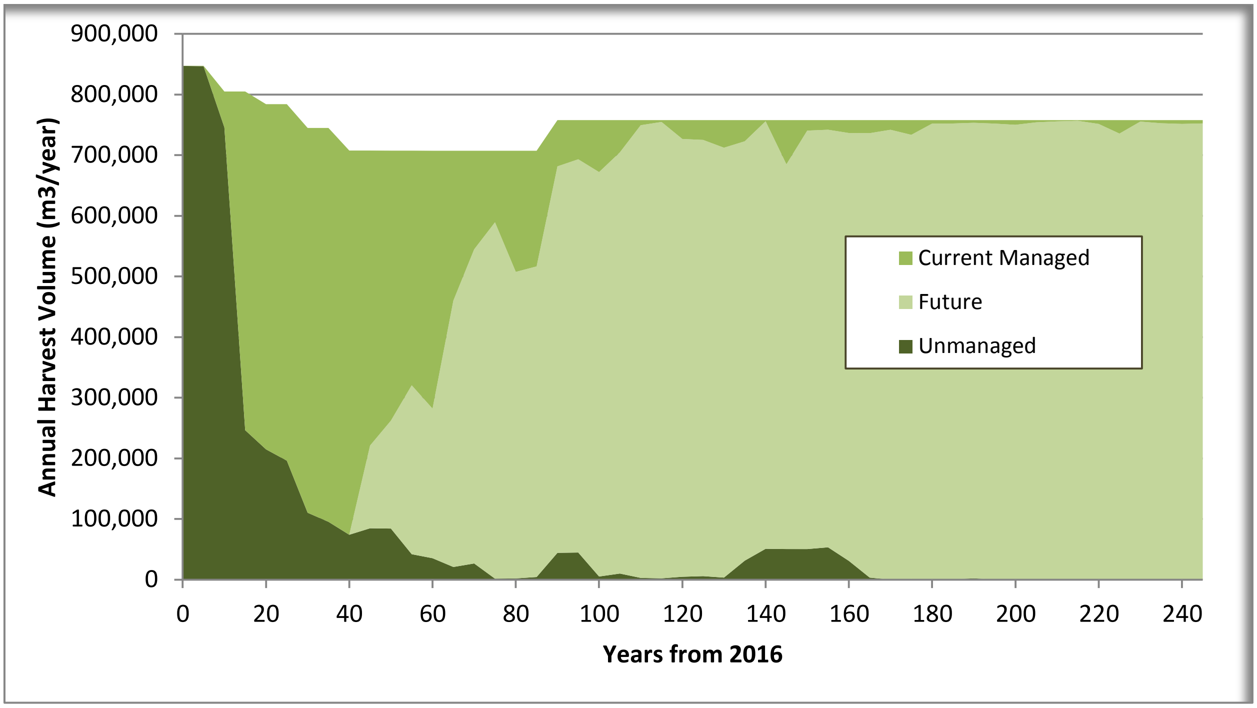

Figure 4 – Stand Eras' contribution to Base Case harvest

Age class distributions over time based on the 5-year age groupings used in Woodstock are examined in Figure 5 and Figure 6. Within the productive forest the oldest age class declines by 33% as harvesting of current old stands occurs and then increases to 97% of the current amount as younger reserved timber ages into the old growth age class (see Figure 5).

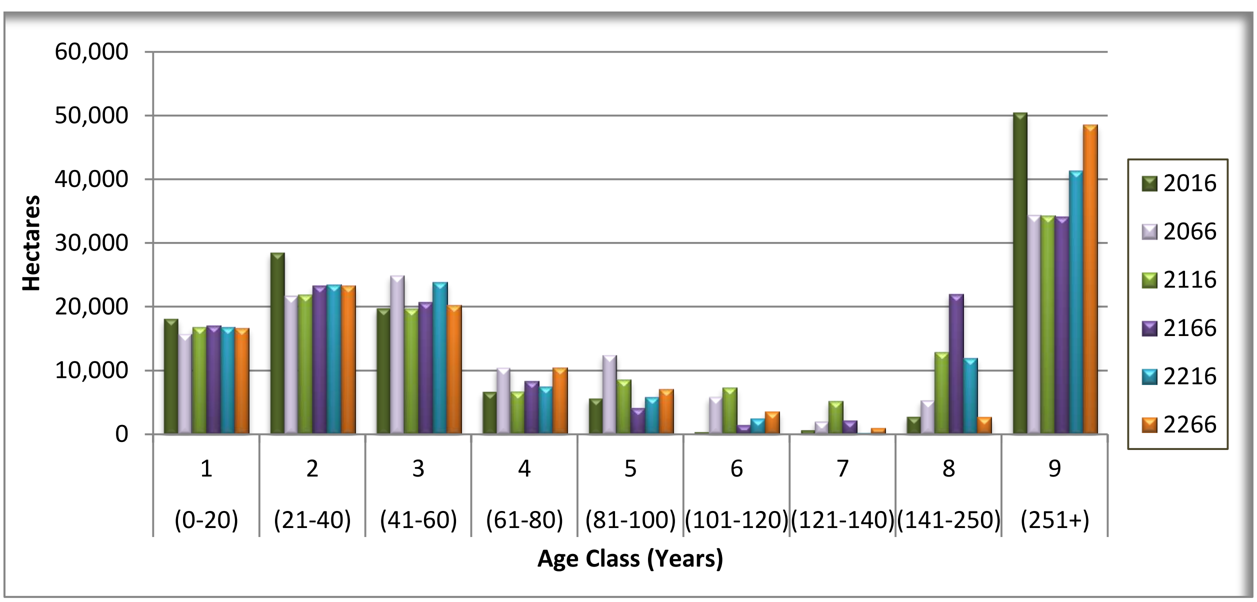

Figure 5 - Age class distribution of productive forest area (132,217 ha)

The total THLB area in Age Classes 1-4 increases initially until a relatively balanced age class distribution is achieved (refer to Figure 6). The THLB age class distribution at the end of the harvest schedule (2266) ensures a sustainable harvest beyond the analysis period is achievable.

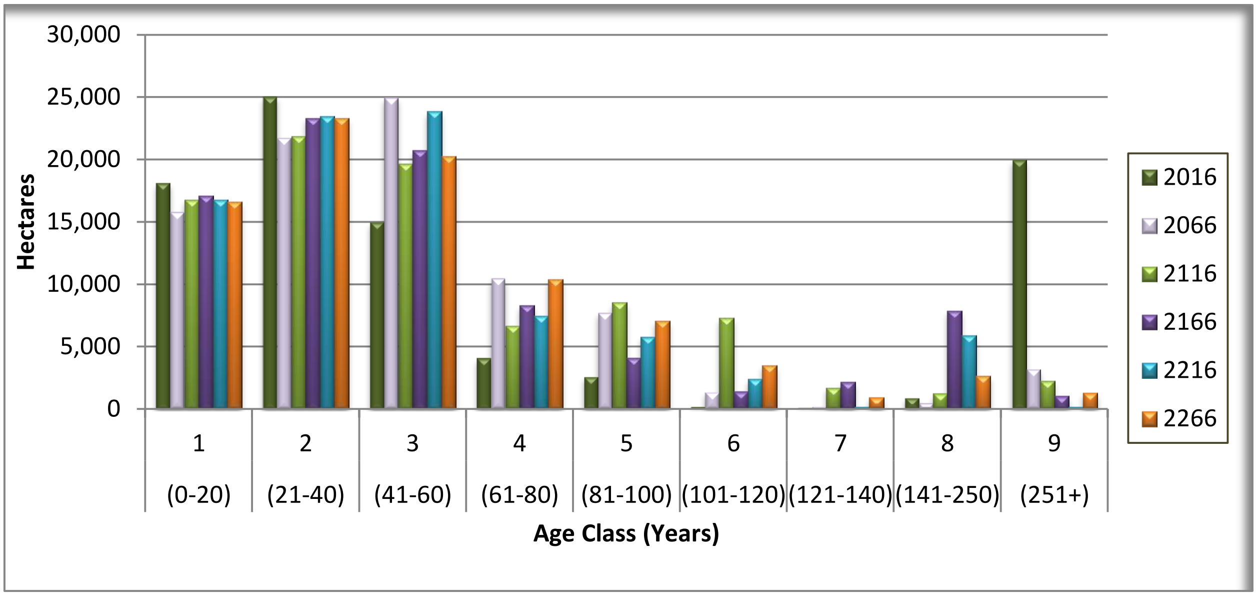

Figure 6 - Age class distribution of timber harvesting land base (86,195 ha)

Figure 7 illustrates harvestable (i.e. meets minimum harvest criteria) and growing stock levels for the timber harvesting landbase, including the ground-based / cable / heli split. For comparative purposes the harvest amount is indicated.

Total THLB growing stock declines by about 16% over the first 40 years while harvesting of heli operable stands is occurring in a significant amount and then returns to approximately 95% of current levels as future stands begin to acquire merchantable volume. Refer to Figure 4 for the contribution of each stand type to the total harvest level over time.

Once the transition to future stands is completed, operable growing stock is steady at approximately 27 million m^3. Ground-based THLB growing stock is fairly constant after the first 40 years at roughly 10 million m^3. As the cable old-growth is harvested and second growth stands begin acquiring merchantable volume, the cable THLB inventory increases to above current levels and then averages approximately 13 million m^3. Heli THLB growing stock initially declines as current stands are harvested and then recovers to a long-term quantity averaging 4 million m^3.

The long-term distribution of THLB growing stock by harvesting system relates directly to differences in harvest age (based on different minimum harvest age criteria) of future stands. Cable THLB is 39% of the total THLB area but in the longer term holds, on average, 49% of the growing stock; while ground-based THLB is 52% of the total area and in the longer term averages 36% of the THLB growing stock. The minimum harvest age is substantially older for cable-based logging areas (average 105 years) than for ground-based areas (average 62 years), with minimum average DBHs of 37 cm and 30 cm respectively for the two systems. Hence longer-term there is more growing stock on cable areas.

Harvestable (i.e. meets minimum harvest criteria) volume declines over the first 40 years as old growth and existing second growth stands are harvested and replaced with managed stands. Once the transition to future stands is complete, harvestable volume fluctuates between 5 and 10 million m^3, averaging about 7 million m^3.

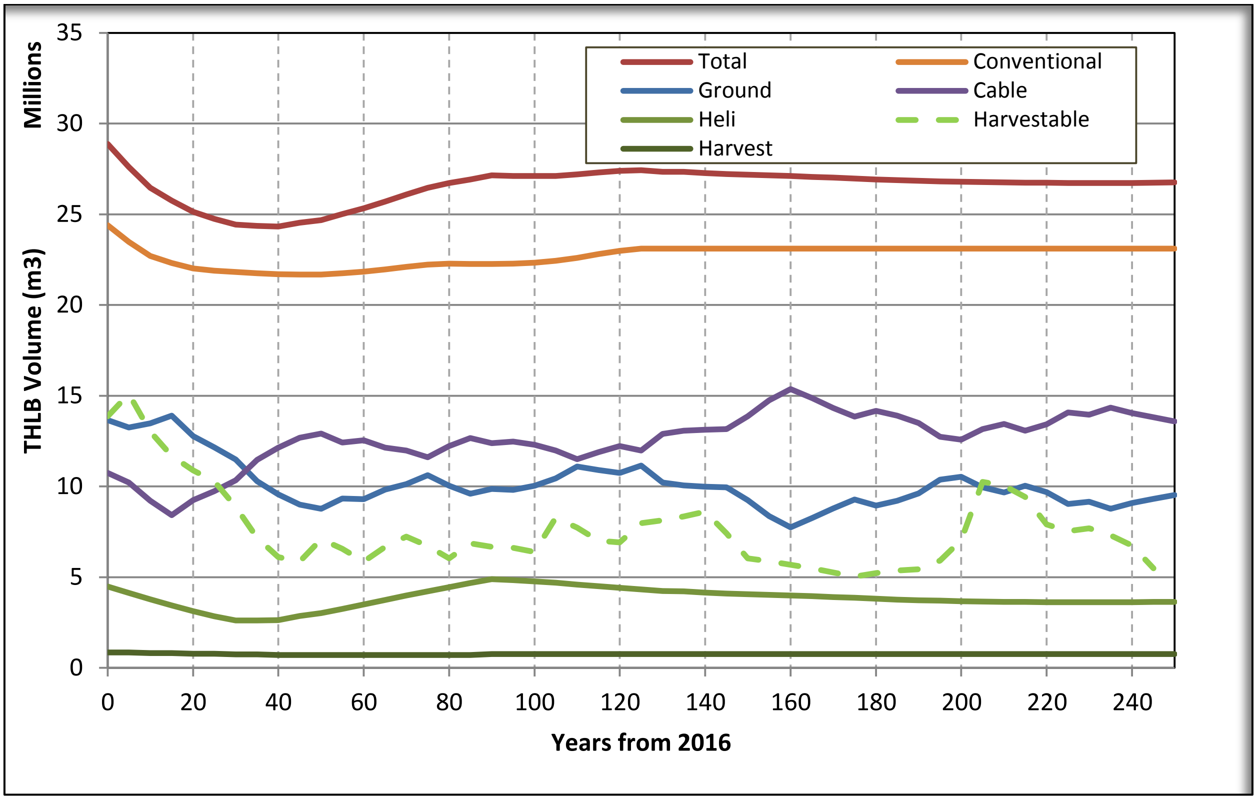

Figure 7 - THLB Growing stock

Figure 8 provides average statistics for timber harvested through the harvest projection. As expected, the mean age of stands harvested declines rapidly as the transition to managed stands occurs. The average age of harvested stands declines from greater than 350 years in the immediate future to approximately 80 years through the mid and long-term. Annual area harvested generally fluctuates between 1,100 and 1,300 hectares and merchantable volume per hectare varies within a relatively narrow range of 600 – 700 m^3/ha.

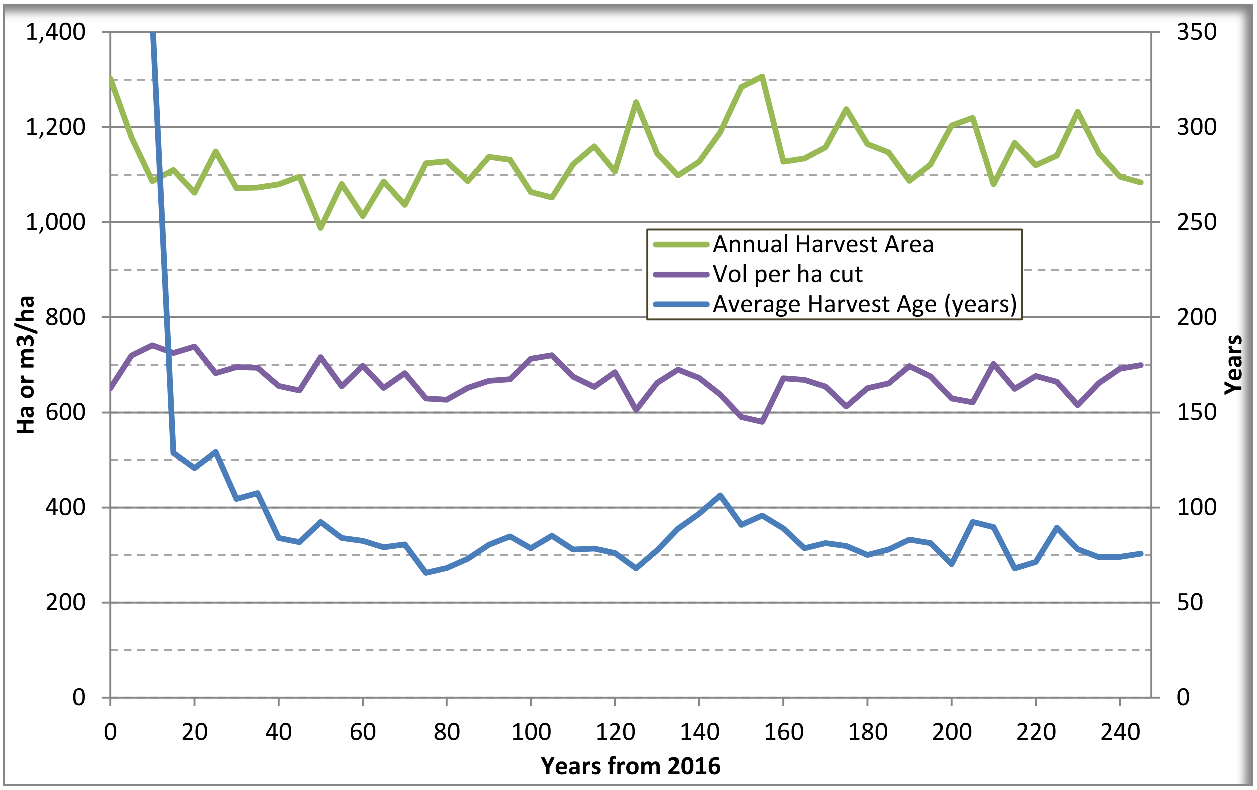

Figure 8 - Harvest Statistics 2009 – 2258

The minimum harvest age modelled for stands varied by harvesting system (see Section 10.3.1 of the IP). Figure 9 indicates the contribution by harvesting system to total annual harvest volume and average harvest age.

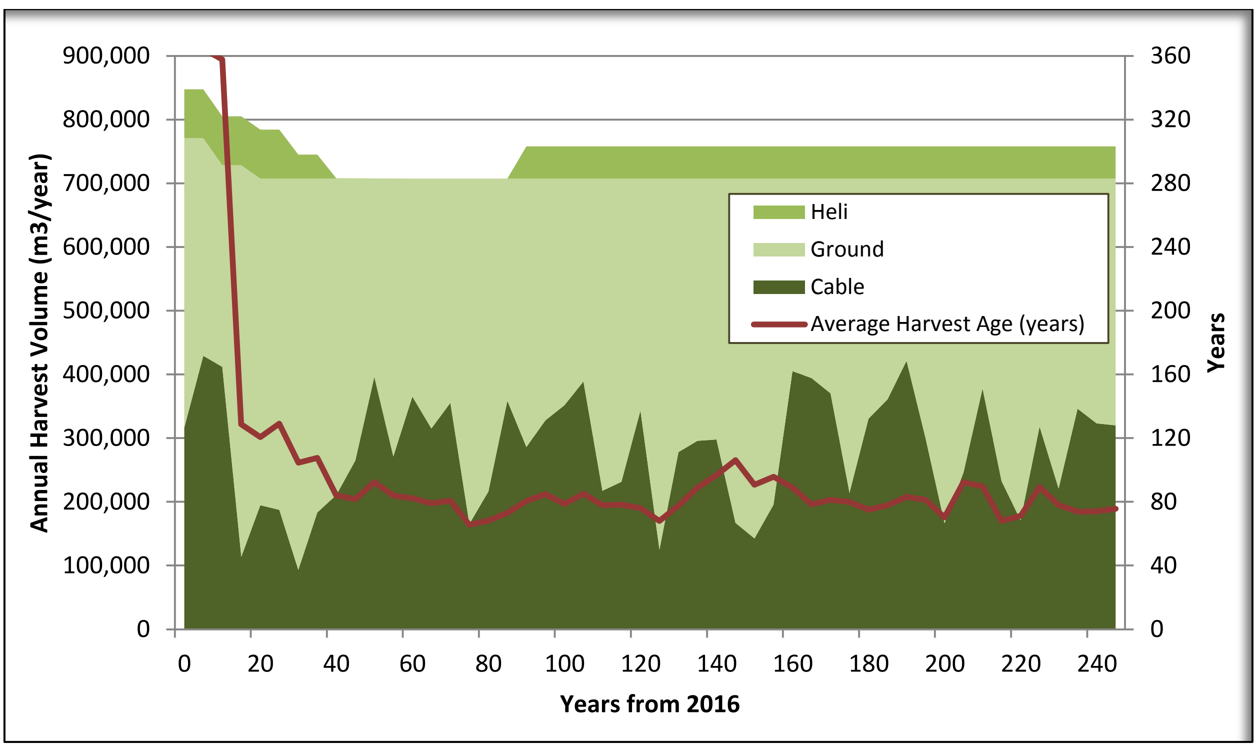

Figure 9 - Volume Contribution by Harvesting System

As would be expected, once the majority of the volume is sourced from managed stands there is generally a positive relation between the amount of cable harvesting and the average harvest age: as the cable contribution increases, so does the average harvest age. This is due to the substantially older harvest ages on cable-based areas compared to ground-based areas discussed earlier in this section. Of course site productivity of the stands harvested is also a factor in determining the average age.

The contribution to harvest by tree species is presented in Figure 10. In the short-term roughly two-thirds of the harvest is hemlock and balsam ("HemBal"), with red cedar, yellow cedar and fir contributing roughly 11%, 12% and 9% respectively. Approximately 1% is sourced from other minor coniferous species such as spruce and pine. In the third and fourth decade, HemBal and fir each contribute roughly 45 % of the harvest, as these species dominate the older current managed stands harvested in this period, with red and yellow cedar providing nearly all the rest of the volume. From the fifth decade to the end of the analysis period HemBal provides, on average, 47% of the volume; fir provides 29%; red cedar provides 19%; and yellow cedar provides 5%.

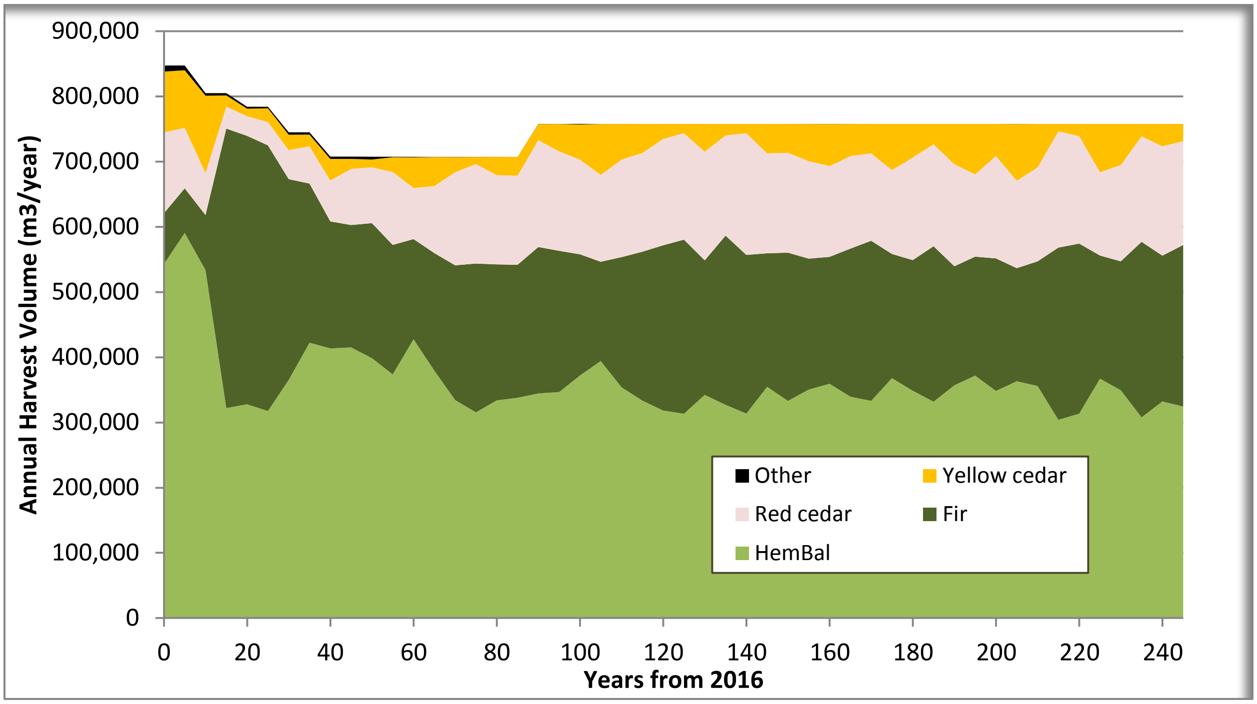

Figure 10 – Species composition of harvest

2.1 Western Red Cedar and Yellow Cedar Projections

Traditional and cultural uses of cedar (red and yellow) are important to First Nations. Opportunities for accessing and managing cedar have increased through the allocation of AAC to First Nations. Within TFL 37 there is a significant volume of cedar.

Figure 11 indicates the estimated volume (at the beginning of each 10-year period) of red (Cw) and yellow (Yc) cedar on the THLB and within the total productive forest associated with the Base Case harvest schedule. These estimates are based on the red and yellow cedar component of each analysis unit.

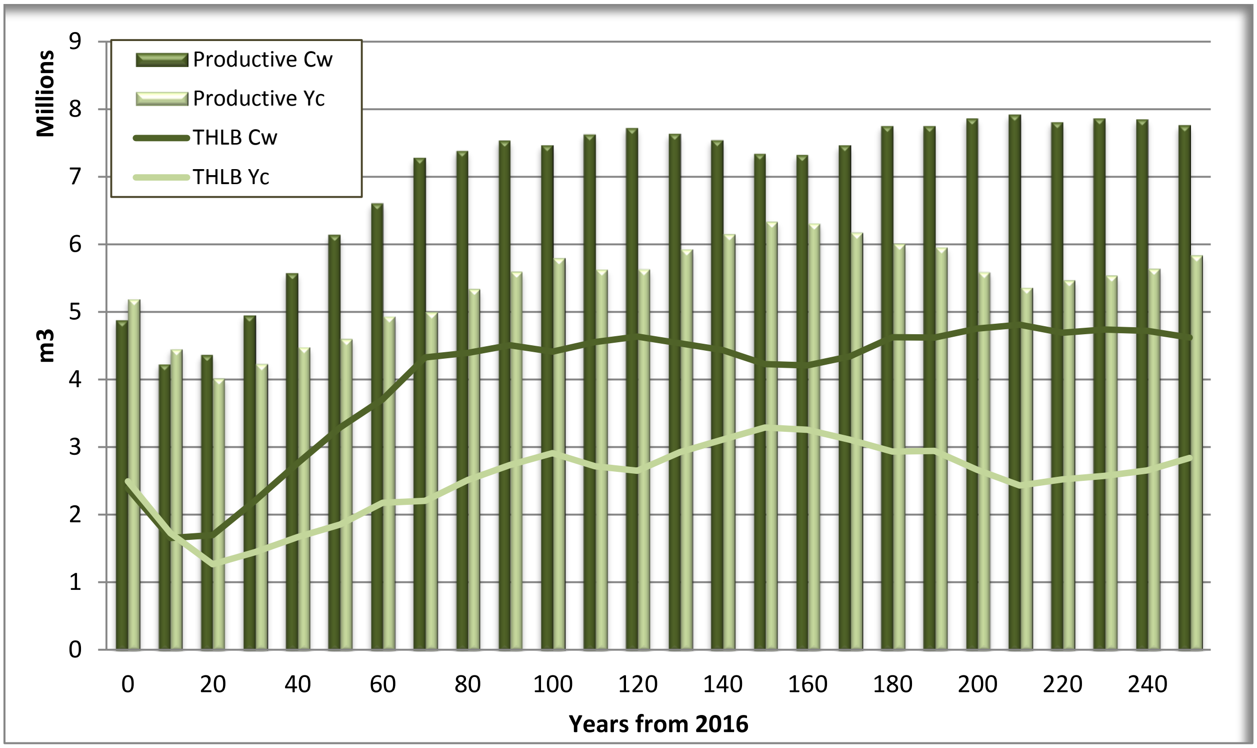

Figure 11 – Base Case cedar volume estimates over time

The amount of cedar (red and yellow) on the THLB declines over the first 20 years as harvesting is occurring in the oldest stands. During this time the amount of cedar within the total productive forest declines by about 19%; however the volume never falls below 8.1 million m^3 (4.1 million m^3 of Cw and 4.0 million m^3 of Yc) – this indicates there is a large inventory of Cw and Yc within the productive forest outside the THLB. Also contributing to this temporary decline in cedar inventory is the fact that the younger unmanaged stands and older managed stands have less cedar within them. Younger unmanaged stands are dominated by fir and hemlock as these species naturally regenerate very successfully after harvesting while cedar tends to form a minor component. Older managed stands are dominated by fir as it was the main species planted due to early seedling production focussing on fir. The dominance of fir in these age ranges can be seen by the large increase in fir harvest between 15 years and 35 years in Figure 10.

By the start of the fourth decade (2046 - 2055) cedar volumes begin to recover as managed stands with significant Cw and Yc components begin to acquire volume (see Tables 36 and 37 in the IP for Cw/Yc distributions in such stands). Recent reforestation strategies have ensured cedar forms a more substantial component of regenerating stands than early planting efforts. Total cedar volume equals the current volume within 50 years and averages in excess of 13 million m^3 from then until the end of the schedule.

Figure 12 presents the total volume of cedar (red and yellow) greater than 250 years old within the productive forest. Total old cedar declines in the short-term as harvesting of old stands occurs and then is relatively stable for a lengthy period at a little more than 5 million m^3. In 170 years the amount of old cedar begins to increase steadily as today's reserved young stands age beyond 250 years.

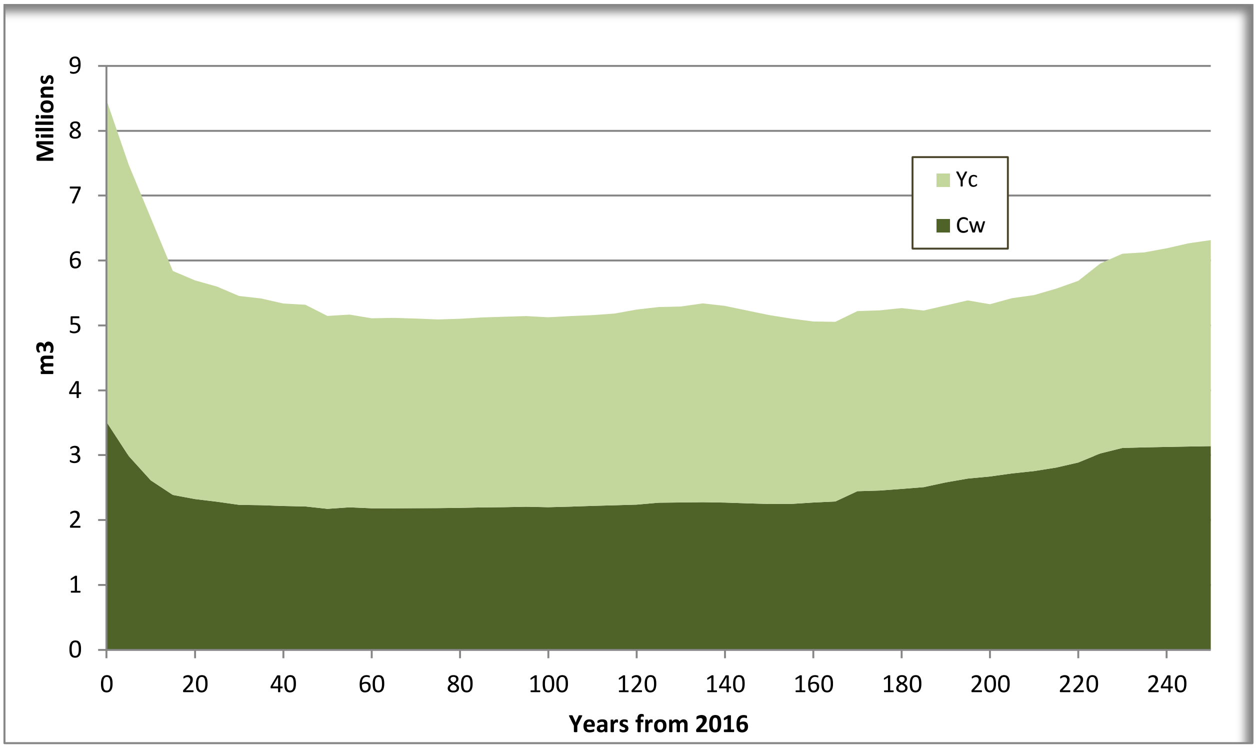

Figure 12 – Volume of cedar greater than 250 years old in productive forest

3 Alternate Harvest Flows

This section examines two alternate flow scenarios:

- maintaining the current AAC;
- non-declining even-flow.

3.1 Maintain current AAC

Table 2 and Figure 13 represent an attempt to maintain the current AAC for the first 10 years.

Table 2 - Harvest levels with maintaining current AAC

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Maintain Current AAC	Difference	
1	2016	2025	847,400	889,400	+42,000	+5.0%
2	2026	2035	805,100	800,400	-4,700	-0.6%
3	2036	2045	784,200	720,400	-63,800	-8.1%
4	2046	2055	745,000	707,400	-37,600	-5.0%
5	2056	2065	707,800	707,400	-400	< -0.1%
6	2066	2075	707,600	707,400	-200	< -0.1%
7 - 9	2076	2105	707,400	707,400	0	0.0%
10 - 25	2106	2265	757,900	757,900	0	0.0%

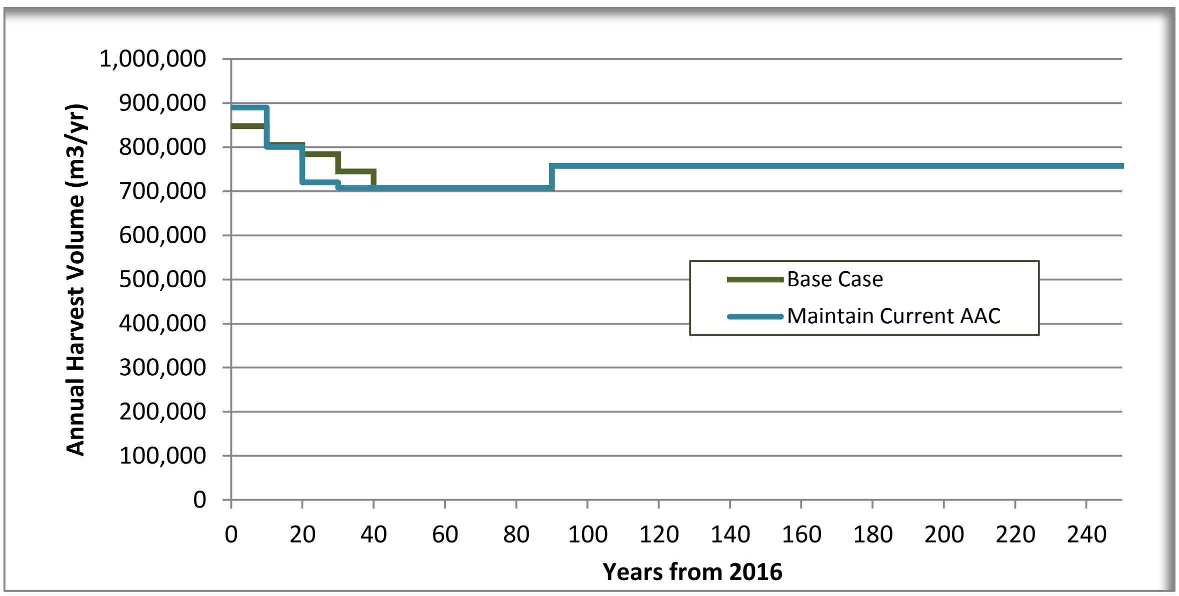

Figure 13 – Harvest levels with maintaining current AAC

The results indicate that the current AAC could be maintained for the next decade and have no impact on mid or long-term timber supply. Harvest levels in the second and third decade must decline by 10% rather than 5% and 2.6% respectively in the Base Case.

Short-term harvest is more reliant on contribution from heli-operable stands, with 118,800 m^3/year required in the first decade and 106,900 m^3/year in the second compared to 76,800 m^3/year in the Base Case.

Over the 250 years, a total of 0.65 million m^3 (0.3%) less is harvested.

3.2 Non-declining even flow

Table 3 and Figure 14 show the impact of immediately dropping to a non-declining even flow (NDEF) harvest level with the Base Case assumptions applied. This scenario was constructed to include an even heli partition throughout the analysis period. This resulted in a conventional harvest of 716,000 m^3/year and heli harvest of 41,900 m^3/year for a total harvest of 757,900 m^3/year – 15% less than the current AAC.

Table 3 – Harvest levels with non-declining even flow

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	NDEF	Difference	
1	2016	2025	847,400	757,900	-89,500	-10.6%
2	2026	2035	805,100	757,900	-47,200	-5.9%
3	2036	2045	784,200	757,900	-26,300	-3.4%
4	2046	2055	745,000	757,900	12,900	1.7%
5	2056	2065	707,800	757,900	50,100	7.1%
6	2066	2075	707,600	757,900	50,300	7.1%
7 - 9	2076	2105	707,400	757,900	50,500	7.1%
10 - 25	2106	2265	757,900	757,900	0	0.0%

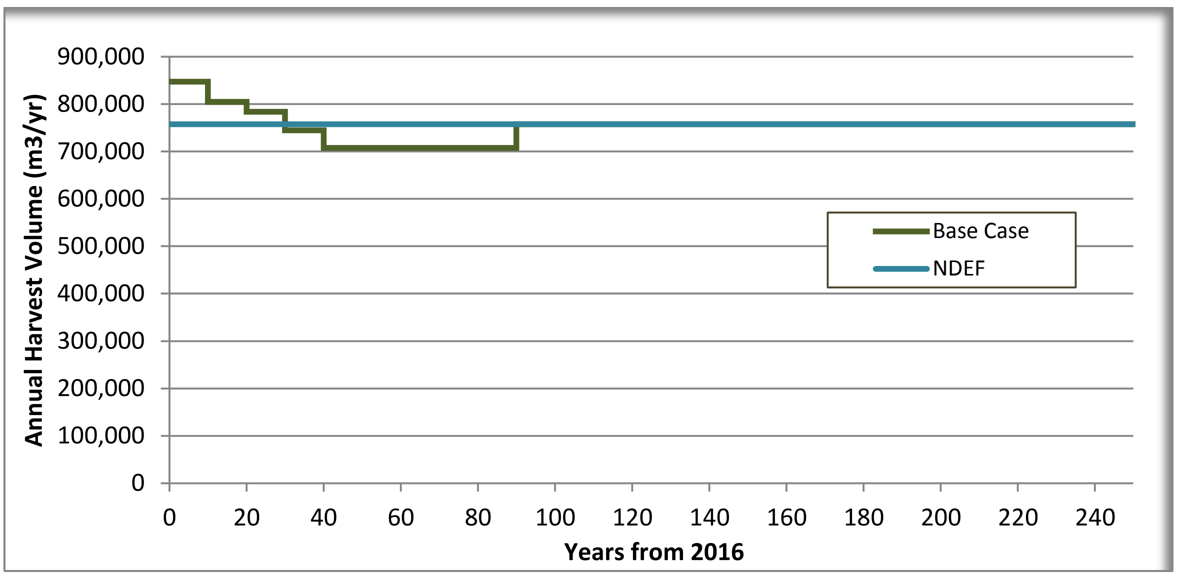

Figure 14 – Harvest levels with non-declining even flow

Short term harvest levels are significantly lower than the Base Case when a NDEF criteria is applied with the Base Case assumptions. However, recent reviews of several assumptions (see Section 4.8, 4.16 and 4.17 for details) indicate that the Base Case initial harvest level is sustainable indefinitely.

The long-term harvest level is equal as this harvest level was determined and incorporated into the Base Case.

Over the 250 years, a total of 1.0 million m^3 (0.5%) more is harvested.

4 Sensitivity Analyses

Sensitivity analysis provides a measure of the upper and lower bounds of the Base Case harvest forecast, reflecting the uncertainty of assumptions made in the Base Case. By developing and testing a number of sensitivity issues, it is possible to determine which variables most affect results. This in turn facilitates management decisions that must be made in the face of uncertainty. As Woodstock was used as an optimization tool to generate the Base Case, it is expected that the results will be sensitive to any changes to the inputs.

To allow meaningful comparison of sensitivity analyses, they are performed by varying (from the Base Case) only the assumption being evaluated.

In general, sensitivities with negative impacts were run with the goal of keeping the short term harvest as close as possible to the harvest in the Base Case. Where impacts were positive, adjustments were made to (1) raise the short and medium term flow, and optionally (2) increase the long term harvest level.

Sensitivity issues are summarized in Table 4. The timber supply impacts are illustrated in Sections 4.1 through 4.17.

Table 4 – Current Management Sensitivity Analyses

Issue	Sensitivity tested summary	Section
Landbase available for harvesting	▪ Exclude 'Namgis treaty settlement offer lands	4.1
	▪ Include deciduous-leading stands	4.2
Growth and Yield	▪ Unmanaged stands yields underestimated by 10%	4.3
	▪ Unmanaged stands yields overestimated by 10%	4.4
	▪ Managed stands yields underestimated by 10%	4.5
	▪ Managed stands yields overestimated by 10%	4.6
	▪ Apply SIBEC Site Index estimates	4.7
	▪ Apply LiDAR-derived OAF 1 estimates	4.8
Forest management / Silviculture	▪ Exclude future genetic gain adjustments	4.9
Operability	▪ Maintain "heli hembal" partition	4.10
	▪ No heli volume constraint	4.11
	▪ Exclude helicopter operable landbase	4.12
Biodiversity	▪ Remove Western Forest Strategy impacts (area and yield impacts)	4.13
Minimum harvest criteria	▪ Decrease minimum harvest DBH by 2 cm	4.14
	▪ 95% culmination mean annual increment	4.15
LiDAR Analyses	▪ Apply LiDAR-derived OAF1 and road widths	4.16
	▪ Combine results of LiDAR reviews of OAF 1, road widths and tree heights	4.17
Summary	▪ Summary of sensitivity impacts	4.18

4.1 Exclude 'Namgis Treaty Settlement Offer Lands

In 2012, potential treaty settlement lands for the 'Namgis First Nation were identified within TFL 37 (and elsewhere) as part of an Agreement in Principle (AIP) with the federal and provincial governments. 'Namgis members rejected the AIP in a March 2013 vote. Ongoing negotiations resulted in the 2015 Forestry Fund Agreement[1] that provides for continuation of timber harvesting within the proposed treaty settlement lands.

Table 5 and Table 6 provide the breakdown of the treaty settlement offer lands (TSOL) within TFL 37. A total area of 14,857 ha was offered; 9.3% of the total TFL area. This area contained 13,837 ha of productive forest (10.5% of TFL), 13,345 operable ha (11.8% of TFL), and 10,408 ha of THLB (12.1% of TFL). This THLB area is estimated to hold roughly 4.5 million m^3 of growing stock; 15.1% of the total THLB inventory of the TFL.

Table 5 – 'Namgis Treaty Settlement Offer Lands within TFL 37

Landbase	Total Area (ha)	Productive Forest Area (ha)	Operable Area (ha)	THLB Area (ha)	THLB Volume (m^3)
'Namgis TSOL	14,857	13,837	13,345	10,408	4,531,742

Table 6 – Age Class Distribution of THLB in Treaty Settlement Offer Lands

Age Class (years)	THLB Area (ha)	THLB Volume (m^3)
1 - 20	1,537	0
21 - 40	1,341	175,058
41 - 60	2,983	1,416,797
61 - 80	1,861	1,062,011
81 - 100	1,463	986,506
101 - 120	95	77,658
121 - 140	37	27,167
141 - 250	352	269,337
251+	740	518,208
Total	10,408	4,532,742

Table 7 and Figure 15 indicate the results of excluding the treaty settlement offer lands from the TFL and achieving a relatively consistent proportional reduction.

Table 7 – Harvest levels excluding 'Namgis Treaty Settlement Offer Lands

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Exclude TSOL	Difference	
1	2016	2025	847,400	712,600	-134,800	-15.9%
2	2026	2035	805,100	677,000	-128,100	-15.9%
3	2036	2045	784,200	663,600	-120,600	-15.4%
4	2046	2055	745,000	630,400	-114,600	-15.4%
5	2056	2065	707,800	598,900	-108,900	-15.4%
6	2066	2075	707,600	598,900	-108,700	-15.4%
7 – 9	2076	2105	707,400	598,900	-108,500	-15.4%
10 - 25	2106	2265	757,900	642,000	-115,900	-15.3%

[1] See https://news.gov.bc.ca/releases/2015ARR0041-001695 for details and a copy of the agreement

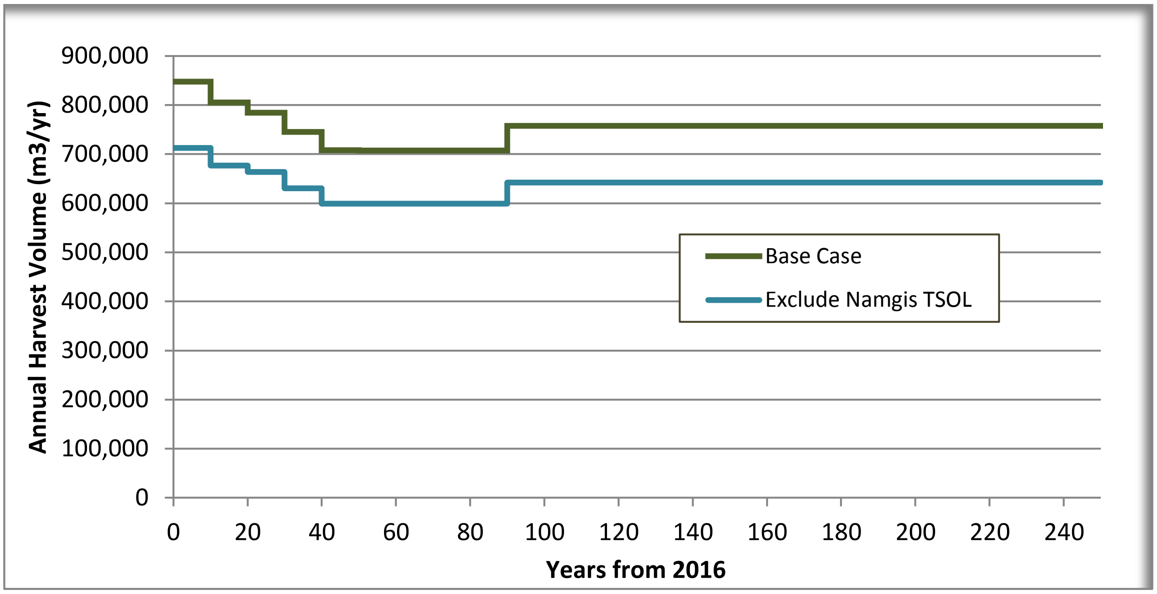

Figure 15 – Harvest levels with ‘Namgis Treaty Settlement Offer Lands removed

Timber supply is reduced by a little more than 15% with the TSOL area removed from the TFL. Approximately 80% of the THLB within the TSOL is operable by ground-based systems and roughly two-thirds falls within the good site classification. As such the impact of excluding the TSOL is greater than the proportion of THLB removed.

Over the 250 years, a total of 29.0 million m^3 (15.4%) less is harvested.

4.2 Include Deciduous-leading Stands

The Base Case excludes deciduous-leading stands from the THLB. This scenario tests the sensitivity of timber supply of including those stands in the THLB. With those stands included the THLB increases by 1,091 ha (1.3%) and THLB growing stock increases by approximately 0.24 million m^3 (0.8%)

Table 8 – Harvest levels with deciduous-leading stands included

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Include Deciduous	Difference	
1	2016	2025	847,400	871,700	+24,300	+2.9%
2	2026	2035	805,100	828,100	+24,300	+2.9%
3	2036	2045	784,200	787,300	+3,100	+0.4%
4	2046	2055	745,000	747,900	+2,900	+0.4%
5	2056	2065	707,800	713,300	+5,500	+0.8%
6	2066	2075	707,600	713,300	+5,700	+0.8%
7 - 9	2076	2105	707,400	713,200	+5,800	+0.8%
10 - 25	2106	2265	757,900	765,000	+7,100	+0.9%

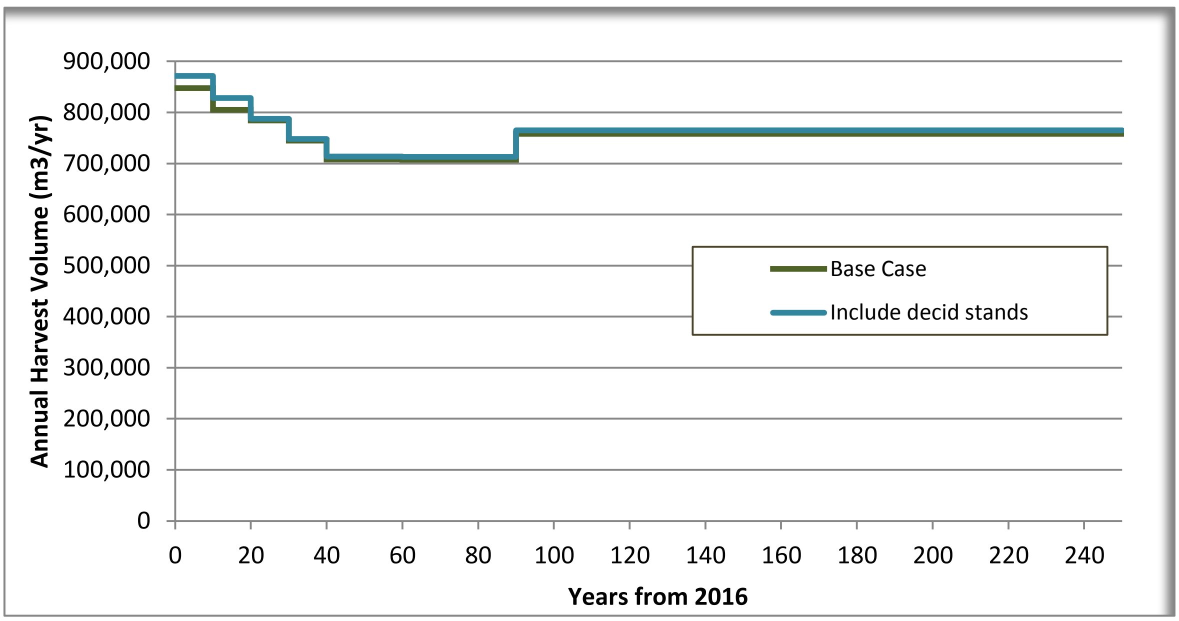

Figure 16 – Harvest levels with deciduous-leading stands included

As expected, with the additional THLB area and volume available short-term harvest levels are increased relative to the Base Case. Mid and long-term harvest levels are greater by roughly the proportional increase in THLB area.

Total harvest over the entire 250 years is 2.0 million m^3 (1.0%) more than the Base Case.

4.3 Unmanaged stands yields underestimated by 10%

The sensitivity of timber supply to unmanaged stands (older than 54 years) volume estimates was tested by increasing (this Section) and decreasing (Section 4.4) these volumes by 10%. The volumes in these stands were estimated from the Vegetation Resources Inventory (VRI) and the Ministry of Forests, Lands and Natural Resource Operations' (MFLNRO) *Variable Density Yield Projection* (VDYP) version 7.29.

The increased yields result in approximately 1.9 million m^3 (6.6%) more inventory on the THLB today when compared to the Base Case, of which nearly 1.2 million m^3 is available immediately (i.e. meets minimum harvest criteria). Table 9 and Figure 17 indicate the results of starting at the current AAC, maintaining the maximum 5% per decade harvest decline rate of the Base Case while achieving the same LTHL.

Table 9 – Harvest levels with increased unmanaged stands yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Increased Unmanaged Yields	Difference	
1	2016	2025	847,400	889,400	+42,000	+5.0%
2	2026	2035	805,100	882,900	+77,800	+9.7%
3	2036	2045	784,200	838,800	+54,600	+7.0%
4	2046	2055	745,000	796,800	+51,800	+7.0%
5	2056	2065	707,800	757,000	+49,200	+7.0%
6	2066	2075	707,600	719,700	+12,100	+1.7%
7 - 9	2076	2105	707,400	717,200	+9,800	+1.4%
10 - 25	2106	2265	757,900	757,900	0	0.0%

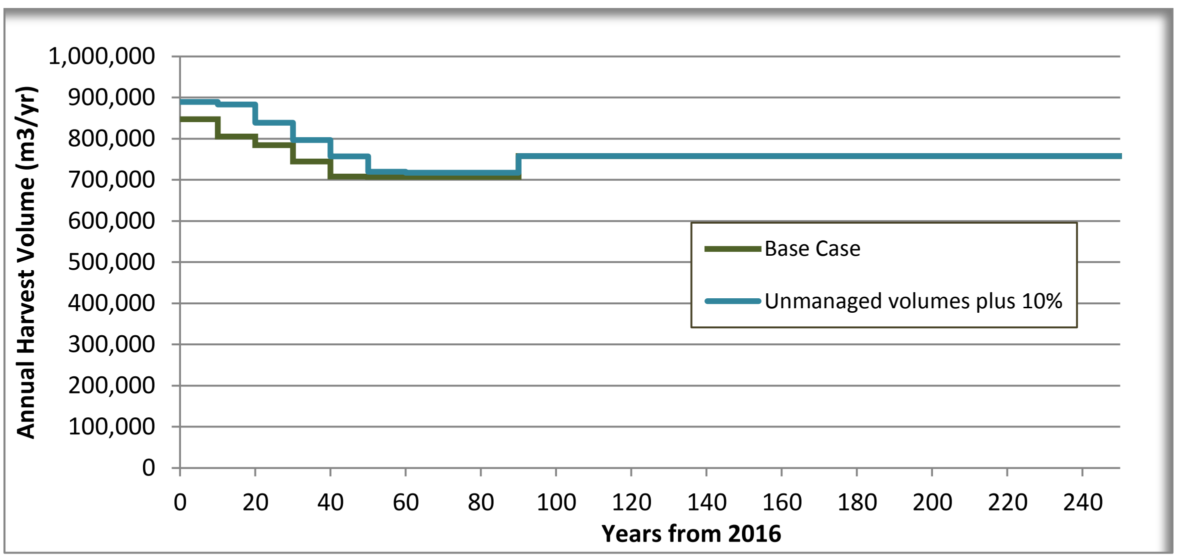

Figure 17 – Harvest levels with increased unmanaged stands yields

Harvest over the first two decades is 7.3%% greater than the Base Case. As the harvest transitions to managed stands the percentage increase in harvest gradually declines until the same long-term harvest is reached. Total harvest over the entire 250 years is 3.2 million m^3 (1.7%) more than the Base Case.

4.4 Unmanaged stands yields overestimated by 10%

A decrease of 10% in unmanaged yields results in approximately 1.9 million m^3 (6.6%) less inventory on the THLB today when compared to the Base Case. Table 10 and Figure 18 indicate that with decreased unmanaged yields short and mid-term harvest levels are affected.

Table 10 – Harvest levels with decreased unmanaged stands yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Decreased Unmanaged Yields	Difference	% Difference
1	2016	2025	847,400	802,600	-44,800	-5.3%
2	2026	2035	805,100	802,600	-2,500	-0.3%
3	2036	2045	784,200	722,400	-61,800	-7.9%
4	2046	2055	745,000	699,900	-45,100	-6.1%
5	2056	2065	707,800	699,900	-7,900	-1.1%
6	2066	2075	707,600	699,900	-7,700	-1.1%
7 - 9	2076	2105	707,400	699,900	-7,500	-1.1%
10 - 25	2106	2265	757,900	750,000	-7,900	-1.0%

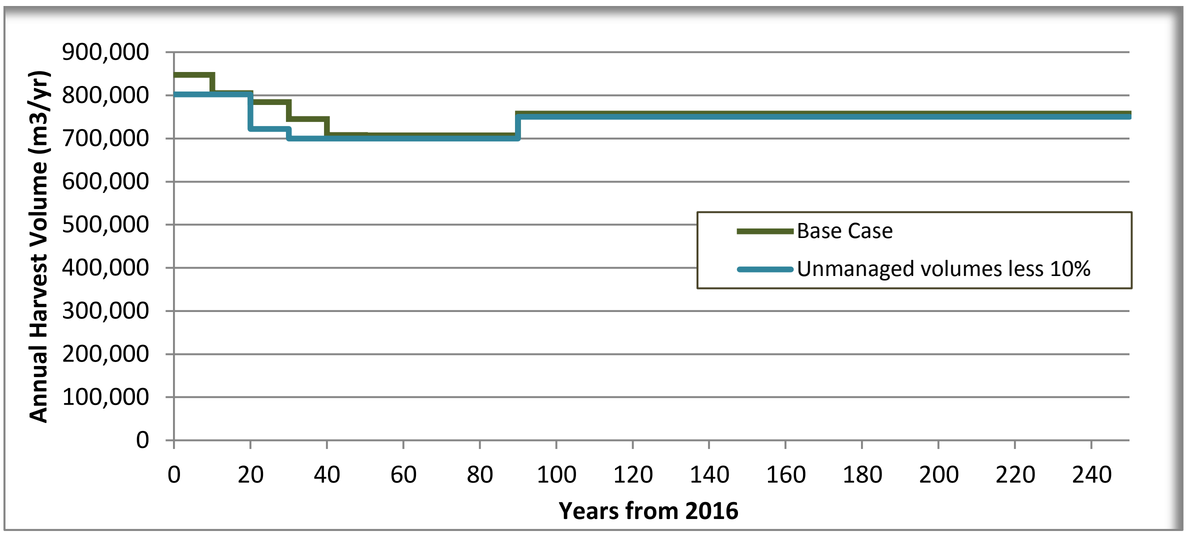

Figure 18 – Harvest levels with decreased unmanaged stands yields

Unmanaged stands provide the entire volume in the first decade of the Base Case harvest schedule and approximately 60% of the second decade. With reduced unmanaged yields and limiting total harvest decline to 10% per decade, conventional harvest is an even-flow of 699,800 m^3/year while even-flow heli harvest can only be maintained for the first two decades (see Figure 19). Mid and long-term harvest levels are reduced by about 1% as the earlier transition to managed stands results in slightly shorter rotations with the corresponding reduction in yield.

This scenario results in approximately 3.19 million m^3 (1.7%) less harvest than in the Base Case over the 250 year planning horizon.

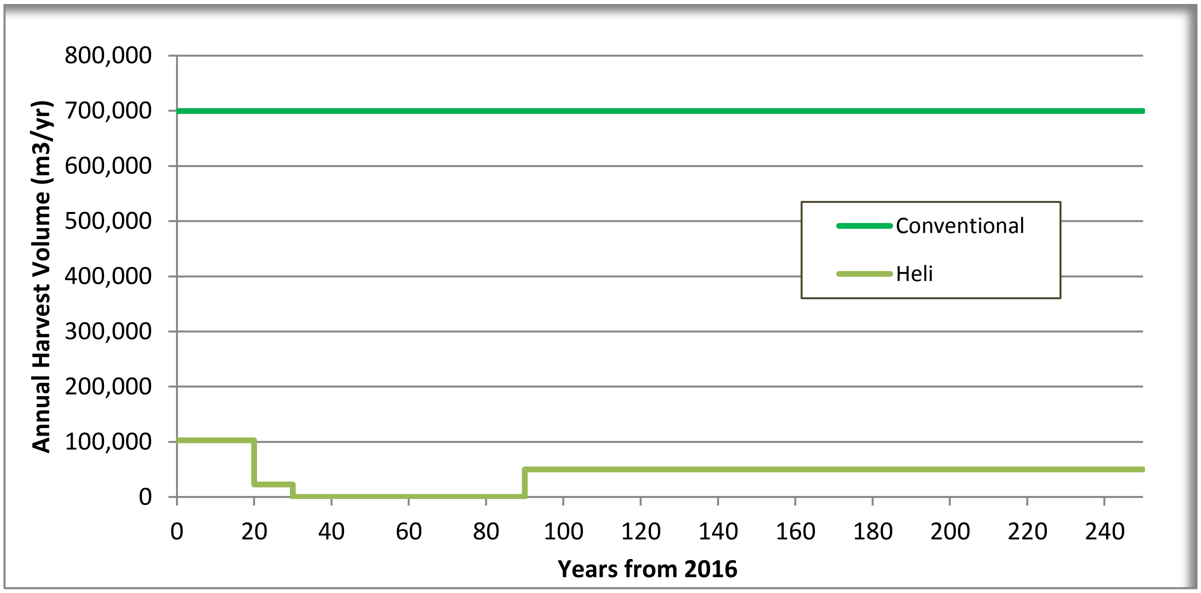

Figure 19 – Harvest by system with decreased unmanaged stands yields

4.5 Managed stands yields underestimated by 10%

The sensitivity of timber supply to managed stands (younger than 55 years) volume estimates was tested by increasing (this Section) and decreasing (Section 4.6) these volumes by 10%. Volumes in these younger stands were estimated from attributes and assumptions detailed in Section 8 of the Information Package and FLNRO's *Table Interpolation Program for Stand Yields* (TIPSY) version

With managed stands yields increased by 10%, initial THLB inventory is increased by 0.98 million m^3 (3.4%). The harvest schedule in Table 11 and Figure 20 indicates that harvest levels could be greater after the first decade.

Table 11 – Harvest levels with increased managed stands yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Increased Managed Yields	Difference	
1	2016	2025	847,400	847,400	0	0.0%
2	2026	2035	805,100	847,400	+42,300	+5.3%
3	2036	2045	784,200	805,100	+20,900	+2.7%
4	2046	2055	745,000	764,800	+19,800	+2.7%
5	2056	2065	707,800	726,600	+18,800	+2.7%
6	2066	2075	707,600	726,400	+18,800	+2.7%
7 - 8	2076	2095	707,400	726,200	+18,800	+2.7%
9	2096	2105	707,400	756,900	+49,500	+7.0%
10 - 25	2106	2265	757,900	811,700	+53,800	+7.1%

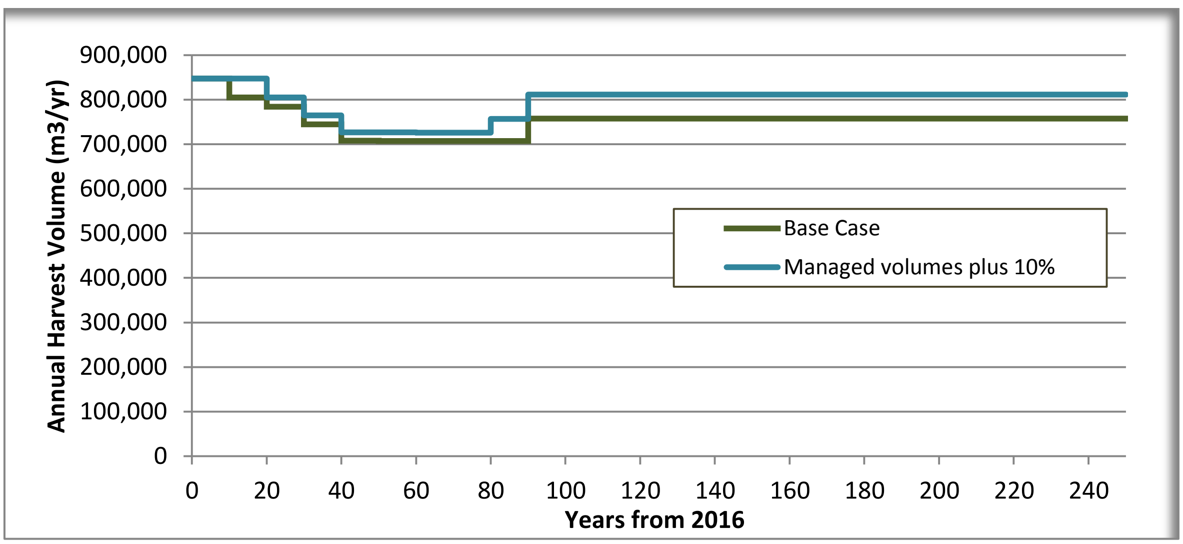

Figure 20 – Harvest levels with increased managed stands yields

Short term harvest levels need not decline as rapidly to allow the transition to the higher mid and long-term harvest levels (relative to the Base Case schedule). Over the entire 250 year planning horizon, 10.69 million m^3 (5.7%) more is harvested in this sensitivity.

LiDAR data indicates the OAF1 value applied in the TIPSY yield tables is overly reducing yields (refer to Section 4.8) and tree heights projected by TIPSY are conservative (see Section 4.17 and Appendix B). Combined these elements indicate the managed stands yield tables used in the analysis are likely underestimating stand volume.

4.6 Managed stands yields overestimated by 10%

With managed stands yields decreased by 10%, initial THLB inventory is reduced by 0.98 million m^3 (3.4%). The harvest schedule in Table 12 and Figure 21 indicates that harvest levels would need to be reduced after the first decade.

Table 12 – Harvest levels with decreased managed stands yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Decreased Unmanaged Yields	Difference	% Difference
1	2016	2025	847,400	847,400	0	0.0%
2	2026	2035	805,100	778,200	-26,900	-3.3%
3	2036	2045	784,200	718,000	-66,200	-8.4%
4	2046	2055	745,000	646,200	-98,800	-13.3%
5	2056	2065	707,800	641,400	-66,400	-9.4%
6	2066	2075	707,600	641,300	-66,300	-9.4%
7 - 9	2076	2105	707,400	641,300	-66,100	-9.3%
10 - 25	2106	2265	757,900	690,000	-67,900	-9.0%

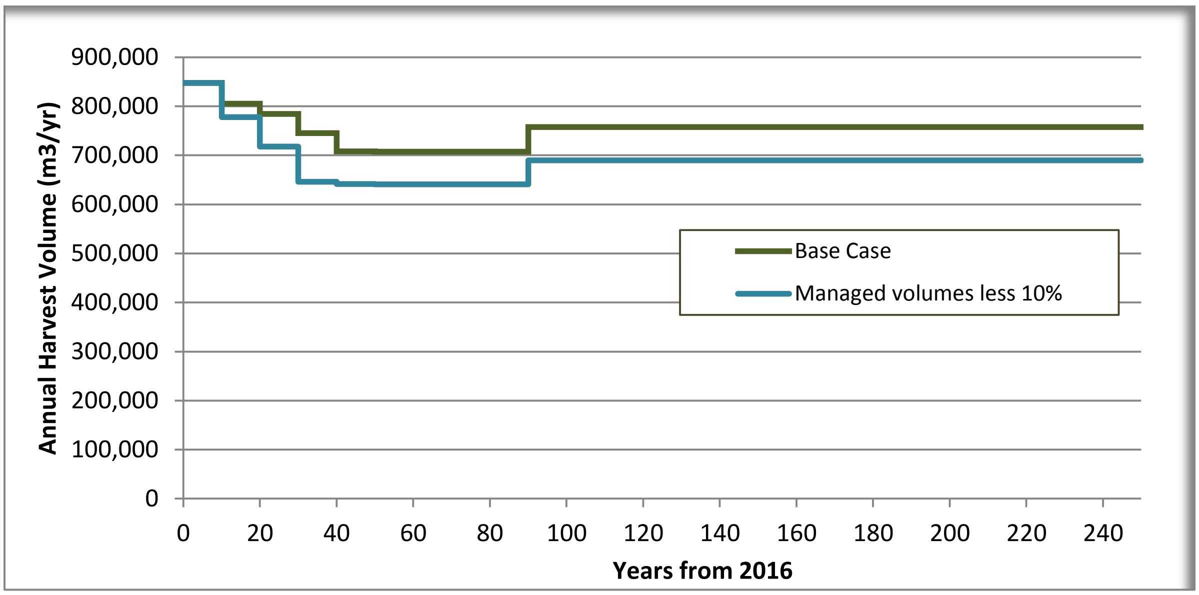

Figure 21 – Harvest levels with decreased managed stands yields

Maintaining the harvest level of the Base Case in the first decade results in reduced harvest levels for the remainder of the analysis period. Mid-term harvest must be reduced to adjust to the lower managed stand yields. Long-term harvest is 9% less than the Base Case indicating that the initial harvest level can be achieved without overly reducing long-term harvest.

Total harvest over the entire 250 years is 16.1 million m^3 (8.5%) less than the Base Case.

4.7 Use SIBEC Site Index estimates

The Base Case used WFP site indexes to estimate site productivity within the CWHxm2, CWHmm1 and CWHvm1 biogeoclimatic variants. These site index values are statistically-based estimates of average site index for the major commercial tree species and ecosystems in TFL 37 and were estimated from randomly located plots (see section 8.1 of the IP for details). As was applied in the Base Case within the CWHvm2 and MHmm1 variants, a frequently used approach for estimating site productivity is to use Terrestrial Ecosystem Mapping (TEM – site series mapping) and the associated SIBEC (Site Index by Biogeoclimatic Ecosystem Classification site series) site index estimates.

New yield tables were generated for managed stand analysis units within the CWHxm2, CWHmm1 and CWHvm1 variants by applying the area-weighted average SIBEC site index by species. In general SIBEC values within these three variants are lower than the site index values used in the Base Case yield tables. Initial THLB growing stock is reduced by 1.55 million m^3 (5.4%).

The decreased managed stands yields result in a reduction in timber supply – refer to Table 13 and Figure 22.

Table 13 – Harvest levels with yields based on SIBEC values

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	SIBEC Yields	Difference	
1	2016	2025	847,400	847,400	0	0.0%
2	2026	2035	805,100	770,400	-34,700	-4.3%
3	2036	2045	784,200	693,300	-90,900	-11.6%
4	2046	2055	745,000	644,500	-100,500	-13.5%
5	2056	2065	707,800	639,300	-68,500	-9.7%
6	2066	2075	707,600	639,300	-68,300	-9.7%
7 - 9	2076	2105	707,400	639,300	-38,100	-9.6%
10 - 25	2106	2265	757,900	691,400	-66,500	-8.6%

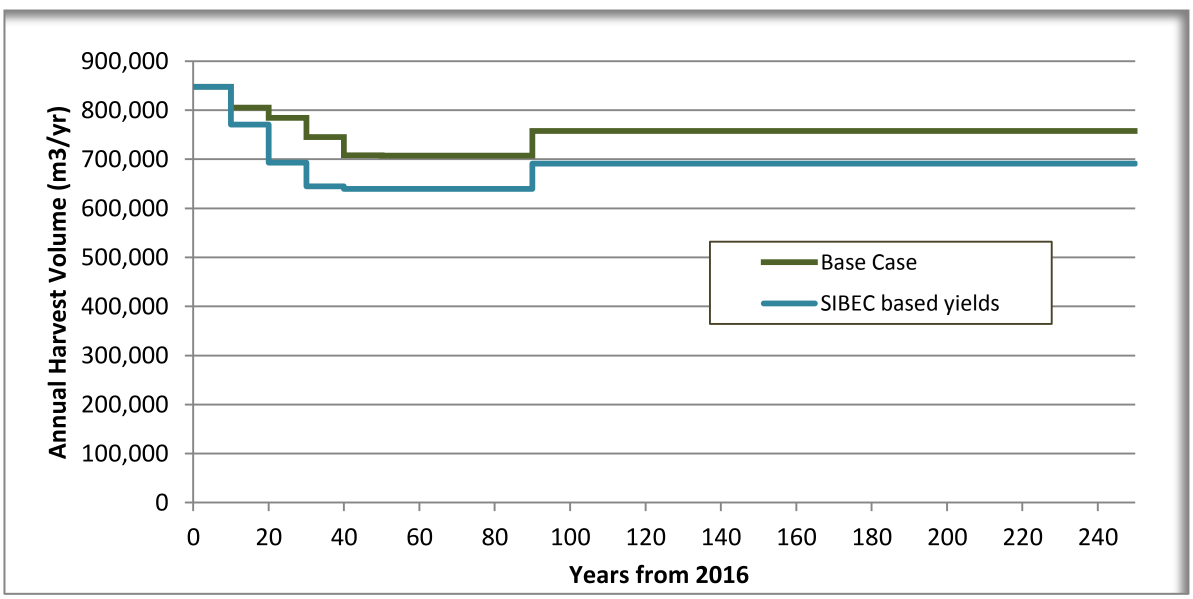

Figure 22 – Harvest levels with yields based on SIBEC values

Maintaining the Base Case initial harvest level with reduced managed stands yields requires mid-term timber supply to be reduced to adjust to the lower long-term harvest level. This schedule is very similar to the schedule in section 4.6 where managed stand yields were reduced by 10%. Over the entire 250 year analysis period 16.3 million m^3 (8.7%) less volume is harvested.

Given that LiDAR data indicates the managed stands tree heights are underestimated by an average of 1.3m when applying the larger WFP site index values (see Section 4.17) and SIBEC values are lower, it appears the provincial-wide average site index values of SIBEC underestimate the site productivity within TFL 37. This is further supported by a comparison of billed volumes from harvested second growth against TIPSY yield estimates - see Section 4.17 for further details.

4.8 Apply LiDAR derived OAF1 Estimates

LiDAR (Light Detection and Ranging) data for TFL 37 acquired in the summer of 2016 was used to review gaps in crown cover as a proxy for the extent of non-productive inclusions in forest stands. The results indicate that the TIPSY default OAF1 of 15% overstates the extent of non-productive inclusions within stands in TFL 37. Further details are provided in Appendix A.

FLNRO documentation[2] describes two components to OAF1:

- *OAF 1a - Portion of OAF 1 not influenced by management. Small non-productive areas incapable of supporting tree growth, or 'holes', must be netted out of the productive land base. The magnitude of an OAF 1a will reflect the level of information you have. If you have a Silviculture Prescription (SP) for the stand, then non-productive areas will be mapped at a higher resolution than for a TFL or TSA inventory. The OAF 1a reduction for 'Holes' would be smaller for a stand with an SP than for one without.*
- *OAF 1b - Portion of OAF 1 influenced by management. Irregular spacing, relative to that assumed in TIPSY, will impact yield, although it takes a substantial difference to generate a small OAF 1b reduction.*

LiDAR provides detailed information down to the tree-level. As such it is even more thorough than mapping done in conjunction with an SP and applies to the entire land base. Therefore it is an ideal tool for measuring OAF 1a. Given that the the measured stands were 40 – 140 years old, the results reflect site occupancy at or near roataion age. With nearly all harvested area being planted, spacing of seedlings is similar to the assumptions within TIPSY and OAF 1b is negligible.

For this sensitivity yields were adjusted upwards to the extent the review indicates the default OAF1 used in TIPSY is excessive; the conservative values determined by the review were applied. For example, on good sites an OAF1 of 5.6% is applied rather than 15% by increasing yields by a factor of 1.11 (0.944/0.85).

Table 14 – Harvest levels with yields based on LiDAR derived OAF1 values

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	LiDAR OAF1	Difference	
1	2016	2025	847,400	847,400	0	0.0%
2	2026	2035	805,100	847,400	+42,300	+5.3%
3	2036	2045	784,200	805,100	+20,900	+2.7%
4	2046	2055	745,000	764,800	+19,800	+2.7%
5	2056	2065	707,800	726,200	+18,800	+2.7%
6	2066	2075	707,600	726,400	+18,800	+2.7%
7 - 9	2076	2105	707,400	726,200	+18,800	+2.7%
10 - 25	2106	2265	757,900	805,900	+48,000	+6.3%

[2] TIPSY 4.3 Help documentation. Available for download at https://www.for.gov.bc.ca/hts/growth/download/download.html

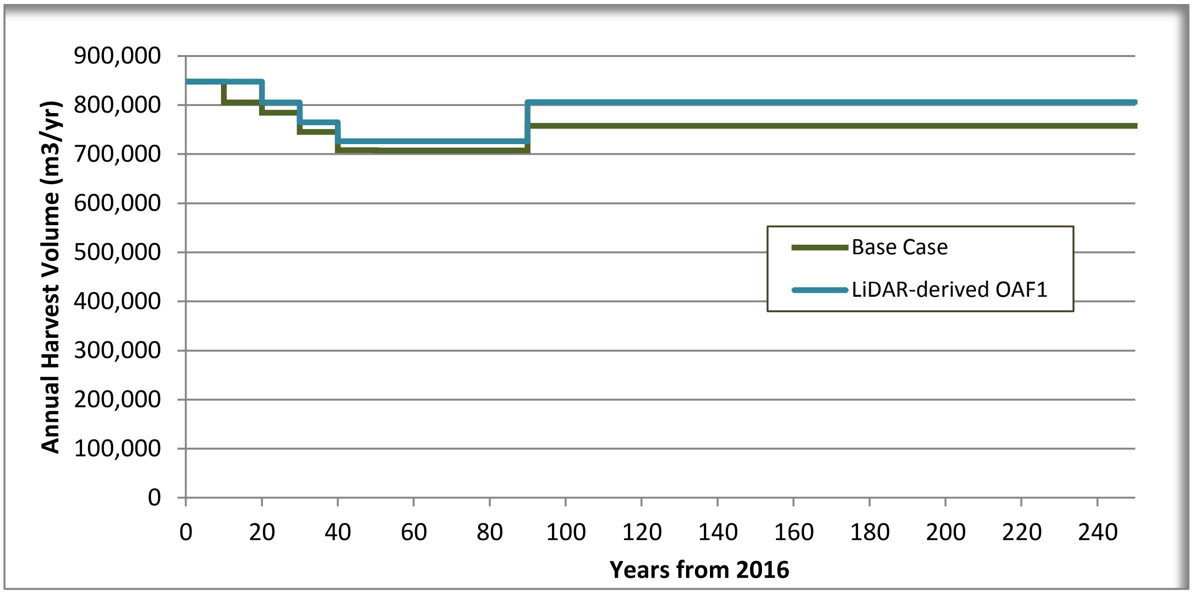

Figure 23 – Harvest levels with yields based on LiDAR derived OAF1 values

Given that the OAF1 revisions apply to only managed stands and they do not contribute to harvest in the first decade, the increased yields result in an increase in harvest levels beginning in the second decade. Initial THLB growing stock is increased by 1.02 million m^3 (3.5%) however only 0.2 million m^3 is available and as such does not influence the initial harvest level.

The increased yields have the largest impact in the long-term when harvest is entirely from managed stands, increasing harvest by 6.3%. The resulting schedule is similar to the results of increasing managed stand yields by 10% (see Section 4.5). Over the 250 year analysis 9.45 million m^3 additional harvest occurs.

4.9 Exclude future genetic gain adjustments

The Base Case includes yield improvements from genetic gain associated with select seed produced at WFP's Saanich Forestry Centre. Long-term tree breeding programs produce well-adapted selectively bred seeds that will grow into trees with stable and improved volume, growth and quality while maintaining the genetic diversity found in natural populations[3]. This sensitivity tests the impact on timber supply if this silviculture investment to improve yields did not occur.

Table 15 and Figure 24 indicate that the genetic gain assumptions need not influence timber supply for the first 20 years.

Table 15 – Harvest levels with no future genetic gain

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	No future genetic gain	Difference	% Difference
1	2016	2025	847,400	847,400	0	0.0%
2	2026	2035	805,100	805,100	0	0.0%
3	2036	2045	784,200	732,200	-52,000	-6.6%
4	2046	2055	745,000	659,100	-85,900	-11.5%
5	2056	2065	707,800	652,600	-55,200	-7.8%
6	2066	2075	707,600	652,600	-55,000	-7.8%
7 - 9	2076	2105	707,400	652,600	-54,800	-7.7%
10 - 25	2106	2265	757,900	700,000	-57,900	-7.6%

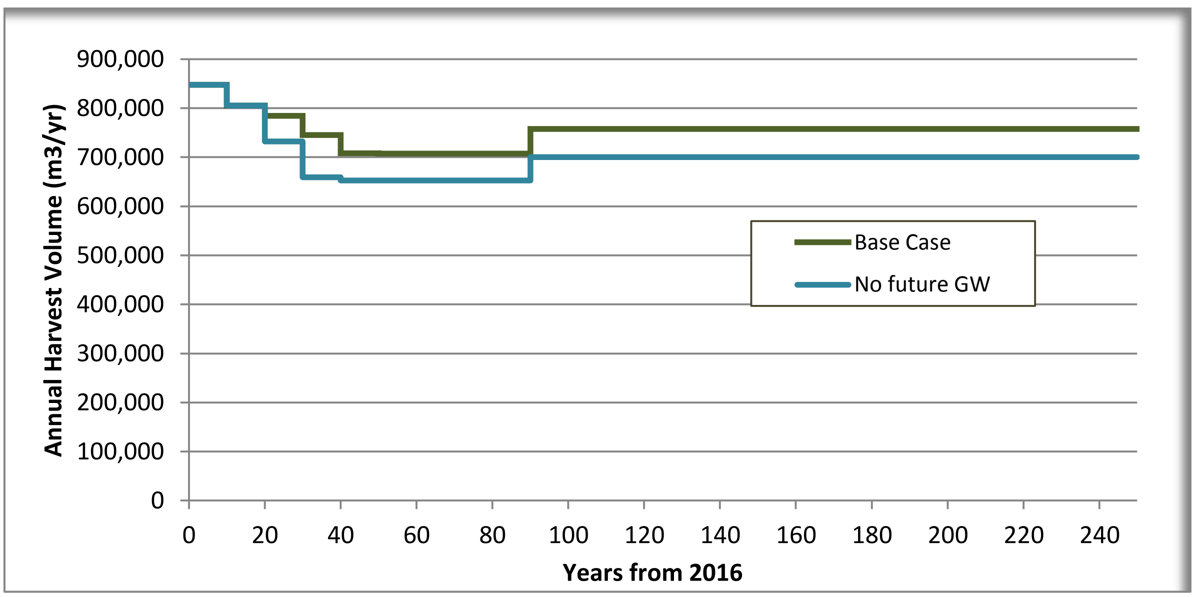

Figure 24 – Harvest levels with no genetic gain

Genetic gain is applied to future stands and current stands less than 15 years old; therefore they do not contribute to timber supply for the first 30 years or so. Mid-term harvest levels need to be reduced to adjust to the reduced yields from these stands. In the long term, the lack of genetic gain generates harvest levels about 7.6% lower than the Base Case. Overall approximately 13.39 million m^3 (~7.1%) less is harvested over the 250 years.

[3] See http://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/tree-seed/forest-genetics/tree-breeding-improvement

4.10 Maintain "heli hembal" partition

The determination in 2006 specified an AAC of 969,000 m^3/year with 37,000 m^3/year (3.8%) attributed to low economic hemlock-balsam helicopter stands. These stands were defined as helicopter operable stands with a fir/red cedar/yellow cedar component of less than 30%. At the time of the MP#9 analysis, these stands covered 7% of the THLB and contained 13% of the THLB growing stock.

Since the AAC determination WFP has been tracking performance in these stands. The tracking is on a harvested area basis as it is not always possible to link scaled timber volumes to an operability inventory classification, especially if a cutblock overlaps more than one classification. The results for the period 2007-2015 indicate that 4.1% of the harvest area was from heli-hembal stands. Therefore these stands have contributed their proportion of the harvest since the last AAC determination.

Applying the same criteria to the MP#10 data results in heli-hembal stands comprising 5,433 ha of the THLB (6.3%) and contain roughly 3.5 million m^3 (12.2%) of inventory.

Table 16 and Figure 25 indicate the schedule resulting from applying a non-declining even-flow heli-hembal partition. For comparison the pro-rated MP #9 schedule is indicated as well.

Table 16 – Harvest levels maintaining heli hembal partition

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	HB Heli Partition	Difference	
1	2016	2025	847,400	840,700	-6,700	-0.8%
2	2026	2035	805,100	798,700	-6,400	-0.8%
3	2036	2045	784,200	758,800	-25,400	-3.2%
4	2046	2055	745,000	720,800	-24,200	-3.2%
5	2056	2065	707,800	684,700	-23,100	-3.3%
6	2066	2075	707,600	684,000	-23,600	-3.3%
7	2076	2085	707,400	684,200	-23,200	-3.3%
8 - 9	2086	2105	707,400	683,400	-24,000	-3.4%
10 - 25	2106	2265	757,900	752,000	-5,800	-0.8%

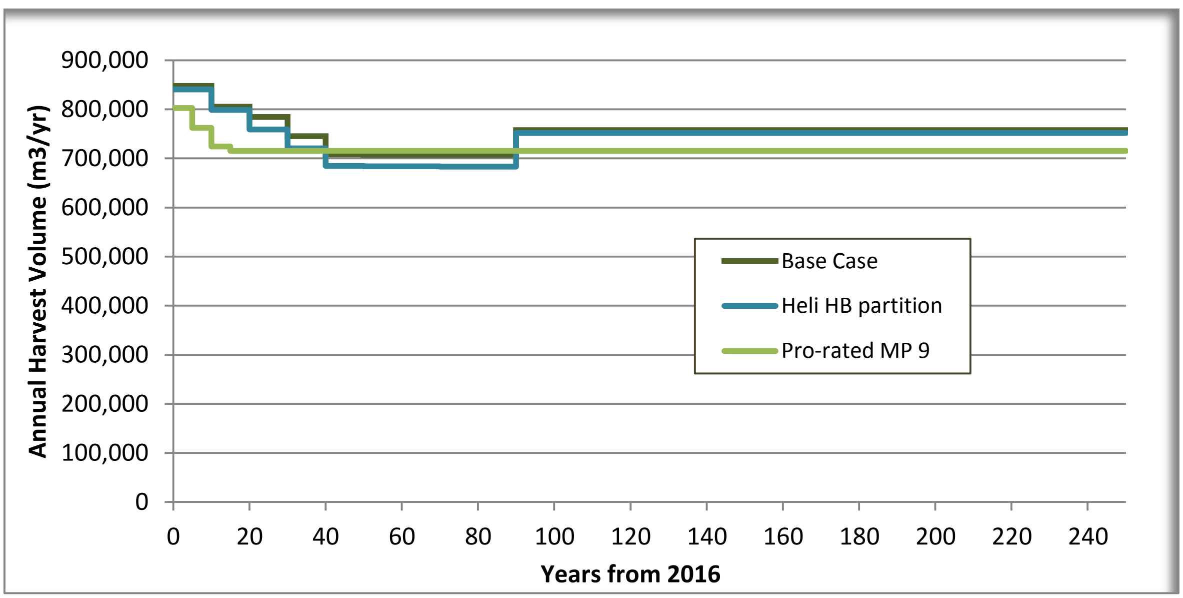

Figure 25 – Harvest levels maintaining heli hembal partition

The resulting heli-hembal partition is 16,800 m^3/year. Figure 26 indicates how the harvest volume is split between heli-hembal, other heli and conventional through time. Over the 250 year analysis period 2.74 million m^3 (1.5%) less is harvested.

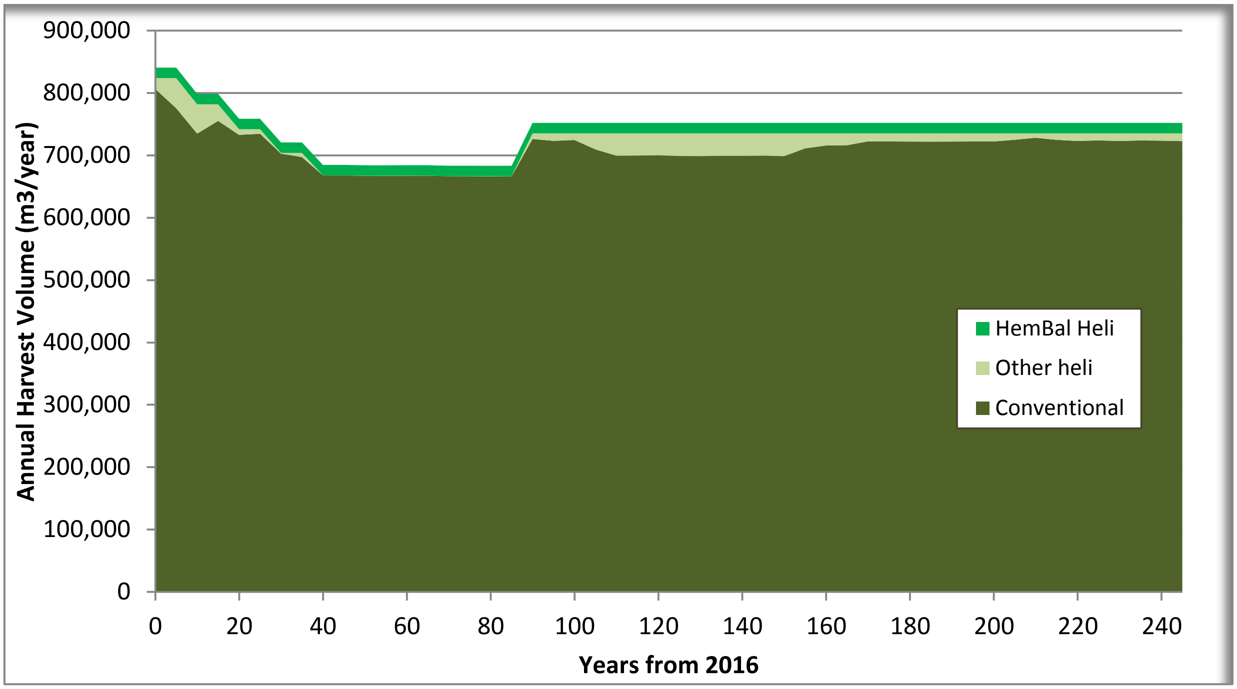

Figure 26 – Harvest by system when maintaining heli hembal partition

As no constraint is applied to the "other heli" its contribution to harvest fluctuates through time. With performance in the heli-hembal having been consistent with the partition established through MP #9 there should be less concern with contribution from this portion of the land base. To enable more efficient mobilization of helicopter equipment the total heli partition construct within the Base Case is preferable to requiring an even-flow contribution from a component of the heli land base throughout time.

4.11 Remove heli volume constraint

The Base Case includes a constraint that even-flows current heli-operable old stands over the first 30 years and then relies upon minimum harvest criteria and a non-declining harvest to determine the contribution to timber supply. This analysis tests the impact that constraint has on harvest levels achieved in the Base Case.

The approach taken here was to set the LTHL to the Base Case amount as there is no constraint on the long-term heli contribution in the Base Case and determine the impact to short and mid-term harvest. In this analysis the "stable" growing stock constraint is applied to the total THLB growing stock (rather than only the conventional THLB growing stock as done in the Base Case) because in this sensitivity the entire THLB is being utilized to provide a sustainable timber supply, whereas in the Base Case the conventional THLB is being utilized to provide a sustainable timber supply while the timber supply from the heli THLB is controlled.

Table 17 and Figure 27 indicate that with the heli harvest constraint removed short-term harvest can be 4.2% higher.

Table 17 – Harvest levels with no heli constraint

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	No Heli Constraint	Difference	
1	2016	2025	847,400	883,400	+36,000	+4.2%
2	2026	2035	805,100	839,200	+34,100	+4.2%
3	2036	2045	784,200	797,300	+13,100	+1.7%
4	2046	2055	745,000	757,400	+12,400	+1.7%
5	2056	2065	707,800	719,500	+11,700	+1.7%
6	2066	2075	707,600	719,500	+11,900	+1.7%
7 - 9	2076	2105	707,400	719,500	+12,100	+1.7%
10 - 25	2106	2265	757,900	757,900	0	0.0%

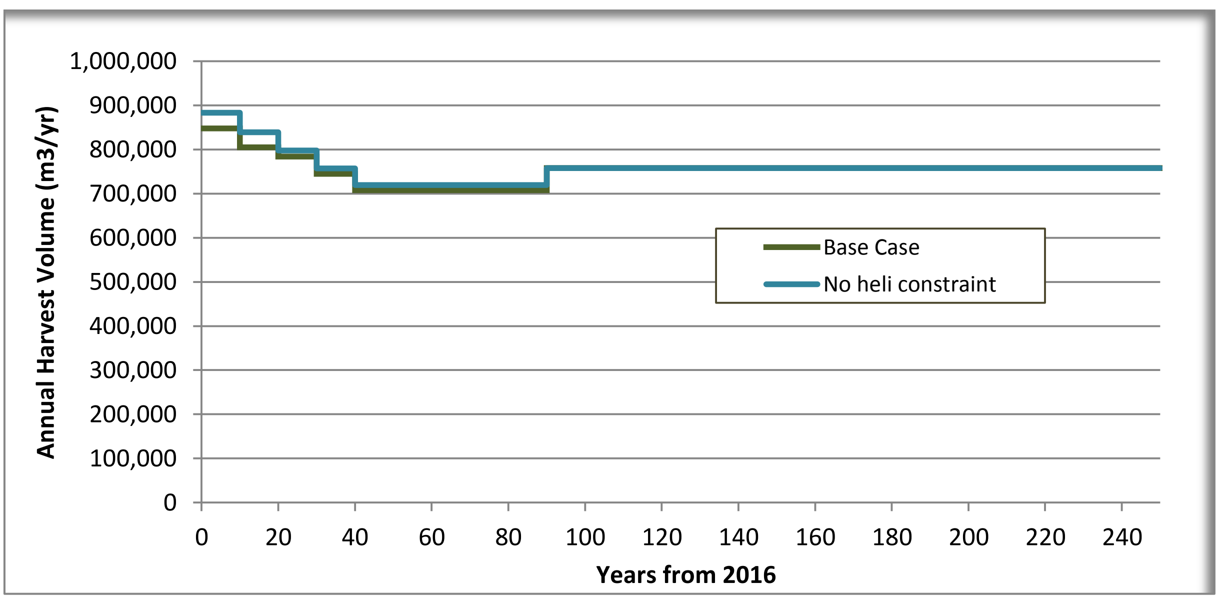

Figure 27 – Harvest levels with no heli constraint

Figure 28 indicates the contribution by harvest system category. Heli harvest fluctuates widely over the first 40 years and is 266,600 m^3/year in the second decade. This contribution from the heli THLB would be impractical to achieve operationally.

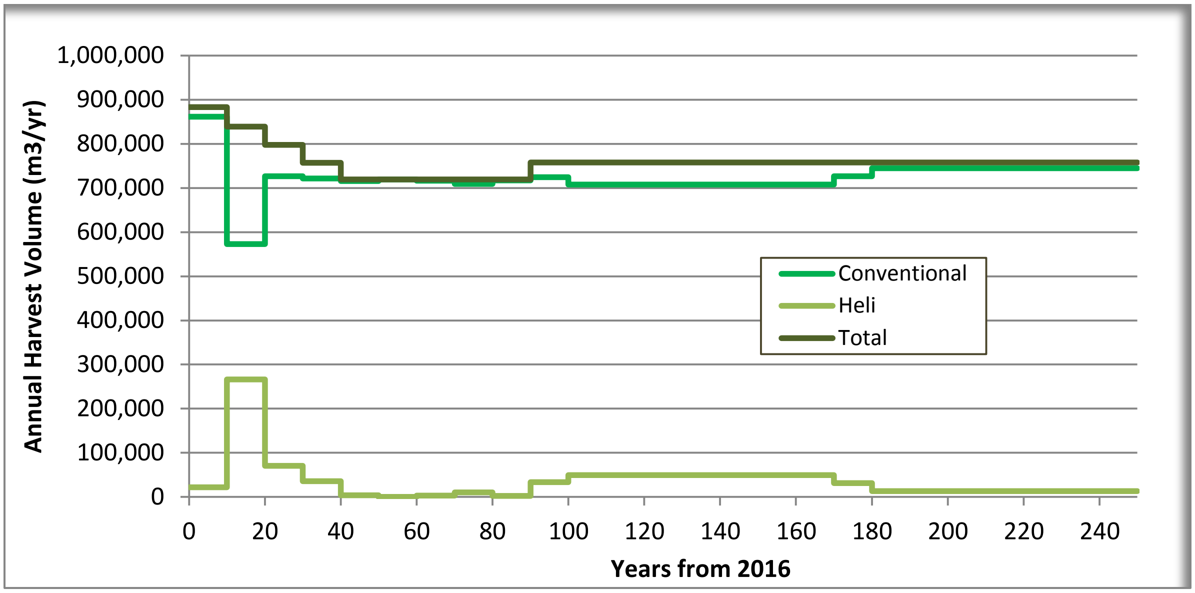

Figure 28 – Harvest by system with no heli constraint

Over the entire 250 years approximately 1.56 million m^3 (0.8%) more is harvested.

4.12 Exclude heli operable landbase

Excluding the heli-operable landbase removes 7,770 ha (9.0%) of THLB area and 4.48 million m^3 (15.5%) of standing inventory. One approach for excluding the heli operable landbase is that it contributes volume as indicated in Table 1 and Figure 2. For this sensitivity analysis the model was set up to follow the Base Case schedule as long as possible and adjust the mid and long-term harvest to reflect the lower available inventory levels and smaller operable landbase.

Table 18 and Figure 29 indicate the results of this sensitivity.

Table 18 – Harvest levels with heli THLB excluded

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	No Heli Harvest	Difference	
1	2016	2025	847,400	847,400	0	0.0%
2	2026	2035	805,100	762,700	-42,400	-5.3%
3	2036	2045	784,200	686,400	-97,800	-12.5%
4	2046	2055	745,000	617,800	-127,200	-17.1%
5	2056	2065	707,800	617,800	-90,000	-12.7%
6	2066	2075	707,600	630,400	-77,200	-10.9%
7	2076	2085	707,400	630,400	-77,000	-10.9%
8	2086	2095	707,400	669,100	-38,300	-5.4%
9	2096	2105	707,400	736,000	+28,600	+4.0%
10 - 25	2106	2265	757,900	738,400	-19,500	-2.6%

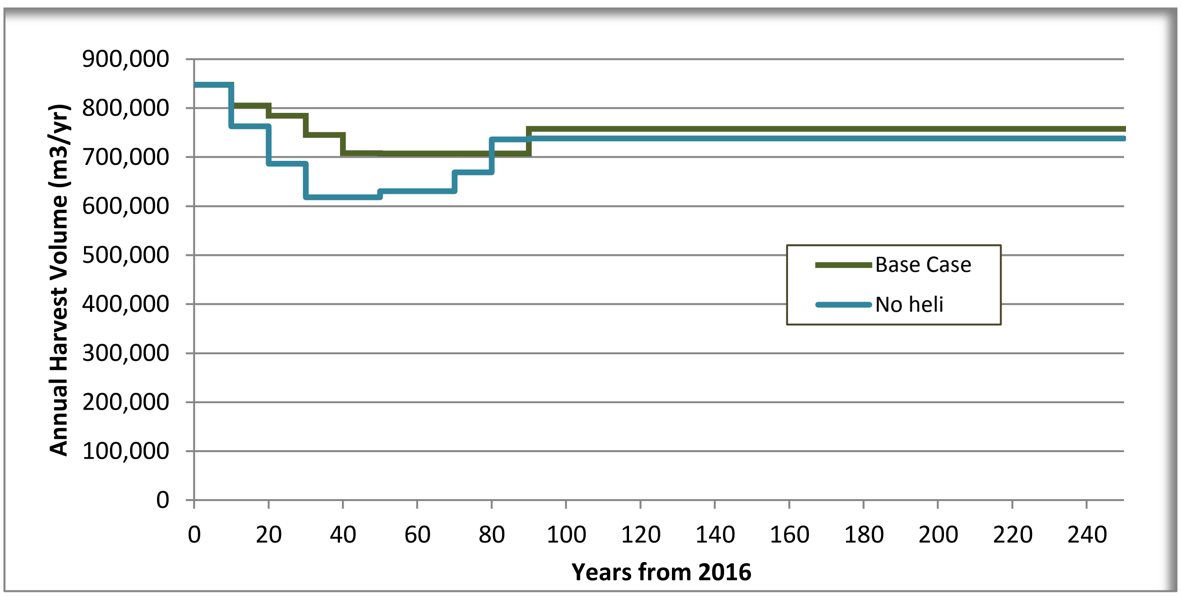

Figure 29 - Harvest levels with heli THLB excluded

The initial harvest of the Base Case can be achieved however mid-term harvest is significantly reduced. The reduced mid-term harvest allows growing stock to recover such that harvest can increase beginning 60 years into the future and continue until the long-term harvest level of 738,400 m^3/year is reached: 2.6% lower than the Base Case. Over the 250 years 8.33 million m^3 (4.4%) less is harvested, compared to the 10.77 million m^3 contribution heli makes to the Base Case schedule.

4.13 Remove Western Forest Strategy Impacts

Since 2001 nearly all harvest within TFL 37 has been done using the retention silviculture system (mainly group retention). This is a result of policies (forest management strategies) of the predecessor licensee (Canfor) and WFP. The WFP forest strategy (WFS) approach is to vary the use of retention systems and the amount of stand level retention by Resource Management Zones of the Vancouver Island Land Use Plan and by ecosection (see Section 10.3.3 in the IP for details).

In the Base Case the impacts of the Western Forest Strategy are modelled by including variable THLB area netdowns (see Section 6.20.2 of the IP) and reducing yields of future stands and stands currently aged 1 – 14 years due to shading from retained trees (see Section 8.4.2.1.2 of the IP). This sensitivity tests the timber supply implications that these forest strategy impacts have on the Base Case harvest levels.

Table 19 and Figure 30 indicate the results of this sensitivity.

Table 19 - Harvest levels with no Western Forest Strategy

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	No Western Forest Strategy	Difference	% Difference
1	2016	2025	847,400	876,100	+28,700	+3.4%
2	2026	2035	805,100	836,800	+31,700	+3.9%
3	2036	2045	784,200	836,800	+52,600	+6.7%
4	2046	2055	745,000	794,900	+49,900	+6.7%
5	2056	2065	707,800	756,600	+48,800	+6.9%
6	2066	2075	707,600	756,600	+49,000	+6.9%
7 - 9	2076	2105	707,400	756,300	+48,900	+6.9%
10 - 25	2106	2265	757,900	810,000	+52,100	+6.9%

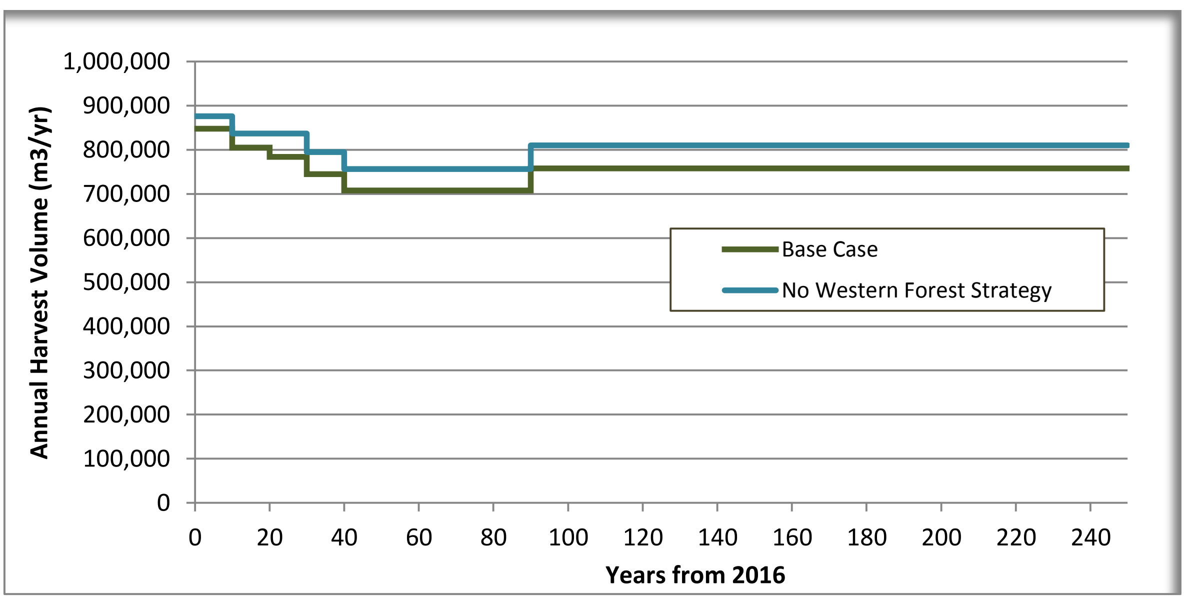

Figure 30 - Harvest levels with no Western Forest Strategy

Removing the area impact of the WFS increases the THLB by approximately 3,800 ha (4.4%) and increases THLB growing stock by 1.64 million m^3 (5.7%). In the short-term harvest can increase roughly proportional to the increase in THLB area as volume is sourced from unmanaged stands that are not influenced by the shading yield reduction applied to younger managed stands in the Base Case. As harvest transitions to managed stands the increased yields allows a further increase in harvest (relative to the Base Case) such that mid and long-term harvest is nearly 7% greater.

Over the 250 year analysis 12.41 million m^3 (6.6%) more is harvested.

4.14 Decrease minimum harvest DBH by 2 cm

Minimum harvest criteria are simply the minimum criteria for use in the timber supply model – stands are not available for harvest by the model until the minimum criteria are met. Actual harvesting occurs in some stands below the minimum modelled criteria while other stands are not harvested until well past the minimum criteria due to managing for other resource values and timing/rate of harvest constraints. Minimum criteria are often specified by an age and a minimum volume per hectare. This analysis used a minimum average stand diameter-at-breast-height (DBH) that varied by harvesting system and a minimum volume per hectare (see section 10.3.1 of the IP). The concept is that larger diameters in general reflect higher net values.

Table 20 indicates the minimum average stand DBH used in the Base Case and in this sensitivity analysis. The minimum DBHs were decreased by 2 cm for the sensitivity analysis. In terms of years, this advances harvest eligibility from 5 to 55 years depending on the analysis unit.

Table 20 - Minimum Harvest Criteria

Harvest System	Base Case		Sensitivity	
	Minimum Average DBH	Wtd Avg Future Stand Age	Minimum Average DBH	Wtd Avg Future Stand Age
Ground	30 cm	62 years	28 cm	54 years
Cable	37 cm	105 years	35 cm	97 years
Heli	42 cm	185 years	40 cm	170 years

The smaller DBH criteria increases the initial available inventory by 1.16 million m^3 (8.4%). Table 21 and Figure 31 indicate the results of allowing short-term harvest to increase, maintaining mid-term harvest level from the Base Case and then allowing the LTHL to adjust to the increased available inventory.

Table 21 - Harvest levels with decreased minimum harvest DBH

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Decreased min. DBH	Difference	
1	2016	2025	847,400	853,300	+5,900	+0.7%
2	2026	2035	805,100	810,600	+5,500	+0.7%
3	2036	2045	784,200	784,200	0	0.0%
4	2046	2055	745,000	745,000	0	0.0%
5	2056	2065	707,800	724,000	+16,200	+2.3%
6	2066	2075	707,600	724,200	+16,600	+2.3%
7 - 9	2076	2105	707,400	723,600	+16,200	+2.3%
10 - 25	2106	2265	757,900	775,000	+17,100	+2.3%

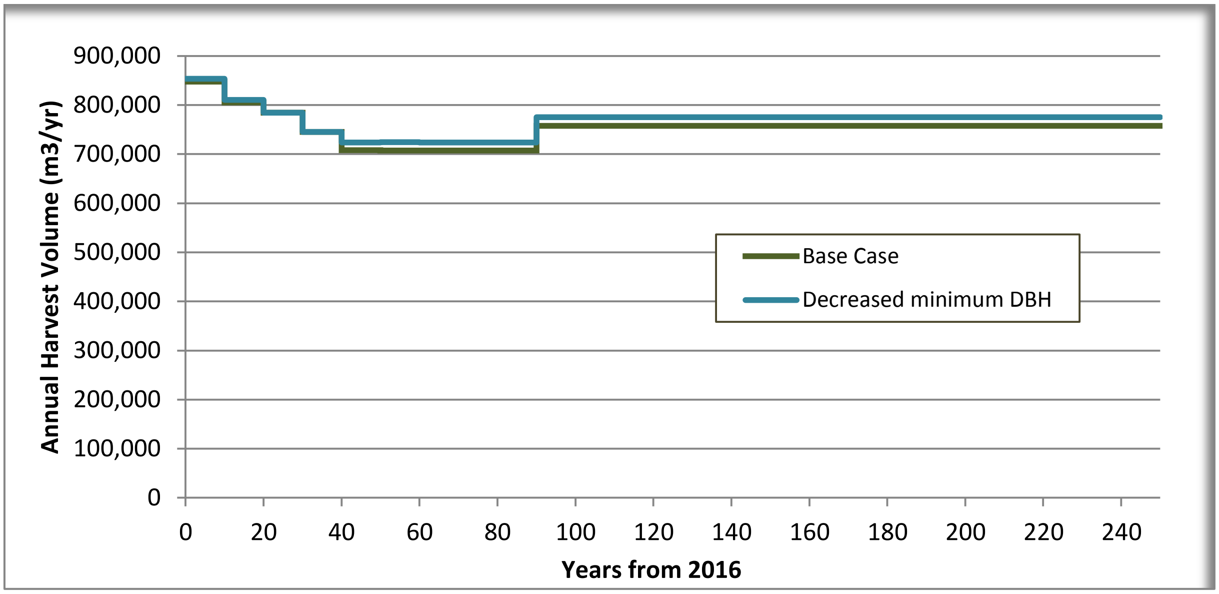

Figure 31 – Harvest levels with decreased minimum harvest DBH

The increased availability of stands allows short-term harvest to increase by 0.7% and long-term harvest to increase by 2.3%. Overall 3.67 million m^3 (1.9%) more is harvested in this sensitivity analysis.

4.15 Use 95% culmination as minimum harvest criteria

As discussed in the preceding section, the Base Case uses average stand diameter criteria to determine minimum harvest age. Using DBH to determine harvest age is managing stands on a financial rotation. To maximize yield from a forest over time the management objective would be to harvest stands when they reach their highest average growth rate or mean annual increment (MAI). This age is often referred to as the culmination age and is the optimal biological rotation age to maximize long-term volume. Given conflicting forest-level objectives it is not feasible to consistently harvest stands at culmination age; therefore achieving 95% of culmination is often seen as a reasonable objective.

For this sensitivity minimum harvest age was set at the age when the mean annual increment first reaches 95% of the culmination MAI. The results indicate that the DBH criteria applied in the Base Case hardly differ from applying culmination MAI criteria (see Table 22 and Figure 32).

Table 22 - Harvest levels using 95% culmination as minimum harvest age

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	95% culmination	Difference	
1	2016	2025	847,400	847,400	0	0.0%
2	2026	2035	805,100	805,100	0	0.0%
3	2036	2045	784,200	764,800	-19,400	-2.5%
4	2046	2055	745,000	726,600	-18,400	-2.5%
5	2056	2065	707,800	708,000	+200	< 0.1%
6	2066	2075	707,600	708,000	+400	< 0.1%
7 - 9	2076	2105	707,400	708,000	+600	< 0.1%
10 - 25	2106	2265	757,900	761,100	+3,200	0.4%

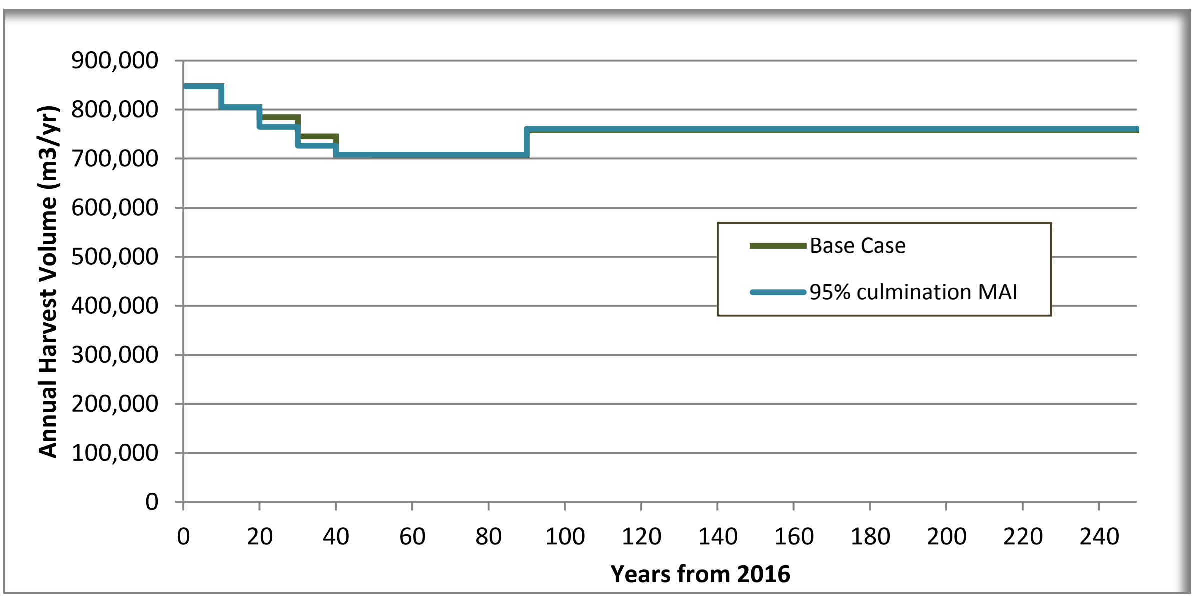

Figure 32 – Harvest levels using 95% culmination as minimum harvest age

Mid-term harvest is reduced for 20 years when harvesting is mainly within the older current managed stands to allow transition to marginally older long-term rotation ages. The slightly longer rotation ages result in an increased long-term harvest level. Over the 250 year analysis 158,000 m^3 (less than 0.1%) more volume is harvested.

Figure 33 compares the available conventional inventory (i.e. meets minimum harvest criteria) over time. There is no discernible difference until 70 years into the future. Beyond 70 years the Base Case DBH criteria results in, on average, roughly 2% more available inventory.

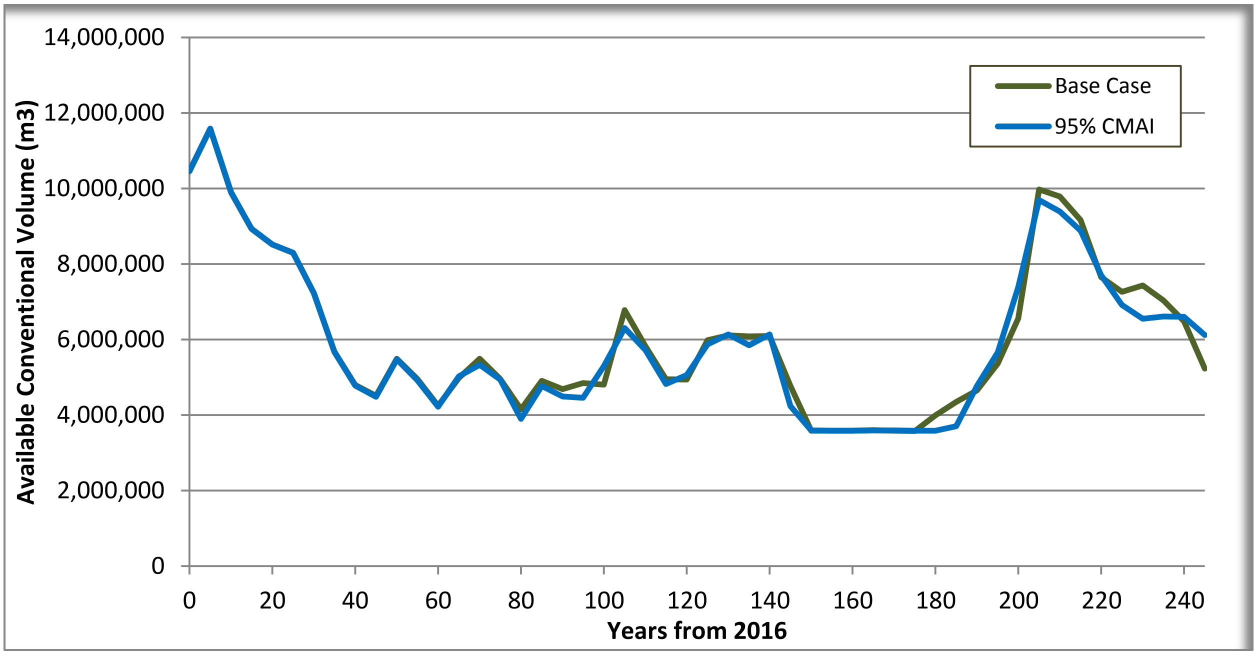

Figure 33 – Available conventional volume using 95% culmination as minimum harvest age

4.16 LiDAR Derived OAF1 and Road Widths

In addition to the review of non-productive areas within managed stands described in Section 4.8, a review of road widths was undertaken using the recently acquired LiDAR data for TFL 37. LiDAR data indicates the amount of road area not supporting tree growth used in the Base Case overstates the amount of growing site lost (see Appendix C). The impact of this overstated netdown is a 1.2% - 2.2% reduction to THLB.

For this sensitivity, the road width adjustment was applied as a 1% yield increase across all yield tables. The lower end of the indicated range was used to reflect that alder frequently, but not always, forms a component of the trees regenerating on roads and little alder has been utilized within TFL 37.

The revised OAF1 values were applied as per Section 4.8.

All yield adjustments were applied multiplicatively. As an example where an OAF1 adjustment is included, the adjustment for managed stands 15 - 54 years old on medium sites is 1.075 based on:

- OAF1 of 9.5% rather than 15% = 0.905 / 0.85 = 1.065
- Road width adjustment = 1.01
- 1.065 * 1.01 = 1.075

Unmanaged stand yields are multiplied by a factor of 1.01 for narrower roads.

Given that the OAF1 revisions affect only managed stand yields and therefore would not impact the initial harvest level of the Base Case, the model was set up to achieve the Base Case harvest level in the first decade and then achieve a non-declining even flow thereafter. This model construct uses the improved yields to increase mid-term timber supply – refer to Table 23 and Figure 34 for results.

Table 23 - Harvest levels applying LiDAR derived OAF1 and road widths

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	LiDAR derived factors	Difference	% Difference
1	2016	2025	847,400	847,400	0	0.0%
2	2026	2035	805,100	828,100	+23,000	+2.9%
3	2036	2045	784,200	828,100	+43,900	+5.6%
4	2046	2055	745,000	828,100	+83,100	+11.2%
5	2056	2065	707,800	828,100	+120,300	+17.0%
6	2066	2075	707,600	828,100	+120,500	+17.0%
7 - 9	2076	2105	707,400	828,100	+120,700	+17.1%
10 - 25	2106	2265	757,900	828,100	+70,200	+9.3%

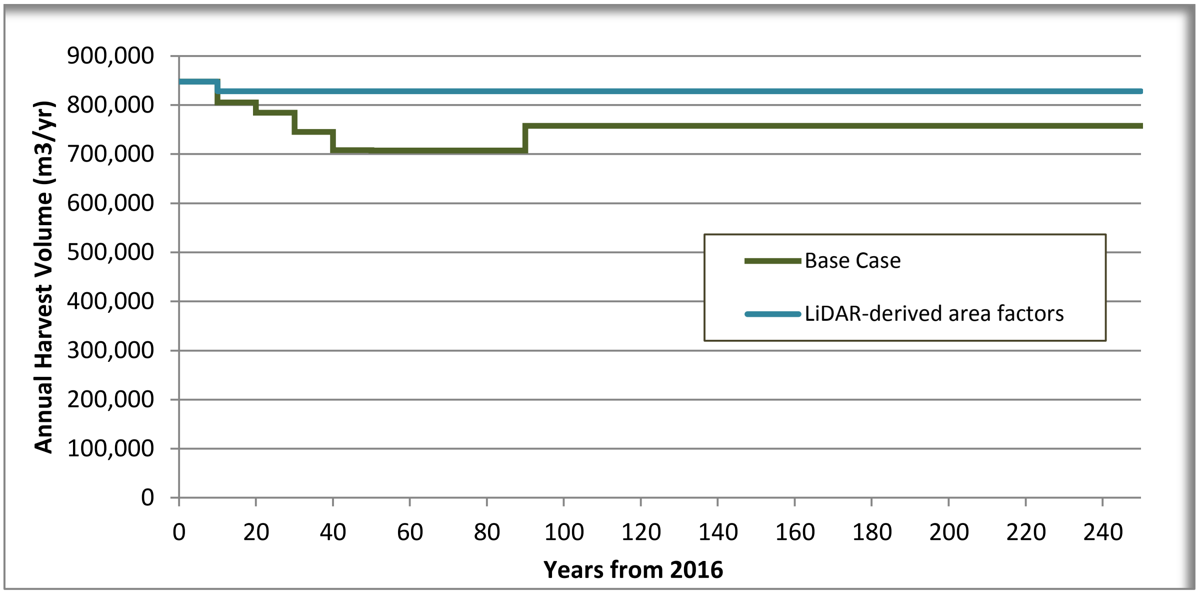

Figure 34 – Harvest levels applying LiDAR derived OAF1 and road widths

The combined effect of applying the adjustments increases the initial THLB growing stock by 1.33 million m^3 (4.6%). After the first decade the resulting harvest level is 828,100 m^3/year with the heli landbase contribution being 76,800 m^3/year for the first 30 years. Figure 35 presents the contribution from conventional and heli operable THLB through time. Over the 250 year analysis 18.76 million m^3 (10.0%) more volume is harvested.

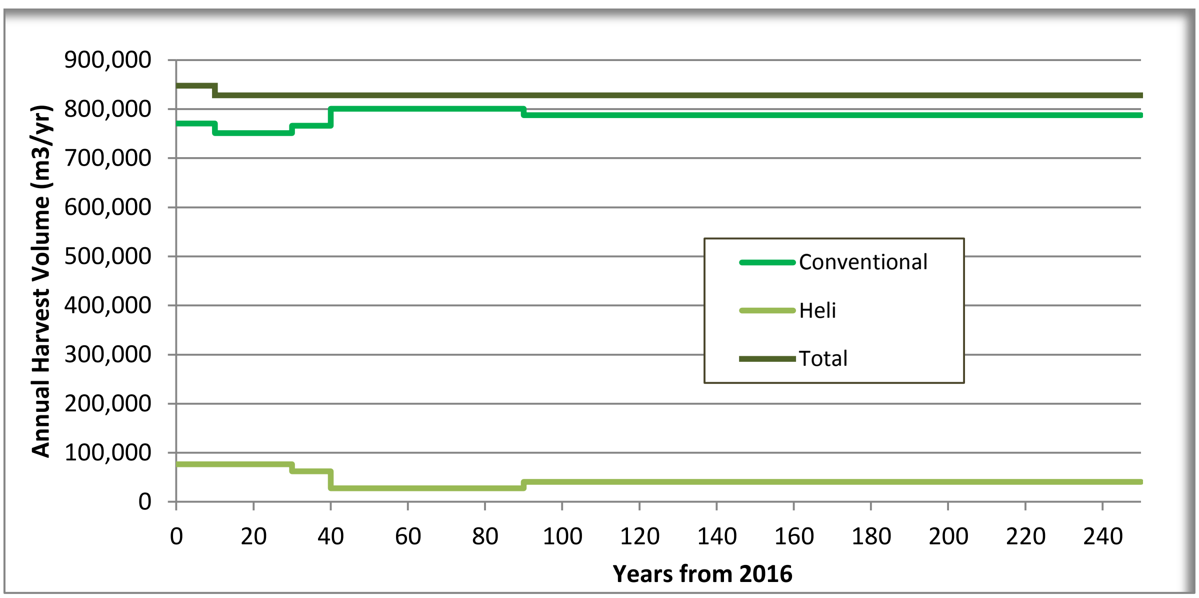

Figure 35 – Harvest system contribution with LiDAR derived OAF1 and road widths

4.17 LiDAR Derived OAF1, Road Widths and Tree Heights

A review of tree heights was also undertaken using the LiDAR data. The analysis indicated that unmanaged stand heights are on average roughly 2m taller than inventory heights projected using VDYP 7. For managed stands the results show that yield tables generated using TIPSY underestimate height by an average of 1.3m – see Appendix B for further details. As height is the main factor in estimating stand volume, height adjustments of these magnitudes increase unmanaged yields by 6% and managed yields by 5% on average.

The tree height differences were applied as a 5% increase to unmanaged stand yields and a 6% increase to managed stand yields.

All yield adjustments were applied multiplicatively. For example unmanaged stand yields are multiplied by a factor of 1.06 as a result of 1.01 for narrower roads and 1.05 for increased tree heights (1.01 * 1.05 = 1.06). As an example where an OAF1 adjustment is included, the adjustment for managed stands 15 - 54 years old on medium sites is 1.14 based on:

- OAF1 of 9.5% rather than 15% = 0.905 / 0.85 = 1.065
- Road width adjustment = 1.01
- Tree height adjustment = 1.06
- 1.065 * 1.01 * 1.06 = 1.14

For comparative purposes, this sensitivity was repeated using the maximum yield increases indicated by the LiDAR reviews. Values applied in the two variations of this sensitivity analysis are indicated in Table 24.

Table 24 - LiDAR derived OAF1, tree heights and road widths adjustments

Yield Factor	Conservative LiDAR derived factor	Maximum LiDAR derived factor
Road Widths	1.0%	2.2%
OAF1 – Good sites	4.0%	5.6%
OAF1 – Medium sites	5.4%	9.5%
OAF1 – Poor sites	7.2%	11.3%
Tree Heights – unmanaged stands	5.0%	5.0%
Tree heights – managed stands	6.0%	6.0%

The results of applying all three analyses in combination are presented in Table 25 and Figure 36.

Table 25 - Harvest levels applying LiDAR derived OAF1, tree heights and road widths

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Conservative LiDAR derived factors	Maximum LiDAR derived factors	% Difference Conservative factors	Maximum factors
1	2016	2025	847,400	882,200	905,200	+4.1%	+6.8%
2	2026	2035	805,100	882,200	905,200	+9.6%	+12.4%
3	2036	2045	784,200	882,200	905,200	+12.5%	+15.4%
4	2046	2055	745,000	882,200	905,200	+18.4%	+21.5%
5	2056	2065	707,800	882,200	905,200	+24.6%	+27.9%
6	2066	2075	707,600	882,200	905,200	+24.7%	+27.9%
7 - 9	2076	2105	707,400	882,200	905,200	+24.7%	+28.0%
10 - 25	2106	2265	757,900	882,200	905,200	+16.4%	+19.4%

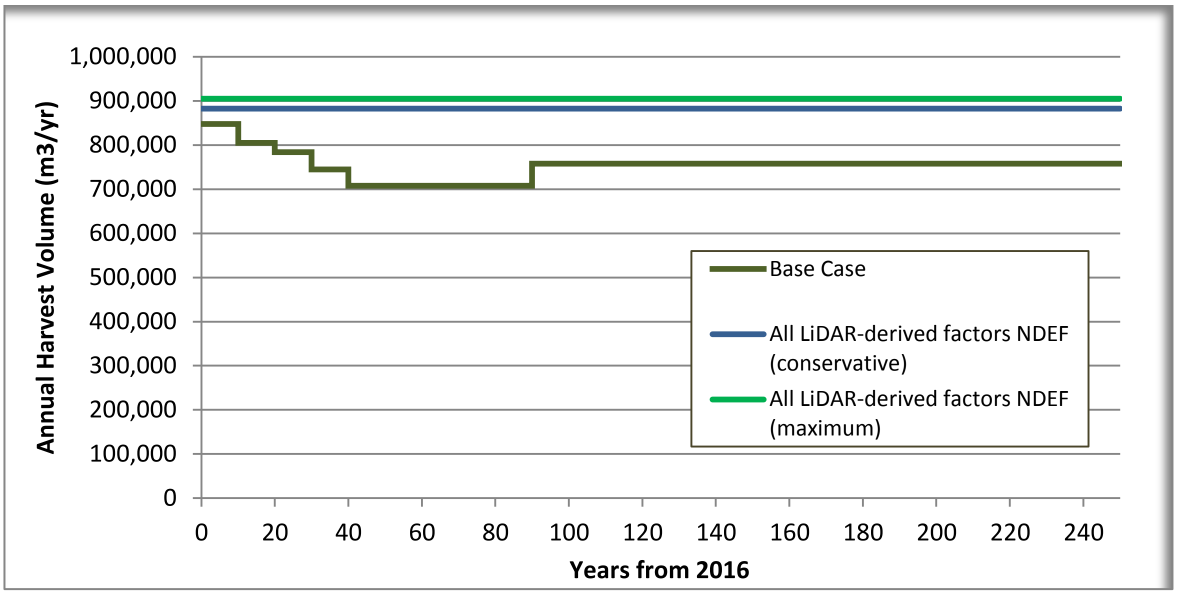

Figure 36 – Harvest levels applying LiDAR derived OAF1, tree heights and road widths

The combined effect of applying all yield adjustments increases the initial THLB growing stock by 2.94 – 3.48 million m^3 (10-12%). Given the increase in current inventory and future yields the model was configured to generate a non-declining harvest schedule. The resulting harvest level is 882,200 – 905,200 m^3/year with the heli landbase contribution being 137,200 – 138,500 m^3/year for the first 30 years. Over the 250 year analysis 32.1 – 37.8 million m^3 (17.0 – 20.1%) more volume is harvested.

Average tree height is the most significant input of yield estimates for a stand however there are other factors that were not tested to determine if there is an overall bias in modelled yields. For the AAC determination any bias in VDYP is important as the first decade harvest is entirely unmanaged stands whose volumes are estimated using VDYP.

A review of mature cutting permits harvested from 2012-2016 indicates that inventory volume (i.e. VDYP7) and billed volume (production + waste) were within 1% of each other. The sample was approximately 2.4 million m^3 (3600 ha) and indicates that there may not be a volume bias in unmanaged stand yields used in the Base Case.

A similar analysis was conducted on the youngest immature blocks harvested in this time frame to sample for bias in the TIPSY yield tables for managed stands. A total of 606 ha of second growth less than 55 years old were harvested. Total billed volume from the 25 cutblocks was 343,489 m^3 while applicable TIPSY yield tables estimated 323,101 m^3. The difference of 20,388 m^3 equates a 6.3% underestimation of managed stand yields.

Table 26 summarizes the results of the analyses comparing yield estimates to billed (production + waste) volumes.

Table 26 – Summary of yield estimates to billed volumes

Age Class	Yield Model	Yield Source	Logged Area (ha)	Yield Estimate (m3)	Billed Volume (m3)	Difference	
						m3	%
Mature	VDYP	Inventory	3,612	2,445,588	2,416,665	28,923	1.2%
Immature	TIPSY	Analysis Unit yield table	606	323,101	343,489	-20,388	-6.3%

4.18 Summary of sensitivity impacts

Table 27 provides a summary of the impacts of the sensitivity issues explored. Impacts shown indicate the aggregate differences over the defined time periods and are rounded to the nearest tenth of a percent.

Table 27 – Summary of sensitivity analyses harvest impacts

		Harvest Interval (years)		
		1 – 30	31 – 90	91 - 250
Base Case total net harvest level (m^3)		24,367,000	42,826,000	121,264,000
Issue tested	Sensitivity	Percentage Impact		
Available landbase	Exclude ‘Namgis treaty settlement offer lands	-11.2%	-16.6%	-16.5%
	Include deciduous-leading stands	+2.1%	+0.7%	+0.9%
Growth and yield	Unmanaged stands yields increased by 10%	+7.2%	+3.3%	0.0%
	Unmanaged stands yields decreased by 10%	-4.5%	-1.9%	-1.0%
	Managed stands yields increased by 10%	+2.6%	+3.4%	+7.1%
	Managed stands yields decreased by 10%	-3.8%	-10.0%	-9.0%
	Use SIBEC Site Index estimates	-5.2%	-10.3%	-8.8%
	Apply LiDAR-derived OAF 1 values	+2.6%	+2.7%	+6.3%
Forest management / Silviculture	Remove benefits of genetic gain	-2.1%	-8.4%	-7.6%
Operability	Maintain heli hembal partition	-1.6%	-3.3%	-0.8%
	Remove heli harvest constraint	+3.4%	+1.7%	0.0%
	Exclude heli landbase	-5.8%	-8.9%	-2.6%
Biodiversity	Remove Western Forest Strategy impacts	+4.6%	+6.9%	+6.9%
Minimum harvest criteria	Decrease minimum DBH by 2 cm	+0.5%	+1.9%	+2.3%
	95% of culmination mean annual increment	-0.8%	-0.4%	+0.4%
LiDAR Reviews	Apply LiDAR derived estimates of OAF1 and road widths	+2.7%	+16.0%	+9.3%
	Apply LiDAR derived estimates of OAF1, road widths and tree heights	+8.6% to 11.4%	+23.6% to 26.8%	+16.4% to 19.4%

5 Analysis Summary and Proposed AAC

5.1 Changes since MP #9

There have been considerable changes in the TFL 37 landbase and timber supply analysis assumptions since MP #9. Main changes include:

- Deletion of approximately 18,350 ha in 2009 due *to Forestry Revitalization Act* to form part of Pacific TSA. The current AAC of 889,415 m^3/year reflects this deletion.
- In 2012 approximately 14,855 ha within TFL 37 were included in an Agreement in Principle (AIP) between the 'Namgis First Nation and the federal and provincial governments. A March 2013 vote by 'Namgis members rejected the AIP; however ongoing negotiations resulted in a 2015 Forestry Fund Agreement that provides for continuation of timber harvesting within the proposed treaty settlement lands. This area is included in the Base Case scenario as it remains within the TFL.
- Use of SIBEC values for managed stand site index within CWHvm2 and MHmm1 BEC variants rather than elevation model and inventory site index values used respectively in MP #9.
- Relying on OAF1 value in TIPSY to account for non-productive area within managed stands instead of applying a landbase netdown for non-productive site series components identified in the terrestrial ecosystem mapping (TEM).
- LiDAR data has been acquired for the TFL that allows some timber supply assumptions to be reviewed for the entire landbase (i.e. no sampling is required as the entire population can be analysed).
- Applying a partition to the entire heli operable landbase rather than "heli hembal" as was done in MP #9.
- Harvest scheduling uses optimization compared to the simulation approach in MP #9.

5.2 MP #10 Base Case Initial Harvest

The starting harvest level of 847,400 m^3/year in the Base Case reflects the reduced landbase plus reduced THLB inventory due to 10 years of harvesting plus growth over that period.

- As noted above, the current TFL 37 AAC of 889,415 m^3/year accounts for area deletions from the TFL.
- Between 2006 and 2015, 8.84 million m^3 was harvested.
- The initial THLB growing stock in MP #9 was estimated at 36.51 million m^3 compared to 29.98 million m^3 for MP #10.

5.3 Sensitivity Analyses

Sensitivity analyses have explored timber supply impacts of several uncertainties individually. This includes:

- A number of sensitivity analyses examined the impacts of varying the timber supply contribution of the heli operable landbase:
  - Maintaining a "heli hembal" partition as per MP #9 reduces short-term timber supply by 0.8% and mid-term timber supply by about 3.3%.
  - Excluding the heli operable landbase can either reduce short-term timber supply by a little more than 9% if simply deduct its contribution to the Base Case schedule or short-term impact can be reduced to about 5% at the expense of mid-term harvest. The impact to long-term harvest is 6.7% and 2.6% respectively.

- Removing constraints associated with heli contribution can increase short-term harvest by 4.2%.
- Performance in the heli operable landbase during MP #9 was consistent with the "heli hembal" partition and the overall proportion of THLB area. The Base Case construct includes a heli partition aimed at harvesting old stands over a similar period as old conventionally operable stands to coordinate equipment complement requirements and mobilization.

- Several sensitivity analyses examined the timber supply impacts of higher and lower volume projections or of management and other factors contributing to uncertainty on forest growth. Comments include:
  - Initial harvest level is moderately sensitive to unmanaged stand yield estimates with a 10% change (plus or minus) in yield resulting in a 5% change to initial harvest. Mid and long-term harvest is more or less unaffected.
  - Changes to managed stand yields (currently aged less than 55 years and future stands) are greatest in the long-term, but still substantial in the mid-term. Initial harvest level is unaffected.
  - Applying SIBEC values rather than local site index values within CWHxm2, CWHvm1 and CWHmm1 biogeoclimatic variants reduces managed stand yields and therefore reduces mid and long-term harvest.

- Sensitivity of timber supply to minimum harvest age was tested by varying the minimum DBH specifications and by applying 95% culmination MAI. Decreasing minimum DBH criteria by 2cm increased timber supply a minor amount whereas applying 95% culmination MAI as minimum harvest age has a negligible impact on the Base Case schedule.

5.4 LiDAR Data Review of Assumptions

WFP has invested to acquire LiDAR (Light Detection and Ranging) data for the majority of its tenures with final delivery of data for TFL 37 being made in April 2017. This data provides very detailed information of the ground shape (e.g. slope, elevation) and vegetation (e.g. canopy extent, tree height). Some assumptions used in the Base Case were reviewed to verify or improve the projected timber supply.

Firstly, as presented in Appendix A, the extent of non-productive area within managed stands is much less than the provincial "default" 15% applied within TIPSY as OAF1 and used in the Base Case. Applying OAF1 values indicated by the LiDAR data increases mid and long-term harvest. Initial harvest is unaffected as it is entirely from unmanaged stands whose yields are estimated with VDYP not TIPSY.

Secondly, tree heights from LiDAR were compared to both inventory (VDYP projection) and analysis unit tables (TIPSY for stands aged 40 - 54 years) – see Appendix B. In both cases LiDAR indicates that trees are taller than the yield models project. Given that height is the main determinant of stand volume this infers that the yield tables used in the Base Case are conservative. For managed stands the 1.3m underestimation of height at ages 40 – 54 years results in an average yield loss of approximately 6% at Base Case rotation ages. For unmanaged stands a 2m height increase, as indicated by the review, would increase yields by about 5%.

Finally, the area lost to roads was reviewed. The Base Case assumption is that all roads become non-productive area for perpetuity. In reality a proportion of roads support tree growth over time but until now there was no reliable way to measure this. LiDAR enables a review of the entire landbase. Identifying area within the road buffers applied in the Base Case that are covered by tree crowns at least 10m tall infers that the Base Case THLB is underestimated by 1-2%.

Applying LiDAR-derived OAF1 values alone indicates the initial harvest level of the Base Case can be maintained for 20 years and that mid and long-term timber supply would be greater than indicated by the Base Case.

Applying the revised OAF1 values and a 1% yield adjustment to reflect the LiDAR-derived road widths allows mid and long-term timber supply to be increased by 16% and 9% respectively while maintaining the Base Case harvest level in the first decade.

Applying all three adjustments in combination and requesting a non-declining even-flow resulted in a harvest level of between 882,200 m^3/year and 905,200 m^3/year, 4.1% - 6.8% greater than the Base Case initial harvest and significantly greater mid and long-term timber supply.

In summary, LiDAR data indicates the Base Case schedule underestimates TFL 37 timber supply, especially in the mid and long term. More research and analyses using this new data source needs to be conducted to verify that the timber supply impacts of these initial assessments are consistent with actual volumes. The greatest advantage of LiDAR data is that the whole population of interest is measured rather than relying on inference based on a sample.

5.5 Conclusions and Recommendations

Compared to the MP #9 analysis, changes in timber supply contribution from the heli operable land base largely offset the negative impacts of reductions in THLB and mature volume on short-term and medium-term (next 40 years) timber supply.

The analysis shows that the initial harvest level for the Base Case is robust across the individual sensitivities. LiDAR data infers that mid and long-term timber supply may be greater than indicated by the Base Case and further analyses will be conducted during the term of MP #10 to inform the next timber supply analysis.

An AAC of 847,400 m^3/year (the initial harvest level of the Base Case) is proposed for TFL 37 during the next ten years. The 847,400 m^3 includes 45,652 m^3 allocated to First Nations.

Appendix A

TFL 37 OAF1 ANALYSIS USING LiDAR DATA

SUMMARY

LiDAR data for TFL 37 acquired in the summer of 2016 was used to analyze gaps in crown cover as a proxy for the extent of non-productive area in over 31,000 ha of stands aged 40-140 years. The results indicate that the TIPSY default OAF1 of 15% overstates the extent of non-productive area within stands in TFL 37. Where there is good alignment between the forest inventory polygons and LiDAR data the results indicate that the following non-productive area adjustment values are appropriate:

- Good sites: 4.0%
- Medium sites: 5.4%
- Poor sites: 7.2%

Applying a 15% non-productive area adjustment value where the forest inventory and LiDAR data do not align well results in:

- Good sites: 5.6%
- Medium sites: 9.5%
- Poor sites: 11.3%

A sensitivity analysis will be conducted in the TFL 37 Management Plan #10 timber supply analysis that applies the latter (conservative) factors for TIPSY yields for managed stands (current and future).

PROCESS

Use Forest Cover polygons as Base data – select stands greater than 40 years old and less than 140 years old in order to analyze stands within which trees have likely occupied the site to the extent they ever will (see Figure 1 for an example). Gaps in such stands are assumed to represent low/non-productive area within the stand.

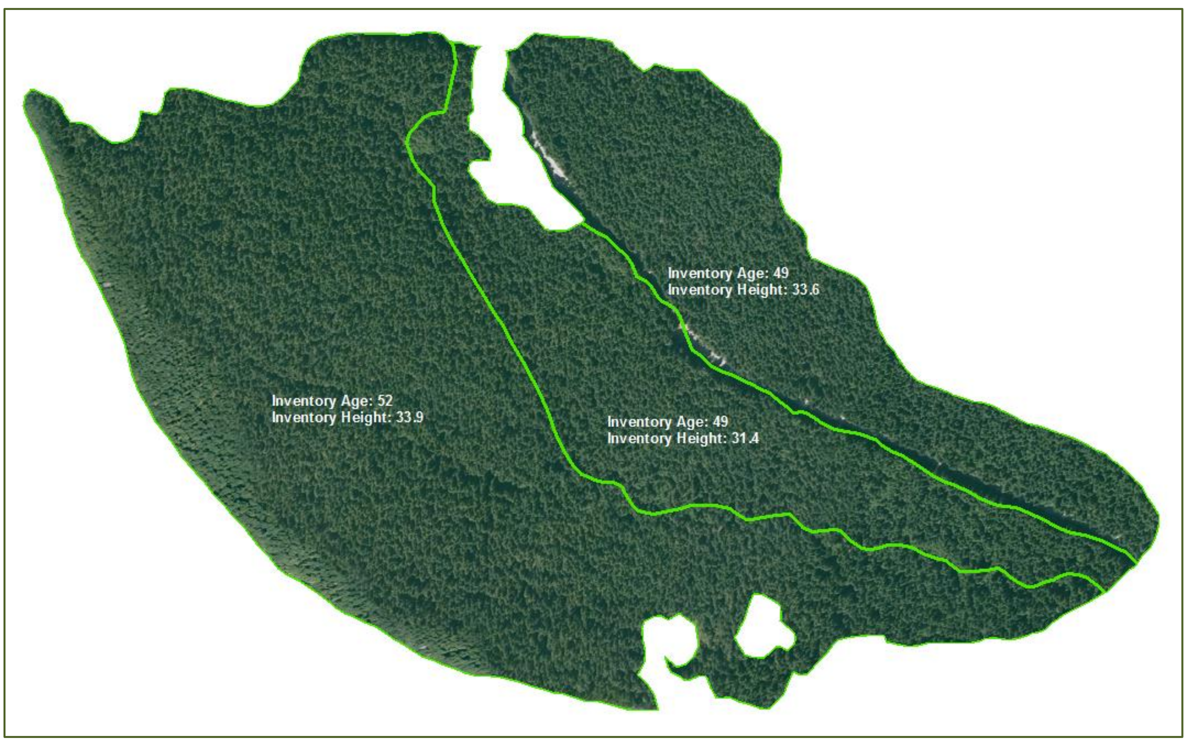

Figure 1 - Orthophoto and Inventory Data

Generate LiDAR-based crown height model for selected stands. The stands in this example (Figure 2) are classified as Good site.

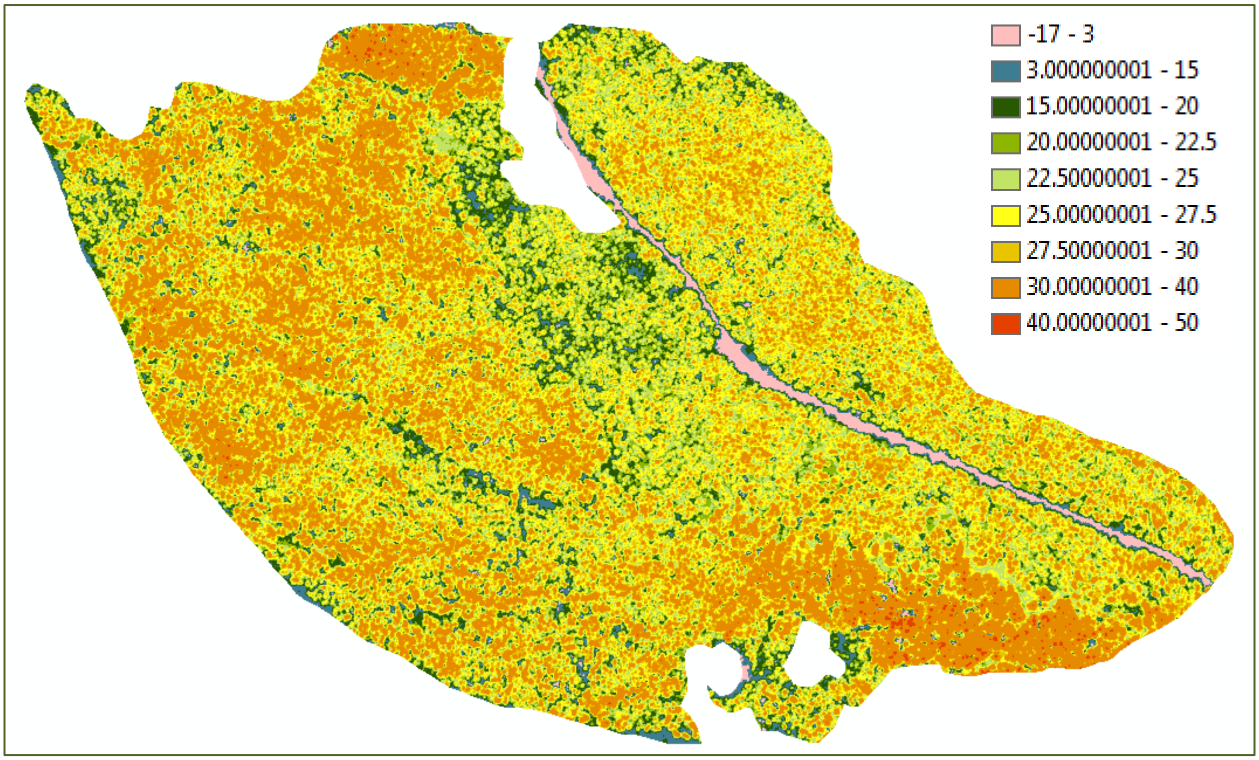

Figure 2 - Crown Height Model from LiDAR

Identify individual trees and their height – see Figure 3.

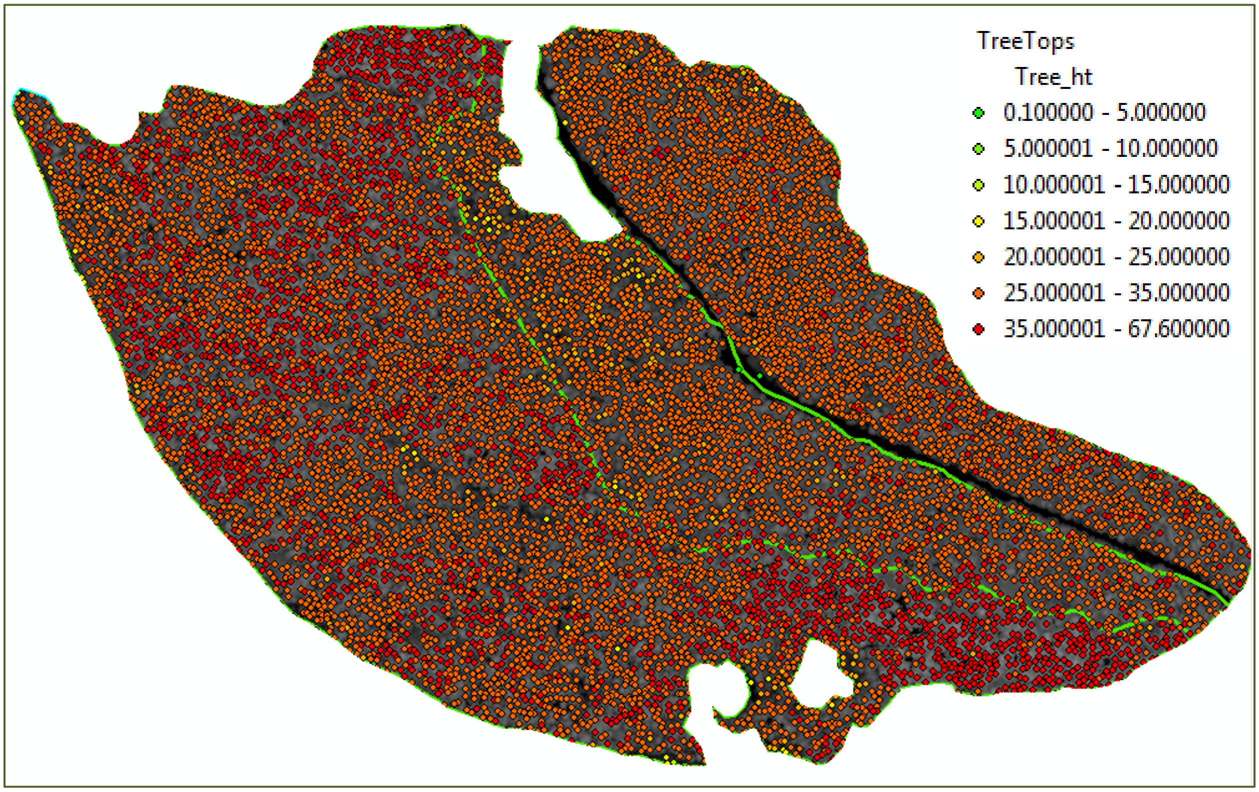

Figure 3 - Individual trees and heights from LiDAR

As an aside, the 85th percentile (mean + 1 standard deviation) of the identified individual tree heights from the LiDAR data in this sample was 36.8m. The average projected inventory height (VDYP 7) was 33m. The corresponding MP #10 analysis unit (using TIPSY) height at age 50 is 29m.

Create polygons of area where there is no crown cover above the 10m height threshold and determine the percent of the underlying forest cover polygon – see pink polygons in Figure 4. A 10m height threshold was selected to represent non/low productive areas within the stands. This 10m height is referenced in the VRI ground sampling procedures as the split between the tree layer and the tall shrubs layer (refer to Figure 5).

Note the influence of the road corridor in the upper right – labels are area factor of polygons where there is no crown cover above 10m ("non-productive area adjustment" factor).

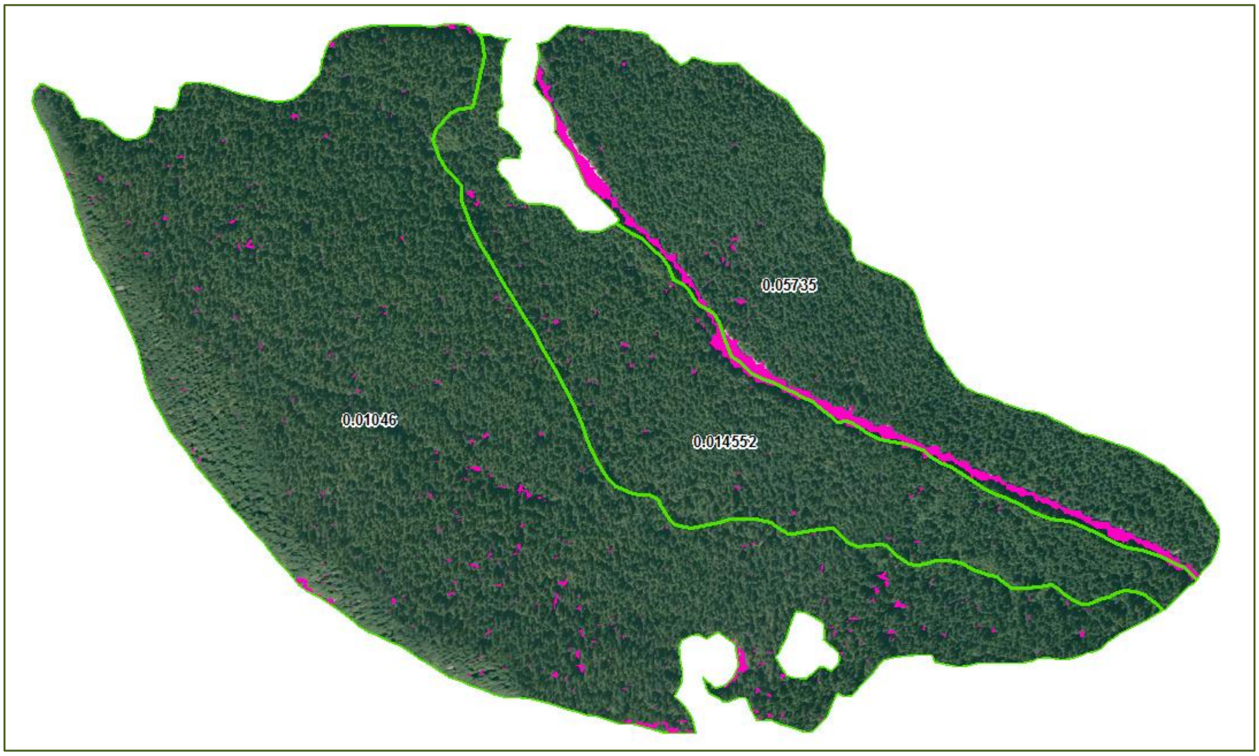

Figure 4 - Orthophoto with inventory polygons and gap factors

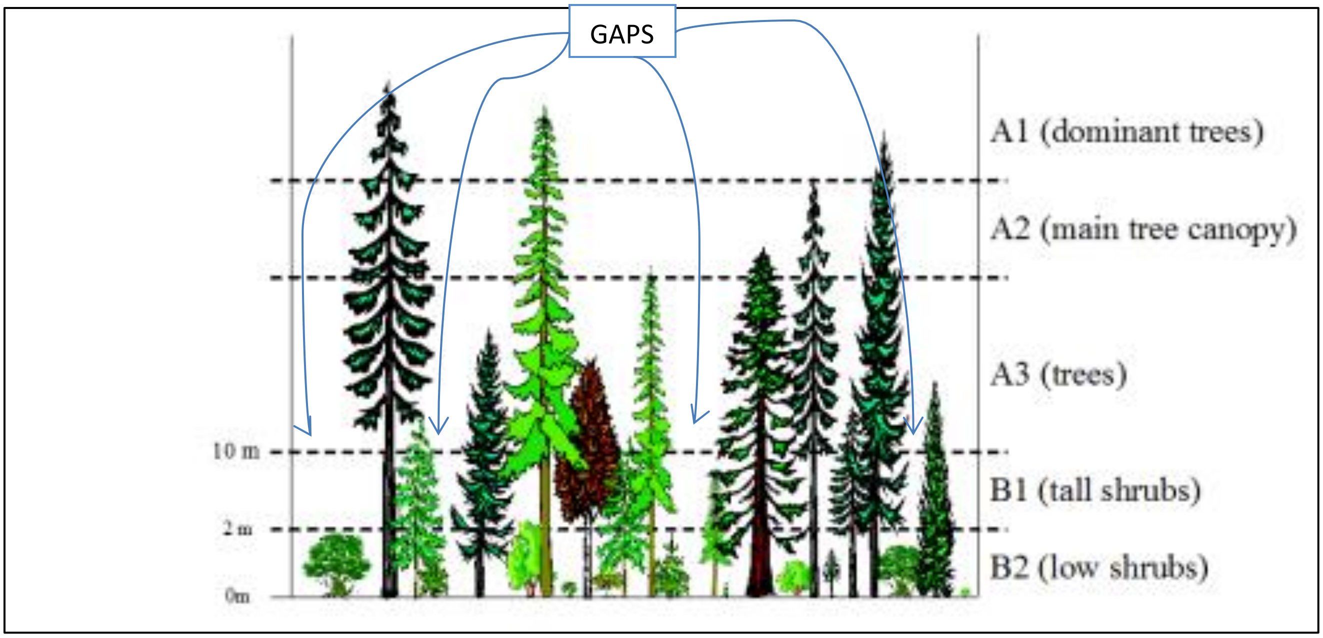

Figure 5 - Diagram of concept for identifying gaps (Figure 7.8 in VRI Ground Sampling Procedures Version 5.4, March 2017)

Repeat the step above recognizing road corridor. Note reduced percent of polygon in upper right (reduced from 5.735% to 1.167%) in Figure 6.

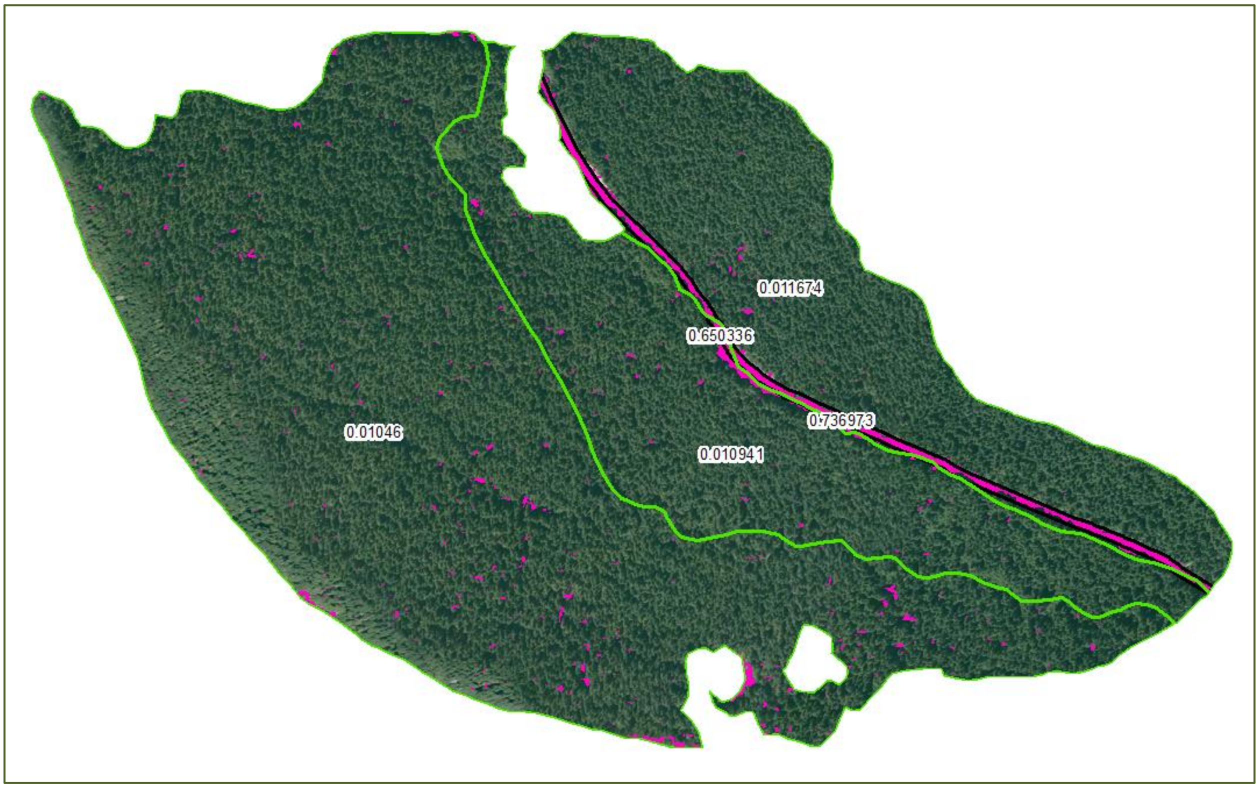

Figure 6 - Orthophoto with inventory polygons and gap factors recognizing road corridor

CHALLENGES

Two challenges were identified related to the data used:

1. Spatial alignment of forest cover polygons relative to the LiDAR data, and
2. Forest cover not updated for depletion to match timing of the LiDAR acquisition.

An example of the first challenge is indicated below in Figure 7 and Figure 8. This stand is identified as 41 years old in the inventory. However, it appears that the very northern portion is older and should be in the polygon to the north (i.e. the stand boundary should be revised southward to exclude the unmanaged stand type). The crown height model confirms the stand is less dense within this northern permimeter and as a result the non-productive area adjustment factor for this stand is greater than it would be if the boundary was more spatially accurate.

Figure 7 - Orthophoto and Inventory Data – note change in stand structure near northern perimieter

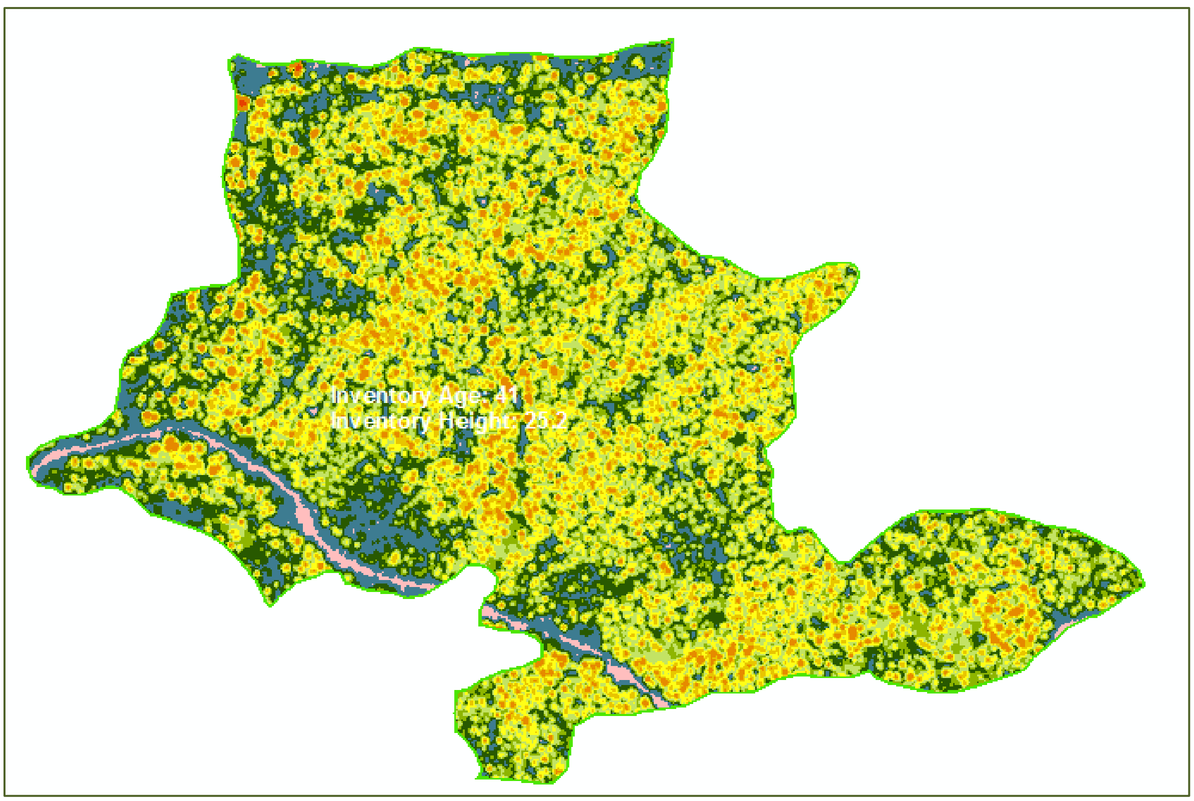

Figure 8 - Crown Height Model from LiDAR– note change in stand density near northern perimieter

An example of challenges associated with incongruent depletion updates is seen below in Figure 9 and Figure 10. The forest cover used was updated for depletion to the end of 2015 whereas the LiDAR data was flown in the summer of 2016. The stands below (figure 9) were part of the sample as the inventory indicated they were 60 years old. The crown height model (Figure 10) indicates the majority of these stands were harvested by the summer of 2016 (indicated by the pink colouring). The labels in Figure 10 are the derivied non-productive area adjustment factor for the underlying forest cover polygon.

Figure 9 - Orthophoto and Inventory Da ta

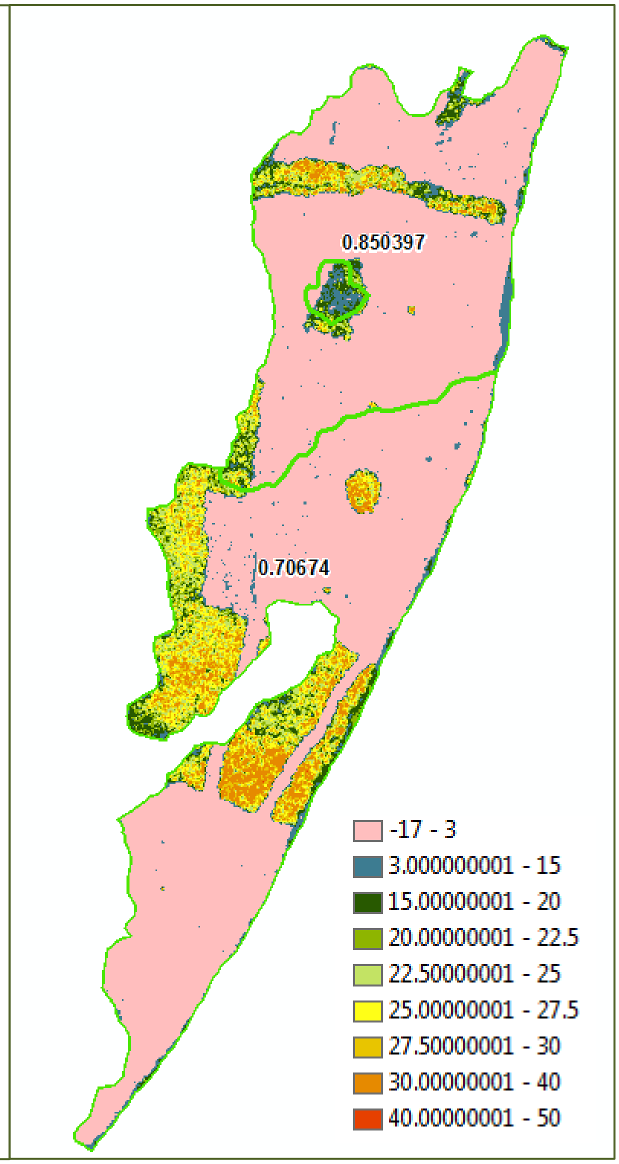

Figure 10 - Crown Height Model from LiDAR

Both challenges result in non-productive area adjustment factor within the sample stands being overstated.

RESULTS

Given the challenges identified, the data was summarized by grouping the resulting non-productive area adjustment factors into 5 classes:

- Less than or equal 1% (1%)
- Greater than 1% and less than or equal 2% (2%)
- Greater than 2% and less than or equal 5% (4%)
- Greater than 5% and less than or equal 10% (8%)
- Greater than 10% and less than 15% (13%)

The values in parentheses above are the values used in calculating area-weighted average factors. The total area assessed was 31,366 ha of which 22,694 ha are THLB based on the MP #10 Base Case assumptions. This equates to 23.7% of the total productive forest and 26.3% of the total THLB.

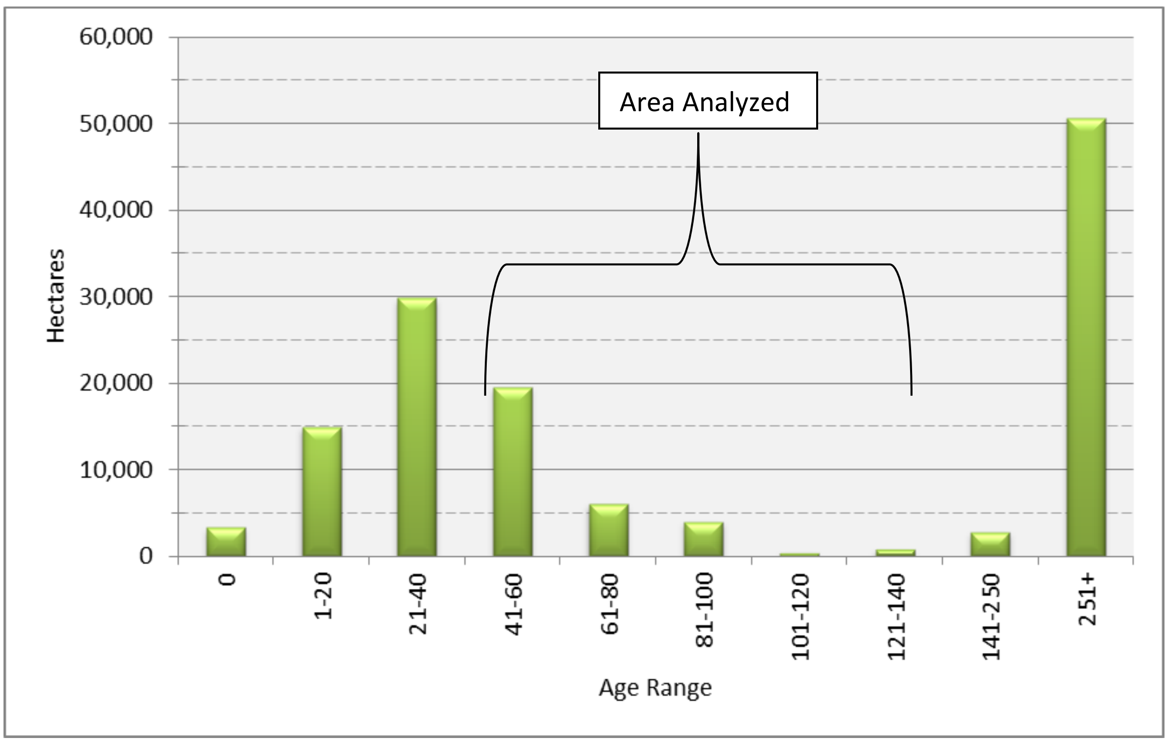

Figure 11 - Productive Forest Age Class Distribution (from MP #10 Information Package)

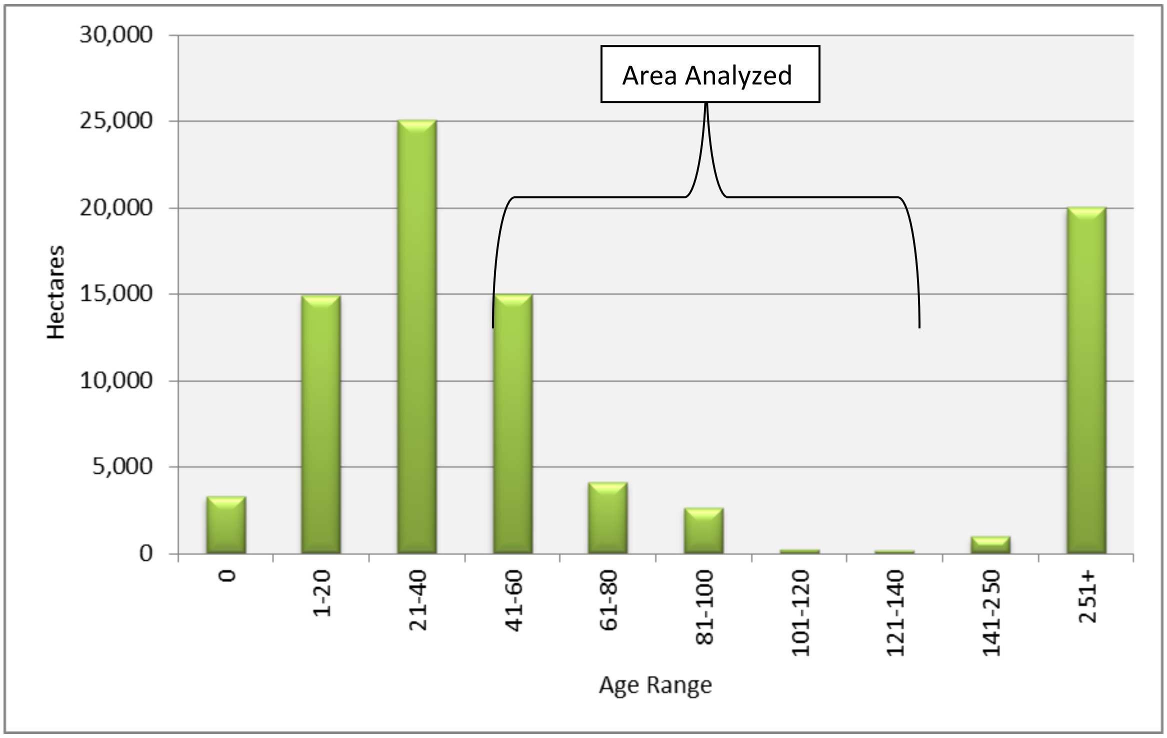

Figure 12 - THLB Forest Age Class Distribution (from MP #10 Information Package)

Excluding areas where the non-productive area adjustment factor was greater than or equal 15% results in the following:

				THLB Ha		
		Gross Ha	THLB Ha	Good	Medium	Poor
Total Area		31,366	22,694	17,687	4,586	421
Gap >10% and < 15%	Ha	2,407	1,460	1,007	406	47
	%	7.7%	6.4%	5.7%	8.9%	11.2%
Gap >5% and <= 10%	Ha	4,390	2,944	2,305	568	71
	%	14.0%	13.0%	13.0%	12.4%	16.9%
Gap >2% and < =5%	Ha	6,805	5,203	4,362	793	48
	%	21.7%	22.9%	24.7%	17.3%	11.4%
Gap > 1% and <=2%	Ha	4,313	3,591	3,194	383	14
	%	13.8%	15.8%	18.1%	8.3%	3.4%
Gap <= 1%	Ha	5,635	4,667	4,175	475	17
	%	18.0%	20.6%	23.6%	10.4%	4.0%
Area-weighted average non-productive area adjustment factor				**4.0%**	**5.4%**	**7.2%**

Overall, 79% of the sampled THLB is captured by one of the non-productive area adjustment factor classes. Applying the values listed above in parentheses for each class results in area-weighted averages of 4.0%, 5.4% and 7.2% for the good, medium and poor sites respectively.

Applying a 15% factor (TIPSY "default") for the area not captured by the above classes increases the area weighted averages to 5.6%, 9.5% and 11.3% for the good, medium and poor sites respectively. Given the results where there is this good alignment this approach is conservative.

DISCUSSION

LiDAR data can provide very detailed information down to the tree-level. This allows accurate stand-level metrics to be derived. In this analysis, the amount of area not supporting trees at least 10m tall within forest cover polygons between the ages of 40 and 140 years was determined as a proxy for the amount of non-productive area within the polygon. When modelling growth and yield with TIPSY, OAF1 is intended to account for these non-productive areas. A "default" OAF1 of 15% is applied unless better information is available.

The results indicate that on good sites, an OAF1 of between 4% and 5.6% is appropriate. In other words, applying the default 15% OAF1 would reduce yields for these stands 10-11% more for non-productive area than LiDAR data indicates is warranted. On medium site the excessive reduction is 5-10% and is 4-8% on poor sites.

Older stands within the sample are the result of less intensive management practices than have been practiced in recent times and are expected to be used in the future. As such, the overall averages determined are likely conservative relative to current practices.

A sensitivity analysis will be done using the conservative factors (incorporating "default" TIPSY OAF1 value of 15% to areas not classified with a non-productive area adjustment factor of less than 15% in weighted-average factor calculation) derived by this analysis as OAF1 for TIPSY yields for managed stands (current and future):

- Good sites: 5.6%
- Medium sites: 9.5%
- Poor sites: 11.3%

Appendix B

TFL 37 TREE HEIGHT ANALYSIS USING LiDAR DATA

SUMMARY

LiDAR data for TFL 37 acquired in the summer of 2016 was used to review tree heights in stands aged between 40 and 100 years old. The mean tree height and associated standard deviation based on LiDAR-derived tree heights was calculated for each forest cover polygon. The 85th percentile tree height (mean + 1 standard deviation) was compared to the projected inventory height.

The data indicates that on average inventory height is 2 m less than LiDAR height. As height is the main determinant within growth and yield models for stand volume, this review indicates that the yield tables being used in the TFL 37 timber supply analysis are conservative.

Comparing LiDAR heights to TIPSY generated heights for 40-54 year old stands indicates that LiDAR heights are on average 1.3m greater. This indicates that the TISPY volume yields being used in the TFL 37 timber supply analysis are conservative.

PROCESS

Use Forest Cover polygons as Base data – select stands between 40 and 100 years old (~24,300 ha) from the data set created to analyze OAF1. The 101-140 year old stands were excluded due to the low number of samples available.

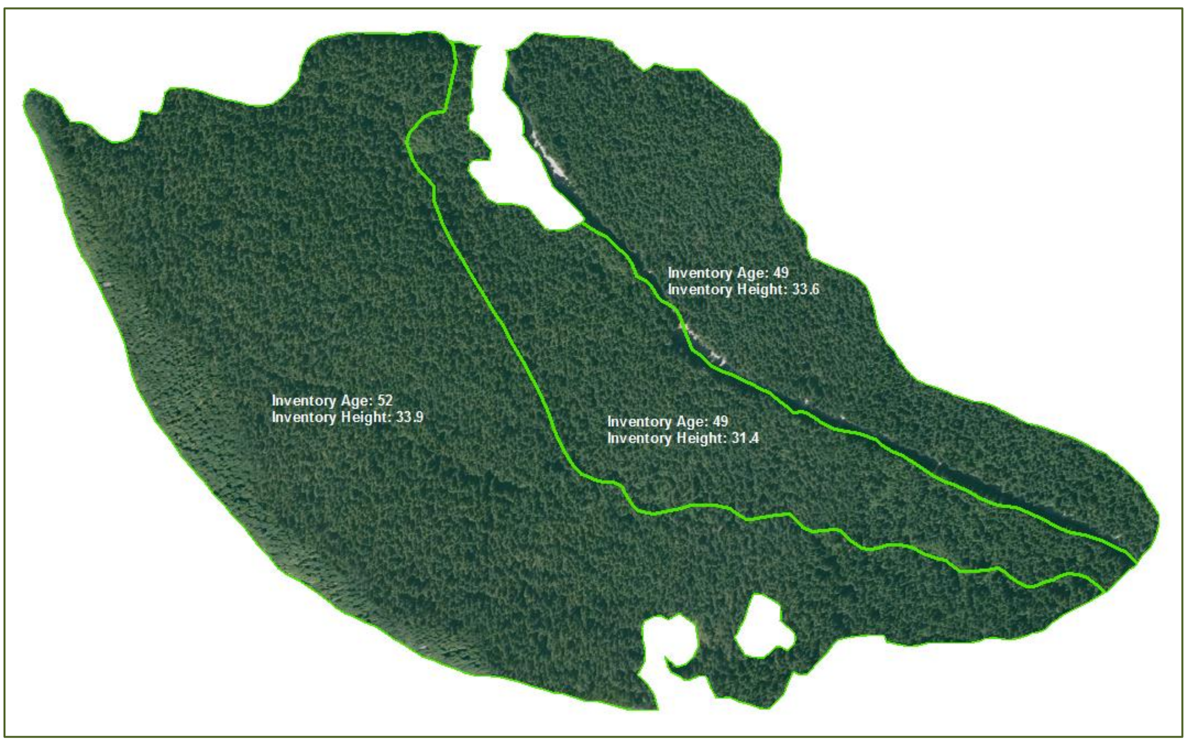

Figure 1 - Orthophoto and Inventory Data

Generate LiDAR-based crown height model for selected stands.

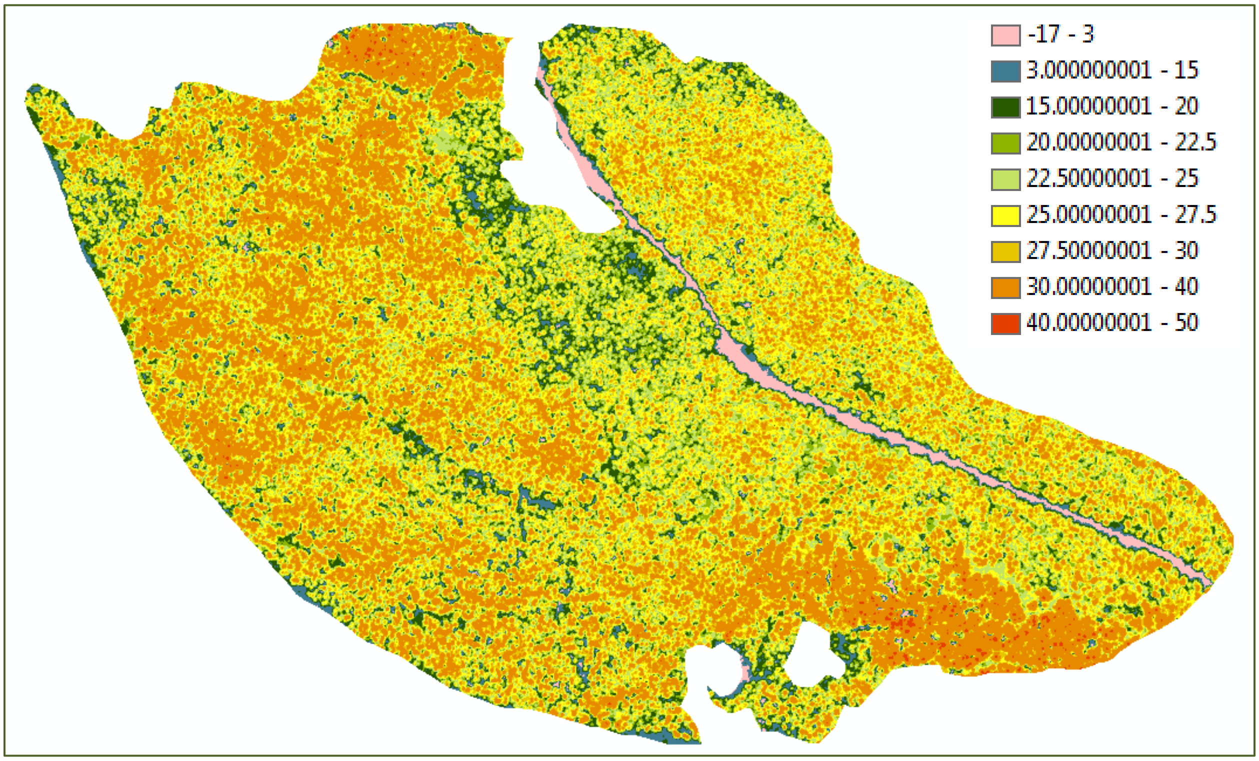

Figure 2 - Crown Height Model from LiDAR

Identify individual trees and their height.

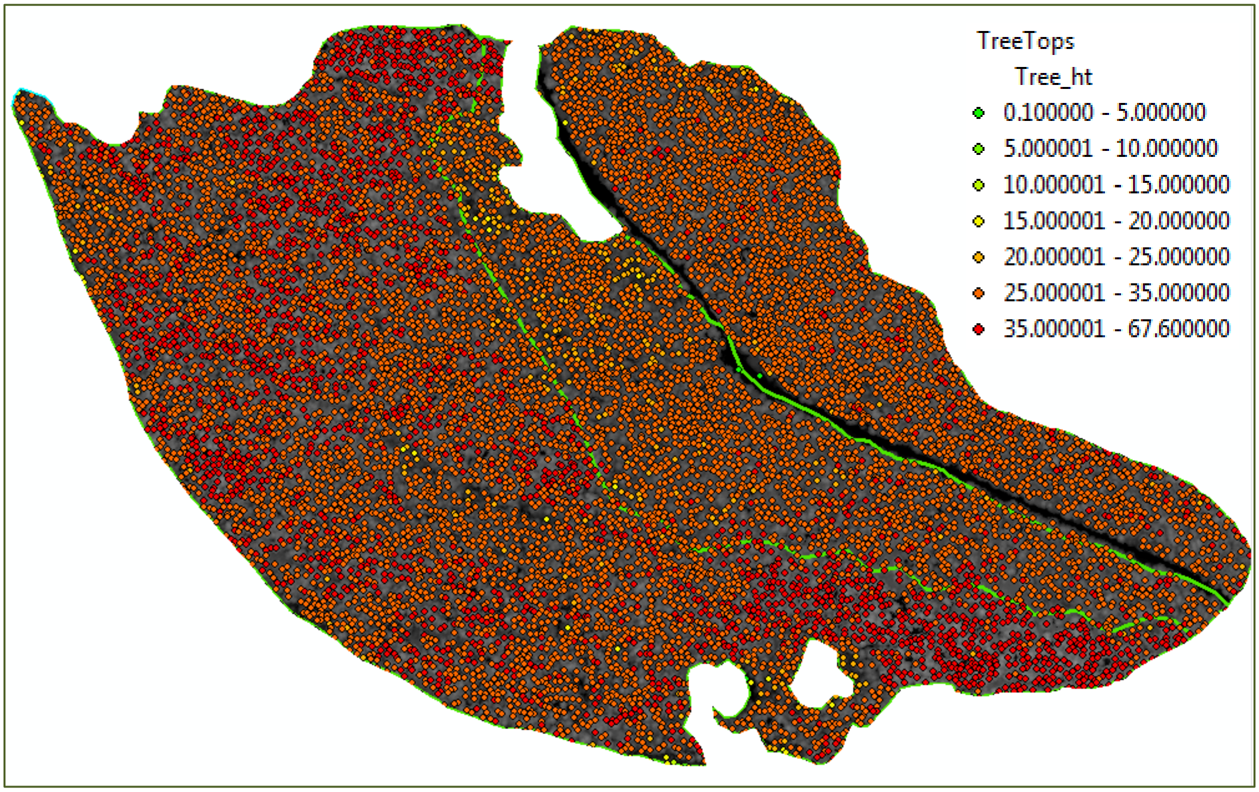

Figure 3 - Individual trees and heights from LiDAR

For each forest cover polygon the mean LiDAR tree height and standard deviation was calculated. The 85^{th} percentile (mean + 1 standard deviation) of the identified individual tree heights from the LiDAR data was compared to the projected inventory height generated using VDYP 7. The 85^{th} percentile height was chosen to represent the co-dominant trees within the stand.

RESULTS

The height difference is summarized against stand age and polygon count in Figure 4. Firstly, when stand age is considered the data indicates that VDYP underestimates the stand height. The blue bars in Figure 4 below indicate the sample number for polygons of the corresponding age. The vertical axis has been truncated in order to be able to indicate the ages with relatively few samples. The red line indicates the average difference between the inventory height and the LiDAR height. Negative values indicate that the inventory height is less than the LiDAR height. Note that where there is a large sample (indicated by blue column height) the red line tends to indicate a negative value indicating the LiDAR height is greater than the inventory height

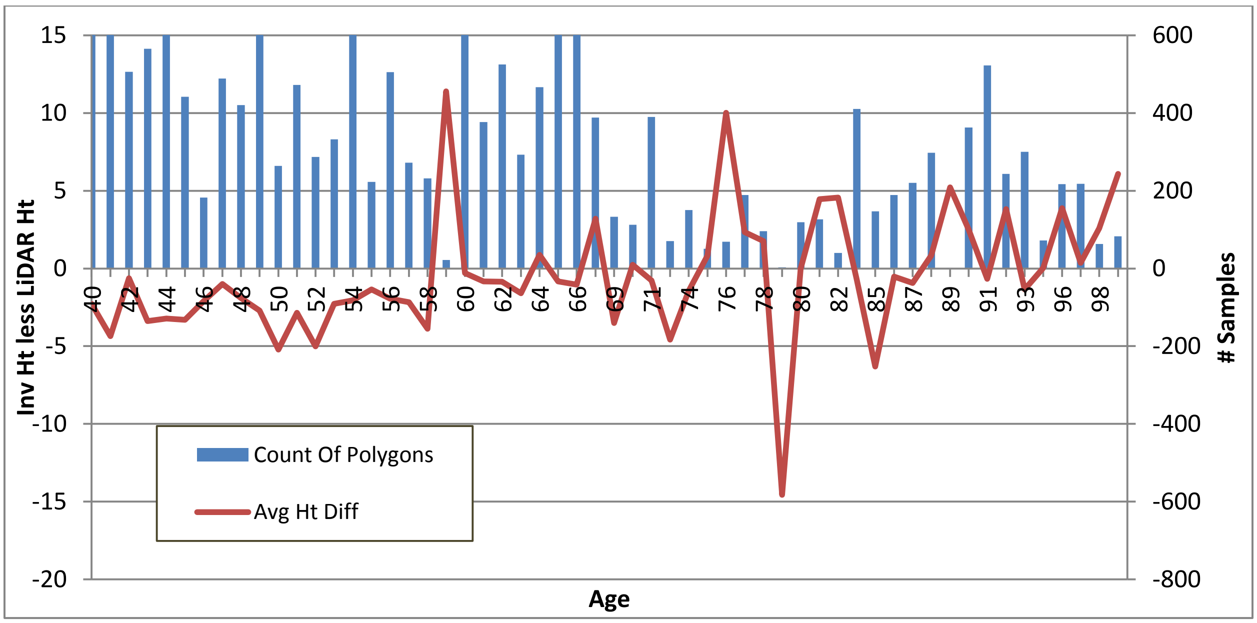

Figure 4 – Average inventory height difference and sample size by age

Eliminating age as a factor and outlier values with small sample size results in Figure 5. Note the large area where the inventory height it 2.7-3.2m less than the LiDAR height. Zero height difference is well to the right in the chart indicating the inventory height is less than the LiDAR height in the vast majority of polygons.

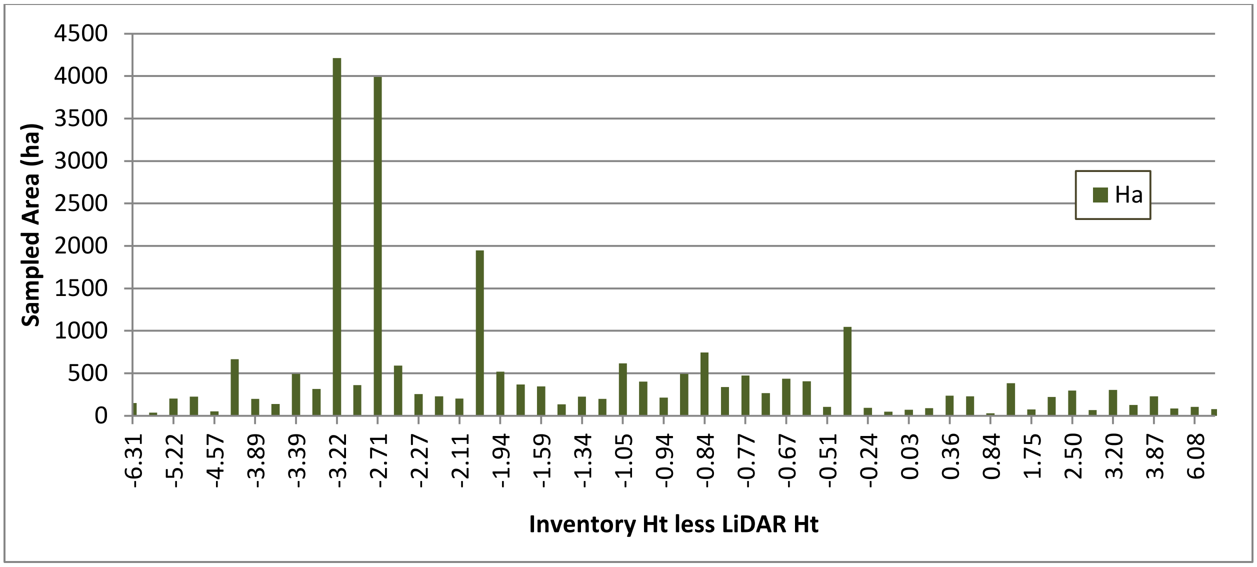

Figure 5 – Average inventory height difference and sample area

DISCUSSION

LiDAR data can provide very detailed information down to the individual tree-level. This allows accurate stand-level metrics to be derived. In this analysis, the mean and standard deviation of tree height from LiDAR data was calculated for every 40 to 100 year old forest inventory polygon within TFL 37. The 85th percentile (mean + 1 standard deviation) LiDAR tree height was compared to the VDYP 7 projected inventory height.

The results indicate that LiDAR heights are greater than inventory heights by an average of roughly 2 m. This infers that site index values are greater than indicated in the inventory. Given that stand height has the largest influence on yields derived from growth and yield models, the VDYP yields used in the timber supply analysis for TFL 37 are conservative.

In the MP #10 timber supply analysis, yields for analysis units for stands less than 55 years old are generated using TIPSY. A comparison of the analysis unit yield table height and LiDAR height was done for stands 40 to 54 years old. For comparison purposes the stands had to be grouped into 5-year age classes as that is how the TIPSY yield tables were generated. Figure 6 indicates the average height difference (LiDAR height less TIPSY height) for the 3 age classes available in the data. In total, 12,411 ha, of which 11,459 ha is THLB for the MP #10 analysis, were reviewed. The results indicate that the LiDAR heights are on average 1.3m greater than the TIPSY heights with a slightly greater difference in the 40 year age class.

As with the VDYP yields, this review indicates that the TIPSY heights are underestimated and therefore the corresponding volume yield is conservative.

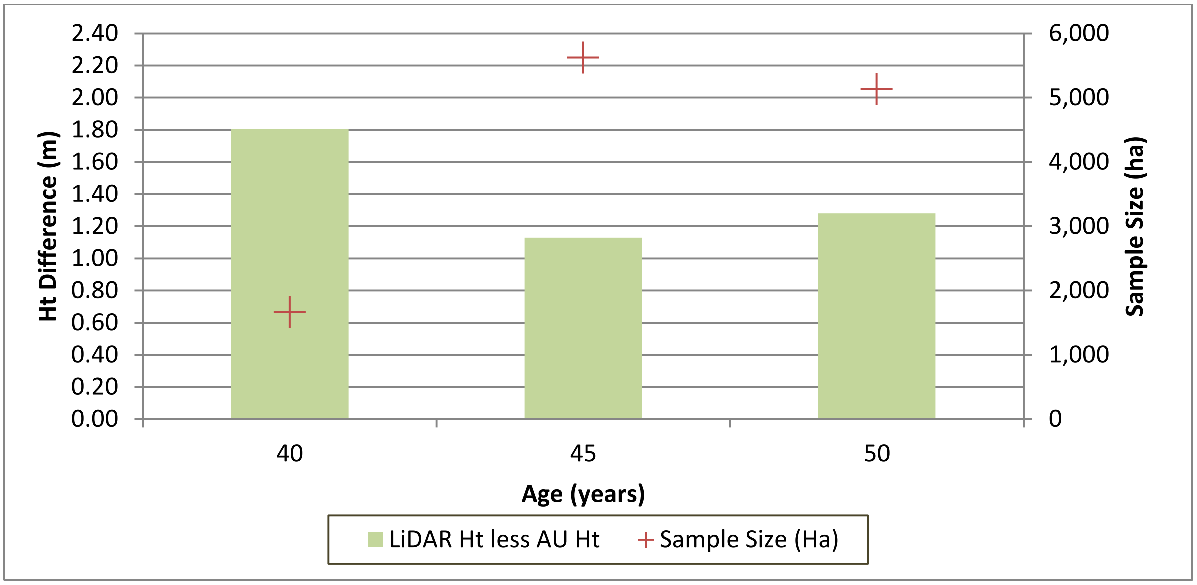

Figure 6 – Average height difference between TIPSY yield table height and LiDAR height

Appendix C

TFL 37 ROAD WIDTHS ANALYSIS USING LiDAR DATA

SUMMARY

When left to nature a proportion of road surface area will support tree growth as productive as the adjacent undisturbed area. The difficulty has been determining the proprtion. LiDAR enables the entire landbase and road network to be analyzed.

For TFL 37, LiDAR indicates the road area not covered by tree crowns at least 10m tall is much less than assumed in the MP #10 Base Case. The results show that the THLB could be 1.2% - 2.2% larger due to less growing site lost to roads.

PROCESS

A review of LiDAR data and orthophotos was conducted to update the lines representing roads within TFL 37. Figure 1 shows a spur road in a 45 year old stand.

Figure 1 – Example road and orthophoto

Apply MP #10 buffers. Figure 2 superimposes the MP 10 uniform buffer width of 10m (5 m per side).

Figure 2 – Road buffer and orthophoto

Intersect road buffers with forest cover so have forest age. Then intersect through crown height model (CHM).

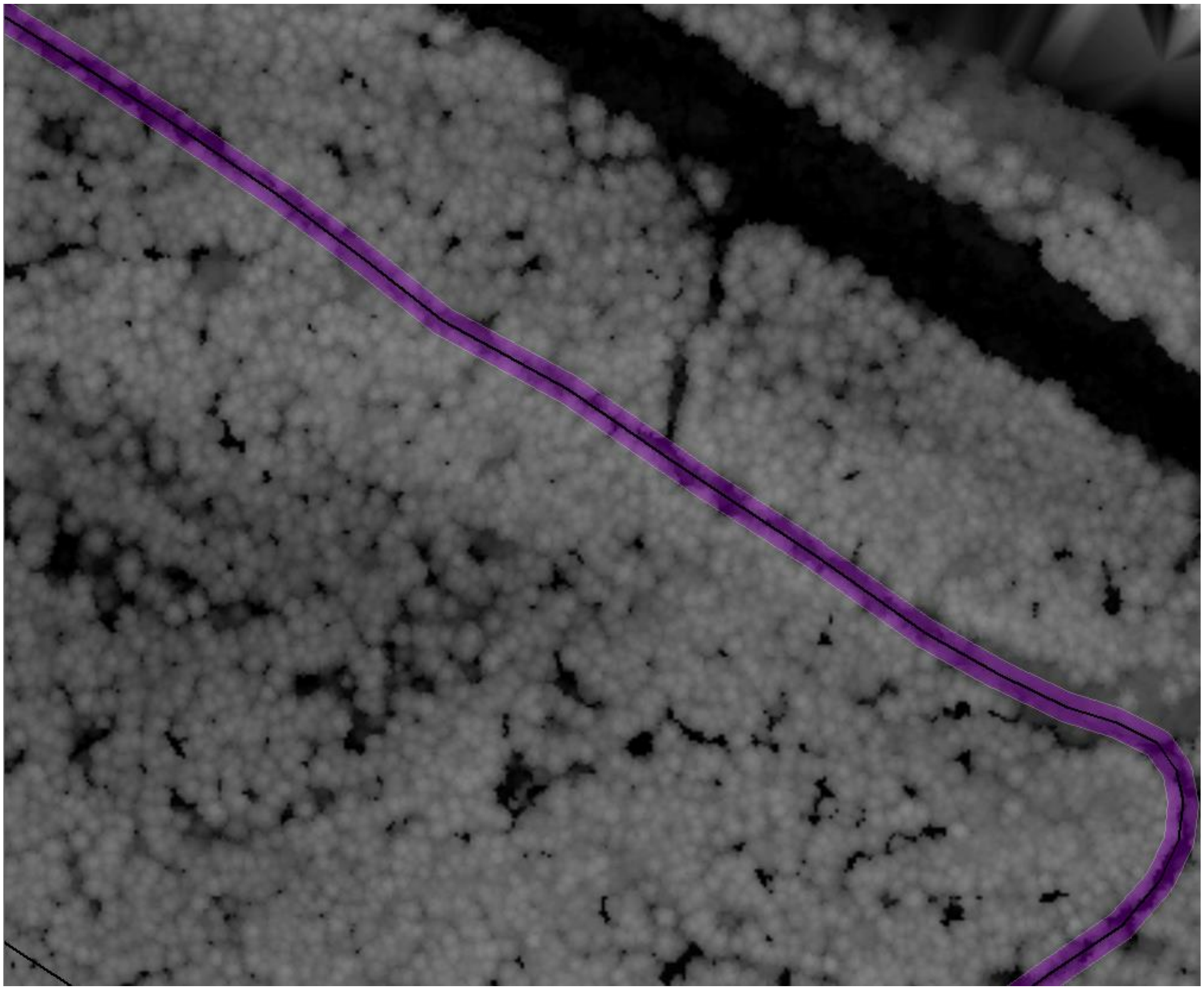

Figure 3 – Road buffer with crown height model

Figure 3 presents the same area with the crown height model in monochrome.

Create polygon where CHM < 10m and determine percentage of road buffer polygon where trees cover is less than 10m tall.

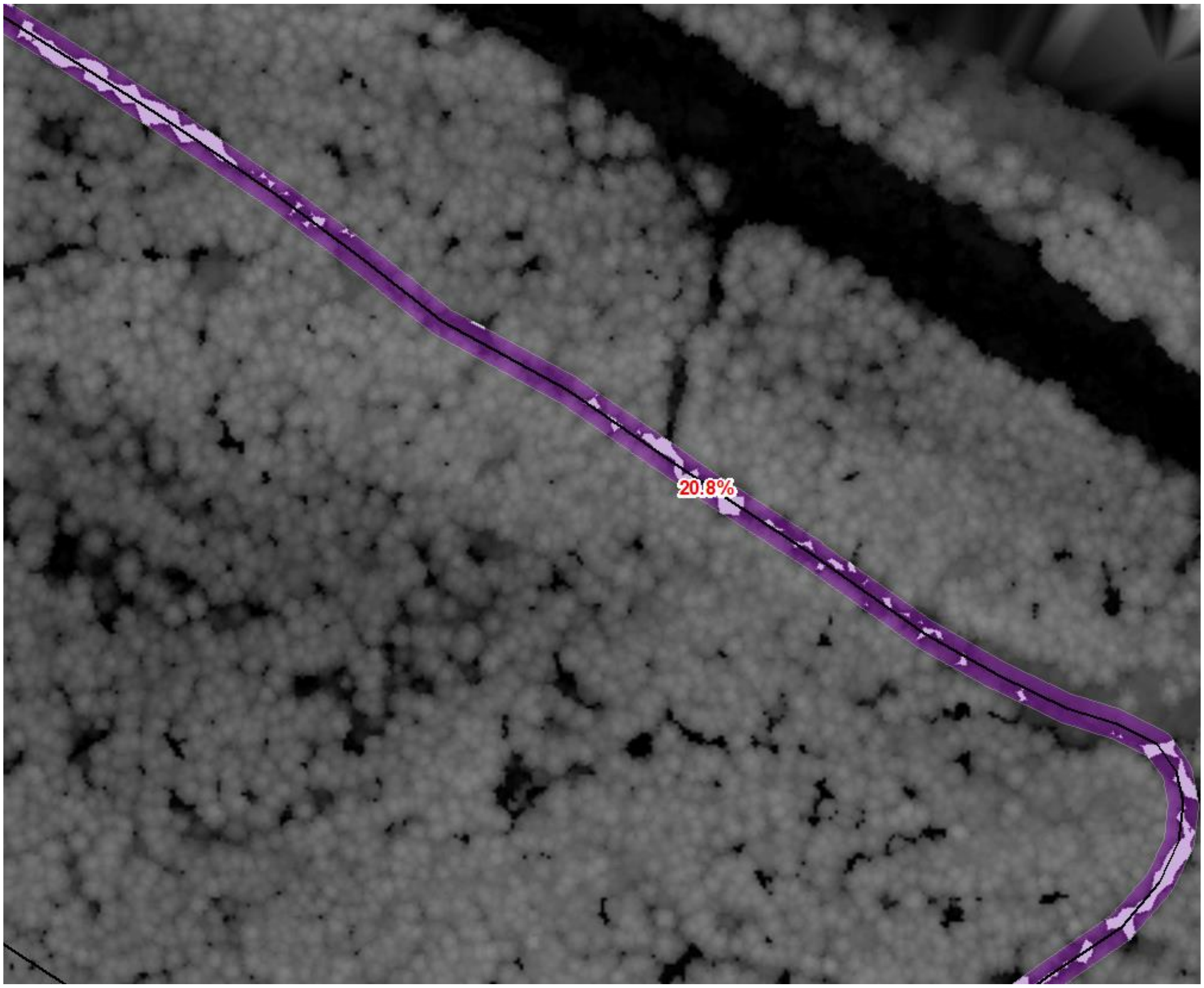

Figure 4 – Percentage of road buffer with crowns less than 10m tall

Figure 4 illustrates polygons assigned to crown openings inside the uniform buffer. In this example 20.8% of the road buffer polygon has crown cover less than 10 m tall. In other words a 2m buffer would accurately represent this area.

RESULTS

The data is summarized two ways:

1. Using all current roads to represent the perpetual impact of roads on the landbase.
   a. In this scenario site disturbance of all recent harvesting up to 40 years is included in the assessment.
2. Using only roads within 40 – 140 year old stands to indicate the extent to which trees will occupy road buffer areas.
   a. In this scenario the 0-40 year old cohort is excluded to more closely approximate stands at or near rotation age.

When all current roads are considered, the LiDAR data indicates that 2,802 ha are not covered with crowns at least 10 m tall (see Table 1). After deducting the landbase lost to Highway 19, 3,837 ha are removed from the THLB by roads applying the Base Case assumptions. The LiDAR data indicates that the actual area lost is roughly 2,802 ha, or 1,035 ha less. This reduction to road buffers would increase the THLB by 1.2%.

Table 1 – LiDAR derived road buffers using all roads

Road Class	Length (km)	Buffer width (m)	Buffer Area (ha)	Proportion with crown cover < 10m tall	Implied Netdown Area (ha)	Implied width (m)
Spur	2,649	10	2,649	0.700	1,855	7.0
Mainline	908	12	1,090	0.799	870	9.6
Railway	100	11	110	0.707	77	7.8
Total	**3,657**	**-**	**3,849**	**0.728**	**2,802**	**-**

Results when only roads within stands 40 – 140 years old are considered are shown in Table 2. When only stands in this age range are considered the buffers applied in the Base Case are roughly twice as wide as indicated by the LiDAR data. This indicates the extent to which trees encroach on road beds. Applying the resulting buffers to the entire road network indicates a road netdown of 1,918 ha. This is one-half of the Base Case netdown area and would result in approximately 2.2% more THLB.

Table 2 – LiDAR derived road buffers within 40 – 140 year old stands

Road Class	Buffer width (m)	Buffer Area (ha)	Proportion with crown cover < 10m tall	Implied width (m)	Total Length in TFL (km)	Implied netdown to total road length (ha)
Spur	10	514.8	0.433	4.3	2,649	1,147
Mainline	12	350.2	0.656	7.9	908	715
Railway	11	21.3	0.509	5.6	100	56
Total	**-**	**886.3**	**-**	**-**	**3,657**	**1,918**

DISCUSSION

When left to nature, a proportion of roads will support tree growth indistinguishable from the adjacent area. Figure 5 and Figure 6 provide an example of roads hardly identifiable in air photos. This example is a 63 year old stand.

Figure 5 - Example of roads barely identifiable in photo

Figure 6 – Road locations

Figure 7 presents the road locations on the crown height model from LiDAR data. There is no discernible variation in the height of the trees growing along the roads compared to the trees growing in the adjacent area.

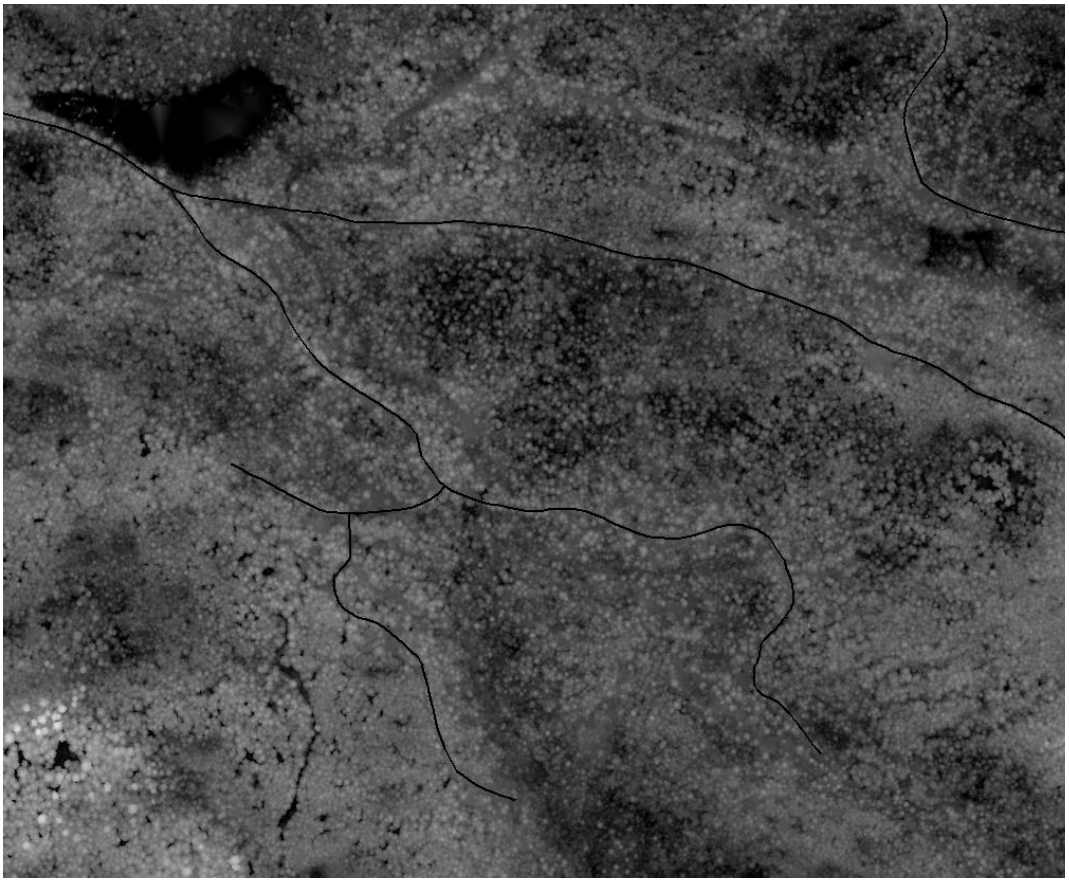

Figure 7 – Road locations on crown height model

The challenge has been to quantify the degree to which trees occupy road corridors. LiDAR enables the entire landbase to be reviewed and to measure (rather than estimate) the road area not supporting tree growth.

Assuming the current road footprint within TFL 37 represents the perpetual road footprint (not unreasonable given the development history within the TFL), LiDAR data indicates that the THLB is underestimated by 1,035 ha or 1.2%. However by including the 0-40 year old stands the time factor of site utilization/occupancy at "rotation age" is not considered.

Alternatively, if the area of roads within 40-140 year olds stands not covered by crowns at least 10m tall represents the impact roads have on the amount of growing site, the THLB is underestimated by roughly 1,918 ha or 2.2%.

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Appendix 2: Timber Supply Analysis Information Package

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Western Forest Products Inc.

DEFINING A HIGHER STANDARD™

Tree Farm Licence 37

Timber Supply Analysis Information Package

MANAGEMENT PLAN 10

Version 2
August 2017

REGISTERED PROFESSIONAL FORESTER
PROVINCE OF BRITISH COLUMBIA
MICHAEL J. DAVIS
NO. 2465

Mike Davis, R.P.F
Tenures Forester
Western Forest Products Inc.

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Revisions since Version 1 (January 2017)

The following revisions were made to Version 1 (January 2017) of the Information Package to create this document.

Corrected typographical errors and formatting issues and updated date on title page and in page headers.
Changed top diameter utilization standard for mature stands from 15 cm to 10 cm to be consistent with VDYP7 output.
Removed element details associated with OAF 1 from section 8.3.1.
Table 2 - Replaced sensitivity analysis with increased DBH criteria with one that will use 95% of culmination mean annual increment to define minimum harvest age.
Revised descriptions for sensitivity analyses with adjusted yields to better explain which yields were adjusted
Corrected forested area associated with karst inventory polygons in Table 5 and Table 21
Revised initial immature stands contribution in section 10.3.2.1

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1 INTRODUCTION

1.1 Background

Tree Farm Licence (TFL) 37 was first awarded to Canadian Forest Products on December 28, 1960 and was purchased by Western Forest Products (WFP) in 2006. Since 1960 there have been nine Management Plans (formerly called 'Management and Working Plans') for the TFL.

This Information Package (IP) provides a summary of data, assumptions, and modelling procedures proposed for use in the Timber Supply Analysis (TSA) for Management Plan (MP) #10. It is intended to provide a detailed account of the factors related to timber supply that the provincial Chief Forester must consider under the *Forest Act* when determining an AAC and how these factors will be applied in the analysis.

Since the last timber supply analysis was completed some significant changes to the administration of the TFL have occurred:

- In 2006, WFP purchased TFL 37 from Canadian Forest Products (Canfor).
- In 2009, a portion of TFL 37 was deleted via Instrument Number 57 to form part of the Pacific Timber Supply Area.
- In 2012, potential treaty settlement lands for the 'Namgis First Nation were identified within TFL 37 (and elsewhere) as part of an Agreement in Principle (AIP) with the federal and provincial governments. 'Namgis members, in a March 2013 vote, did not approve the AIP. Ongoing negotiations resulted in the 2015 Forestry Fund Agreement that provides for continuation of timber harvesting within the proposed treaty settlement lands.

Based on the last TSA, on October 1, 2006 the AAC was set at 969,000 m^3/year. The AAC was reduced in 2009 to reflect the deletion of the land base for the Pacific Timber Supply Area, resulting in an AAC of 889,415 m^3/year that remains in effect today (January 2017). Further details of these changes are provided in Section 6.1.

In November 2009, provincial legislation concerning the provincial Timber Supply Review (TSR) process was revised to require AAC Determinations to be made at least every ten years. Previously, AAC reviews were required every five years. Other legislation changes include revision of content requirements and the approval process for TFL Management Plans.

WFP will complete a timber supply analysis that estimates timber harvest over a 250-year planning horizon (in five-year planning periods) based on the current estimate of the harvestable land base, existing mature and old forest timber volumes and regenerating forest growth rates. The harvest forecast projects timber supply impacts of current environmental protection and management practices including operational requirements of the *Forest and Range Practices Act* (FRPA), approved Forest Stewardship Plans (FSPs), orders and other regulations and guidelines significant to timber supply. Sensitivity analyses will be used to investigate impacts of different management scenarios and to examine the relative importance of variations in assumptions. These may include the removal of area from the timber harvesting land base (THLB), imposing forest-cover constraints, or changes in growth and yield (G&Y) estimates.

The timber supply forecast will attempt to achieve the long-term harvest potential, and minimize the rate of change during the transition from the current level of harvest to the mid- and long-term sustainable levels.

1.2 First Nations Interests

Through various information-sharing processes, First Nation values and interests have been identified. While not an exhaustive list of interests, Table 1 lists the sections of this document within which the associated interest is discussed.

Table 1 – Sections Discussing First Nation Interests

First Nation Interest	Information Package Section
Cultural Heritage	6.16 Archaeological Sites
Fish Habitat	6.9 Riparian Management Areas
Wildlife	6.10 Ungulate Winter Ranges
	6.12 Wildlife Habitat Areas
Old Growth and Biodiversity	5.3 Current Age Class Distributions
	6.11 Old Growth Management Areas
	6.17 Existing Stand-level Reserves
	6.20 Area Reductions to Reflect Future Stand-level Retention
	7.1 Resource Management Zones
	7.2 Landscape Units
	10.3.3 Silviculture Systems

1.3 Analysis Area

TFL 37 is located in the Nimpkish valley on northern Vancouver Island (see Figure 1). Communities within or near the TFL include Woss, Port McNeill, and Sayward.

Adjacent provincial parks include:

- Lower Nimpkish,
- Nimpkish Lake,
- Claude Elliot,
- Schoen Lake,
- Woss Lake.

TFL 37 is comprised of two landscape units - Upper and Lower Nimpkish – and seven Resource Management Zones (RMZs) established by the Vancouver Island Land Use Plan:

- Woss-Zeballos Special Management Zone (SMZ #6),
- Tsitika-Woss Special Management Zone (SMZ #9),
- Pinder-Atluck Special Management Zone (SMZ #10),
- Schoen-Strathcona Special Management Zone (SMZ #11),
- Woss-Vernon General Management Zone (GMZ #13),
- Tsitika General Management Zone (GMZ #26),
- Nimpkish Enhanced Forestry Zone (EFZ #10).

The Special and Enhanced Zones were assigned legal objectives effective December 1, 2000 by the Vancouver Island Land Use Plan Higher Level Plan Order (VILUP) – an order made pursuant to the *Forest Practices Code of British Columbia Act* and continued under FRPA. Other FRPA objectives and planning requirements apply across the entire land base, including the General Management Zones.

Climate within TFL 37 is dominated by maritime variants of the Coastal Western Hemlock (CWH), Mountain Hemlock (MH) and Alpine Tundra (AT) biogeoclimatic zones.

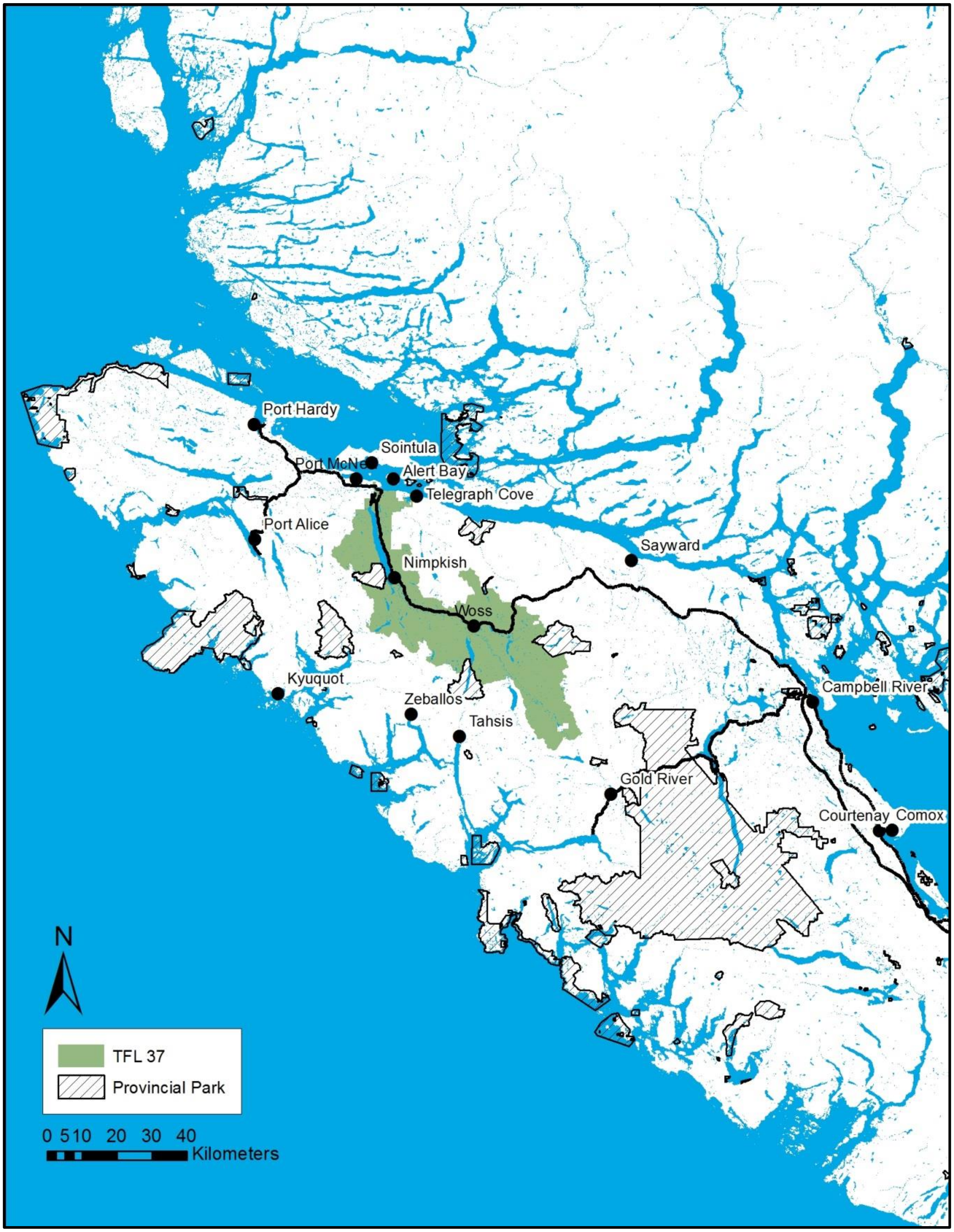

Figure 1 – Location of TFL 37

2 PROCESS

2.1 Overview

This Information Package is submitted for review to the Timber Supply Forester at the Forest Analysis and Inventory Branch (FAIB), Ministry of Forests, Lands and Natural Resource Operations (FLNRO). Upon acceptance, the IP will guide the timber supply analysis and, with the timber supply analysis report, be appended to MP #10. These will be considered by the Chief Forester in determining the new AAC for TFL 37. Two review and comment opportunities will be provided to the general public, First Nations and other interested stakeholders: review of this draft IP and review of the draft MP.

2.2 Analysis Approach

The complexity of timber supply means that a single forecast is not adequate to portray possible timber supply of TFL 37. There are many uncertainties about how well assumptions used in the analysis reflect the realities of timber availability and there are many options for setting harvest levels in response to timber supply dynamics of the TFL. Several forecasts will be developed in the analysis to account for these uncertainties and to gain an understanding of the timber supply dynamics of TFL 37:

Base Case: The Base Case is the standard against which other forecasts are compared. It reflects the best available knowledge about current management activities and forest development within TFL 37.

Sensitivity Analyses: Sensitivity analyses are used to determine the risk associated with uncertainties in the assumptions of the analysis. These forecasts isolate an area of uncertainty and test the implications of using more optimistic or pessimistic assumptions.

2.3 Data Preparation and Missing Data

WFP created a master database with a complete resultant polygon list from spatial information through a series of Geographic Information System (GIS) overlays. In this master database each polygon has a unique identification number. All summaries and values in this document were derived from this database.

The data described in this document is only as reliable as the source data used to generate it. Though the data is believed to be accurate, an exact match was not always possible between overlapping coverages. Some had to be manipulated to approximate a best fit. For example, GIS data for watersheds and landscape unit boundaries may differ even though in reality they are defined by the same height-of-land. Although the final resultant is a close approximation of the actual landscape, caution should be used when viewing geographic data results at a large scale.

WFP may modify any data, netdown order or calculation in the future if it will enhance the accuracy of the analysis. Any modifications to the dataset will be documented in subsequent versions of the Information Package.

3 TIMBER SUPPLY FORECASTS AND SENSITIVITY ANALYSES

This section summarizes the harvest forecasts that will be presented in the Timber Supply Analysis.

3.1 Base Case

The Base Case represents current operational requirements and management practices within the TFL. The forecast of current management incorporates existing land use designations, including Resource Management Zones; current regulations and guidelines including the *Forest and Range Practices Act*; and approved Forest Stewardship Plans. This option is used as the basis for analysing various timber supply projections.

Current management of TFL 37 includes:

- Operable land base of forested area accessible using conventional and non-conventional (e.g. helicopter) harvesting methods.
- Exclusion of uneconomic mature forest stands.
- Harvesting of mature and immature stands.
- Silviculture carried out on all regenerated stands to meet free growing requirements.
- Known tree improvement gains applied to existing stands established since 2001 and future regenerated stands.
- Visual Quality Objectives (VQOs) modelled on VQOs established for TFLs within the North Island-Central Coast Forest District on December 13, 2004 (date *Government Action Regulation* (GAR) came into force).
- Green-up heights for cutblock adjacency based on RMZs established in VILUP. Special and General zones have 3m green-up requirement while Enhanced zones have 1.3m green-up height.
- Future Wildlife Tree and other stand-level retention within the THLB accounted for by a percentage area reduction.
- Biodiversity and Landscape Units – Established Old Growth Management Areas (OGMAs) removed from the THLB. Mature seral targets are incorporated for the Special Management Zones as per VILUP.
- Established Ungulate Winter Ranges (UWRs) and Wildlife Habitat Areas (WHAs) removed from the THLB.
- Netdowns for terrain stability management depending on mapped classification and watershed.
- Riparian management based on the FSP results/strategies and a review of riparian management applied on more than one thousand cutblocks harvested or planned between 1995 and 2015.
- Minimum harvest criteria based on varying average stand diameter-at-breast-height (DBH) by harvesting system plus a minimum harvestable volume of 350m^3 per hectare. Both minimum DBH and minimum volume requirements must be met before a stand can be harvested.

- A relatively small area of deciduous leading stands excluded from the THLB and volume in these stands does not contribute to timber supply.

3.2 Sensitivity Analyses

Sensitivity analyses will be conducted for the Base Case to examine the potential impact of uncertainty in several key attributes, including the removal of operable areas from the THLB, imposing forest-cover constraints, or changes in growth and yield estimates.

Table 2 – Planned Sensitivity Analyses

Concern Tested	Proposed Sensitivity Analysis
Land base available for harvesting	▪ Exclude potential 'Namgis treaty settlement lands ▪ Include deciduous-leading stands
Growth and yield	▪ adjust natural stand volumes +/-10% ▪ adjust managed stand volumes +/-10% ▪ apply SIBEC estimates of site index
Forest Management / Silviculture	▪ exclude future genetic gain adjustments
Operability	▪ maintain "heli hembal" partition ▪ no heli volume constraint ▪ no harvesting of heli-operable landbase
Biodiversity	▪ remove Western Forest Strategy impacts (area and yield impacts)
Minimum harvest ages	▪ subtract 2cm to the minimum harvest criteria ▪ 95% of culmination mean annual increment

3.3 Alternate Harvest Flows

The harvest level in the Base Case will adjust each decade in the short and mid-term towards the estimated long-term harvest level (LTHL) and will change at a rate that minimizes the length of time (if any) where harvest levels are less than the LTHL. The results of the Base Case will determine potential alternate harvest flows. One option may be to maintain the current AAC as long as possible while still minimizing the length of time (if any) where harvest levels are less than the LTHL. Another option is a non-declining harvest level.

During preparation of the timber supply analysis the need for further sensitivity analyses or harvest flows may become apparent. If warranted, additional analyses will be included in the final timber supply analysis for consideration by the Chief Forester.

3.4 Climate Change

Climate change is one significant source of uncertainty. There is significant scientific agreement that climate changes will affect forest ecosystems and that forest management practices will need to adapt. However, the rate and amount of change is uncertain. Given the uncertainty no modelling of climate change impacts is planned. As better information becomes available it can be incorporated into future timber supply analyses.

4 HARVEST MODEL

The TFL 37 timber supply analysis, including harvest level and forest inventory projections, will be developed using the Woodstock component of Remsoft's Spatial Planning System (www.remsoft.com).

Woodstock is a pseudo-spatial timber supply model that projects harvesting activities across a land base over a specific period of time. These models are referred to as pseudo-spatial because data used to create the model has spatial components to it, but harvest schedules produced are not spatially explicit. Harvest schedules produced using these models report harvest timing for different types of stands as opposed to specific polygons harvested in each period. Therefore, it is not possible to explicitly model spatial management objectives such as cutblock size, adjacency and green-up requirements or patch size targets for the entire forecast period using these models. It is possible to bring spatial context into the model by applying constraints to spatial attributes of the land base such as landscape units or watersheds. Also, as the spatial relation of polygons in the initial forest conditions is known, adjacency rules can be applied to recently harvested cutblocks and planned blocks that are incorporated into the data.

Woodstock uses optimization to establish a harvest schedule that incorporates objectives such as visual quality, biodiversity, wildlife habitat with the objective of timber harvest. In Woodstock, harvest volume will be maximized subject to the maintenance of other values on the land base.

5 FOREST COVER INVENTORY

The forest cover inventory for TFL 37 is based on 1:15,000 colour aerial photography flown in 1995 for an effective scale of 1:5,000. The inventory is updated to the end of 2015 for harvesting and silviculture activities and survey results.

5.1 Vegetation Resources Inventory

In June 1995, Canfor (former holder of TFL 37) initiated discussions regarding implementation of a re-inventory of TFL 37. In January 1996, Canfor staff and their consulting foresters met with Resource Inventory Branch (RIB - now FAIB) personnel to discuss the re-inventory approach and methodology. The Branch indicated they preferred the 1994 inventory standards be followed rather than the Vegetation Resources Inventory (VRI) approach that was being developed and tested through various pilot projects. Canfor agreed with the condition that photo delineation standards (May 1996) and some elements of the VRI would be employed in order to make retro-fit to full VRI standards more practicable at some future date.

A work plan for the re-inventory of TFL 37 was developed and submitted to RIB in August 1996. Fieldwork for calibration of the photo-interpretation was completed over a 3-week period in September 1996. The photo-interpretation phase was initiated in November 1996 and completed by July 1997. Digital forest cover mapping was completed by December 1997.

5.2 VRI Attribute Adjustments

Between 2000 and 2001, eighty (80) VRI timber emphasis ground sample plots were randomly established in polygons considered operable for harvesting in order to develop statistical adjustments for unbiased inventory estimates of height, age and net merchantable volume (Phase II adjustments). Stands established since 1961 were not adjusted as attributes in these stands were assumed known without error. For various reasons twenty (20) plots were established in polygons outside of the population of interest, leaving sixty (60) plots for the statistical adjustment analysis.

J.S. Thrower and Associates completed the Phase II adjustments in July 2003 and updated them with new data in June 2004. This process calculated statistical adjustments for age, site index, and then volume based on comparisons of species composition, basal area, height, volume, and age between plot data and the photo-interpreted estimates. This deviated from the standard procedure of adjusting age, height and then volume, but Ministry of Sustainable Resource Management (now FLNRO) accepted the approach for use in the last timber supply analysis. J.S Thrower and Associates also calculated net volume adjustment factors (NVAF) in June 2004 (see Appendix A).

The Phase II adjustment process described above was completed with *Variable Density Yield Projection* (VDYP) 6. The current FLNRO standard is VDYP 7 and it will be applied in this timber supply analysis for modelling growth and yield for unmanaged stands. VDYP 7 adjustment procedures require adjustment ratios be calculated for age, height, density (trees per hectare), basal area, lorey height and volume. Forest Ecosystem Solutions Ltd. calculated the applicable adjustment ratios for WFP (see Appendix B).

5.3 Current Age Class Distributions

Table 3, Figure 2 and Figure 3 indicate the area-based age class distributions of the productive forest land base and the timber harvesting land base of TFL 37 as of December 31, 2015. Areas listed as zero years old are overstated because they include areas planted in 2015 but for which the species information was not yet available.

Table 3 – Forest Age Class Distribution

		Forest Area (ha)	
Age Class	Age range (years)	Productive Forest	THLB
0	0	3,288	3,276
1	1-20	14,948	14,866
2	21-40	29,864	25,048
3	41-60	19,563	15,000
4	61-80	6,015	4,102
5	81-100	3,943	2,620
6	101-120	400	200
7	121-140	778	163
8	141-250	2,771	933
9	>250	50,646	19,987
Total		**132,217**	**86,195**

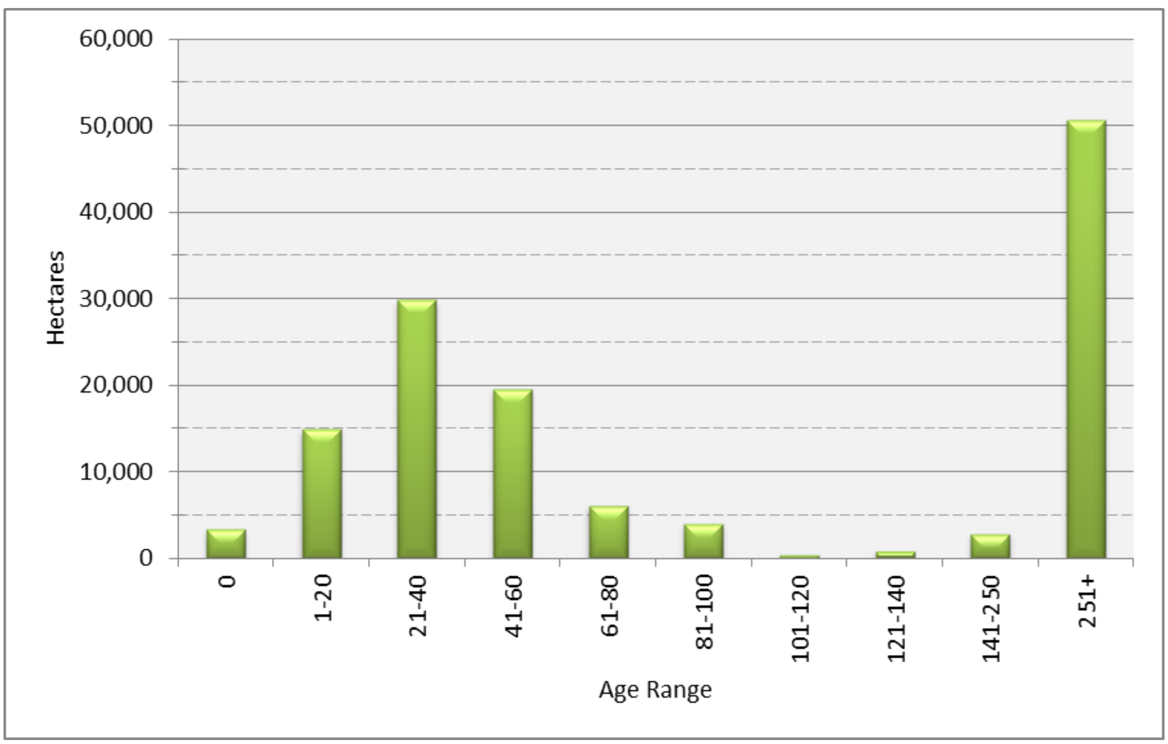

Figure 2 – Productive Forest Age Class Distribution

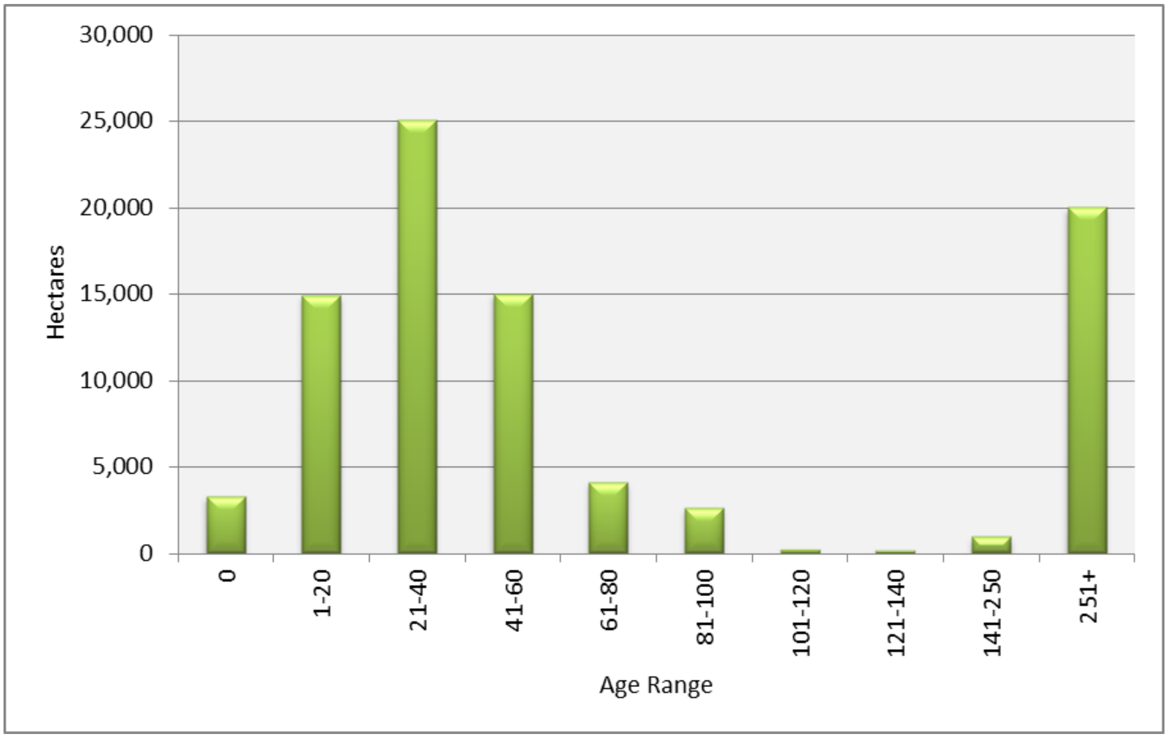

Figure 3 – THLB Age Class Distribution

5.4 Age and Volume Projections

Woodstock will be structured using five-year long planning periods. For the purpose of timber volume estimates the assumption will be that harvesting occurs during the mid-year of the five-year planning periods. To achieve this, the initial ages and volumes used in Woodstock are projected to the year 2018: the mid-year of the first five-year planning period (i.e., 2016 – 2020). In areas recently harvested waiting reforestation the assumption is that that the new stand was established two years after harvest was completed (e.g., areas harvested in 2015 are reforested in 2017 with one-year old seedlings) according to the assumptions detailed in Section 8.6.5.

6 DESCRIPTION OF LAND BASE

This section describes the TFL 37 land base and methods used to determine the portion of the land base that contributes to timber harvesting – the THLB. Portions of the productive land base, while not contributing to harvest, are crucial to meeting demands for non-timber resource sustainability. Areas within all tables in this section may not sum due to rounding to the nearest hectare.

6.1 AAC Allocation and Land Base Changes

In 2003, the provincial government enacted the *Forestry Revitalization Act*, which reallocated 20 percent of the AAC for major licensees to others, such as BC Timber Sales (BCTS), First Nations and small tenures such as Community Forests and Woodlots. The effect for TFL 37 was the reallocation of 82,053 m^3 of AAC from WFP to others: 36,401 m^3 to BCTS (for a new total of 79,585 m^3) and 45,652 m^3 to First Nations. WFP's AAC was reduced by 36,401 m^3 as of the end of 2004 and by a further 45,652 m^3 as of the end of 2005. An area has been deleted from TFL 37 for the BCTS allocation but not for the First Nations allocation. The 'N<u>a</u>m<u>g</u>is First Nation began accessing this volume via a non-replaceable Forest Licence (A84672) issued in October 2008. Several other smaller area deletions and additions have occurred but for which no AAC adjustments were made. Refer to Table 4 for a summary of changes in area and AAC since the MP #8 AAC determination in 1999.

6.2 Proposed 'N<u>a</u>m<u>g</u>is First Nation Treaty Settlement Lands

In 2012, 21,401 ha of proposed treaty settlement lands for the 'N<u>a</u>m<u>g</u>is First Nation were identified as part of an Agreement in Principle (AIP) with the federal and provincial governments (see Figure 4). Of this, approximately 14,855 ha are within TFL 37. A March 2013 vote by 'N<u>a</u>m<u>g</u>is members rejected the AIP. Ongoing negotiations resulted in a Forestry Fund Agreement in 2015 that provides for continuation of timber harvesting within the proposed treaty settlement lands. As the proposed treaty settlement lands are within the TFL they will be included in the land base used for the TSA. A scenario will be run that excludes these lands to identify their contribution.

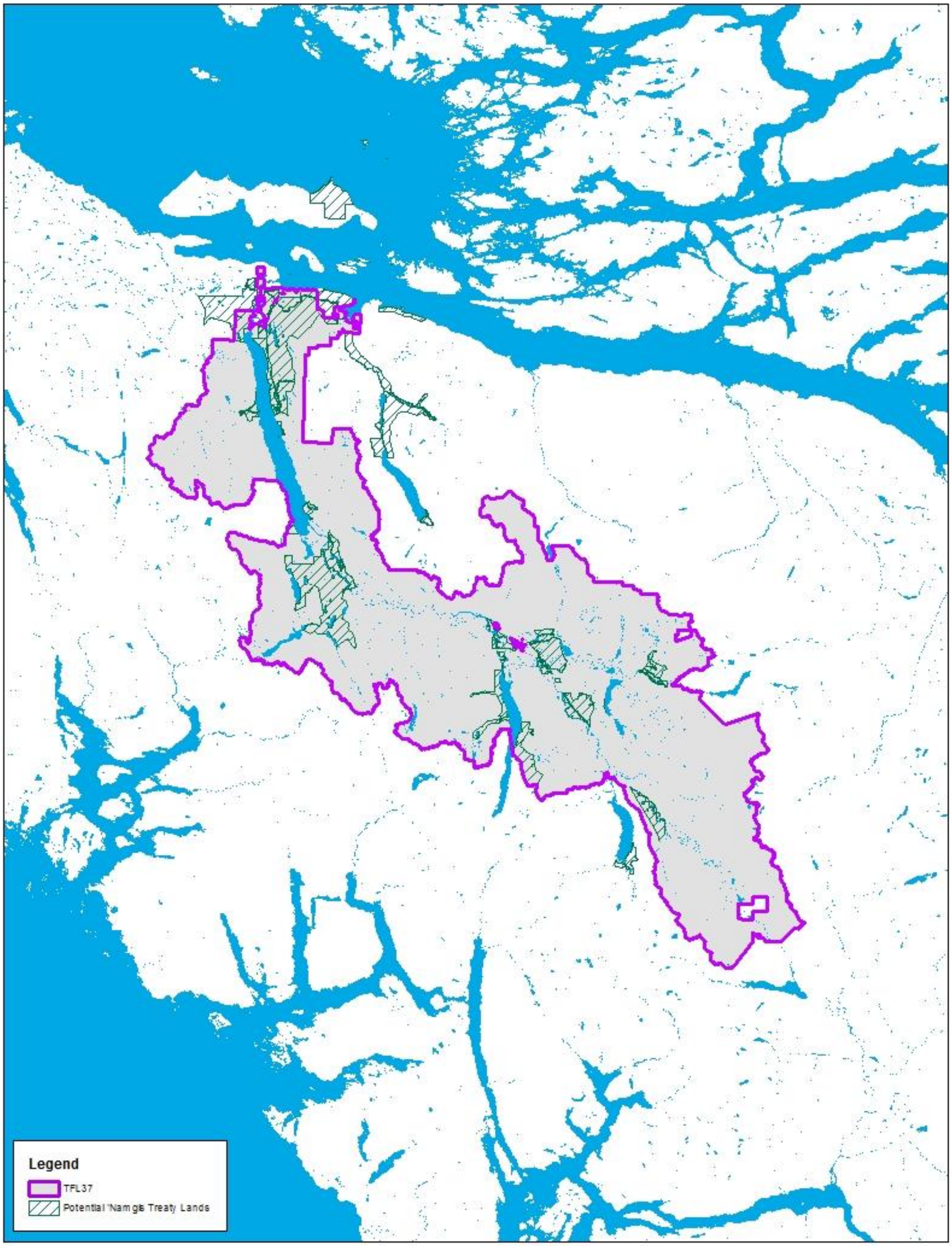

Figure 4 – Proposed 'N̲am̲g̲is First Nation Treaty Settlement Lands

Table 4 – Changes in Area and AAC since MP#8 AAC Determination

Description	Effective Date	AAC Allocation (m^3)				Area / Impact to TFL 37
		WFP	BCTS	First Nations	Total	
MP #8 AAC Determination	January 1, 1999	1,024,816	43,184	-	1,068,000	**178,311 ha**
Instrument 53 – Deletion of area for fish hatchery	January 22, 2002	1,024,816	43,184	-	1,068,000	-2.8 ha
Instrument 54 – Deletion of area for BC Hydro substation	May 15, 2003	1,024,816	43,184	-	1,068,000	-0.4 ha
Instrument 55 – Deletion of area for maintenance yard	September 22, 2003	1,024,816	43,184	-	1,068,000	-6.8 ha
Instrument 56 – Addition of area from TFL 19	November 8, 2004	1,024,816	43,184	-	1,068,000	+35.1 ha
Forestry Revitalization Act Order #3(2) 5-1	January 1, 2005	988,415	79,585	-	1,068,000	-
Forestry Revitalization Act Order #3(2) 5-3	January 1, 2006	942.763	79,585	45,652	1,068,000	-
MP #9 AAC Determination	October 1, 2006	843,763	79,585	45,652	969,000	**178,336 ha**
Instrument 57 – Deletion of area for Pacific TSA	July 15, 2009	843,763	-	45,652	889,415	-18,351 ha
Instrument 58 – Deletion of area for hydroelectric powerhouse	May 5, 2012	843,763	-	45,652	889,415	-1.2 ha
Instrument 60 – Deletion of area for BC Hydro switching station	April 24, 2013	843,763	-	45,652	889,415	-1.6 ha
Current TFL 37 Area	**January 2017**	843,763	-	45,652	889,415	**159,982 ha**

6.3 Timber Harvesting Land Base Determination

The productive forest land base (PFLB) is the area of productive forest within the TFL that contributes to landscape-level objectives (e.g., biodiversity) and non-timber resource management. It excludes non-forested areas, non-productive forest area and existing roads.

The THLB is the portion of the TFL where harvesting is expected to occur. It is a subset of the PFLB as it excludes areas that are inoperable, uneconomic for harvesting or expected to be set aside for management of non-timber resources. Operationally, harvesting occurs outside the modelled THLB as the THLB used in the analysis is a GIS-based estimate of an operational reality. The inclusion or exclusion of a specific site in the THLB does not necessarily relate to how it will be managed. Consequently, the estimate of the THLB has limited utility outside of the timber supply analysis.

The THLB and total long-term land base in TFL 37 are presented in Table 5, including the Schedule 'A' (Timber Licence and Private land) / Schedule 'B' (Crown land) split. Merchantable volume estimates are indicated in Table 6. Areas and volumes have been compiled from databases constructed for the preparation of this Information Package.

For MP #9 in 2005, land base reductions amounted to 49 percent of the total area of the TFL. For MP #10 the reductions are 73,787 ha or 46 percent of the total area.

The following sections show total area classified in each category noted in Table 5 and serve to summarize the area deducted from the land base in the order the categories appear in Table 5 (i.e., overlapping constraints are addressed in a hierarchy).

Table 5 - Land Base Netdown (ha)

Classification	Total Area (Ha)	Net Area (Ha)					% Total	% PFLB
		Schedule A			Schedule B			
		Private	Timber Licence	Schedule A Total	Crown	Grand Total		
Total Land Base	**159,982**	**6,986**	**17,886**	**24,872**	**135,110**	**159,982**	**100.0%**	**-**
Less Non-forest	15,652	431	416	847	14,805	15,652	9.8%	-
Less Existing Roads	4,155	287	634	921	3,234	4,155	2.6%	-
Total Forested	**140,175**	**6,268**	**16,836**	**23,404**	**117,071**	**140,175**	**87.6%**	**-**
Less Non-productive	7.958	79	131	210	7,748	7,958	5.0%	-
Total Productive	**132,217**	**6,189**	**16,705**	**23,194**	**109,323**	**132,217**	**82.6%**	**100.0%**
Less Inoperable	40,218	169	600	769	17,966	18,735	11.8%	14.2%
Total Operable	**-**	**6,020**	**16,105**	**22,125**	**91,357**	**113,482**	**70.9%**	**85.8%**
Reductions:								
Riparian Management	8,162	317	872	1,189	3,691	4,880	3.1%	3.7%
Ungulate Winter Ranges	5,699	170	1,554	1,724	3,148	4,872	3.0%	3.7%
Old Growth Management Areas	15,203	72	728	800	3,914	4,714	2.9%	3.6%
Wildlife Habitat Areas - legal	2,824	0	20	20	237	257	0.2%	0.2%
Wildlife Habitat Areas - proposed	3,558	0	67	67	134	201	0.1%	0.2%
Uneconomic	3,301	13	249	262	1,736	1,998	1.2%	1.5%
Deciduous-leading	2,278	273	123	396	1,017	1,413	0.9%	1.1%
Recreation	55	0	0	0	13	13	0.0%	0.0%
Archaeological Sites	69	1	45	46	7	53	0.0%	0.0%
Existing Stand-level Reserves	4,211	126	301	427	2,022	2,449	1.5%	1.9%
Karst	8,618	16	105	121	613	734	0.5%	0.6%
Terrain Stability	40,203	42	133	175	1,587	1,762	1.1%	1.3%
Future Stand-level Reserves	74,624	253	581	834	3,107	3,941	2.5%	3.0%
Total Operable Reductions	**-**	**1,283**	**4,778**	**6,061**	**21,226**	**27,287**	**17.1%**	**20.6%**
Current THLB		**4,737**	**11,327**	**16,064**	**70,131**	**86,195**	**53.9%**	**65.2%**
Less future roads	445	14	31	45	316	361	0.2%	0.3%
Long-term Land base		**4,723**	**11,296**	**16,019**	**69,815**	**85,834**	**53.7%**	**64.9%**

Table 6 – Timber Volume[1] Netdown ('000 m³)

Classification	Total Volume	Net Volume					% Total	% PFLB
		Schedule A			Schedule B			
		Private	Timber Licence	Schedule A Total	Crown	Grand Total		
Total Land Base	**54,671**	**2,696**	**6,406**	**9,102**	**45,569**	**54,671**	**100.0%**	**-**
Less Non-forest	0	0	0	0	0	0	-	-
Less Existing Roads	839	75	119	194	645	839	1.5%	-
Total Forested	**53,832**	**2,621**	**6,287**	**8,908**	**44,924**	**53,832**	**98.5%**	**-**
Less Non-productive	662	3	11	14	648	662	1.2%	-
Total Productive	**53,170**	**2,618**	**6,276**	**8,894**	**44,276**	**53,170**	**97.3**	**100.0%**
Less Inoperable	7,710	82	315	397	7,313	7,710	14.1%	14.5%
Total Operable	**45,460**	**2,536**	**5,961**	**8,497**	**36,963**	**45,460**	**83.2%**	**85.5%**
Reductions:								
Riparian Management	3,249	176	476	652	2,102	2,754	5.0%	5.2%
Ungulate Winter Ranges	3,993	139	1,297	1,436	2,124	3,560	6.5%	6.7%
Old Growth Management Areas	9,427	66	565	631	2,617	3,248	5.9%	6.1%
Wildlife Habitat Areas - legal	1,804	0	10	10	141	151	0.3%	0.3%
Wildlife Habitat Areas - proposed	2,625	0	23	23	85	108	0.2%	0.2%
Uneconomic	893	5	101	106	508	614	1.1%	1.2%
Deciduous-leading	701	99	37	136	304	440	0.8%	0.8%
Recreation	21	0	0	0	8	8	0.0%	0.0%
Archaeological Sites	46	1	32	33	5	38	0.1%	0.1%
Existing Stand-level Reserves	2,774	75	222	297	1,400	1,697	3.1%	3.2%
Karst	2,910	11	31	42	232	274	0.5%	0.5%
Terrain Stability	15,706	18	47	64	789	853	1.6%	1.6%
Future Stand-level Reserves	32,597	123	187	310	1,429	1,739	3.2%	3.3%
Total Operable Reductions		**713**	**3,027**	**3,740**	**11,743**	**15,483**	**28.3%**	**29.1%**
Current THLB		**1,823**	**2,934**	**4,757**	**25,220**	**29,977**	**54.8%**	**56.4%**

[1] Data updated to the December 31, 2015 for logging and ages; therefore, volumes listed represent estimates at the end of 2015.

6.4 Recently Harvested Cutblocks

Within cutblocks harvested or planned between 2000 and 2015 for which Site Plan Standard Unit (SU) mapping data is available, the productive forest area (net area to reforest (NAR)) will be designated as 100% THLB. The roads and reserves for these cutblocks (WTPs, WTRAs, retention patches, etc.) will be designated as 0% THLB.

For the rest of the land base the following land base netdowns will be applied to derive the THLB. Netdowns are listed in the order applied such that THLB impact values listed are the incremental impact accounting for all previously applied netdowns.

6.5 Non-Forest

The non-forest portion of TFL 37 includes areas where merchantable tree species are largely absent and most of the area is alpine, rock and wet areas (Table 7).

Table 7 - Non-forest Area

Description	Gross non-forest area (ha)	Area Reduction (ha)
Alpine	5,051	5,051
Rock	1,361	1,361
Water	8,515	8,515
Industrial	480	480
Other	244	244
Total	***15,652***	***15,652***

6.6 Existing Roads and Railway

Existing roads and rail lines are excluded from the timber harvesting land base. This reduction is due to a combination of features represented by polygons within the forest cover and features represented by a line within the GIS. Highway 19 and Beaver Cove Road are the only roads represented by polygons. For the purposes of determining the area of features represented by a line, varying total widths are applied depending on the class:

- Mainlines – 13m
- Railway – 11m
- Spurs/stubs – 10m

All trails and the majority of landings are rehabilitated and restocked following logging; therefore, the associated area reduction is thought to be insignificant. Table 8 summarizes the areas of existing roads in the TFL.

Table 8 - Existing Roads and Railway

Feature Class	Length (km)	Buffer Width (m)	Area Reduction (ha)
Highway 19/Beaver Cove Rd.	85	N/A	318
Mainlines	907	13	1,143
Spurs	2,660	10	2,579
Railway	107	11	118
Total	***3,759***		***4,155***

6.7 Non-Productive Forests

TFL 37 includes 7,958 ha of non-productive forest (Table 9). These areas are mostly forest growing on poor sites and brush. Non-productive forests contribute to landscape level biodiversity. While not incorporated into the biodiversity calculations, these components provide a margin of safety around biodiversity requirements.

Table 9 - Non-productive Area

Description	Gross non-productive area (ha)	Area Reduction (ha)
Alpine Forest	3,225	3,225
Brush	1,198	1,198
Non-commercial species	99	99
Scrub forest	3,436	3,436
Total	***7,958***	***7,958***

6.8 Physical Operability

Physical operability mapping classifies areas as:

- Conventional - accessible by ground-based harvesting systems;
- Non-conventional - access limitations suitable for aerial systems such as helicopter; or
- Inoperable.

Mapping of physical operability was updated in 1997/1998 in preparation for MP #9 and reviewed for this MP. Several areas classified as non-conventional in the late 1990's have since had roads built or planned into them. For these areas a 125m buffer was applied to the lines representing the roads and the ensuing polygons classified as conventional harvesting, resulting in approximately 1,670 ha more conventionally operable land base. Refer to Figure 5 for the final physical operability classifications.

Physically inoperable areas were identified based on safety considerations, operational performance, environmental sensitivity, and local knowledge. Harvesting in physically inoperable areas is unrealistic for reasons of accessibility, soil sensitivity, or worker safety.

Only Inoperable areas are removed from the THLB (see Table 10).

Table 10 - Area and Volume by Physical Operability Type

Description	Productive Area (ha)	Volume (000 m^3)	% of Productive Area	% of Productive Volume
Conventional	100,919	38,269	89%	84%
Non-conventional	12,563	7,191	11%	16%
Operable (subtotal)	***113,482***	***45,460***	***100%***	***100%***
Inoperable	18,735	7,710	-	-
Total	***132,217***	***53,170***	**-**	**-**

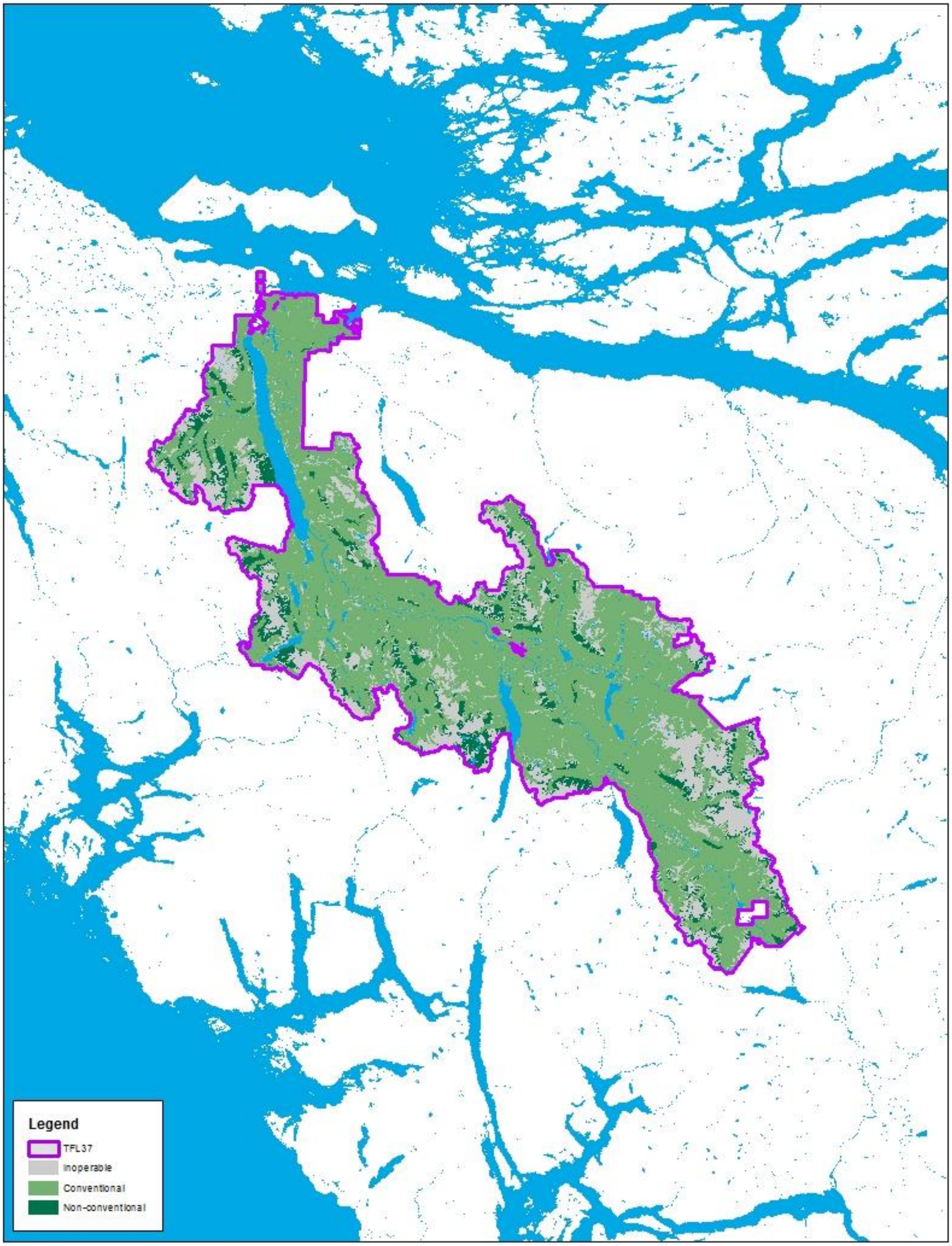

Figure 5 – Physical Operability Classes

6.9 Riparian Management Areas

Detailed riparian features mapping is on-going for TFL 37 through cutblock development. Operational stream inventories associated with development planning have been conducted since the late 1980's (with the introduction of the *Coastal Fisheries Forestry Guidelines*) and various reconnaissance (1:20,000) fish and fish habitat inventory projects have been completed. These inventories provide information on fish distribution, habitat and habitat restoration opportunities. This detailed information provides the basis for estimating riparian classes and reserve areas for waterbodies.

The timber supply analysis utilizes the available stream classifications in the Geographic Information System (GIS) to apply Riparian Management Areas (RMAs) to known streams, lakes and wetlands based on FRPA Riparian Reserve Zone (RRZ) widths and assumed levels of retention within Riparian Management Zones (RMZs). The assumed RMZ retention levels and effective RMAs are listed in Table 11. Retention levels were estimated based on a review of cutblocks harvested or planned between 1995 and 2015 plus classification of riparian features in and adjacent to the harvest area. As most S2-S6 streams are represented by a line, effective management area widths also account for the stream body width.

Table 11 – Riparian Management Areas

Riparian Feature Class	Size Class	Reserve Zone (m)	Management Zone		Effective Management Area (m)[1]
			Width (m)	Netdown (%)	
Streams	*Width (m)*				
S1-A	>=100	0	100	100	100
S1-B	>20.0 - 99.9	50	20	65	63
S2	>5.0 - 20.0	30	20	50	40
S3	>1.5 - 5.0	20	20	40	28
S4	<1.5	0	30	40	12
S5	>3.0	0	30	50	15
S6	<3.0	0	20	15	3
Lakes	*Area (ha)*				
L1-A	>=1000	0	15[2]	100	15
L1-B	>5.0 - 999.9	10	0	0	10
L2 (dry zones)	1.0 - 5.0	10	20	80	26
L3 (wet zones)	1.0 - 5.0	0	30	90	27
L4 (dry zones)	0.5 - 1.0	0	30	80	24
Wetlands	*Area (ha)*				
W1	>5.0	10	40	60	34
W2 (dry zones)	1.0 - 5.0	10	20	50	20
W3 (wet zones)	1.0 - 5.0	0	30	70	21
W4 (dry zones)	0.5 - 1.0	0	30	50	15
W5	>5.0	10	40	60	34

[1] Effective Management Area = RRZ + (RMZ *(netdown %/100)). This width is applied to both sides of streams and to the perimeter of lakes and wetlands
[2] WFP RMZ for TSA purposes only, not FPPR RMZ

6.10 Ungulate Winter Ranges

An Ungulate Winter Range (UWR) is an identified area that contains habitat necessary for the winter survival of an ungulate species. A UWR plan for TFL 37 was first established in 1983. The most recent revisions to the UWR plan were completed in July 2001 and approved by government in September 2001 (U-1-001). The plan identified specific areas of forest where harvesting is reserved to provide cover attributes necessary for the survival of Columbian black-tailed deer and Roosevelt elk.

As with most landscape-level reserves, UWRs were designed at a coarse scale without detailed knowledge of development challenges in the immediate vicinity. As more accurate field work is completed, boundary discrepancies may arise at the operational scale and/or unforeseen timber impacts may become apparent. For this reason the UWRs have been amended through time, with all amendments requiring government approval. See Table 12 and Figure 6 for the area currently designated as UWR and the associated reduction to the THLB.

Table 12 - Ungulate Winter Ranges Area

Ungulate Species	Productive UWR Area (ha)	Area Reduction (ha)
Deer	4,781	4,241
Elk	918	631
Total	***5,699***	***4,872***

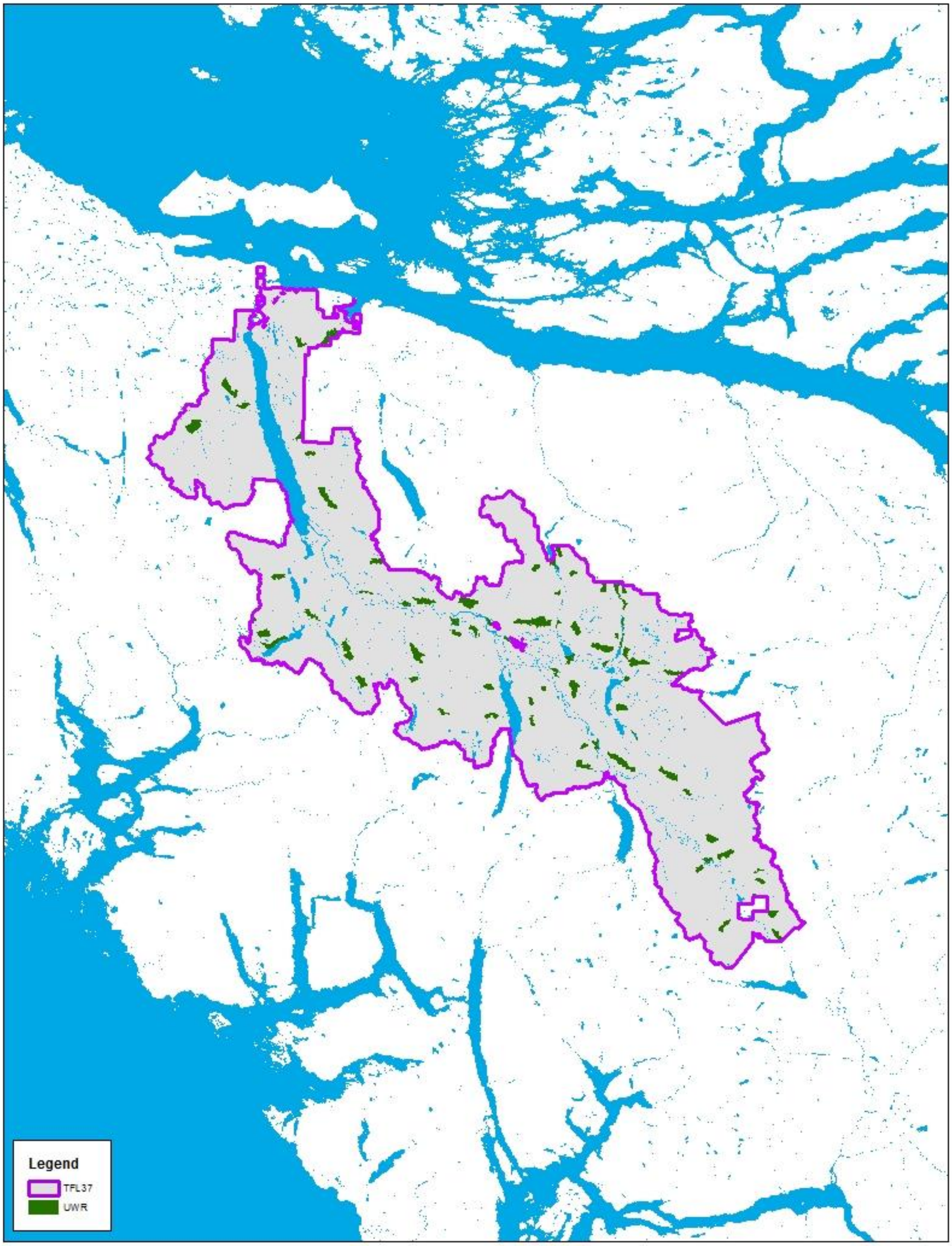

Figure 6 – Ungulate Winter Ranges

6.11 Old Growth Management Areas

Landscape Units (LUs) are areas of land used for long-term planning of resource management activities. They are usually 50,000 to 100,000 hectares in size. Landscape Units, Biodiversity Emphasis Options (BEOs) and old forest retention targets by biogeoclimatic (BEC) variant were designated through the *Order Establishing Provincial Non-Spatial Old Growth Objectives* effective June 30, 2004 (NSOG order). This order applies within an LU until Old Growth Management Areas (OGMAs) are spatially determined through Landscape Unit planning. The NSOG order specifies that the old forest retention target for landscape units with a Low BEO can be reduced by up to 2/3 to the extent necessary to address impacts on timber supply.

Two landscape units are found within TFL 37: Lower Nimpkish LU (with a Low BEO) and Upper Nimpkish LU (with an Intermediate BEO). OGMAs within these two landscape units were established by Order in September 2005. The Lower Nimpkish LU Plan identified sufficient OGMAs to meet the full old forest retention target so the reduction permitted under the NSOG order was not utilized. The Upper Nimpkish LU Plan identified enough OGMAs to meet the old forest retention target in all BEC variants except the CWHmm1 (Coastal Western Hemlock submontane moist maritime) variant. The 84 hectare OGMA shortfall in the CWHmm1 was expected to be met by riparian reserves along fish streams. Forest in Protected Areas (e.g. parks) within both landscape units contributes towards a portion of the old forest retention targets.

Like UWRs, the initial OGMA boundaries were designed at a coarse scale without a great deal of detailed field work. Since establishment in 2005, the OGMAs within TFL 37 have been revised as per the objectives in the LU Orders. Adequate area remains identified as OGMA to meet the old forest retention targets; therefore, all OGMAs are removed from the THLB (Figure 7). Refer to Table 13 for a summary of the area identified as OGMA and the impact to the THLB.

Table 13 - Old Growth Management Areas

Landscape Unit (Biodiversity Emphasis)	BEC Variant	Old Forest Retention Target	TFL 37 OGMA Area (ha)	
			Productive	Area Reduction
Lower Nimpkish (Low)	CWHxm2	9%	1,202	847
	CWHvm1	13%	2,421	750
	CWHvm2	13%	1,576	599
	MHmm1	19%	1,190	280
Lower Nimpkish OGMAs (subtotal)			***6,389***	***2,476***
Upper Nimpkish (Intermediate)	CWHxm2	9%	626	352
	CWHmm1	9%	827	354
	CWHvm1	13%	2,043	298
	CWHvm2	13%	2,350	713
	MHmm1	19%	2,012	521
Upper Nimpkish OGMAs (subtotal)			***7,858***	***2,238***
OGMAs Total			***14,247***	***4,714***

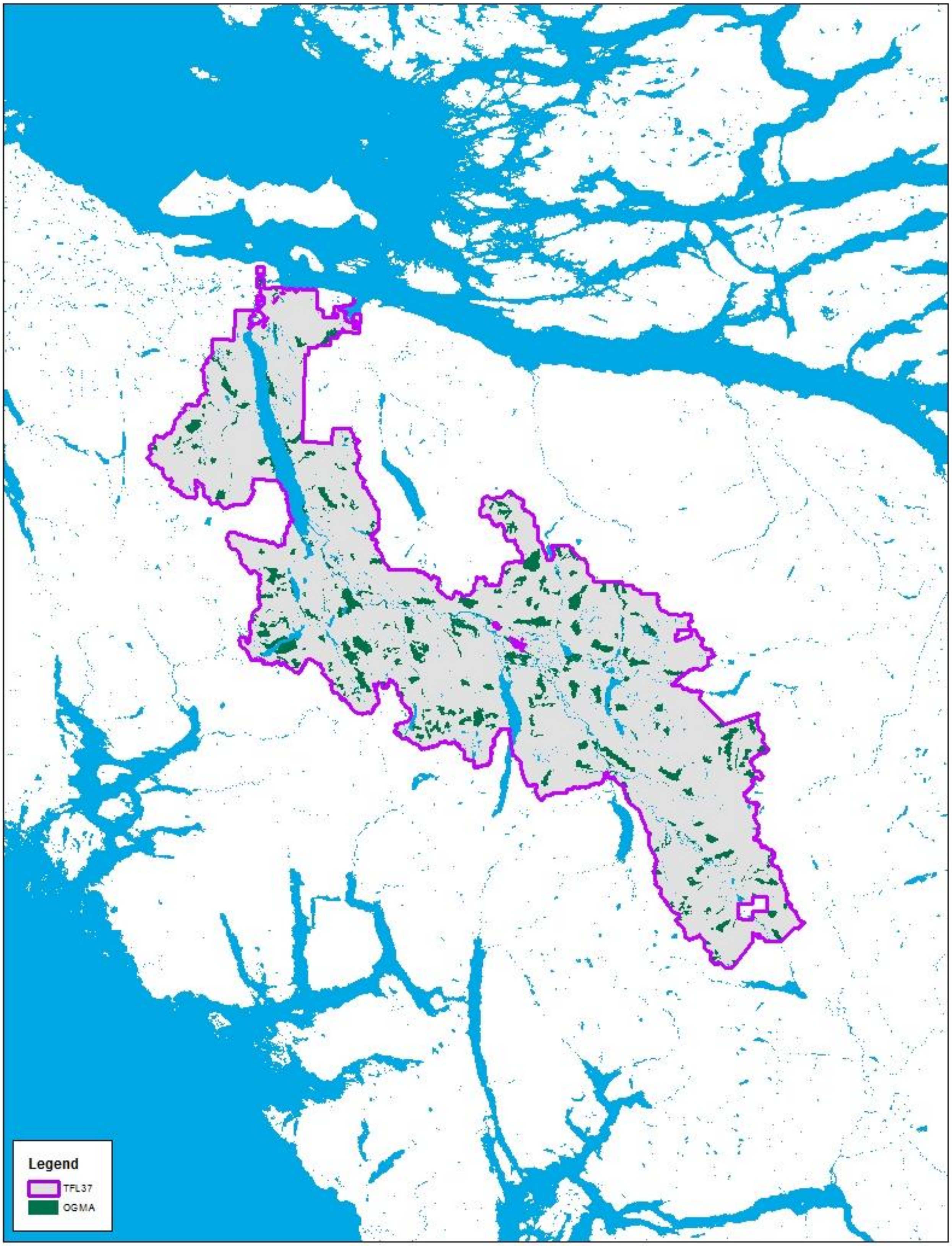

Figure 7 – Old Growth Management Areas

6.12 Wildlife Habitat Areas

Wildlife Habitat Areas (WHAs) are established to conserve habitat of species at risk. In the absence of WHAs, Section 7 of the *Forest Planning and Practices Regulation* (FPPR) requires holders of a Forest Stewardship Plan (FSP) to specify a result or strategy to address species at risk habitat if a notice has been issued under section 7 of the FPPR. Some WHA's overlap so the areas listed below will not match the areas reported in the orders establishing WHAs or the areas used during discussions for proposed WHAs.

6.12.1 Legally Established WHAs

At the time the timber supply analysis data set was put together a total of fifteen WHAs had been approved within the boundaries of TFL 37 (Figure 8). The WHAs have a total area of 2,824 ha and encompass 2,687 ha of productive forest (see Table 14).

Table 14 – Established Wildlife Habitat Areas

WHA ID	Species	Productive Wildlife Habitat Area (ha)	Area Reduction (ha)
1-014	Marbled Murrelet	313	7
1-042	Northern Goshawk	296	0
1-043	Northern Goshawk	91	0
1-044	Northern Goshawk	262	0
1-045	Northern Goshawk	260	0
1-046	Northern Goshawk	214	1
1-047	Northern Goshawk	348	0
1-048	Northern Goshawk	441	225
1-049	Northern Goshawk	142	0
1-050	Northern Goshawk	80	0
1-051	Northern Goshawk	72	8
1-150	Marbled Murrelet	4	2
1-391	Keen's Long-eared Myotis	52	7
1-392	Keen's Long-eared Myotis	100	3
1-491	Red-legged Frog	12	4
Total		***2,687***	***257***

It should be noted for the purposes of the IWMS policy regarding the timber supply impact, the THLB impact of these WHAs is determined using MP#8 data and is different than the impacts indicated in Table 14.

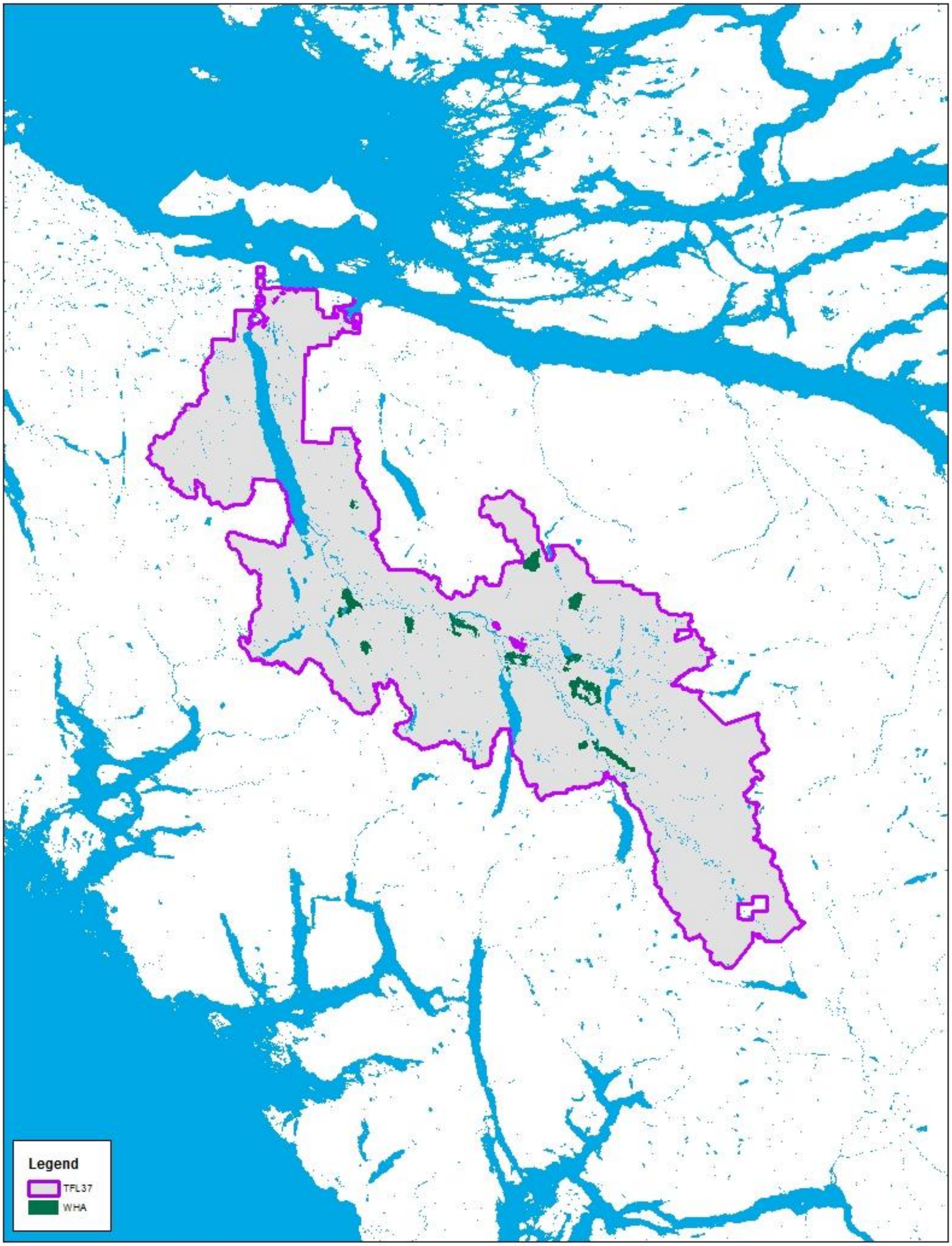

Figure 8 – Established Wildlife Habitat Areas

6.12.2 Proposed WHAs

At the time the timber supply analysis data set was put together a total of fifty-three WHAs were proposed within the boundaries of TFL 37 (Figure 9):

- 2 for Northern Goshawk
- 51 for Marbled Murrelet

The Goshawk WHAs were agreed to proceed to legal status. As for the proposed Murrelet WHAs:

- 14 are agreed to proceed to legal status (gross 714 ha);
- 10 are agreed to have harvesting deferred to allow further review (gross 967 ha); and
- 27 should be dropped due to poor habitat or significant harvesting/planning invested (gross 1,749 ha).

The proposed WHAs for Murrelet were drafted based on a pre-standard habitat inventory completed in 2002-2003. A new inventory was completed in 2012 following the latest standard. As the provincial policy for Marbled Murrelet is undetermined at this time, the Implementation Plan will likely have a different impact (lesser or greater is not known). The proposed WHAs in the data set will be used to represent the potential THLB impact of WHAs. The proposed WHAs used in the analysis have no legal status but are an estimate of the potential impact to the THLB of future Marbled Murrelet Implementation Plan(s). If new information becomes available during the Management Plan process it will be incorporated - either in a revised Base Case THLB or as a sensitivity analysis.

Table 15 – Proposed Wildlife Habitat Areas

Species	Productive Wildlife Habitat Area (ha)	Area Reduction (ha)
Marbled Murrelet	3,139	123
Northern Goshawk	203	78
Total	***3,342***	***201***

Other species identified in the FPPR Section 7 notice for North Island – Central Coast District include Coastal-tailed frogs and Great blue herons. While WHAs may be established within TFL 37 in the future to address conservation of habitat for these species at risk and additional WHAs may be established for species listed above, no additional netdowns will be applied as this would be speculation as to where the Identified Wildlife Management Strategy (IWMS) impact will be allocated.

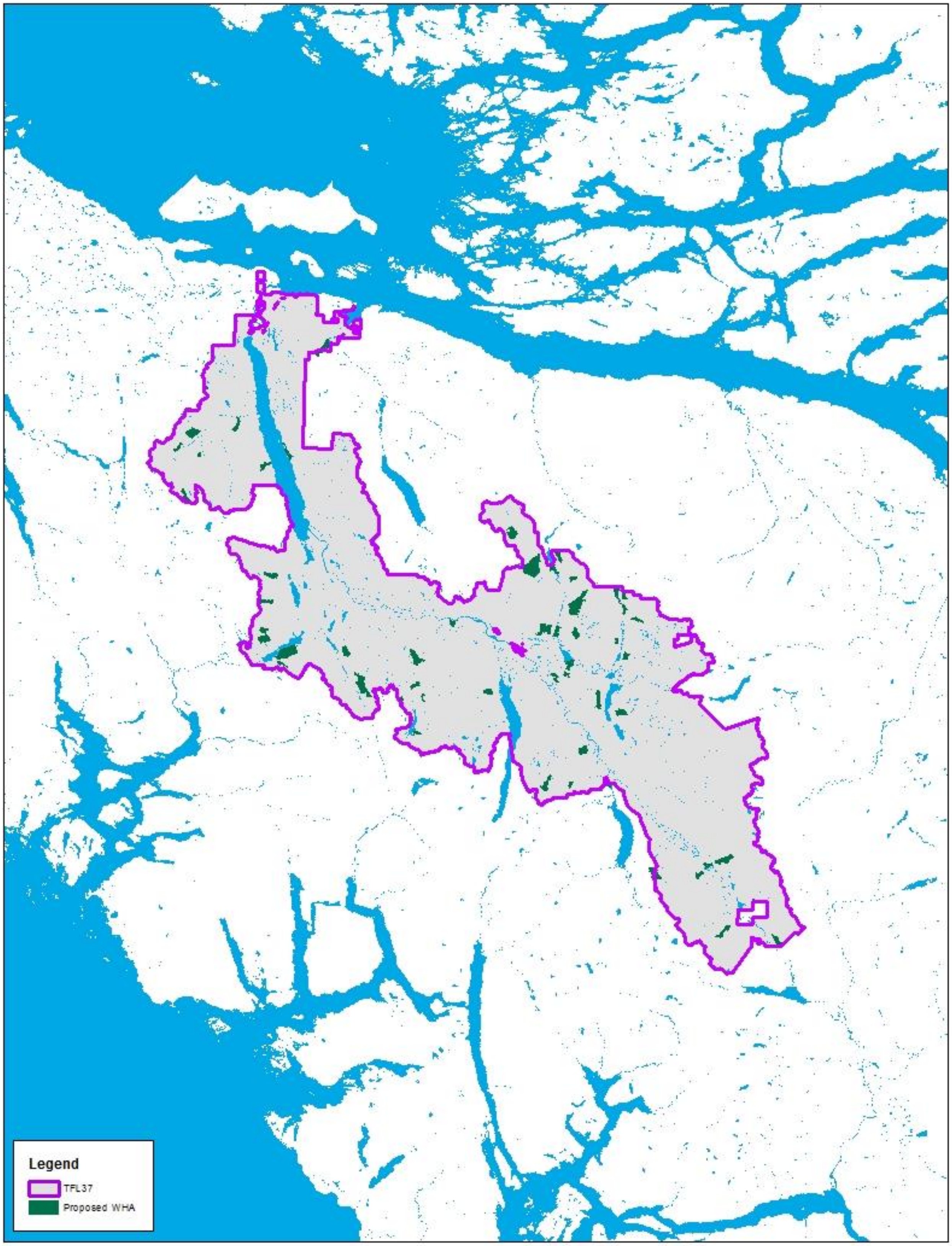

Figure 9 – Proposed Wildlife Habitat Areas

6.13 Economic Operability

Mapping of the economic operability was updated in 1997/1998 in preparation for MP #8. The mapping classifies areas as:

- Economic—available for harvest;
- Marginally economic—available for harvest under favourable market conditions, particularly where adjacent to economically operable stands; or
- Uneconomic—stand value is not expected to offset harvesting costs.

The economic operability classification was primarily a database and GIS exercise using the following attributes as criteria:

- BEC site series,
- maximum mean annual increment,
- local knowledge, previous performance,
- stand volume,
- stand value,
- stand height,
- crown closure, and
- leading species.

Stands removed from the THLB as uneconomic are summarized in Table 16 and indicated in Figure 10. A sensitivity analysis will test the impact of removing marginally economic stands from harvest.

Table 16 - Area and Volume by Economic Operability Type

Description	Productive Area (ha)	Productive Volume (000 m^3)	Area Reduction (ha)	Volume Reduction (000 m^3)
Economic	101,331	40,997	-	-
Marginal	8,850	3,567	-	-
Operable (subtotal)	***110,181***	***44,564***	**-**	**-**
Uneconomic	3,301	896	1,998	614
Total	***113,482***	***45,460***	***1,998***	***614***

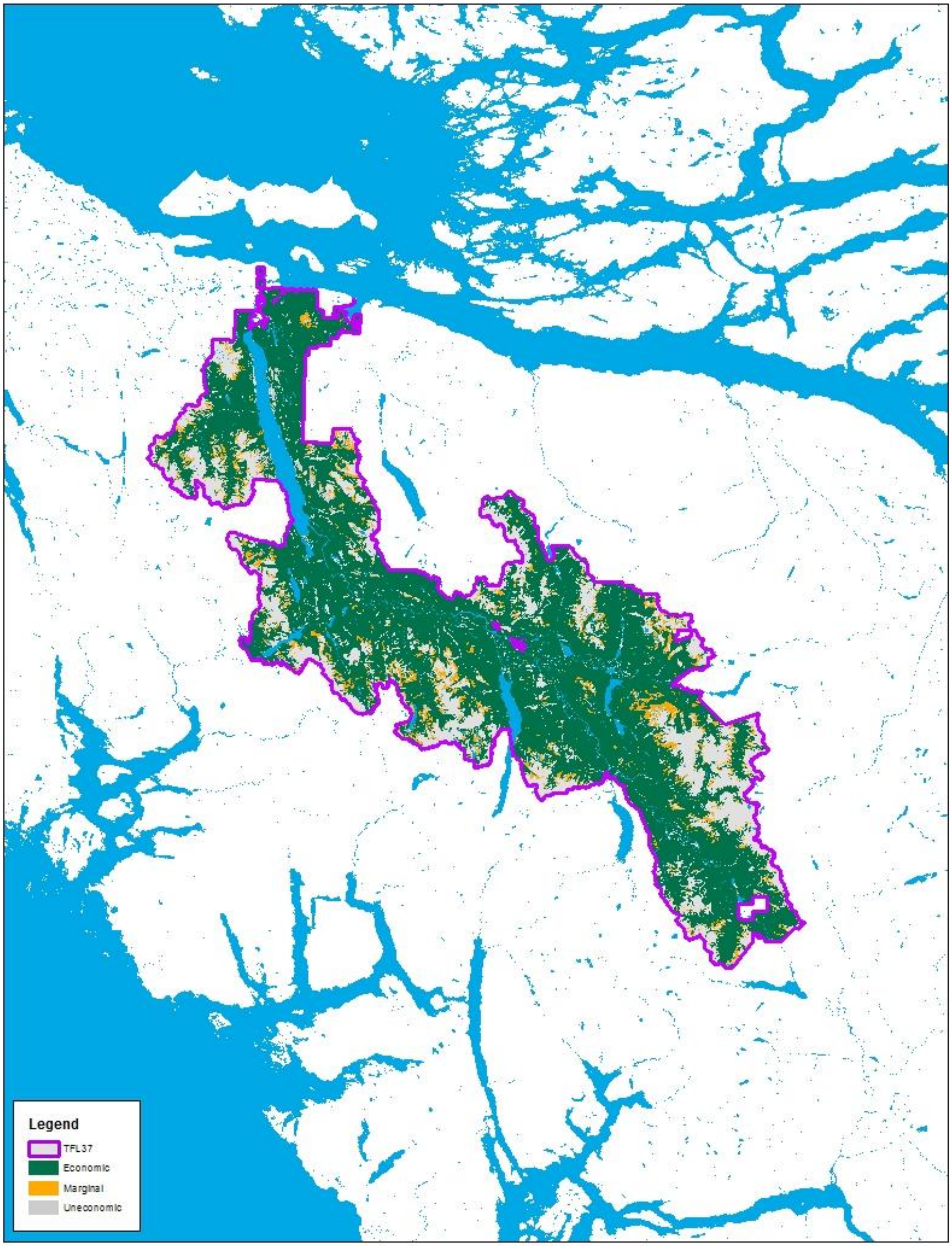

Figure 10 – Economic Operability Classes

6.14 Deciduous-leading Stands

Table 17 and Figure 11 show areas in the inventory defined as deciduous-leading. In total, deciduous-leading stands represent about 1.6 percent of the productive forest. Recent harvest history indicates negligible harvest of deciduous-leading stands; therefore, these stands are removed from the THLB. A sensitivity analysis is planned that will include these stands in the THLB.

Table 17 - Area of Deciduous Forest Types

Description	Productive Deciduous Area (ha)	Area Reduction (ha)
Deciduous-leading stands	2,180	1,413

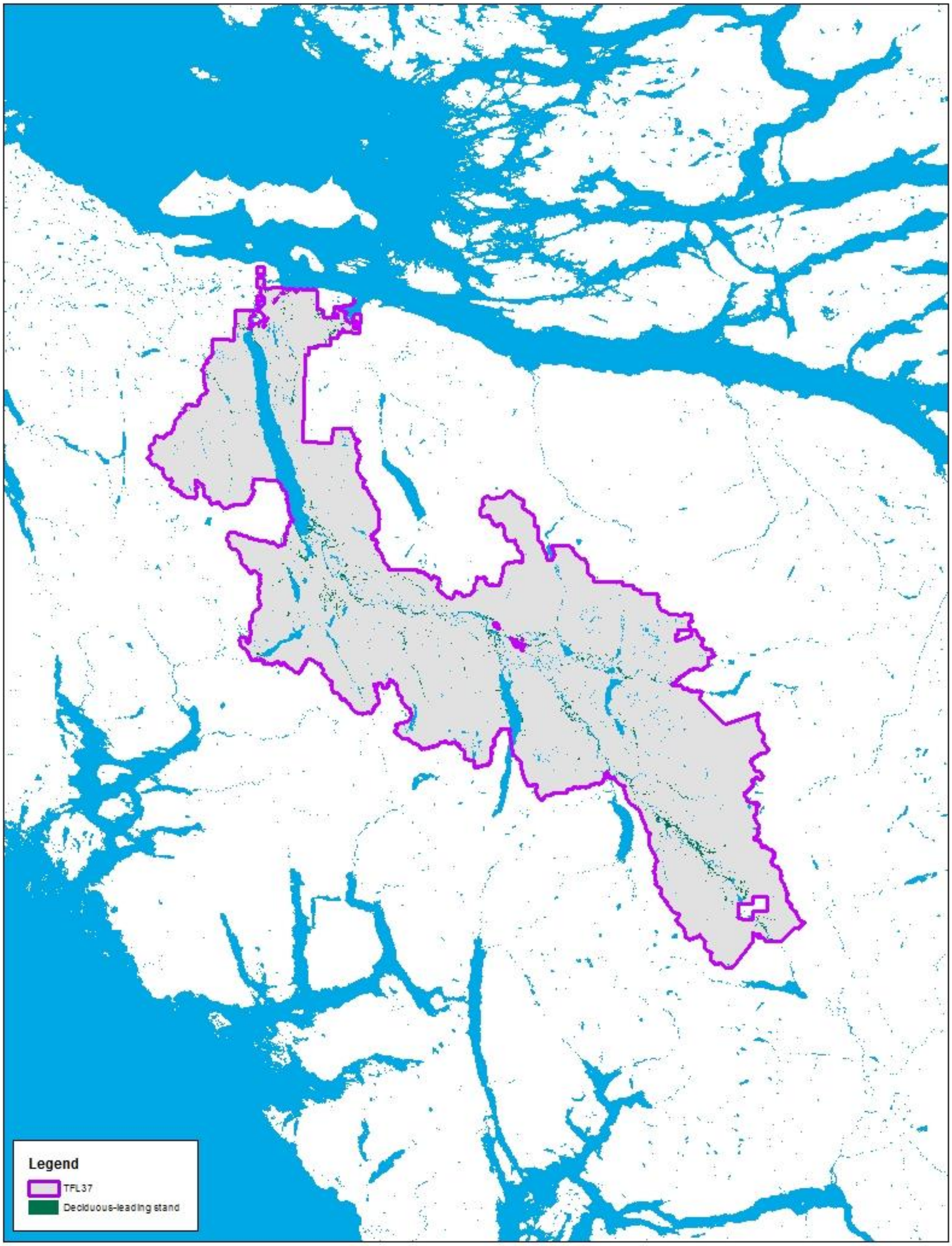

Figure 11 – Deciduous-leading stands

6.15 Recreation

Within TFL 37 there are several recreation sites and trails. All recreation sites listed in Table 18 were removed from the THLB while listed trails had a 10m buffer added to each side to create an area to remove from the THLB. No overview figure is provided as these features are too small to stand out at the scale being used for the figures.

Table 18 – Recreation Areas

Site / Trail	Productive Recreation Area (ha)	Area Reduction (ha)
Atluck Lake	2	1
Canyon Lake	1	1
Kinman Creek	17	5
Lower Klaklakama	1	0
Nimpkish Lake	5	2
Woss Lake	2	0
Woss Lookout	1	0
Sites Subtotal	29	9
Hoomak Lake	3	3
Woss Lookout	2	1
Siding 4	1	0
Trails Subtotal	6	4
Total	***35***	***13***

6.16 Archaeological Sites

The First Nations of British Columbia have varied cultures, histories and traditions. The *Heritage Conservation Act* provides for the protection and conservation of archaeological sites that contain evidence of human habitation or use before 1846. In accordance with the Act, archaeological sites may not be damaged, excavated or altered without a permit issued by the Minister responsible for the Act or a designate. The term "cultural heritage resources" applies to a variety of heritage resources defined in the *Forest Act* as "an object, a site or the location of a traditional societal practice that is of historical, cultural or archaeological significance to British Columbia, a community or an aboriginal people." Under FRPA, the objectives set by government for cultural heritage resources are to conserve, or, if necessary, protect cultural heritage resources that are:

a) the focus of a traditional use by an aboriginal people that is of continuing importance to that people, and

b) not regulated under the *Heritage Conservation Act*.

WFP has signed agreements with several First Nations in an effort to gain a fuller understanding of their interests in land and resources within their traditional territory and to seek reasonable ways to integrate those interests into WFP's forest resource management and planning processes. First Nations who have completed traditional use studies (TUS) retain the detailed information regarding traditional use sites and values identified within their asserted traditional territories. TUS information is not typically shared with forest licensees, but where this information exists it is considered by decision-makers when making statutory decisions.

Numerous proposed cutblocks within TFL 37 have been intensively surveyed for CMTs. This stand level information has been entered into WFP's GIS database and is used for planning purposes. The most common cultural heritage resources found within TFL 37 are culturally modified trees (CMTs). These are trees that have been modified by aboriginal people as part of their traditional use of the forest. Examples of CMTs include trees with bark removed, stumps and felled logs, trees tested for soundness and trees with scars from plank removal. The most common and important species of tree used is western redcedar. Retention of timber to protect these resources is addressed via stand-level retention netdowns (see Sections 6.17 and 6.20) and other landscape-level netdowns such as riparian management (see Section 6.9).

Even though some sites may be altered under a permit, archaeological sites registered with the provincial government will be removed from the THLB (see Table 19).

Table 19 – Archaeological Sites

Description	Productive Area (ha)	Area Reduction (ha)
Archaeological Sites	66	53

6.17 Existing Stand-level Reserves

Stand-level reserves are important for maintaining biodiversity and wildlife habitat. Policy direction for wildlife tree management was initiated in 1985 with the release of *Protection of Wildlife Trees*. In 1995, with the introduction of the *Forest Practices Code of British Columbia* and the associated *Biodiversity Guidebook*, wildlife tree patches (WTPs) were designated for nearly every harvested cutblock. This requirement was continued under FRPA as wildlife tree retention areas (WTRAs). Landscape Unit Plans usually establish a WTP/WTRA objective by biogeoclimatic variant.

Licensee forest management policies and/or strategies may dictate additional stand-level retention beyond those specified in legislation. For further discussion on this subject, see Sections 6.20 and 10.3.3.

For this analysis existing long-term stand-level retention areas will be excluded from the THLB as indicated in Table 20, the assumption being that these areas will be retained again in future harvest operations.

Table 20 – Existing Stand-level Retention

Description	Productive Retention Area (ha)	Area Reduction (ha)
Existing stand-level retention	4,026	2,449

6.18 Karst

Karst landscapes are sensitive to logging impacts due to safety concerns, the intrinsic value of cave systems, and the presence of karst-associated flora and fauna. The North Island – Central Coast Resource District (within which TFL 37 is located) issued a GAR Order identifying the following as karst resource features:

- karst caves;
- important features and elements within very high or high vulnerability karst terrain; and
- significant surface karst features.

With the issuing of this order, forest licensees in the district must ensure primary forest activities (i.e., timber harvesting; road construction, maintenance and deactivation; and silviculture treatments) do not damage or render these features ineffective (FPPR Section 70).

In 2004, a planning-level karst inventory was completed for TFL 37 that identified, among other things, the karst vulnerability potential (KVP) of areas within the TFL (see Figure 12). Based on KVP, the features that are likely to exist and best management practices, netdown reductions were estimated for each karst polygon. Table 21 presents the average netdown applied by KVP class and the resulting area removed from the THLB.

Table 21 – Karst Inventory Netdowns

Karst Vulnerability	Average Netdown	Productive Area (ha)	Area Reduction (ha)
Low	11%	3,319	188
Moderate	17%	4,028	472
High	23%	463	64
Very high	29%	207	10
Total		***8,016***	***734***

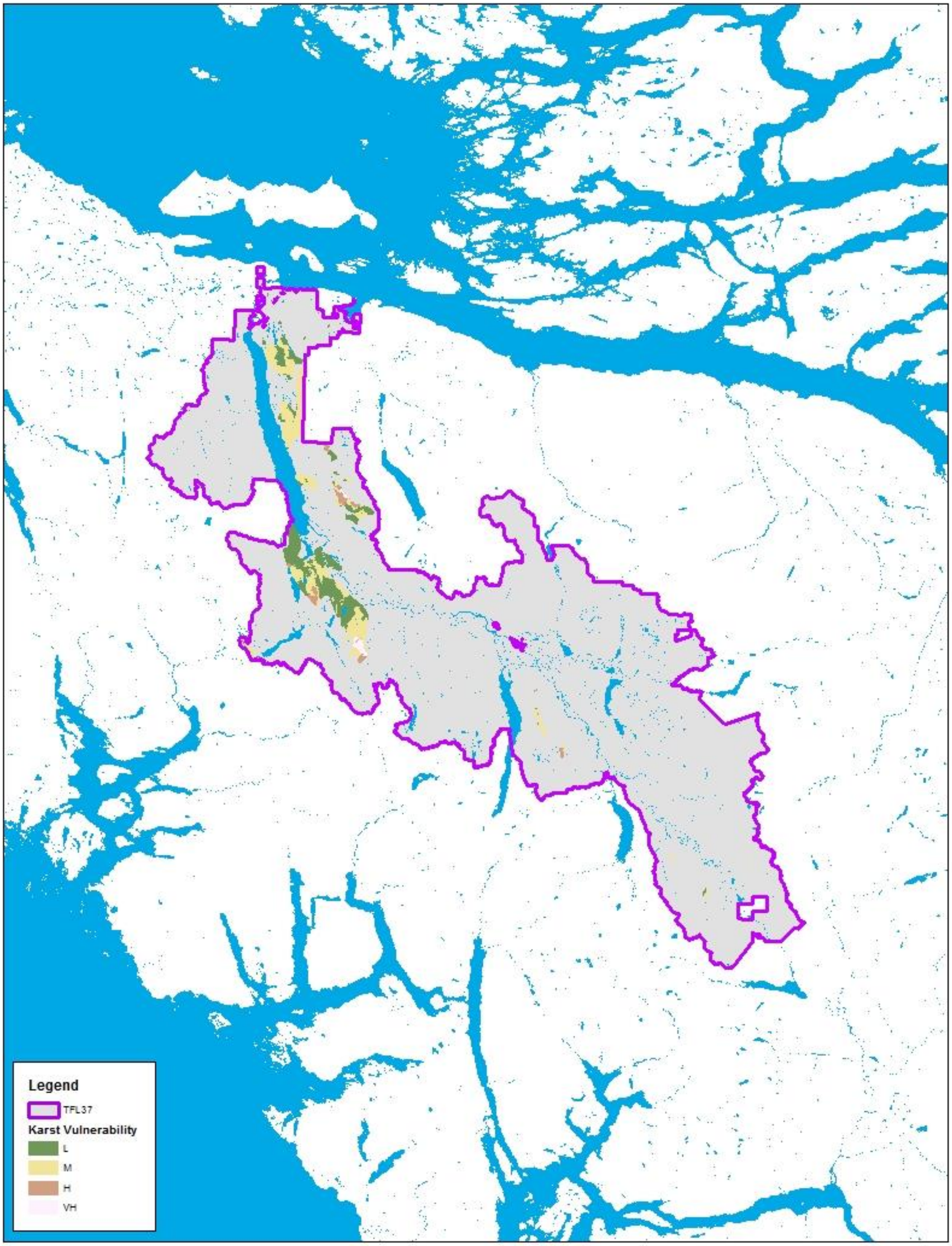

Figure 12 – Karst Vulnerability Classes

6.19 Terrain Stability

Detailed terrain stability mapping was completed for TFL 37 in 1999 at a scale of 1:15,000. Areas were classified into one of five classes of likelihood for post-harvest instability:

- Class I – no likelihood of post-harvest instability
- Class II – very low likelihood of post-harvest instability
- Class III – low likelihood of post-harvest instability
- Class IV – moderate likelihood of post-harvest instability
- Class V – high likelihood of post-harvest instability

No netdowns are applied to Class I, II and III polygons. Percent reductions for Classes IV and V are based on recent operational experience. Class V terrain is a criterion in the inoperability determination, and has almost been completely removed as inoperable. Cutblocks on class IV terrain typically require 10% area reductions. The class IV reduction factor in the Kilpala area (area within TFL 37 on west side of Nimpkish Lake and north of Nimpkish Lake Park) is 26%, which reflects the greater sensitivity of this area to logging-related slope failures (refer to Figure 13).

Table 22 indicates the area by stability class and the netdowns associated with various classifications.

Table 22 - Terrain Stability Netdowns

Terrain Stability Class (likelihood of post-harvest landslide)	Special Area	Area Netdown %	Productive Area (ha)	Area Reduction (ha)
IV (moderate)		10%	22,220	1,308
IV (moderate)	Kilpala	26%	3,086	452
V (high)		95%	5,772	2
Total			***31,078***	***1,762***

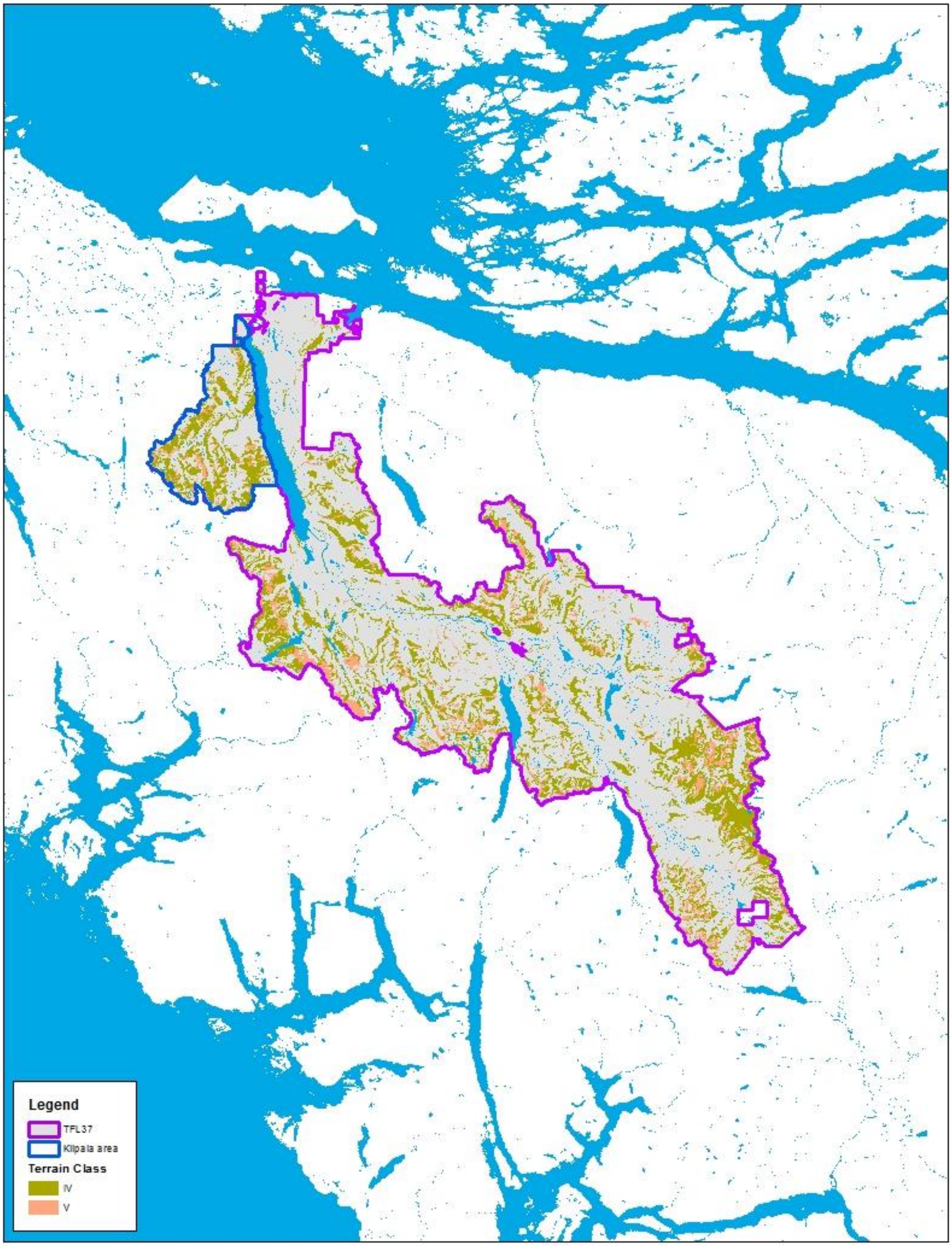

Figure 13 – Terrain Stability Classes

6.20 Area Reductions to Reflect Future Stand-level Retention

6.20.1 Wildlife Tree Retention Areas

Where feasible and wildlife objectives can be met, wildlife tree retention areas (WTRAs) are located in constrained areas such as riparian reserves, inoperable stands or unstable slopes. For the two landscape units within TFL 37, the orders establishing OGMAs (refer to Section 6.11) also specified the WTRA requirements (see Table 23).

Table 23 –WTRA Objectives

Landscape Unit	BEC Subzone	WTRA %
Lower Nimpkish	CWHxm	11%
	CWHvm	9%
	MHmm	1%
Upper Nimpkish	CWHxm	13%
	CWHmm	14%
	CWHvm	9%
	MHmm	3%

In order to account for WTRA located in harvestable areas a THLB area reduction is applied. A review of the same harvested or planned cutblocks (1995-2015) used to derive the riparian management areas (Section 6.9) indicated that approximately 40% of the stand-level retention was located on otherwise harvestable land base. As the WTRA requirements differ by landscape unit and BEC subzone, varying netdowns are applied (see Table 24).

6.20.2 Western Forest Strategy Stand-level Retention

As detailed in Section 10.3.3 applying the Western Forest Strategy (WFS) results in at least 64 percent of the harvest area in TFL 37 being within retention system cutblocks (with the remainder being clearcut or clearcut-with-reserves) As WFS requirements differ by resource management zone and BEC subzone, varying netdowns are applied such that the total THLB reduction is consistent with the results of the review discussed in Section 6.20.1, with the relationship between resource management zones and landscape units accounted for (see Table 24).

Table 24 - THLB % Netdowns for Stand-level Retention

Landscape Unit	BEC Subzone	WFS Zone	Productive Area (ha)	THLB % reduction for WTRA	THLB % reduction for WFS	Total THLB % reduction	Area reduction (ha)
Lower Nimpkish	CWHxm2	Enhanced Basic	5	4.4%	0.0%	4.4%	0
	CWHxm2	Enhanced Dry	11,715	4.4%	1.0%	5.4%	322
	CWHxm2	General Dry	8	4.4%	2.5%	6.9%	0
	CWHxm2	Special	391	4.4%	3.6%	8.0%	21
	CWHvm1	Enhanced Basic	18,645	3.6%	0.2%	3.8%	428

Landscape Unit	BEC Subzone	WFS Zone	Productive Area (ha)	THLB % reduction for WTRA	THLB % reduction for WFS	Total THLB % reduction	Area reduction (ha)
	CWHvm1	Enhanced Dry	48	3.6%	1.4%	5.0%	2
	CWHvm1	Enhanced Windy	2,858	3.6%	0.1%	3.7%	65
	CWHvm1	Special	3,860	3.6%	4.4%	8.0%	162
	CWHvm2	Enhanced Basic	10,936	3.6%	0.2%	3.8%	230
	CWHvm2	Enhanced Windy	225	3.6%	0.1%	3.7%	4
	CWHvm2	General Basic	3	3.6%	1.4%	5.0%	0
	CWHvm2	Special	2,446	3.6%	4.4%	8.0%	99
	MHmm1	Enhanced Basic	7,715	0.4%	1.8%	2.2%	57
	MHmm1	Enhanced Windy	99	0.4%	1.1%	1.5%	0
	MHmm1	General Basic	6	0.4%	3.4%	3.8%	0
	MHmm1	Special	778	0.4%	7.6%	8.0%	13
	Total		***59,736***				***1,403***
Upper Nimpkish	CWHxm2	Enhanced Dry	38	5.2%	0.5%	5.7%	1
	CWHxm2	General Dry	813	5.2%	2.0%	7.2%	30
	CWHxm2	Special	4,260	5.2%	2.8%	8.0%	212
	CWHmm1	General Basic	16	5.6%	0.2%	5.8%	0
	CWHmm1	General Dry	10,497	5.6%	1.7%	7.3%	537
	CWHmm1	Special	2,122	5.6%	2.4%	8.0%	109
	CWHvm1	Enhanced Basic	37	3.6%	0.2%	3.8%	1
	CWHvm1	General Basic	12,331	3.6%	1.4%	5.0%	469
	CWHvm1	General Dry	35	3.6%	3.1%	6.7%	0

Landscape Unit	BEC Subzone	WFS Zone	Productive Area (ha)	THLB % reduction for WTRA	THLB % reduction for WFS	Total THLB % reduction	Area reduction (ha)
	CWHvm1	Special	5,100	3.6%	4.4%	8.0%	268
	CWHvm2	Enhanced Basic	45	3.6%	0.2%	3.8%	2
	CWHvm2	General Basic	17,560	3.6%	1.4%	5.0%	498
	CWHvm2	Special	3,938	3.6%	4.4%	8.0%	153
	MHmm1	Enhanced Basic	40	1.2%	1.4%	2.6%	0
	MHmm1	General Basic	13,531	1.2%	2.9%	4.1%	209
	MHmm1	Special	2,117	1.2%	6.8%	8.0%	49
	Total		***72,481***				***2,538***
Grand Total			***132,217***				***3,941***

6.21 Future Roads

In 2013, WFP operational staff developed a longer-term plan whereby sufficient potential cutblocks were projected to provide approximately 20 years of harvest. A key component of this plan was the projection of future roads to develop conventional harvest opportunities. While not a comprehensive development plan, for TFL 37 the projected roads accessed nearly all the remaining undeveloped conventional harvest area. Any further conventional harvest development is currently believed to be achieved using minimal road length; therefore, the projected roads are a practical representation of future roads and will be incorporated into the analysis data set. The area available for timber production will be reduced when the model harvests these polygons.

Table 25 indicates future road areas in the TFL that have to be developed.

Table 25 - Future Roads

Description	Productive Road Area (ha)	Area Reduction (ha)
Future Roads	361	0

7 INVENTORY AGGREGATION

This section describes the delineation of the TFL land base and definition of stand types needed to complete the timber supply analysis. The TFL area is categorized in a hierarchy of different management zones to allow for modelling a variety of forest cover constraints (e.g., biodiversity). Areas within all tables in this section may not sum due to rounding to the nearest hectare.

7.1 Resource Management Zones

Unique forest cover objectives will be modelled through different management zones. VILUP Resource Management Zones:

- Special Management Zones (SMZs),
- General Management Zones (GMZs),
- Enhanced Forestry Zones (EFZs)

are delineated in the data (refer to Table 26 and Figure 14) and will be used to apply forest cover constraints (see Section 10.2 for details).

Table 26 - Area by VILUP Resource Management Zone

Mgmt Zone	Mgmt Unit	Seral[1] Stage	Productive Forest (ha)	THLB Area (ha)	Management Considerations (from Vancouver Island Summary Land Use Plan)
EFZ 10	Nimpkish	Early	20,502	18,514	***Enhanced Forestry Zone*** suited for enhanced timber harvesting and silviculture; significant fish, wildlife and biodiversity (CWHxm2) values require active integration; adaptive road engineering and harvesting methods indicated in sensitive terrain west of Nimpkish Lake.
		Mid	7,147	5,156	
		Mature	6,155	3.349	
		Old	17,296	6,851	
		Total	***51,100***	***33,870***	
GMZ 13	Woss-Vernon	Early	17,151	15,388	***General Management Zone*** with significant timber resources to be developed with due and active consideration and integration of significant wildlife, fish, biodiversity and recreation values; adaptive engineering/deactivation efforts in areas of unstable terrain are indicated; specific opportunities for enhanced timber harvesting exist, and are to be identified at the local/landscape planning level.
		Mid	10,918	8,629	
		Mature	681	223	
		Old	18,260	7,280	
		Total	***47,010***	***31,520***	
GMZ 26	Tsitika	Early	2,590	2,410	***General Management Zone*** with maintenance of high wildlife, fish and biodiversity values, and integrated management for timber and other resources.
		Mid	161	19	
		Mature	45	20	
		Old	4,290	1,743	
		Total	***7,086***	***4,192***	

[1] Early seral is <40 years old; Mid seral is 40-80 years old in CWH zone and 40-120 years old in MH zone; Mature seral is 81-250 years old in CWH zone and 121-250 years old in MH zone; Old seral is >250 years old.

Mgmt Zone	Mgmt Unit	Seral[1] Stage	Productive Forest (ha)	THLB Area (ha)	Management Considerations (from Vancouver Island Summary Land Use Plan)
SMZ 6	Woss-Zeballos	Early	296	266	***Special Management Zone*** with focus on old growth biodiversity conservation, maintenance of recreation opportunities associated with lakes and alpine/subalpine, and maintenance of scenic values associated with recreation sites and access corridors.
		Mid	78	66	
		Mature	47	7	
		Old	2,427	1,128	
		Total	***2,847***	***1,466***	
SMZ 9	Tsitika-Woss	Early	4,628	3,998	***Special Management Zone*** where focus should be on maintenance and/or restoration of biodiversity attributes associated with old growth forests and riparian habitats, with particular attention to CWHxm2
		Mid	5,416	4,136	
		Mature	229	80	
		Old	3,462	1,035	
		Total	***13,735***	***9,248***	
SMZ 10	Pinder-Atluck	Early	1,235	1,111	***Special Management Zone*** where focus should be on maintenance of recreational opportunities and viewsheds associated with lakes, as well as maintenance of wildlife and fish habitat.
		Mid	1,599	1,069	
		Mature	297	31	
		Old	3,234	1,360	
		Total	***6,365***	***3,571***	
SMZ 11	Schoen-Strathcona	Early	380	374	***Special Management Zone*** where focus should be on maintenance of old growth biodiversity and habitat values, as well as backcountry recreation potential and maintenance of viewsheds around Victoria and Warden Peaks.
		Mid	169	17	
		Mature	50	19	
		Old	1,448	508	
		Total	***2,056***	***917***	
None	None	Early	607	538	Portions of TFL 37 are outside of Resource Management Zones established by the Vancouver Island Land Use Plan.
		Mid	926	638	
		Mature	266	153	
		Old	220	82	
		Total	***2,019***	***1,411***	
Grand Total		Early	47,389	42,598	
		Mid	26,413	19,729	
		Mature	7,770	3,881	
		Old	50,646	19,987	
		Total	***132,217***	***86,195***	

[1] Early seral is <40 years old; Mid seral is 40-80 years old in CWH zone and 40-120 years old in MH zone; Mature seral is 81-250 years old in CWH zone and 121-250 years old in MH zone; Old seral is >250 years old.

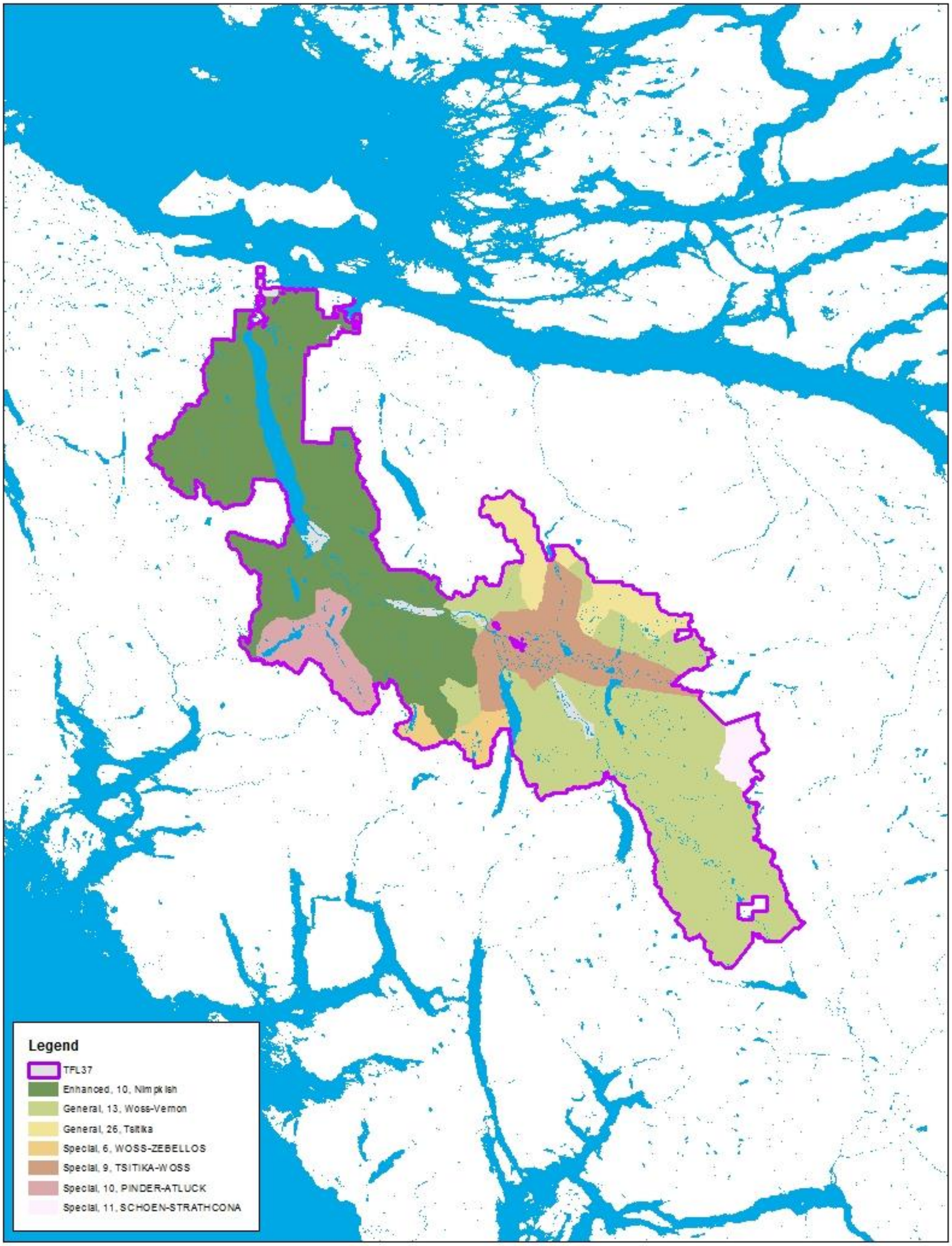

Figure 14 – Resource Management Zones

7.2 Landscape Units

As discussed in Section 6.11 two landscape units are found within TFL 37:

- Lower Nimpkish,
- Upper Nimpkish.

Old seral targets and corresponding old growth management areas are based on landscape unit and biogeoclimatic variant (BEC). Table 27 presents the seral stage distribution of the productive forest by BEC within each landscape unit while Figure 15 indicates the boundaries of the landscape units.

Table 27 – Seral Stage Area by Landscape Unit and BEC Variant

Landscape Unit (BEO)	BEC	Seral Stage	Productive Forest (ha)	Non Contributing Area		THLB Area	
				ha	%	ha	%
Lower Nimpkish (Low)	CWHxm2	Early	5,224	484	9%	4,739	91%
		Mid	2,937	1,031	35%	1,906	65%
		Mature	2,731	1,441	53%	1,290	47%
		Old	1,228	820	67%	407	33%
	CWHxm2 Total		12,119	3,777	31%	8,342	69%
	CWHvm1	Early	11,190	1,128	10%	10,062	90%
		Mid	5,189	1,278	25%	3,910	75%
		Mature	3,516	1,421	40%	2,096	60%
		Old	5,516	3,118	57%	2,398	43%
	CWHvm1 Total		25,411	6,945	27%	18,466	73%
	CWHvm2	Early	4,653	344	7%	4,309	93%
		Mid	929	193	21%	736	79%
		Mature	356	248	70%	108	30%
		Old	7,670	3,597	47%	4,073	53%
	CWHvm2 Total		13,608	4,382	32%	9,226	68%
	MHmm1	Early	1,164	190	16%	974	84%
		Mid	190	166	87%	24	13%
		Mature	82	74	91%	8	9%
		Old	7,162	5,327	74%	1,835	26%
	MHmm1 Total		8,598	5,757	67%	2,840	33%
Lower Nimpkish LU		Early	*22,230*	*2,146*	*10%*	*20,804*	*90%*
		Mid	*9,244*	*2,669*	*29%*	*6,576*	*71%*
		Mature	*6,686*	*3,184*	*48%*	*3,502*	*52%*
		Old	*21,576*	*12,863*	*60%*	*8,713*	*40%*
		Total	***56,736***	***20,862***	***35%***	***38,874***	***65%***
Upper Nimpkish (Intermediate)	CWHxm2	Early	1,491	260	17%	1,232	83%
		Mid	2,735	728	27%	2,007	73%
		Mature	311	216	70%	94	30%
		Old	574	475	83%	99	17%
	CWHxm2 Total		5,111	1,679	33%	3,432	67%
	CWHmm1	Early	3,874	595	15%	3,279	85%
		Mid	7,692	1,865	24%	5,826	76%
		Mature	62	40	70%	22	30%
		Old	1,007	869	86%	138	14%
	CWHmm1 Total		12,635	3,369	27%	9,266	73%

Landscape Unit (BEO)	BEC	Seral Stage	Productive Forest (ha)	Non Contributing Area		THLB Area	
				ha	%	ha	%
	CWHvm1	Early	8,636	1,046	12%	7,591	88%
		Mid	4,488	647	14%	3,841	86%
		Mature	255	145	57%	110	43%
		Old	4,124	2,841	69%	1,284	31%
	CWHvm1 Total		17,503	4,679	27%	12,825	73%
	CWHvm2	Early	9,019	606	7%	8,413	93%
		Mid	1,591	319	20%	1,272	80%
		Mature	293	171	58%	122	42%
		Old	10,639	5112	48%	5,528	52%
	CWHvm2 Total		21,542	6,208	29%	15,335	71%
	MHmm1	Early	2,119	135	6%	1,984	94%
		Mid	663	456	69%	207	31%
		Mature	163	132	81%	31	19%
		Old	12,744	8,502	67%	4,242	33%
	MHmm1 Total		15,689	9,226	59%	6,464	41%
Upper Nimpkish LU		Early	*25,140*	*2,642*	*11%*	*22,498*	*89%*
		Mid	*17,168*	*4,015*	*23%*	*13,153*	*77%*
		Mature	*1,084*	*705*	*65%*	*380*	*35%*
		Old	*29,090*	*17,798*	*61%*	*11,291*	*39%*
		Total	***72,481***	***25,160***	***35%***	***47,321***	***65%***
Grand Total		Early	*47,370*	*4,789*	*10%*	*42,581*	*90%*
		Mid	*26,413*	*6,684*	*25%*	*19,729*	*75%*
		Mature	*7,770*	*3,889*	*50%*	*3,881*	*50%*
		Old	*50,665*	*30,660*	*61%*	*20,004*	*39%*
		Total	***132,217***	***46,022***	***35%***	***86,195***	***65%***

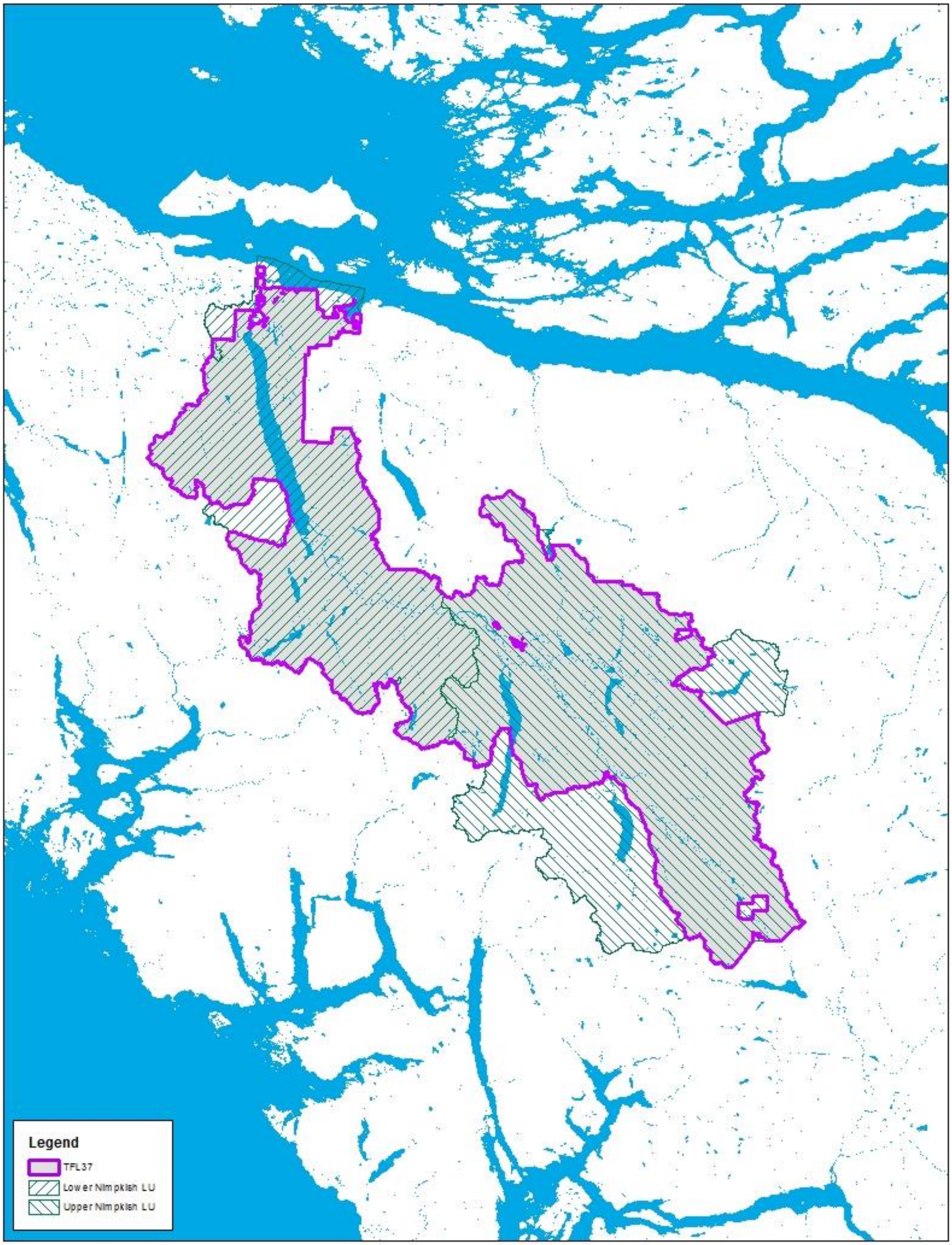

Figure 15 – Landscape Units

7.3 Analysis Units

The productive forested area is aggregated into groups of similar stands to produce growth and yield information needed to model timber supply with separate groupings for the THLB and non-contributing (NC) components of the TFL. For existing stands, analysis units (AUs) are based on biogeoclimatic subzone variant (variant), site productivity class, age class, and leading species. These grouping are described in more detail in the following sections.

7.3.1 Biogeoclimatic Variant assignment

Variants were assigned using the TFL 37 Terrestrial Ecosystem Mapping (TEM). The productive forest was assigned to one of five analysis unit level variants (Figure 16 and Table 28). A detailed breakdown by landscape unit and seral stage is indicated in Table 27.

Table 28 - Analysis Units Biogeoclimatic Variants

Variant	Area (ha)	
	Productive Forest	THLB
CWHxm2	17,230	11,775
CWHmm1	12,635	9,266
CWHvm1	42,914	31,290
CWHvm2	35,151	24,560
MHmm1	24,287	9,304
Total	***132,217***	***86,195***

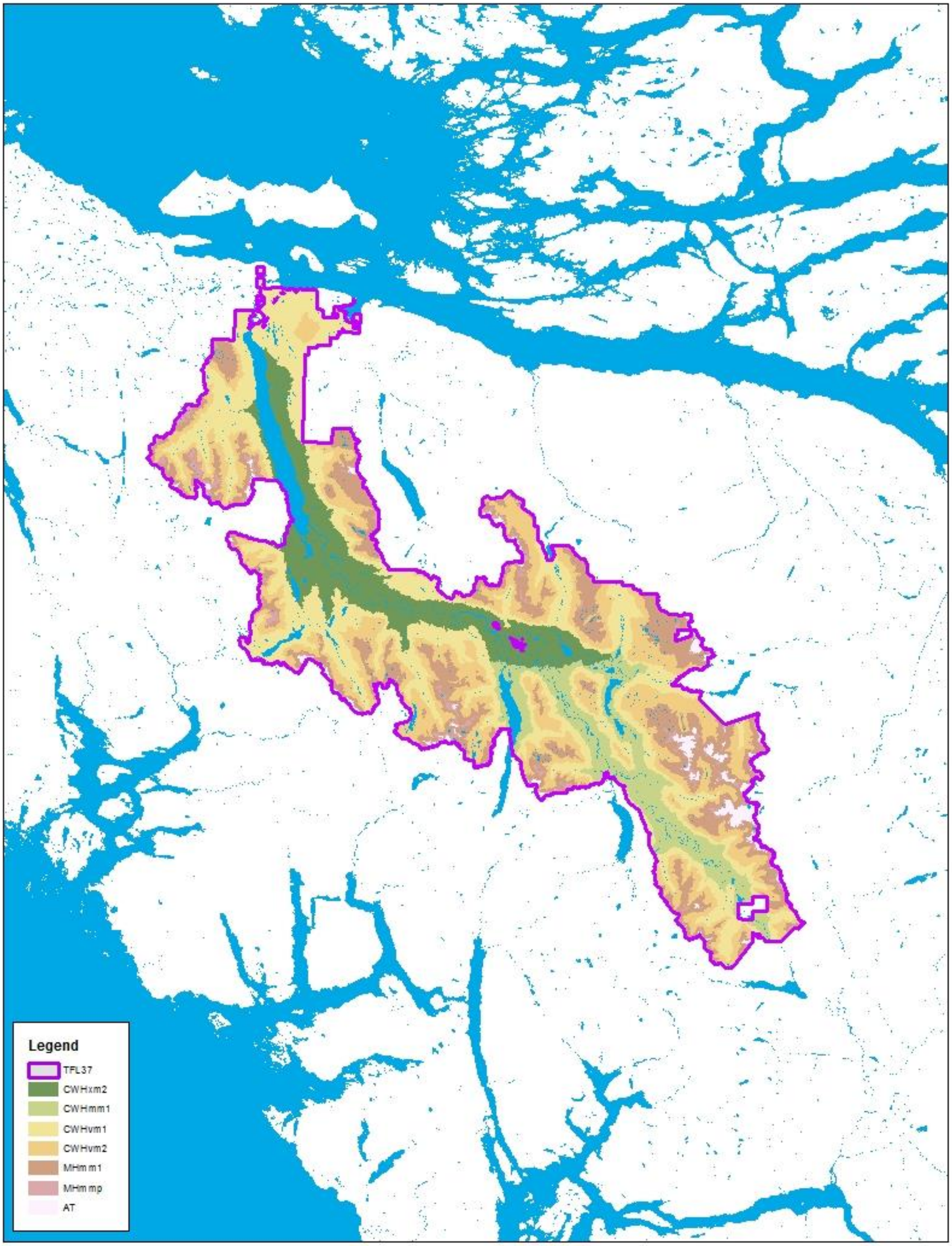

Figure 16 – Biogeoclimatic variants

7.3.2 Site Productivity Class assignment

Site productivity (measured via site index) is the next level of aggregation for analysis units. Site index values will come from 3 different sources:

- for unmanaged stands (established prior to 1961), adjusted inventory site index values will be applied. The adjustment is based on the Phase II VRI plots measured in 2001 (see Appendix A and B).
- for managed stands (established since 1961), two different site index sources will be used:
    - for CWHxm2, CWHmm1 and CWHvm1 local site index values by site series as determined in a 2000 study by J.S. Thrower & Associates will be applied (see Appendix C),
    - for CWHvm2 and MHmm1, SIBEC values will be applied.

7.3.2.1 Unmanaged Stands Site Classes

Unmanaged stands will be grouped into 3 productivity classes (good, medium, poor) based on the adjusted inventory site index value for the leading species. Site index ranges were determined such that approximately 25% of the productive area within a leading-species group is classified 'poor', 50% is classified 'medium' and 25% is classified 'good' – see Table 29.

Table 29 – Unmanaged Stands Site Index Ranges

Leading Species	Site Index Range (m)		
	Poor Site	Medium Site	Good Site
Fd	< 20	20 - 31	> 31
Hw	< 11	11 - 19	> 19
Hm	< 7	7 - 9	> 9
Ba	< 12	12 - 16	> 16
Cw	< 12	12 - 16	> 16
Yc	< 9	9 - 11	> 11
Dr	< 25	25 - 29	> 29
Misc Conifer	< 14	14 - 28	> 28

7.3.2.2 *Managed Stands Site Classes*

Managed stand site index estimates for the five main species (Ba, Cw, Fd, Hw, Yc) were attached to each forest cover polygon (see Section 8.1 for details). Site productivity classes for managed stands are based on the site index value for the species listed by variant as indicated in Table 30.

Table 30 – Species and Site Index Ranges Used to Define Managed Stand Site Productivity Class

Variant	Site Index Source	Site Productivity Species	Site Index Range (m)		
			Poor Sites	Medium Sites	Good Sites
CWHxm2	Adjusted Local	Fd	< 26	26 – 32	> 32
CWHmm1	Adjusted Local	Fd	< 26	26 – 32	> 32
CWHvm1	Adjusted Local	Fd	< 26	26 – 32	> 32
CWHvm2	SIBEC	Hw	< 16	16 – 24	> 24
MHmm1	SIBEC	Hm	< 16	16 – 24	> 24

7.3.3 Age Class

Existing stands are assigned to five different age classes based on management era. Ages are based on known or estimated date of establishment, with ages reported as of December 31, 2015.

7.3.3.1 *Unmanaged stands*

Unmanaged stands are 55 years and older (established 1960 and earlier). The assumption is these stands are the result of natural regeneration following harvesting or natural disturbances. Volume in these stands is estimated using FLNRO's *Variable Density Yield Projection* (VDYP) version 7.29.

7.3.3.2 *Managed Stands*

Managed stands have been established since 1961 when detailed silviculture records began to be maintained for the TFL. Most of these stands are the result of planting but there are naturally regenerated stands present in this age range, particularly in the upper end of the age range. Volume in these stands is estimated using FLNRO's *Table Interpolation Program for Stand Yields* (TIPSY) version 4.3.2.

7.3.3.2.1 Stands established between 1961 and 2000

Reforestation goals between 1961 and 1985 were to reforest areas immediately following harvest and to eliminate not-satisfactorily restocked (NSR) areas. Stands in this age class (30 – 54 years) were reforested to lower densities (950 stem/ha) than more recent stands and did not benefit in any significant amount from genetic gain values associated with tree nursery stock.

Stands established between 1986 and 2000 benefit from the deployment of seedlings with early genetic gain values and higher target stocking (1100 stems/ha). Yields are not influenced by high levels of stand retention.

For simplicity these two eras will be combined and modelled with planting density of 1000 stems/ha and no genetic gain values.

7.3.3.2.2 Stands established between 2001 and 2015

These most recently established stands (ages 1-14 years) have greater genetic gain values and are influenced by higher levels of stand-level retention due to the use of the retention silviculture system.

7.3.3.2.3 Future stands

These stands (including current NSR stands) have genetic gain values greater than the 1 – 14 year old stands and are influenced by higher levels of stand-level retention from the previous harvest due to the use of the retention silviculture system (refer to Section 8.4.2 for details on the modelling of this influence).

7.3.4 Leading Species

Existing stands are grouped based on the leading species:

- 'Ba' if the leading species is balsam;
- 'Cw' if the leading species is western red cedar;
- 'Fd' if the leading species is Douglas fir;
- 'Hw' if the leading species is western hemlock;
- 'Hm' if the leading species is mountain hemlock;
- 'Yc' if the leading species is yellow cedar;
- 'Decid' if the leading species is deciduous (alder or maple);
- 'Misc' if the leading species is another conifer species (pine, spruce); and,
- 'Grouped' to limit the number of unique combinations if applying the above logic results in a minor area (generally less than 10 ha) of a species group.

As future stands assumptions are based on variant and site class (refer to Section 8.6.5) no species group is required. Therefore, 'N/A' is applied for future stands species groups.

7.3.5 Analysis unit codes

A four-digit code identifies the variant, productivity class, age class and species group for each analysis unit (Table 31).

Table 31 - Analysis Units Legend

First Digit ***BEC Variant***	**Second Digit** ***Site Class***	**Third Digit** ***Establishment Year*** **(2015 age range)**	**Fourth Digit** ***Species Group***
1 CWHxm2	1 Poor	1 Future (N/A)	0 Grouped or N/A
2 CWHmm1	2 Medium	2 2001 – 2015 (1-14 yrs)	1 Ba
3 CWHvm1	3 Good	3 1961 – 2000 (15 - 54 yrs)	2 Cw
4 CWHvm2		4 < 1961 (> 54 yrs)	3 Fd
5 MHmm1			4 Hw
			5 Hm
			6 Yc
			7 Decid
			8 Other Conifer

For example, code 2344 identifies the CWHmm1/Good Site/Unmanaged/western hemlock analysis unit.

8 GROWTH AND YIELD

This section describes the approach used to develop yield tables for managed and unmanaged stands. The general approach is to develop yield tables for existing and future stands. Specific yield tables are developed for:

1) Existing unmanaged stands;
2) Existing managed stands; and
3) Future managed stands.

Summaries in this section are for the THLB only as this is the portion of the land base that contributes to timber supply. Similar summaries were produced for the non-contributing land base such that separate yield tables were generated for each AU where applicable, i.e., one for the THLB and one for the NC land base.

8.1 Site Index

Site Index (SI) is a measure of productivity and is based on the stand's height as a function of its age, normally 50 years. The productivity of a site largely determines the time seedlings will take to reach green-up conditions, the volume of timber that can be produced and the age at which a stand will reach merchantable size.

Two approaches to assigning site index are employed:

- For unmanaged stands, results of the VRI Phase II ground samples are used to determine an adjusted inventory site index (see Appendix A and B);
- For managed stands, site index values by biogeoclimatic site series will be used. For CWHxm2, CWHmm1 and CWHvm1 site series the site index values are based on a study done in 2000 by J.S. Thrower & Associates where local adjusted site index estimates were developed based on field sampling (see Appendix C). Within CWHvm2 and MHmm1 site series the site index values are sourced from FLNRO 's *Site Index Estimates by BEC Site Series* (SIBEC). SIBEC is a long-term research project intended to provide site index estimates by tree species that reflect the average growth potential in forested site series in British Columbia. Site index values are assigned to all species within a stand where available. Where a site index value is not available, site index conversion equations within TIPSY will be employed.

Table 32 shows the mean managed stand site index for the TFL is 29.8 m.

Table 32 - THLB Area-weighted Average Managed Stand Site Index Values

	Site Class			
BEC variant	**Poor**	**Medium**	**Good**	**Total**
CWHxm2	24.7	26.7	36.5	33.7
CWHmm1	19.2	26.7	35.2	34.5
CWHvm1	25.0	30.6	36.7	35.2
CWHvm2	11.8	17.1	28.0	24.3
MHmm1	10.2	16.0	-	15.7
Total	***15.9***	***21.7***	***33.9***	***29.8***

8.2 Utilization Levels

The utilization level is 12.5 cm for stands less than 121 years old and for future stands. Stump height for these stands is 30 cm and top diameter inside bark (DIB) is 10 cm. Utilization level for mature stands is 17.5 cm, with stump height of 30 cm and top DIB of 10 cm (Table 33).

Table 33 - Utilization Levels

Age Class	Utilization			Firmwood Standard
	Minimum DBH (cm)	Stump Height (cm)	Top DIB (cm)	
Mature (>120 years old)	17.5	30.0	10.0	50%
Immature (<121 years old)	12.5	30.0	10.0	50%

8.3 Operational Adjustment Factors

Adjustments to managed stand volumes are incorporated into their yield tables. The unadjusted TIPSY output reflects growth relationships observed in research plots generally located in fully-stocked, even-aged stands of uniform site and in forests of little or no pest activity. To reflect operational environments, two operational adjustment factors (OAFs) are applied to TIPSY outputs to reduce the potential yields:

1. OAF 1: 15 percent
2. OAF 2: 5 percent

8.3.1 OAF 1

OAF 1 is constant across all ages and is intended to account for small, unmapped non-productive areas in a stand, uneven spacing of crop trees (clumping) and competition from non-commercial tree species and brush. The “standard” OAF 1 of 15 percent is considered a province-wide estimate of the difference between research plots and typical yields.

8.3.2 OAF 2

OAF 2 increases with age and is intended to reflect the impact of insects, disease and decay. For this analysis, since no studies have been done to develop local factors, subject to Section 8.4.2.1.1, provincial “standard” OAF 2 of 5% will be applied.

8.4 Volume Reductions

8.4.1 Unmanaged Stands Volume

Gross stand volumes (close utilization less decay) are reduced to reflect estimates of waste and breakage based on the factors built into VDYP 7.

8.4.2 Managed Stands Volume

8.4.2.1.1 Root Rot in CWHxm2

Root diseases (mainly *Phellinus weirii*) are commonly found on medium and good sites within the CWHxm2 variant. Such diseases spread primarily through root contact and can attack and gradually kill trees throughout their life cycle. Various studies have indicated volume losses ranging from 5.0% to 8.9%, with a 7% mid-point. To account for this estimated volume loss, OAF 2 is increased from the provincial "standard" 5% to 12% for current managed Douglas fir leading stands within the CWHxm2 variant. This change is not to be interpreted as a local OAF adjustment but merely the methodology chosen to model the impact of root rot.

8.4.2.1.2 Shading from Retained Trees

Volume reductions will be applied to stands established since 2001 and all future stands to model the growth impact of stand-level retention in the previous harvest. Unadjusted TIPSY yields are estimated volumes from regenerating stands within a clearcut environment. Retention of standing trees within the harvest area is expected to reduce the yields of the regenerating stand. TIPSY includes an adjustment factor for variable retention (VRAF). The VRAF has two components: the removal of area from future timber production and the competition influence (shading) of retained areas on the adjacent regenerating portions of the cutblock. Given that the area impact is addressed as a THLB netdown (refer to Sections 6.17 and 6.20), only the yield impact from shading needs to be applied to the subject stands.

The VRAF uses three main variables: percent crown cover, edge length (perimeter) and top height. To determine the yield adjustments to apply, several scenarios were run in TIPSY using Fd and Hw species across a range of site index values and retention levels of 0% (base), 10%, 15% and 20% (refer to Section 10.3.3 for where these retention levels apply). Top height was determined at approximate rotation ages (see Section 10.3.1) from the scenarios run with no VRAF applied. Nearly all retention has been, and is anticipated to be, group retention in varying sizes and shapes. To represent the edge length required for VRAF calculations, the assumption used in the TIPSY scenarios was 0.25 ha groups in a 1x5 rectangular shape.

Table 34 indicates the range and average yield impacts observed in the TIPSY scenarios. The average VRAF applies to the percentage of the harvest area anticipated to be harvested with the retention system where the corresponding retention level applies to generate the average yield impact to apply. This reduction will occur when individual stands are harvested during modelling. Yield curves are left unaltered.

Table 34 – Yield Component of Variable Retention Adjustment Factor

Description	Retention Level		
	10%	**15%**	**20%**
Range in VRAF in TIPSY scenarios	1.5% - 5%	3% - 6%	4% - 8%
Average VRAF	2%	3.5%	5%
Percent of harvest area	51%	62%	100%
Average yield impact to be applied	***1.0%***	***2.2%***	***5%***

8.5 Yield Tables for Unmanaged Stands

Unmanaged stands are 55 years and older (established 1960 and earlier). The assumption is these stands are the result of natural regeneration following harvesting or natural disturbances. Volume is estimated using VDYP and applying adjustments discussed in Section 5.2.

The large number of unmanaged stand yield curves (14,244 VRI stands in the productive forest) were aggregated into 81 analysis unit yield curves.

Yield tables for each unmanaged analysis unit are listed in Appendix D: Yield Tables for Unmanaged Stands.

8.5.1 Unmanaged Stands Volume Check

The results of comparing inventory polygon-specific volumes against the aggregated analysis unit volumes for unmanaged stands are presented Table 35. Within the THLB total volumes are nearly identical. Analysis units for the non-contributing landbase result in approximately 3% less volume in total. This difference is a result of VDYP not being able to project some low volume old growth stands within the non-contributing land base backwards to contribute to the associated analysis unit volume curve at younger ages.

Table 35 – Unmanaged Volumes Check

Land Base	Inventory Volume (m^3)	Analysis Unit Volume (m^3)	Difference (m^3)	Difference (%)
THLB	17,519,327	17,345,980	-173,347	-1%
Non-Contributing	17,327,768	16,765,784	-561,985	-3.2%
Total	34,847,095	34,111,764	-735,331	-2.1%

8.6 Yield Tables for Managed Stands

8.6.1 Stocking density

A significant planting program has existed in TFL 37 since 1961. For the last 20 to 25 years most of the harvested area has been planted, typically at planting levels of around 1,100 sph, with many areas also consisting of substantial natural in-growth. TIPSY does not directly model planted stands with natural in-growth so managed stands yields are modelled on generalized planting success alone but with species distributions that reflect natural regeneration of western hemlock.

Future stands are modelled as if planted at between 900 and 1,100 sph depending on the site, with higher densities typically utilized on more productive sites to mitigate competition from brush.

Stands currently aged 1 to 14 years are modelled as if planted at 1,000 sph. This is supported by recent practice and a review of free-growing stands.

Stands currently aged 15 to 54 years are modelled as if planted at 1,000 sph. Although much of this area was planted, there were more naturally regenerated areas in earlier years and less use of fertilizer at-time-of-planting.

8.6.2 Fertilization

Since 1996, nitrogen fertilization (post-establishment) has occurred on approximately 9,000 ha in TFL 37. Fertilization treatments mostly occurred on Douglas fir leading stands growing on good sites where

TIPSY shows very little volume gain. Fertilization programs have been contingent on government funding programs and are expected to continue in the next few years. Fertilization will not be incorporated into the yield tables for current or future stands.

8.6.3 Volumes for Existing Managed Stands Aged 15 - 54 Years

Silviculture assumptions for existing managed stands aged 15 – 54 years (established 1961 – 2000) includes a plantation regeneration method for all stands, species composition from the inventory database, establishment density based on inventory and free-growing stand data and expected relative stocking success. These silviculture assumptions and THLB area-weighted site index estimates by species were used as inputs in Batch TIPSY 4.3.2 (see Table 36). No genetic gain was applied to stands in this age range.

Table 36- TIPSY Inputs for Existing Managed Stands Aged 15 – 54 Years

Existing AU	SPH	Spp[1] %	Spp1 SI	Spp2 SI	Spp3 SI	Spp4 SI	THLB Area (ha)
1132	1,000	Cw56 Hw33 Fd11	23.8	26.7	25.6	-	11
1133	1,000	Fd60 Hw22 Cw14 Pl04	24.6	23.5	22.6	23.5	36
1134	1,000	Hw60 Fd27 Cw13	25.3	25.1	23.3	-	15
1232	1,000	Cw52 Hw29 Fd19	22.4	23.2	26.7	-	24
1233	1,000	Fd63 Hw26 Cw11	26.7	23.2	22.4	-	807
1234	1,000	Hw55 Fd30 Cw15	23.2	26.7	22.4	-	488
1332	1,000	Cw60 Hw22 Fd18	25.7	31.4	35.7	-	40
1333	1,000	Fd68 Hw25 Cw07	35.9	31.5	25.7	-	1,829
1334	1,000	Hw62 Fd27 Cw11	31.5	36.1	25.7	-	889
2133	1,000	Fd66 Hw22 Cw06 Pl06	19.2	18.5	20.6	13.2	72
2134	1,000	Hw64 Fd26 Cw10	18.7	19.2	20.7	-	27
2230	1,000	Hw50 Fd18 Cw18 Pl14	21.3	26.7	21.7	21.3	5
2233	1,000	Fd69 Hw27 Cw04	26.7	21.3	21.7	-	341
2234	1,000	Hw65 Fd25 Cw10	21.3	26.7	21.7	-	143
2331	1,000	Ba43 Cw37 Hw20	26.3	24.5	28.3	-	10
2333	1,000	Fd74 Hw26	35.1	28.4	-	-	5,477
2334	1,000	Hw63 Fd31 Cw06	28.5	35.1	24.5	-	1,123
2338	1,000	Ss43 Hw23 Pl23 Cw11	36.0	29.4	21.3	24.8	10
3132	1,000	Cw47 Hw32 Fd14 Ba07	22.1	22.2	25.6	19.6	14
3133	1,000	Fd69 Hw24 Cw07	25.4	18.6	20.7	-	40
3134	1,000	Hw57 Cw22 Fd14 Ba07	22.1	22.0	25.6	19.5	46
3231	1,000	Ba49 Hw32 Cw12 Fd07	19.8	22.4	22.2	30.8	55
3232	1,000	Cw54 Hw30 Fd08 Ba08	22.5	23.3	29.4	20.8	166
3233	1,000	Fd68 Hw27 Cw05	30.7	22.5	22.2	-	1,794
3234	1,000	Hw62 Fd16 Cw13 Ba09	22.6	30.4	22.2	20.1	2,082
3331	1,000	Ba54 Hw26 Cw12 Fd08	27.4	29.3	24.8	36.9	410
3332	1,000	Cw45 Hw27 Fd14 Ba14	24.8	29.3	36.3	27.3	194
3333	1,000	Fd72 Hw28	36.6	29.2	-	-	5,698
3334	1,000	Hw63 Fd15 Ba12 Cw10	29.3	36.6	27.3	24.8	6,032
3335	1,000	Hw65 Fd30 Cw5	29.1	36.3	24.7	-	4

[1] Ba = balsam; Cw = western red cedar; Fd = Douglas fir; Hw = western hemlock; Hm = mountain hemlock; Pl = pine; Ss = sitka spruce; Yc = yellow cedar

Existing AU	SPH	Spp[1] %	Spp1 SI	Spp2 SI	Spp3 SI	Spp4 SI	THLB Area (ha)
3336	1,000	Yc39 Hw32 Ba19 Cw10	24.7	29.1	27.1	24.7	25
3338	1,000	Ss54 Hw32 Ba14	38.1	29.9	28.0	-	36
4131	1,000	Ba45 Hw38 Yc17	12.0	12.0	12.0	-	33
4133	1,000	Fd66 Hw25 Cw09	12.0	12.0	12.0	-	31
4134	1,000	Hw56 Ba19 Cw13 Yc12	12.0	12.0	12.0	12.0	58
4230	1,000	Hw39 Cw35 Ba15 Yc11	17.3	16.7	24.0	16.7	6
4231	1,000	Ba56 Hw30 Yc14	24.0	18.5	17.2	-	266
4233	1,000	Fd68 Hw32	24.0	16.6	-	-	782
4234	1,000	Hw59 Ba20 Yc12 Fd09	17.7	24.0	16.8	24.0	1,168
4236	1,000	Yc51 Hw30 Ba19	17.8	19.6	24.0	-	32
4330	1,000	Hw55 Pl21 Ba19 Yc05	28.0	24.0	25.8	24.0	7
4331	1,000	Ba56 Hw26 Yc18	25.7	28.0	24.0	-	1,343
4332	1,000	Cw50 Hw21 Fd19 Ba10	20.1	28.0	28.0	25.7	71
4333	1,000	Fd70 Hw30	28.0	28.0	-	-	1,344
4334	1,000	Hw55 Ba24 Yc15 Fd06	28.0	25.8	24.0	28.0	3,477
4336	1,000	Yc50 Ba27 Hw23	24.0	25.7	28.0	-	126
5131	1,000	Ba59 Hw25 Yc16	10.0	10.0	10.0	-	31
5134	1,000	Hw50 Ba36 Yc14	10.0	10.0	10.0	-	9
5136	1,000	Yc56 Hw23 Ba15 Fd06	10.0	10.0	10.0	10.0	3
5231	1,000	Ba59 Hw21 Yc20	12.2	16.0	12.0	-	486
5234	1,000	Hw63 Ba25 Yc12	16.0	12.0	12.0	-	207
5235	1,000	Hw51 Ba30 Yc19	16.0	12.0	12.0	-	24
5236	1,000	Yc53 Hw25 Ba22	12.0	16.0	12.0	-	398
5238	1,000	Ss51 Pl26 Hw12 Ba11	12.0	12.0	16.0	12.0	13

Yield curves for each existing managed age 15 – 54 years analysis unit are listed and shown in Appendix E: Yield Tables for Existing Managed Stands Aged 15 – 54 Years.

8.6.4 Volumes for Existing Managed Stands Aged 1 - 14 Years

Silviculture assumptions for existing managed stands aged 1 – 14 years (established 2001 – 2015) includes a plantation regeneration method for all stands, species composition from the inventory database and stand assessments, establishment density reflecting stocking success. Genetic gain for Cw and Fd are applied to stands in this age range based on average values for common seedlots planted in TFL 37 since 2000. Expected genetic gains for low elevation Hw are reduced from 14% to 0% to reflect the extent of natural regeneration expected in the harvested stand; very little Hw has been planted recently so Hw found in stands is nearly all naturally regenerated with no genetic gain.

In the timber supply model, yields for these stands will be reduced to account for the impact on growth by trees retained in the previous harvest (see Sections 8.4.2 and 10.3.3 for more details).

Average TIPSY inputs for existing managed stands aged 1 – 14 years are given in Table 37.

Table 37 - TIPSY Inputs for Existing Managed Stands Aged 1 – 14 years

Existing AU	SPH	Spp%	Spp1 SI	Spp2 SI	Spp3 SI	Spp4 SI	Genetic Gain %		THLB Area (ha)
							Cw	Fd	
1120	1,000	Hw48 Fd29 Cw18 Ba05	22.3	24.6	22.1	19.8	7	7	8
1222	1,000	Cw58 Hw27 Fd15	22.4	23.2	26.7	-	7	7	78
1223	1,000	Fd58 Hw23 Cw19	26.7	23.2	22.4	-	7	7	205
1224	1,000	Hw55 Fd28 Cw17	23.2	26.7	22.4	-	7	7	250
1321	1,000	Pl51 Fd30 Cw19	30.0	37.3	25.8	-	7	7	19
1322	1,000	Cw59 Fd17 Hw15 Pl09	25.6	35.4	31.4	30.0	7	7	90
1323	1,000	Fd66 Hw20 Cw14	37.1	31.7	25.8	-	7	7	799
1324	1,000	Hw58 Fd24 Cw13 Pl05	31.4	35.7	25.7	30.0	7	7	521
2123	1,000	Fd76 Hw19 Cw05	18.7	18.7	20.7	-	7	7	7
2220	1,000	Fd43 Hw27 Cw20 Pl10	26.7	21.3	21.7	21.3	7	7	14
2323	1,000	Fd64 Hw19 Cw12 Ba05	34.9	28.4	24.5	26.3	7	7	211
2324	1,000	Hw59 Fd23 Cw11 Ba07	28.5	35.0	24.5	26.4	7	7	76
3123	1,000	Fd59 Hw33 Cw08	22.0	13.1	18.5	-	7	7	12
3124	1,000	Hw71 Cw13 Fd09 Ba07	20.4	21.3	24.0	17.6	7	7	27
3222	1,000	Cw65 Hw22 Fd13	22.3	22.7	30.3	-	7	7	83
3223	1,000	Fd67 Hw18 Cw15	30.9	22.4	22.1	-	7	7	185
3224	1,000	Hw60 Cw19 Fd14 Ba07	22.6	22.2	30.5	20.1	7	7	346
3321	1,000	Ba60 Hw29 Cw06 Yc05	27.2	29.2	24.7	24.7	7	-	63
3322	1,000	Cw59 Hw19 Fd15 Ba07	24.8	29.2	36.3	27.2	7	7	209
3323	1,000	Fd60 Hw27 Cw13	36.5	29.2	24.7	-	7	7	606
3324	1,000	Hw69 Fd13 Cw12 Ba06	29.3	36.8	24.8	27.3	7	7	2,545
3326	1,000	Yc50 Ba25 Hw19 Cw06	24.7	27.1	29.1	24.7	7	-	37
3328	1,000	Ss45 Hw22 Fd18 Cw15	37.0	29.4	37.0	24.8	7	7	40
4121	1,000	Ba52 Hw18 Cw16 Yc14	12.0	12.0	12.0	12.0	7	-	12
4124	1,000	Hw54 Yc17 Ba16 Cw13	10.0	11.2	12.0	11.2	7	-	76
4126	1,000	Yc55 Ba26 Hw19	12.0	12.0	12.0	-	-	-	27
4221	1,000	Ba50 Hw24 Yc20 Cw06	24.0	18.3	17.2	17.2	7	-	174
4222	1,000	Cw57 Ba16 Yc15 Hw12	16.8	24.0	16.8	17.5	7	-	32
4223	1,000	Fd67 Hw22 Yc11	24.0	16.2	16.1	-	-	2	71
4224	1,000	Hw53 Yc20 Ba19 Fd08	17.0	16.5	24.0	24.0	-	2	354
4226	1,000	Yc51 Hw29 Ba20	16.7	17.5	24.0	-	-	-	127
4228	1,000	Yc40 Pl30 Fd20 Hw10	16.0	20.0	24.0	16.0	-	2	11

Existing AU	SPH	Spp%	Spp1 SI	Spp2 SI	Spp3 SI	Spp4 SI	Genetic Gain % Cw	Genetic Gain % Fd	THLB Area (ha)
4321	1,000	Ba50 Hw29 Yc21	25.8	28.0	24.0	-	-	-	821
4322	1,000	Cw56 Ba17 Hw17 Fd10	20.0	25.7	28.0	28.0	7	2	106
4323	1,000	Fd61 Cw24 Hw15	28.0	20.1	28.0	-	7	2	82
4324	1,000	Hw59 Ba26 Yc15	28.0	25.8	24.0	-	-	-	1,676
4326	1,000	Yc54 Ba25 Hw21	24.0	25.7	28.0	-	-	-	415
5121	1,000	Ba58 Hw23 Yc19	10.0	10.1	10.0	-	-	-	39
5124	1,000	Hw50 Ba30 Yc20	10.4	10.0	10.0	-	-	-	13
5126	1,000	Yc47 Ba42 Hw11	10.0	10.0	10.0	-	-	-	61
5221	1,000	Ba56 Yc24 Hw20	12.1	12.0	16.0	-	-	-	686
5222	1,000	Cw60 Ba20 Yc20	12.0	12.8	12.0	-	-	-	10
5224	1,000	Hw50 Ba30 Yc20	12.0	12.1	12.0	-	-	-	146
5225	1,000	Hw44 Yc30 Ba26	16.0	12.0	12.0	-	-	-	30
5226	1,000	Yc51 Ba32 Hw17	12.0	12.1	16.0	-	-	-	283

Yield curves for each existing managed age 1 – 14 years analysis unit are listed and shown in Appendix F: Yield Tables for Existing Managed Stands Aged 1 – 14 Years.

8.6.5 Future Stand Volumes

Ecologically-based silviculture strategies for future stands were developed by Western Forest Products staff based on current practices and a review of surveys for stands established between 1997 and 2014. Species composition reflects natural ingress of hemlock on most sites (Table 39). Species and stocking levels are portrayed at a broad average level to simplify modelling.

Stand density is represented by planting at 900 to 1,100 sph to reflect the continued practice to plant almost all harvested areas and natural in-growth experienced on many sites. It is recognized that this includes a range of specific prescriptions that might include establishment of alder on a small percentage of the land base (for further discussion on this see *Hardwood Management in the Coast Forest Region* (MoFR, 2009)) or a greater reliance on natural regeneration in some areas.

8.6.5.1 Site Series Groups

When applied to future analysis units the site productivity aggregation discussed in Section 7.3.2.2 results in the grouping of site series as indicated in Table 38

Table 38 – Future Analysis Unit Site Series Groups

Future Analysis Unit	BEC	Site Class	Site Series
1110	CWHxm2	Poor	02, 11, 12
1210	CWHxm2	Medium	01p, 01s, 03, 04, 06p, 06s, 12
1310	CWHxm2	Good	01, 05, 06, 07, 08
2110	CWHmm1	Poor	02, 11
2210	CWHmm1	Medium	03, 04
2310	CWHmm1	Good	01, 05, 06, 07, 08, 09
3110	CWHvm1	Poor	02, 14
3210	CWHvm1	Medium	01p, 01s, 03, 04, 06p, 06s, 12

Future Analysis Unit	BEC	Site Class	Site Series
3310	CWHvm1	Good	01, 05, 06, 07, 09, 10
4110	CWHvm2	Poor	02, 06s, 09, 10
4210	CWHvm2	Medium	01s, 03, 04, 06, 11
4310	CWHvm2	Good	01, 05, 07, 08
5110	MHmm1	Poor	02, 06, 07, 08, 09
5210	MHmm1	Medium	01, 03, 04, 05

8.6.5.2 Regeneration Delay

Regeneration delay refers to the average time between harvesting and the establishment of the next rotation. Nearly all harvested area is planted and prompt establishment after harvesting continues to be practiced in the TFL. Planted seedlings are typically one year old and early seedling growth is assisted on some sites by the practice of fertilization at time of planting. The regeneration delay from harvest until germination of the next crop of planted trees is generally less than one year within CWH variants and somewhat longer within the MH zone. A one year regeneration delay is applied for future managed stands in the CWH zone and a two year delay is applied in the MH zone. These delays are incorporated into yield tables used in the analyses.

8.6.5.3 Genetic Gain

Projections of Genetic Gain were developed from WFP's Saanich Forestry Centre seed inventory, development plans and the Forest Genetics Council business plans. Gain is projected to increase somewhat over the period from 2015 to 2034; however for future stands within the analysis, values associated with 2015 cone harvest will be used. As very little hemlock is planted expected gain values for low elevation Hw are reduced from 17% to 2% and not applied for high elevation to reflect natural regeneration expected in harvested stands. Average values for genetic gain by species and BEC variant listed in Table 39 will be applied to future managed stands. Note that in the MHmm1 variant, mountain hemlock (Hm) is assumed rather than western hemlock (Hw) so no GW value is applied.

8.6.5.4 Yields

Future stands yield tables generated for the Base Case are found in Appendix G: Yield Tables for Future Managed Stands.

In the timber supply model, yields for these stands are reduced to account for the impact on growth by trees retained in the previous harvest to meet stand-level retention targets (see Sections 8.4.2 and 10.3.3 for more details).

Table 39 - TIPSY Inputs for Future Managed Stands

Future AU	SPH	Ba %	Cw %	Fd %	Hw %	Yc %	Ba SI	Cw SI	Fd SI	Hw SI	Yc SI	Genetic Gain %				THLB Area (ha)
												Cw	Fd	Hw[1]	Yc	
1110	900	-	15	50	35	-	-	22.6	24.7	23.5	-	18	19	2	-	140
1210	1,000	-	20	45	35	-	-	22.4	26.7	23.2	-	18	19	2	-	3,131
1310	1,100	-	20	40	40	-	-	25.7	36.5	31.6	-	18	19	2	-	8,503
2110	900	-	10	50	40	-	-	17.2	19.2	19.4	-	18	19	2	-	18
2210	1,000	-	20	40	40	-	-	21.6	26.7	21.0	-	18	19	2	-	634
2310	1,100	-	20	40	40	-	-	24.5	35.2	28.5	-	18	19	2	-	8,614
3110	900	5	15	50	30	-	17.4	21.3	25.0	20.2	-	18	19	2	-	336
3210	1,000	-	20	50	30	-	-	22.2	30.6	22.6	-	18	19	2	-	7,321
3310	1,100	10	30	30	30	-	27.3	24.8	36.7	29.3	-	18	19	2	-	23,634
4110	900	20	10	10	40	20	12.0	11.8	10.0	11.8	11.8	-	9	-	20	547
4210	1,000	20	10	10	40	20	24.0	20.2	24.0	17.1	16.5	-	9	-	20	7,567
4310	1,100	30	10	10	30	20	25.8	20.2	28.0	28.0	23.6	-	9	-	20	16,449
5110	1,000	30	-	-	35	35	10.2	-	-	10.2	12.0	-	-	-	20	555
5210	1,000	20	-	-	45	35	12.1	-	-	16.0	16.0	-	-	-	20	8,747
Total							***23.7***	***22.9***	***32.1***	***25.6***	***19.7***					***86,195***

8.6.6 Not Satisfactorily Restocked Areas

The data set prepared for analysis includes 3,158 ha described as not satisfactorily restocked (NSR) and 3,150 ha of the "NSR" area is in the timber harvesting land base. The "NSR" area is significantly larger than in operational records as it includes areas planted in 2015 and other licensees' (e.g., First Nations, BCTS) cutblocks for which no planting data was available when the timber supply data set was compiled. NSR areas will be regenerated to the appropriate future Analysis Unit within the model in the first planning period.

Table 40 - NSR Area

Description	Productive Area (ha)	THLB Area (ha)
NSR lands	3,158	3,150

[1] Gain for Hw reduced from 17% in CWHxm2, CWHmm1, and CWHvm1 variants and from 11% in CWHvm2 variant to reflect expected natural regeneration component in future harvested stands.

9 NON-RECOVERABLE LOSSES

Windthrow, insects, disease and fire can cause catastrophic losses of whole stands of trees. Over the long-term, the probability of losses to such natural causes can be predicted. Where losses occur in merchantable stands some dead or dying timber may be salvageable. When modelling timber supply, unsalvaged losses are subtracted from the forecast upon completion of the modelling exercise.

9.1 Windthrow

Loss of single trees or small groups of trees are mostly accounted for in inventory sampling for existing timber yield estimates and OAFs applied to young stands. A great deal of research has been undertaken during the past ten to fifteen years to determine the variables that affect the amount of expected windthrow along cutblock edges following harvest and the effectiveness of various edge treatment techniques (e.g., pruning, topping, and feathering) to reduce the amount of windthrow experienced. Research results have aided in cutblock design and treatment prescriptions so that the amount of windthrow experienced from endemic winds has been greatly reduced. To date estimates of unrecovered windthrown timber varies between 0.2 percent to 0.5 percent of the annual harvest.

9.2 Insects and Disease

The forests of TFL 37 have been relatively free of major insect or disease infestations. There have been no major catastrophic outbreaks causing significant unsalvaged mortality or volume losses. Recently the main active agent has been the defoliator Western blackheaded budworm (*Acleris gloverana*). Western hemlock and true firs (balsam) are the preferred host species. An outbreak was identified in 2010 that peaked in 2012. There has been a steady decline in damage and activity since, with no incidences observed in 2015. This is the typical coastal cycle observed for blackheaded budworm: outbreaks last two or three years before declining to low levels, with outbreaks occurring roughly every ten to fifteen years. Healthy western hemlock appear to be able to withstand one year of severe defoliation without sustaining serious damage, often recovering within a year or two with minimal growth loss.

Most of TFL 37 is within the hazard zones for Sitka spruce weevil (*Pissodes strobe*). The rules for planting Sitka spruce are followed to reduce damage by the weevil and weevil resistant seedlings are being bred and planted.

Hemlock dwarf mistletoe is widespread throughout mature stands. Sanitation treatments of advanced regeneration are sometimes required to prevent the spread in newly regenerated western hemlock stands. Usually regenerated stands are not significantly impacted by hemlock dwarf mistletoe.

Root diseases, mostly *Phellinus weirii*, sometimes result in small pockets of mortality. These losses are assumed accounted for by the operational adjustment factors (OAFs) applied to yield curves.

9.3 Fire

The risk of timber loss due to fire is relatively low within the TFL. The bulk of the TFL has a wet climate characterized by relatively cool, wet summers and fire suppression has been effective; therefore, the likelihood of loss to forest fire is small. Despite that, in 2009 lighting ignited a fire that eventually impacted approximately 450 ha of plantations and timber and in 2014 a fire of unknown cause impacted 150 ha of plantations and timber. The affected plantations have been re-planted and the forest cover reflects the latest available data.

9.4 Total Non-recoverable Losses

An allowance of one percent of the harvest volume will be made for non-recoverable losses. This volume will be subtracted from the annual harvest in order to remove this volume from the THLB and transition an applicable amount of stand area to age zero. The volume of unrecovered timber will not be included in the reported harvest volumes.

10 INTEGRATED RESOURCE MANAGEMENT

The intent of this section is to provide an overview of resource inventories available and used for the timber supply review. This section also describes other resource management information utilized for planning within TFL 37.

10.1 Forest Resource Inventories

Table 41 summarizes the forest resource inventories currently being maintained for the TFL. Other inventories are maintained by the provincial government and periodically accessed via the *BC Geographic Warehouse*.

Table 41 - Forest Resource Inventory Status

Item	Status
Forest Inventory	1997 photo-interpretation updated to VRI standards. Statistical adjustments applied based on 2001 / 2002 field plots. Updated for disturbance and silviculture to December 31, 2015.
Ecosystems	1999 inventory to 1998 RIC standards (Level 3 survey intensity).
Terrain Stability	1999 inventory to 1995 RIC standards (Survey Intensity C).
Karst	2004 inventory to RIC standard for planning-level inventory.
Recreation Inventory	2000 inventory to 1998 MoF standards.
Visual Landscape Inventory	1992 inventory updated in 2002. rVQC's continued as VQOs per GAR s.17.
Ungulate Winter Ranges (UWRs)	Established UWRs (U-1-001) maintained on an on-going basis.
Wildlife Habitat Areas (WHAs)	Established and proposed WHAs maintained on an on-going basis.
Old Growth Management Areas (OGMAs)	Established OGMAs maintained on an on-going basis.
Stream Classification	Operational stream inventories.
Archaeological	Archaeological Overview Assessments (AOAs) available via FLNRO. Registered features and sites available via GeoBC.
Operability	Physical and economic operability updated in 1997 projects.

10.2 Forest Cover Requirements

10.2.1 Research Sites

There are 28 active government research sites within TFL 37, all associated with studying the growth of stands reforested with trial seedlings. Some sites were established as far back as 1959 but most date from the 1980's and 1990's. The contacts listed for each site were canvassed for a release year by which the research will have gathered all valuable data and the site can be released for harvesting. Not all researchers replied; however those that did provided dates that ranged from 40 to 60 years from the establishment date.

A 50 m buffer will be created around each active research site and the resulting area will not be available for harvest by the timber supply model until the release year is reached. If no release year was provided by the researchers the assumption will be that the area is not available for harvest until 60 years after the research site was established.

10.2.2 Visual Quality

The TFL visual landscape inventory forms the basis for managing visual quality within the North Island – Central Coast District. Scenic areas were made known by the District Manager in 1999. Under Section 17 of GAR, the recommended Visual Quality Classes (rVQCs) for scenic areas within TFL visual landscape inventories were continued as visual quality objectives (VQOs).

The *Procedures for Factoring Visual Resources into Timber Supply Analyses* (BC Ministry of Forests 1998) will guide the modelling of visual management. Visual Quality Objectives to be modelled are:

- Partial Retention (PR) – activities are visible but remain subordinate;
- Modification (M) – activities are visually dominant but have characteristics that appear natural.

There are no “Retention” VQO polygons within the TFL 37 visual inventory and the “Maximum Modification” polygons will not be modelled.

The procedures document lists visually effective green-up (VEG) heights varying from 3 m to 8.5 m depending on slope class (Table 42).

Table 42 – Visually Effective Green-up heights by slope

Slope (%)	0-5	5.1-10	10.1-15	15.1-20	20.1-25	25.1-30	30.1-34	35.1-45	45.1-50	50.1-55	55.1-60	>60
VEG (m)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5

An area-weighted average VEG height of 6.5 m will be used for TFL 37. TIPSY height curves by analysis unit will be used to track total area less than 6.5 m tall within VQO polygons.

Cutblock designs that follow the lines and forms of the viewscape allow more timber to be removed and still meet the VQO when compared to unnatural cutblock shapes. Additionally, the use of the retention silviculture system can result in more timber removal in visually sensitive areas by strategically placing retention patches to act as visual screens. As these practices are common within TFL 37, the maximum allowable disturbance by VQO will set at the upper end of the range typically used to model visual quality management constraints. Table 43 outlines assumptions for dealing with visual quality management within the TFL.

Table 43 - Visual Quality Management Assumptions

Visual Quality Objective (VQO)	Productive Forest (ha)	THLB Area (ha)	Maximum Allowable Disturbance (% of productive area)
Partial Retention (PR)	10,438	6,651	15%
Modification (M)	6,406	4,579	25%

10.2.3 Adjacent Cutblock Green-up

Legislation requires trees within plantations to reach specified heights before the adjacent timber can be harvested. A 3 m green-up height in VILUP General and Special Management Zones will be used for areas without visual quality objectives. A 1.3 m green-up height in VILUP Enhanced Forestry Zones will be used for areas without established VQOs.

Since Woodstock does not have the capability to spatially model adjacency requirements beyond the initial forest conditions, a proxy will be used with a maximum of 25 percent of the THLB within a zone but outside of VQO polygons being permitted to be less than the green-up height. TIPSY height curves by analysis unit will be used to track total area not greened-up.

For the initial forest conditions, areas within 200 m of recent plantations in General and Special Management Zones are restricted in the model to address adjacency requirements:

- Adjacent to stands established between 2005 and 2009 not available in first 5 years;
- Adjacent to NSR areas and stands established between 2010 and 2015 not available in first decade.

10.2.4 Landscape Level Biodiversity

Landscape Units and Biodiversity Emphasis Options (BEOs) were designated through the *Order Establishing Provincial Non-Spatial Old Growth Objectives* effective June 30, 2004. This order is in effect until Old Growth Management Areas are spatially determined through Landscape Unit planning. OGMAs have been established in the two landscape units within TFL 37 (refer to Section 6.11).

For forest types within TFL 37, old forest is defined as stands >250 years old. The old seral target is based on a combination of BEO, BEC variant, and variant natural disturbance type (NDT). Since the established OGMAs meet the full old forest retention target, no forest cover constraint is required.

For a breakdown of the current forest age by landscape unit and variant see Table 27.

10.2.5 Community Watersheds

There are no Community Watersheds within TFL 37.

10.2.6 Fisheries Sensitive Watersheds

There are no Fisheries Sensitive Watersheds within TFL 37.

10.2.7 VILUP Higher Level Plan

The order establishing Resource Management Zones and Resource Management Zone objectives within the area covered by the Vancouver Island Land Use Plan came into effect December 1, 2000. Each Special Management Zone (SMZ) established by the order includes an objective (Section II 1(a)(i)) of maintaining mature seral forest over one quarter to one third of the forested area in the SMZ, with the final target to be set through landscape unit planning. The Landscape Unit Plan orders for the Upper and Lower Nimpkish LU's established the objective at 25 percent for all SMZ's within the LU's.

As detailed in Table 26, portions of four Special Management Zones are found within TFL 37:

- SMZ 6 – Woss-Zeballos;
- SMZ 9 – Tsitika-Woss;
- SMZ 10 – Pinder-Atluck;

- SMZ 11 – Schoen-Strathcona.

For this analysis, a constraint will be incorporated that maintains 25 percent of the productive forest land base in mature and/or old seral stage within each SMZ.

10.3 Timber Harvesting

10.3.1 Minimum Harvestable Age

Minimum harvestable ages are the minimum criteria for use in the timber supply model. While actual harvesting may occur in stands below the minimum requirements in order to meet forest level objectives (e.g., maintaining overall timber flows, addressing forest health concerns), many stands will not be harvested until well past the minimum ages because consideration of other resource values may take precedence or timber may be in ample supply.

The data set prepared for analysis includes logging system (e.g., ground, cable or heli) based on a combination of operability class (see Section 6.8) and slope class. Conventionally operable areas with a slope between 0 and 40 percent are assumed harvestable by ground-based systems and conventionally operable areas on steeper slopes are assumed harvestable by cable systems. Helicopter operable areas are found across all slope classes as feasible road development determines areas not accessible by conventional harvesting systems.

This analysis will use minimum harvest ages based on average stand diameters that vary by harvesting system:

- 30 cm for ground-based harvesting;
- 37 cm for cable harvesting;
- 42 cm for helicopter harvesting;

and a minimum volume of 350 m3/ha. The notion being larger diameters in general reflect higher values and cable and heli yarding costs are particularly sensitive to piece (log) size. An economically sustainable harvesting program relies on average stand values being greater than average harvesting costs. Average harvesting costs are lowest for ground-based systems (e.g., skidder and “hoe-chucking”) and highest for helicopter, while cable systems (e.g., grapple yarding) costs fall between these. If the minimum DBH and/or volume thresholds are not reached by 250 years, a minimum harvest age of 250 years will be applied.

Table 44 and Table 45 indicate the minimum harvest ages by analysis unit and harvest system that will be used in the analysis. Younger ages are on higher productivity sites while older ages are on lower productivity sites. Culmination ages and volumes are provided for comparison purposes.

Table 44 - Minimum Harvest Ages (MHA) for Current Stands

Analysis Unit	Current THLB Area (ha)	Culm. Age	Culm. Volume	Ground-based Harvest		Cable Harvest		Helicopter Harvest	
				MHA	Volume at MHA	MHA	Volume at MHA	MHA	Volume at MHA
Unmanaged Stands (established 1960 and earlier)									
1142	24	115	212	250	329	250	329	250	329
1143	125	115	306	145	361	250	431	250	431
1144	26	150	403	250	488	250	488	250	488
1242	99	115	415	120	410	185	570	250	597

Analysis Unit	Current THLB Area (ha)	Culm. Age	Culm. Volume	Ground-based Harvest MHA	Ground-based Harvest Volume at MHA	Cable Harvest MHA	Cable Harvest Volume at MHA	Helicopter Harvest MHA	Helicopter Harvest Volume at MHA
1243	880	100	537	90	480	120	627	135	687
1244	501	115	435	120	431	220	615	250	615
1248	38	135	830	100	583	130	799	160	939
1342	173	110	559	100	505	120	595	140	678
1343	578	90	711	70	535	95	750	110	863
1344	2,121	100	716	75	522	105	750	120	838
1348	9	70	717	60	606	75	764	100	951
2142	10	150	354	150	354	180	393	250	422
2143	17	115	304	140	356	250	449	250	449
2144	5	165	394	175	412	250	450	250	450
2242	35	115	493	110	470	130	545	165	640
2243	499	95	534	85	472	130	701	190	813
2244	62	145	698	220	801	250	798	250	798
2342	26	95	616	60	331	80	509	95	616
2343	211	100	827	70	541	95	784	110	906
2344	185	100	728	80	571	105	762	120	853
3141	19	160	522	200	592	250	605	250	605
3142	308	150	309	180	355	250	388	250	388
3143	236	115	266	165	353	250	398	250	398
3144	577	160	342	235	408	250	411	250	411
3146	14	175	127	250	152	250	152	250	152
3241	152	145	843	120	653	145	843	235	995
3242	459	115	464	120	463	165	619	250	680
3243	230	100	531	90	474	120	621	140	698
3244	2,108	145	718	120	570	180	811	250	833
3246	73	155	335	165	353	250	413	250	413
3248	1	250	254	250	303	250	303	250	303
3341	121	115	815	105	734	120	842	240	1,114
3342	272	110	551	105	525	120	587	215	764
3343	179	95	777	70	603	90	735	105	856
3344	3,499	90	662	85	624	110	801	140	956
3346	40	115	583	120	579	160	757	250	854
3348	3	70	755	65	700	95	952	115	1,044
4141	191	165	551	140	428	250	640	250	640
4142	295	160	306	200	350	250	368	250	368
4143	71	115	325	150	405	250	494	250	494
4144	2,345	165	394	180	422	250	463	250	463
4241	337	145	816	120	622	145	816	130	975
4242	361	115	538	120	536	155	688	250	783
4243	9	110	627	120	656	155	815	250	934
4244	4,226	145	724	135	665	195	849	250	862

Analysis Unit	Current THLB Area (ha)	Culm. Age	Culm. Volume	Ground-based Harvest MHA	Ground-based Harvest Volume at MHA	Cable Harvest MHA	Cable Harvest Volume at MHA	Helicopter Harvest MHA	Helicopter Harvest Volume at MHA
4246	801	155	346	160	355	250	423	250	423
4341	171	115	718	105	648	125	772	165	935
4342	8	115	705	105	642	125	744	160	892
4344	129	100	606	90	541	120	714	140	803
4345	95	180	623	150	463	250	689	250	689
4346	506	115	480	120	474	190	697	250	737
5141	215	165	376	140	454	250	675	250	675
5142	18	155	327	205	384	250	401	250	401
5144	1,590	165	419	175	440	250	497	250	497
5241	147	150	758	120	552	155	779	250	902
5242	76	115	551	120	555	155	709	250	813
5244	1,741	145	669	125	549	220	813	250	826
5246	807	155	368	155	368	250	451	250	451
5341	57	115	843	105	758	125	911	155	1,072
5344	7	105	459	105	459	130	550	175	625
5345	277	180	623	150	461	250	701	250	701
5346	360	145	599	120	474	200	708	250	742
Managed Stands 15-54 years old (established 1961 - 2000)									
1132	11	105	721	75	493	125	838	165	1,005
1133	36	85	510	75	445	125	689	175	800
1134	15	90	736	70	541	105	847	140	1,063
1232	24	90	669	70	488	110	816	145	1,012
1233	807	85	560	70	453	110	697	195	887
1234	488	95	706	70	488	115	842	150	1,018
1332	40	90	978	55	538	75	805	95	1,031
1333	1,829	65	751	45	462	65	751	80	902
1334	889	70	880	50	562	70	880	85	1,062
2133	72	100	370	125	460	250	681	250	681
2134	27	125	605	105	503	185	810	250	941
2230	5	80	439	85	467	150	711	240	837
2233	341	90	598	70	451	120	768	160	909
2234	143	105	705	85	556	125	827	170	1,012
2331	10	95	908	60	513	90	859	120	1,111
2333	5,477	70	795	50	518	70	795	85	946
2334	1,123	75	836	55	557	75	836	95	1,036
2338	10	70	891	45	495	60	748	80	1,001
3132	14	110	769	75	497	120	836	160	1,028
3133	40	90	520	80	457	135	732	190	873
3134	46	110	764	80	531	125	856	165	1,039
3231	55	115	767	80	501	130	854	175	1,049
3232	166	105	798	70	493	110	836	145	1,042

Analysis Unit	Current THLB Area (ha)	Culm. Age	Culm. Volume	Ground-based Harvest MHA	Ground-based Harvest Volume at MHA	Cable Harvest MHA	Cable Harvest Volume at MHA	Helicopter Harvest MHA	Helicopter Harvest Volume at MHA
3233	1,794	85	706	60	468	90	745	115	902
3234	2,082	105	785	75	531	115	853	150	1,035
3331	410	80	842	55	513	85	895	105	1,077
3332	194	80	822	55	501	80	822	105	1,066
3333	5,698	70	850	45	476	65	787	80	958
3334	6,032	75	850	55	561	80	905	95	1,062
3335	4	75	873	50	508	75	873	90	1,029
3336	25	90	954	60	546	85	846	110	1,092
3338	36	65	1,057	40	531	50	760	65	1,057
4131	33	165	374	215	476	250	536	250	536
4133	31	130	171	250	280	250	280	250	280
4134	58	160	340	230	465	250	493	250	493
4230	6	115	554	105	503	185	815	250	957
4231	266	105	696	85	545	135	867	185	1,073
4233	781	95	459	95	459	170	722	250	843
4234	1,168	110	585	100	528	170	851	250	1,037
4236	32	110	621	90	491	155	829	220	1,021
4330	7	80	747	60	517	95	875	120	1,052
4331	1,344	95	896	65	569	95	896	125	1,126
4332	71	95	723	70	503	105	794	145	1,008
4333	1,344	80	677	60	479	95	793	120	945
4334	3,477	80	791	60	537	90	888	115	1,108
4336	126	100	924	60	491	95	877	120	1,084
5131	31	200	327	250	403	250	403	250	403
5134	9	190	286	250	370	250	370	250	370
5136	3	170	210	250	301	250	301	250	301
5231	486	165	450	180	488	250	632	250	632
5234	207	160	524	155	507	250	727	250	727
5235	24	155	476	165	506	250	686	250	686
5236	398	150	377	190	461	250	55	250	555
5238	13	160	476	140	412	250	661	250	661
Managed Stands 1-14 years old (established 2001 - 2015)									
1120	8	105	721	75	493	125	838	165	1,005
1222	78	105	812	65	462	105	812	140	1,019
1223	205	85	587	65	437	105	702	145	838
1224	250	95	722	70	503	110	830	145	1,012
1321	19	55	576	45	454	65	662	85	778
1322	90	85	905	50	474	75	795	85	905
1323	799	65	801	45	504	60	738	75	904
1324	521	70	867	50	562	70	867	85	1,040
2123	7	95	353	125	458	250	661	250	661

Analysis Unit	Current THLB Area (ha)	Culm. Age	Culm. Volume	Ground-based Harvest MHA	Ground-based Harvest Volume at MHA	Cable Harvest MHA	Cable Harvest Volume at MHA	Helicopter Harvest MHA	Helicopter Harvest Volume at MHA
2220	14	85	571	70	455	120	774	160	915
2323	211	70	792	50	519	70	792	85	940
2324	76	75	828	55	551	80	881	95	1,029
3123	12	95	371	115	442	145	528	250	696
3124	27	120	741	85	502	145	866	195	1,039
3222	83	85	670	65	473	100	784	135	1,010
3223	185	75	657	55	446	85	740	110	904
3224	346	105	799	80	591	110	836	145	1,026
3321	63	85	881	60	569	90	931	115	1,146
3322	209	90	937	55	516	80	828	110	1,115
3323	606	70	847	45	476	65	784	80	952
3324	2,545	75	865	55	574	75	865	95	1,080
3326	37	95	941	60	539	85	835	110	1,074
3328	40	65	984	40	497	55	805	65	984
4121	12	160	364	250	534	250	534	250	534
4124	76	165	267	250	378	250	378	250	378
4126	27	150	314	230	446	250	475	250	475
4221	174	105	667	85	521	140	857	195	1,055
4222	32	110	541	100	487	175	780	250	946
4223	71	90	433	95	456	170	708	250	823
4224	354	110	550	105	523	180	833	250	983
4226	127	115	575	100	493	175	811	250	982
4228	11	85	343	105	419	225	658	250	684
4321	821	90	854	65	575	95	902	120	1,103
4322	106	95	730	70	506	110	829	150	1,043
4323	82	85	657	65	484	100	761	135	932
4324	1,676	85	856	60	545	90	904	115	1,130
4326	415	100	920	60	488	95	872	120	1,079
5121	39	215	352	250	402	250	402	250	402
5124	13	190	290	250	374	250	374	250	374
5126	61	190	277	250	359	250	359	250	359
5221	686	160	425	185	488	250	616	250	616
5222	10	145	301	230	427	250	455	250	455
5224	146	170	372	225	475	250	513	250	513
5225	30	150	436	170	492	250	647	250	647
5226	283	150	364	200	465	250	546	250	546

Table 45 - Minimum Harvest Ages for Future Stands

Analysis Unit	Future THLB Area (ha)	Culm. Age	Culm. Volume	Ground-based Harvest		Cable Harvest		Helicopter Harvest	
				MHA	Volume at MHA	MHA	Volume at MHA	MHA	Volume at MHA
1110	140	90	659	65	454	100	730	145	948
1210	3,131	85	673	65	495	100	784	135	965
1310	8,503	65	868	45	541	65	868	80	1,044
2110	18	110	499	95	427	185	718	250	819
2210	634	85	614	70	491	110	781	155	970
2310	8,614	70	830	50	550	70	830	90	1,028
3110	336	90	578	70	434	115	423	170	915
3210	7,321	75	669	55	453	85	753	110	926
3310	23,634	70	832	50	548	70	832	110	1,212
4110	547	155	291	230	410	250	434	250	434
4210	7,567	105	545	100	516	170	812	250	985
4310	16,449	85	797	65	582	100	929	125	1,100
5110	555	180	410	205	467	250	549	250	549
5210	8,747	145	652	115	491	195	822	250	940

10.3.2 Harvest Rules

Analysis will be undertaken with the Woodstock model, using optimization to project harvest schedules. With optimization the model determines harvest order to achieve the defined objective. This differs from a simulation approach where rules are specified for harvest priority. Harvest constraints will, however, be applied to model the transition from old-growth to second-growth harvest.

10.3.2.1 Immature Stands Contribution

Recent harvest and short-term plans indicate significant harvesting of immature stands (i.e., <121 years old) in TFL 37. The Base Case will be constructed such that at least 20% of the harvest in the first decade is from immature stands and increase over time until the transition to managed stands is largely complete. Small volumes of old-growth harvest may continue because of the scheduling impacts of forest cover constraints.

10.3.2.2 Non-conventional Harvesting Contribution

The last AAC Determination attributed 37,000 m^3, or 3.8%, of the harvest to low economic hemlock-balsam helicopter stands (“heli-hembal”). Since then, WFP has been tracking performance in these stands. The tracking is on a harvested area basis as it is not always possible to link scaled timber volumes to an operability inventory classification, especially if a cutblock overlaps more than one classification. The results for the period 2007-2015 indicate that 4.1% of the harvest area was from heli-hembal stands. Therefore these stands have contributed their proportion of the harvest since the last AAC determination.

An overall summary of 2007-2015 harvesting performance by general operability categories is presented in Table 46. The THLB area by operability class is provided for comparative purposes. Actual harvest performance outside the conventionally operable landbase (8.4%) is nearly identical to the proportion of THLB (9.0%) and the average contribution in the MP #9 Base Case (9%).

WFP intends to explore the contribution of this economically challenging timber in the timber supply analysis. The sensitivity of timber supply to assumptions related to the contribution from the heli-operable land base will be tested by applying a series of constraints (refer to Section 3.2).

Table 46 - Harvest Area for 2007 to 2015 by Operability Class

Operability Class	% of Harvest Area (2007-2015)	% of Total THLB
Conventional economic	85.4%	85.0%
Non-conventional economic	6.6%	6.7%
Conventional marginal	6.2%	6.0%
Non-conventional marginal	0.5%	2.3%
Inoperable/Uneconomic	1.3%	0.0%
Total	***100.0%***	***100.0%***

10.3.3 Silviculture Systems

The majority of harvesting within TFL 37 over the past fifteen years was done using the retention silviculture system (mainly group retention). This is the result of the policies of WFP and predecessor companies (i.e., Canfor).

WFP reviewed its Forest Strategy, which includes a program for conserving biodiversity on company tenures. The approach is to vary the use of retention systems and the amount of stand level retention by Resource Management Zones in the Vancouver Island Land Use Plan and by ecosection. Figure 17 indicates the resulting zones found within TFL 37.

In Enhanced Management Zones the retention system will be used for between 30 and 60 percent (depending on the ecosection with lower levels being used in windy areas and higher levels being used in leeward areas) of the harvested area with minimum long-term stand-level retention targets of 10 and 15 percent (depending on variant with the higher target being used in drier variants). In General Management Zones the retention system will be used for between 40 and 70 percent of the harvested area utilizing minimum long-term stand-level retention targets of 15 and 20 percent. In Special Management Zones the VILUP Higher Level Plan Order specifies: “applying a variety of silvicultural systems, patch sizes and patch shapes across the zone, subject to a maximum cutblock size of 5 ha if clearcut, clearcut with reserves or seed tree silvicultural systems are applied, and 40 ha if shelterwood, selection or retention silvicultural systems are applied.” A minimum of 20 percent long-term stand-level retention is recommended for SMZs in the Western Forest Strategy. These targets are summarized in Table 47.

Table 47 – Western Forest Strategy Targets

Ecosection	Resource Management Zone	Variants	THLB Area (ha)	Retention Strategy Use (% of harvest area)	Long Term Retention (% of harvest area)
Nahwitti Lowland	Enhanced	All	1,884	30%	10%
Windward Island Mountains	Special	All	388	100%	20%
	Enhanced	All	555	30%	10%
Northern Island Mountains	Special	All	14,822	100%	20%
	General	CWHxm2, CWHmm1	8,285	70%	20%
		CWHvm1, CWHvm2, MHmm1	27,933	60%	15%
	Enhanced	CWHxm2, CWHmm1	8,140	60%	15%
		CWHvm1, CWHvm2, MHmm1	24,188	50%	10%
Total			***86,195***	***64.3%***	***14.8%***

This retention is long-term and must remain in place for at least one rotation. Applying retention system targets to the Ecosection/Management Zone/BEC variant combinations within TFL 37 will result in 64.3 percent of the total harvest area being in retention system cutblocks (with the remaining being clearcut or clearcut-with-reserves) and an area-weighted average overall minimum stand level retention requirement of 14.8 percent.

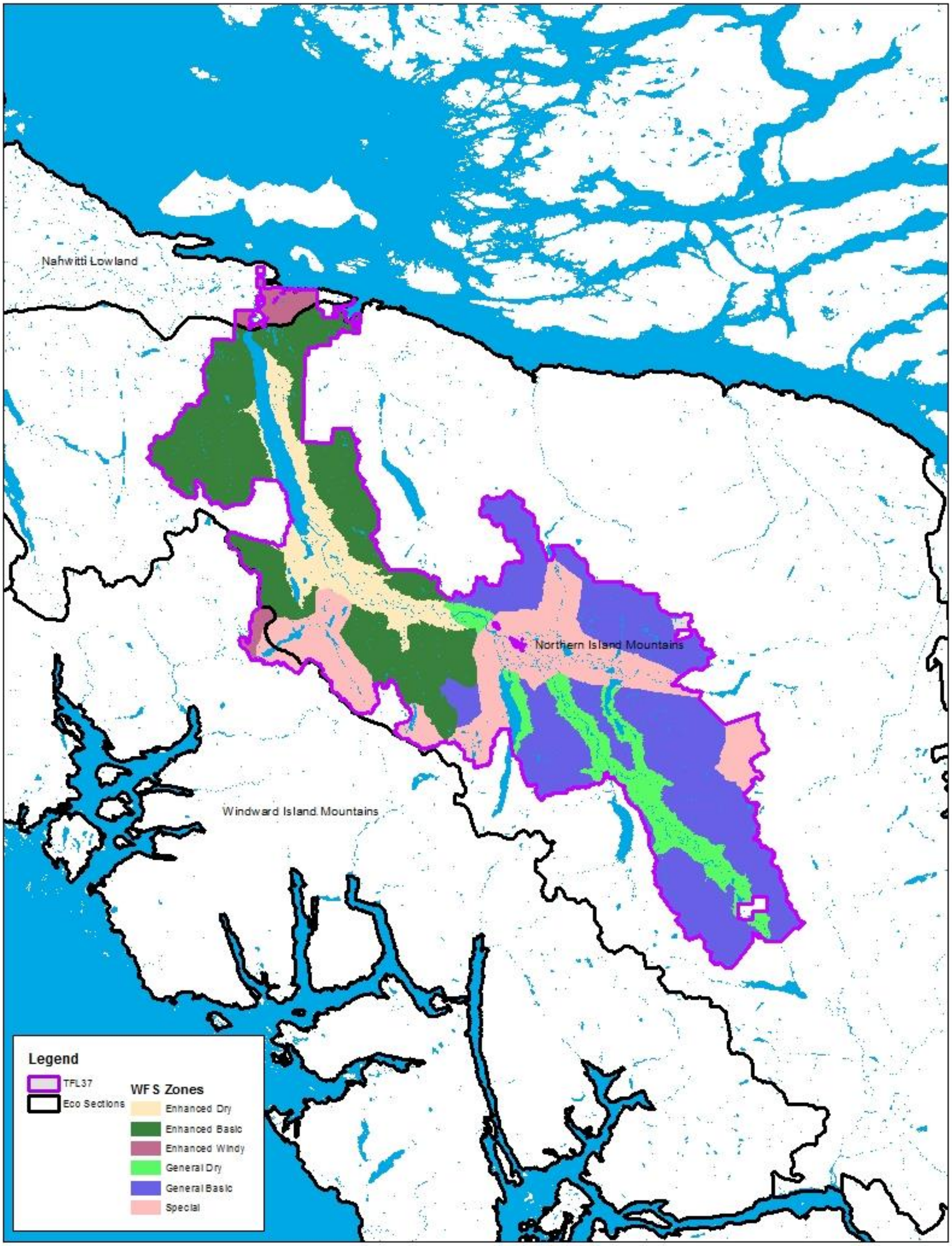

Figure 17 – Western Forest Strategy Zones

10.3.4 Initial Harvest Rate

The current AAC for the analysis area, 889,415 m^3, includes 843,763 m^3 for WFP and 45,652 m^3 for First Nations. The MP #9 Base Case forecast a 10% reduction by 2017; however this was for TFL 37 before deletion of the area for the Pacific TSA. Given changes to the land base, THLB netdowns and growth and yield factors the timber supply dynamics for TFL 37 may be different than portrayed in MP #9. As such, various initial harvest rates will be modelled until a Base Case harvest schedule that meets the harvest flow objectives (refer to 10.3.5) is determined.

10.3.5 Harvest Flow Objectives

Harvest level projections will maximize volumes harvested subject to the following constraints:

- Gradually adjust harvest levels toward the best estimate of the long-term stable harvest level;
- Minimize the length of time that harvest is less than the long-term harvest level; and
- Achieve a stable long-term growing stock.

11 Glossary

Allowable Annual Cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres per year.
Analysis Unit (AU)	A grouping of forest types – for example, by biogeoclimatic zone, site productivity, leading tree species, and age - done to simplify analysis and the generation of timber yield tables.
Base case harvest forecast (Current Management Option)	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animal and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic zones and variants (BEC)	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested cutblocks must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested.
Equivalent Clearcut Area (ECA)	An indicator that quantifies the percentage of the productive forest area within a watershed where the hydrologic response resulting from disturbance is equivalent to the hydrologic response of a clearcut.
Forest inventory	An assessment of timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and wildlife habitat.
Forest and Range Practices Act	Legislation that governs forest and range practices and planning, with a focus on ensuring management of all forest values.

11 Glossary

Forest type	The classification or label given to a forest stand, usually based on tree species composition.
Free-growing	An established seedling of an acceptable species that is free from growth-inhibiting brush, weeds and excessive tree competition.
Geographic Information System (GIS)	A geographic information system, also known as a geographical information system or geospatial information system, is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the Earth.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually expressed as a specific height) - to ensure maintenance of water quality, wildlife habitat, soil stability, or aesthetics – before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The potential flow of timber harvest over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and a set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Inoperable areas	Areas defined as unavailable for timber harvest for terrain-related or economic reasons. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs in resource planning and decision-making.
Karst features	Karst is a distinctive topography that develops as a result of the dissolving action of water on carbonate bedrock (usually limestone, dolomite or marble). Karst features include fluted rock surfaces, vertical shafts, sinkholes, sinking streams, springs, complex sub-surface drainage systems and caves.

11 Glossary

Landscape-level biodiversity	The *Landscape Unit Planning Guide* and the *Order Establishing Provincial Non-Spatial Old Growth Objectives* provide objectives for maintaining biodiversity at the landscape level and stand level. At the landscape level, objectives are provided for the maintenance of old growth.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100,000ha), and designed for application of landscape-level biodiversity objectives.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Lorey height	Basal area weighted average stand height: Sum of tree height multiplied by tree basal area for all trees, then divided by the basal area of the stand.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specifications for minimum harvestable ages, utilization levels, and integrated resource management and silviculture and pest management programs.
Model	An abstraction and simplification of reality constructed to help understand an actual system. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help management activities.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires and wind, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more old forests.

11 Glossary

Non-recoverable losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Riparian habitat	The stream bank and flood plain area adjacent to streams or water bodies.
Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed and the results are compared to a baseline or the base case.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground).
Site Index by Biogeoclimatic Ecosystem Classification site series (SIBEC)	Site index estimates for tree species according to site units of the Biogeoclimatic Ecosystem Classification system of British Columbia.
Site Series	Sites capable of producing similar late seral or climax plant communities within a biogeoclimatic subzone or variant.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
TIPSY (Table Interpolation Program for Stand Yields)	A BC Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

11 Glossary

Timber harvesting land base (THLB)	Crown forest land within the TFL where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and harvesting technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed herbivore, such as a deer.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds (basins).
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for wildlife.

12 References

TFL 37 MP #9 Timber Supply Analysis Information Package, Canadian Forest Products Ltd., December 2004;

TFL 37 MP #9 Timber Supply Analysis, Canadian Forest Products Ltd., April 2005;

Tree Farm Licence 37 Rationale for Allowable Annual Cut Determination, BC Ministry of Forests, Effective October 1, 2006;

TFL 37 Sustainable Forest Management Plan 9, Canadian Forest Products Ltd., September 2005;

Western Forest Strategy, A Program for Conserving Biodiversity on Company Tenures, Western Forest Products Inc., September 2007;

Guide for Tree Farm Licence Management Plans (20-month) and Calendar Year Reports, BC Ministry of Forests, March 2001;

Vancouver Island Summary Land Use Plan, Province of British Columbia, February 2000;

Vancouver Island Land Use Plan Higher Level Plan Order, Province of British Columbia, Effective December 2000;

Procedures for Factoring Visual Resources into Timber Supply Analyses, BC Ministry of Forests, 1998;

Identified Wildlife Management Strategy. Accounts and Measures for Managing Identified Wildlife, BC Ministry of Water, Land and Air Protection, Version 2004.

Order Establishing Provincial Non-Spatial Old Growth Objectives, 2004;

Forest Act and regulations, current to July 2017;

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Forestry Revitalization Act, current to July 2017;

Established Wildlife Habitat Areas, Ministry of Environment
http://www.env.gov.bc.ca/wld/frpa/uwr/approved_uwr.html;

Established Ungulate Winter Ranges, Ministry of Environment

http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html;

Designated Community Watersheds, Ministry of Environment

http://www.env.gov.bc.ca/wsd/data_searches/comm_watersheds/index.html;

Order- Fisheries Sensitive Watersheds – Vancouver Island, effective December 28, 2005;

Order to Identify Karst Resource Features for the North Island - Central Coast Forest District, effective March 29, 2007;

An Order to Establish a Landscape Unit and Objectives – Lower Nimpkish Landscape Unit, effective October 24, 2005;

An Order to Establish a Landscape Unit and Objectives – Upper Nimpkish Landscape Unit, effective October 24, 2005;

Notice – Indicators of the Amount, Distribution and Attributes of Wildlife Habitat Required for the Survival of Species at Risk in the North Island – Central Coast Forest District, March 2, 2006;

Forest Stewardship Plan – North Vancouver Island Region Forest Operations of Western Forest Products Inc., Western Forest Products, January 2012;

Tree Farm Licence 37, Instrument 53, January 22, 2002;

Tree Farm Licence 37, Instrument 54, May 15, 2003;

Tree Farm Licence 37, Instrument 55, September 22, 2003;

Tree Farm Licence 37, Instrument 56, November 8, 2004;

Tree Farm Licence 37, Instrument 57, July 15, 2009;

Tree Farm Licence 37, Instrument 58, May 5, 2012;

Tree Farm Licence 37, Instrument 60, April 24, 2013;

Forestry Revitalization Act Order No. 3(2) 5-1, December 2, 2004;

Forestry Revitalization Act Order No. 3(2) 5-3, December 1, 2004;

Forestry Fund Agreement, Province of British Columbia and ‘Na̱mg̱is First Nation, September 2015;

Extension Note 69 – Variable Retention Yield Adjustment Factors in TIPSY, BC Ministry of Forests, March 2004;

Coast Area Forest Health Aerial Overview Survey, 2015 Summary Report, B.A. Blackwell & Associates Ltd.;

13 APPENDICES

13.1 Appendix A: VRI Statistical Adjustments for VDYP 6

Tree Farm Licence 37
Vegetation Resources Inventory
Statistical Adjustment

Version 3.0

Prepared for

Pat Bryant, RPF
Inventory Forester
Canadian Forest Products Ltd.
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Woss, BC

Project: CFW-019

June 3, 2004

J.S. Thrower & Associates Ltd. *Consulting Foresters*
Vancouver – Kamloops, BC

Executive Summary

Canadian Forest Products Ltd. (Canfor) completed a Vegetation Resources Inventory (VRI) on Tree Farm Licence (TFL) 37. Eighty (80) VRI timber emphasis ground sample plots were randomly selected and installed in polygons considered economical or marginally economical for harvesting in the vegetated treed (VT) land base (128,590 ha, 67% of the TFL). However, only polygons 41 years and older were adjusted (93,498 ha, 49% of the TFL). Young (<41 years), non-vegetated, vegetated non-treed (VN) and VT polygons considered uneconomical for harvesting were left unadjusted. The adjusted volumes reported do not include the net volume adjustment factor (NVAF). NVAF volumes are reported in a separate document.

Following VRI adjustment, the overall average merchantable volume less decay, waste, and breakage was 345 m^3/ha for the entire TFL. The average volume was 662 m^3/ha in mature (polygons 61 years or older), economic and marginally economic polygons.

		2001 Volume (m^3/ha)	
Population	Maturity	Pre-Adjustment	Post-Adjustment
Adjusted	Mature	601	662
	All	575	629
Entire TFL	All	318	345

We recommend that Canfor use these adjusted site index, height, age, and volume estimates for the upcoming Management Plan 9 for TFL 37.

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1. INTRODUCTION

1.1 Background

Canadian Forest Products Ltd. (Canfor) began implementing a Vegetation Resources Inventory (VRI) program on Tree Farm Licence (TFL) 37 in 1996. The VRI program is a four-phase process (Figure 1):

1. Phase I (unadjusted inventory data) - Attributes of all polygons are estimated using photo-interpretation;
2. Phase II (ground plot data) - Measurements are taken from randomly located ground samples;
3. Adjustment Phase - Phase I estimates are adjusted using the Phase II ground samples to give the preliminary adjusted VRI database; and
4. Net Volume Adjustment Factor (NVAF) Sampling - Random trees are selected for stem-analysis studies to develop adjustment ratios that correct taper and decay estimation bias. These ratios are then applied to the VRI database to obtain the final adjusted VRI database.

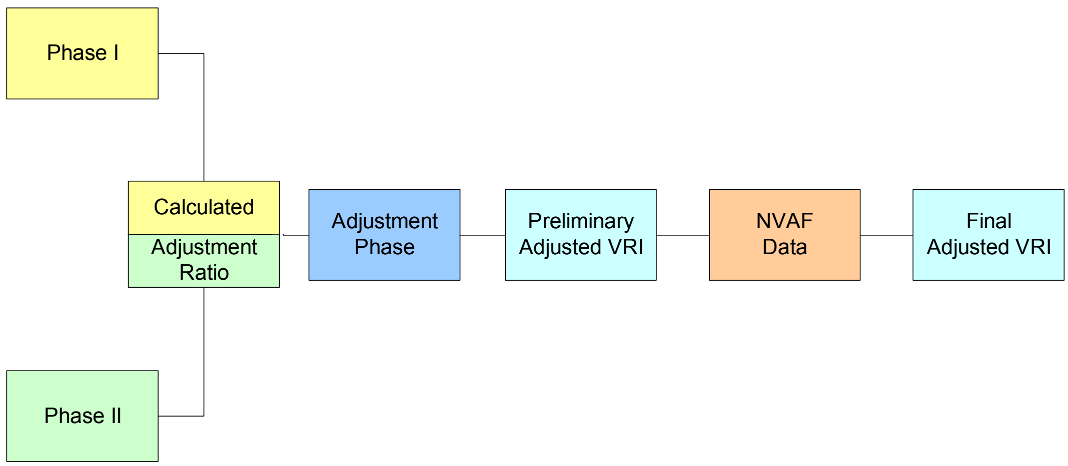

Figure 1. VRI program.

Olympic Resource Management Ltd. (ORM) completed Phase I in 1997,[1] Phase II occurred during the 2000 and 2001 field seasons, and the preliminary statistical adjustment was completed in March 2002.[2] In this updated version of the preliminary statistical adjustment, ground volumes were re-compiled using the most recent Ministry of Sustainable Resource Management (MSRM) VRI compiler and regular VRI and VRI enhanced plots. The NVAF Sampling Phase was completed in December 2003 and the NVAF analysis was completed in May 2004. The NVAF analysis is not included in this report, and is discussed under separate cover.[3]

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[1] Phase I was a retro-fit of a recent inventory to VRI standards.

[2] J.S. Thrower & Associates Ltd. 2002. Statistical adjustment of Tree Farm Licence 37 Vegetation Resources Inventory. Unpublished Report, Contract No. CFW-014, March 31, 2002. 6 pp.

[3] J.S. Thrower & Associates Ltd. 2004. Tree Farm Licence 37 Net Volume Adjustment Factor Analysis. Unpublished Report, Contract No. CFW-021, June 3, 2004. 13 pp.

1.2 Project Objectives

The objectives of this project were:

1. *To develop unbiased average inventory estimates of height, age, and net merchantable volume for the economic and marginally economic vegetated treed polygons, 41 years and older on TFL 37.*
2. *To develop polygon-level estimates of height, age, site index, and net merchantable volume.*

1.3 Terms of Reference

Pat Bryant, *RPF* of Canfor was the project leader. Guillaume Thérien, *PhD* of J.S. Thrower & Associates Ltd. (JST) completed the statistical adjustment and prepared this report.

2. METHODS

2.1 Study Area

TFL 37 is located on northern Vancouver Island, approximately 100 km north of Campbell River. The TFL covers 190,669 ha (Table 1), of which about 142,000 ha (75%) is Vegetated Treed (VT). The area sampled in Phase II was the economic and marginally economic area of the VT land base (128,590 ha, 67% of the TFL). The adjusted land base was the area where stand age was 41 years or older (93,498 ha, 49% of the TFL).

Table 1. TFL 37 land base net down statistics.

Description	Area	
	(ha)	(%)
TFL land base	190,669	100
Non-Vegetated	34,655	18
Vegetated Non-Treed	13,721	7
Vegetated Treed (VT)	142,293	75
Uneconomic VT	13,703	8
Economic/Marginally Economic	128,590	67
Age <= 40 yrs	35,091	18
Age >= 41 yrs	93,498	49

2.2 Estimation Phase Data

ORM completed Phase I using 1996 aerial photography. The inventory was updated for depleted areas to December 2001. Age and height were projected to 2001. Crown closure and stocking class were not projected. Approximately 27% of the sampled land base (35,091 ha) was 40 years or younger. Attributes in these stands were assumed known without error and were left unadjusted. Inventory (1996) age was not photo-interpreted past 300 years, thus all stands older than this limit were labeled 300 years old. This is similar to labeling these stands as old-growth without estimating age. Hence, the adjusted land base was divided into two strata based on age: less than 300 years in 1996 (Young stratum, 67,545 ha) and 300 years in 1996 (Old stratum, 25,953 ha).

Phase I showed an average volume[4] of 575 m^3/ha for the adjusted land base (41 yrs and older), while the mature portion of the sampled land base (61 years and older) was 601 m^3/ha (82,044 ha). The average volume for the entire TFL was 318 m^3/ha.

[4] For the purpose of this project, Estimation Phase volume was defined as whole-stem volume minus stump (30 cm height), top (the section above a diameter inside bark of 10 cm), decay, waste, and breakage at a utilization level of 17.5 cm+. Volume was estimated using *VDYP version 6.6d*.

2.3 Ground Sampling Phase Data

Eighty (80) VRI ground sample plots were established in the 2000 and 2001 field seasons. Nine of the originally selected plots were replaced because they were located in previously harvested cut-blocks (therefore, vegetated non-treed). One original plot location was relocated for safety reasons; a second plot was dropped for safety and replaced with another plot as a similar plot location could not be found in the selected polygon. The remaining 69 plots were established at their original locations.

Forty (40) plots were sampled in each of the two sampling seasons; however, we assumed that all plots were sampled in 2001 for this study. One plot was rejected because it was now in a non-vegetated polygon and 19 plots were in stands between 0 and 40 years. This left 60 plots for analysis: 21 in the Young stratum and 39 in the Old stratum.

2.4 Statistical Adjustment

The MSRM standards and procedures for attribute adjustment were modified for this statistical adjustment.[5] Site index, not height, was adjusted in both strata. Canfor considered the adjustment of site index more important than height. Adjusted height was derived from adjusted age and adjusted site index. Age in the Old stratum was not available; the average ground age was therefore used as the adjusted age for all stands in that stratum. For stands in the Young stratum, a confidence index (CI) was computed based on age:

$$CI = 9 - 6 \times \frac{(age - 40)}{(305 - 40)}$$

and used in the statistical adjustment. The CI decreased linearly from 9 at age 40 to 3 at age 305 and is a measure of the reliability of the Phase I attributes (with 9 meaning known without error). Phase I attributes in the Old stratum were all assumed to have the same reliability and therefore did not require a CI estimate.

The NVAF ratio estimation and application were completed in May 2004, under a separate cover.[3] Therefore, volumes presented in this report do no include the NVAF adjustment.

[5] Ministry of Sustainable Resources Management. 2001. Vegetation Resources Inventory Attribute Adjustment Procedures. Draft Version 4.4, April 2002. 36 pp.

3. RESULTS AND DISCUSSION

3.1 OVERVIEW

The MSRM assumes that the Estimation Phase inventory volume is biased due to two sources of error: an attribute bias associated with the photo-interpreted height and age, and a model bias inherent to the growth and yield model used to estimate volume (*VDYP version 6.6d*). The MSRM assumes that the other attributes used by VDYP (species composition, stocking class, and crown closure) have a marginal impact on the volume adjustment procedure.

The attribute adjustment procedure was a two-step process. In the first step, the Estimation Phase site index and age bias were corrected using the adjustment ratio estimated from the ground and the Estimation Phase site index and age and the confidence index. Adjusted height was then derived using adjusted site index and adjusted age. An attribute-adjusted volume was then estimated using VDYP. In the second step, the model bias in the attribute-adjusted volume was corrected using the adjustment ratio estimated from the ground and the attribute-adjusted volume. All adjustment ratios were estimated using the ratio of means (ROM) method following MSRM standards.

3.2 SITE INDEX AND AGE

Fifty-eight (58) plots had data for a species that matched the leading species in the Estimation Phase using the MSRM criteria.[6] One Old stratum plot was dropped from the analysis because the Estimation Phase and ground data did not come from the same layer in the two-layered stand. No age (and no site index) was measured on one plot in the Young stratum and on two plots in the Old stratum and no height (and no site index) was estimated on seven plots in the Old stratum.

Phase I site index tended to be over-estimated while Phase I age was under-estimated (Table 2). The relationship between ground and Estimation Phase site index was slightly better than the age relationship (Figure 2 to Figure 3). The sampling error was about 14-15% for site index, and 16-18% for age.

Table 2. Site index and age adjustment statistics for economic and marginally economic polygons, 41 years and older, in the TFL 37 VT area.

Attribute	Stratum	Population		Sample					Adj. Pop.	
		Area (ha)	Avg	Size	Ground Avg	Est Avg	ROM	R^2	Avg	E[a]
Site Index (m)	Young	25,953	26.4	20	22.7	23.5	0.966	56%	24.6	14%
	Old	67,545	12.4	29	11.8	14.7	0.802	59%	11.7	15%
Age (yrs)	Young	25,953	92.9	20	138.6	112.1	1.236	76%	110.2	18%
	Old	67,545	N/A	36	436.8	N/A	N/A	N/A	436.8	16%

[a] E is sampling error.

6 First, a match was attempted at the species level (case 1); second at the genus level (case 3); and third at the conifer/deciduous level (case 5). No height/age for the second species was available in the inventory.

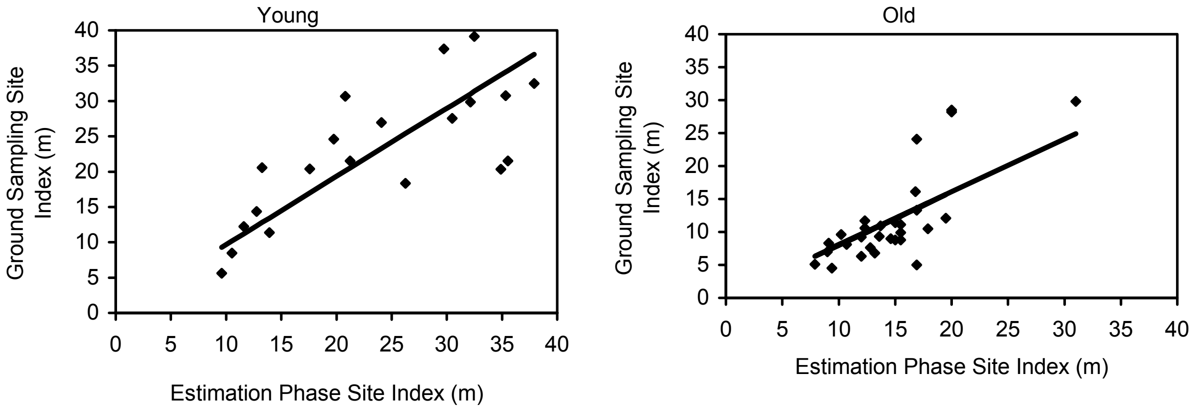


Figure 2. Ground sampling vs. Estimation Phase site index by stratum.

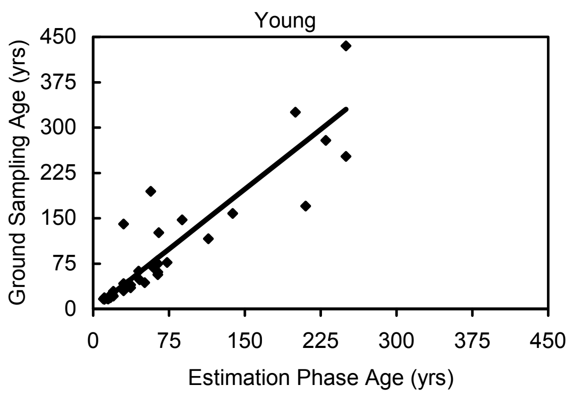


Figure 4. Ground sampling vs. Estimation Phase age (Young stratum).

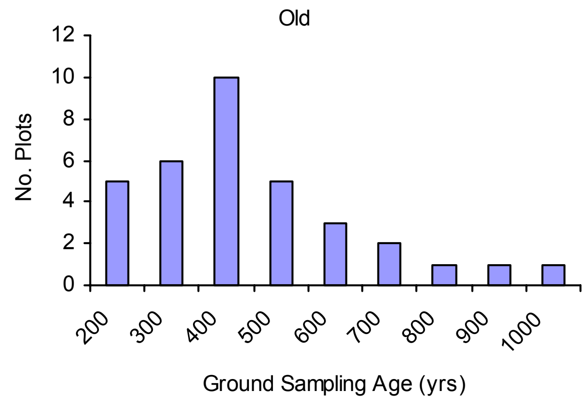


Figure 3. Distribution of ground sampling age (Old stratum).

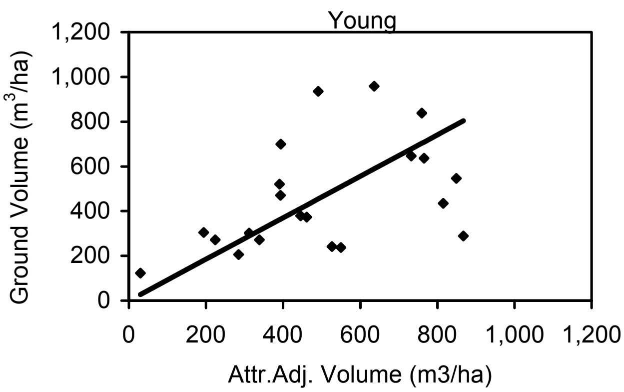
3.3 VOLUME

An attribute-adjusted volume was generated with VDYP using the Phase I attributes and the adjusted site index and age. The average attribute-adjusted volume for the adjusted land base was 483 m^3/ha (Table 3). Before adjusting height and age, the Phase I volume was 575 m^3/ha. Therefore, the height and age correction resulted in a 16% decrease to Phase I volume (from 575 to 483 m^3/ha). The attribute-adjusted volume tended to over-estimate ground volume in the Young stratum but largely under-estimated volume in the Old stratum (Figure 5). On average, the attribute-adjusted volume under-estimated ground volume by approximately 29% (total sample ground average [604.8 m^3/ha] / overall sample map average [467.4 m^3/ha]). The adjusted volume for the land base was approximately 9% higher than the original Phase I volume (from 575 to 629 m^3/ha).

Table 3. Volume adjustment statistics for economic and marginally economic polygons, 41 years and older, in the TFL 37 VT area.

Stratum	Population		Sample					Adj. Pop.	
	Area (ha)	Avg (m^3/ha)	Size	Ground Avg (m^3/ha)	Map[a] Avg (m^3/ha)	ROM	R^2	Avg (m^3/ha)	E (m^3/ha)
Young	25,953	486.8	21	461.2	498.1	0.926	22%	450.8	24%
Old	67,545	481.6	39	659.9	455.6	1.449	51%	697.7	13%
Total	*93,498*	*483.0*	*60*	*604.8*	*467.4*	*1.294*		*629.2*	*12%*

[a] Map average is the attribute-adjusted volume.



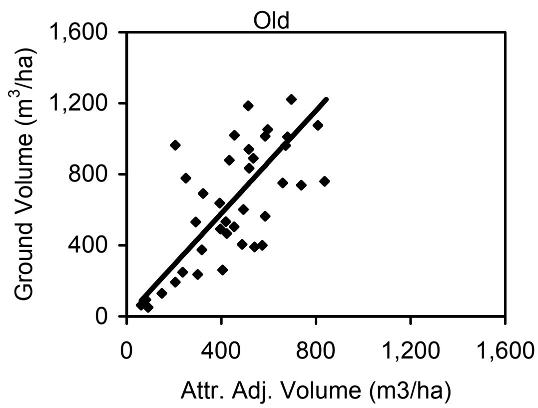


Figure 5. Ground vs. attribute-adjusted volume for the economic and marginally economic polygons, 41 years and older, in the TFL 37 VT area.

When only the mature adjusted land base was considered, the average adjusted volume was 662 m^3/ha, an increase of 10% compared to the corresponding Phase I volume (Table 4). The overall average adjusted volume was 345 m^3/ha for the entire TFL land base.

Table 4. Phase I and adjusted volumes.

Population	Maturity	Est. Phase		Adjusted Pop.		Diff
		Area (ha)	Volume (m^3/ha)	Area (ha)	Volume (m^3/ha)	%
Adjusted	Mature	82,044	601	82,601	662	10
	All	93,498	575	93,498	629	9
Entire TFL	All	190,669	318	190,669	345	8

4. CONCLUSION

In this project, we adjusted the TFL 37 VT economic and marginally economic polygons following the MSRM standard statistical adjustment procedures. We recommend that:

Canfor use the adjusted age, site index, height, and volume for the upcoming Management Plan 9 for TFL 37.

Tree Farm Licence 37
Net Volume Adjustment
Factor Analysis

Version 2.0

Prepared for

Pat Bryant, RPF
Canadian Forest Products Ltd.
Englewood Division
Woss, BC

Project: CFW-021

June 3, 2004

J.S. Thrower & Associates Ltd. *Consulting Foresters*
Vancouver – Kamloops, BC

Executive Summary

Canadian Forest Products Ltd. (Canfor) completed Net Volume Adjustment Factor (NVAF) ground sampling in 2002 and 2003 on Tree Farm Licence (TFL) 37. The NVAF sampling and analysis is a required component of the provincial Vegetation Resources Inventory (VRI) program. The NVAF uses destructive sampling to derive the true volume of the sample trees. This information is then used to adjust the bias in VRI volume due to taper equations and decay estimation methods.

Seventy-nine (79) trees were sampled. An NVAF adjustment ratio was computed for three species groups:

1. Dead trees;
2. Live, Douglas-fir (F) mature trees, and
3. All other live trees (non F-mature).

The adjustment ratios varied significantly across these three groups:

Species Group	Sample Size	NVAF Ratio
Dead	10	0.90
Live F-mature	9	1.19
Live Others (non F-mature)	60	1.01
Live Total	*69*	*1.03*

This means that there is approximately 3% more live net merchantable volume (whole-stem volume less top, stump, decay, and waste) on TFL 37 than indicated in the preliminary VRI adjusted database. This corresponds to a volume increase of 18 m^3/ha.

The 95% sampling error of the overall NVAF adjustment ratio for live volume was 5.5%. Therefore, we are 95% confident that the true NVAF ratio is between 0.97 and 1.09.

We recommend that the TFL 37 VRI database be corrected to reflect the information provided by the NVAF analysis.

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1. INTRODUCTION

1.1 BACKGROUND

Canadian Forest Products Ltd. (Canfor) began implementing a Vegetation Resources Inventory (VRI) on Tree Farm Licence (TFL) 37 in 1996 to comply with the Ministry of Sustainable Resource Management's (MSRM) provincial inventory standard. The VRI program is a four-step process:

1. Phase I (unadjusted inventory data) - Attributes of all polygons are estimated using photo-interpretation;
2. Phase II (ground plot data) - Measurements are taken from randomly located ground samples;
3. Adjustment Phase - Phase I estimates are adjusted using the Phase II ground samples to give the preliminary adjusted VRI database; and
4. Net Volume Adjustment Factor (NVAF) Sampling - Random trees are selected for stem-analysis studies to develop adjustment ratios that correct taper and decay estimation bias. These ratios are then applied to the VRI database to obtain the final adjusted VRI database.

Olympic Resource Management (ORM) completed Phases I and II for Canfor in 1997 and 2001, respectively. A preliminary NVAF sample was collected in 2002 by R.G. Mecredy Cruising & Forest Consulting and analyzed by J.S. Thrower & Associates Ltd. (JST) in March 2003.[1] In August 2003, Canfor decided to sample additional NVAF trees to increase the confidence in the NVAF. The NVAF adjustment ratios developed in this report will be used to finalize the adjusted VRI database.

1.2 OBJECTIVES

The objectives of this project were to:

1. *Determine the NVAF ratios for the different species groups on TFL 37.*
2. *Estimate the impact of the NVAF adjustment on the preliminary VRI adjusted inventory.*

1.3 TERMS OF REFERENCE

JST completed this project for Pat Bryant, *RPF* of Canfor. Guillaume Thérien, *PhD* was the JST analyst. Funding was provided through Canfor's Forest Investment Account allocation. The original version of this report was submitted to Canfor in March 2004; however, data problems were identified and have been corrected in this updated version (2.0).

[1] J.S. Thrower & Associates Ltd. 2003. Tree Farm Licence 37 Net Volume Adjustment Factor Analysis. March 31, 2003. Unpublished Report. Project No. CFW-018. 11 pp.

2. METHODS

2.1 STUDY AREA

TFL 37 is located on northern Vancouver Island, approximately 100 kilometres north of Campbell River. The TFL covers 190,669 ha (Table 1), of which about 142,000 ha (75%) is Vegetated Treed (VT). The sampled land base was the economic and marginally economic area of the VT land base (128,590 ha, 67% of the TFL). The adjusted land base was stands 41 years and older (93,498 ha, 49% of the TFL).

Table 1. TFL 37 land base net down statistics.

Description	Area (ha)	Area (%)
TFL land base	190,669	100
Non-Vegetated	34,655	18
Vegetated Non-Treed	13,721	7
Vegetated Treed (VT)	142,293	75
Uneconomic VT	13,703	8
Economic/Marginally Economic	128,590	67
Age <= 40 yrs	35,091	18
Age >= 41 yrs	93,498	49

An accurate description of the volume composition on TFL 37 was determined from the 80 VRI ground samples (Phase II data) completed in 2000/2001. The immature component of the TFL (<100 years at sampling time) represents approximately 20% of the TFL volume (Figure 1). Most of the immature volume is either hemlock (H) or Douglas-fir (F). The mature component (80% of the total estimated net merchantable volume) is a mixture of mainly H, F, balsam (B), and yellow cedar (Y). Cedar (C) and minor species are also present.

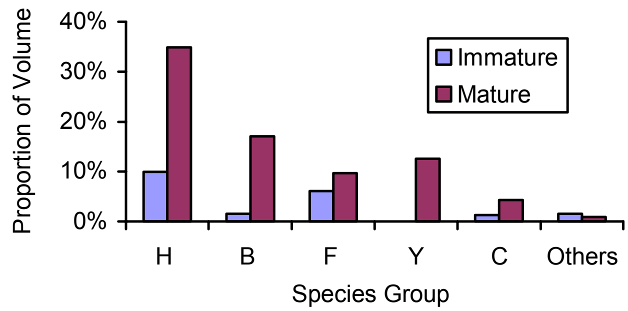

Figure 1. Distribution of ground volume by species group and maturity class.

Approximately two thirds of the volume on the TFL is from trees 25 to 75 cm in diameter at breast height (DBH), while about 15% comes from trees 95 cm or larger (Figure 2).

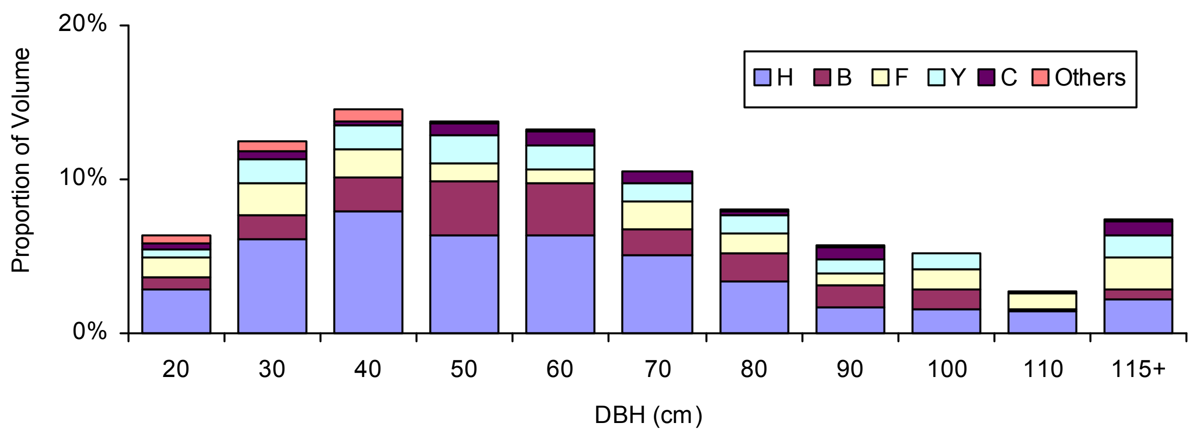

Figure 2. Distribution of ground volume by species group and tree size.

2.2 Sample Distribution

Canfor's initial objective was to distribute the NVAF sample of live trees proportionally to each species' volume in the population. However, following discussion with the MSRM, it was decided to disproportionately sample F trees (28% in the sample versus only 16% in the population) to address a concern that the NVAF ratio adjustment for F trees might not be constant across all ages.[2] The B and C species groups were under-sampled to address this initiative (Table 2). The sample size for dead trees was arbitrarily set at 10 trees.

Table 2. Distribution of live trees in the TFL 37 population and sample by species.

Species	Population	Sample
H	44%	43%
B	19%	12%
F	16%	28%
Y	13%	12%
C	6%	3%
Others	3%	3%

2.3 Sample Selection

The NVAF sample of live trees for this project was selected in two batches. The MSRM selected the first batch and JST selected the second. Seventy-nine trees (69 live and 10 dead) were selected in total (Table 3).

Table 3. Distribution of TFL 37 NVAF sample trees by maturity class and species group.

Status	Maturity	H	B	F	Y	C	Others	Total
Live	Immature	8	0	10	0	0	2	20
	Mature	22	8	9	8	2	0	49
	Total	*30*	*8*	*19*	*8*	*2*	*2*	*69*
Dead	Immature	2	0	0	0	0	1	3
	Mature	2	0	0	3	0	2	7
	Total	*4*	*0*	*0*	*3*	*0*	*3*	*10*
All	*Immature*	*10*	*0*	*10*	*0*	*0*	*3*	*23*
	Mature	*24*	*8*	*9*	*11*	*2*	*2*	*56*
	Total	*34*	*8*	*19*	*11*	*2*	*5*	*79*

Will Smith, *RPF* (MSRM – Terrestrial Information Branch) selected all dead trees and the first batch of 50 live trees. The sample selection followed a stratified sampling approach. Live trees were stratified by economic status[3] and species group, and trees within each stratum were systematically selected with a random start from a list sorted by DBH. Dead trees were randomly selected within each economic status.[4]

JST selected the second batch of 19 live trees also following a stratified sampling approach. Trees were stratified by species group, elevation class, and DBH class and selected randomly within each stratum (Appendix I, Table 12).

Five selected F trees from batch 2, all in cluster 85, were rejected for safety reasons and needed replacement; however, only one potential F replacement tree was available in the original NVAF tree list. Hence, four new F trees were selected from all trees located in auxiliary plots that had not been NVAF-enhanced during initial ground sampling. There were 20 clusters with 84 F trees available for further sampling. After consultation with Will Smith, two clusters (cluster 23 and 96) were randomly selected. The four trees were randomly selected from a list of 17 F trees in these two clusters, resulting in three trees from cluster 96 and one tree from cluster 23.

[2] J.S. Thrower & Associates Ltd. 2003. Tree Farm Licence 37 Net Volume Adjustment Factor Sampling Second Phase – Sample Plan. Unpublished Report, Contract No. CFW-021, August 13 2003. 9 pp.

[3] Economic status is a Canfor internal polygon-level attribute used to describe the economic potential of a stand.

[4] Will Smith, personal communication, July 29, 2003.

In addition, due to harvesting, four of the selected trees were no longer available for NVAF sampling when the crew returned to the field (Table 4). Therefore, these four trees were replaced by trees of the same species and similar size in the vicinity of the plot. These trees were considered as replacements for a non-response (similar to replacing a VRI plot location for safety reasons). Sampling weights for these four replacement trees were assumed to remain identical to those computed for the original trees.

Table 4. Tree data for original and replacement trees.

Cluster	Plot	Tree	Spp	Original DBH (cm)	Original Height (m)	Replacement DBH (cm)	Replacement Height (m)
35	E	1	F	78.3	57.3	75.0	59.4
35	E	7	F	139.1	60.9	143.2	69.1
35	E	8	F	113.3	61.3	119.9	66.0
43	N	2	B	76.0	39.8	69.7	36.0

2.4 ANALYSIS

2.4.1 Overview

JST computed the sampling weight and the actual and predicted net merchantable tree volumes[5] for all trees (Appendix I). JST computed the actual volumes using the NVAF compiler provided by the MSRM. Sampling weights were estimated using the method recommended by the MSRM.[6] All sampling weights, predicted volumes, and actual volumes are given in Appendix I.

It should be noted that the MSRM has modified their NVAF analysis standards since the project analysis stage began. However, we decided to analyze the data using the original method since it corresponds to the NVAF design proposed by the VRI design committee.

Statistical and graphical analyses were used to determine those groups of trees that had statistically similar NVAF ratios. These groups were based on pre-stratification rules, expert knowledge, and statistical tests. Adjustment ratios were computed for three species groups:

1. Dead trees;
2. Live F-mature trees, and
3. Live (non F-mature) trees.

2.4.2 Elevation Analysis

The preliminary NVAF analysis[1] indicated that H trees may have different adjustment ratios below and above 1,000 m. However, analysis of the entire NVAF sample showed that the adjustment ratios were similar in both elevation strata; therefore, stratifying by elevation was not required.

[5] For this report, net merchantable volume is whole-stem volume less top, stump, cruiser-called decay and waste.

[6] Sit, Vera. 2002. Net volume adjustment ratio based on inclusion probability. Unpublished draft document, April 18, 2002.

3. RESULTS & DISCUSSION

3.1 DEAD TREES

3.1.1 Net Merchantable Volume

Ten dead trees were selected for NVAF analysis. Both actual and predicted net merchantable volumes were zero in three of the sample trees. A net merchantable volume was predicted for two trees with an actual volume of zero (Figure 3). This inflated the 95% sampling error to ± 34%. The net merchantable volume showed a bias of approximately 10%. Therefore, the NVAF ratio for dead net merchantable volume (with relative 95% sampling error) was:

Net Merchantable Dead NVAF = 0.898 ± 0.307 (34%)

3.1.2 Whole-stem Volume

The taper equations over-estimated the true whole-stem volume of dead trees by approximately 7% on average (Figure 3). This over-estimation was very consistent across the range of observed volumes. This consistency led to a small sampling error. The NVAF ratio for dead whole-stem volume (with relative 95% sampling error) was:

Whole-stem Dead NVAF = 1.069 ± 0.143 (13%)

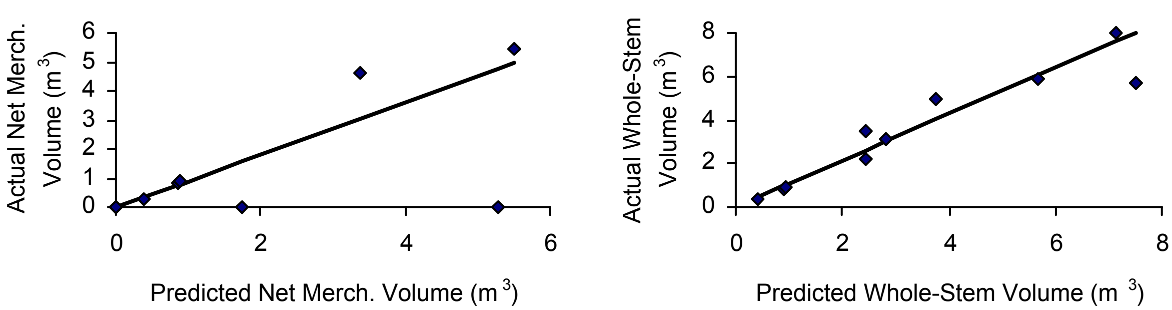

Figure 3. Actual versus predicted net merchantable and whole stem volume for dead trees on TFL 37.

3.2 LIVE NVAF RATIO OVERVIEW

The NVAF ratios and sampling errors were computed by species group, maturity class, and economic status (Table 5). This analysis showed that the NVAF ratios were similar with the exception of F-mature trees. Differences among the different ratio of means can be explained by the sampling variation (as measured by the sampling error).

Table 5. NVAF ratio and sampling error by species group, maturity class, and economic status (A to D).

Spp. Group	Immature A			Mature B			Mature C			Mature D			Total Mature		
	n	Ratio	E	n	Ratio	E	n	Ratio	E	n	Ratio	E	n	Ratio	E
B				2	0.977	0.717	5	1.008	0.096	1	0.906		8	1.004	0.073
C							2	0.957	0.843				2	0.957	0.843
F	10	1.05	0.082				6	1.193	0.089	3	1.145	0.325	9	1.189	0.079
H	8	0.999	0.282	3	0.33	0.918	15	1.077	0.241	4	0.664	0.619	22	1.028	0.218
Others	2	1.171	0.911												
Y				1	1.388		1	0.881		6	1.032	0.132	8	0.999	0.140
Total	*20*	*1.02*	*0.192*	*6*	*0.924*	*0.267*	*29*	*1.064*	*0.098*	*14*	*0.968*	*0.166*	*49*	*1.048*	*0.085*

Note: n= sample size, E=sampling error.

3.3 LIVE F-MATURE TREES

F trees from clusters located in stands that are at least 100 years old (economic strata B, C, and D) were analyzed separately from the other live trees because the adjustment ratio for these F-mature trees was significantly different. There were nine trees in the live F-mature stratum.

The adjustment ratio for live F-mature trees was exceptionally large due to taper equation bias (Figure 4). The gross merchantable volume estimated by the taper equation was 19% less than the actual gross merchantable volume. The gross merchantable volume bias can only be explained by taper equation bias.

The NVAF ratio for net merchantable volume was similar to the ratio observed for gross merchantable volume. The 95% sampling error around the adjustment ratio was small (7%), indicating a high confidence in the ratio estimate. Therefore, the NVAF ratio for live F-mature net merchantable volume (with relative 95% sampling error) was:

Live F-mature NVAF = 1.189 ± 0.079 (7%)

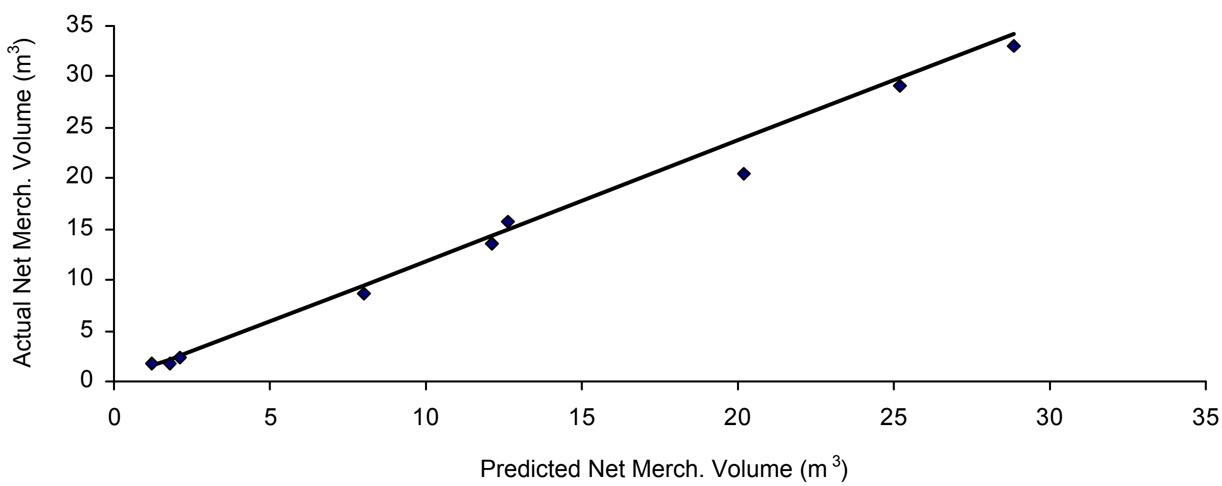

Figure 4. Actual versus predicted net merchantable volume for live F-mature trees on TFL 37.

3.4 Live (Non F-Mature) Trees

All other live trees (non F-mature) had relatively similar adjustment ratios (around 1.0), except for the Other species (approximately 1.17). Since the Other species group represents a minor component of the species composition on TFL 37, it could have been grouped with either the live F-mature or the live (non F-mature) trees without any major impact at the TFL level. After comparing both options, it was decided to put the Other species with the live (non F-mature) trees because its impact on the NVAF adjustment ratio was slightly smaller in this group, and because the NVAF adjustment ratio for the live (non F-mature) trees was more conservative.

There were 60 trees in the live (non F-mature) stratum. The NVAF adjustment ratio was greater than 1.0 mainly because the taper equation under-estimated the gross merchantable volume (Figure 5). The 95% sampling error of the NVAF adjustment ratio for live (non F-mature) trees (8%) was largely due to the variation around the prediction for H, indicating that it was more difficult to estimate decay in H trees than in other species. Therefore, the NVAF ratio for live (non F-mature) net merchantable volume (with relative 95% sampling error) was:

Live (non F-mature) NVAF = 1.013 ± 0.081 (8%)

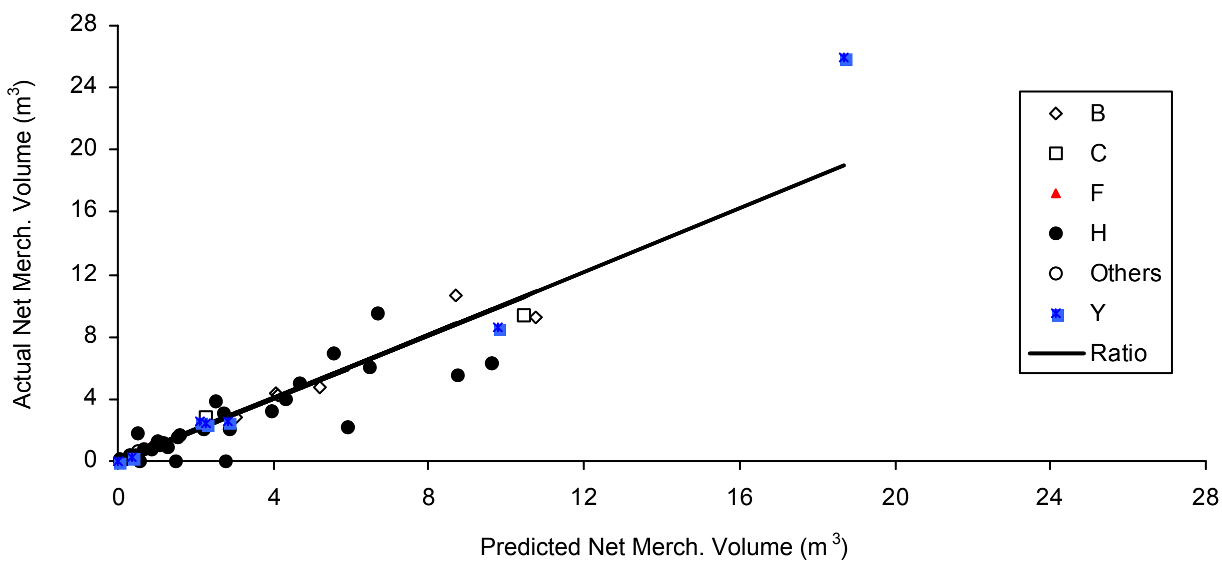

Figure 5. Actual versus predicted net merchantable volume for live (non F-mature) trees on TFL 37.

3.5 NVAF Ratio Summary

A few key points were shown in this analysis. These points include:

1. There was no difference in NVAF ratio between low- and high- elevation H.
2. NVAF ratio in live F-mature trees was significantly different from other live trees.
3. Taper equations appeared to be a major source of bias on TFL 37.
4. Overall, VRI volumes were under-estimated on TFL 37.

3.6 IMPACT OF NVAF RATIOS ON THE ADJUSTED VRI DATABASE

Only areas that are economical and marginally economical for harvesting, 41 years and older, and in the VT were statistically adjusted on TFL 37.[7] The population was divided into two strata before adjustment: Young (established after 1696) and Old (established in or before 1696). The average NVAF ratios were 1.035 and 1.028 in the Young and Old strata, respectively (Table 6).

Table 6. NVAF ratios and sampling errors for TFL 37 Young and Old strata.

	Area	Non F-Mature			F-Mature			Overall	
	(ha)	(%)	Ratio	E	(%)	Ratio	E	Ratio	E%
Young	25,953	86.9%	1.013	0.081	13.1%	1.189	0.079	1.035	6.8%
Old	67,545	90.8%	1.013	0.081	9.2%	1.189	0.079	1.028	7.2%
Total	*93,498*							*1.030*	*5.5%*

The overall relative 95% sampling error for the NVAF ratio was 5.5%. The sampling error translates into a 95% confidence interval of [0.973, 1.087]. Therefore, we have a 95% confidence level that the true net merchantable volume bias was between -3% and 9%. Similarly, we can estimate the 50% confidence interval as [1.011, 1.049]. Hence, we have 50% confidence that the volume bias was between 1% and 5%.

The NVAF ratios must be applied to correct the adjusted volumes presented in the TFL 37 VRI statistical adjustment report.[7] The preliminary average adjusted volume was 629.2 m^3/ha (Table 7). The average NVAF ratio was 1.030 and the final average adjusted volume increased to 647.6 m^3/ha.

Table 7. Final volumes for the adjusted VRI database.

Stratum	Area (ha)	Adj. Vol. (m^3/ha)	Avg. NVAF Ratio	Adj. Vol (m^3/ha)
Young	25,953	450.8	1.035	466.6
Old	67,545	697.7	1.028	717.2
Total	*93,498*	*629.2*	*1.030*	*647.6*

4. RECOMMENDATIONS

The NVAF analysis presented in this report provides unbiased information for TFL 37. We recommend that:

The adjusted VRI database be corrected to account for the NVAF ratio adjustment.

7 J.S. Thrower & Associates Ltd. 2004. Statistical adjustment of Tree Farm Licence 37 Vegetation Resources Inventory –Version 3.0. Unpublished Report, Contract No. CFW-019, June 3, 2004. 6 pp.

APPENDIX I – SAMPLING WEIGHTS AND NVAF TREE DATA

Table 8. Number of enhanced clusters and total area by economic status.

Economic Status	VT Area[a] (ha)	No. Enhanced Clusters	
		H, B, C, Y, Others	F
A	70,198	7	7
B	5,566	2	2
C	53,101	7	8
D	17,620	5	6

[a] total VT area differs from VT area in Table 1 due to changes in the population since the initial VRI selection in 2000.

Table 10. Number of plots and polygon area by VRI cluster.

Stratum	Cluster No.	No. Plots	Polygon Area (ha)
A	2	4	20.8
A	17	3	1.3
A	49	4	10.4
A	59	3	8.4
A	61	4	43.6
A	64	3	17.4
A	81	2	4.0
B	40	2	7.3
B	102	4	21.5
C	23[a]	4	3.6
C	35	3	3.9
C	36	4	8.7
C	43	4	22.8
C	55	3	5.2
C	69	3	7.1
C	83	3	26.6
C	85	4	27.4
D	25	4	21.5
D	44	4	3.5
D	45	4	138.8
D	50	2	3.0
D	58	2	41.5
D	96[a]	3	123.6

a: F trees only.

Table 9. MSRM matrix selection for dead trees.

Economic Status	Total No. Trees	No. Sample Trees
A	16	3
B	9	2
C	19	3
D	15	2

Table 11. MSRM matrix selection for live trees (50 trees).

Economic Status	Species Group	Total No. Trees	No. Sample Trees
A	C	0	0
	F	27	9
	H	46	8
	Others	15	2
	Y	0	0
B	C	2	0
	F	0	0
	H	5	3
	Others	14	2
	Y	2	0
C	C	5	2
	F	11	1
	H	45	15
	Others	28	2
	Y	19	0
D	C	0	0
	F	0	0
	H	27	2
	Others	1	1
	Y	41	3

Table 12. JST matrix selection (19 trees).

Species	Elevation Class (m)	DBH Class (cm)	Total No. Trees	No. Sample Trees
C, Y	All	0-60	42	0
		60.1+	22	5
F	All	0-40	17	0
		40.1+	5	5
		Extra	17	4
H, B, Others	> 1,000 m	0-40	10	1
		40.1-60	13	2
		60.1+	9	2
H, B, Others	<= 1,000 m	12.5+	114	0

Table 13. NVAF dead trees sample.

Economic Status	Cluster No.	Plot	Tree No.	Species	DBH (cm)	Basal Area Factor	Cruiser Volume (m^3)	Actual Volume (m^3)	Total Weight	Relative Weight
D	44	S	9	Pw	85.9	20.25	5.2730	0.0000	192,400	3.692
D	44	W	6	Pw	62.9	20.25	1.7439	0.0000	358,831	6.885
C	55	E	10	Yc	88.3	20.25	0.0000	0.0000	463,380	8.892
C	55	N	8	Yc	71.4	20.25	3.3657	4.6153	708,700	13.599
A	61	N	5	Hw	20.0	9	0.3750	0.2886	3,830,523	73.502
A	61	S	5	Hw	31.2	9	0.8828	0.8712	1,574,015	30.203
A	81	W	4	Dr	39.3	9	0.8505	0.8044	1,984,097	38.072
C	83	E	4	Yc	69.0	16	5.5018	5.4820	599,592	11.505
B	102	N	5	Hw	96.8	12.25	0.0000	0.0000	52,115	1.000
B	102	W	7	Hw	73.0	12.25	0.0000	0.0000	91,636	1.758

Total Weight = W_1 x W_2 x W_3

W_1 = Area (Table 8) / [No. Enhanced Clusters (Table 8) x Polygon Area (Table 10)]
W_2 = Polygon Area (Table 10) x Basal Area factor (Table 13) / [No. Plots (Table 10) x 0.00007854 x DBH^2 (Table 13)]
W_3 = Total No. Trees (Table 9) / No. Sample Trees (Table 9)

Table 14. NVAF sample of live F-mature trees.

Economic Status	Cluster No.	Plot	Tree No.	Species	DBH (cm)	Basal Area Factor	Cruiser Volume (m^3)	Actual Volume (m^3)	Total Weight	Relative Weight
C	23	N	7	Fdc	109.8	20.25	12.1103	13.6026	150,825	4.392
C	35	E	4	Fdc	98.3	25	12.6241	15.6708	801,728	23.344
C	35	I	5	Fdc	75.0	25	8.0160	8.6695	125,204	3.646
C	35	N	3	Fdc	139.5	25	25.1921	29.1295	36,190	1.054
C	35	S	98	Fdc	143.2	25	28.8379	33.1084	34,344	1.000
C	35	S	99	Fdc	119.9	25	20.1746	20.5282	48,990	1.426
D	96	S	1	Fdc	47.4	12.25	1.2433	1.7308	288,810	8.409
D	96	S	6	Fdc	45.8	12.25	1.7874	1.8648	309,341	9.007
D	96	W	2	Fdc	50.5	12.25	2.1387	2.3193	254,440	7.408

Table 15. NVAF sample of live (non F-mature) trees.

Economic Status	Cluster No.	Plot	Tree No.	Species	DBH (cm)	Basal Area Factor	Cruiser Volume (m^3)	Actual Volume (m^3)	Total Weight	Relative Weight
A	2	N	3	Dr	13.5	6.25	0.0447	0.0408	8,210,140	344.766
A	2	W	2	Fdc	28.9	6.25	0.4122	0.3725	716,609	30.092
A	2	W	4	Fdc	25.0	6.25	0.3062	0.3523	957,631	40.214
A	2	W	5	Fdc	18.1	6.25	0.1484	0.1532	1,826,926	76.718
A	17	E	3	Hw	84.1	12.25	8.7362	5.5559	423,865	17.799
A	17	N	1	Hw	63.4	24.5	2.5309	3.8423	1,491,664	62.639
A	17	W	1	Hw	33.7	12.25	1.1063	1.0127	2,639,731	110.850
D	25	E	5	Yc	58.0	9	2.8069	2.5798	410,143	17.223
D	25	E	9	Hw	69.3	9	1.4710	0.0000	283,789	11.917
D	25	N	4	Ba	25.9	9	0.3325	0.3014	150,497	6.320
C	35	E	5	Hw	58.0	25	4.3177	4.0298	717,792	30.142
C	35	N	5	Cw	86.1	25	10.4388	9.3868	271,436	11.398
C	36	E	3	Hm	47.4	20.25	1.5721	1.7278	652,897	27.417
C	36	E	4	Hw	42.7	20.25	0.5578	0.0000	804,536	33.785
C	36	S	4	Hw	39.2	20.25	1.0460	1.3354	954,617	40.087
C	36	W	4	Hw	59.1	20.25	2.7285	3.0234	419,978	17.636
B	40	S	4	Hw	66.5	16	2.7808	0.0000	106,836	4.486
B	40	S	6	Ba	62.6	16	4.0926	4.2432	506,364	21.264
C	43	E	1	Ba	89.4	20.25	8.7129	10.6946	275,307	11.561
C	43	E	4	Ba	61.7	20.25	4.0908	4.3440	1,798,198	75.511
C	43	E	6	Ba	30.9	20.25	0.8959	0.8714	5,121,095	215.049
C	43	E	99	Ba	69.7	20.25	5.1819	4.7757	452,926	19.020
C	43	N	4	Hm	94.2	20.25	6.6725	9.5598	165,310	6.942
C	43	S	3	Hm	27.7	40.5	0.4614	0.3463	3,823,592	160.563
D	44	E	1	Yc	61.5	20.25	2.0879	2.6298	264,249	11.097
D	44	N	3	Yc	56.5	20.25	2.2410	2.3886	972,471	40.837
D	44	S	5	Yc	92.3	20.25	0.0000	0.0000	117,317	4.926
D	45	E	4	Yc	38.4	5.06	0.3415	0.2176	526,062	22.091
D	45	S	1	Hm	42.6	5.06	0.3284	0.4373	422,232	17.731
A	49	E	1	Fdc	22.0	6.25	0.2859	0.3276	1,236,610	51.929
A	49	N	1	Fdc	32.1	12.5	0.7356	0.8577	1,161,711	48.783
A	49	N	2	Fdc	28.0	12.5	0.4330	0.4035	1,526,835	64.116
A	49	N	5	Fdc	24.4	12.5	0.3868	0.3739	2,010,613	84.431
A	49	N	7	Fdc	54.2	12.5	2.0902	2.4867	135,828	5.704
A	49	S	1	Fdc	19.6	6.25	0.2263	0.2484	1,557,995	65.424
A	49	S	4	Fdc	30.6	6.25	0.5601	0.5415	639,198	26.842
D	50	E	2	Yc	120	6.25	0.0000	0.0000	42,844	1.799
D	50	E	3	Hm	42.0	6.25	0.6753	0.7157	516,667	21.696
D	50	N	1	Hm	55.3	12.5	1.2971	0.9397	596,059	25.030
C	55	E	4	Hw	24.7	20.25	0.1906	0.1484	3,205,870	134.623

Economic Status	Cluster No.	Plot	Tree No.	Species	DBH (cm)	Basal Area Factor	Cruiser Volume (m^3)	Actual Volume (m^3)	Total Weight	Relative Weight
C	55	E	9	Hw	68.9	20.25	3.9528	3.2641	412,004	17.301
C	55	N	2	Yc	104.2	20.25	9.8017	8.6381	264,202	11.095
C	55	W	2	Ba	53.7	20.25	3.0126	2.8584	3,165,177	132.915
C	55	W	7	Hm	72.2	20.25	4.6631	5.0296	375,202	15.756
A	59	E	2	Hw	22.1	9	0.3246	0.3392	4,509,635	189.372
A	59	S	3	Dr	31.3	9	0.5116	0.6311	2,932,450	123.142
A	61	N	4	Hw	31.4	9	1.1716	1.0965	1,675,436	70.356
A	61	W	2	Hw	13.3	9	0.0758	0.0669	9,338,646	392.155
A	61	W	3	Hw	36.2	9	1.5201	1.5317	1,260,579	52.935
C	69	E	1	Hw	84.8	40.5	5.5638	6.8814	543,974	22.843
C	69	W	4	Hw	50.0	40.5	0.5305	1.8290	1,564,695	65.706
A	81	N	2	Hw	44.5	9	2.2242	2.0754	1,668,388	70.060
C	83	E	1	Hw	75.9	16	6.4668	6.0973	268,257	11.265
C	85	N	4	Cw	59.0	16	2.2756	2.7623	277,467	11.652
C	85	N	6	Hw	107.5	16	9.6245	6.3370	100,295	4.212
C	85	S	4	Hw	59.2	16	2.9033	2.0186	330,714	13.888
B	102	E	4	Yc	141.6	12.25	18.7069	25.9621	23,814	1.000
B	102	N	4	Ba	88.7	12.25	10.7668	9.2316	96,550	4.054
B	102	S	3	Hw	75.1	12.25	5.8948	2.1646	32,068	1.347
B	102	W	1	Hw	33.0	12.25	0.8532	0.8296	166,081	6.974

13.2 Appendix B: VRI Statistical Adjustments for VDYP 7

MEMO

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To: Mike Davis

From: Rueben Schulz

Date: September 9, 2016

Subject: TFL 37 and TFL 6 Inventory Adjustment

Introduction

This document describes the application of a new adjustment, using VDYP 7, for Western Forest Products (WFP) TFL 37 and TFL 6 forest inventories. Both inventories had Phase 2 adjustments completed for them in 2004 and 2009 (respectively). The original inventory adjustments were applied using VDYP 6 and an older adjustment methodology.

The original adjustments are described in the following reports:

- J.S. Thrower & Associates Ltd., Vancouver-Kamloops, BC, June 2004, Tree Farm Licence 37 Vegetation Resources Inventory Statistical Adjustment Version 3.0

- J.S. Thrower & Associates Ltd., Vancouver-Kamloops, BC, June 2004, Tree Farm Licence 37 Net Volume Adjustment Factor Analysis Version 2.0

- Ewen, Stephanie, Timberline Natural Resources Group Ltd., Kamloops, BC, Dec 2009, Western Forest Products Inc. TFL 6 Vegetation Resources Inventory Statistical Adjustment

Both TFLs had take back areas removed and added to the Pacific TSA. During the 2015 TSR for the Pacific TSA, the adjustments for Pacific Block 7 (formerly part of TFL 6) and Pacific Block 8 (formerly in TFL 37) were re-calculated for VDYP 7 and applied to the Pacific TSA inventories and growth and yield curves. Since the re-calculated adjustments used all of the ground plots in the original TFL areas, the new adjustments can also be applied to the TFL inventories.

The re-calculation of the Pacific TSA block 7 and 8 inventory adjustments are described in the following reports:

- Forest Ecosystem Solutions Ltd., April 2015, Pacific TSA Supply Block 8 Vegetation Resources Inventory Statistical Adjustment Version 1.0

- Forest Ecosystem Solutions Ltd., May 2015, Pacific TSA Supply Block 7 Vegetation Resources Inventory Statistical Adjustment Version 1.0

This memo details the application of the new adjustments calculated for the Pacific TSA to the TFL 37 and TFL 6 inventories.

Data

WFP provided original forest inventories for TFL 37 and TFL 6 to apply the adjustment to. The TFL 6 inventory was projected to 2000 and the TFL 37 inventory had a 1996 reference year. Both inventories include take back areas that are no longer part of the TFLs.

Methods

The original VDYP 6 based adjustment had two stages. In the first stage age and height ratios were computed between the inventory and plot values. The inventory stands were then adjusted with these ratios and projected with VDYP 6 to generate an attribute adjusted volume. A volume adjustment ratio (VAF) was then calculated between the attribute adjusted volume and ground volume (NVAF). The application of the linear VAF completed the adjustment.

The new adjustment methodology with VDYP 7 is similar and adds an adjustment for basal area, density and lorey height. Age, height, basal area, and tree density adjustment ratios are calculated between the inventory and plot values. The adjustment factors are applied to the stand inputs and an attribute adjusted output is calculated. Ratios for the VAF and for lorey height are calculated. The main difference with the application of the volume adjustment in VDYP 7 is that it applies the volume and lorey height adjustments internally. Rather than just a linear adjustment, the adjustment is applied at the year plots were measured and then tappers over time.

The application of the new adjustments calculated for the Pacific TSA required the adjustment population and strata for each TFL inventory to be determined. For both TFLs the adjustment was only applied to the rank 1 inventory layer.

TFL 37

The total area of TFL 37 is 190,669 ha, with 163,895 ha having a rank 1 tree species (forested). The adjustment population was the economic and marginally economic, vegetative treed area where the 1996 stand age was greater than or equal to 36 years.

The TSR economic classification was not available; however a TSR dataset with an adjusted inventory was available. The old (>= 36 years in 1996) areas that were not adjusted in the TSR dataset were cut out and rated into the TFL 37 inventory. These uneconomic older areas, and stands younger than 36 years (1996) were excluded from the adjustment population. Additionally, non-productive areas were also excluded from the adjustment, as they were found to be unadjusted in the TSR dataset.

The adjustment population was split into two strata: old and young. The old strata consisted of stands greater than or equal to 300 years (1996), while the young strata comprised stands from 36 to 299 years old. In the original inventory, all stands older than 300 years were assigned an age of 300 years. The old stratum was 71,245 ha and the young stratum was 27,270 ha.

TFL 6

The original TFL 6 adjustment was applied to a 2006 VRI and the adjustment used FOR_PID as the unique link between the adjustment table and inventory. The inventory adjusted here is a 2000 VRI, which lacked a FOR_PID identifier. The 2000 VRI also includes the take back area, which is no longer part of the TFL and was excluded from the 2009 adjustment.

The total area of the 2000 TFL 6 VRI is 287,537 ha, of which 273,407 ha is forested with a rank 1 tree species. The adjustment population was the vegetated portion of the TFL with an age greater than or equal to 30 (in 2001), excluding private lands, parks or other protected areas.

The original adjustment table and a 2006 VRI were used to restrict the adjustment population for the 2000 VRI. The 2006 VRI was rated into the older inventory to provide the FOR_PID link. This excluded the take back, private land, parks and protected areas from the population.

The adjustment population was separated into two strata: the old strata comprised stands greater than or equal to 140 years (2001) and the young strata included stands between 30 and 139 years old (2001). The old stratum was 76,541 ha and the young stratum was 60,120 ha.

Results

TFL 37

The inventory adjustment applied to TFL 37 increased the overall TFL volumes in both 2001 (the base year of the adjustment) and 2016 (Table 1). The adjustment to the old strata increased the volumes, though the increase was reduced by 2016. The slight decrease in the old unadjusted volumes from 2001 to 2016 resulted from VDYP 7 dropping the volume of mature stands as they age. The young strata has a slight downward adjustment in 2001, which is further increased in 2016. Between 2001 and 2016 the young strata gained volume, both adjusted and unadjusted. The upward adjustment to the entire forest was lessened in 2016 by the drop in the adjusted young volumes.

Table 1: TFL 37 average adjusted and un-adjusted volumes (12.5 cm untilization, net decay waste and breakage)

Population	Average 2001 Volume (m^3/ha)		Average 2016 Volume (m^3/ha)		Area (ha)
	Unadjusted	Adjusted	Unadjusted	Adjusted	
Old Strata	683	748	678	702	71,245
Young Strata	493	490	616	575	27,270
Entire Forested VRI	422	450	487	491	163,716

When running the entire forest in VDYP 7, 179 ha of stands failed to run. These stands were too young for VDYP to process and were excluded from the Entire Forested VRI summary.

TFL 6

The adjustment to the TFL 6 inventory increased the average volumes in both 2001 and 2016 (Table 1). Both the old and young strata volumes were adjusted upwards. The slight drop in the old strata volumes between 2001 and 2016 is due to VDYP 7 lowering the volume of old stands as they age. The 2001 adjustment impact is only slightly diluted by 2016.

Table 2: TFL 6 average adjusted and un-adjusted volumes (12.5 cm untilization, net decay waste and breakage)

Population	Average 2001 Volume (m^3/ha)		Average 2016 Volume (m^3/ha)		Area (ha)
	Unadjusted	Adjusted	Unadjusted	Adjusted	
Old Strata	553	660	549	629	76,541
Young Strata	406	463	535	600	60,120
Entire Forested VRI	333	375	383	420	273,407

The 2006 TFL 6 inventory that was originally adjusted included depletions that were young and therefore outside of the adjustment population. In the 2000 TFL 6 inventory, adjusted in this project, these stands were old. Since they were not part of the original adjustment population these older stands remained unadjusted in this analysis. When the 2000 inventory is updated for depletions, these unadjusted older stands will once again be young.

One 30 year old stand in the adjustment population, TL_LINK 17719 (KEYID 851_092L064), failed to run in VDYP 7 and has no adjustment output. This stand is 8.6 ha.

Pacific TSA Supply Block 8

Vegetation Resources Inventory Statistical Adjustment

Version 1.0

April 27, 2015

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1 Introduction

As part of the current timber supply review (TSR) for the Pacific TSA, the best available inventory and growth and yield data is being compiled. Supply Block 8 of the Pacific TSA was formerly part of Tree Farm Licence (TFL) 37. The TFL 37 phase 1 inventory that provides the basis for the Supply Block 8 Vegetation Resource Inventory (VRI) was completed in 1997 and has a 1996 reference date.

In support of the last TSR for TFL 37 (Management Plan 9), an inventory adjustment to Age, Site Index and Volume (net volume adjustment factor) was completed in 2004. Eighty phase 2 ground plots were established in 2001/2002 as part of that statistical adjustment. The original inventory adjustment was described in the following reports:

- Tree Farm Licence 37 Vegetation Resources Inventory Statistical Adjustment: Version 3.1, June 3, 2004 (revised December 6, 2004), J.S. Thrower & Associates Ltd.
- Tree Farm Licence 37 Net Volume Adjustment Factor Analysis: Version 2.0, June 3, 2004, J.S. Thrower & Associates Ltd.

The original VRI phase 2 inventory adjustment was completed with VDYP 6. The growth and yield modeling for natural stands for the Pacific TSA TSR will use VDYP 7, the current Ministrty of Forests, Lands and Natural Resourves Operations (FLNRO) standard. Adjustment procedures for VDYP 7 require adjustment ratios to be calculated for age, height, density, basal area, lorey height and volume. This necessitated a re-calculation of the adjustment ratios so that they could be applied to the Supply Block 8 VRI for the Pacific TSA.

2 Methods

The methodology used for this adjustment was based on the following documents:

- Vegetation Resources Inventory, Interim Procedures and Standards for Statistical Adjustment of Baseline VRI Timber Attributes. Jan 2008
- Procedure for Adjusting VRI Attributes for VDYP7 Projection

Additional help was provided by Sam Otukol and his staff at the Forest Analysis and Inventory Branch (FAIB) of FLNRO.

2.1 Study Area

The Supply Block 8 has a total area of 18,351 ha, of which 12,517 ha is classified as forest management land base (FMLB). The adjustment population was the economic and marginally economic, vegetative treed area where the stand age (in 1996) was greater than or equal to 36 years old (greater than or equal to 41 years old in 2001). Note that the economic and marginally economic area definitions are those of TFL 37, as per their Management Plan 9 (MP 9).

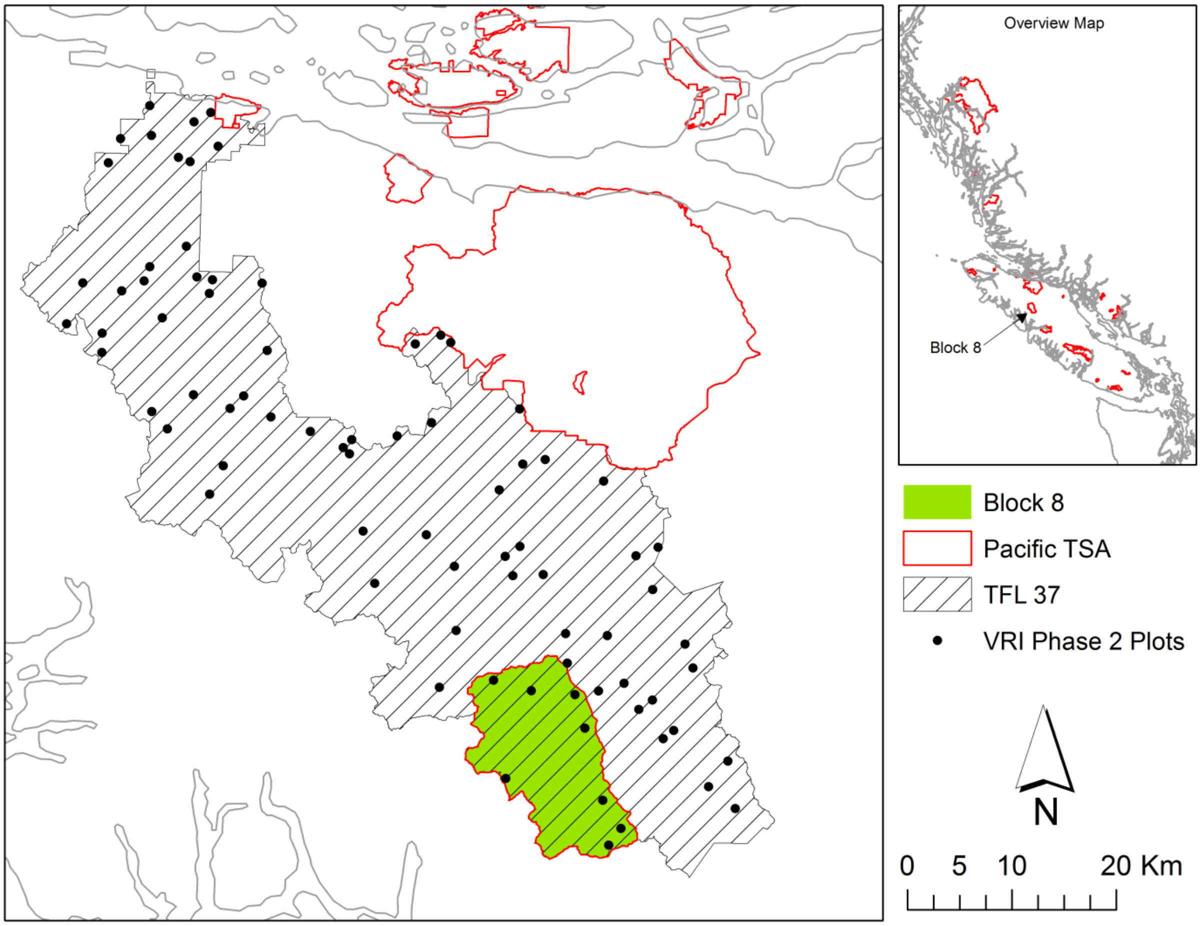

Figure 1: Location of the Pacific TSA Block 8, relative to TFL 37 and phase 2 ground plots.

The adjustment population was separated into two strata. The old strata were stands greater or equal to 300 years (1996) and the young strata included stands from 36 to 299 years old (1996). In the original inventory, all old growth stands older than 300 years old were assigned an age of 300 years.

The economic land base definition from the TFL 37 MP 9 analysis was not available; however, a forest inventory from MP 9 containing adjusted age and volume values was available. The adjusted portion of this inventory was used to define the economic and marginally economic areas that the original adjustment applied to.

The Block 8 VRI was updated with recent depletions. These areas were removed from the adjustment population as they are now young.

The Pacific TSA Block 8 VRI areas and adjustment population are described in Table 1.

Table 1: Pacific TSA Block 8 VRI Areas

Description	FMLB Area (ha)	Non-FMLB Area (ha)	Total Area (ha)
Block 8 VRI	12,517	5,835	18,351
Block 8 VRI Treed	12,006	1,399	13,406
Old Adjustment Strata	5,500	105	5,605
Young Adjustment Strata	930	30	960

2.2 Ground Sampling Data

Compiled plot data for the Eighty 2001/2002 VRI timber emphasis ground sample plots was provided by Sam Otukol of FAIB. These plots consisted of a central plot and up to 4 satellite plots. The plot data was compiled to provide stand level values at 4, 7.5, 12.5, 17.5 and 22.5 cm utilization levels. The plots were linked to the original TFL 37 inventory based on their UTM coordinates.

2.3 Statistical Adjustment

The adjustment calculation involved the following steps:

1. Project the original 1996 inventory with VDYP 7 to 2001 to match the ground plot date.
2. Calculate adjustment ratios between the 2001 inventory and plot values for age, height, density and basal area
3. Apply the adjustment ratios to the 2001 age, height, density and basal area and project these values (at both 7.5cm and 12.5cm utilization levels) with VDYP 7 to produce attribute adjusted volumes (7.5cm and 12.5cm utilization levels) and lorey height (7.5cm utilization level).
4. Calculate adjustment ratios between the attribute adjusted volume and lorey height and the Net Volume Adjusted Factor (NVAF) plot volume and lorey height.
5. Project the inventory using the adjusted 2001 age, height, density and basal area. The adjustment ratios were applied to the volumes and lorey height; these adjusted values were included as inputs to VDYP 7, which applied the volume adjustment to the output.

The BEC zone used in the VDYP7 projections came from the ecology data of the MP 9 analysis, which matches the BEC zone in Supply Block 8 VRI. Where a stand with a ground plot was covered by more than one BEC zone, the zone in which the plot centre landed was used.

Detailed adjustment procedures are provided in an Appendix at the end of this document.

3 Results

Of the 80 inventory plots established for the original adjustment, 58 were established in stands greater than or equal to 41 years old (2001) and had a leading species that matched the inventory stand leading species (at least to the conifer/deciduous level).

One plot in the old stratum did not have an age and six were missing height information.

Table 2 details the statistics for the age, height, density, basal area, lorey height and volume adjustment. The phase 1 inventory tended to underestimate age and overestimate height. The final volume adjustment increased the volume in the old stratum, but only applied a slight downward adjustment to the young stratum.

Table 2: Table of adjustment values

Attribute	*Stratum*	*n*	*Mean weighted Phase II value, by stratum*	*Mean weighted Phase I value, by stratum*	*Ratio of means adjustment factors*	*Sampling error %*
Age of 1st sp	Old	37	438.6	305.0	1.4382	13.9%
	Young	20	144.2	112.1	1.2861	20.8%
Height of 1st sp	Old	32	28.9	35.4	0.8174	10.2%
	Young	20	29.6	29.7	0.9971	11.6%
Trees/ha @7.5cm+ dbh	Old	38	768.9	585.7	1.3129	19.4%
	Young	20	989.8	932.1	1.0620	29.2%
Basal area/ha @7.5cm+ dbh	Old	38	74.1	67.1	1.1044	12.2%
	Young	20	55.8	54.8	1.0184	16.2%
Lorey height @7.5cm+ dbh	Old	38	26.0	25.0	1.0413	10.3%
	Young	20	26.6	26.0	1.0246	13.3%
Volume/ha net top, stump, decay & waste @12.5cm+ dbh	Old	38	738.0	573.7	1.2863	12.4%
	Young	20	511.0	519.5	0.9837	26.4%

Figure 2 to Figure 7 provide scatter graphs of the phase 1 inventory and phase 2 plot values for each stratum.

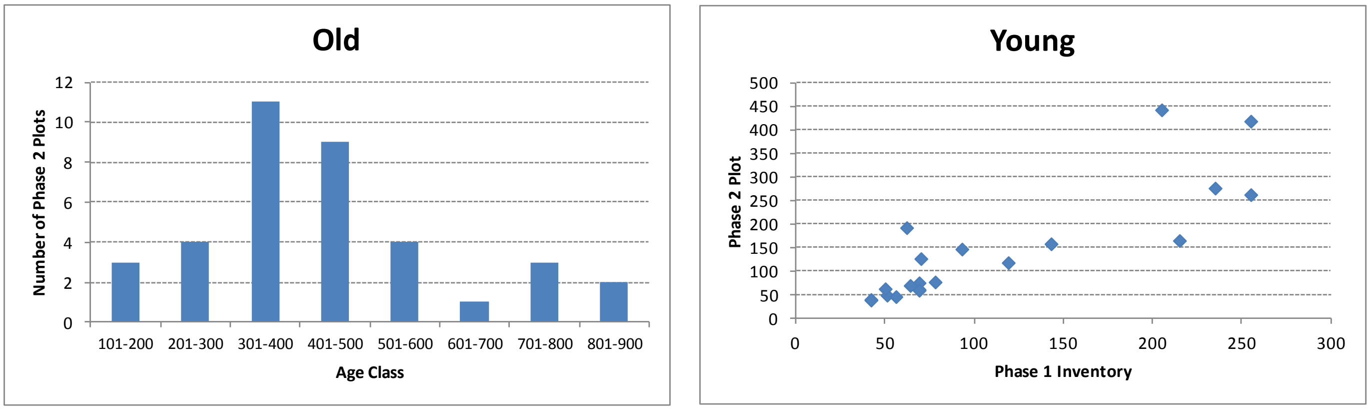

Figure 2: Phase 2 vs. Phase 1 age (yrs), by stratum. The phase 1 age within the old stratum was a constant value of 305 (year 2001).

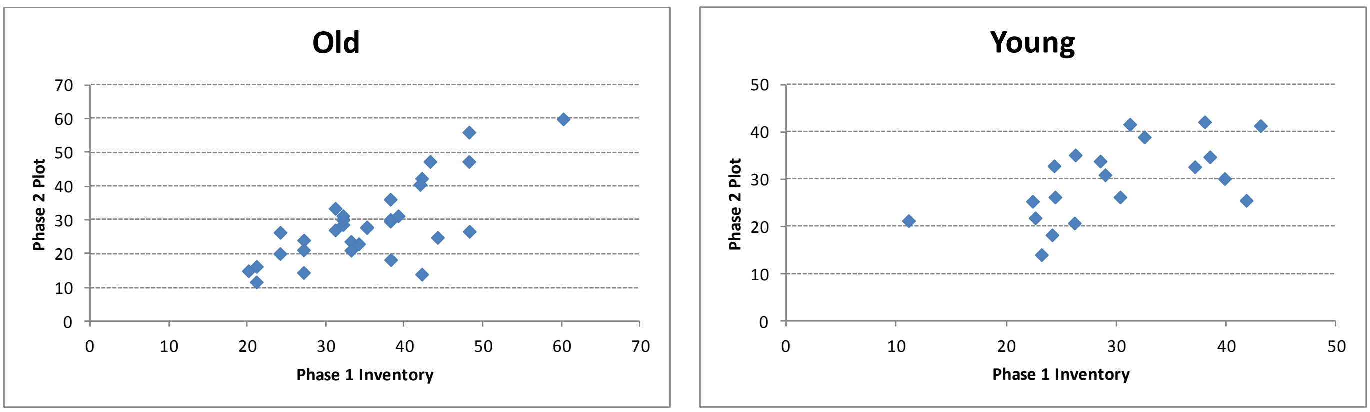

Figure 3: Phase 2 vs. Phase 1 height (m), by stratum.

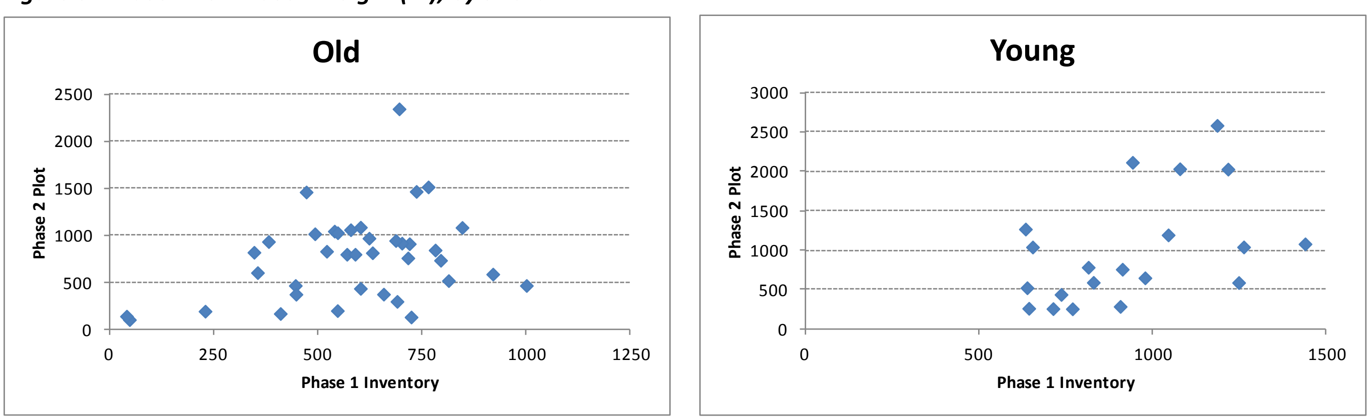

Figure 4: Phase 2 vs. Phase 1 density (stems/ha), by stratum.

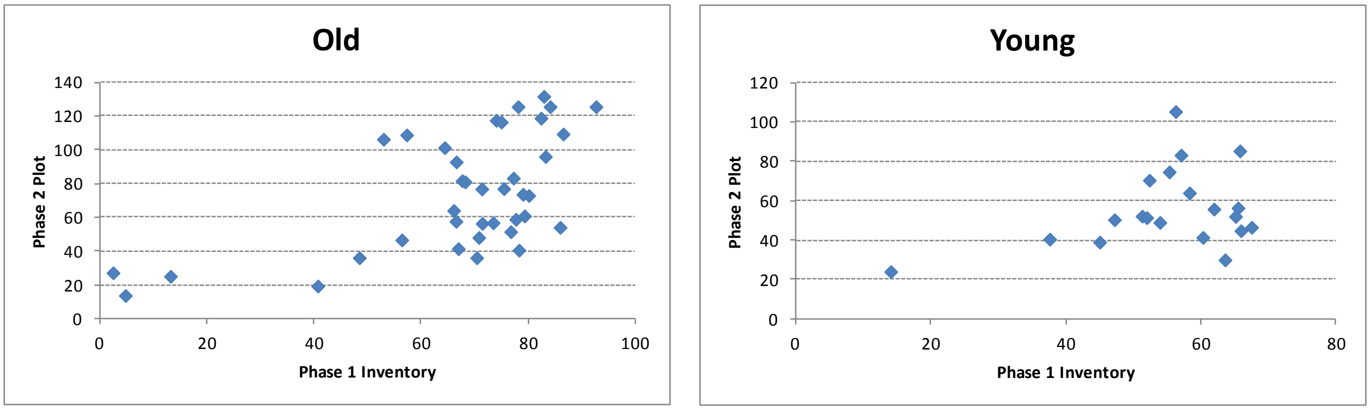

Figure 5: Phase 2 vs. Phase 1 basal area (m^2/ha), by stratum.

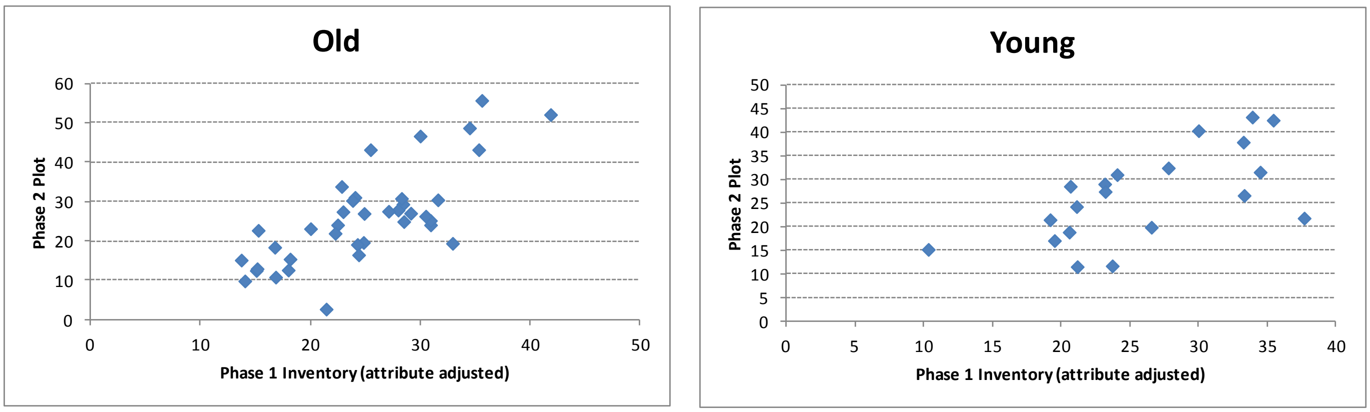

Figure 6: Phase 2 vs. Phase 1 (attribute adjusted) lorey height (m), by stratum.

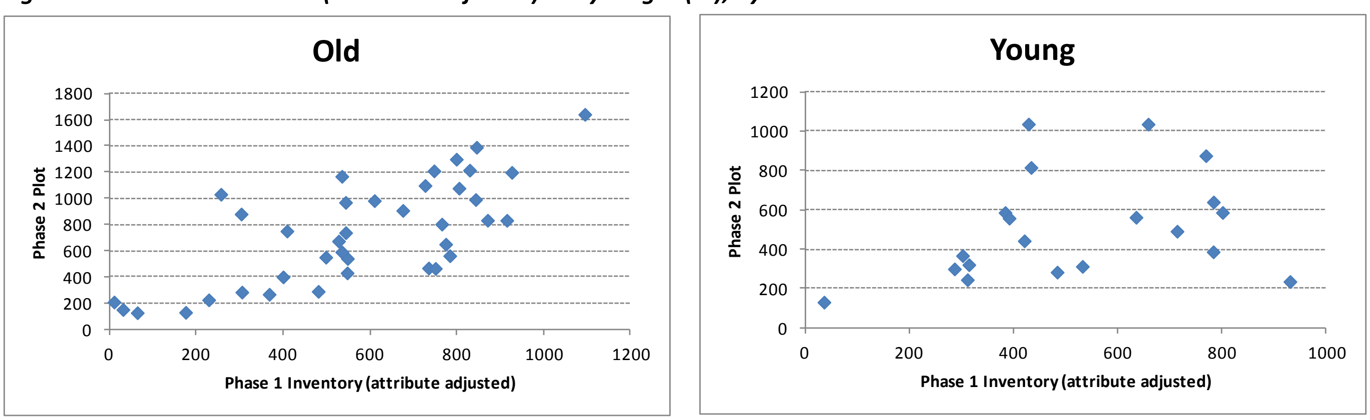

Figure 7: Phase 2 NVAF vs. Phase 1 (attribute adjusted) close utilization decay and waste volume (m^3/ha), by stratum.

The inventory adjustment slightly increases the overall Block 8 VRI volumes, as see in Table 3 and Table 4. The increase comes from the upward adjustment to the old stratum, which offsets the slight downward adjustment to the young stratum.

The largest impact of the adjustment is to the 2001 reference year. As the inventory is projected farther from the reference year (2014), the adjustment effect is diluted. Also the projected volume of old stands in VDYP 7 drops slightly over time, which further leads to a slight decrease to old stratum volumes.

Table 3: Block 8 VRI average adjusted and un-adjusted volume (12.5 cm utilization, decay wasted and breakage)

Population	Average 2001 Volume (m^3/ha)		Average 2014 Volume (m^3/ha)		Area (ha)
	Unadjusted	Adjusted	Unadjusted	Adjusted	
Old Strata	649	703	645	663	5,605
Young Strata	324	321	415	384	960
Entire VRI (updated with depletions to 2013)	346	368	380	386	13,406

Table 4: 8 VRI average adjusted and un-adjusted volume, FMLB only (12.5 cm utilization, decay wasted and breakage)

Population	Average 2001 Volume (m^3/ha)		Average 2014 Volume (m^3/ha)		Area (ha)
	Unadjusted	Adjusted	Unadjusted	Adjusted	
Old Strata	657	711	652	670	5,500
Young Strata	335	331	428	396	930
Entire VRI (updated with depletions to 2013)	376	401	415	421	12,006

4 Discussion

There were a few inconsistencies between this adjustment and the original 2004 adjustment done for Management Plan 9:

- There were 37 plots available to use in the old stratum for the age adjustment, but only 36 were used in the original adjustment
- A slightly different average phase 2 age in the old and young strata was produced than in the original adjustment
- The adjusted forest inventory from the MP 9 analysis indicated that the adjustment was originally applied to stands with an age >= 30 years (1996). This was inconsistent with the adjustment report stating that the adjustment population was stand ages >=36 years old (1996).

The first two issues likely resulted from a slightly different compilation of the plot data between the original analysis and this analysis. The reason for the inconsistency on the age used to define the adjustment stratum is unknown. This adjustment elected to use the stated population from the 2004 adjustment report as it matches the range of plot data used for the adjustment calculation.

The adjusted inventory values provide an unbiased estimate of the inventory attributes and volumes for the Supply Block 8 VRI and should be used in the preparation of growth and yield curves for the Pacific TSA TSR analysis.

Appendix: Detailed Methodology

The following procedure describes re-calculating the adjustment for TFL 37 and applying it to the inventory. The original adjustment was done for VDYP 6, which is incomplete for VDYP 7.

1) Obtained plot data fromFLNRO. The data was:

- TFL_37_Cluster_Data.csv - compiled plot data for 5 utilization levels (4, 7.5, 12.5, 17.5, 22.5).
- UTM_Coordinates_etc.csv - includes plot locations

The 80 plots include (separated by TYPE_CD): Timber Emphasis + CWD (D01), Monitoring (M01), and Net Volume Adjustment (N01). We used the D01 plots.

Each plot included 4 satellite plots (total of 5). A call was made on the ground to determine which 4 satellite plots were within the inventory stand (some were in neighbouring stands). Outside plots were excluded.

The data has already been compiled to give per ha plot information (and the NVAF was applied). The following fields were required:

- CLSTR_ID - unique ID
- TYPE_CD - plot type (D01 was used)
- UTIL
- SPB_CPCT – species composition – used for matching plots to inventory stands
- BA_HA - basal area live
- STEMS_HA - density live
- HT_MEAN1 - weighted mean ht (incl. broken top) - used for Lorey Ht adjustment
- HT_M_TLS - mean height of top, site, and second spp site height trees (T,L,S).
- AT_M_TLS - mean age of (T,L,S trees)
- NVL_NW2 - NVAF * Whole stem vol/ha less Top, Stump, Cruiser Decay and Waste (live)

2) Plots were linked to an original TFL 37 inventory (1996 reference and projection year). Points were created from the UTM_Coordinates data and intersected with the inventory. FOREST_ID was used as the unique inventory ID.

3) Species attributes were compared to determine if inventory and plot layers match (4 cm utilization).

The result was that:

- 45plots matched at spp level
- 6 plots matched at genus level
- 27 plots matched at conif/decid level
- 2 plots did not match at conif/decid level and could not be used.

While the linkage is used to determine which inventory layer should be matched to the plot, we only have a single layer inventory.

Note, the original adjustment says only 58 (of 80) plots were used. The reason 78 plots are usable at this stage is because this includes young (<=35 years in 1996) plots. Excluding young plots the number is 58.

Only 20 plots in the young stratum can be used, since the other half are <=35 years old. The sampling targeted the entire population of stands, but the adjustment is only being done on >=36 year old (1996) stands.

4) Inventory is 1996 and plots were measured in 2001/2002. First the inventory needs to be projected to 2001 so it can be properly compared to the plots (also missing SPH and BA needs to be filled in by the VDYP7 FIP module).

The inventory values for the 80 plots were inserted into a VDYP 7 input template. Inv_Standard_Cd of "F" was used since the inventory is closer to an FC1 (with BA added) than a VRI. Reference year was 1996.

BEC Zone was taken from the TFL 37 MP 9 Ecology data (this is the BEC zone used in the Supply Block 8 VRI).

This input file was run in VDYP 7 ("Step 1") at a 7.5 cm utilization. Multiple years (1996-2015) were run but only 2001 is needed.

5) Compute Age, Height, Basal Area, and SPH adjustment ratios.

The original sample plan describes some very complex strata and sampling weights, however the original adjustment report just says “The sample was distributed evenly across the target population. Therefore each plot represented the same area/plot and had the same sampling weight.” Sam Otukol suggested we should use unweighted plots as originally done.

There were two strata: young (<300 yrs) and old (300 yrs). The original inventory just called all >=300 year old trees age 300.

Adjustment ratio of means (ROM) were calculated for each strata between:

- 2001 inventory (VDYP 7) age and plot AT_M_TLS (old strata just uses average age, no ratio)
- 2001 inventory (VDYP 7) PRJ_DOM_HT(7.5) and plot HT_M_TLS(7.5).
- 2001 inventory (VDYP 7) PRJ_BA(7.5) and plot BA_HA(7.5)
- 2001 inventory (VDYP 7) PRJ_TPH(7.5) and plot STEMS(7.5)

The Ministry Excel Marco VRI Analysis1_Original.xlsm was used to calculate sampling error.

While the average inventory age for the young strata matches the original adjustment, the average plot age does not (resulting in a new ROM of 1.286 vs the original 1.236). Most likely the plot compilation was slightly different between the original adjustment and the plot data used.

6) Calculate attribute adjusted volumes (and Lorey Ht).

VDYP 7 was run a second time ("Step 2") with the same species composition and other fields, however the age, height, basal area and stems/ha (output from the "step 1" run) were adjusted using the calculated adjustment ratios. The Inv_Standard_Cd was set to "V" so that VDYP will use the basal area and SPH. The reference year was set to 2001.

Only the 58 plots in the adjustment population were run. VDYP 7 output is needed at both 7.5 and 12.5 cm utilizations (same input file is run twice with different util parameters).

7) Calculate volume and lorey height adjustment ratios.

Adjustment ratios for each strata were calculated between:

- Inventory (VDYP 7 Step 2) PRJ_LOREY_HT(7.5) and plot HT_MEAN1(7.5)
- Inventory (VDYP 7 Step 2) PRJ_VOL_DW(12.5) and plot NVL_NW2 (12.5)

The lorey height ROM is used to adjust the lorey height, while the same volume ROM gets applied to WSV7.5, WSV12.5, CUV12.5, VOL_NET_D12.5, and VOL_NET_DW12.5.

8) Calculate final adjusted volumes ("Step 3")

The same "Step 2" VDYP input file is run (which has adjusted age, ht, BA, sph), but the following fields are also filled in:

- R1_ADJ_INPUT_ID - id based on strata (must be non null)
- R1_LOREY_HEIGHT - adjusted PRJ_LOREY_HT (7.5)
- R1_BASAL_AREA_125 - **un**adjusted PRJ_BA (12.5)
- R1_VOL_PER_HA_75 - adjusted PRJ_VOL_WS (7.5)
- R1_VOL_PER_HA_125 - adjusted PRJ_VOL_WS (12.5)
- R1_CLOSE_UTIL_VOL_125 - adjusted PRJ_VOL_CU (12.5)
- R1_CLOSE_UTIL_DECAY_VOL_125 - adjusted PRJ_VOL_D (12.5)
- R1_CLOSE_UTIL_WASTE_VOL_125 - adjusted PRJ_VOL_DW (12.5)

The above values came from the "Step 2" output multiplied by the adjustment ROM.

When this input is run in VDYP 7, it will use the adjusted lorey height and volumes to apply a final volume adjustmet to the output values.

9) Apply the final adjustment to the entire inventory.

The same steps need to be done:

a) project inventory to 2001 ("Step 1")

b) apply calculated age, height, BA, sph ROM to 2001 values and re-run VDYP to generate attribute adjusted values ("Step 2").

c) apply calculated lorey ht and volume ROM to attribute adjusted lorey ht and volumes. Input these as adjusted values and re-run VDYP to generate final adjusted volumes ("Step 3").

The adjustment population should be the economic land base that is >=41 years (2001). We do not have access to the original economic land base data, but do have the original TFL 37 TSR resultant with adjusted age/volume. The TSR resultant was used to determine the adjustment population.

An examination of the TSR resultant showed that stands >=30 (1996) were adjusted. This is inconsistent with the adjustment report stating that only stands >=41 (>=36 in 1996) were adjusted. We used the original adjustment report age (>=36 in 1996) to define the adjustment population.

Some old stands (>=36, 1996) were not adjusted in the TFL 37 TSR resultant. These were deemed the un-adjusted non-economic stands. They were extracted from the TSR resultant and rated into the TFL 37 inventory (50% rule). A few stands (< 100) were in the 25%-75% rating range.

Finally, the TSR resultant showed that no non-productive stands (NP_FOREST = “NP”) were adjusted.

The final adjustment was applied to the inventory where age (1996) >=36, not non-economic (in the old non-adjusted set), not non-productive, and the inventory had not been updated with a recent depletion.

13.3 Appendix C: Managed Stands Site Index Values

Potential Site Index Estimates
for the Main Commercial Species
on TFL 37

Final Report

Prepared for

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Project: CFW-011-007

31 March 2000

J.S. Thrower & Associates Ltd. *Consulting Foresters*
Vancouver – Kamloops – Victoria BC

Executive Summary

Potential site index (PSI) estimates were developed for Pacific silver fir (Ba), western red cedar (Cw), coastal Douglas-fir (Fdc), western hemlock (Hw), mountain hemlock (Hm), and yellow cedar (Yc) for the forested ecosystems on TFL 37. These PSI estimates will be used to generate managed stand yield tables for the next timber supply analysis for Management Plan 9.

PSI estimates were developed using four different methods:

1. statistical adjustment of ecologically-based preliminary site index estimates (in the CWHxm, CWHmm1, and CWHvm1),
2. elevation model (CWHvm2),
3. unadjusted preliminary PSI (MHmm1), and
4. localized site index conversion equations (for Ba and Cw throughout the TFL).

The main contribution of this project is that new PSI estimates are available at the eco-polygon level. This provides a spatial distribution of estimates across the TFL that will improve yield table data used in the timber supply analysis.

Adjustment Formula	Ba	Cw	Fdc	Hw
Inventory Avg Site Index (m)	21.1	17.7	30.5	20.3
Avg PSI (m)	21.8	21.7	32.0	23.1
Difference (m)	0.7	4.0	1.5	2.8
Difference (%)	3.2	22.6	4.9	13.8

The adjusted PSI estimates for the four main species (Fdc, Hw, Ba, and Cw) are between 5% and 20% higher than the current forest cover inventory site index estimates. The new PSI estimates should better reflect growth in PHR stands on TFL 37. These estimates should be monitored and updated as new information becomes available.

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1. INTRODUCTION

1.1 BACKGROUND

Site index is a function of height and age and is the most important variable used in models to develop yield tables. Traditionally, site index has been determined using photo-interpretation. However, photo-interpretation under-estimates site index in old-growth stands because tree damage is not visible on a photo and suppression is not accounted for. As well, photo-interpretation does not provide accurate height estimates for young stands (age class 1 and 2). On Canadian Forest Products Ltd. (Canfor) Tree Farm Licence (TFL) 37, more than 50% of the productive forested landbase (PFLB) is in age-class 8 and 9 and another 35% is too young to provide accurate site index estimates (Appendix I).

A site index project was completed on TFL 37 in 1997 to provide reliable potential site index (PSI) estimates for post-harvest regenerated (PHR) stands. After field sampling, the average PSI was estimated by species for three different productivity groups (low, medium, and high). The average PSI estimates can now be updated, and localized PSI estimates generated at the eco-polygon level. Accurate site index estimates are important to provide a realistic forecast of predicted yield for the upcoming timber supply analysis.

1.2 OBJECTIVE

The objective of this project was to:

> *Develop reliable PSI estimates for the main tree species on TFL 37 using relationships between height growth and biogeoclimatic site series on the PFLB.*

The main tree species are coastal Douglas-fir (Fdc), western hemlock (Hw), Pacific silver fir (Ba), western red cedar (Cw), mountain hemlock (Hm), and yellow cedar (Yc). Site index estimates will be applied at the site series level to develop reliable yield estimates for the timber supply analysis for Management Plan 9.

1.3 TERMS OF REFERENCE

This project was completed for Pat Bryant, *RPF,* of Canfor. The project was completed by Guillaume Thérien, *PhD*, Christie Staudhammer, *MSc,* and Céline Boisvenue, *MSc, RPF,* of J.S. Thrower and Associates Ltd. Funding for the project was provided through Forest Renewal BC.

2. METHODS

2.1 OVERVIEW

The final PSI estimates were developed in three phases:

Phase 1: **Preliminary PSI estimates** were developed for the major tree crop species and ecosystems on TFL 37 using the knowledge and experience of experts in coastal forest productivity and ecosystem classification.

Phase 2: **Field sampling** was completed to estimate actual site index in random plots throughout the TFL.

Phase 3: **Final PSI estimates** for the different species were developed using four different methods (Table 1):

1. Statistical adjustment of preliminary PSI estimates (AdjPSI) from field sampling,
2. Elevation model (Elev),
3. Unadjusted preliminary PSI (PPSI), and
4. MOF site index conversion equations (ConvEqn).

Table 1. Final PSI estimation method.

	Site	Adjustment Method					
Subzone	Series	Ba	Cw	Fdc	Hm	Hw	Yc
CWHxm, CWHmm1 & CWHvm1	All	ConvEqn	ConvEqn	AdjPSI		AdjPSI	
CWHvm2	02/10 Others	ConvEqn Elev	ConvEqn Elev	AdjPSI Elev		AdjPSI Elev	
MHmm1	All	PPSI			PPSI	PPSI	PPSI

2.2 PHASE 1 – PRELIMINARY PSI ESTIMATES

Preliminary site index estimates were developed by Karel Klinka, *PhD, RPF*, Bob Green, *MSc, RPF*, Jim Thrower, *PhD, RPF*, and Pat Bryant, *RPF,* in 1997 for all site series in the PFLB (Appendix II). These experts used their collective knowledge of ecosystem classification and forest productivity attributes of the TFL as well as the SIBEC database to produce these estimates.

Table 2. Preliminary PSI estimates by species.

Spp	Area (ha)	Avg (m)	Min (m)	Max (m)
Ba	138,801	24.8	8.0	40.0
Cw	123,096	24.6	8.0	30.0
Fdc	122,355	31.3	18.0	43.0
Hm	21,079	12.4	8.0	18.0
Hw	144,174	24.7	8.0	32.0
Yc	21,079	12.4	8.0	19.0

The CWHmm1 subzone was established following the completion of the 1997 project. Site indices from the CWHxm were used to develop PSI estimates in the CWHmm1 because both subzones have similar productivity characteristics. Weighted average preliminary PSI estimates by species are provided in Table 2.

2.3 Phase 2 – Field Sampling

2.3.1 Objective

The objective was to measure height and age of site trees to determine site index from a random sample of stands and ecological conditions in the TFL. The field site index estimates were then compared to the preliminary PSI estimates and a ratio developed to adjust the PSI estimates.

2.3.2 Target and Sample Populations

The target population was the PFLB (144,174 ha), and is where PSI estimates will be applied. The sample population consisted of all Fdc and Hw leading stands in age classes 2 to 6 in the CWHmm1, CWHvm1, and CWHxm subzone/variants (33,798 ha, 23% of PFLB) where reliable site index estimates could be obtained (Figure 1).[1] The MHmm1 variant was not included in the sample population as very few sampling opportunities existed in age class 2 to 6 in this subzone.

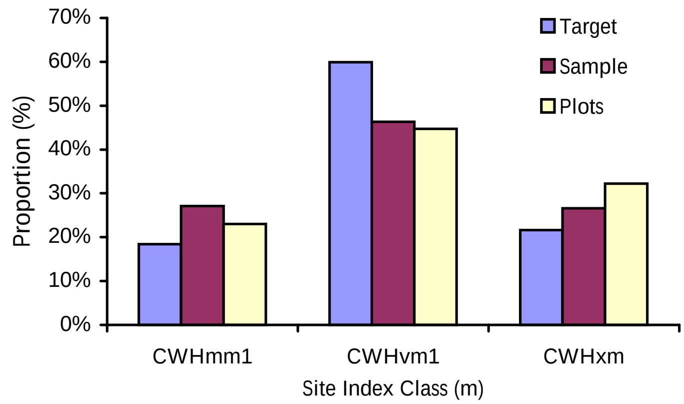

Figure 1. Area proportion (%) by BEC subzone in the target and sample populations, and the sample.

2.3.3 Sample Size and Allocation

Field sampling produced data from 87 400-m^2 (11.28-m radius) plots located throughout the CWHxm, CWHmm1, and CWHvm1 subzones/variants. Sample polygons were selected with probability proportional to area and a sample point was then randomly selected within each polygon. Universal Transverse Mercator (UTM) coordinates for the random points were estimated from field maps.

Ecological classification of the TFL has changed since field sampling and four additional plots are now located in the CWHvm2 variant. These four plots were removed from analysis since an elevation model was used to develop PSI estimates in the CWHvm2 variant. The remaining 83 plots were used in the adjustment process.

Site index estimates were also collected for Ba and Cw to construct localized site index conversion equations with Hw. Site index measurements were taken on 42 paired Ba and Hw site trees and 48 Cw and Hw pairs.

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[1] J.S. Thrower & Associates Ltd. 1997. Canadian Forest Products TFL 37 Site Index BEC Map Unit Correlations Work Plan – Version 3.2. Unpublished Report, Contract No. CFW-011-002. 22 p.

2.3.4 Site Index

Site index was estimated from height and age measurements for the target species in each plot. Both target species were present in 17 of the 83 plots, for a total of 100 observations (53 Fdc and 47 Hw observations). Breast-height ages were adjusted to account for sampling during the growing season. Height growth was assumed to have started May 10 and ceased July 17. The average site index for the TFL was 35.6 m for Fdc and 28.5 for Hw (Table 3).

Table 3. Field site index statistics.

Spp	Subzone	N	Avg (m)	Min (m)	Max (m)	Std Dev
Fdc	CWHmm1	25	35.3	19.5	43.8	6.1
	CWHvm1	11	39.6	35.8	44.0	2.3
	CWHxm	19	33.7	24.8	40.0	4.4
	Total	*55*	*35.6*	*19.5*	*44.0*	*5.3*
Hw	CWHmm1	8	27.4	20.9	32.5	4.1
	CWHvm1	28	28.6	17.6	37.9	4.7
	CWHxm	14	29.0	19.9	33.9	5.0
	Total	*50*	*28.5*	*17.6*	*37.9*	*4.6*

Note: N is greater than 100 because five plots split across two subzones/variants.

2.4 PHASE 3 – FINAL PSI ESTIMATES

2.4.1 Statistical Adjustment

Adjusted PSI estimates were developed for Fdc and Hw in all site series in the CWHxm, CWHmm1, CWHvm1 subzones/variants. The preliminary PSI estimate for each eco-polygon in the sample population was adjusted using a ratio reflecting the relationship between preliminary PSI and field site index estimates. Two ratios were required for Hw since the direction of the observed bias in the preliminary PSI estimates was not consistent between the subzones. A single Fdc adjustment ratio was estimated because the adjustment ratios were similar in each subzone. The coefficients of the model were estimated using the least-squares method where each observation was weighted by the portion of the sample cluster area inside the eco-polygon[2].

2.4.2 Elevation Model

Experts in ecological classification and forest productivity recognize that forest productivity within a site series in the CWHvm2 variant generally decreases as elevation increases. For most site series in this variant, site indices were assumed to decrease linearly as elevations increased from 450 m (the limit between the CWHvm1 and CWHvm2 variants) to 1,000 m (the limit between the CWHvm2 and MHmm1 variants).

A maximum and minimum site index was required for each site series to develop the rate of decrease. A table was constructed of equivalent site associations between the CWHvm2, CWHvm1 (ending at 450 m), and MHmm1 (starting at 1,000 m, Appendix III). For a given site series in the CWHvm2, a rate of decrease was calculated between:

1. the adjusted PSI estimate in the corresponding CWHvm1 site association (max PSI), and
2. the unadjusted PSI estimate from the corresponding MHmm1 site association (min PSI).

[2] Weights were required because some clusters crossed eco-polygon boundaries.

However, there were exceptions in the use of the elevation method:

1. oooThe rates of decrease were developed for Ba and Hw only. The minimum site indices were not available because Fdc and Cw do not grow in the MHmm1 variant. Therefore, the rates developed for Hw were used to decrease the adjusted PSI estimate from the CWHvm1 variant for Fdc and Hw.
2. In site series CWHvm2/02 and CWHvm2/10, forest productivity is very low and likely will not be affected by changes in elevation. Therefore, the rate of decrease was assumed to be zero for all species within these two site series.
3. As the CWHvm2/09 does not have an equivalent site association in the CWHvm1 variant, the preliminary PSI estimate for CWHvm2/09 was used as the maximum site index for calculating the rate of decrease for Ba and Hw.

2.4.3 Unadjusted Preliminary PSI Estimates

Very few sampling opportunities existed in age class 2 to 6 in the MHmm1 variant (21,079 ha, 15% of the PFLB). Forest productivity in this variant was assumed not to be correlated to elevation since the range of productivity in the MHmm1 variant is already narrow and other climatic factors also influence productivity. For this variant, it was considered reasonable to use the unadjusted preliminary site index estimates.

2.4.4 Site Index Conversion Equations

A localized site index conversion equation was developed for Ba and Cw using Hw site index as the independent variable. The equation was applied to the CWHxm, CWHmm1, and CWHvm1 subzones/variants where the conversion field data was collected.

3. RESULTS

3.1 ADJUSTMENT STATISTICS

3.1.1 Fdc

The average adjusted Fdc PSI estimate for the CWHxm, CWHmm1, and CWHvm1 subzone/ variants was 34.4 m with a sampling error of ±1.2 m (Table 4). This represents a 6.6% increase from the preliminary PSI estimates (Figure 2). The final adjusted Fdc PSI estimates have shifted slightly upward compared to the preliminary estimates (Figure 3).

$$\text{Adjusted Fdc SI} = 1.066 * \text{prelim Fdc SI}$$

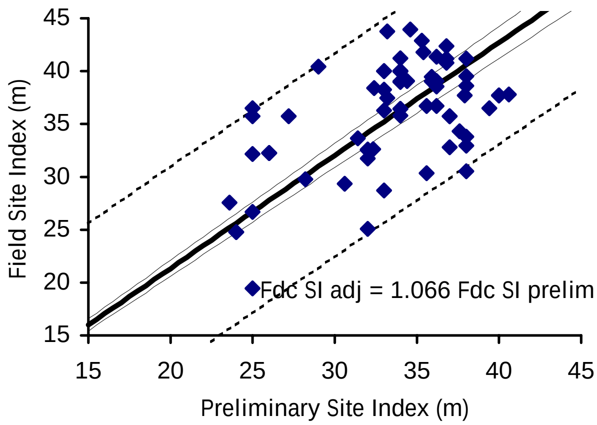

Figure 2. Field and preliminary site indices for Fdc (dashed line is 95% confidence interval of observations; thin solid line is 95% confidence interval of the ratio; weight is not represented).

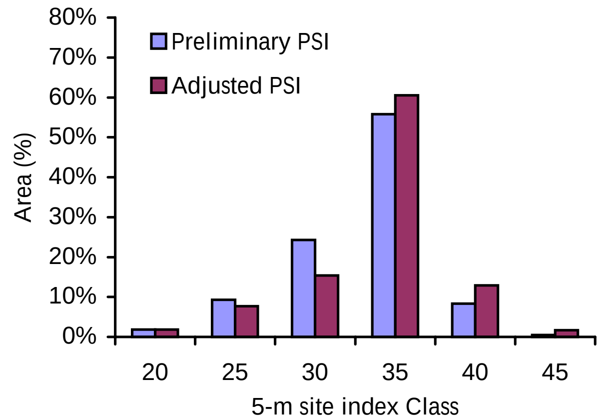

Figure 3. Fdc PSI distribution, before and after statistical adjustment.

Table 4. Statistical adjustment statistics.

Spp	Subzone/Variant CWH_	N[a]	Ratio	SE of ratio	CI of ratio (95%)	Avg Prelim PSI	Avg Adj PSI	SE of Adj PSI	CI of Adj PSI (95%)
Fdc	xm, mm1, & vm1	65	1.066	0.019	[1.030, 1.105]	32.3	34.4	0.6	[33.2, 35.7]
Hw	xm	17	1.159	0.056	[1.040, 1.278]	24.7	28.6	1.4	[25.6, 31.5]
	mm1 & vm1	47	0.970	0.023	[0.924, 1.016]	28.2	27.3	0.7	[26.0, 28.6]

a: N is greater than the number of sample plots because some plots crossed more than one eco-polygon.

3.1.2 Hw

The average adjusted Hw PSI estimate was 28.6 m (± 2.9 m) for the CWHxm and 27.3 m (± 1.3 m) for the CWHmm1 and CWHvm1 variants (Table 4). This is a 15.9% increase in the CWHxm and a 3.0% decrease in the CWHmm1 and CWHvm1 from the preliminary PSI estimates (Figure 4). The distribution of the final adjusted Hw PSI estimates shifted towards the 30-m class in the CWHxm subzone (Figure 5) and changed mainly in the 20 m and 25 m class in the CWHmm1 and CWHvm1 variants.

CWHxm:	Adjusted Hw SI	= 1.159 * prelim Hw SI
CWHmm1 and CWHvm1:	Adjusted Hw SI	= 0.970 * prelim Hw SI

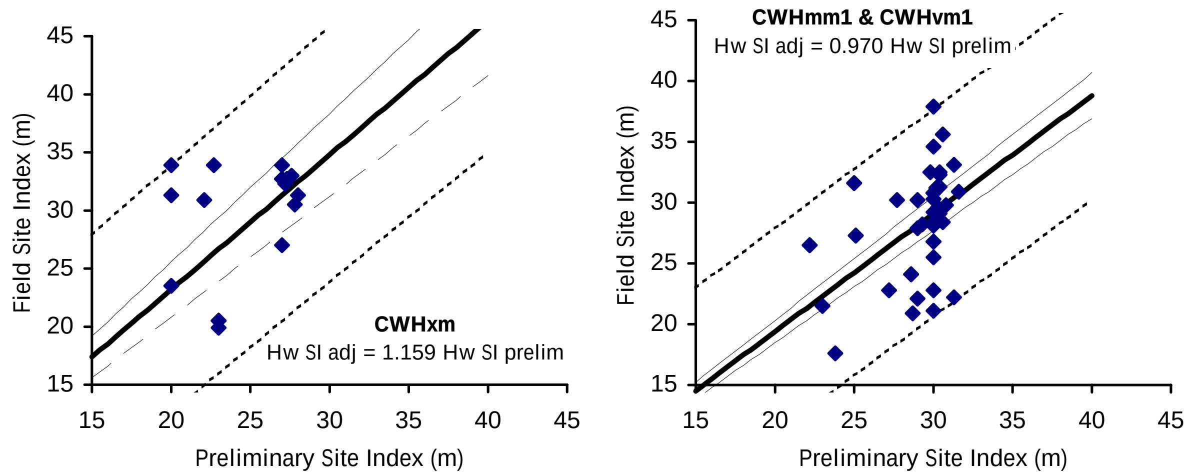

Figure 4. Field and preliminary site indices for Hw (dashed line is 95% confidence interval of observations; thin solid line is 95% confidence interval of the ratio; weight is not represented).

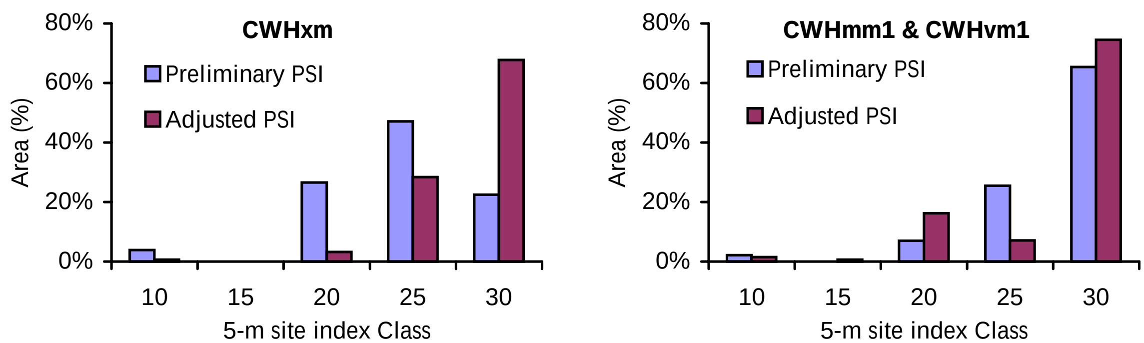

Figure 5. Hw PSI distribution, before and after statistical adjustment.

3.2 Elevation Model

The rate of decrease in forest productivity ranged from 2.0 m to 3.0 m per 100 m gain in elevation for Cw, Fdc, and Hw, and 1.3 to 2.5 m per 100 m gain in elevation for Ba (Table 5). The average site index for the site series where the elevation model was used was 18.8 m, 16.4 m, 26.8 m, and 19.5 m for Ba, Cw, Fdc, and Hw, respectively.

Table 5. Rate of decrease in productivity (m/100 m elevation gain).

Site Series	Ba	Hw, Fdc, Cw
CWHvm2/01	-2.0	-2.6
CWHvm2/01-poor	-1.3	-2.1
CWHvm2/01s	-1.3	-2.1
CWHvm2/03	-2.1	-2.6
CWHvm2/04	-2.5	-3.0
CWHvm2/05	-2.0	-2.6
CWHvm2/06	-2.2	-2.7
CWHvm2/06-poor	-2.2	-2.7
CWHvm2/06s	-2.2	-2.7
CWHvm2/07	-1.9	-2.4
CWHvm2/09	-2.0	-2.0
CWHvm2/11	-2.1	-2.6

3.3 Unadjusted Preliminary PSI Estimates

The unadjusted preliminary PSI estimates were used in the MHmm1 variant. The average site indices in this subzone were 12.9 m, 12.3 m, 12.3 m, and 12.4 m for Ba, Hw, Hm, and Yc, respectively. The MHmm1 variant was the only variant where Hm and Yc are crop species.

3.4 Site Index Conversion Equations

Site index conversion equations for Ba and Cw were built using site pair information collected during field sampling. These equations are:

Adj PSI Ba = -4.6 + 1.09 * Adj PSI Hw

Adj PSI Cw = 13.4 + 0.39 * Adj PSI Hw

These equations were used to calculate the final PSI estimates for Ba and Cw in the CWHmm1, CWHvm1, CWHxm subzone/variants. Using site index conversion equations, the average adjusted PSI estimates were 25.4 m for Ba and 24.1 m for Cw.

4. DISCUSSION

4.1 Target and Sample Populations

Normally, in a sampling design, the sample population is identical to the target population. However, in cases where the variable of interest (site index) cannot be measured throughout the target population, sampling is limited to a subset of the target population. The relationship between preliminary and field site index must be identical on a given ecological unit in the target and sample population to infer results from the sample population. This is considered a safe assumption as site series is independent of age and leading species, the criteria used to define the sample population (Figure 1).

4.2 Adjustment Ratio

There are many unbiased estimators of the relationship between preliminary and field site index estimates that can be used. The weighted least-squares method without intercept was considered the most appropriate estimator because the variation in field site index appeared constant across the range of preliminary PSI estimates.

The adjustment ratio for Hw in the CWHxm subzone appears to be high because the preliminary PSI estimates were based on the dry CWHxm subzone usually encountered on southern Vancouver Island. On northern Vancouver Island, the annual precipitation in the CWHxm subzone is higher, closer to what is typically observed in the CWHvm1 variant. Given the lower elevation of the CWHxm subzone, it is expected that the final PSI estimates are slightly higher in the CWHxm subzone than in the CWHvm1 variant after adjustment.

4.3 Variation Between Preliminary and Field Estimates

The adjustment ratios showed a high degree of variability, especially for Hw in the CWHxm subzone. This is expected since there are many sources of variation that cannot be controlled by the sampling design. There are four main sources of variation:

1. Within-site series variation.
2. Within-polygon variation.
3. Mapping error.
4. Different bias trends in the relationship between preliminary and field estimates.

4.3.1 Within-Site Series Variation

Forest productivity variation within a site series is the major source of variation in the relationship between PSI and field site index estimates. Site index on any individual site series can deviate by 2 to 3 m from the average site index due to local variation in environmental and climatic factors.

4.3.2 Within-Polygon Variation

There are approximately 185,523 ha (79% of the PFLB) of complex site series in the eco-polygons database. The preliminary PSI estimate for these eco-polygons is a weighted average of the preliminary PSI estimates for each site series within the polygon. If a sample cluster is established in an ecologically complex eco-polygon, the site series proportions within the cluster may differ from the site series proportions for the entire eco-polygon. This difference introduces variation in the relationship between preliminary PSI and field site index estimates.

4.3.3 Mapping Error

The ecological map was developed using photo-interpretation with ground truthing. Mapping from an aerial photo can be imprecise and some polygon lines or labels may not reflect the actual site series on the ground. Therefore, for plots established close to eco-polygon boundaries, the map polygon may be different from the ground polygon. This variation increases as mapping resolution increases and smaller polygons are delineated.

4.3.4 Different Bias Trends in the Relationship Between Preliminary and Field Estimates

Ideally, each species and site series combination has a unique adjustment ratio. However, this would make sampling too costly as each combination would require an independent sample. To reduce sampling costs, it is safe to assume that the same adjustment ratio applies to a group of site series. This assumption introduces a source of variation but is a reasonable compromise between sampling costs and precision.

4.4 APPLICATION IN TIMBER SUPPLY ANALYSIS

The new PSI estimates should be slightly higher than the site index estimates in the current inventory database. For polygons where inventory site index estimates are reliable (age class 3 to 6), PSI estimates are the same for Hw-leading polygons, and about 10% higher for Fdc polygons (Table 6). There is not enough area in other leading species to be conclusive. The productivity increase is more pronounced when all polygons in the PFLB are considered (Table 7).

Table 6. Comparing current inventory to potential site index estimates (age class 3 to 6).

	Area	Site Index		Difference	
Spp	(ha)	Current	Potential	(m)	(%)
Fdc	3,197	31.7	35.2	3.6	11.2%
Hw	11,773	28.1	28.3	0.2	0.8%

Table 7. Comparing current inventory to potential site index estimates (entire PFLB).

	Site Index		Difference	
Spp	Current	Potential	(m)	(%)
Ba	21.1	21.8	0.7	3.2%
Cw	17.7	21.7	4.0	22.6%
Fdc	30.5	32.0	1.5	4.9%
Hw	20.3	23.1	2.8	13.8%

Note: Hm and Yc only occur in the MHmm1.

The main contribution of this project is the spatial resolution of site index estimates for PHR stands for use in timber supply analysis. Previously, site index was assigned to an entire forest cover polygon. The new PSI estimates, developed at the eco-polygon level, create a more realistic estimate of spatial timber supply and should contribute to better planning and forest management.

5. CONCLUSIONS

1. **Use the new PSI estimates in the MP 9 timber supply analysis.**

   The final PSI estimates represent the best forest productivity estimates available for TFL 37. They should provide a more accurate estimate of the long-run sustained yield in future timber supply analysis. Thus, we recommend these estimates be used to generate the managed stand yield tables for existing and future PHR stands on the TFL for the timber supply analysis for MP 9.

2. **Update these PSI estimates frequently.**

   The PSI estimates reflect the best information currently available on TFL 37. However, these estimates should be updated regularly as old-growth stands are harvested and replaced with PHR stands. Silviculture surveys, monitoring plots, and special surveys and projects are potential sources of information.

3. **Improve site index estimates for higher elevation subzones.**

   PSI estimates at higher elevations were not based on field data because there are few areas to measure PSI accurately. The elevation model and unadjusted PSI should provide better information than is currently available in the inventory. However, we recommend that special studies be conducted to quantify forest productivity at higher elevations.

4. Monitor the growth of PHR stands.

There is some uncertainty in the new PSI estimates resulting from the sampling and site index prediction methods. We recommend that PHR stands on the TFL be periodically monitored to ensure the PSI estimates and the associated growth and yield continue to adequately represent the actual conditions of the TFL.

APPENDIX I – TFL 37 LANDBASE

Location

Canfor's TFL 37 is located in the north central portion of Vancouver Island around the Nimpkish valley, northwest of Campbell River (Figure 6). The total landbase of the TFL is 190,668 ha of which 144,174 ha (76%) is the PFLB (Table 8). The allowable annual cut for the TFL is 1,068,000 m^3.

Figure 6. Location of TFL 37.

Table 8. Landbase description of TFL 37.

Description	Area (ha)
Entire TFL	190,665
Non-Forested	33,163
Forested	157,502
Non-Productive Forest	13,328
Productive Forest (PFLB)	144,174
NSR	531
Stocked	143,644

Forest Cover

The most important species on TFL 37 are Hw and Fdc, which occupy almost 75% of the productive landbase (Table 9). Yc, Ba, Cw), and Hm cover approximately 23%. Other species present include cottonwood (Ac), grand fir (Bg), alder (Dr), broadleaf maple (Mb), lodgepole pine (Pl), white pine (Pw), and Sitka spruce (Ss).

Almost half the productive landbase is in age class 9 (251 years or older), while approximately a third has been regenerated in the last 40 years. Only 13% of the productive landbase is between 41 and 140 years old. About 1,500 ha are regenerated every year.

Table 9. Species and age class distribution.

	Age Class									Total	
Spp	1	2	3	4	5	6	7	8	9	(ha)	(%)
Hw	12,481	6,211	5,927	4,615	747	484	1,520	3,290	39,006	74,281	51.7
Fdc	10,673	15,319	2,061	1,024	45	81	456	745	2,711	33,114	23.1
Yc	384	122	15	3	10		3	176	10,920	11,633	8.1
Ba	3,885	150	52	56	80	20	57	327	4,676	9,303	6.5
Cw	484	180	280	190	14	8	209	184	6,427	7,975	5.6
Hm	3	42	14	29	1		6	42	4,253	4,390	3.1
Dr	618	1,088	496	261	25	5	11	6		2,509	1.7
Pl	12	29	14	22		2	95	27	3	205	0.1
Ss	71	4		8		3		10	84	180	0.1
Pw	11	7								18	0.0

Bg	18									18	0.0
Ac			1	4				10		16	0.0
Mb		2								2	0.0
Total (ha)	*28,638*	*23,153*	*8,861*	*6,213*	*922*	*603*	*2,356*	*4,817*	*68,081*	*143,644*	
(%)	*19.9*	*16.1*	*6.2*	*4.3*	*0.6*	*0.4*	*1.6*	*3.4*	*47.4*		

Note: An extra 531 ha is considered NSR for a total PFLB area of 144,174 ha. The shaded area highlights age classes with reliable site estimates.

Ecological Classification

More than 85% of the PFLB (123,00 ha) is in the CWH biogeoclimatic zone, and the rest is in the MH zone (Figure 7). Within the CWH, the CWHvm1 and CWHvm2 variants occupy almost 75% of the area, the rest being split evenly between the CWHmm1 variant and the CWHxm subzone. The most common subzone/variants on the TFL are also the subzone/variants for which we have the most forest productivity information.

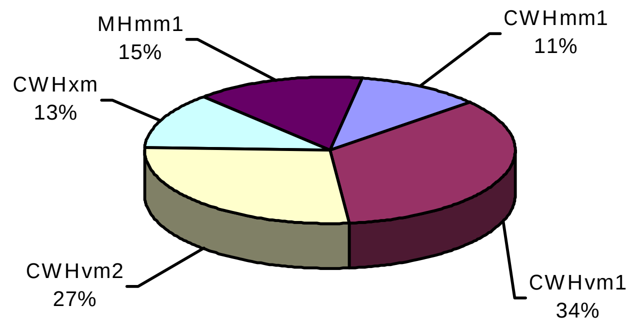

Figure 7. Area by subzone/variant.

APPENDIX II – PRELIMINARY SITE INDEX ESTIMATES

Table 10. Preliminary PSI estimates in the CWHmm1 and CWHxm.

	CWHmm1				CWHxm			
Site Series	Ba	Cw	Fdc	Hw	Ba	Cw	Fdc	Hw
01	28	27	32	29	30	25	33	27
01-poor	25	22	26	24	25	22	26	24
01s					25	22	26	24
02	10	11	18	10		12	20	12
03	21	22	25	22		20	25	20
04	23	23	28	22	26	22	28	22
05	30	28	35	30	36	26	37	28
06	31	28	33	31	30	28	34	28
06-poor	25	22	26	23	25	22	26	23
06s					25	22	26	23
07	35	30	38	31	40	28	40	28
08	35	30	38	31	40	28	43	28
09	40	28	43	28	40	28	43	28
11		10		10		8		8
12	18	22		20		22	24	23

Table 11. Preliminary PSI estimates in the CWHvm1 and CWHvm2.

	CWHvm1				CWHvm2			
Site Series	Ba	Cw	Fdc	Hw	Ba	Cw	Fdc	Hw
01	29	27	34	30	27	25	31	28
01-poor	25	23	26	25	23	21	24	23
01s	25	23	26	25	23	21	24	23
02	12	12	20	12	10	10	18	10
03	21	21	29	23	21	19	26	21
04	24	23	29	25	22	21	26	23
05	29	28	37	31	27	26	35	29
06	30	30	34	31	28	26	31	30
06-poor	23	22	26	23	21	20	24	21
06s	23	22	26	23	21	20	24	21
07	31	30	38	32	29	28	36	30
09	31	30	38	32	21	20	21	21
10	31	30	38	32	8	8		8
11					21	20	22	21
12	23	22		23				
13	8	8		8				
14	23	22	24	23				

Table 12. Preliminary PSI estimates in the MHmm1.

	MHmm1			
Site Series	Ba	Hm	Hw	Yc
01	16	15	15	15
01-poor	15	14	14	14
02	8	8	8	8
03	17	16	16	17
04	16	15	15	15
05	19	18	18	19
06	10	10	10	10
07	11	11	11	11
08	8	8	8	8
09	8	8	8	8
20	8	8	8	8
21	8	8	8	8
27	14	13	13	13

APPENDIX III – SITE SERIES EQUIVALENT AMONG CWHVM1, CWHMM2, AND MHMM1

Table 13. Site Series equivalent in the CWHvm1, CWHvm2, and MHmm1.

CWHvm1	CWHvm2	MHmm1
01	01	01
01-poor	01-poor	01
01s	01s	01
02	02	02
03	03	02
04	04	02
05	05	03
06	06	04
06-poor	06-poor	06
06s	06s	06
07	07	05
08	08	07
N/A	09	06
13	10	08
14	11	09

APPENDIX IV – ADJUSTED PRELIMINARY SITE INDEX ESTIMATES

Table 14. Adjusted PSI estimates.

	CWHmm1		CWHvm1		CWHxm	
Site Series	Fdc	Hw	Fdc	Hw	Fdc	Hw
01	34.2	28.1	36.3	29.1	35.2	31.3
01-poor			27.8	24.3	27.8	27.8
01s			27.8	24.3	27.8	27.8
02	19.2	9.7	21.4	11.6	21.4	13.9
03	26.7	21.3	31.0	22.3	26.7	23.2
04	29.9	21.3	31.0	24.3	29.9	25.5
05	37.4	29.1	39.5	30.1	39.5	32.5
06	35.2	30.1	36.3	30.1	36.3	32.5
06-poor			27.8	22.3	27.8	26.7
06s			27.8	22.3	27.8	26.7
07	40.6	30.1	40.6	31.0	42.7	32.5
08	40.6	30.1			45.9	32.5
09			40.6	31.0		
11		9.7				9.3
12		19.4		22.3	25.6	26.7
13				7.8		
14			25.6	22.3		

13.4 Appendix D: Yield Tables for Unmanaged Stands

Net Merchantable Volume Yield Tables
Unmanaged Stands
CWHxm2 Variant – All Sites

	Analysis Unit											
Age	1142	1143	1144	1148	1242	1243	1244	1248	1342	1343	1344	1348
55	16	92	27	0	98	240	104	145	190	388	335	542
60	41	112	49	0	126	276	132	195	230	439	383	606
65	55	133	67	2	155	312	160	246	269	486	431	664
70	69	153	88	3	184	348	190	298	307	535	477	717
75	87	173	109	13	213	383	219	349	344	583	522	764
80	103	191	130	15	242	417	249	399	379	628	564	806
85	119	210	152	18	270	449	278	447	413	671	604	844
90	136	227	175	21	296	480	306	494	445	711	643	877
95	152	244	198	25	322	509	334	540	476	750	680	915
100	168	261	221	30	347	537	360	583	505	788	716	951
105	183	277	243	35	371	563	386	625	533	827	750	983
110	198	292	265	40	393	588	411	664	559	863	783	1,013
115	212	306	286	44	415	612	435	702	584	897	813	1,041
120	199	299	287	33	410	627	431	731	595	925	838	1,063
125	213	313	309	37	431	648	454	766	618	954	865	1,086
130	226	326	329	41	450	668	477	799	639	981	890	1,106
135	238	339	350	45	469	687	499	830	659	1,006	913	1,124
140	251	351	369	48	487	705	519	860	678	1,028	934	1,140
145	262	361	387	52	503	720	538	885	694	1,047	951	1,153
150	271	371	403	54	516	732	553	907	707	1,062	965	1,161
155	279	379	416	57	528	743	566	924	718	1,074	975	1,167
160	287	386	427	59	538	751	576	939	728	1,083	982	1,170
165	293	392	437	60	547	758	585	951	736	1,091	988	1,172
170	298	397	445	61	554	764	592	960	742	1,097	992	1,172
175	303	402	453	62	560	769	598	968	748	1,102	995	1,171
180	307	406	459	63	566	774	603	974	753	1,106	997	1,169
185	310	409	465	64	570	777	607	979	757	1,110	998	1,167
190	313	412	469	65	574	781	610	983	760	1,113	999	1,164
195	316	415	473	66	578	784	613	987	763	1,115	999	1,160
200	318	418	477	66	581	786	615	989	766	1,117	998	1,156
205	319	419	478	66	583	787	615	988	767	1,117	995	1,150
210	321	421	479	66	585	788	615	987	768	1,117	992	1,144
215	322	422	481	67	587	789	615	986	769	1,117	990	1,138
220	323	424	482	67	588	790	615	985	769	1,116	987	1,133
225	324	425	483	67	590	790	615	985	770	1,116	984	1,127
230	325	426	484	67	591	791	615	984	771	1,115	981	1,121
235	326	428	485	67	593	791	615	983	771	1,115	978	1,116
240	327	429	486	67	594	792	615	983	772	1,114	975	1,110
245	328	430	487	67	596	792	615	982	773	1,113	972	1,104
250	329	431	488	67	597	792	615	981	773	1,113	970	1,098
255	330	432	489	67	598	793	615	981	774	1,112	967	1,092
260	331	433	490	67	599	793	615	980	774	1,111	964	1,086
265	332	434	490	67	601	793	615	980	775	1,110	961	1,081
270	333	435	491	68	602	793	615	979	775	1,109	959	1,075
275	334	436	492	68	603	793	614	978	775	1,108	956	1,069
280	335	437	493	68	604	793	614	978	776	1,107	953	1,063
285	336	438	494	68	605	793	614	978	776	1,106	950	1,057
290	337	439	495	68	606	793	614	977	776	1,105	948	1,053
295	338	440	495	68	607	793	613	977	776	1,103	945	1,049
300	339	441	496	68	608	793	613	976	777	1,102	942	1,044
305	340	442	497	68	609	793	613	976	777	1,101	940	1,040
310	341	443	498	68	610	792	612	976	777	1,100	938	1,039
315	342	444	498	68	611	791	612	975	777	1,098	935	1,038
320	343	444	499	67	611	791	611	975	777	1,097	933	1,037
325	343	445	500	67	612	790	610	975	776	1,095	931	1,035
330	344	445	500	67	613	789	610	975	776	1,094	929	1,034
335	344	446	501	67	613	788	609	975	776	1,092	927	1,033
340	344	446	502	67	614	787	609	975	776	1,091	925	1,031
345	345	447	502	67	615	786	608	975	776	1,089	923	1,030
350	345	447	503	67	615	785	607	975	775	1,087	921	1,029

Net Merchantable Volume Yield Tables
Unmanaged Stands
CWHmm1 Variant – All Sites

	Analysis Unit								
Age	2142	2143	2144	2242	2243	2244	2342	2343	2344
55	15	85	8	116	246	105	283	376	333
60	35	105	13	154	286	140	331	431	382
65	56	126	32	191	327	178	379	486	432
70	76	147	50	228	366	217	425	541	481
75	98	167	67	264	403	257	468	594	527
80	120	186	86	298	438	297	509	645	571
85	141	205	106	331	472	337	547	693	613
90	163	223	128	362	503	375	583	740	653
95	184	241	150	391	534	413	616	784	691
100	204	257	173	419	562	449	646	827	728
105	224	273	196	445	590	484	673	867	762
110	243	289	219	470	616	517	698	906	795
115	261	304	242	493	641	549	722	942	826
120	258	302	228	501	658	554	740	974	853
125	276	316	250	524	681	586	762	1,006	880
130	294	330	273	545	701	617	784	1,036	905
135	311	343	295	566	720	646	806	1,063	928
140	327	356	317	585	737	673	827	1,089	950
145	341	367	337	602	753	698	841	1,111	967
150	354	377	355	615	765	718	852	1,129	981
155	365	386	370	625	775	735	862	1,143	991
160	373	394	382	633	784	750	874	1,155	998
165	379	400	394	640	791	761	885	1,164	1,004
170	384	406	403	646	797	771	894	1,172	1,008
175	389	412	412	650	802	779	902	1,179	1,011
180	393	416	419	654	806	786	909	1,185	1,012
185	396	421	425	657	810	792	914	1,190	1,013
190	399	424	430	660	813	796	919	1,194	1,013
195	402	428	435	663	816	800	922	1,197	1,013
200	405	431	439	665	819	802	923	1,200	1,012
205	406	433	440	666	820	802	922	1,201	1,009
210	408	435	442	667	820	802	922	1,201	1,006
215	410	437	443	668	821	801	921	1,202	1,003
220	412	439	444	669	822	801	920	1,202	1,000
225	414	440	445	670	822	800	920	1,202	997
230	415	442	446	670	823	800	919	1,202	994
235	417	444	447	671	823	799	918	1,201	991
240	419	446	448	672	824	799	917	1,201	988
245	420	447	449	673	824	798	917	1,201	986
250	422	449	450	674	825	798	916	1,200	983
255	423	450	451	674	825	797	915	1,200	980
260	425	452	452	675	825	797	914	1,199	977
265	426	453	452	676	825	796	913	1,199	974
270	428	455	454	677	825	796	913	1,198	972
275	429	457	455	677	825	795	912	1,198	969
280	431	459	455	678	826	795	911	1,197	966
285	432	461	456	679	826	794	910	1,196	963
290	433	462	457	679	826	794	909	1,196	961
295	435	464	458	680	826	793	909	1,195	958
300	436	466	459	681	826	793	908	1,194	955
305	437	467	460	681	825	792	907	1,193	953
310	438	469	461	682	825	792	906	1,192	950
315	440	470	461	682	824	791	905	1,191	948
320	441	471	462	683	823	791	904	1,189	946
325	442	473	463	683	822	790	904	1,188	944
330	443	474	463	684	821	790	903	1,186	942
335	445	475	464	684	820	789	902	1,185	939
340	446	476	465	685	819	789	901	1,183	937
345	447	477	465	685	818	789	900	1,182	935
350	448	478	466	685	817	788	899	1,180	933

Net Merchantable Volume Yield Tables
Unmanaged Stands
CWHvm1 Variant – All Sites

	Analysis Unit																		
Age	3141	3142	3143	3144	3146	3148	3241	3242	3243	3244	3245	3246	3248	3341	3342	3343	3344	3346	3348
55	0	16	72	3	0	0	35	104	234	105	0	4	76	165	193	390	354	143	571
60	0	29	90	13	0	0	68	137	271	142	0	23	97	225	233	445	405	183	639
65	7	46	107	24	0	0	125	170	309	181	0	43	118	300	272	500	454	224	700
70	24	62	125	38	0	0	174	203	345	222	0	59	138	363	308	553	500	265	755
75	47	80	142	53	3	15	226	236	379	264	0	77	157	424	343	603	544	305	804
80	71	100	159	70	8	18	281	269	413	305	0	97	174	482	376	650	585	345	848
85	100	119	175	88	14	21	335	300	444	346	0	116	190	538	407	694	624	384	887
90	131	137	191	107	19	24	389	331	474	386	0	137	204	591	439	735	662	421	922
95	164	158	207	127	24	29	441	360	503	424	0	157	217	642	468	777	698	456	952
100	197	177	222	148	30	35	492	388	531	462	0	178	229	689	497	817	734	490	980
105	231	196	237	168	36	41	540	415	557	497	1	198	242	734	525	856	769	523	1,004
110	265	214	252	189	44	48	586	440	583	532	2	218	254	776	551	892	801	554	1,025
115	298	232	266	210	50	54	631	464	606	565	2	237	265	815	576	925	832	583	1,044
120	304	220	260	200	52	39	653	463	621	570	2	223	249	842	587	953	858	579	1,058
125	338	236	273	221	61	44	696	486	642	603	3	241	260	878	609	982	885	608	1,073
130	371	252	286	241	69	49	737	509	662	634	4	259	269	912	631	1,009	911	636	1,086
135	403	268	299	262	78	54	775	530	680	664	4	277	277	943	650	1,032	934	662	1,097
140	434	283	311	282	87	59	811	551	698	693	5	294	285	972	669	1,053	956	687	1,107
145	462	297	321	300	95	63	843	569	713	718	6	310	291	998	685	1,071	973	709	1,129
150	485	309	331	316	102	66	869	584	725	739	13	323	295	1,018	699	1,086	987	728	1,146
155	505	319	339	330	108	69	891	598	736	756	21	335	299	1,036	711	1,097	997	744	1,160
160	522	328	346	342	114	72	910	609	744	771	29	345	301	1,050	721	1,106	1,005	757	1,170
165	536	336	353	352	118	74	925	619	751	784	38	353	303	1,062	730	1,113	1,010	769	1,178
170	548	343	358	361	123	75	939	628	757	794	46	360	305	1,072	737	1,119	1,014	780	1,184
175	558	349	363	369	127	77	950	635	763	803	54	366	306	1,080	743	1,124	1,017	789	1,188
180	567	355	367	376	130	78	959	642	767	811	60	372	307	1,087	748	1,129	1,018	797	1,191
185	575	360	371	382	133	79	967	647	771	817	66	377	308	1,093	752	1,132	1,018	805	1,192
190	581	364	375	387	136	80	974	652	774	822	71	382	308	1,098	756	1,136	1,018	812	1,192
195	587	368	378	391	138	81	980	657	777	827	76	386	309	1,103	759	1,138	1,017	817	1,192
200	592	371	381	398	141	82	985	661	780	830	79	390	309	1,106	761	1,141	1,015	823	1,190
205	593	373	383	400	142	82	987	663	781	831	80	392	308	1,107	762	1,141	1,011	826	1,186
210	595	375	385	401	143	82	988	665	782	831	80	395	308	1,108	763	1,141	1,007	830	1,182
215	596	377	387	403	144	82	990	667	783	832	81	397	307	1,109	764	1,142	1,003	833	1,177
220	597	378	389	404	145	82	991	669	784	832	81	400	307	1,110	765	1,142	999	837	1,173
225	599	380	390	405	146	83	992	671	784	832	81	402	306	1,111	765	1,142	995	840	1,168
230	600	382	392	407	148	83	993	673	785	832	82	404	306	1,112	766	1,142	992	843	1,164
235	601	384	394	408	149	83	995	675	786	833	82	406	305	1,113	767	1,142	988	846	1,160
240	603	385	395	409	150	83	996	677	786	833	82	408	305	1,114	767	1,142	984	849	1,155
245	604	387	397	410	151	83	997	679	787	833	83	411	304	1,115	768	1,142	980	852	1,151
250	605	388	398	411	152	83	998	680	787	833	83	413	303	1,115	768	1,142	977	854	1,146
255	606	390	400	412	153	83	1,000	682	787	834	83	415	303	1,116	769	1,141	973	857	1,142
260	607	391	401	413	154	84	1,001	684	788	834	83	417	302	1,117	769	1,141	969	860	1,138
265	609	393	403	414	155	84	1,002	685	788	834	84	419	302	1,118	769	1,141	966	862	1,133
270	610	394	404	415	156	84	1,003	687	788	834	84	420	301	1,119	770	1,140	962	865	1,129
275	611	396	405	416	156	84	1,004	689	789	834	84	422	300	1,120	770	1,140	959	867	1,125
280	612	397	407	417	157	84	1,005	690	789	834	85	424	300	1,121	770	1,140	956	870	1,120
285	613	399	408	418	158	84	1,007	692	789	834	85	426	299	1,122	771	1,139	952	872	1,116
290	614	400	409	419	159	84	1,008	693	790	834	85	428	298	1,122	771	1,139	949	874	1,112
295	615	401	411	420	160	84	1,009	695	790	835	85	430	298	1,123	771	1,138	946	876	1,108
300	616	403	412	421	161	84	1,010	696	790	835	86	431	297	1,124	771	1,138	943	879	1,103
305	618	404	413	422	162	84	1,011	697	790	835	86	433	296	1,125	771	1,137	940	881	1,099
310	619	405	415	423	163	84	1,012	699	790	835	86	435	296	1,125	771	1,136	937	883	1,098
315	620	406	416	424	163	84	1,013	700	790	835	86	436	295	1,126	771	1,135	935	885	1,097
320	621	408	416	424	164	84	1,014	701	789	835	87	438	294	1,127	771	1,133	932	887	1,095
325	622	409	417	425	165	84	1,015	703	788	835	87	439	294	1,127	771	1,132	930	889	1,094
330	623	410	418	426	166	83	1,016	704	788	834	87	441	293	1,128	771	1,130	927	891	1,093
335	624	411	419	427	166	83	1,017	705	787	834	87	442	292	1,128	770	1,129	925	893	1,091
340	625	412	420	427	167	83	1,018	706	787	834	88	444	292	1,129	770	1,127	922	895	1,090
345	626	413	421	428	168	83	1,019	707	786	834	88	445	291	1,129	770	1,126	920	897	1,089
350	627	414	422	429	169	83	1,020	708	786	834	88	447	290	1,130	770	1,124	917	899	1,087

Net Merchantable Volume Yield Tables
Unmanaged Stands
CWHvm2 Variant – All Sites

	Analysis Unit																
Age	**4141**	**4142**	**4143**	**4144**	**4145**	**4146**	**4241**	**4242**	**4243**	**4244**	**4245**	**4246**	**4341**	**4342**	**4344**	**4345**	**4346**
55	0	7	83	1	0	0	24	123	221	86	0	8	147	208	259	2	90
60	1	18	104	9	0	0	54	162	265	121	0	22	202	261	303	5	121
65	5	31	127	18	0	0	106	201	308	159	0	41	268	311	347	8	155
70	16	45	149	32	0	0	152	241	350	200	0	61	323	360	389	12	190
75	30	63	170	49	0	4	202	280	390	242	0	80	377	407	430	17	225
80	50	81	192	67	0	12	254	317	429	285	0	100	429	452	469	25	260
85	72	100	213	86	0	19	307	353	466	327	0	120	478	494	506	38	295
90	104	118	233	107	0	25	360	388	501	369	0	141	524	535	541	53	329
95	135	139	253	129	0	33	412	421	535	410	0	163	568	573	574	71	362
100	169	157	272	153	0	41	462	453	567	450	0	184	609	608	606	92	393
105	204	175	290	176	0	50	510	483	597	488	0	205	648	642	636	116	423
110	240	193	308	201	0	59	556	511	627	525	0	225	684	674	665	142	452
115	276	211	325	224	0	68	600	538	655	561	0	245	718	705	692	174	480
120	281	196	316	214	0	66	622	536	656	562	0	232	741	715	714	188	474
125	318	213	333	238	0	75	666	563	683	598	1	251	772	744	739	228	501
130	355	229	349	262	0	84	707	588	709	632	2	269	802	772	762	272	528
135	392	244	365	286	0	93	747	613	734	665	6	287	830	798	783	320	553
140	428	260	380	310	0	102	784	635	758	696	11	305	856	823	803	371	577
145	461	273	393	332	0	111	816	656	780	724	17	321	879	845	820	420	599
150	489	286	405	351	0	118	843	673	799	748	26	334	897	863	833	463	617
155	513	296	416	367	0	124	866	688	815	768	36	346	912	878	844	500	633
160	533	306	425	381	0	129	885	702	830	784	46	355	925	892	852	533	647
165	551	314	433	394	0	133	901	713	843	799	57	363	935	903	859	561	658
170	566	321	441	404	0	140	915	723	854	811	69	371	944	912	864	585	668
175	579	327	447	414	0	144	927	732	864	821	82	377	951	921	868	605	677
180	590	333	453	422	0	148	937	739	873	830	95	382	957	928	870	623	684
185	600	338	459	429	0	152	946	746	882	837	106	388	962	934	872	638	691
190	608	343	464	435	0	156	953	751	889	844	116	392	966	940	873	651	697
195	616	347	468	441	0	159	960	757	895	849	125	396	970	945	873	662	702
200	622	350	472	447	0	161	965	761	901	854	132	400	972	949	873	671	707
205	624	352	474	449	0	163	967	764	905	855	132	403	973	951	871	673	710
210	626	354	477	450	0	164	968	766	909	856	133	405	974	953	868	675	714
215	628	356	479	452	0	165	970	768	912	857	134	408	975	955	865	677	717
220	630	358	481	454	0	167	972	771	915	858	134	410	976	956	863	679	720
225	631	360	484	455	0	168	974	773	919	858	135	412	976	958	860	681	723
230	633	361	486	457	0	169	975	775	922	859	136	415	977	960	858	682	726
235	635	363	488	458	0	171	977	777	925	860	136	417	978	961	855	684	729
240	637	365	490	460	0	172	978	779	928	861	137	419	978	963	853	686	731
245	638	366	492	461	0	173	980	781	931	861	138	421	979	964	850	687	734
250	640	368	494	463	0	174	981	783	934	862	138	423	979	966	848	689	737
255	642	369	496	464	0	175	983	785	937	863	139	425	980	967	845	690	739
260	644	371	498	465	0	176	984	787	940	863	139	427	980	968	843	692	742
265	645	372	500	467	0	178	986	789	943	864	140	429	981	970	840	693	744
270	647	374	502	468	0	179	987	791	946	865	140	431	981	971	838	695	747
275	648	375	504	469	0	180	989	793	949	865	141	433	982	972	835	696	749
280	650	377	505	470	0	181	990	795	952	866	141	435	982	974	832	697	751
285	652	378	507	472	0	182	991	796	955	866	142	437	983	975	830	699	754
290	653	379	509	473	0	183	993	798	957	867	143	438	983	976	827	700	756
295	655	381	511	474	0	184	994	800	960	867	143	440	984	977	825	701	758
300	656	382	512	475	0	185	995	801	963	868	144	442	984	978	822	703	760
305	658	383	514	476	0	186	997	803	965	868	144	444	984	980	820	704	763
310	659	385	516	477	0	187	998	805	968	869	144	445	985	981	818	705	765
315	661	386	517	478	0	188	999	806	971	869	145	447	985	982	816	706	767
320	662	387	519	479	0	189	1,001	808	973	870	145	448	985	983	814	707	769
325	664	388	520	480	0	190	1,002	809	976	870	146	450	985	984	812	709	771
330	665	390	522	481	0	191	1,003	811	978	870	146	452	985	985	810	710	773
335	666	391	523	482	0	192	1,005	812	981	871	147	453	985	986	809	711	775
340	668	392	525	483	0	193	1,006	814	983	871	147	455	986	987	807	712	777
345	669	393	526	484	0	194	1,007	815	985	871	148	456	986	988	805	713	779
350	671	395	528	485	0	195	1,008	817	988	872	148	458	986	989	803	714	781

Net Merchantable Volume Yield Tables
Unmanaged Stands
MHmm1 Variant – All Sites

	Analysis Unit													
Age	**5141**	**5142**	**5144**	**5145**	**5146**	**5241**	**5242**	**5244**	**5245**	**5246**	**5341**	**5344**	**5345**	**5346**
55	1	10	1	0	0	18	127	66	0	9	165	180	0	82
60	2	24	8	0	1	41	167	97	0	22	229	214	0	114
65	6	42	17	0	1	85	208	131	0	43	306	248	1	147
70	21	56	32	0	1	124	248	168	0	63	372	279	3	182
75	38	78	50	0	4	168	288	207	0	83	436	308	5	218
80	61	99	69	0	9	215	326	247	0	104	497	336	11	253
85	87	119	90	0	13	262	363	287	0	126	555	363	20	288
90	118	139	112	0	18	310	399	327	0	148	611	389	32	322
95	151	158	136	0	26	357	432	365	0	171	663	414	49	355
100	186	178	161	0	36	403	464	403	0	193	712	437	71	387
105	222	197	186	0	45	447	494	440	0	215	758	459	96	417
110	259	215	212	0	55	489	523	475	0	236	802	480	124	446
115	295	233	237	0	65	530	551	509	0	257	843	500	156	474
120	307	225	233	0	64	552	555	515	0	249	874	516	175	474
125	344	242	258	0	74	593	582	549	0	269	911	533	218	501
130	381	259	283	0	83	631	608	581	0	288	946	550	264	528
135	418	275	308	0	93	667	632	612	6	307	978	565	314	553
140	454	290	332	0	103	702	655	642	16	326	1,008	580	367	577
145	486	304	355	0	112	732	676	669	29	342	1,034	592	417	599
150	514	316	374	0	119	758	694	692	48	356	1,055	602	461	617
155	538	327	391	0	125	779	709	711	68	368	1,072	611	499	633
160	558	336	406	0	131	798	723	728	88	377	1,086	617	532	647
165	576	344	419	1	135	813	735	742	110	386	1,097	622	560	659
170	591	352	430	1	141	827	745	755	133	393	1,107	625	584	668
175	605	358	440	3	146	838	754	766	157	400	1,115	627	605	677
180	616	364	449	4	150	848	762	775	180	406	1,121	629	623	685
185	626	369	457	5	153	857	769	784	200	411	1,127	631	639	691
190	635	374	464	6	156	865	775	791	218	416	1,131	632	652	698
195	643	378	470	7	159	872	780	798	233	421	1,135	633	664	703
200	649	382	476	8	162	878	785	803	246	425	1,137	634	674	708
205	652	384	478	8	163	880	788	806	247	428	1,137	634	677	712
210	655	386	480	8	165	883	791	808	249	430	1,137	634	680	716
215	657	388	483	8	166	885	794	811	250	433	1,137	634	683	719
220	660	390	485	8	168	888	797	813	252	436	1,137	633	685	723
225	662	392	487	8	169	890	799	815	253	438	1,137	633	688	726
230	665	394	489	8	170	892	802	818	255	441	1,137	633	691	729
235	667	396	491	8	172	895	805	820	256	444	1,137	633	693	732
240	670	398	493	8	173	897	807	822	257	446	1,137	632	696	736
245	672	400	495	8	174	900	810	824	259	448	1,139	632	698	739
250	675	401	497	8	175	902	813	826	260	451	1,140	632	701	742
255	677	403	499	8	177	904	815	828	261	453	1,141	631	703	745
260	679	405	501	8	178	907	818	830	263	455	1,142	631	706	748
265	682	407	503	9	179	909	820	832	264	458	1,143	630	708	750
270	684	409	505	9	180	911	822	834	265	460	1,144	630	711	753
275	686	410	507	9	181	914	825	836	266	462	1,145	629	713	756
280	689	412	509	9	182	916	827	838	268	464	1,146	629	715	759
285	691	414	511	9	184	918	829	840	269	467	1,147	628	718	762
290	693	415	512	9	185	921	832	842	270	469	1,147	628	720	764
295	696	417	514	9	186	923	834	844	271	471	1,148	627	722	767
300	698	419	516	9	187	925	836	846	273	473	1,149	627	724	769
305	700	420	518	9	188	927	838	848	274	475	1,149	626	726	772
310	702	422	519	9	189	930	841	850	275	477	1,150	626	729	775
315	705	423	521	9	190	932	843	851	276	479	1,150	625	731	777
320	707	425	523	9	191	934	845	853	277	481	1,151	625	733	780
325	709	426	524	9	192	936	847	855	279	483	1,151	624	735	782
330	711	428	526	9	193	938	849	857	280	485	1,152	624	737	785
335	714	430	528	9	194	941	851	859	281	487	1,152	624	739	787
340	716	431	529	9	195	943	853	860	282	489	1,153	623	741	790
345	718	433	531	9	196	945	855	862	283	491	1,153	623	743	792
350	720	434	532	9	197	947	858	864	284	492	1,154	623	746	794

13.5 Appendix E: Yield Tables for Existing Managed Stands Aged 15 – 54 Years

Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 15 – 54 Years Old
CWHxm2 Variant – All Sites

	Analysis Unit								
Age	**1132**	**1133**	**1134**	**1232**	**1233**	**1234**	**1332**	**1333**	**1334**
0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	1	2	1
20	4	3	3	2	5	3	22	48	40
25	37	29	33	23	36	26	78	123	117
30	91	66	84	66	79	68	148	202	200
35	151	113	141	117	129	120	223	285	288
40	211	159	198	170	177	172	306	376	383
45	278	202	256	224	224	224	387	462	477
50	341	245	312	281	272	278	457	538	562
55	401	285	373	333	320	330	538	616	653
60	462	328	432	382	367	384	614	687	737
65	524	370	487	436	413	438	686	751	814
70	585	409	541	488	453	488	750	806	880
75	642	445	596	536	490	533	805	855	941
80	694	479	646	583	526	579	859	902	1,003
85	740	510	692	629	560	625	920	945	1,062
90	781	538	736	669	592	667	978	985	1,118
95	826	564	775	706	622	706	1,031	1,018	1,170
100	873	589	812	742	648	743	1,076	1,047	1,214
105	917	613	847	779	674	779	1,117	1,073	1,253
110	958	634	883	816	697	812	1,157	1,097	1,290
115	994	655	917	850	719	842	1,196	1,121	1,328
120	1,029	673	949	882	737	871	1,234	1,144	1,365
125	1,062	689	979	911	754	897	1,270	1,167	1,401
130	1,094	705	1,009	938	771	923	1,303	1,188	1,433
135	1,122	720	1,036	964	786	949	1,333	1,205	1,460
140	1,149	734	1,063	988	801	973	1,361	1,216	1,485
145	1,174	747	1,088	1,012	813	996	1,386	1,226	1,508
150	1,198	757	1,108	1,034	824	1,018	1,411	1,236	1,531
155	1,220	767	1,127	1,055	835	1,039	1,437	1,246	1,531
160	1,241	776	1,145	1,076	845	1,059	1,437	1,246	1,531
165	1,261	785	1,163	1,095	854	1,078	1,437	1,246	1,531
170	1,280	793	1,179	1,114	863	1,096	1,437	1,246	1,531
175	1,299	800	1,195	1,131	871	1,114	1,437	1,246	1,531
180	1,316	806	1,211	1,146	876	1,127	1,437	1,246	1,531
185	1,332	810	1,226	1,160	879	1,140	1,437	1,246	1,531
190	1,348	813	1,240	1,173	883	1,152	1,437	1,246	1,531
195	1,363	816	1,254	1,185	887	1,164	1,437	1,246	1,531
200	1,377	819	1,268	1,197	890	1,175	1,437	1,246	1,531
205	1,390	822	1,281	1,208	893	1,186	1,437	1,246	1,531
210	1,406	824	1,293	1,221	896	1,197	1,437	1,246	1,531
215	1,422	827	1,303	1,233	899	1,208	1,437	1,246	1,531
220	1,437	829	1,314	1,246	901	1,219	1,437	1,246	1,531
225	1,452	831	1,323	1,258	901	1,228	1,437	1,246	1,531
230	1,465	834	1,332	1,270	901	1,238	1,437	1,246	1,531
235	1,477	836	1,341	1,282	901	1,247	1,437	1,246	1,531
240	1,488	838	1,350	1,293	900	1,256	1,437	1,246	1,531
245	1,499	837	1,358	1,304	900	1,265	1,437	1,246	1,531
250	1,510	837	1,365	1,315	900	1,273	1,437	1,246	1,531

Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 15 – 54 Years Old
CWHmm1 Variant – All Sites

	Analysis Unit								
Age	**2133**	**2134**	**2230**	**2233**	**2234**	**2331**	**2333**	**2334**	**2338**
0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	1	1	6
20	0	0	7	5	2	5	42	25	50
25	3	2	28	35	17	40	111	86	127
30	19	18	62	74	48	102	188	159	217
35	45	44	108	125	96	167	267	235	309
40	70	79	150	172	144	234	355	316	403
45	102	116	190	219	191	306	440	399	495
50	131	152	230	267	239	375	518	481	582
55	160	188	267	315	287	444	595	557	666
60	186	222	303	363	334	513	667	632	748
65	211	254	338	408	381	579	735	705	823
70	235	287	374	451	429	644	795	773	891
75	259	319	408	491	475	705	851	836	951
80	282	354	439	527	516	759	901	890	1,001
85	305	387	467	563	556	808	946	939	1,046
90	328	420	494	598	595	859	988	987	1,089
95	350	449	521	631	634	908	1,028	1,036	1,128
100	370	477	547	662	670	954	1,062	1,080	1,165
105	389	503	570	691	705	996	1,095	1,122	1,198
110	407	528	591	718	738	1,036	1,126	1,162	1,228
115	426	555	611	744	770	1,075	1,155	1,199	1,228
120	443	580	630	768	800	1,111	1,182	1,231	1,228
125	460	605	647	790	827	1,145	1,207	1,260	1,228
130	476	629	662	810	851	1,178	1,232	1,289	1,228
135	491	651	676	828	874	1,210	1,257	1,316	1,228
140	506	672	688	846	895	1,240	1,281	1,344	1,228
145	519	692	700	862	915	1,269	1,303	1,370	1,228
150	531	711	711	878	936	1,294	1,319	1,393	1,228
155	542	729	722	894	956	1,318	1,334	1,415	1,228
160	553	745	733	909	975	1,341	1,348	1,435	1,228
165	563	759	744	923	994	1,361	1,361	1,452	1,228
170	572	772	754	937	1,012	1,381	1,361	1,452	1,228
175	581	785	763	949	1,028	1,402	1,361	1,452	1,228
180	589	798	772	960	1,044	1,422	1,361	1,452	1,228
185	597	810	781	971	1,059	1,441	1,361	1,452	1,228
190	605	822	789	981	1,074	1,460	1,361	1,452	1,228
195	613	833	797	991	1,088	1,478	1,361	1,452	1,228
200	620	845	803	1,001	1,101	1,496	1,361	1,452	1,228
205	627	856	809	1,010	1,114	1,513	1,361	1,452	1,228
210	633	867	815	1,019	1,127	1,530	1,361	1,452	1,228
215	640	877	820	1,027	1,138	1,546	1,361	1,452	1,228
220	647	888	824	1,034	1,147	1,561	1,361	1,452	1,228
225	653	898	828	1,040	1,156	1,575	1,361	1,452	1,228
230	659	907	831	1,045	1,164	1,589	1,361	1,452	1,228
235	665	916	834	1,050	1,172	1,602	1,361	1,452	1,228
240	670	925	837	1,055	1,179	1,615	1,361	1,452	1,228
245	676	933	840	1,060	1,187	1,629	1,361	1,452	1,228
250	681	941	843	1,065	1,194	1,642	1,361	1,452	1,228

Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 15 – 54 Years Old
CWHvm1 Variant – All Sites

	Analysis Unit														
Age	3130	3132	3133	3134	3231	3232	3233	3234	3331	3332	3333	3334	3335	3336	3338
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	3	1	1	0	19
20	9	1	2	1	2	2	18	4	13	15	48	21	28	8	79
25	35	17	28	15	11	20	57	21	62	64	124	81	94	51	186
30	75	52	58	47	36	63	113	60	131	131	206	155	171	115	297
35	120	99	101	93	72	113	171	109	204	203	294	233	252	183	415
40	161	149	144	143	120	166	229	162	279	278	387	315	336	254	531
45	201	200	186	192	168	223	294	217	357	357	476	400	423	331	646
50	238	253	226	242	217	281	356	270	437	430	561	484	508	403	760
55	273	303	269	292	266	334	415	324	513	501	641	561	586	472	868
60	305	348	310	338	311	384	468	375	586	575	718	641	666	546	967
65	336	399	350	390	361	440	522	430	656	645	787	716	741	616	1,057
70	367	450	388	440	408	493	573	482	725	711	850	787	810	683	1,136
75	397	497	424	487	455	544	620	531	787	770	907	850	873	744	1,201
80	424	542	457	531	501	593	664	577	842	822	958	905	927	797	1,259
85	449	585	489	573	545	641	706	624	895	871	1,004	958	977	846	1,312
90	472	626	520	616	586	682	745	668	943	925	1,047	1,012	1,029	901	1,361
95	493	663	549	656	624	721	781	709	989	976	1,086	1,062	1,078	954	1,406
100	512	698	576	693	660	757	814	747	1,034	1,023	1,123	1,110	1,124	1,004	1,449
105	530	732	601	728	697	798	845	785	1,077	1,066	1,159	1,156	1,167	1,049	1,449
110	547	769	625	764	733	836	875	821	1,118	1,107	1,192	1,199	1,208	1,092	1,449
115	563	804	649	798	767	872	902	853	1,156	1,144	1,224	1,235	1,244	1,131	1,449
120	577	836	671	828	798	906	926	883	1,192	1,179	1,255	1,269	1,277	1,167	1,449
125	591	866	693	856	827	935	948	911	1,226	1,213	1,284	1,302	1,308	1,202	1,449
130	603	892	713	882	854	964	970	937	1,258	1,246	1,308	1,333	1,338	1,235	1,449
135	614	917	732	906	880	991	990	963	1,290	1,277	1,329	1,364	1,365	1,268	1,449
140	623	941	749	931	906	1,017	1,008	989	1,318	1,305	1,348	1,392	1,392	1,298	1,449
145	631	965	765	955	930	1,042	1,025	1,012	1,318	1,330	1,367	1,419	1,417	1,326	1,449
150	639	987	781	977	951	1,065	1,042	1,035	1,318	1,330	1,367	1,419	1,417	1,352	1,449
155	646	1,008	795	999	972	1,088	1,058	1,057	1,318	1,330	1,367	1,419	1,417	1,376	1,449
160	654	1,028	809	1,019	992	1,109	1,073	1,078	1,318	1,330	1,367	1,419	1,417	1,398	1,449
165	660	1,047	822	1,039	1,011	1,130	1,087	1,098	1,318	1,330	1,367	1,419	1,417	1,420	1,449
170	667	1,065	833	1,058	1,030	1,150	1,100	1,117	1,318	1,330	1,367	1,419	1,417	1,441	1,449
175	673	1,083	844	1,076	1,049	1,168	1,113	1,135	1,318	1,330	1,367	1,419	1,417	1,462	1,449
180	679	1,099	854	1,093	1,067	1,184	1,126	1,153	1,318	1,330	1,367	1,419	1,417	1,483	1,449
185	684	1,115	864	1,110	1,084	1,199	1,138	1,170	1,318	1,330	1,367	1,419	1,417	1,503	1,449
190	690	1,130	873	1,126	1,101	1,213	1,149	1,184	1,318	1,330	1,367	1,419	1,417	1,522	1,449
195	694	1,144	882	1,141	1,116	1,226	1,158	1,197	1,318	1,330	1,367	1,419	1,417	1,541	1,449
200	697	1,156	892	1,153	1,130	1,239	1,168	1,209	1,318	1,330	1,367	1,419	1,417	1,558	1,449
205	699	1,167	900	1,164	1,144	1,251	1,177	1,221	1,318	1,330	1,367	1,419	1,417	1,574	1,449
210	702	1,180	909	1,176	1,158	1,265	1,187	1,233	1,318	1,330	1,367	1,419	1,417	1,591	1,449
215	704	1,192	916	1,187	1,172	1,279	1,196	1,245	1,318	1,330	1,367	1,419	1,417	1,606	1,449
220	706	1,204	923	1,198	1,185	1,293	1,204	1,256	1,318	1,330	1,367	1,419	1,417	1,621	1,449
225	709	1,216	929	1,209	1,198	1,307	1,213	1,267	1,318	1,330	1,367	1,419	1,417	1,634	1,449
230	711	1,227	936	1,219	1,211	1,320	1,221	1,278	1,318	1,330	1,367	1,419	1,417	1,648	1,449
235	713	1,239	942	1,229	1,223	1,333	1,229	1,288	1,318	1,330	1,367	1,419	1,417	1,662	1,449
240	716	1,250	948	1,239	1,235	1,346	1,236	1,299	1,318	1,330	1,367	1,419	1,417	1,675	1,449
245	718	1,261	954	1,249	1,247	1,358	1,241	1,308	1,318	1,330	1,367	1,419	1,417	1,688	1,449
250	720	1,272	959	1,258	1,257	1,370	1,245	1,318	1,318	1,330	1,367	1,419	1,417	1,701	1,449

Net Merchantable Volume Yield Tables

Existing Managed Stands Aged 15 – 54 Years Old
CWHvm2 Variant – All Sites

	Analysis Unit													
Age	**4131**	**4133**	**4134**	**4230**	**4231**	**4233**	**4234**	**4236**	**4330**	**4331**	**4332**	**4333**	**4334**	**4336**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	1	0	0	13	5	5	12	8	4
25	0	0	0	2	8	21	6	3	57	37	30	59	50	37
30	0	0	0	13	35	43	21	21	121	97	74	118	114	96
35	0	0	0	36	74	76	48	54	186	162	127	178	181	158
40	1	3	2	68	122	111	86	94	252	228	180	237	250	223
45	5	9	7	105	170	148	125	136	318	296	235	295	321	293
50	14	17	17	141	218	182	165	178	388	365	294	360	396	360
55	24	29	27	178	266	216	204	219	454	436	353	421	468	424
60	40	41	45	214	318	251	244	263	517	504	408	479	537	491
65	59	52	64	251	368	286	283	306	581	569	457	534	606	556
70	78	62	81	287	414	319	321	347	641	632	503	584	672	619
75	96	72	99	322	457	351	357	384	697	694	552	632	735	680
80	115	82	116	354	501	381	392	421	747	750	599	677	791	733
85	133	91	133	385	545	409	428	456	791	800	642	718	841	781
90	151	102	150	415	586	434	463	491	833	848	683	755	888	826
95	168	112	165	444	625	459	496	526	875	896	723	793	938	877
100	185	121	181	474	661	483	528	558	914	939	760	828	984	924
105	201	130	197	503	696	507	558	591	951	980	794	860	1,028	969
110	217	139	211	529	726	530	585	621	986	1,018	825	890	1,069	1,009
115	233	148	226	554	756	551	611	650	1,020	1,057	854	918	1,108	1,048
120	249	156	240	578	784	571	636	677	1,052	1,093	882	945	1,146	1,084
125	264	163	254	601	812	589	661	703	1,077	1,126	906	967	1,177	1,117
130	278	171	268	625	840	607	687	728	1,102	1,158	933	988	1,208	1,149
135	292	178	280	647	867	623	711	752	1,125	1,188	959	1,008	1,236	1,180
140	307	184	293	669	893	640	734	773	1,147	1,218	984	1,027	1,264	1,209
145	321	191	306	689	918	656	756	793	1,171	1,246	1,008	1,046	1,292	1,237
150	335	196	317	709	941	671	777	811	1,193	1,274	1,031	1,064	1,319	1,264
155	348	202	328	728	964	686	797	829	1,213	1,299	1,053	1,080	1,343	1,289
160	361	208	340	745	985	699	816	845	1,232	1,321	1,071	1,095	1,366	1,311
165	374	213	351	760	1,006	711	834	861	1,250	1,342	1,088	1,109	1,387	1,332
170	386	219	362	775	1,025	722	851	877	1,264	1,361	1,104	1,122	1,406	1,352
175	398	224	372	790	1,043	733	868	893	1,279	1,380	1,119	1,134	1,424	1,370
180	408	229	382	803	1,058	744	881	909	1,292	1,398	1,133	1,146	1,441	1,388
185	419	234	392	815	1,073	754	894	924	1,306	1,417	1,146	1,156	1,458	1,407
190	429	238	401	826	1,087	764	907	938	1,319	1,435	1,159	1,165	1,475	1,424
195	439	243	410	837	1,102	773	919	952	1,332	1,453	1,172	1,174	1,491	1,442
200	449	247	418	847	1,116	782	930	966	1,346	1,471	1,184	1,183	1,507	1,459
205	458	252	427	857	1,130	790	941	978	1,359	1,488	1,196	1,192	1,524	1,475
210	467	255	434	868	1,145	797	953	993	1,372	1,506	1,209	1,200	1,540	1,493
215	476	259	442	881	1,159	803	964	1,007	1,384	1,522	1,222	1,209	1,555	1,511
220	485	263	450	892	1,173	809	976	1,021	1,395	1,537	1,234	1,217	1,570	1,528
225	494	266	458	904	1,187	815	987	1,033	1,406	1,551	1,246	1,224	1,584	1,543
230	503	269	465	915	1,201	821	998	1,045	1,417	1,565	1,258	1,231	1,597	1,556
235	511	272	472	926	1,214	827	1,008	1,056	1,427	1,578	1,269	1,238	1,609	1,570
240	520	275	479	937	1,227	832	1,018	1,066	1,435	1,590	1,279	1,242	1,619	1,582
245	528	278	486	947	1,239	837	1,028	1,077	1,443	1,601	1,288	1,247	1,629	1,593
250	536	280	493	957	1,249	843	1,037	1,087	1,450	1,613	1,297	1,252	1,639	1,605

Net Merchantable Volume Yield Tables

Existing Managed Stands Aged 15 – 54 Years Old

MHmm1 Variant – All Sites

	Analysis Unit							
Age	**5131**	**5134**	**5136**	**5231**	**5234**	**5235**	**5236**	**5238**
0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0
35	0	0	0	2	5	4	2	2
40	0	0	0	5	14	12	6	7
45	0	0	0	13	33	27	17	20
50	1	1	2	25	54	46	31	38
55	3	4	6	40	77	67	48	57
60	8	10	11	57	100	88	66	77
65	16	17	19	79	125	112	87	98
70	24	24	27	101	150	136	107	119
75	36	37	37	122	174	159	126	144
80	51	51	50	144	198	181	146	169
85	66	64	61	165	222	205	165	193
90	79	77	73	185	245	227	184	217
95	93	90	83	206	268	248	202	239
100	107	103	94	226	291	270	220	260
105	121	116	104	246	315	292	238	281
110	134	128	114	265	338	314	255	301
115	147	140	123	284	360	335	273	320
120	159	152	133	303	381	355	290	338
125	172	163	142	320	401	374	305	357
130	184	174	150	337	419	391	321	376
135	195	184	158	353	437	409	335	394
140	206	195	166	371	454	425	349	412
145	217	205	174	388	472	442	363	429
150	228	215	182	405	490	459	377	445
155	239	224	189	420	507	476	389	461
160	249	233	196	435	524	491	401	476
165	259	242	203	450	540	506	412	490
170	269	251	210	463	555	521	423	504
175	278	260	216	476	570	534	433	517
180	288	268	223	488	583	547	443	529
185	298	277	229	500	596	560	452	541
190	308	286	235	511	609	571	461	552
195	317	294	241	522	621	583	469	563
200	327	302	247	533	632	593	477	573
205	336	310	253	543	643	604	485	583
210	344	317	258	554	654	614	493	593
215	353	325	264	565	665	625	502	603
220	361	332	270	575	676	636	510	613
225	369	339	275	586	686	645	519	622
230	376	345	281	595	695	654	526	630
235	383	351	286	605	703	662	534	638
240	390	358	291	614	711	671	541	646
245	397	364	296	623	719	679	548	653
250	403	370	301	632	727	686	555	661

13.6 Appendix F: Yield Tables for Existing Managed Stands Aged 1 – 14 Years

Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 14 Years Old
CWHxm2 Variant – All Sites

	Analysis Unit							
Age	1120	1222	1223	1224	1321	1322	1323	1324
0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	0	0	0	0	15	3	6	3
20	2	3	8	4	72	31	59	44
25	22	29	42	29	150	94	143	123
30	58	76	90	74	226	167	226	206
35	106	130	141	128	304	242	322	293
40	155	184	191	180	384	327	418	388
45	205	243	241	235	454	403	504	479
50	253	301	294	290	518	474	587	562
55	302	352	342	343	576	552	667	651
60	348	406	390	398	622	624	738	731
65	400	462	437	453	662	689	801	805
70	449	514	478	503	695	745	856	867
75	493	564	515	549	724	795	904	924
80	535	612	552	595	752	849	951	984
85	575	656	587	641	778	905	992	1,040
90	614	695	619	683	778	905	1,030	1,040
95	651	732	647	722	778	905	1,064	1,040
100	686	772	675	760	778	905	1,094	1,040
105	721	812	702	797	778	905	1,123	1,040
110	755	849	725	830	778	905	1,152	1,040
115	785	884	746	860	778	905	1,180	1,040
120	813	914	764	888	778	905	1,200	1,040
125	838	942	781	914	778	905	1,216	1,040
130	862	969	798	940	778	905	1,231	1,040
135	885	995	813	966	778	905	1,231	1,040
140	907	1,019	826	989	778	905	1,231	1,040
145	929	1,043	838	1,012	778	905	1,231	1,040
150	949	1,065	850	1,034	778	905	1,231	1,040
155	969	1,086	861	1,055	778	905	1,231	1,040
160	988	1,106	871	1,075	778	905	1,231	1,040
165	1,005	1,125	880	1,094	778	905	1,231	1,040
170	1,023	1,144	888	1,112	778	905	1,231	1,040
175	1,039	1,160	894	1,129	778	905	1,231	1,040
180	1,054	1,174	898	1,142	778	905	1,231	1,040
185	1,069	1,187	902	1,155	778	905	1,231	1,040
190	1,083	1,200	906	1,167	778	905	1,231	1,040
195	1,094	1,212	909	1,178	778	905	1,231	1,040
200	1,105	1,223	913	1,189	778	905	1,231	1,040
205	1,115	1,234	916	1,200	778	905	1,231	1,040
210	1,126	1,247	920	1,211	778	905	1,231	1,040
215	1,136	1,259	921	1,221	778	905	1,231	1,040
220	1,146	1,272	921	1,231	778	905	1,231	1,040
225	1,155	1,284	921	1,241	778	905	1,231	1,040
230	1,165	1,297	921	1,251	778	905	1,231	1,040
235	1,174	1,308	921	1,260	778	905	1,231	1,040
240	1,182	1,320	921	1,269	778	905	1,231	1,040
245	1,190	1,331	921	1,278	778	905	1,231	1,040
250	1,198	1,342	921	1,286	778	905	1,231	1,040

Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 14 Years Old

CWHmm1 Variant – All Sites

	Analysis Unit				
Age	**2123**	**2220**	**2320**	**2323**	**2324**
0	0	0	0	0	0
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	3	1
20	0	7	12	43	24
25	4	35	51	113	83
30	27	77	106	189	155
35	51	127	166	271	232
40	78	176	227	359	313
45	110	224	287	441	393
50	140	275	340	519	474
55	168	323	396	595	551
60	193	368	451	666	625
65	218	412	504	732	698
70	242	455	553	792	765
75	264	496	597	846	828
80	287	535	636	895	881
85	309	571	675	940	931
90	332	604	718	983	982
95	353	636	759	1,022	1,029
100	372	666	795	1,057	1,074
105	390	695	826	1,090	1,116
110	408	723	856	1,121	1,157
115	425	750	883	1,151	1,195
120	442	774	910	1,179	1,228
125	458	797	935	1,206	1,259
130	474	817	959	1,233	1,288
135	488	836	981	1,258	1,316
140	502	853	1,001	1,281	1,343
145	514	869	1,019	1,299	1,368
150	526	885	1,036	1,315	1,392
155	536	900	1,052	1,331	1,414
160	546	915	1,067	1,346	1,434
165	555	929	1,081	1,346	1,434
170	563	942	1,095	1,346	1,434
175	571	954	1,095	1,346	1,434
180	579	965	1,095	1,346	1,434
185	587	976	1,095	1,346	1,434
190	594	987	1,095	1,346	1,434
195	601	997	1,095	1,346	1,434
200	608	1,006	1,095	1,346	1,434
205	615	1,015	1,095	1,346	1,434
210	621	1,024	1,095	1,346	1,434
215	627	1,032	1,095	1,346	1,434
220	632	1,038	1,095	1,346	1,434
225	638	1,045	1,095	1,346	1,434
230	643	1,051	1,095	1,346	1,434
235	648	1,057	1,095	1,346	1,434
240	652	1,062	1,095	1,346	1,434
245	657	1,068	1,095	1,346	1,434
250	661	1,074	1,095	1,346	1,434

Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 14 Years Old
CWHvm1 Variant – All Sites

	Analysis Unit										
Age	**3123**	**3124**	**3222**	**3223**	**3224**	**3321**	**3322**	**3323**	**3324**	**3326**	**3328**
0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	1	5	1	0	15
20	0	0	6	26	5	9	18	48	23	8	73
25	14	8	32	70	25	54	72	125	86	50	171
30	35	30	80	130	66	121	140	206	161	113	274
35	59	70	135	191	116	192	214	296	241	181	385
40	86	113	191	256	171	265	294	390	324	252	497
45	114	157	253	324	227	342	370	476	411	328	602
50	140	202	312	389	282	420	440	561	495	397	705
55	169	245	364	446	334	496	516	640	574	467	805
60	196	288	415	501	386	569	589	715	655	539	899
65	224	330	473	557	443	639	658	784	731	607	984
70	252	375	527	609	496	708	723	847	802	674	1059
75	277	421	578	657	545	771	778	903	865	732	1123
80	302	463	626	700	591	827	828	952	920	784	1178
85	327	502	670	740	637	881	883	998	974	835	1229
90	350	539	709	778	680	931	937	1043	1029	889	1277
95	371	573	746	812	721	978	989	1084	1080	941	1321
100	390	610	784	844	760	1022	1033	1123	1129	990	1361
105	408	644	825	876	799	1066	1075	1160	1175	1034	1400
110	425	678	864	904	836	1108	1115	1197	1220	1074	1400
115	442	710	899	931	868	1146	1153	1230	1256	1112	1400
120	458	741	930	955	898	1182	1188	1262	1290	1149	1400
125	473	770	958	977	925	1217	1222	1287	1321	1184	1400
130	487	798	984	996	951	1250	1252	1309	1352	1218	1400
135	501	823	1,010	1,015	977	1283	1281	1331	1383	1251	1400
140	515	845	1,034	1,032	1,002	1313	1308	1352	1383	1281	1400
145	528	866	1,057	1,049	1,026	1339	1308	1352	1383	1307	1400
150	541	886	1,079	1,065	1,049	1364	1308	1352	1383	1332	1400
155	554	904	1,100	1,080	1,071	1387	1308	1352	1383	1355	1400
160	565	923	1,120	1,095	1,091	1409	1308	1352	1383	1378	1400
165	576	942	1,139	1,108	1,111	1431	1308	1352	1383	1399	1400
170	586	960	1,157	1,121	1,131	1453	1308	1352	1383	1421	1400
175	596	977	1,174	1,134	1,149	1474	1308	1352	1383	1443	1400
180	605	994	1,189	1,146	1,166	1495	1308	1352	1383	1463	1400
185	614	1,010	1,203	1,157	1,183	1516	1308	1352	1383	1483	1400
190	622	1,025	1,216	1,169	1,197	1536	1308	1352	1383	1503	1400
195	630	1,039	1,228	1,178	1,209	1554	1308	1352	1383	1520	1400
200	638	1,053	1,239	1,188	1,221	1571	1308	1352	1383	1537	1400
205	645	1,066	1,250	1,197	1,233	1587	1308	1352	1383	1553	1400
210	651	1,079	1,263	1,206	1,245	1603	1308	1352	1383	1568	1400
215	657	1,092	1,276	1,215	1,257	1618	1308	1352	1383	1583	1400
220	663	1,104	1,288	1,224	1,268	1632	1308	1352	1383	1598	1400
225	669	1,116	1,301	1,232	1,279	1646	1308	1352	1383	1612	1400
230	675	1,128	1,314	1,238	1,290	1661	1308	1352	1383	1627	1400
235	680	1,139	1,326	1,243	1,301	1676	1308	1352	1383	1641	1400
240	686	1,149	1,338	1,248	1,311	1691	1308	1352	1383	1655	1400
245	691	1,157	1,350	1,253	1,320	1705	1308	1352	1383	1668	1400
250	696	1,164	1,361	1,258	1,329	1719	1308	1352	1383	1681	1400

Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 14 Years Old
CWHvm2 Variant – All Sites

	Analysis Unit													
Age	**4121**	**4124**	**4126**	**4221**	**4222**	**4223**	**4224**	**4226**	**4228**	**4321**	**4322**	**4323**	**4324**	**4326**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	1	0	0	1	5	4	10	8	4
25	0	0	0	7	2	22	5	3	15	38	27	49	50	36
30	0	0	0	32	16	45	18	16	32	100	73	101	115	95
35	0	0	0	69	43	78	43	40	59	164	127	157	183	157
40	2	0	2	115	79	113	75	75	89	231	181	211	252	221
45	6	2	7	161	116	149	113	113	121	300	236	266	325	291
50	15	6	17	208	154	183	150	150	152	370	296	326	402	357
55	26	13	29	254	191	217	188	188	182	440	356	384	474	420
60	42	23	45	304	229	253	226	227	212	509	409	436	545	488
65	61	34	63	352	269	287	263	265	239	575	458	484	616	553
70	80	46	81	397	306	320	299	302	267	638	506	529	683	615
75	98	61	97	438	340	352	334	338	294	700	557	575	748	675
80	117	75	115	480	371	382	368	372	319	756	605	617	805	729
85	135	89	132	521	400	408	400	404	343	806	648	657	856	776
90	153	102	148	560	428	433	432	435	364	854	690	693	904	820
95	170	115	163	597	457	456	463	464	383	902	730	728	955	872
100	187	128	179	633	487	479	493	493	401	946	767	761	1002	920
105	204	141	193	667	515	502	523	523	419	988	799	790	1047	965
110	220	153	208	696	541	524	550	549	438	1027	829	817	1089	1005
115	236	165	223	725	566	545	575	575	456	1066	859	843	1130	1043
120	252	176	237	752	589	564	599	599	472	1103	886	867	1169	1079
125	267	187	251	779	612	582	622	623	488	1135	914	890	1201	1112
130	282	198	264	806	634	599	644	646	502	1167	942	911	1232	1144
135	296	209	277	832	655	615	668	669	516	1198	969	932	1261	1175
140	310	219	290	857	675	630	690	691	529	1227	995	952	1290	1204
145	325	230	302	880	694	646	711	711	541	1256	1020	971	1319	1233
150	338	240	314	902	712	660	731	731	553	1283	1043	988	1346	1260
155	351	249	324	924	727	674	751	750	564	1308	1064	1003	1371	1284
160	364	258	334	944	741	686	769	766	574	1330	1082	1017	1395	1306
165	376	267	344	964	755	697	787	782	584	1351	1099	1031	1417	1327
170	388	275	354	982	768	708	803	797	593	1371	1114	1043	1436	1347
175	398	283	362	999	780	719	818	811	602	1389	1129	1055	1455	1366
180	409	291	371	1,013	791	729	833	824	609	1407	1144	1066	1472	1383
185	419	298	379	1,027	802	738	846	836	615	1426	1158	1076	1490	1402
190	429	305	387	1,041	812	747	859	847	621	1444	1171	1085	1507	1420
195	438	312	394	1,055	821	755	872	858	627	1462	1184	1094	1524	1437
200	447	318	401	1,069	831	763	882	868	632	1480	1197	1102	1542	1454
205	456	324	408	1,082	842	770	893	878	637	1497	1209	1111	1558	1470
210	464	330	416	1,096	854	777	903	889	642	1515	1223	1119	1575	1489
215	474	337	423	1,111	867	784	914	902	648	1531	1236	1128	1591	1506
220	483	343	431	1,125	879	790	925	914	653	1546	1249	1136	1606	1523
225	492	349	439	1,139	891	796	935	926	658	1560	1261	1144	1621	1538
230	501	355	446	1,152	903	802	946	938	663	1574	1273	1152	1634	1552
235	510	361	454	1,165	914	807	956	950	668	1587	1284	1158	1648	1565
240	518	366	461	1,178	925	813	965	961	674	1599	1294	1164	1658	1577
245	526	372	468	1,189	936	818	975	972	679	1610	1304	1170	1668	1589
250	534	378	475	1,199	946	823	983	982	684	1622	1313	1175	1678	1601

Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 14 Years Old
MHmm1 Variant – All Sites

	Analysis Unit							
Age	5121	5124	5126	5221	5222	5224	5225	5226
0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0
35	0	0	0	2	0	0	4	1
40	0	0	0	5	1	1	10	5
45	0	0	0	13	7	4	25	13
50	1	2	1	24	17	13	42	25
55	4	6	5	39	30	23	62	40
60	9	12	10	56	47	39	82	57
65	17	20	18	77	65	58	105	78
70	24	30	26	99	83	76	128	98
75	37	43	38	119	100	94	150	116
80	52	57	51	140	116	112	172	135
85	66	71	65	161	133	130	194	155
90	80	84	77	181	149	147	215	173
95	94	97	90	201	164	163	235	191
100	108	110	102	221	179	180	256	209
105	121	123	114	240	193	196	277	226
110	134	134	126	259	207	211	297	243
115	147	146	137	278	223	227	317	260
120	160	158	149	296	237	241	337	277
125	172	169	160	313	250	256	354	292
130	184	180	170	330	264	270	371	307
135	195	190	180	346	277	284	388	322
140	206	200	190	362	289	297	403	336
145	217	210	199	379	301	311	419	350
150	228	220	209	395	312	324	436	364
155	239	229	218	410	321	336	451	377
160	249	238	226	425	330	348	465	388
165	258	247	235	439	338	360	479	400
170	268	256	243	452	346	372	492	411
175	277	264	251	465	353	383	505	421
180	287	273	260	477	360	393	517	430
185	297	282	268	488	367	403	528	439
190	307	290	277	499	373	413	539	448
195	316	298	284	509	380	423	549	457
200	325	306	292	520	386	432	559	465
205	334	313	299	530	392	441	569	473
210	343	320	307	540	399	450	578	481
215	352	328	314	550	405	458	588	490
220	360	335	322	561	413	466	598	499
225	367	342	329	571	420	475	608	507
230	374	349	335	580	427	483	616	516
235	382	356	341	589	435	491	624	523
240	389	362	348	598	441	498	632	531
245	395	368	354	607	448	506	639	539
250	402	374	359	616	455	513	647	546

13.7 Appendix G: Yield Tables for Future Managed Stands

Net Merchantable Volume Yield Tables
Future Managed Stands
CWHxm2 Variant – All Sites

	Analysis Unit		
Age	**1110**	**1210**	**1310**
0	0	0	0
5	0	0	0
10	0	0	0
15	0	0	8
20	8	15	65
25	40	49	154
30	88	104	248
35	141	160	349
40	193	217	448
45	245	276	541
50	297	333	632
55	348	387	719
60	403	443	798
65	454	495	868
70	499	543	927
75	541	589	988
80	582	632	1,044
85	621	673	1,096
90	659	711	1,147
95	695	749	1,194
100	730	784	1,236
105	761	817	1,275
110	789	846	1,313
115	815	872	1,346
120	840	897	1,376
125	864	920	1,404
130	886	943	1,404
135	908	965	1,404
140	928	985	1,404
145	948	1,005	1,404
150	966	1,024	1,404
155	983	1,040	1,404
160	999	1,056	1,404
165	1,014	1,071	1,404
170	1,027	1,086	1,404
175	1,039	1,099	1,404
180	1,050	1,110	1,404
185	1,060	1,120	1,404
190	1,070	1,130	1,404
195	1,079	1,140	1,404
200	1,088	1,148	1,404

Net Merchantable Volume Yield Tables
Future Managed Stands
CWHmm1 Variant – All Sites

	Analysis Unit		
Age	**2110**	**2210**	**2310**
0	0	0	0
5	0	0	0
10	0	0	0
15	0	0	6
20	0	13	46
25	8	40	122
30	31	85	204
35	59	138	294
40	94	190	382
45	129	245	466
50	162	298	550
55	194	348	627
60	226	397	700
65	256	444	768
70	284	491	830
75	316	536	886
80	346	577	936
85	375	614	983
90	401	649	1,028
95	427	684	1,070
100	451	718	1,111
105	475	750	1,150
110	499	781	1,188
115	521	809	1,224
120	542	835	1,255
125	561	859	1,283
130	579	880	1,307
135	596	900	1,329
140	612	919	1,351
145	627	937	1,372
150	640	954	1,372
155	652	970	1,372
160	664	986	1,372
165	676	1,001	1,372
170	686	1,015	1,372
175	697	1,029	1,372
180	707	1,041	1,372
185	718	1,053	1,372
190	727	1,065	1,372
195	737	1,076	1,372
200	746	1,085	1,372

Net Merchantable Volume Yield Tables
Future Managed Stands
CWHvm1 Variant – All Sites

	Analysis Unit		
Age	**3110**	**3210**	**3310**
0	0	0	0
5	0	0	0
10	0	0	0
15	0	1	6
20	8	27	44
25	35	74	117
30	73	133	202
35	118	196	291
40	163	265	379
45	210	335	464
50	259	395	548
55	304	453	626
60	350	512	702
65	393	569	771
70	434	622	832
75	474	669	887
80	511	712	940
85	545	753	993
90	578	791	1,042
95	608	828	1,087
100	638	863	1,131
105	668	896	1,173
110	696	926	1,212
115	723	952	1,243
120	747	976	1,274
125	769	997	1,302
130	790	1,018	1,302
135	810	1,038	1,302
140	828	1,058	1,302
145	845	1,076	1,302
150	860	1,093	1,302
155	875	1,110	1,302
160	889	1,125	1,302
165	902	1,140	1,302
170	915	1,154	1,302
175	928	1,167	1,302
180	940	1,180	1,302
185	951	1,192	1,302
190	962	1,202	1,302
195	972	1,212	1,302
200	981	1,221	1,302

Net Merchantable Volume Yield Tables

Future Managed Stands

CWHvm2 Variant – All Sites

	Analysis Unit		
Age	**4110**	**4210**	**4310**
0	0	0	0
5	0	0	0
10	0	0	0
15	0	0	0
20	0	1	9
25	0	7	50
30	0	24	114
35	0	53	180
40	2	89	248
45	7	128	315
50	16	167	383
55	27	205	455
60	41	246	520
65	57	285	582
70	72	322	641
75	88	356	697
80	103	390	748
85	118	421	797
90	133	453	844
95	147	485	890
100	161	516	929
105	174	545	967
110	188	571	1,003
115	201	595	1,038
120	213	619	1,071
125	225	641	1,100
130	237	664	1,129
135	249	686	1,157
140	260	707	1,183
145	271	727	1,208
150	281	746	1,232
155	291	764	1,254
160	300	781	1,274
165	310	797	1,293
170	319	812	1,310
175	328	826	1,326
180	336	839	1,341
185	345	852	1,357
190	352	864	1,371
195	360	875	1,386
200	368	885	1,400

Net Merchantable Volume Yield Tables
Future Managed Stands
MHmm1 Variant – All Sites

	Analysis Unit	
Age	**5110**	**5210**
0	0	0
5	0	0
10	0	0
15	0	0
20	0	0
25	0	0
30	0	4
35	1	13
40	3	29
45	8	48
50	14	77
55	23	106
60	35	137
65	47	171
70	62	205
75	81	237
80	99	269
85	117	299
90	135	333
95	153	366
100	171	399
105	189	430
110	207	460
115	224	491
120	241	521
125	257	550
130	273	578
135	289	604
140	304	629
145	320	652
150	334	673
155	348	693
160	361	712
165	374	729
170	386	747
175	398	763
180	410	779
185	422	794
190	434	809
195	445	822
200	456	835