WFP

Western Forest Products Inc.

DEFINING A HIGHER STANDARD™

Tree Farm Licence 19

MANAGEMENT PLAN 11

October 2020

This Management Plan was prepared by and under the supervision of

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

Mike Davis, R.P.F
Tenures Manager

and is submitted on behalf of Western Forest Products Inc. by

Shannon Janzen, R.P.F
Vice President and Chief Forester

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1 Introduction

This is the eleventh Management Plan ("MP") prepared for Tree Farm Licence ("TFL") 19 and the second MP prepared by Western Forest Products ("Western" or "WFP") 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 19.

2 Description of TFL 19

TFL 19 is located on the west side of Vancouver Island in the vicinity of Nootka Sound, approximately 80 kilometers due west of Campbell River (see Figure 1). The eastern boundary abuts onto Strathcona Provincial Park, while to the west it borders Tahsis Inlet and Nootka Island. The western boundary has a diverse shoreline by virtue of several inlets (Espinosa, Zeballos, Tahsis, Tlupana, Muchalaht), which dissect the coastal rainforest landscape.

Communities within or near the TFL include:

- Gold River,
- Tsaxana,
- Tahsis,
- Zeballos,
- Ehatis,
- Oclugjie.

Nearby provincial parks include:

- Strathcona (248,700 ha),
- Gold Muchalat (650 ha),
- Weymer Creek (300 ha),
- Woss Lake (6,500 ha),
- White Ridge (1,400 ha)
- Artlish Caves (280 ha).

TFL 19 is comprised of both 'Schedule A' lands (Timber Licences) and 'Schedule B' (Crown) land.

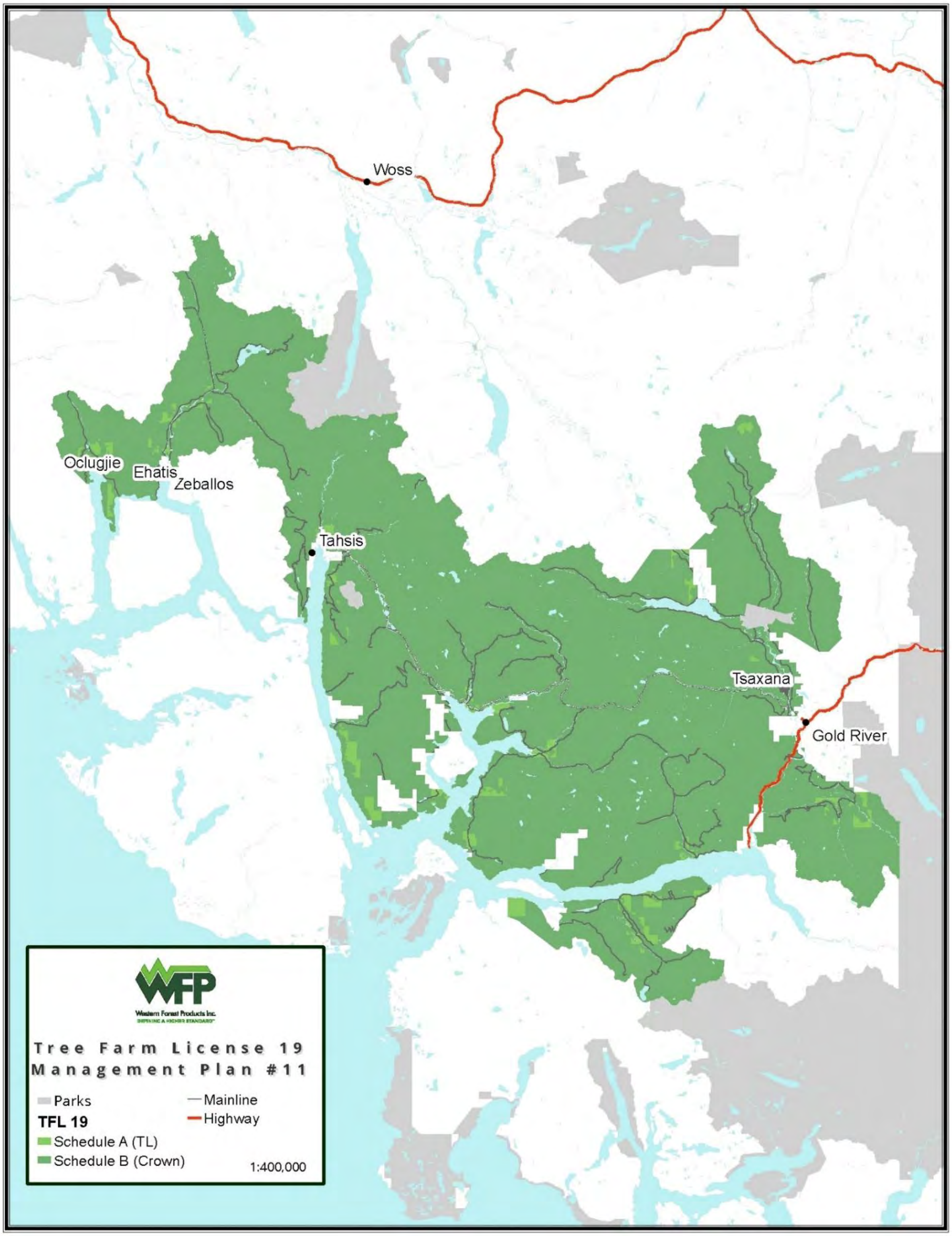

Figure 1 - TFL 19

The total TFL area is approximately 170,000 hectares and approximately 125,000 hectares is considered productive forest land. Of this, 63,177 hectares is anticipated to be available for timber harvesting (timber harvesting land base or "THLB"), with roughly 61,800 ha of productive forest assumed not available for harvesting (non-contributing land base or "NCLB"). The THLB is derived by deducting areas not available for harvesting due to:

- legal orders (e.g. ungulate winter range, wildlife habitat area),
- identified to meet legal requirements but not yet legally designated (e.g. proposed old growth management areas),
- practice requirements (e.g. riparian management areas, wildlife tree retention areas),
- estimates of areas required to be reserved to manage and conserve non-timber resources at the site-level (e.g. cultural heritage features, karst features, unstable terrain), and
- physical and economic constraints (e.g. inoperable, uneconomic)

Figure 2 and Figure 3 present the age class distribution (by area) and the current volume distribution (by volume class) respectively for the THLB and NCLB.

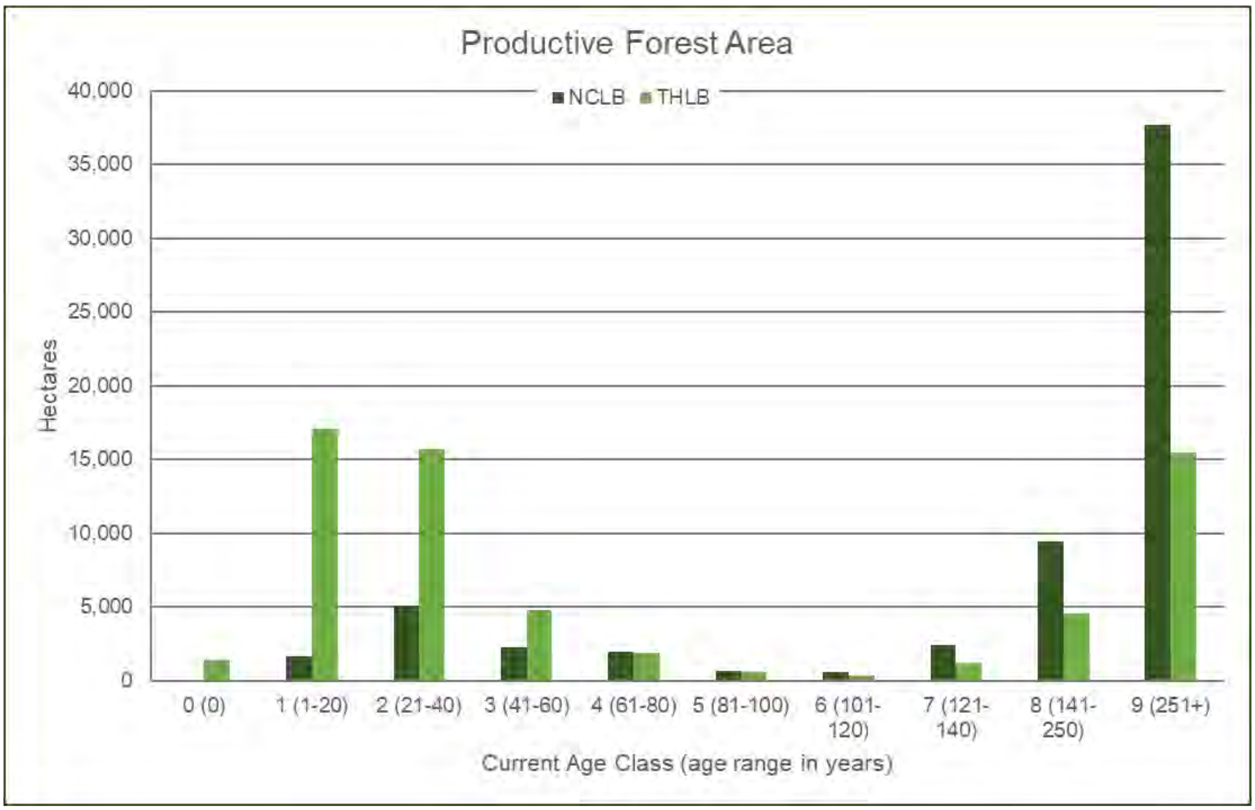

Figure 2 – THLB and NCLB age class distributions

As indicated in Figure 2, the NCLB is dominated by mature (121-250 years old) and old (251 years old and older) forest. This is a result of wildlife reserves, such as ungulate winter ranges and wildlife habitat areas, and old growth management areas preserving mostly old forest. Further details are presented in the Information Package in Appendix 2.

Figure 3 indicates that the NCLB contains a greater proportion of the high-volume stands than are within the THLB. This is consistent with the greater amount of old forests in the NCLB.

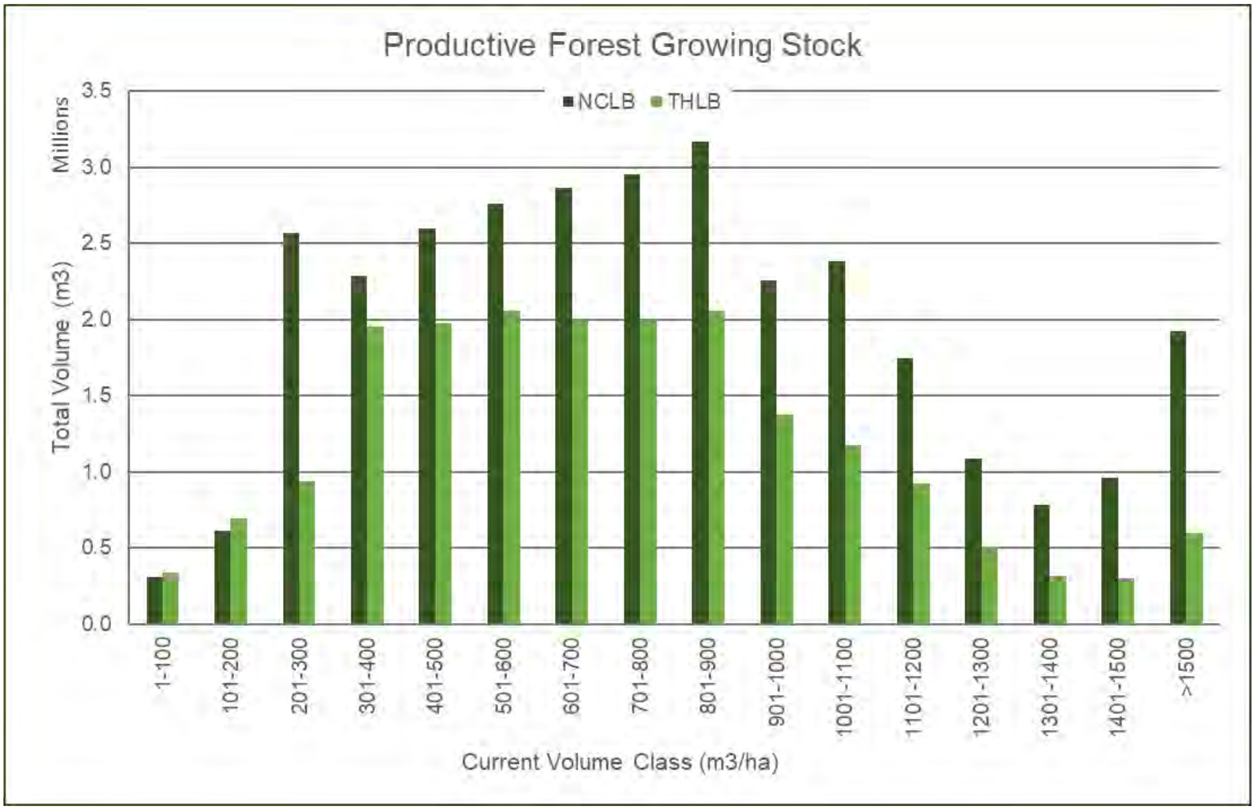

Figure 3 – THLB and NCLB volume class distributions

TFL 19 has significant overlap with the traditional territories of the Mowachaht/Muchalaht and Ehattesaht First Nations. TFL 19 also overlaps to a minor degree the traditional territories of the following First Nations:

- ‘Namgis
- Ka:'yu:k't'h/Che:k:tles7et'h'
- Wei Wai Kum
- We Wai Kai

The topography of TFL 19 is mountainous and steep with limestone outcrops common throughout the landscape. The licence area is drained by numerous rivers and streams. Many streams support significant anadromous (migratory, such as salmon) and non-anadromous (resident, such as rainbow trout) fish populations. Large animals, notably Roosevelt elk, Columbia black-tailed deer, cougars and black bears are abundant throughout the licence area. Numerous other large and small animals, reptiles, amphibians, and birds can also be found.

The forests of TFL 19 lie within the wetter and very dry maritime coastal western hemlock biogeoclimatic zone. Annual precipitation levels reach 3,000 to 5,000 mm. The climate is characterized by relatively short winters with intermittent wet snow storms. The summer period from July to September can be dry and warm. The dominant tree species is western hemlock, which occurs in conifer stands mixed with varying amounts of amabilis fir, western red cedar and Douglas fir. Lesser amounts of Sitka spruce, yellow cedar and mountain hemlock also occur.

3 TFL 19 Licence Holder History

TFL 19 was originally granted to Tahsis Company Ltd. on December 23, 1954. In 1997 a Western Forest Products predecessor purchased TFL 19 from Pacific Forest Products (refer to Table 1).

Table 1 - TFL 19 Licence Holders

Date listed company became licence holder	Licence Holder	Description
December 23, 1954	Tahsis Company Ltd.	Original FML
January 1, 1982	Tahsis Company Ltd.	TFLs replace FMLs
January 1, 1985	CIP Forest Products Inc.	Company name change
August 22, 1985	CIP Inc.	Company name change
January 1, 1989	Canadian Pacific Forest Products Limited	Company name change
August 2, 1993	Pacific Forest Products Limited	Assignment to subsidiary
December 8, 1997	Doman-Western Lumber Ltd	Purchase of licence
September 10, 2004	4018982 Canada Inc.	Company name change
March 31, 2005	WFP Western Lumber Ltd.	Company name change
May 1, 2006	Western Forest Products Inc.	Company amalgamation

4 TFL 19 AAC History

Table 2 shows the history of the AAC for TFL 19. 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), old forest conservation initiatives (e.g. Old Growth Management Areas, Wildlife Habitat Areas) and variable retention harvesting standards voluntarily adopted for the purposes of biodiversity management by Western.

Table 2 - TFL 19 AAC History

Date From	Date To	Management Plan No.	TFL 19 AAC (m^3/year)
January 1, 1955	December 31, 1959	1	283,170
January 1, 1960	December 31, 1965	2	351,131
January 1, 1966	December 31, 1966	2	427,303
January 1, 1967	December 31, 1969	3	588,944
January 1, 1970	December 31, 1976	4	855,169
January 1, 1977	December 31, 1977	5	862,248
January 1, 1978	December 31, 1982	5	898,674

January 1, 1983	July 31, 2001	6,7,8	978,000
August 1, 2001	January 30, 2007	9	940,000
January 31, 2007	July 14, 2009	9	921,200
July 15, 2009	August 9, 2010	9	855,947
August 10, 2010	March 14, 2012	10	730,000
March 15, 2012	Present	10	728,837

5 TFL 19 Consolidations and Subdivisions

There have been no consolidations or subdivisions associated with TFL 19 since its issuance in 1954.

6 Significant TFL 19 Boundary Changes

Table 3 lists major changes to the TFL of record and the date of those changes. There has been multiple minor (< 200 ha) area revisions since 1954 to accommodate other land such as gravel pits, radio towers, and transmission line 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 19 Significant Boundary Changes

Date	Mechanism	Boundary Change
August 1, 1957	Instrument 7	Addition of roughly 1,540 ha to Schedule “A” lands (Lot 174 and northerly portion of Lot 175, Nootka Land District)
February 5, 1965	Instrument 14	Deletion of approximately 291 ha from Schedule “B” lands for Gold River townsite
May 31, 1967	Instrument 29	Addition of approximately 150 ha to Schedule “A” lands (Lot 3, Nootka Land District)
November 21, 1967	Instrument 30	Deletion of approximately 60 ha associated with Highway 28 right-of-way
June 17, 1969	Instrument 35	Deletion of approximately 53 ha associated with Highway 28 right-of-way
January 7, 1971	Instrument 36	Deletion of approximately 70 ha from Schedule “A” lands (Lots 595 and 600, Nootka Land District) at Tahsis
September 15, 1971	Instrument 38	Deletion of approximately 8 ha from Schedule “B” lands for Zeballos townsite
March 8, 1972	Instrument 40	Deletion of approximately 55 ha from Schedule “B” lands at Tahsis
April 21, 1972	Instrument 41	Deletion of approximately 6.5 ha from Schedule “B” lands at Tahsis
August 7, 1972	Instrument 44	Deletion of approximately 6 ha from Schedule “B” lands at Tahsis
July 30, 1976	Instrument 46	Deletion of approximately 35 ha from Schedule “B” lands at Gold River for a park
March 5, 1975	Instrument 47	Deletion of approximately 196 ha from Schedule “B” lands for the Head Bay Forest Service Road right-of-way
February 2, 1976	Instrument 48	Deletion of approximately 38 ha from Schedule “B” lands for Zeballos townsite

Date	Mechanism	Boundary Change
June 26, 1980	Instrument 51	Deletion of approximately 85 ha associated with powerline right-of-way from near Moutcha Bay to Tahsis
September 29, 1980	Instrument 52	Deletion of approximately 15 ha from Schedule “B” lands for the Head Bay Forest Service Road right-of-way
June 6, 1989	Instrument 61	Deletion of approximately 81 ha from Schedule “A” lands (Lot 175, Nootka Land District) at Gold River
March 21, 1995	Instrument 63	Deletion of approximately 125 ha for relocation of Mowachaht/Muchalaht Reserve (Tsaxana)
December 15, 20015	Instrument 67	Deletion of five parcels of private land totalling 292 ha not owned by licence holder Doman-Western Lumber Ltd. (were owned by Bowater at the time)
January 23, 2007	Forest Revitalization Act order #3(4) 7-1	Deletion of 781 ha near Gold River for a woodlot with an AAC of 5,300 m^3
January 31, 2007	Forest Revitalization Act order #3(4) 7-2	Deletion of 614 ha (plus further 125 ha effective July 10, 2011) near Hisnit Inlet for a woodlot with an AAC of 4,700 m^3
January 31, 2007	Instrument 70	Deletion of all private land from Schedule “A” – approximately 2,007 ha
July 15, 2009	Instrument 72	Deletion of approximately 16,596 ha for BCTS operating area (Pacific TSA)
March 15, 2012	Instrument 73	Deletion of approximately 131 ha from Schedule “B” lands near Antler Lake

7 TFL 19 Planning Documents

The following are the publicly available planning documents used by Western to guide forest management and operations within TFL 19.

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 the Vancouver Island Land Use Plan (VILUP) as legal requirements. Effective December 1, 2000 the HLP established resource management objectives that vary from standard forest management standards. The HLP enables forest operations to be consistent with the intent of VILUP's zones, including the special management and enhanced forestry zones which have unique requirements for forestry practices.

Special Management Zones (SMZs) are areas where forest management emphasis is on higher levels of protection for special resource values, including visual quality, biodiversity, and other wildlife values. Portions of two SMZ's are found within TFL 19:

- Woss-Zeballos (SMZ 6)
- 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. Parts of TFL 19 are located within five different EFZs:

- Burman (EFZ 24)
- Eliza (EFZ 18)
- Kleeptee (EFZ 23)
- Tahsis (EFZ 19)
- Tlupana (EFZ 21).

As of October 2020, the Vancouver Island HLP order can be found at: https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/west-coast/vancouverisland-lup

7.2 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 October 2020, the FSP applicable to TFL 19 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/.

7.3 Forestry Certification Plans

Operations within TFL 19 are certified to the Sustainable Forestry Initiative (SFI) standard. SFI is a forest certification standard with principles that protect water quality, biodiversity, wildlife habitat, species at risk and forests with exceptional conservation value. It is used widely across North America and is accepted in the global marketplace under the Programme for the Endorsement of Forest Certification (PEFC). Western also maintains SFI Fiber Sourcing certification ensuring all fibre entering our mills is from legal and responsible sources.

While there is no plan required under SFI certification, the most recent audit results are available at https://www.westernforest.com/wp-content/uploads/2017/10/SFI-Audit-Report-Summary.pdf

Details regarding the standard are available at https://www.sfiprogram.org/standardguide2015-2019/.

8 Western Forest Products Forest Management

The following are proprietary WFP planning documents used to guide forest management and operations within TFL 19. These are internal WFP policies and practices that directly or indirectly influence forest management and therefore timber supply. Substantial detail is contained within each of these documents, with short summaries provided here for the reader to be made aware that these exist and are used by Western in managing the forests within its tenures.

8.1 Stewardship and Conservation Plan

The Stewardship and Conservation Plan (SCP) sets direction on managing forest values across the landscape over time, while identifying key corporate indicators of Sustainable Forest Management. The SCP connects and aligns practices through all planning levels from strategic to site-level. It also provides a standardized approach to achieving stewardship results. There are five programs within the SCP:

- Wildlife and Biodiversity,
- Fish and Watershed,
- Carbon and Climate Change,
- Communities,
- Timber and Reforestation.

The Wildlife and Biodiversity Program is complete and has been implemented. The remaining programs are under development.

8.1.1 Wildlife and Biodiversity Program

Western is committed to managing biodiversity on our tenures. Western's Wildlife and Biodiversity program is founded on over 15 years of local research and adaptive management learnings which is summarized in *Forestry and Biodiversity- Learning to Sustain Biodiversity in Managed Forests* (2009) edited by Dr. Fred Bunnell and Glen Dunsworth. The program is designed to achieve the three indicators for the successful management of biodiversity in our coastal rainforests:

(i) Ecologically distinct ecosystem types are represented in the non-harvestable land base of the tenure to maintain lesser known species and ecological function;

(ii) The amount, distribution, and heterogeneity of stand and forest structures important to sustain native species richness are maintained over time; and

(iii) The abundance, distribution and reproductive success of native species are not substantially reduced by forest practices.

The following outlines the nine components:

8.1.1.1 Rare Ecosystems

A rare ecosystem is an ecosystem within a biogeoclimatic unit that is either:

(i) a subset of an ecological community that is 'listed' by the BC Conservation Data Centre as being 'at risk' or

(ii) an unlisted community that is rare or uncommon.

Western has collaborated with three independent ecologists to develop a robust approach for identifying and protecting rare forested ecosystems. Corporate targets for high quality occurrences for each rare ecosystem have been established and these targets have been met.

8.1.1.2 *Old Forest*

Retention of old forests and management for recruitment of old forest characteristics across a landscape is considered a foundational element for sustaining biological diversity. These conserved old forests occur at low, mid and high elevations and are well distributed across the managed forest in a variety of patch sizes.

8.1.1.3 *Forest Interior Conditions*

Forest interior is generally defined as the portion of the forest that is not influenced by edge effects. An edge is the interface between two distinct habitats (e.g. a cutblock and the adjacent old forest) where a microclimate gradient exists between two habitat types. Forest interior conditions is a measure of quality of conserved forests for species that prefer to not live close to an edge.

8.1.1.4 *Forest Structure – Retention Silvicultural System*

There is strong scientific evidence that using a retention system across the landscape contributes to the management of biological diversity. The retention silvicultural system is designed to conserve biodiversity by sustaining species and ecological processes following disturbances. This is accomplished through maintaining habitat over time and reducing micro-climate effects of harvesting. In turn, retention enriches soil for regenerating trees by maintaining soil mycorrhizae and enhances connectivity by supporting the movement of mature and old forest species across the forested landscape.

8.1.1.5 *Forest Structure – Stand-level retention*

Stand-level retention is a combination of retention used in Retention Silvicultural System cutblocks and Wildlife Tree Retention Areas. Both types of stand-level retention contribute to biodiversity management at the landscape-level.

8.1.1.6 *Forest Structure – Big Trees*

A rare feature of BC's coastal forests is exceptionally large, iconic trees. These trees have significant cultural, social, economic (tourism) and environmental values and are important to retain. In June 2016, Western implemented a program to identify and retain very large Douglas-fir, Sitka spruce, western redcedar, and yellow-cedar by using them as anchors for stand-level retention or included in landscape-level reserves. Since 2016, Western's Big Tree Standard has expanded to include arbutus, bigleaf maple, black cottonwood, Garry oak, grand fir, Pacific yew, and western white pine.

8.1.1.7 *Species at Risk*

Over time, species evolve to survive in particular ecological niches. When changes occur in the environment through either natural or man-made processes, a species may become at risk of extinction if these changes negatively influence its persistence upon the landscape. The goal of species at risk management is to prevent a species from becoming extinct and facilitate species recovery.

8.1.1.8 Species of Conservation Concern

When changes occur in the environment through either natural or man-made processes, a species may become less common. Western's process of determining species of significant concern is based on:

(i) global and provincial risk classification categories,
(ii) species distribution,
(iii) if the species is negatively influenced by forestry,
(iv) BC Conservation Framework priority 1 species, and
(v) if the species population is declining.

8.1.1.9 Common Species

The overall goal of managing common species is to ensure they remain common. Maintaining common species is most effectively accomplished by selecting species that are sensitive to forest practices, can be effectively monitored and serve as indicators to the viability of other common species.

8.1.2 Fish and Watershed Program

The Fish and Watershed component is under development, however, the following two sections are complete

8.1.2.1 Watershed Management

WFP has watershed management strategies for all its tenures on Vancouver Island plus the portions of TFL 25 and TFL 39 in the Stafford and Phillips watersheds respectively. These strategies are based on measurable data on physical watershed processes. Inventories of the following are produced periodically to characterize each watershed, identify trends in condition and identify sensitive and key concerns:

- landslides,
- road stability hazard,
- sediment delivery potential from roads,
- stream channel type (alluvial, semi-alluvial, nonalluvial), and
- riparian forest condition.

From these inventories, a set of indicators are determined that allow the physical condition of any watershed to be evaluated from a consistent data set and allow comparison between watersheds with respect to watershed sensitivity and relative fisheries values. Periodic updates of the data allow trends in watershed condition to be identified and management strategies revised accordingly. These strategies are then connected to site-level decision-making through the Terrain Risk Management Strategy (TRMS).

8.1.2.2 Terrain Risk Management

Western's terrain risk management strategy is a framework for connecting landscape-level watershed management strategies to the site-level by managing landslide risk specific to detailed site-level information. The strategy considers:

- values at risk should a landslide occur (i.e. consequence), and
- the likelihood of a landslide occurring (i.e. hazard)

to determine a risk level. This risk level then guides WFP's forest professionals in deciding whether to have a terrain stability assessment conducted by a qualified professional (e.g. Professional Engineer or

Professional Geoscientist). Finally, areas selected for road building and harvesting have practices implemented that are appropriate for managing the identified risk.

8.2 Standards and Guidelines

8.2.1 Karst Management

WFP's karst management guidelines are based on the *Karst Management Handbook for British Columbia* (https://www.for.gov.bc.ca/hfp/publications/00189/Karst-Mgmt-Handbook-web.pdf) and BC inventory standards. The guidelines:

- provide information to manage karst terrain as a connected and functioning landscape system and individual features;
- provide a checklist to be used when conducting karst field assessments; and,
- protect worker safety from hazards that may occur in karst terrain.

8.2.2 Northern Goshawk Management

Western's management standard for Northern Goshawks provides direction regarding activities around Northern Goshawk nests. Strategies are intended to minimize risk of nest and territory abandonment while minimizing disruption to harvest activities. Reserves are designed around confirmed goshawk nests consistent with science-based guidelines (https://jem-online.org/index.php/jem/article/viewFile/576/506) and timing constraints for harvesting and road construction activities are applied in the vicinity of active nests.

8.2.3 Bald Eagle Nest Management

Similar to the goshawk standard, Western's eagle nest standard gives direction to maintain eagle nests in a functional state and to prevent disturbance of nesting eagles. Guidance is provided for ways of incorporating nest trees into forested reserves and timing constraints are listed for harvesting activities in the vicinity of active nests.

8.2.4 Bear Den Management

WFP has a standard for bear den management in order to maintain viable bear dens in a functional state and prevent disturbance of hibernating bears. Where worker safety permits, all identified dens will be retained in a functional state by incorporating the den in a forested retention area. Where safety does not permit retention of the den, other habitat containing large diameter trees suitable for den recruitment will be retained. Proximity restrictions near active dens for harvesting activities apply during the denning season of October 21st – April 30th.

8.2.5 Big Trees

Western was one of the first organizations to implement a big tree policy to recognize and retain these unique and important features of coastal BC. Western's commitment is to retain all live trees that exceed either:

- 50% of the largest diameter tree (by species referenced in section 8.1.1.6) in the provincial Big Tree Registry, or
- 80 metres in height.

Identified trees are to be retained in contiguous forested areas; forested patches, preferably at least 2 hectares in size; or as a single tree or in a patch less than 0.25 hectares where worker safety or engineering constraints do not allow larger patch retention. Light Detection and Ranging (LiDAR) technology, a 3D mapping tool, is used to identify potential big trees that are then verified in the field. Western's standard was revised in September 2020 to recognize the requirements of the provincial *Special Tree Protection Regulation*[1].

[1] See https://www.bclaws.ca/civix/document/id/complete/statreg/229_2020

9 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, Natural Resource Operations and Rural Development.

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10 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.
Alluvial stream	Alluvial streams have at least one unconfined erodible bank in alluvial deposits. Alluvial deposits are material deposited by the stream under its current flow regime. These stream channels can widen or change direction due to disturbance or a large flood event.
Biogeoclimatic zones and variants (BEC)	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Nonalluvial stream	Nonalluvial streams are confined to entrenched channels with stable position which is typically composed of bedrock.
Schedule “A” Land	Crown grant (private) and Crown land subject to timber licences contained within the boundaries of the TFL. Listed in Schedule “A” of the licence document.
Schedule “B” Land	Crown land contained within the boundaries of the TFL. Detailed in Schedule “B” of the licence document.
Semi-alluvial stream	Semi-alluvial streams have confining banks and stable position. They cannot widen their banks significantly or move laterally beyond the active channel.
Timber harvesting land base (THLB)	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 Licence	A licence that describes an area of Crown land within which the licence holder is granted exclusive right during its term to harvest all merchantable timber. For the purposes of defining rights within a timber licence, merchantable timber means timber that on January 1, 1975 was older than 75 years old (*Forest Act* section 1).
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.

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Appendix 1: Timber Supply Analysis

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Western Forest Products Inc.

DEFINING A HIGHER STANDARD™

Tree Farm Licence 19

Timber Supply Analysis

MANAGEMENT PLAN 11

Version 1
October 2020

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

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

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Executive Summary

This analysis examines timber supply projections for Tree Farm Licence 19 located on western Vancouver Island in the vicinity of Nootka Sound. 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 2268.

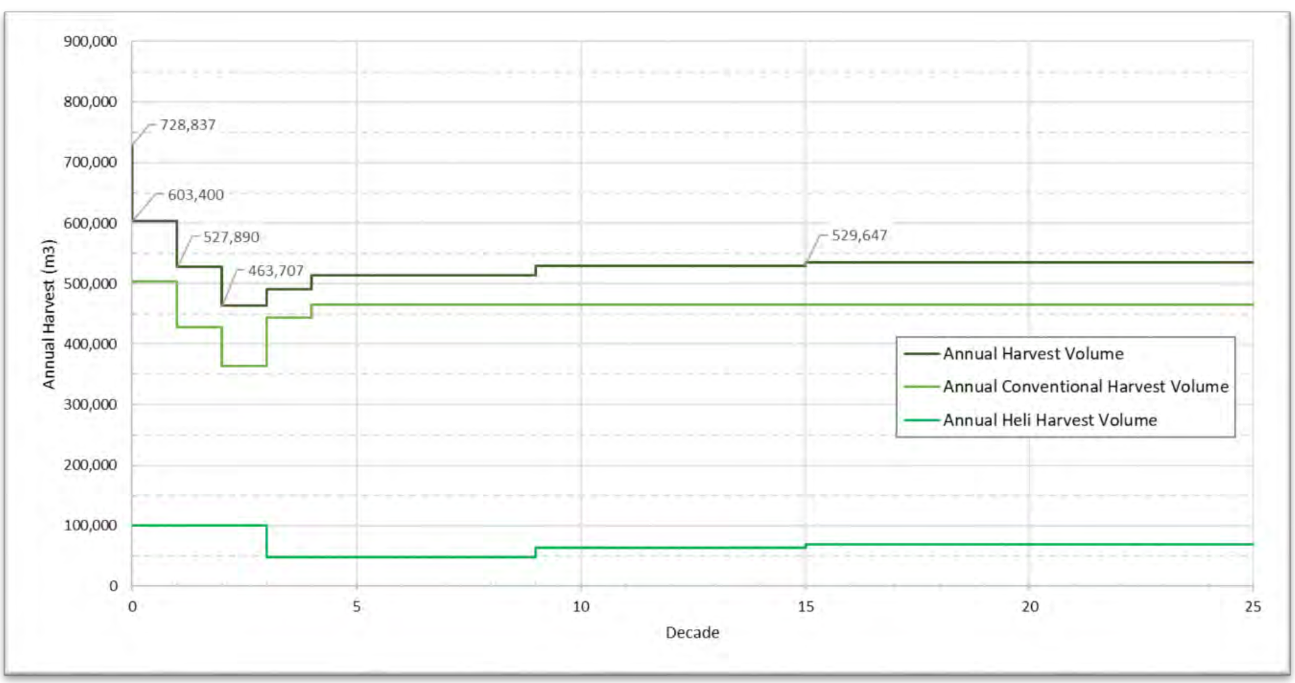
Several inputs and assumptions for this analysis are based on recently acquired LiDAR (Light Detection and Ranging) data, including:

- physical operability,
- managed stands heights and site index,
- OAF1 (small non-productive areas within forest stands), and
- growing site loss due to roads.

LiDAR provides very accurate three-dimensional representation of the Earth's surface and vegetation.

After allowances for non-recoverable losses, the modelling of current management practice as set out in the associated Information Package suggests an AAC of 603,400 m^3/year (a reduction of 17%). This represents a reasonable harvest level that reflects the current physical and legal constraints of the land base, voluntary measures reflecting Western Forest Products' Stewardship and Conservation Plan, and balances short-term timber supply change with long-term sustainable harvest levels. This harvest level is predicated upon a maximum contribution of 503,400 m^3/year from the conventionally operable land base.

The modelling indicates that a minimum of 42,500 ha (34%) of productive forest area will be maintained in old forests (>250 years old) and a minimum of 19,000,000 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 63,062 ha (51% of the productive forest) while 61,923 ha (49%) 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.



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1.1 Background

TFL 19 is located on the west side of Vancouver Island in the vicinity of Nootka Sound (see Figure 1). Communities within or near the TFL include:

- Gold River
- Tsaxana
- Tahsis
- Zeballos
- Ehatis
- Oclugjie

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

- In July 2009, a portion of TFL 19 was deleted via Instrument Number 72 to form part of BCTS' Pacific Timber Supply Area.
- In March 2012, a portion of TFL 19 was deleted via Instrument 73 as part of a land exchange agreement with the provincial government.

The TFL encompasses 171,119 ha of which 63,177 ha are expected to be available for timber production. The allowable annual cut (AAC) for this landbase is currently set at 728,837 m^3 per year. A history of the AAC is provided in the body of Management Plan #11.

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 #11. 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).

The inventory database was current to January 1, 2019 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.

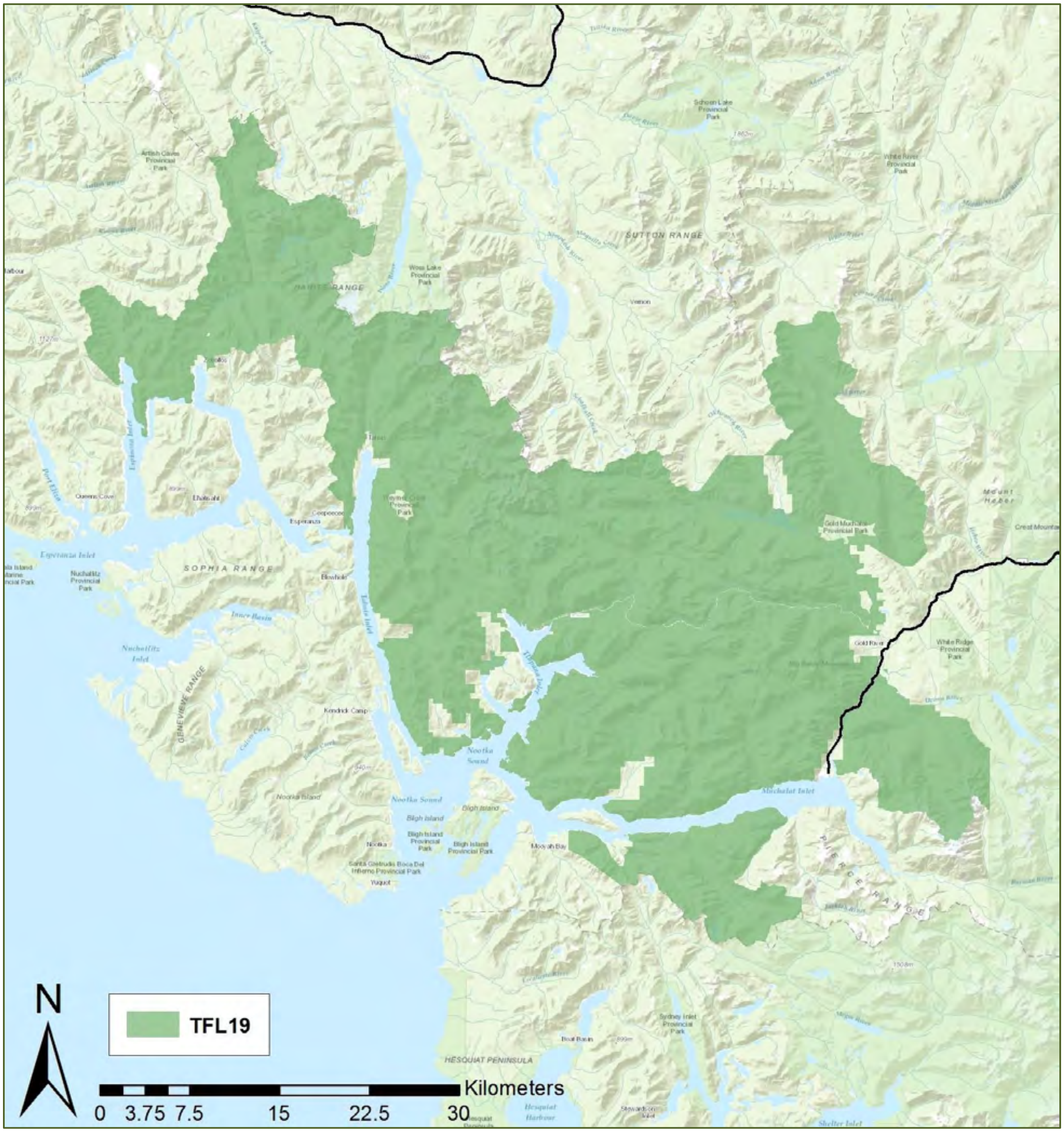

Figure 1 - TFL 19

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 ≤ 12 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.
- Proposed Old Growth Management Areas (OGMAs) for the seven landscape units are removed from the THLB. Mature seral targets are incorporated for the portions of two Special Management Zones within TFL 19.
- 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 two WHAs that were working their way through the approval process at the time the data was prepared.
- 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 2017.
- 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 ten decades subject to no more than a 15% decline in total conventional harvest per decade and maintaining a stable conventionally operable growing stock on the THLB over the final 150 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. A separate stable growing stock constraint was applied to the heli-operable land base over the final 150 years.

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	2019	2028	503,400	100,000	603,400	-17.2%
2	2029	2038	427,890	100,000	527,890	-12.5%
3	2039	2048	363,707	100,000	463,707	-12.2%
4	2049	2058	443,907	47,593	491,500	+6.0%
5 - 9	2059	2108	465,750	47,593	513,343	+4.4%
10 - 15	2109	2168	465,750	63,900	529,650	+3.2%
16 - 25	2169	2268	465,750	69,500	535,250	+1.1%

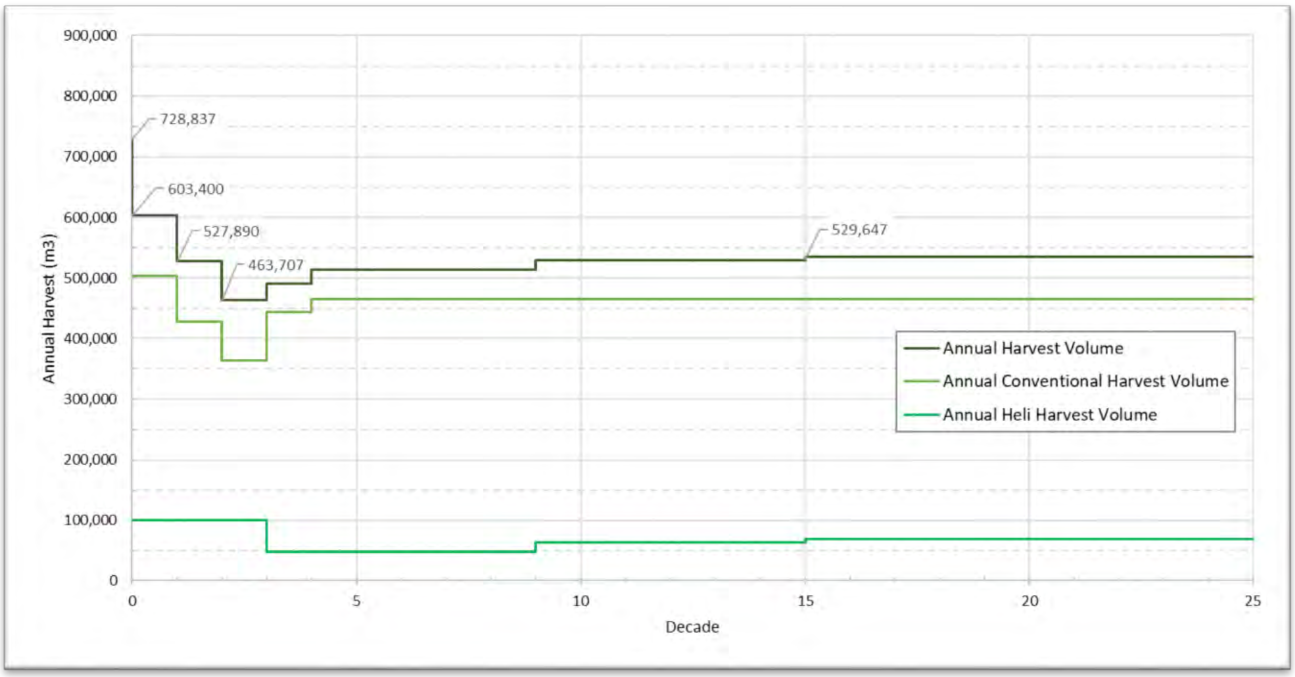

Figure 2 - Base Case Harvest Schedule

The initial harvest level of 603,400 m^3/year is a reduction of 125,437 m^3/year (17.2%) from the current AAC of 728,837 m^3/year. It is comprised of 503,400 m^3/year (83%) from conventionally operable stands and 100,000 m^3/year (17%) from heli operable stands. The projected harvest schedule declines 23.2% over the following 20 years to 463,707 m^3/year through to 2048 before increasing to the current long-term harvest level (LTHL) estimate of 535,250 m^3/year. The mid-term timber supply “dip” in Decades 3 and 4 occurs during the transition from unmanaged to managed second growth stands (see Figure 5), coinciding with a period of minimal harvestable (i.e. meets minimum harvest criteria) inventory (see Figure 8). The total volume harvested over the 250 years is roughly 131.8 million m^3.

Figure 3 compares the MP #11 Base Case to the MP #10 Base Case schedule (2009). The timber supply analysis for MP #10 was conducted prior to AACs being in effect for up to 10 years; hence, it was run in 5-

year periods. Also, and additional 300,000 m³ of harvest was incorporated into the first period to reflect licenses issued to First Nations using unused volume from an earlier cut control period.

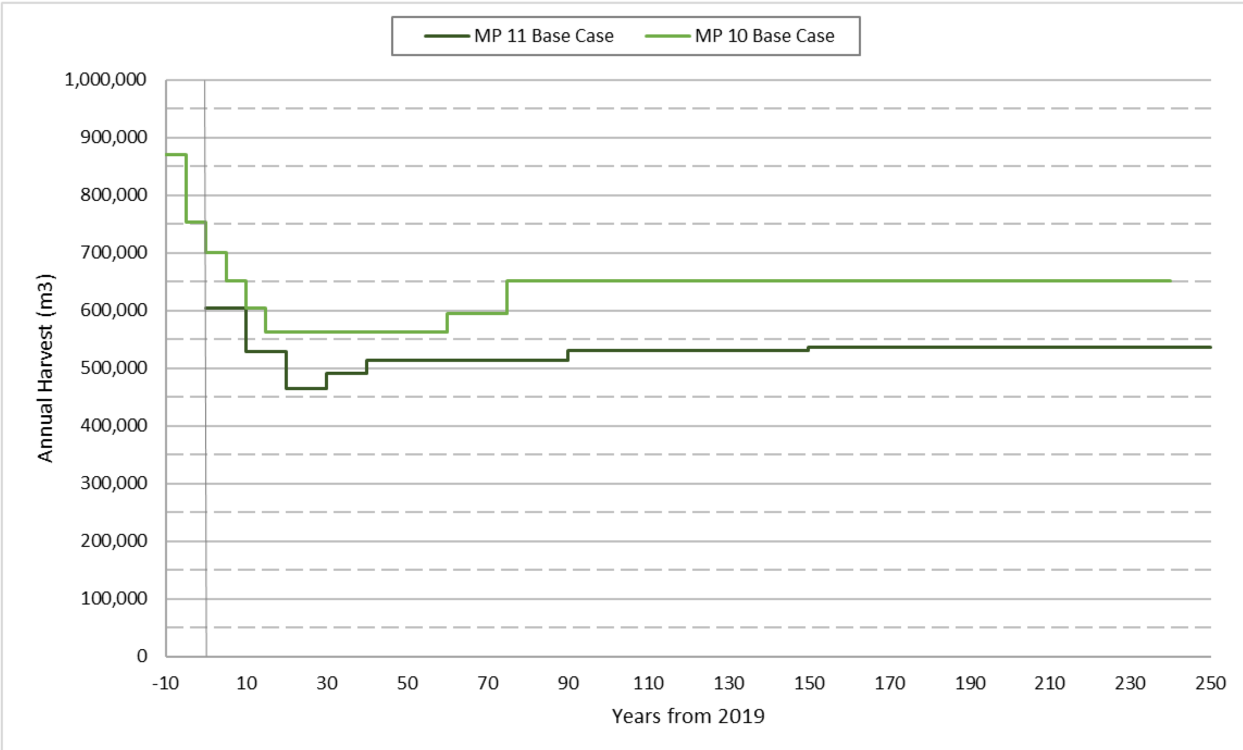

Figure 3 – Comparison to MP #10

Several significant changes in data and assumptions have been made relative to those applied in MP #10. Downward pressure on timber supply results from:

- improved operability and non-productive forest mapping using LiDAR data;
- Spatial netdowns applied for:
  - riparian management zone retention,
  - wildlife tree retention areas,
  - OGMAs,
  - archaeological sites, and
  - application of retention silviculture system;

Upward pressure on timber supply results from:

- improved data regarding site loss to roads and site occupancy within managed stands using LiDAR data;
- increased contribution from the heli-operable land base.

Figure 4 presents the influence each of the above items has on the AAC in moving from the MP #10 AAC determination of 730,000 m³/year to the MP #11 Base Case initial harvest of 603,400 m³/year.

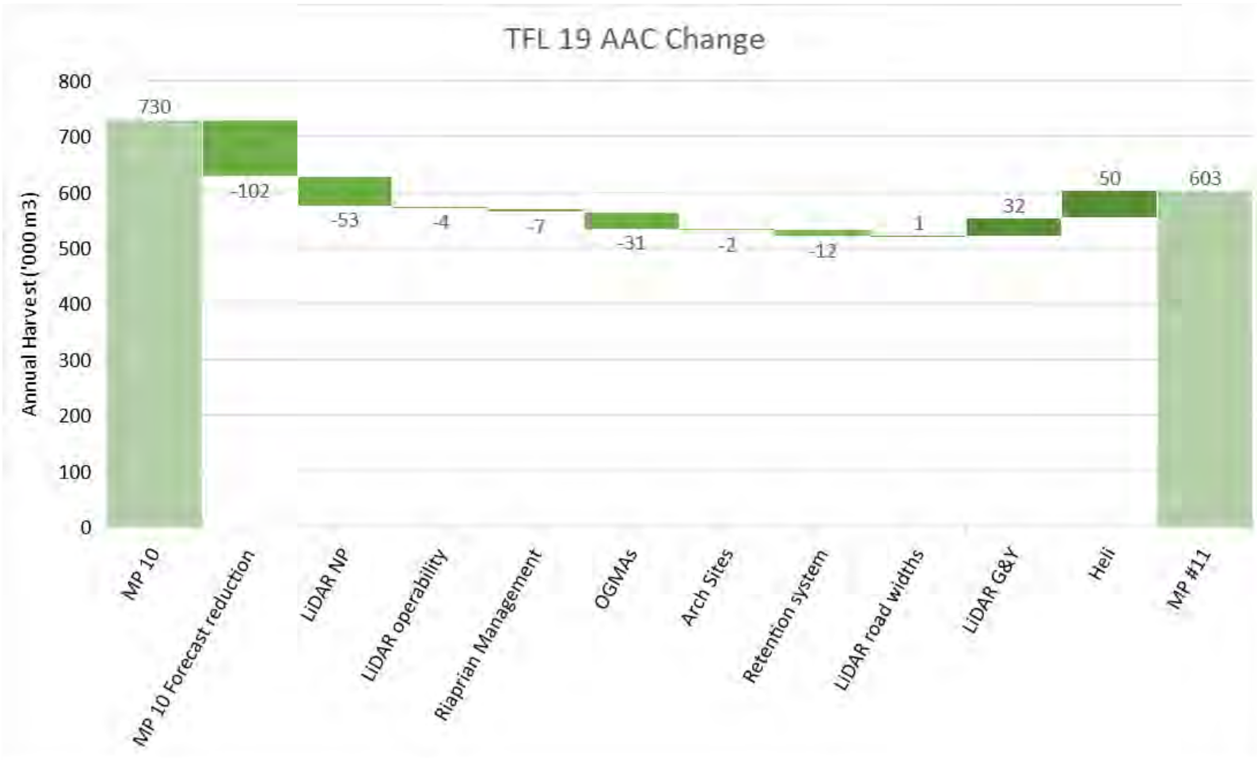

Figure 4 – Timber Supply Impacts of Revised Data and Assumptions

Figure 5 indicates the contribution to the total harvest volume by period from each of the four broad stand eras used to define the analysis units. As expected, current mature stands (greater than 156 years old in 2019 and indicated in dark green) contribute the greatest proportion of volume in the first 15 years. In the subsequent 65 years current managed stands (indicated in medium green) provide the largest proportion of the volume as natural stands harvest continues to decline. Future managed stands (indicated in light green) contribute some volume in the fifth decade (2059 – 2068) and provide the majority of the harvest volume as of the ninth decade (2099 – 2108).

The contribution from current mature stands in decades 21 and 22 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.

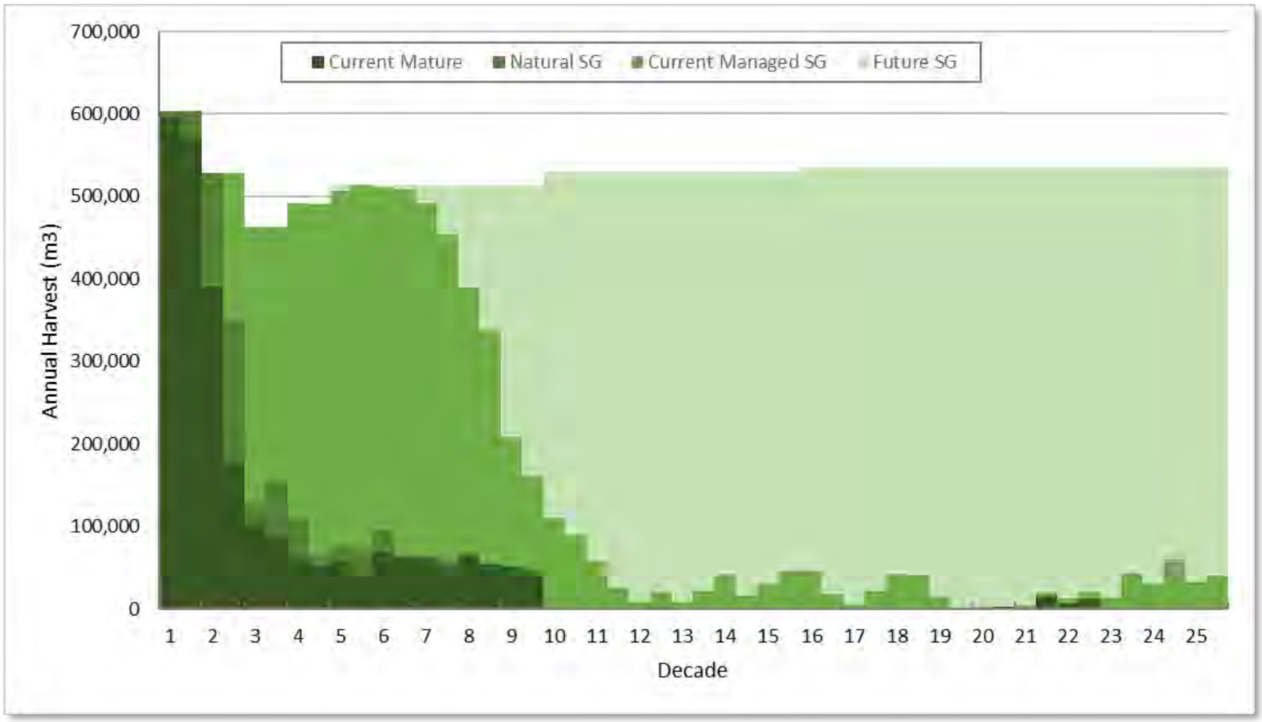

Figure 5 – Stand Eras' contribution to Base Case harvest

Age class distributions over time based on the 5-year age groupings used in Woodstock are examined in Figure 6 and Figure 7. Within the productive forest the oldest age class declines by 12% as harvesting of current old stands occurs and then increases to 116% of the current amount as younger reserved timber ages into the old growth age class (see Figure 6).

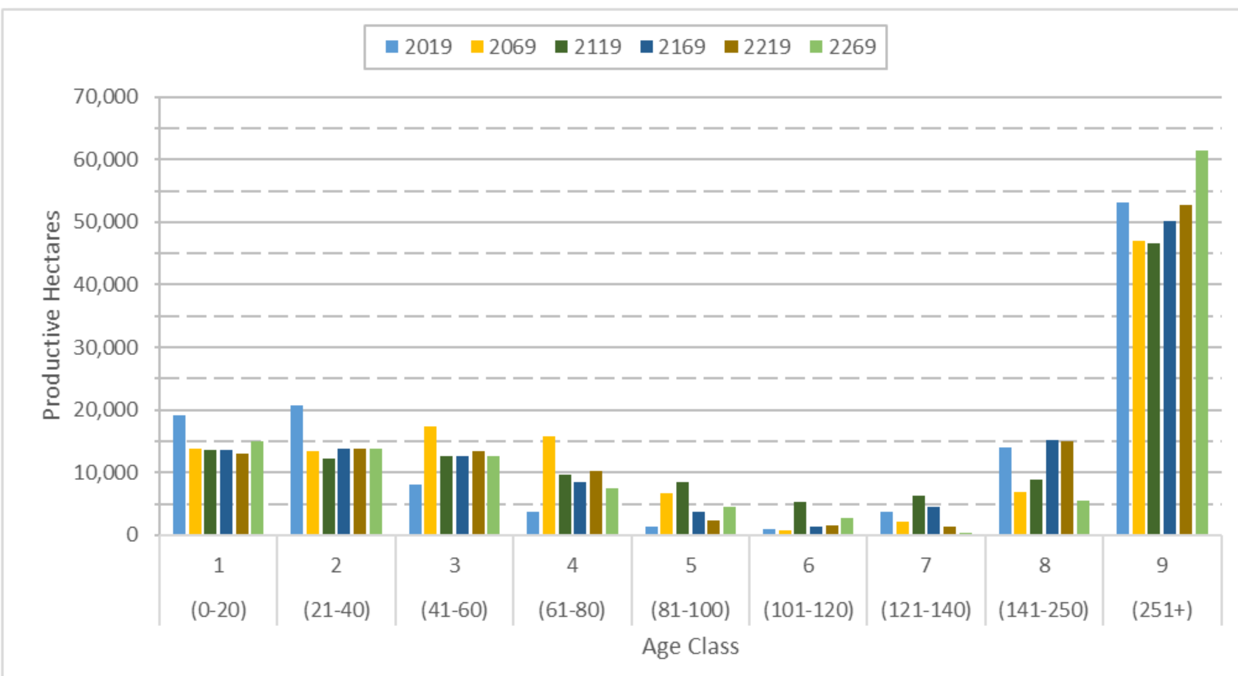

Figure 6 - Age class distribution of productive forest area (124,985 ha)

The total THLB area in Age Classes 1-4 increases initially until a relatively balanced age class distribution is achieved (refer to Figure 7). The THLB age class distribution at the end of the harvest schedule (2269) ensures a sustainable harvest beyond the analysis period is achievable.

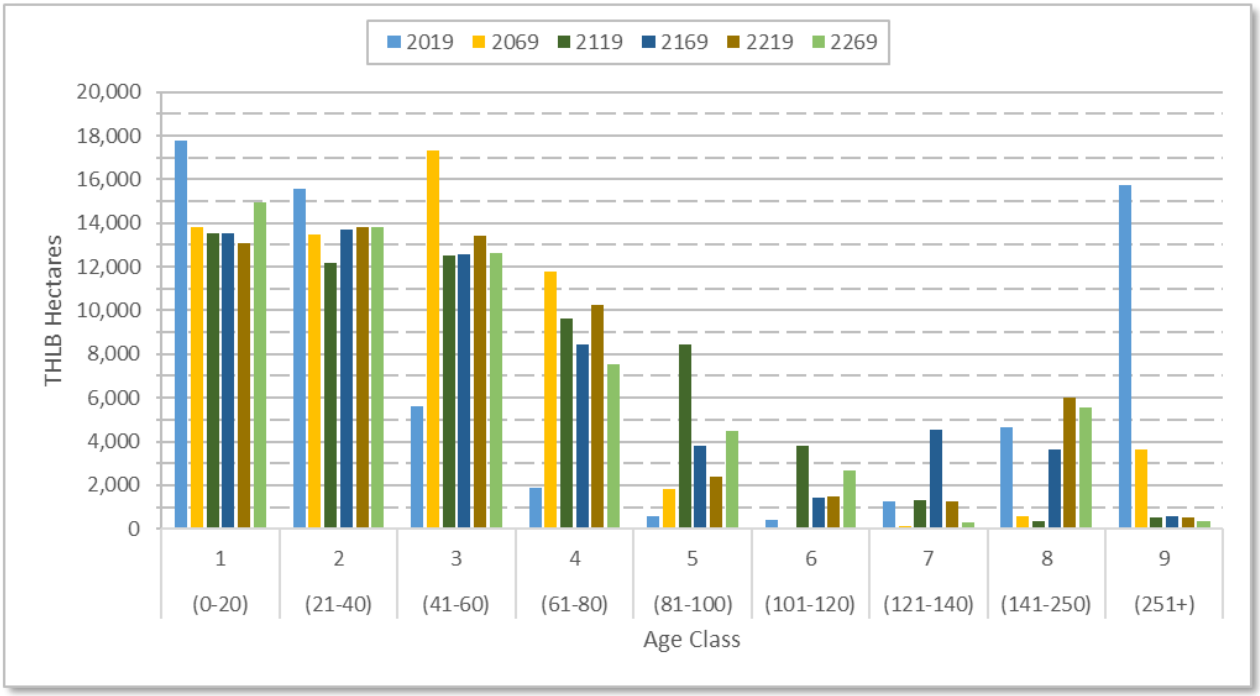

Figure 7 - Age class distribution of timber harvesting land base (63,177 ha)

Figure 8 illustrates harvestable (i.e. meets minimum harvest criteria) and growing stock levels for the timber harvesting land base, including the conventional / heli split.

Total THLB growing stock declines by about 10% over the first 20 years while harvesting of current mature stands is occurring in a significant amount and then returns to approximately 110% of current levels as future stands begin to acquire merchantable volume. Refer to Figure 5 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 23 million m^3. Conventional THLB growing stock declines initially as current mature stands are and as second growth stands begin acquiring merchantable volume, the conventional THLB inventory increases to above current levels and then averages approximately 17.3 million m^3. Heli THLB growing stock initially declines as current stands are harvested and then recovers to a long-term quantity averaging 5.7 million m^3.

Available (i.e. meets minimum harvest criteria) volume begins at 12.9 million m^3 and declines over the first 40 years as mature and existing second growth stands are harvested and replaced with managed stands. Once the transition to future stands is complete, harvestable volume fluctuates between 4 and 6 million m^3, averaging about 4.6 million m^3.

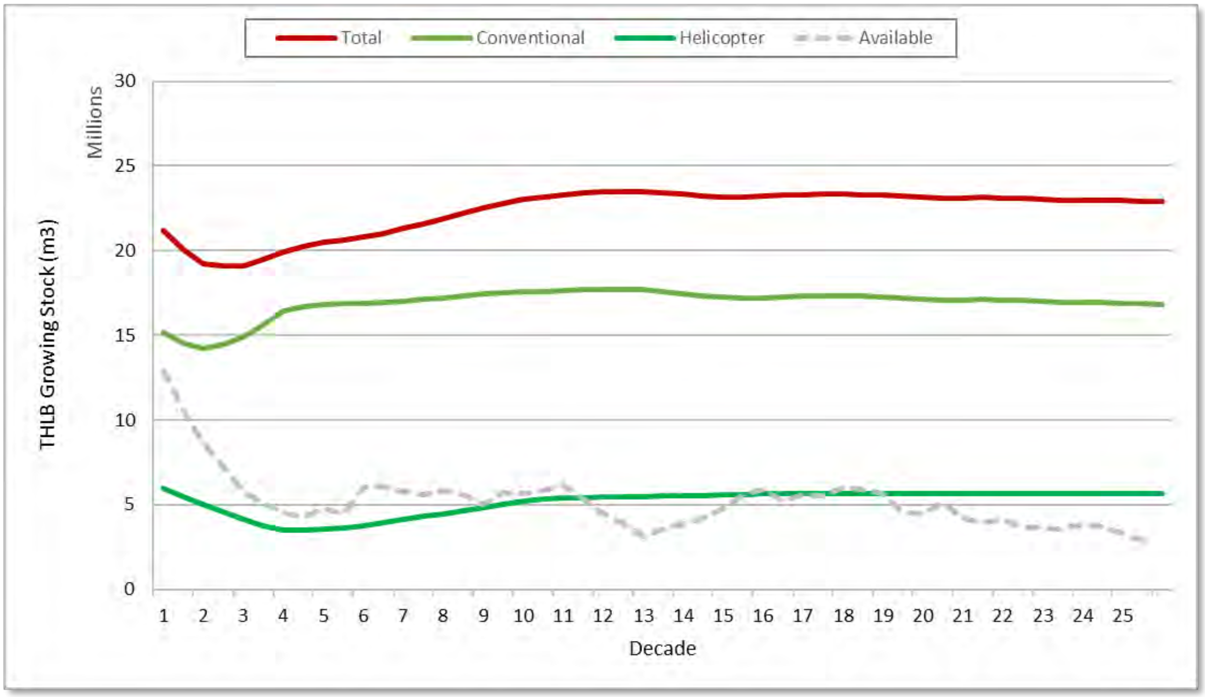

Figure 8 - THLB Growing stock

Figure 9 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 280 years in the immediate future, to 110 years in the mid-term, and to approximately 90 years in the long-term. Annual area harvested generally fluctuates between 600 and 800 hectares and merchantable volume per hectare varies within a range of 700 – 850 m^3/ha.

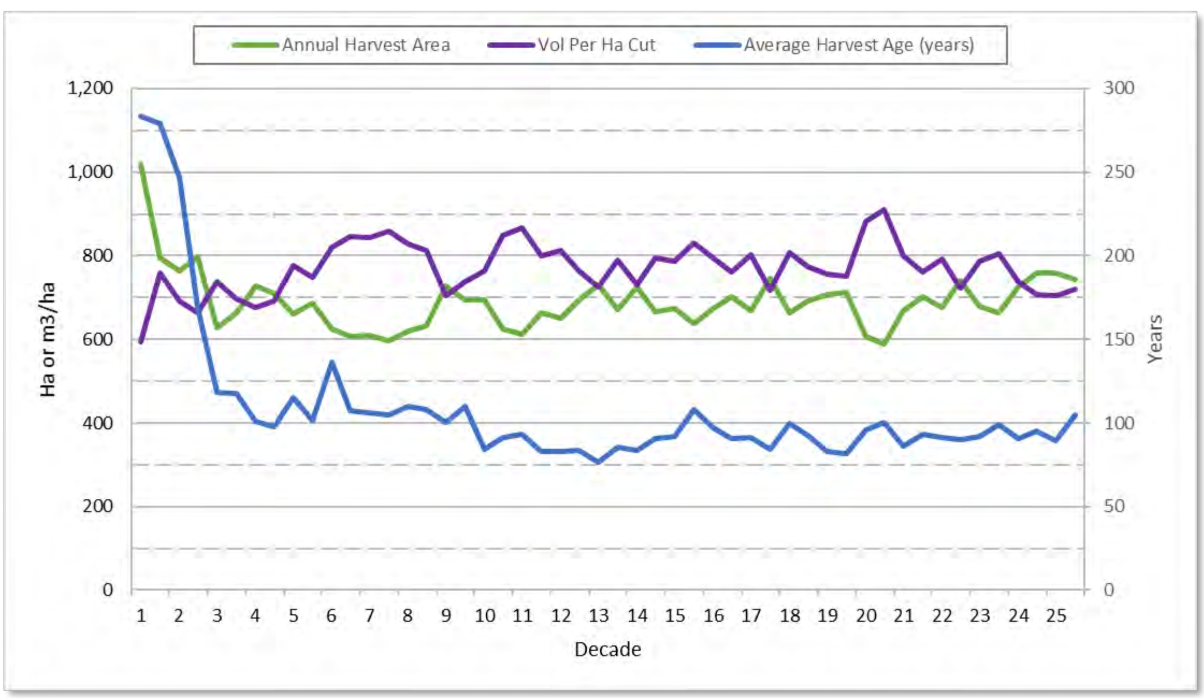

Figure 9 - Harvest Statistics

The contribution to harvest by tree species is presented in Figure 10. In the short-term roughly 55% of the harvest is hemlock and balsam ("HemBal"), with red cedar, yellow cedar and fir contributing roughly 15%, 11% and 18% respectively. Approximately 1% is sourced from other minor coniferous species such as spruce and pine. In the third and fourth decade, HemBal contributes 57% and fir contributes 26% of the harvest, as these species dominate the older current managed stands harvested in this period, with red cedar providing nearly all the rest of the volume. Little yellow cedar is harvested in this period due to lack of its presence in older managed stands.

From the fifth decade to the end of the analysis period, HemBal harvest declines while red and yellow cedar harvest increases due to the species in current young and future managed stands – Hembal decreases from roughly 60% of the total to approximately 30% while red cedar increases from about 15% to about 50%. Fir averages around 15% over this period.

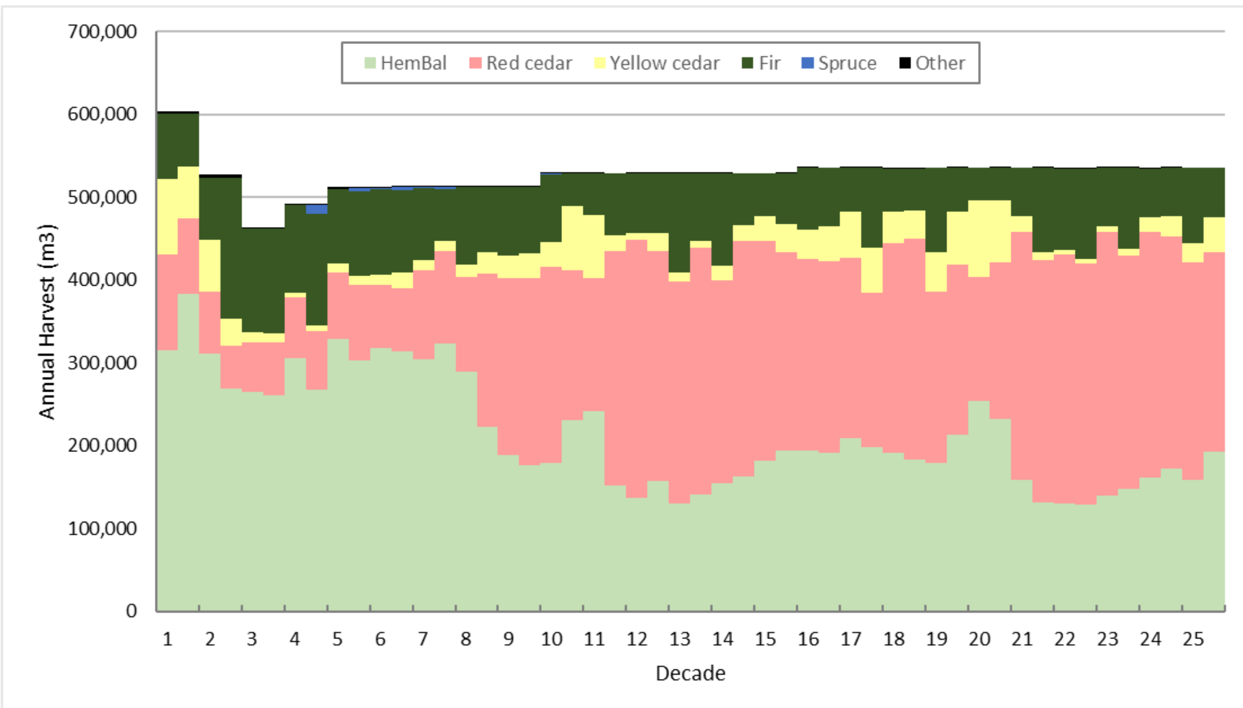

Figure 10 – Species composition of harvest

Section 10.3.2.1 of the Information Package discusses the contribution of immature stands (< 121 years old) to the initial harvest level and proposed that at least 20% of the initial harvest be sourced from these stands to model the implications of seasonal constraints associated with elevation and snow during the winter and early spring. Elevation ranges of less than 300m (generally operable year-round), 300m – 800m (generally operable from spring to early winter) and greater than 800m (generally only operable summer to early winter) are incorporated into the model. Initial model runs did not include a minimum harvest contribution constraint and reviewing the harvest distribution by elevation range indicated there is enough timber supply available in the low elevation range (<300m) to meet the intent of the proposed 20% contribution of immature stands. Therefore, the constraint for minimum contribution from immature stands is not applied; nor is completion of the planned sensitivity analysis applying seasonal constraints.

Figure 11 presents the percentage of the Base Case harvest across the three elevation ranges. Harvest from the low elevation averages 21% in the first decade and exceeds 20% in all decades except Decade 20 (2209-2218), when it averages 15%.

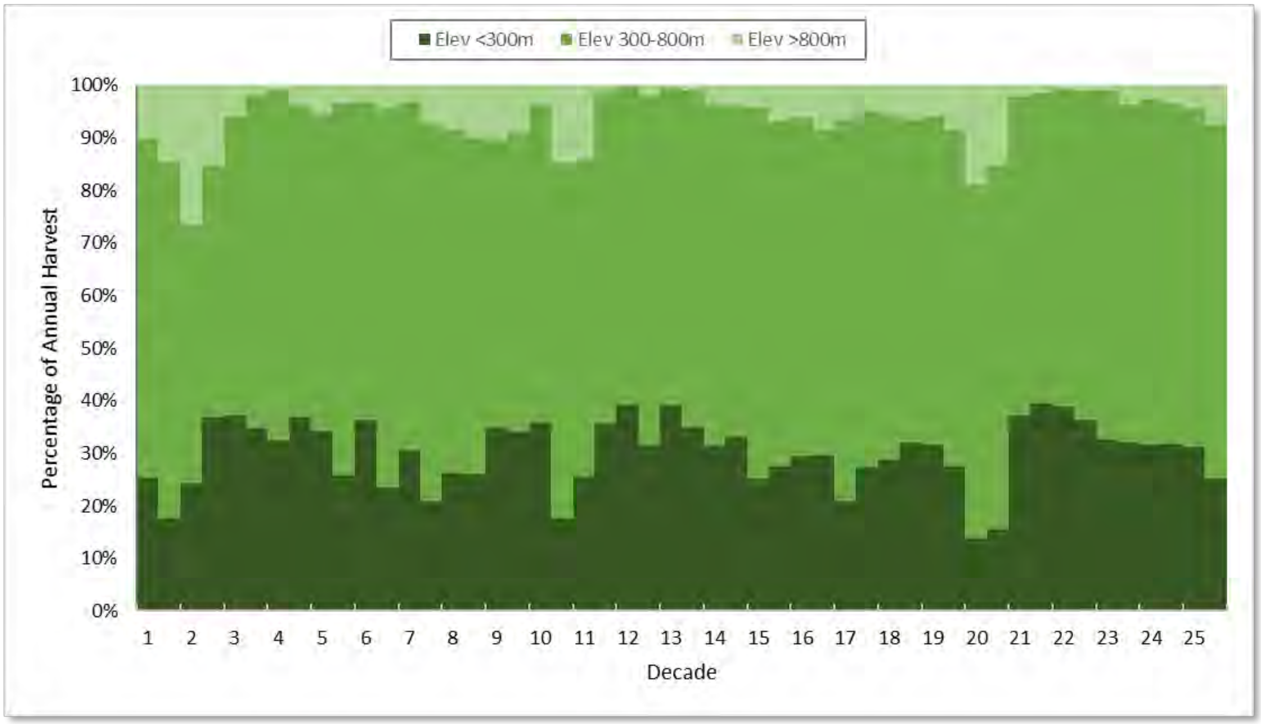

Figure 11 – Harvest percentage by elevation range

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 19 there is a significant volume of cedar.

Figure 12 indicates the estimated volume 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.

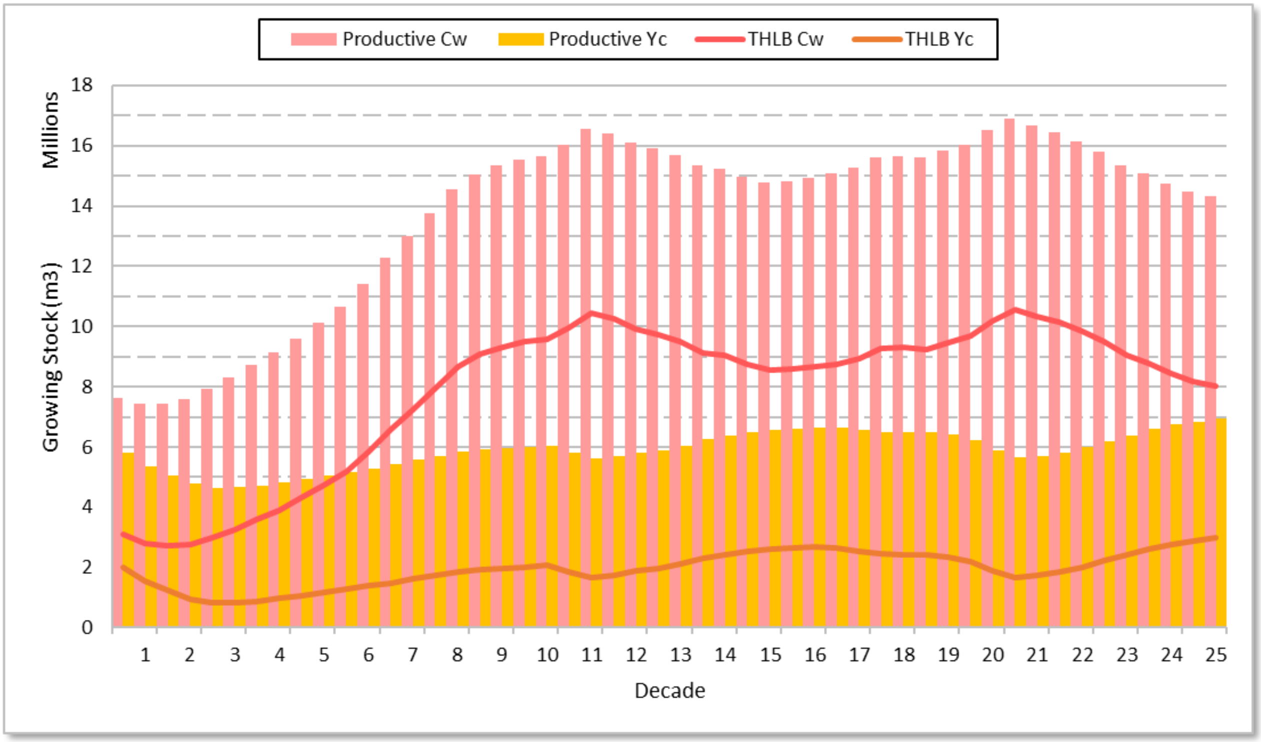

Figure 12 – Base Case cedar volume estimates over time

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 25%; however the volume never falls below 3.7 million m^3 (2.7 million m^3 of Cw and 1.0 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 in Decades 3 and 4 in Figure 10.

By the start of the third decade (2039 - 2048) cedar volumes begin to recover as managed stands with significant Cw and Yc components begin to acquire volume (see Tables 38 and 39 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 30 years and averages in excess of 20 million m^3 from then until the end of the schedule.

Figure 13 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 nearly 8 million m^3. In 200 years, the amount of old cedar begins to increase steadily as today's reserved young stands age beyond 250 years.

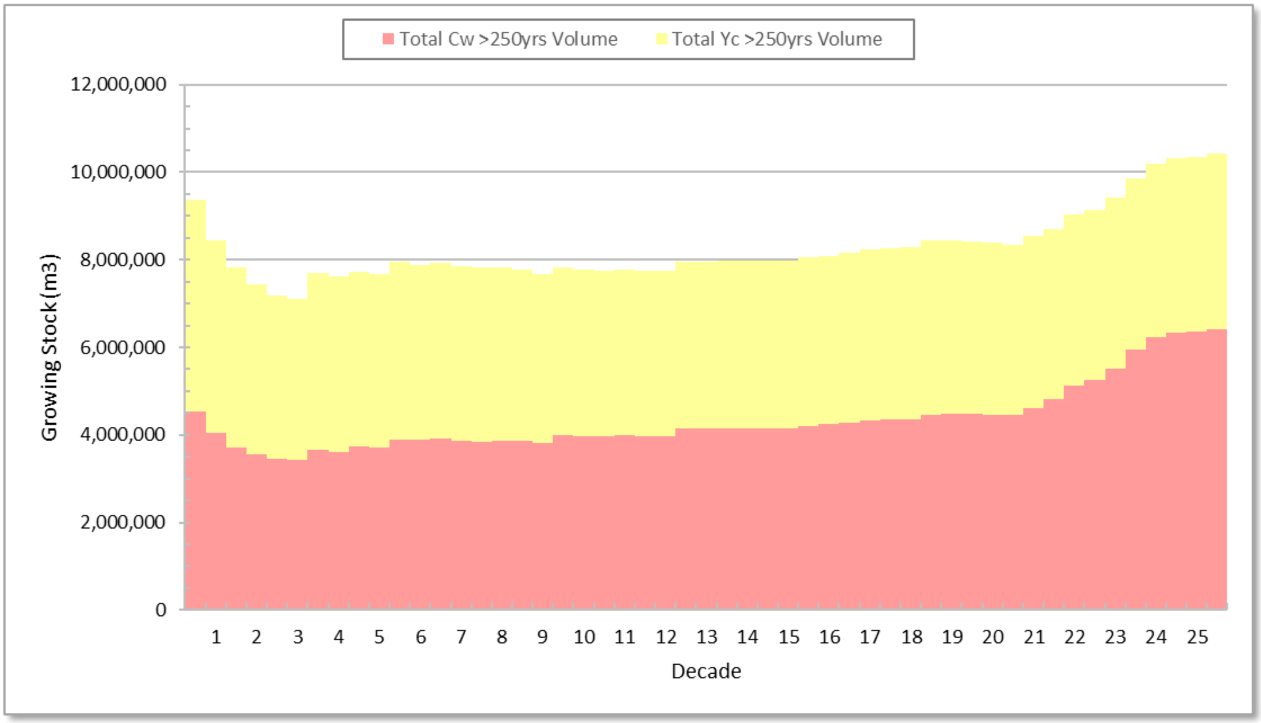

Figure 13 – Volume of cedar greater than 250 years old in productive forest

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 14 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	2019	2028	603,400	728,800	125,400	+20.8%
2	2029	2038	527,890	583,000	55,110	+10.4%
3	2039	2048	463,707	466,400	2,693	+0.6%
4	2049	2058	491,500	412,800	-78,700	-16.0%
5	2059	2068	513,343	475,200	-38,143	-7.4%
6 - 9	2069	2108	513,343	511,300	-2,043	-0.4%
10 - 15	2109	2168	529,650	527,500	-2,150	-0.4%
16 - 25	2169	2268	535,250	527,500	-7,750	-1.4%

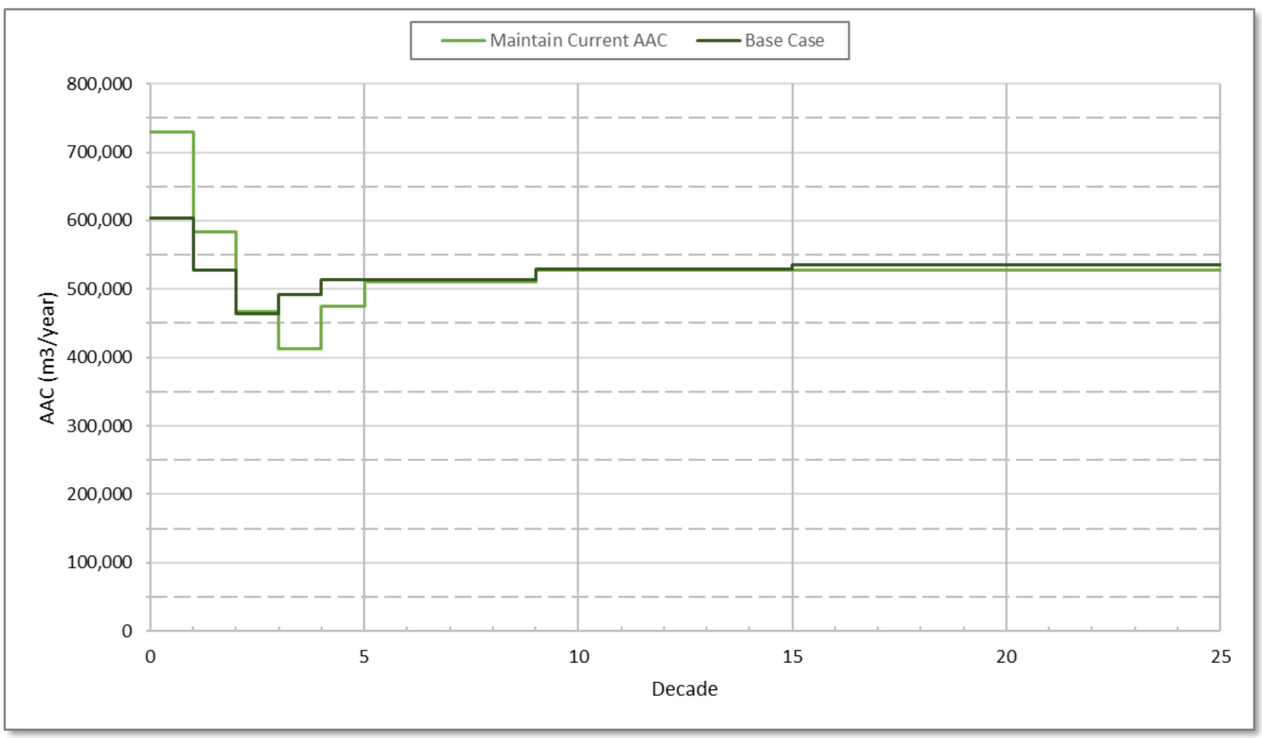

Figure 14 – Harvest levels with maintaining current AAC

The results indicate that maintaining the current AAC for an additional 10 years requires 20% harvest reductions in the second and third decade rather than 12.5% in the Base Case. Harvest in the fourth and fifth decades are 16% and 7.4% less than the Base Case respectively. Harvest in decades 6-25 is marginally lower than the Base Case.

Short-term harvest is more reliant on contribution from heli-operable stands, with 184,100 m^3/year required in the first decade and 232,500 m^3/year in the second compared to 100,000 m^3/year in the Base Case.

Over the 250 years, a total of 0.3 million m^3 (0.2%) less is harvested.

An alternative schedule was developed whereby the current AAC is maintained for only 5 years; Table 3 and Figure 15 present this schedule and Figure 15 includes the above schedule for comparison.

Table 3 - Harvest levels with maintaining current AAC for 5 years

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Maintain Current AAC for 5 years	Difference	% Difference
1	2019	2028	603,400	712,500	109,100	+18.1%
2	2029	2038	527,890	591,800	63,910	+12.1%
3	2039	2048	463,707	503,000	39,293	+8.5%
4	2049	2058	491,500	427,500	-64,000	-13.0%
5	2059	2068	513,343	421,800	-91,453	-17.8%
6 - 9	2069	2108	513,343	505,700	-7,643	-1.5%
10 - 15	2109	2168	529,650	525,400	-4,250	-0.8%
16 - 25	2169	2268	535,250	525,400	-9,850	-1.8%

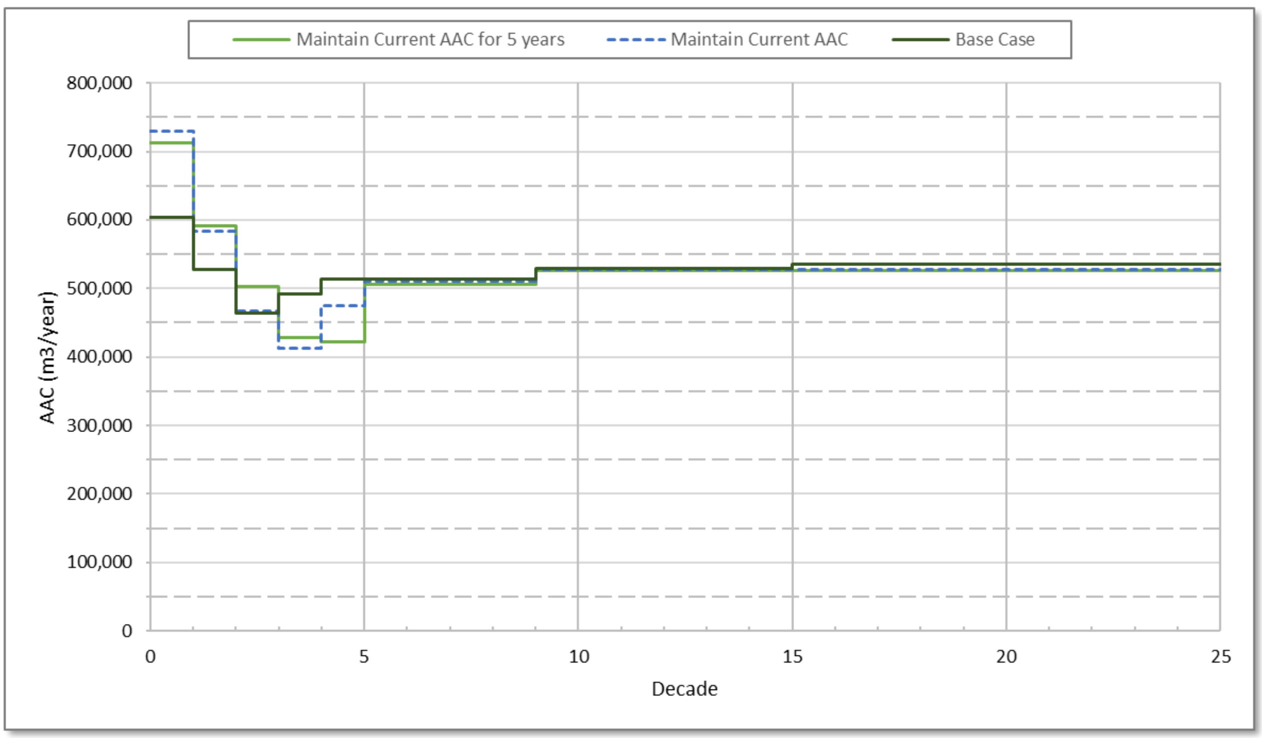

Figure 15 – Harvest levels with maintaining current AAC for 5 years

Harvest in the first 5 years is 728,800 m^3/year and 696,200 m^3/year in the second 5 years (4% decline), for an average of 712,500 m^3/year for the decade. Harvest declines 15% per decade for the following three decades, to a low of 421,800 m3/year in the fifth decade. The higher harvest level in Decades 2-4 (relative to maintain the current AAC for 10 years) delays the beginning of recovery in harvest level by one decade, to Decade 6.

Again, short-term harvest is heavily reliant on contribution from heli-operable stands, with 270,800 m³/year required in the first decade and 127,000 m³/year in the second compared to 100,000 m³/year in the Base Case.

Over the 250 years, a total of 0.9 million m³ (0.7%) less is harvested than in the Base Case.

3.2 Non-declining even flow

Table 4 and Figure 16 show the impact of immediately dropping to a non-declining even flow (NDEF) harvest level when no constraint is applied to the contribution from the heli-operable land base.

Table 4 – Harvest levels with non-declining even flow

Period	Start	End	Annual Harvest Volume (m³)			
(Decade #)	Year	Year	Base Case	NDEF	Difference	% Difference
1	2019	2028	603,400	532,800	-70,600	-11.7%
2	2029	2038	527,890	532,800	4,910	0.9%
3	2039	2048	463,707	532,800	69,093	14.9%
4	2049	2058	491,500	532,800	41,300	8.4%
5 - 9	2059	2108	513,343	532,800	19,457	3.8%
10 - 15	2109	2168	529,650	532,800	3,150	0.6%
16 - 25	2169	2268	535,250	532,800	-2,450	-0.5%

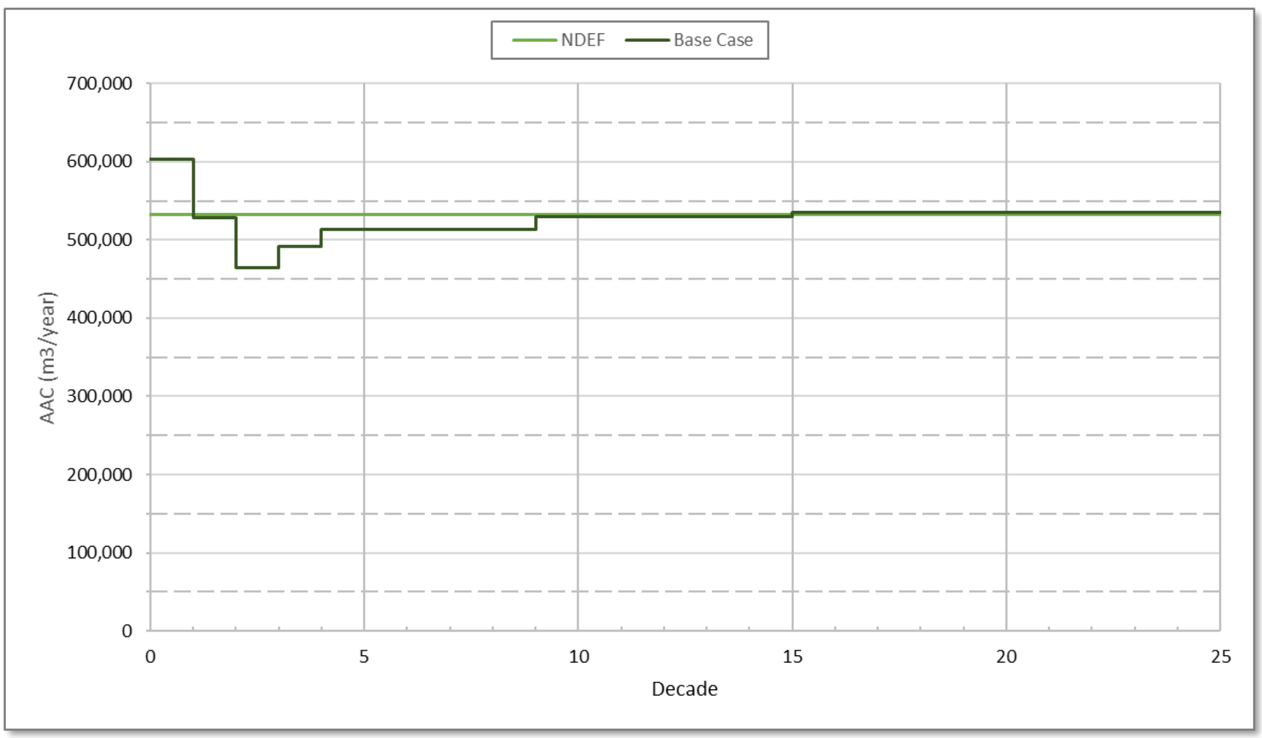

Figure 16 – Harvest levels with non-declining even flow

Short term harvest levels are significantly lower than the Base Case when a NDEF criteria is applied, resulting in a 27% reduction in harvest from the current AAC. Like the scenarios run exploring maintenance of the current AAC, short-term harvest is heavily reliant on contribution from the heli-operable land base:

162,600 m³/year in the first decade and 185,300 m³/year in the second decade. Over the 250 years, a total of 1.36 million m³ (1.0%) more is harvested.

To moderate the contribution of the heli-operable land base, an alternative scenario was constructed to include an even heli partition throughout the analysis period (refer to Table 5 and Figure 17). This resulted in a conventional harvest of 439,700 m³/year and heli harvest of 54,200 m³/year for a total harvest of 493,900 m³/year – 32% less than the current AAC and 18% less than the initial harvest level of the Base Case.

Table 5 – Harvest levels with non-declining even flow and heli partition

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m³) Base Case	NDEF	Difference	% Difference
1	2019	2028	603,400	493,900	-109,500	-18.1%
2	2029	2038	527,890	493,900	-33,990	-6.4%
3	2039	2048	463,707	493,900	30,193	6.5%
4	2049	2058	491,500	493,900	2,400	0.5%
5 - 9	2059	2108	513,343	493,900	-19,443	-3.8%
10 - 15	2109	2168	529,650	493,900	-35,750	-6.7%
16 - 25	2169	2268	535,250	493,900	-41,350	-7.7%

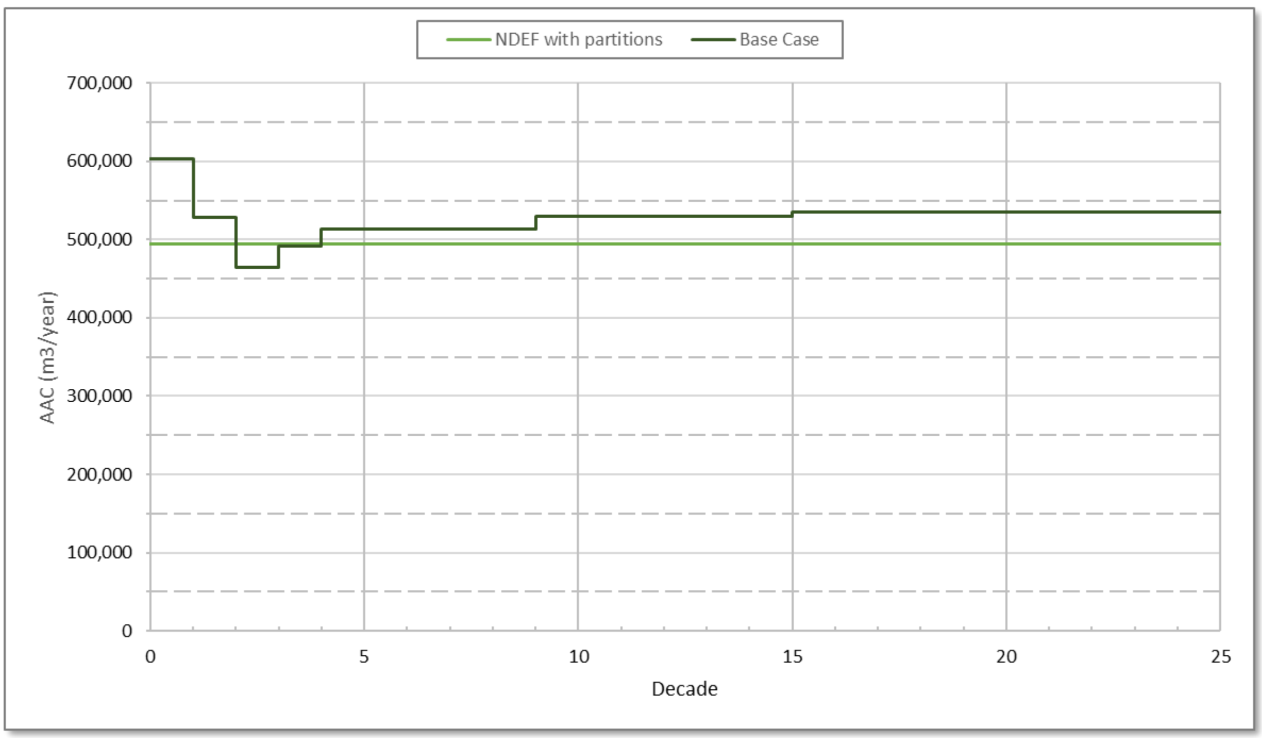

Figure 17 – Harvest levels with non-declining even flow and heli partition

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 6 – Current Management Sensitivity Analyses

Issue	Sensitivity tested summary	Section
Landbase available for harvesting	▪ Exclude marginally economic stands	4.1
Growth and Yield	▪ Natural stands yields underestimated by 10%	4.2
	▪ Natural stands yields overestimated by 10%	4.3
	▪ Managed stands yields underestimated by 10%	4.4
	▪ Managed stands yields overestimated by 10%	4.5
	▪ Static old yields	4.6
Operability	▪ No heli volume constraint	4.7
	▪ Exclude helicopter operable land base	4.8
Minimum harvest criteria	▪ Decrease minimum harvest DBH by 2 cm	4.9
	▪ Increase minimum harvest DBH by 2 cm	4.10
	▪ 95% culmination mean annual increment	4.11
Forest management / Climate Change	▪ Exclude future genetic gain adjustments	4.12
	▪ ECA limits on entire Tahsis and McKelvie watersheds	4.13
	▪ Tahsis Landscape Unit reserves to address forthcoming Marbled Murrelet order	4.14
	▪ Predicted future biogeoclimatic subzone boundaries	4.15
Unused Volume	▪ 2007-2011 unused volume disposition	**Error! Reference**
Summary	▪ Summary of sensitivity impacts	4.17

4.1 Exclude Marginally Economic Stands

As detailed in Section 6.13 of the Information Package, a portion of the heli-operable THLB is assumed marginally economic. This scenario tests the timber supply impact of removing these stands from the THLB. Removing these stands reduces the THLB area by 996 ha (1.6%) and the initially available THLB volume by 0.51 million m3 (4.0%) or 10.9% of the initially available heli-operable THLB volume.

Table 7 and Figure 18 indicate the results of excluding the marginally economic lands from the TFL.

Table 7 – Harvest levels excluding Marginally Economic Stands

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Exclude Marg Econ	Difference	% Difference
1	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	527,890	0	0.0%
3	2039	2048	463,707	463,707	0	0.0%
4	2049	2058	491,500	480,800	-10,700	-2.2%
5 – 8	2059	2098	513,343	502,600	-10,743	-2.1%
9	2099	2108	513,343	514,800	1,457	0.3%
10 - 15	2109	2168	529,650	523,000	-6,650	-1.3%
16 - 25	2169	2268	535,250	526,900	-8,350	-1.6%

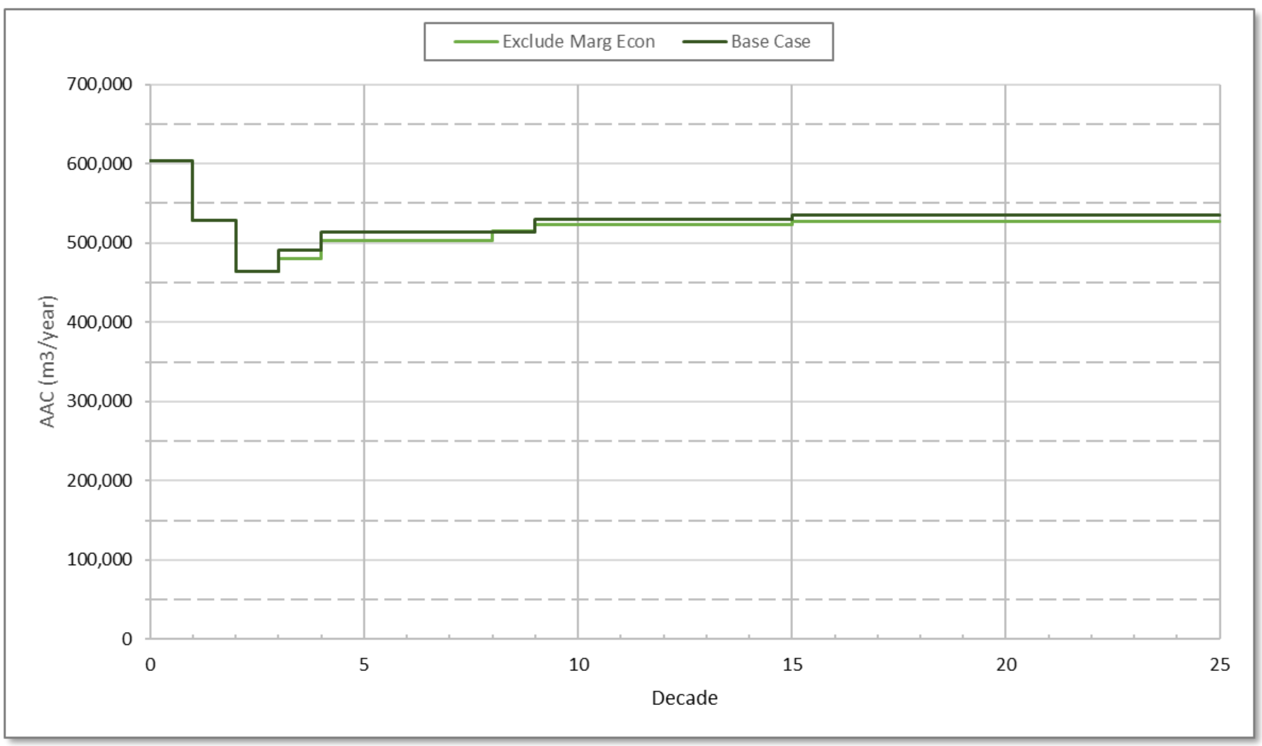

Figure 18 – Harvest levels with Marginally Economic Stands removed

Timber supply is not affected in the first 30 years and then is reduced by a little more than 1.3% over the balance of the schedule. Given the Base Case starts with 4.68 million m^3 of available heli-operable inventory and harvests 100,000 m3/year for the first 30 years, it's logical to not see a timber supply impact until the fourth decade of removing 0.51 million m^3 of inventory.

4.2 Natural stands yields underestimated by 10%

The sensitivity of timber supply to natural stands (older than 57 years) volume estimates is tested by increasing (this Section) and decreasing (Section 4.3) these volumes by 10%. The volumes in these stands are 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 1.6 million m^3 (7.5%) more inventory on the THLB today when compared to the Base Case, of which nearly 1.3 million m^3 is available immediately (i.e. meets minimum harvest criteria). Table 8 and Figure 19 indicate the results of starting at the Base Case initial harvest level and using the additional inventory to increase mid-term timber supply.

Table 8 – Harvest levels with increased natural stands yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Increased Natural Yields	Difference	% Difference
1	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	533,400	5,510	1.0%
3	2039	2048	463,707	533,400	69,693	15.0%
4	2049	2058	491,500	523,300	31,800	6.5%
5 - 9	2059	2108	513,343	523,300	9,957	1.9%
10 - 15	2109	2168	529,650	530,800	1,150	0.2%
16 - 25	2169	2268	535,250	536,800	1,550	0.3%

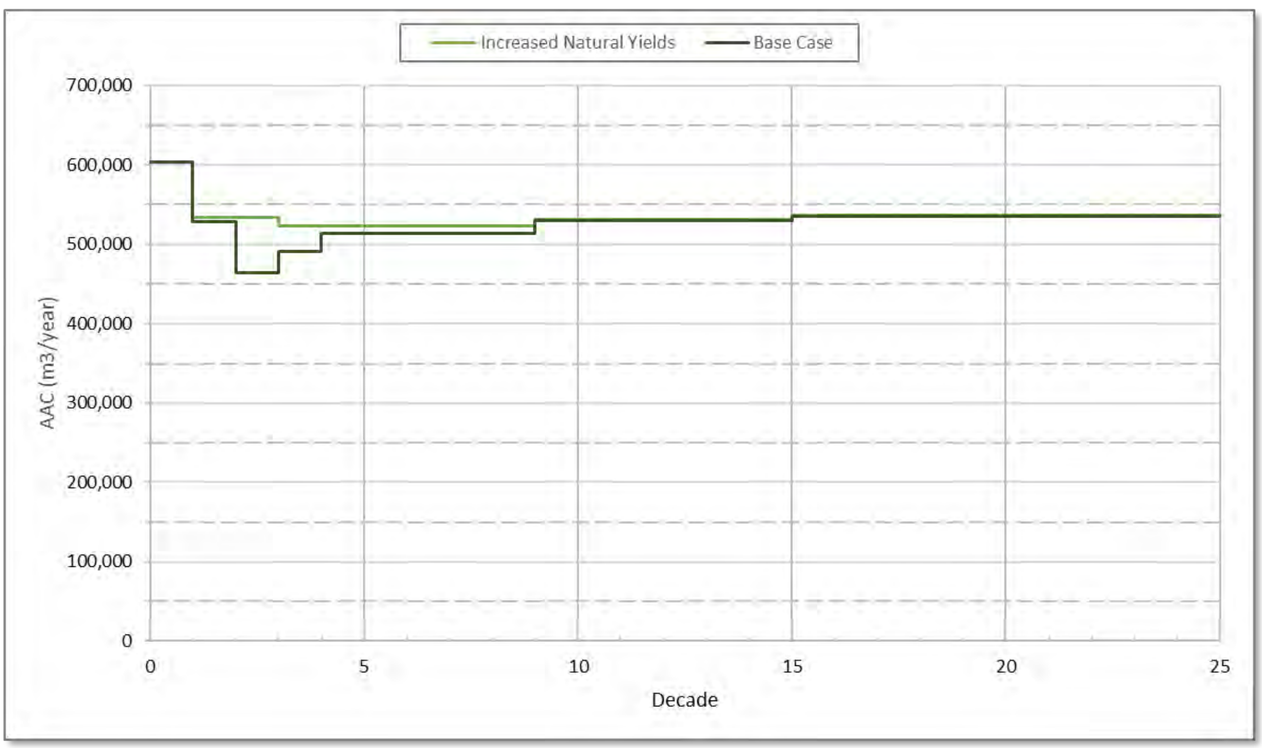

Figure 19 – Harvest levels with increased natural stands yields

The increased natural stands volume not only eliminates the timber supply shortfall in Decades 3 and 4, but also delays the transition to current managed stands, allowing for increased harvest in Decades 5 – 9. Total harvest over the entire 250 years is 1.8 million m^3 (1.4%) more than the Base Case.

4.3 Natural stands yields overestimated by 10%

A decrease of 10% in natural yields results in approximately 1.6 million m^3 (7.5%) less inventory on the THLB today when compared to the Base Case. Table 9 and Figure 20 indicate that with decreased unmanaged yields short and mid-term harvest levels are affected.

Table 9 – Harvest levels with decreased natural stands yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Decreased Natural Yields	Difference	% Difference
1	2019	2028	603,400	585,800	-17,600	-2.9%
2	2029	2038	527,890	512,900	-14,990	-2.8%
3	2039	2048	463,707	451,000	-12,707	-2.7%
4	2049	2058	491,500	370,900	-120,600	-24.5%
5	2059	2068	513,343	420,900	-92,443	-18.0%
6	2069	2078	513,343	478,400	-34,943	-6.8%
7 - 8	2079	2098	513,343	515,000	1,657	0.3%
9	2099	2108	513,343	520,700	7,357	1.4%
10 - 15	2109	2168	529,650	541,200	11,550	2.2%
16 - 25	2169	2268	535,250	546,300	11,050	2.1%

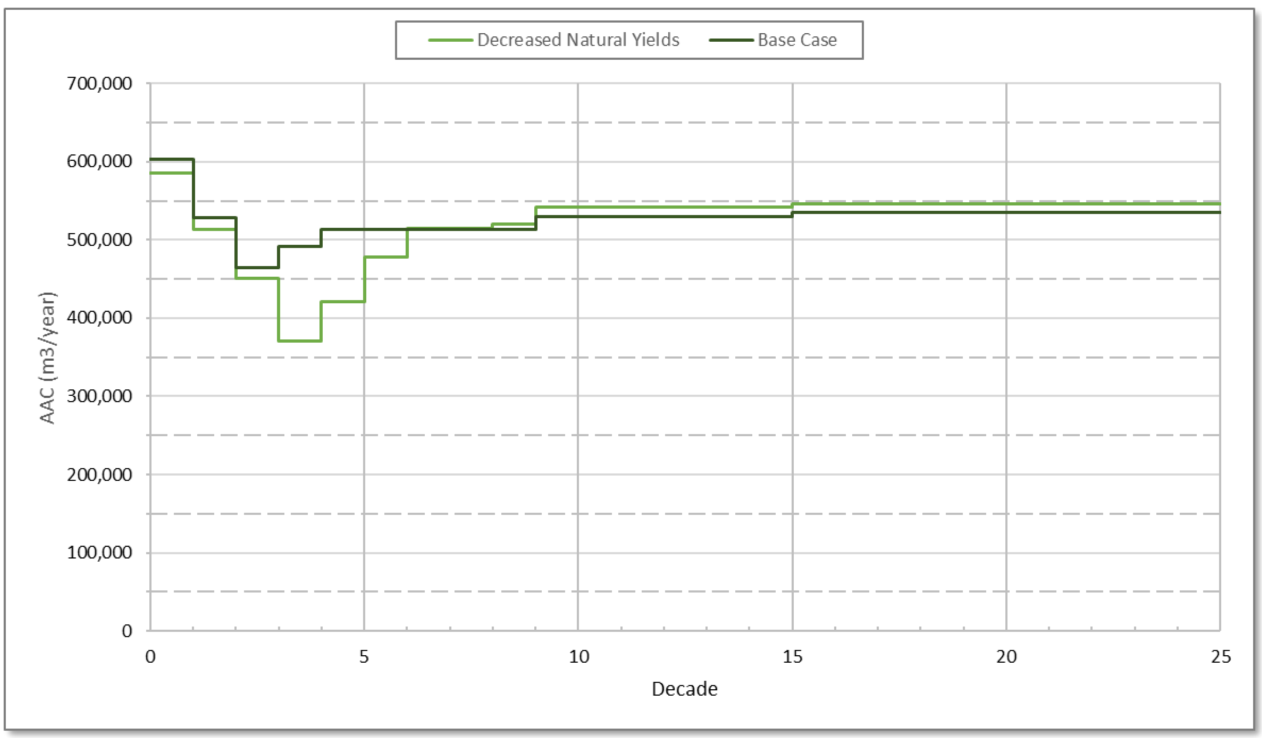

Figure 20 – Harvest levels with decreased natural stands yields

Natural stands provide the entire volume in the first decade of the Base Case harvest schedule and approximately 83% of the second decade (refer to Figure 5). With reduced natural yields and limiting conventional harvest decline to 15% per decade, short and mid-term harvest is roughly 2.8% lower than the Base Case (see Figure 19). The reduced mid-term harvest level delays the transition to managed stands, allowing these stands to achieve greater volumes and thereby increasing long-term harvest by about 2%.

This scenario results in approximately 1.02 million m^3 (0.8%) less harvest than in the Base Case over the 250 year planning horizon.

4.4 Managed stands yields underestimated by 10%

The sensitivity of timber supply to managed stands (younger than 58 years) volume estimates is tested by increasing (this Section) and decreasing (Section 4.5) these volumes by 10%. Volumes in these younger stands are 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 0.53 million m^3 (2.5%). The harvest schedule in Table 10 and Figure 21 indicates that harvest levels could be greater after two decades.

Table 10 – Harvest levels with increased managed stands yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Increased Managed Yields	Difference	% Difference
1	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	527,890	0	0.0%
3	2039	2048	463,707	510,900	47,193	10.2%
4	2049	2058	491,500	520,100	28,600	5.8%
5 - 9	2059	2108	513,343	560,300	46,957	9.1%
10 - 15	2109	2168	529,650	582,900	53,250	10.1%
16 - 25	2169	2268	535,250	589,000	53,750	10.0%

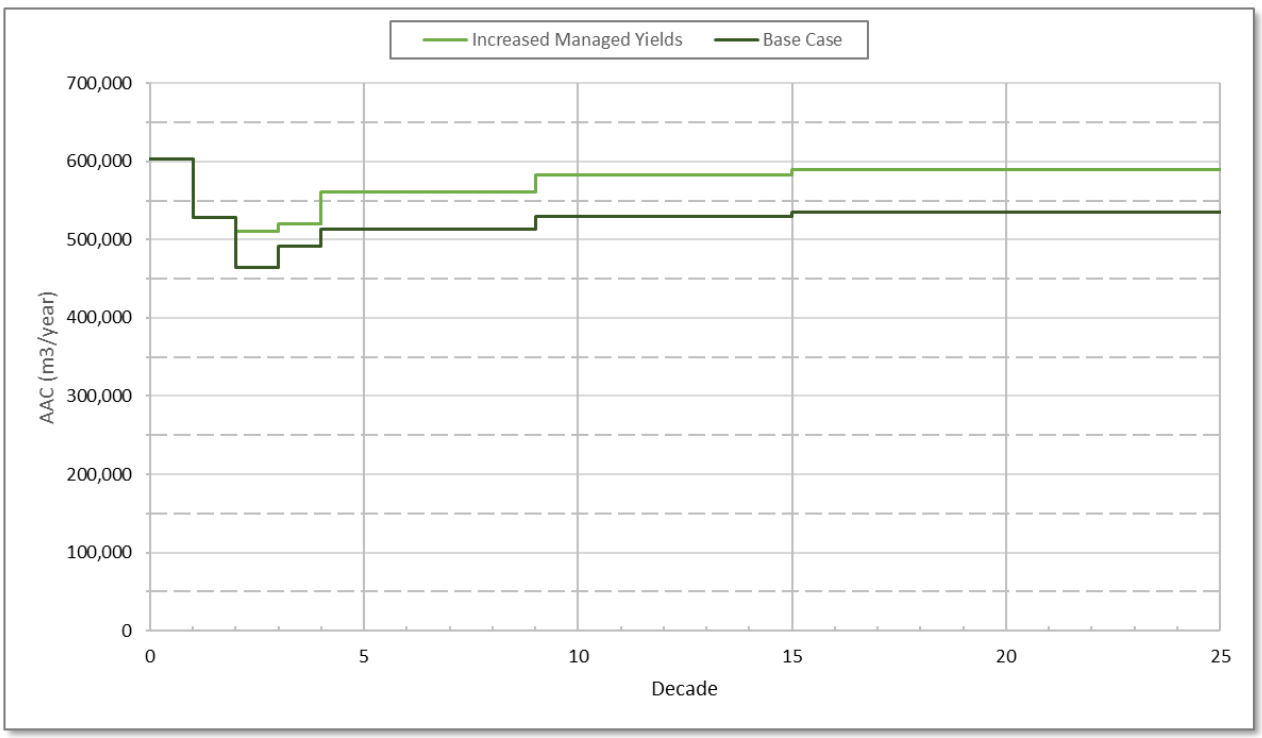

Figure 21 – Harvest levels with increased managed stands yields

Short-term harvest cannot be increased due to minimum harvest criteria; however, mid-term harvest levels need not decline as significantly to allow the transition to the higher long-term harvest levels (relative to the Base Case schedule). Over the entire 250-year planning horizon, 11.68 million m^3 (8.9%) more is harvested in this sensitivity.

4.5 Managed stands yields overestimated by 10%

With managed stands yields decreased by 10%, initial THLB inventory is reduced by 0.98 million m³ (3.4%). The harvest schedule in Table 11 and Figure 22 indicates that harvest levels would need to be reduced after the first decade.

Table 11 – Harvest levels with decreased managed stands yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m³)			% Difference
			Base Case	Decreased Unmanaged Yields	Difference	
1	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	502,700	-25,190	-4.8%
3	2039	2048	463,707	450,900	-12,807	-2.8%
4	2049	2058	491,500	451,100	-40,400	-8.2%
5 - 9	2059	2108	513,343	467,100	-46,243	-9.0%
10 - 15	2109	2168	529,650	477,000	-52,650	-9.9%
16 - 25	2169	2268	535,250	482,100	-53,150	-9.9%

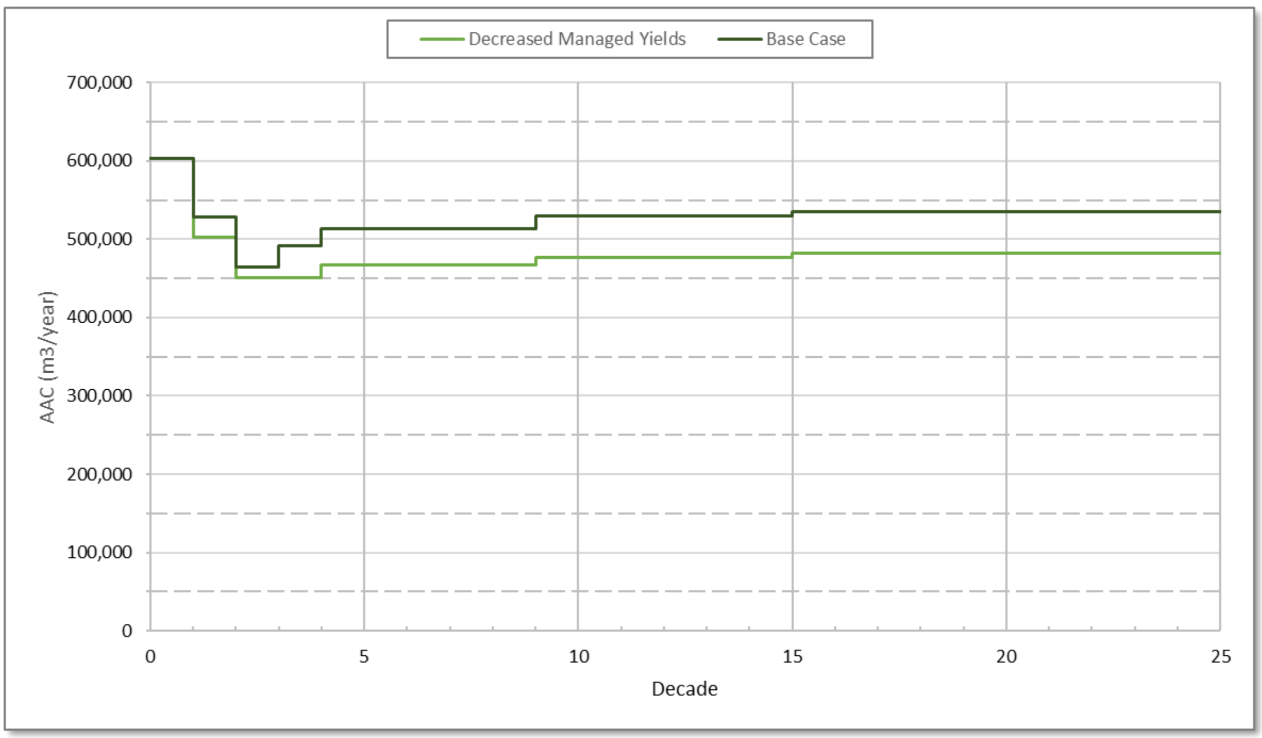

Figure 22 – Harvest levels with decreased managed stands yields

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 10% 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 11.56 million m³ (8.8%) less than the Base Case.

4.6 Static Old Yields

Most VDYP yield tables indicate slowly declining volume as stands age beyond around 250 years old – see examples in Appendix E of the Information Package. This scenario tests the impact of declining volumes in old stands by using the yields at 250 years for stands that age and older.

The static yields for old stands yields result in a slight increase in timber supply – refer to Table 12and Figure 23.

Table 12 – Harvest levels with static old yields

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Static Old Yields	Difference	% Difference
1	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	527,890	0	0.0%
3	2039	2048	463,707	463,707	0	0.0%
4	2049	2058	491,500	497,100	5,600	1.1%
5 - 9	2059	2108	513,343	513,400	57	0.0%
10 - 15	2109	2168	529,650	529,400	-250	0.0%
16 - 25	2169	2268	535,250	535,400	150	0.0%

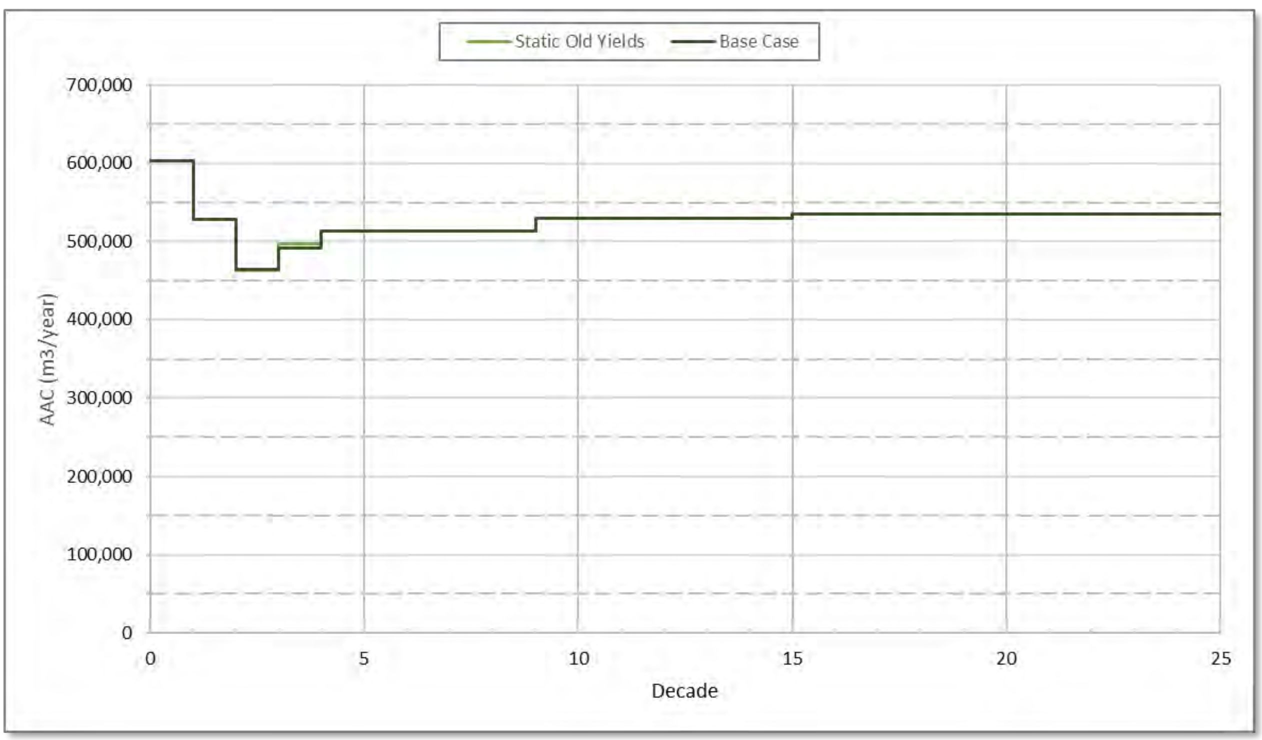

Figure 23 – Harvest levels with static old yields

Maintaining the Base Case short-term harvest levels with static old stands yields requires less contribution from managed stands in the second and third decades. This slight delay allows more volume to accumulate in managed stands, thereby increasing harvest in the fourth decade. The harvest is basically identical over the balance of the forecast period. Over the entire 250-year analysis period 61,600 m^3 (0.0%) more volume is harvested.

4.7 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 separate constraints for the conventional and heli THLB growing stocks 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 13 and Figure 24 indicate that with the heli harvest constraint removed short-term harvest can be 16% higher.

Table 13 – Harvest levels with no heli constraint

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	No Heli Constraint	Difference	% Difference
1	2019	2028	603,400	699,900	96,500	16.0%
2	2029	2038	527,890	594,900	67,010	12.7%
3	2039	2048	463,707	505,700	41,993	9.1%
4	2049	2058	491,500	429,800	-61,700	-12.6%
5	2059	2068	513,343	429,500	-83,843	-16.3%
6 - 9	2069	2018	513,343	507,200	-6,143	-1.2%
10 - 15	2109	2168	529,650	520,800	-8,850	-1.7%
16 - 25	2169	2268	535,250	535,250	0	0.0%

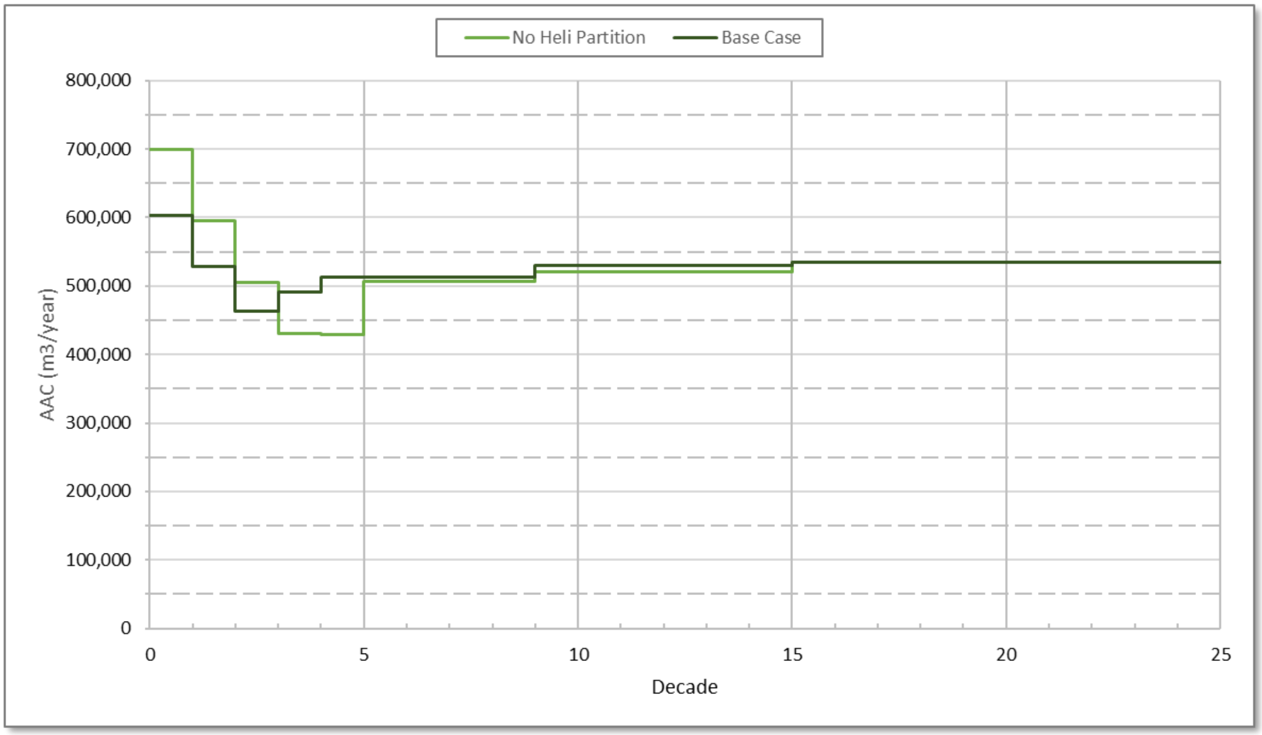

Figure 24 – Harvest levels with no heli constraint

Figure 25 indicates the contribution by harvest system category. Heli harvest is 240,900 m^3/year in the first decade and 152,600 m^3/year in the second. This contribution from the heli THLB would be impractical to achieve operationally.

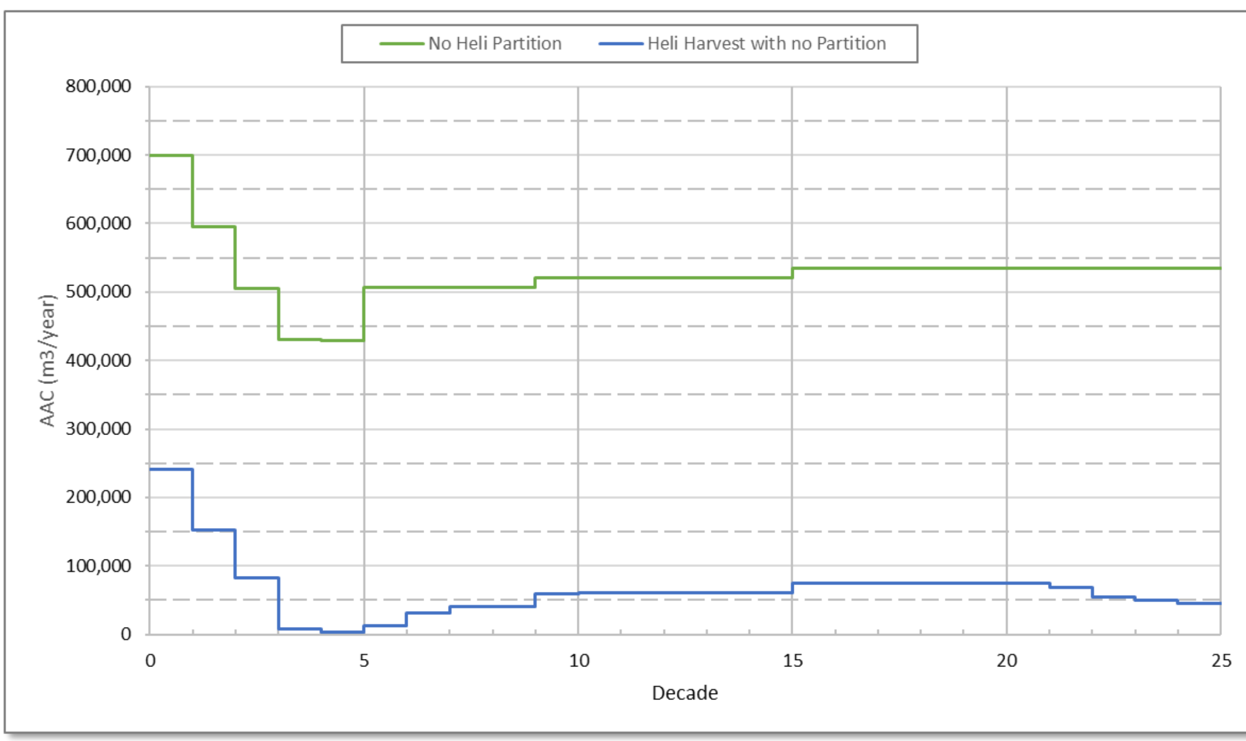

Figure 25 – Harvest by system with no heli constraint

Over the entire 250 years approximately 0.18 million m^3 (0.1%) less is harvested.

4.8 Exclude heli operable land base

Excluding the heli-operable land base removes 10,464 ha (16.6%) of THLB area and 6.08 million m^3 (31.6%) of standing inventory. One approach for excluding the heli operable land base is that it contributes volume as indicated in Table 1 and Figure 2. For this sensitivity analysis the model was set up to achieve the greatest short-term harvest possible subject to no more than a 15% decline per decade and a stable long-term growing stock.

Table 14 and Figure 26 indicate the results of this sensitivity; the conventional harvest within the Base Case is indicated in Figure 26 for comparison.

Table 14 – Harvest levels with heli THLB excluded

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	No Heli Harvest	Difference	% Difference
1	2019	2028	603,400	520,200	-83,200	-13.8%
2	2029	2038	527,890	442,200	-85,690	-16.2%
3	2039	2048	463,707	375,800	-87,907	-19.0%
4	2049	2058	491,500	343,900	-147,600	-30.0%
5	2059	2068	513,343	378,300	-135,043	-26.3%
6	2069	2078	513,343	416,100	-97,243	-18.9%
7	2079	2088	513,343	457,700	-55,643	-10.8%
8 – 9	2089	2108	513,343	479,100	-34,243	-6.7%
10 - 15	2109	2168	529,650	479,100	-50,550	-9.5%
16 - 25	2169	2268	535,250	479,100	-56,150	-10.5%

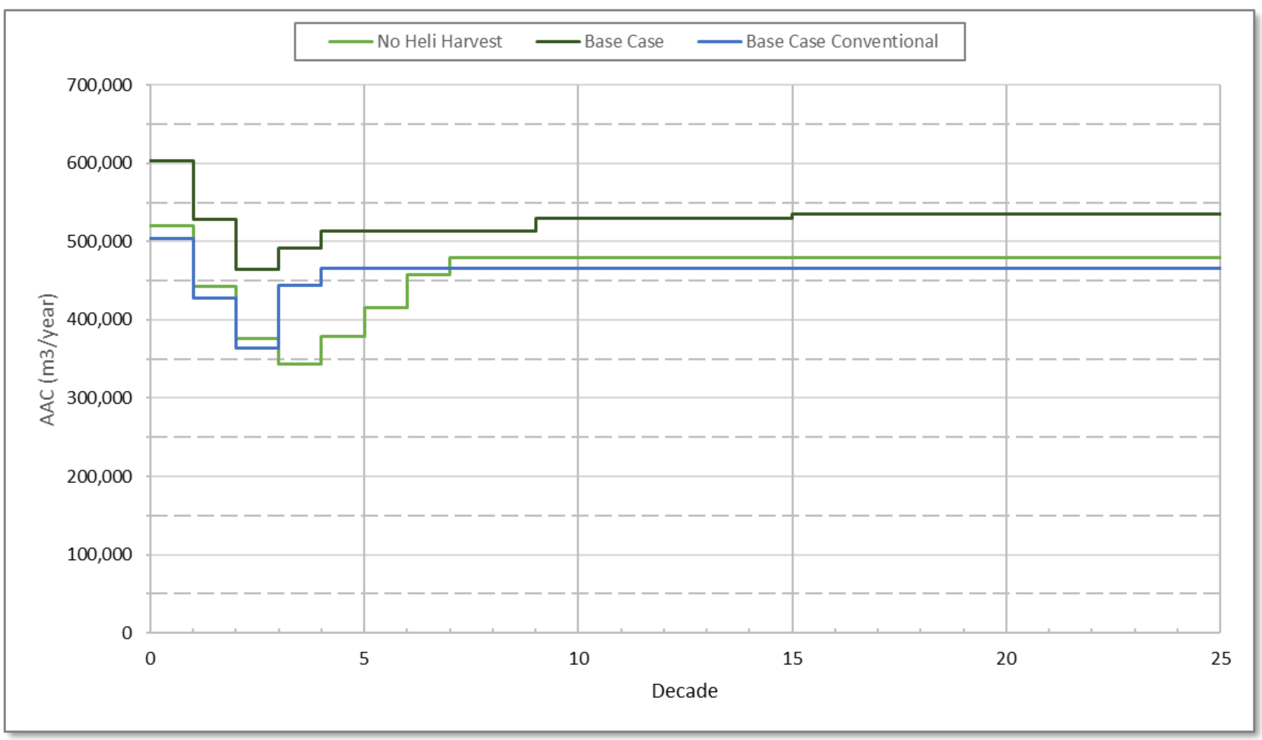

Figure 26 - Harvest levels with heli THLB excluded

Relative to the conventional harvest in the Base Case, the greater short-term harvest in this scenario generates a greater mid-term timber supply deficit. This reduced mid-term harvest does allow the long-term harvest to be 2.9% greater than the long-term conventional harvest in the Base Case. Over the 250 years, 16.26 million m^3 (12.3%) less is harvested, compared to the 16.64 million m^3 contribution heli makes to the Base Case schedule.

4.9 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 uses 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 15 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 15 - Minimum Harvest Criteria

Harvest System	Base Case		Decreased DBH Sensitivity	
	Minimum Average DBH	Wtd Avg Future Stand Age	Minimum Average DBH	Wtd Avg Future Stand Age
Ground	30 cm	64 years	28 cm	56 years
Cable	37 cm	112 years	35 cm	111 years
Heli	42 cm	174 years	40 cm	156 years

The smaller DBH criteria increases the initial available inventory by 0.65 million m^3 (5.0%). Table 16 and Figure 27 indicate the results of maintaining short-term harvest, allowing mid-term harvest to increase and then allowing the LTHL to adjust to the increased available inventory.

Table 16 - 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	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	527,890	0	0.0%
3	2039	2048	463,707	465,100	1,393	0.3%
4	2049	2058	491,500	517,500	26,000	5.3%
5	2059	2068	513,343	518,900	5,557	1.1%
6 - 8	2069	2098	513,343	519,300	5,957	1.2%
9	2099	2108	513,343	533,300	19,957	3.9%
10 - 15	2109	2168	529,650	533,300	3,650	0.7%
16 - 23	2169	2248	535,250	538,000	2,750	0.5%
24 - 25	2149	2268	535,250	541,800	6,550	1.2%

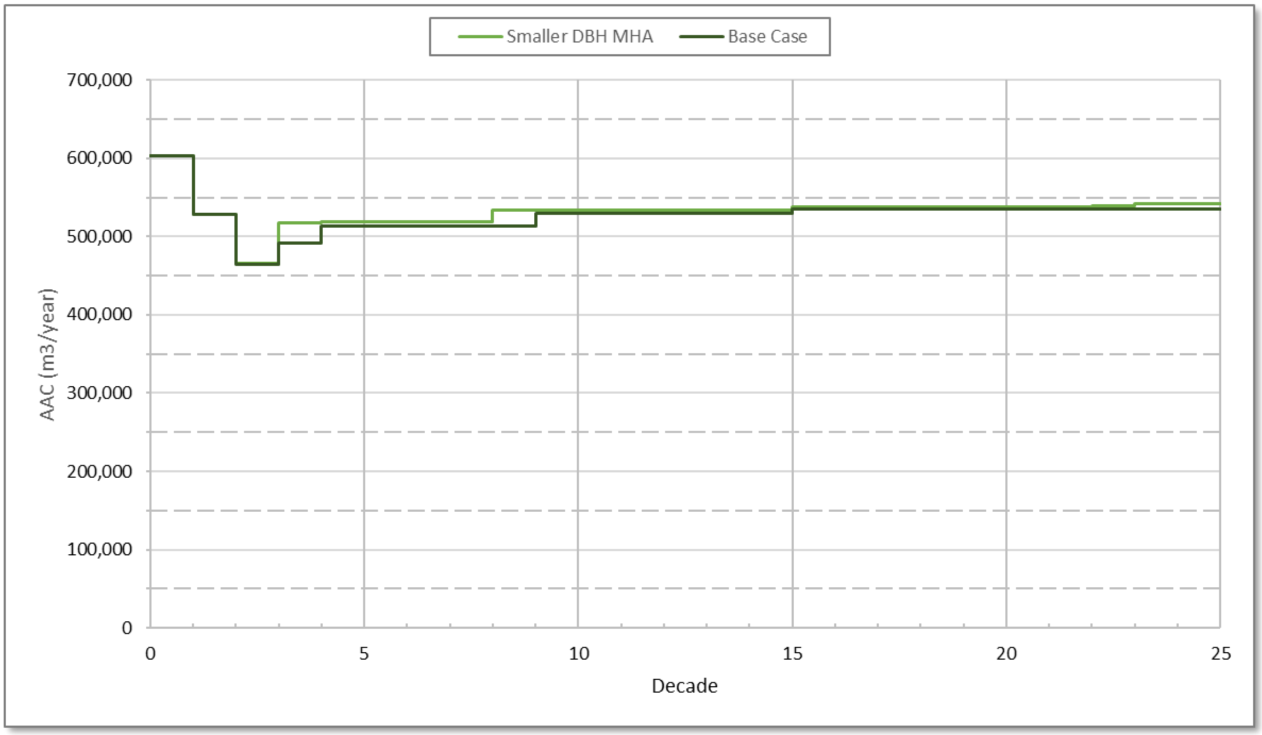

Figure 27 – Harvest levels with decreased minimum harvest DBH

The increased availability of stands allows increases to mid and long-term harvest. Overall 1.29 million m^3 (1.0%) more is harvested in this sensitivity analysis.

4.10 Increase minimum harvest DBH by 2 cm

In this sensitivity analysis the minimum DBHs were increased by 2 cm - see Table 17. In terms of years, this advances harvest eligibility from 5 to 30 years depending on the analysis unit.

Table 17 - Minimum Harvest Criteria

Harvest System	Base Case		Increased DBH Sensitivity	
	Minimum Average DBH	Wtd Avg Future Stand Age	Minimum Average DBH	Wtd Avg Future Stand Age
Ground	30 cm	64 years	32 cm	73 years
Cable	37 cm	112 years	39 cm	120 years
Heli	42 cm	174 years	44 cm	180 years

The larger DBH criteria decreases the initial available inventory by 0.43 million m^3 (3.3%). Table 18 and Figure 28 indicate the results of maintaining short-term harvest as close to the Base Case level as possible, allowing mid-term harvest to decrease and then allowing the LTHL to adjust to the decreased available inventory.

Table 18 - Harvest levels with increased minimum harvest DBH

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Increased min. DBH	Difference	
1	2019	2028	603,400	590,900	-12,500	-2.1%
2	2029	2038	527,890	492,700	-35,190	-6.7%
3	2039	2048	463,707	414,200	-49,507	-10.7%
4	2049	2058	491,500	331,300	-160,200	-32.6%
5	2059	2068	513,343	374,500	-138,843	-27.0%
6	2069	2078	513,343	424,200	-89,143	-17.4%
7	2079	2088	513,343	481,300	-32,043	-6.2%
8 - 9	2089	2108	513,343	495,300	-18,043	-3.5%
10 - 11	2109	2128	529,650	495,300	-34,350	-6.5%
12	2129	2138	529,650	515,300	-14,350	-2.7%
13 – 15	2139	2168	529,650	517,300	-12,350	-2.3%
16 - 22	2169	2238	535,250	517,300	-17,950	-3.4%
23 - 24	2239	2258	535,250	519,700	-15,550	-2.9%
25	2259	2268	535,250	521,600	-13,650	-2.6%

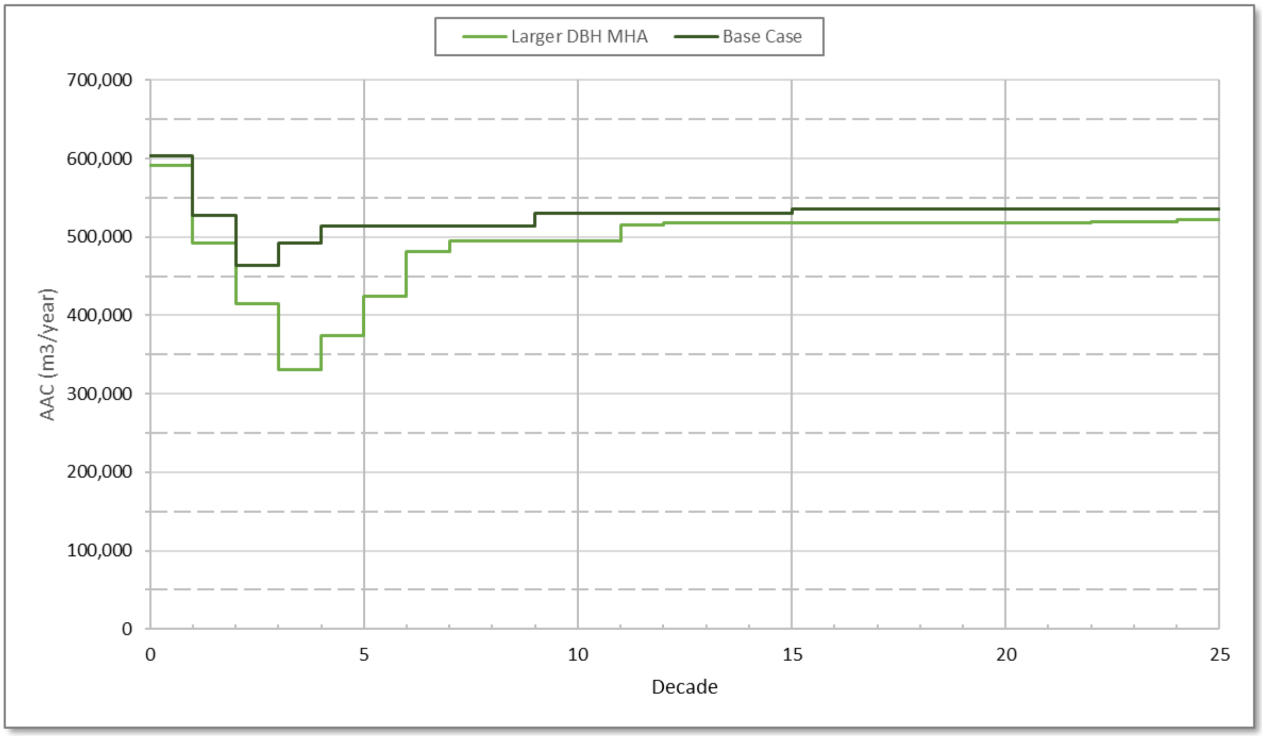

Figure 28 – Harvest levels with increased minimum harvest DBH

Maintaining short-term harvest as high as possible creates a significant mid-term timber supply deficit. Overall 8.44 million m^3 (6.4%) less is harvested in this sensitivity analysis.

4.11 Use 95% culmination as minimum harvest criteria

As discussed in the preceding two sections, 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 (see Table 19). The results indicate that the DBH criteria applied in the Base Case result in significantly longer rotations than culmination MAI criteria.

Table 19 - Minimum Harvest Criteria

Harvest System	Base Case		Culmination Sensitivity
	Minimum Average DBH	Wtd Avg Future Stand Age	Wtd Avg Future Stand Age
Ground	30 cm	64 years	68 years
Cable	37 cm	112 years	72 years
Heli	42 cm	174 years	79 years

Table 20 - 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	2019	2028	603,400	676,100	72,700	12.0%
2	2029	2038	527,890	589,700	61,810	11.7%
3	2039	2048	463,707	516,200	52,493	11.3%
4	2049	2058	491,500	556,200	64,700	13.2%
5 - 9	2059	2108	513,343	556,200	42,857	8.3%
10 - 15	2109	2168	529,650	556,200	26,550	5.0%
16 - 25	2169	2268	535,250	556,200	20,950	3.9%

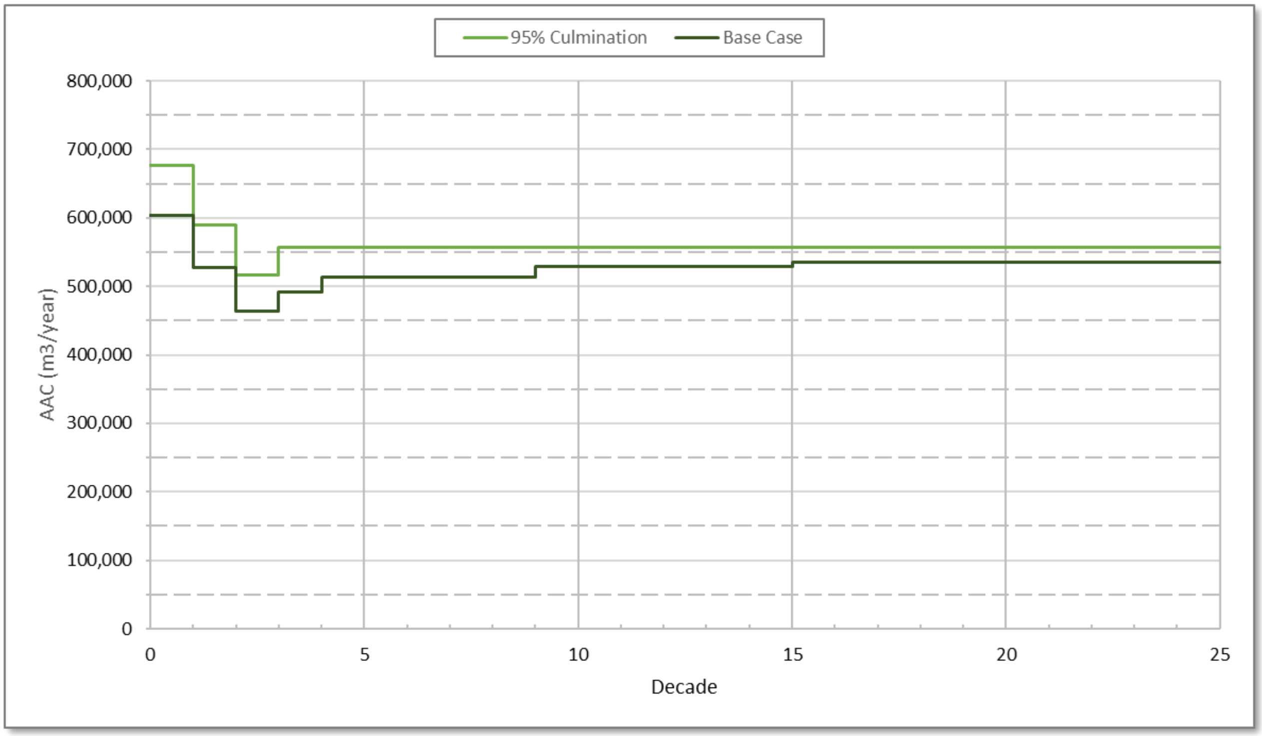

Figure 29 – Harvest levels using 95% culmination as minimum harvest age

The shorter rotations associated with using 95% culmination ages allows short-term harvest to increase by 12% for the first 40 years. The increased harvest results from greater contribution from cable and heli operable stands. Over the 250-year analysis, 8.34 million m^3 (6.3%) more volume is harvested.

Figure 30 compares the available inventory (i.e. meets minimum harvest criteria) over time. Even with the increased harvest levels of this scenario, the available inventory is maintained at an average of approximately 6.2 million m^3, 25% higher than the Base Case.

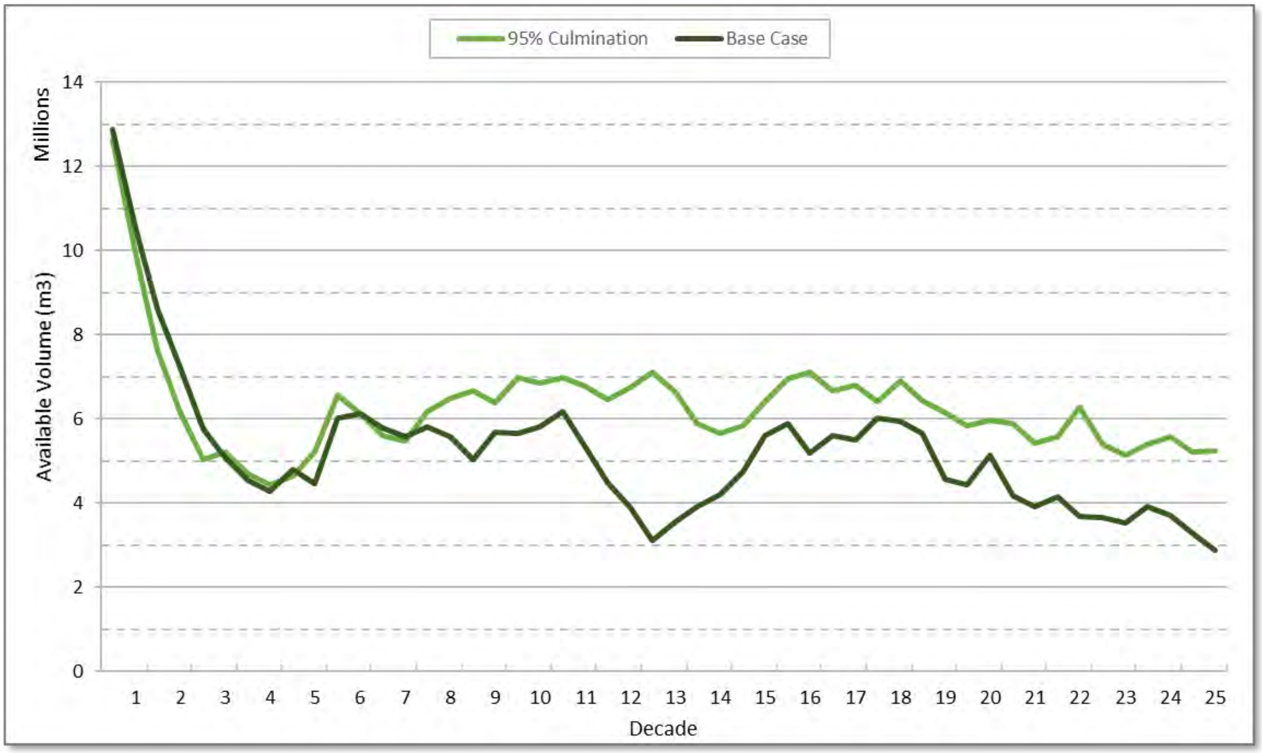

Figure 30 – Available conventional volume using 95% culmination as minimum harvest age

4.12 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[1]. This sensitivity tests the impact on timber supply if this silviculture investment to improve yields did not occur.

Table 21 and Figure 31 indicate that the genetic gain assumptions need not influence timber supply for the first 20 years.

Table 21 – 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	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	527,890	0	0.0%
3	2039	2048	463,707	471,400	7,693	1.7%
4	2049	2058	491,500	481,500	-10,000	-2.0%
5 - 8	2059	2098	513,343	481,500	-31,843	-6.2%
9	2099	2108	513,343	497,400	-15,943	-3.1%
10 - 15	2109	2168	529,650	497,400	-32,250	-6.1%
16 - 25	2169	2268	535,250	503,600	-31,650	-5.9%

Figure 31 – Harvest levels with no genetic gain

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

Genetic gain is applied to future stands and current stands less than 13 years old; therefore, they do not contribute to timber supply for the first 40 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 6% lower than the Base Case. Overall approximately 6.55 million m^3 (5.0%) less is harvested over the 250 years.

4.13 ECA limits on entire Tahsis and McKelvie watersheds

To address water quality and quantity objectives, the Base Case includes forest cover constraints for the rain-on-snow zone (300 – 800m elevation range) for both the McKelvie Creek and Tahsis River watersheds; equivalent clearcut area (ECA) limits of 30% were applied to the rain-on-snow zone in each watershed. This scenario tests the timber supply impact of expanding the 30% ECA limit to the entire watersheds.

Table 22 indicates that expanding the scale of the ECA constraints in these two watersheds has no timber supply impact.

Table 22 – Harvest levels with ECA limits applied to full McKelvie and Tahsis watersheds

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Revised ECA limits	Difference	
1	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	527,890	0	0.0%
3	2039	2048	463,707	463,707	0	0.0%
4	2049	2058	491,500	491,500	0	0.0%
5 - 9	2059	2108	513,343	513,343	0	0.0%
10 - 15	2109	2168	529,650	529,650	0	0.0%
16 - 25	2169	2268	535,250	535,250	0	0.0%

There is no timber supply impact when applying the 30% ECA constraint to the entire watersheds rather than just the rain-in-snow zone due to the proportion of the total THLB located in the rain-on-snow zone and the amount of non-contributing land base in each of the watersheds. In other words, the ECA limits are never reached.

4.14 Tahsis Landscape Unit reserves to address forthcoming Marbled Murrelet order

The BC Marbled Murrelet Implementation Plan was released in February 2018. One of the key actions is issuing an Order under the *Land Use Objectives Regulation* for suitable Marbled Murrelet habitat protection. The amount of suitable habitat being retained will increase with the Order. The spatial component will be managed through a revised *Forest Planning and Practices Regulation* (FPPR) Section 7 notice. On September 18, 2020 the provincial government released a proposed Order and a proposed FPPR Section 7 notice for comment[2], with the comment period ending November 17,2020. This Order and Section 7 notice will trigger a redesign of OGMAs to replace OGMAs that only have a representation value with OGMAs of sufficient size with suitable marbled murrelet habitat.

As part of a pilot project for the BC Marbled Murrelet Implementation Team, WFP undertook an analysis of the Tahsis landscape unit (LU) to test the feasibility of meeting draft targets for marbled murrelet habitat protection. The draft targets for the Tahsis LU used in the pilot project have been carried forward unchanged into the proposed Order and Section 7 notice. This project also involved discussions with representatives of the Village of Tahsis to capture their values in the reserves design, focussing on protection of the McKelvie Creek community watershed. Discussion with, and input from, the Mowachaht/Muchalaht First Nation has been hampered by COVID-19. Once their input is received, any significant changes to the alternative OGMAs and WHAs can be reflected in a revised version of this sensitivity analysis and included in the final timber supply analysis report.

To meet Tahsis' aspiration to fully protect the McKelvie watershed, the revised reserves (OGMAs and WHAs) for the Tahsis LU would result in permanent protection for, and no THLB within, the watershed. Within McKelvie Creek, the revised reserves would conserve suitable marbled murrelet habitat, old forest, and protect drinking water quality. Elsewhere within the LU, the reserves capture a multitude of resource values, including, but not limited to:

- suitable marbled murrelet habitat,
- cultural heritage resources
- karst terrain,
- riparian areas,
- deer and elk winter range,
- recreation and scenic areas,
- big trees.

The permanent protection for, and no THLB within, the watershed goes beyond the 2-year deferral of old growth harvesting in the McKelvie Creek Watershed which the provincial government announced on September 11, 2020.

Table 23 and Figure 32 present the timber supply impacts of the alternative OGMAS and WHAs in the Tahsis LU.

[2] See https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/proposed-land-use-objectives-regulation-orders

Table 23 - Harvest levels applying alternative OGMAs and WHAs in Tahsis LU

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)			% Difference
			Base Case	Alternate Tahsis LU Reserves	Difference	
1	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	527,890	0	0.0%
3	2039	2048	463,707	463,707	0	0.0%
4	2049	2058	491,500	426,300	-65,200	-13.3%
5	2059	2068	513,343	502,200	-11,143	-2.2%
6 - 9	2069	2108	513,343	515,900	2,557	0.5%
10 - 15	2109	2168	529,650	532,600	2,950	0.6%
16 - 25	2169	2268	535,250	538,100	2,850	0.5%

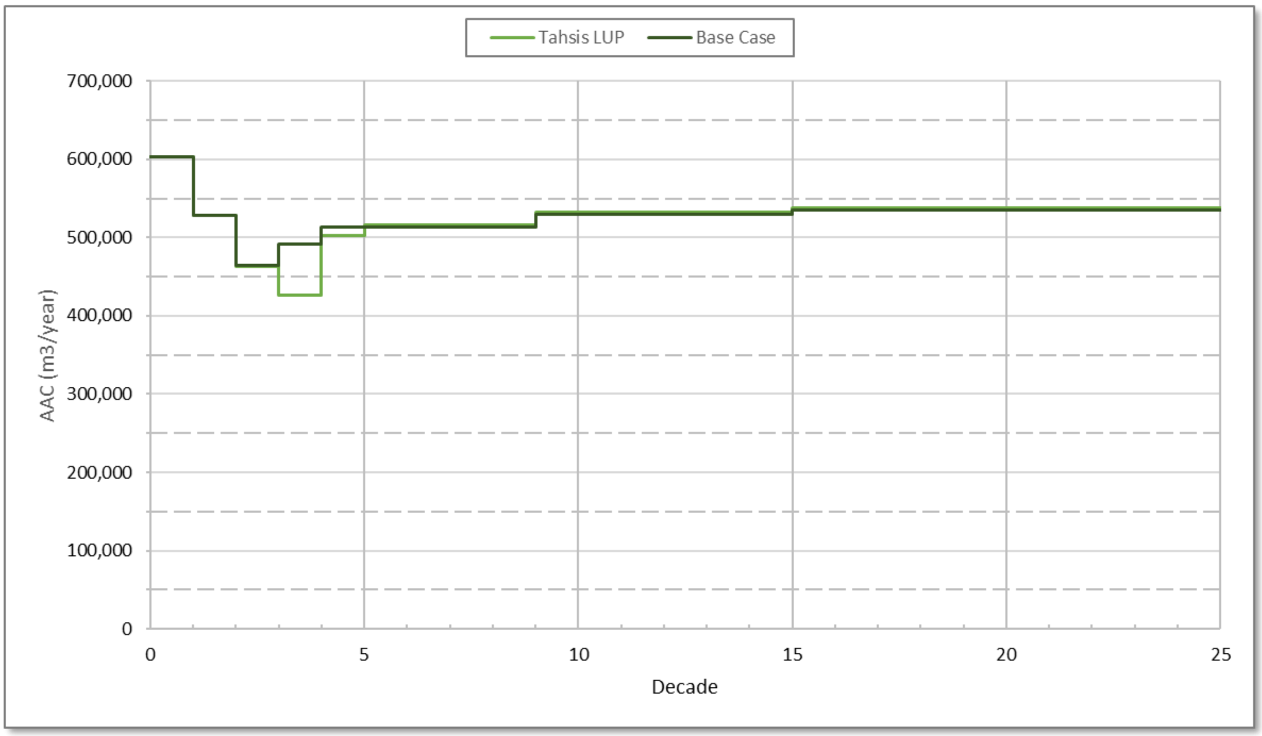

Figure 32 – Harvest levels applying alternative OGMAs and WHAs in Tahsis LU

The alternative OGMAs and WHAs in the Tahsis LU reduces the total THLB area of the TFL by 190 hectares (0.3%) and the initial THLB growing stock by 134,000 m^3 (0.6%). The schedule shown in Table 23 and Figure 32 maintains the Base Case harvest levels in the first 3 decades and indicates that reduced harvest levels are required in the fourth and fifth decades. For the balance of the analysis period, harvest levels are 0.5% greater than the Base Case. Over the 250-year analysis, 0.2 million m^3 (0.2%) less volume is harvested.

The mid-term timber supply impact indicated above may be overstated as the land use order is anticipated to create LU aggregates and establish minimum habitat protection targets within individual LUs and within the LU aggregates. The LU aggregates may allow any “surplus” habitat protected within one LU (i.e. in excess of the target for the LU) to be offset elsewhere within the LU aggregate as long as the target for the aggregate is achieved. These alternative reserves for the Tahsis LU capture habitat in excess of the draft target. These hectares could be used to increase the THLB in another LU within the aggregate Tahsis is a member of, thereby increasing timber supply relative to the schedule shown here.

4.15 Predicted future biogeoclimatic subzone boundaries

During the review process for the Information Package, the Mowachaht/Muchalaht First Nation raised several questions regarding potential timber supply impacts resulting from climate change. This sensitivity analysis was conducted as a result of the questions they raised.

To test the sensitivity of timber supply to potential climate change implications, Climate BC[3] data was used to predict the boundaries of biogeoclimatic (BEC) variants in 2050. Figure 33 presents current BEC zone boundaries and predictions for 2050 for the vicinity of TFL 19. The Costal Mountain-heather Alpine (CMA) zone is predicted to nearly disappear, while the extent of the Mountain Hemlock (MH) zone is forecast to significantly shrink, replaced by the Coastal Western Hemlock (CWH) zone.

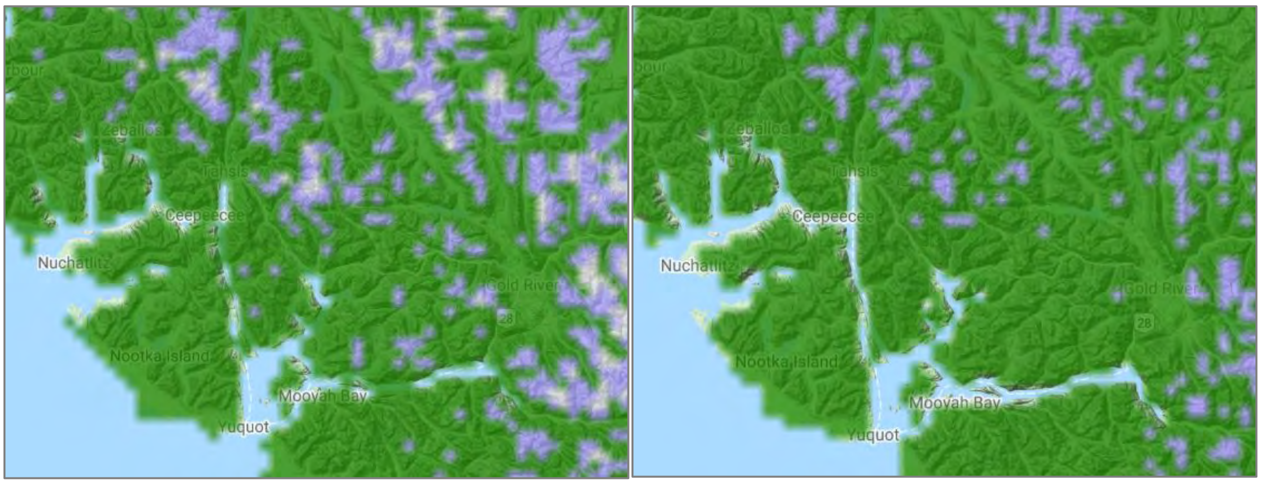

Figure 33 – BEC zones current (left) and 2050 prediction (right)
(CMA-yellow; MH – purple; CWH – green)

The 2050 BEC variant boundaries were incorporated into the model and harvested stands transition to the corresponding future stand based on the revised BEC variant. For example, if a current stand is a poor stand within the MHmm1 variant but is predicted to become CWHvm2 by 2050, this current stand transitions to the poor CWHvm2 future stand.

The results of applying predicted future BEC variants are presented in Table 24 and Figure 34.

[3] See https://cfcg.forestry.ubc.ca/projects/climate-data/climatebcwna/

Table 24 - Harvest levels applying predicted future BEC boundaries

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3) Base Case	Future BEC	Difference	% Difference
1	2019	2028	603,400	603,400	0	0.0%
2	2029	2038	527,890	527,890	0	0.0%
3	2039	2048	463,707	465,100	1,393	0.3%
4	2049	2058	491,500	517,500	26,000	5.3%
5	2059	2068	513,343	518,900	5,557	1.1%
6 - 8	2069	2098	513,343	519,300	5,957	1.2%
9	2099	2108	513,343	533,300	19,957	3.9%
10 - 15	2109	2168	529,650	533,300	3,650	0.7%
16 – 23	2169	2248	535,250	538,000	2,750	0.5%
24 - 25	2249	2268	535,250	541,800	6,550	1.2%

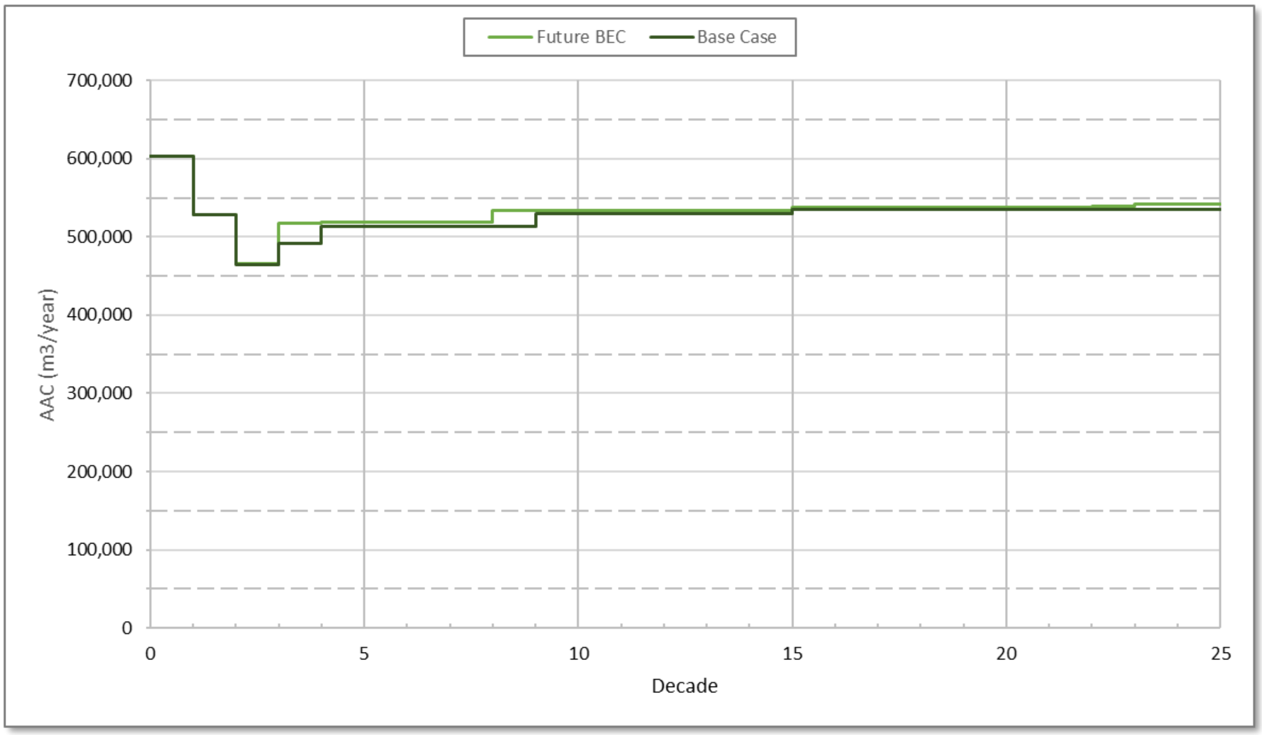

Figure 34 – Harvest levels applying predicted future BEC boundaries

The predicted expansion of the CWH zone increases the average productivity of the TFL. This increase results in more available inventory, allowing increased mid-term harvest levels and marginally greater long-term harvest. Over the 250-year analysis, 1.29 million m^3 (1.0%) more volume is harvested.

4.16 2007-2011 unused volume disposition

The TFL 19 2007-2011 cut control period finished with approximately 1.38 million m^3 of unused volume. Nearly 898,000 m^3 of this unused volume was disposed of to local First Nations. None of this volume had been harvested when the data set for this timber supply analysis was prepared. To test the timber supply impact of this potential additional harvest, this scenario was run by requesting an additional 90,000 m^3/year of harvest in the first decade (i.e. 900,000 m^3 more harvest in the first decade).

Two alternatives were run for this sensitivity analysis: (i) an old-growth (OG) focus for the additional harvest (i.e. similar to the Base Case), and (ii) a second-growth (SG) focus for the additional harvest. The results are presented in Table 25 and Figure 35.

Table 25 - Harvest levels accounting for disposed unused volume

Period (Decade #)	Start Year	End Year	Annual Harvest Volume (m^3)						
			Base Case	OG-focus for unused	Difference	% Difference	SG-focus for unused	Difference	% Difference
1	2019	2028	603,400	691,700	88,300	14.6%	691,700	88,300	14.6%
2	2029	2038	527,890	527,890	0	0.0%	527,890	0	0.0%
3	2039	2048	463,707	422,300	-41,407	-8.9%	395,900	-67,807	-14.6%
4	2049	2058	491,500	374,600	-116,900	-23.8%	362,600	-128,900	-26.2%
5	2059	2068	513,343	440,100	-73,243	-14.3%	425,700	-87,643	-17.1%
6	2069	2078	513,343	518,600	5,257	1.0%	501,300	-12,043	-2.3%
7 - 9	2079	2108	513,343	524,100	10,757	2.1%	526,200	12,857	2.5%
10 - 15	2109	2168	529,650	540,500	10,850	2.0%	542,500	12,850	2.4%
16 – 25	2169	2268	535,250	546,000	10,750	2.0%	548,100	12,850	2.4%

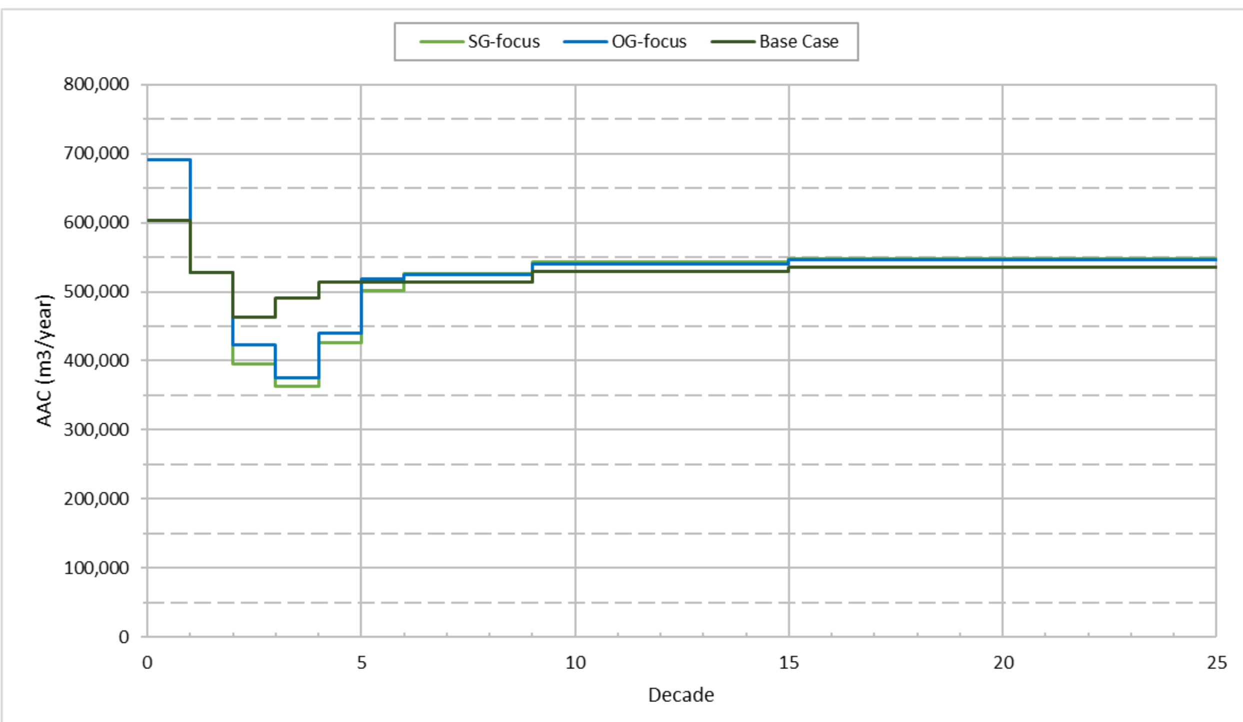

Figure 35 – Harvest levels accounting for disposed unused volume

When requiring the same harvest level in the second decade, the model was able to add 88,300 m^3/year harvest in the first decade. The increased short-term harvest has a significant impact on mid-term harvest, with a greater impact if the unused volume harvest is mostly second growth timber. This larger impact is a result of there being a relatively small amount of merchantable second growth currently available in the TFL. Harvesting that volume in the short-term further reduces available inventory in the mid-term; in other words, those second growth stands are intended to support mid-term timber supply of the TFL.

In both cases, long-term harvest is greater than the Base Case. This is a result of converting natural stands to managed stands, with their greater yields, more rapidly and the reduced mid-term harvest. Over the 250 years, the old-growth focussed schedule harvests 0.68 million m^3 (0.5%) more than the Base Case, while the second growth focussed schedule harvests 0.37 million m^3 (0.3%) more.

4.17 Summary of sensitivity impacts

Table 26 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 26 – Summary of sensitivity analyses harvest impacts

		Harvest Interval (years)		
		1 – 30	31 – 90	91 - 250
Base Case total net harvest level (m³)		15,949,965	30,582,121	85,302,010
Issue tested	Sensitivity	Percentage Impact		
Available landbase	Exclude marginally economic stands	0.0%	-1.7%	-1.4%
Growth and yield	Natural stands yields increased by 10%	4.7%	2.7%	0.3%
	Natural stands yields decreased by 10%	-2.8%	-7.8%	2.1%
	Managed stands yields increased by 10%	3.0%	8.6%	10.1%
	Managed stands yields decreased by 10%	-2.4%	-8.9%	-9.9%
	Static old yields	0.0%	0.2%	0.0%
Operability	Remove heli harvest constraint	12.9%	-5.6%	-0.6%
	Exclude heli landbase	-16.1%	-16.5%	-10.1%
Minimum harvest criteria	Decrease minimum DBH by 2 cm	0.1%	2.3%	0.7%
	Increase minimum DBH by 2 cm	-6.5%	-14.4%	-3.9%
	95% of culmination mean annual increment	11.7%	9.1%	4.3%
Forest management / Climate Change	Exclude future genetic gain adjustments	0.5%	-5.0%	-6.0%
	ECA limits on entire Tahsis and McKelvie watersheds	0.0%	0.0%	0.0%
	Tahsis Landscape Unit reserves to address forthcoming Marbled Murrelet order	0.0%	-2.2%	0.5%
	Predicted future biogeoclimatic subzone boundaries	0.1%	2.3%	0.7%
Unused Volume	2007-2011 unused volume disposition	1.3% - 2.9%	- 5.0% - - 6.2%	2.0% - 2.4%

5 Analysis Summary and Proposed AAC

5.1 Changes since MP #10

There have been considerable changes in the TFL 19 timber supply analysis assumptions since MP #10. Main changes include:

- Updated operability and identification of non-productive forest area using LiDAR data.
- Spatial THLB netdowns for riparian management zone retention, OGMAs, archaeological sites, and stand-level retention.
- Use of tree heights from LiDAR data for natural immature stands (58-156 years old) to calculate site index values.
- Applying an OAF1 value in TIPSY to account for non-productive area within managed stands based on site occupancy indicated by LiDAR data.

5.2 MP #11 Base Case Initial Harvest

The starting harvest level of 604,300 m^3/year in the Base Case reflects the reduced THLB area plus reduced THLB inventory due to 10 years of harvesting plus growth over that period.

- The current TFL 19 AAC of 728,837 m^3/year accounts for area deletions from the TFL.
- Between 2010 and 2019, 6.5 million m^3 was harvested, including waste and residue.
- The initial THLB growing stock in MP #10 was estimated at 27.5 million m^3 compared to 19.2 million m^3 for MP #11.

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:
    - Excluding the heli operable landbase can either reduce short-term timber supply by a little more than 16.5% if simply deduct its contribution to the Base Case schedule or short-term impact can be reduced to about 16% at the expense of mid-term harvest. The impact to long-term harvest is 10%.
    - Removing constraints associated with heli contribution can increase short-term harvest by nearly 13%.
    - Performance in the heli operable landbase during MP #10 was consistent with the “heli” 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:
    - Mid-term harvest level is moderately sensitive to unmanaged stand yield estimates with a 10% change (plus or minus) in yield resulting in a +2.7% and -7.8% change respectively to mid-term harvest. Short and long-term harvest is more or less unaffected. Alternative schedules are possible whereby the short-term harvest is adjusted such that mid-term

impacts are reduced. These were not indicated as the initial harvest is already more than 17% less than the current AAC.

- Changes to managed stand yields (currently aged less than 58 years and future stands) are greatest in the long-term, but still substantial in the mid-term. Initial harvest level is unaffected.

- 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 increasing DBH criteria by 2cm has a significant impact in the mid-term. Applying 95% culmination MAI as minimum harvest age increases short and mid-term timber supply.
- Alternative forest cover constraints and landscape-level reserves within the Tahsis River and McKelvie Creek watersheds and Tahsis landscape unit respectively have minimal short and long-term timber supply impacts.
- The disposition of unused volume from the 2007-2011 cut control period will have a significant mid-term timber supply impact, especially if the licensees focus on second growth harvesting.

5.4 Conclusions and Recommendations

Compared to the MP #10 analysis forecast, changes in timber supply contribution from the heli operable land base and improved growth and yield estimates largely offset the negative impacts of reductions in THLB and mature volume on the initial harvest. In the mid and long term, the reduced THLB necessitates lower harvest levels.

The analysis shows that the initial harvest level for the Base Case is robust across the individual sensitivities.

An AAC of 603,400 m^3/year (the initial harvest level of the Base Case) is proposed for TFL 19 during the next ten years. WFP recommends an AAC partition of no more than 503,400 from the conventional land base be established. The 603,400 m^3 includes 12,152 m^3 allocated to First Nations.

Appendix 2: Timber Supply Analysis Information Package

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Western Forest Products Inc.

DEFINING A HIGHER STANDARD™

Tree Farm Licence 19

Timber Supply Analysis Information Package

In Preparation of

MANAGEMENT PLAN 11

Submitted to the
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Forest Analysis & Inventory Branch
Victoria, BC

Version 2
October 2020

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

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

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Revisions since Version 1 (May 2019)

The following revisions were made to Version 1 (May 2019) of the Information Package to create this document.

Corrected typographical errors and formatting issues and updated date on title page and in page headers.
Revised planned sensitivity analyses list in Table 3
Expanded discussion on climate change in Section 3.4
Used TIPSY 4.4 for managed stand yields rather than TIPSY 4.3.2. This affected applicable yield tables, minimum harvest ages and section 7.3.3.2
Revised discussion re: VDYP 7 adjustment factors
Added table comparing 2006-2018 harvest area by harvest system to MP #11 THLB area (section 6.8)
Added table comparing 2006-2018 harvest area by terrain stability class to MP #11 THLB area (section 6.19)

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Acknowledgements

The signatory greatly appreciates the following for their contributions to the preparation of this document:

- Tammy Myers of WFP for her preparation of the timber supply resultant database and data summaries used in preparation of this document;
- Scott Boyd of WFP for his analyses using LiDAR data;
- Annette Van Niejenhuis of WFP for her summaries of seedlots and genetic gain employed in reforestation efforts on the TFL;
- Doug Meske, Brian Sommerfeld, Colin McKenzie and Paul Kutz of WFP for their operational input;
- John Deal and Sue McDonald for their input on wildlife and biodiversity management.

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1 INTRODUCTION

1.1 Background

Tree Farm Licence (TFL) 19 was first awarded to Tahsis Company Ltd. on December 23, 1954 and was purchased by Doman-Western Lumber Limited in December 1997. Through a series of corporate restructurings, the TFL came under the management of Western Forest Products Inc. (WFP) in May 2006. Since 1954 there have been ten 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) #11. 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.

Based on the last TSA, on August 10, 2010 the AAC was set at 730,000 m^3/year. The AAC was reduced in March 2012 to reflect the deletion of three small parcels, resulting in an AAC of 728,837 m^3/year that remains in effect today. Further details 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 Cultural Heritage Resources
Fish Habitat	6.9 Riparian Management Areas
Wildlife	6.10 Ungulate Winter Ranges
	6.12 Wildlife Habitat Areas
Old Growth and Biodiversity	5.5 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 19 is located on the west side of Vancouver Island in the vicinity of Nootka Sound (see Figure 1). Communities within or near the TFL include:

- Gold River,
- Tsaxana,
- Tahsis,
- Zeballos,
- Ehatis,
- Oclugjie.

Nearby provincial parks include:

- Strathcona,
- Gold Muchalat,
- Weymer Creek,
- Woss Lake,
- Artlish Caves.

TFL 19 is located within seven landscape units and nine Resource Management Zones (RMZs) established by the Vancouver Island Land Use Plan (see Table 2).

Table 2 – Landscape Units and Resource Management Zones

Landscape Unit (Biodiversity Emphasis)	Resource Management Zone (Type)
Burman (Low)	Burman (Enhanced)
Eliza (Low)	Eliza (Enhanced)
Gold (High)	Gold (General)
Kleeptee (Low)	Kleeptee (Enhanced)
Tahsis (Low)	Schoen-Strathcona (Special)
Tlupana (Intermediate)	Tahsis (Enhanced)
Zeballos (Low)	Tlupana (Enhanced)
	Woss-Zeballos (Special)
	Zeballos (General)

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. Refer to Section 7 for further details regarding the landscape units and resource management zones.

Climate within TFL 19 is dominated by maritime variants of the Coastal Western Hemlock (CWH) and Mountain Hemlock (MH) biogeoclimatic zones, with Coastal Mountain-heather Alpine (CMA) at high elevation.

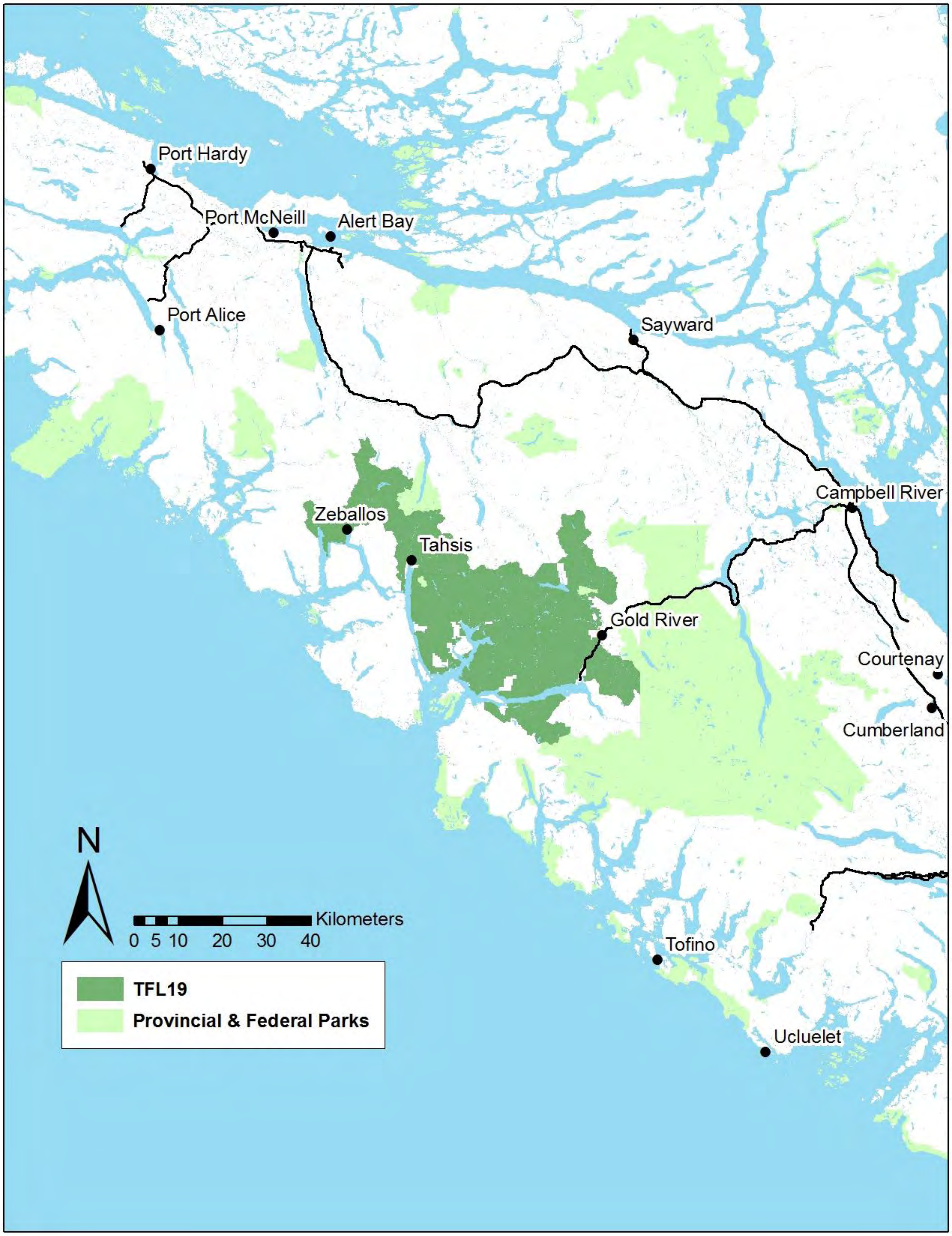

Figure 1 – Location of TFL 19

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, Natural Resource Operations and Rural Development (FLNRORD). Upon acceptance, the IP will guide the timber supply analysis and, with the timber supply analysis report, be appended to MP #11. These will be considered by the Chief Forester in determining the new AAC for TFL 19. 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 19. 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 19:

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 19.

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 inventory 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 19 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 2006 and future regenerated stands.
- Visual Quality Objectives (VQOs) modelled on VQOs established for the Campbell River Forest District on December 14, 2005.
- 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.
- Riparian management based on the FSP results/strategies and a review of riparian management applied on nearly 1200 cutblocks harvested or planned between 1995 and 2018.
- 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.
- 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 3 – Planned Sensitivity Analyses

Concern Tested	Proposed Sensitivity Analysis
Land base available for harvesting	▪ Exclude marginally economic stands
Growth and yield	▪ adjust natural stand volumes +/-10% ▪ adjust managed stand volumes +/-10% ▪ static old volumes
Climate Change	▪ apply predicted biogeoclimatic variants
Forest Management / Silviculture	▪ apply increased OAF2 for existing Fd-leading managed stands on CWHxm2 medium sites ▪ more restrictive visual management constraints ▪ apply ECA constraints to entire McKelvie and Tahsis watersheds
Operability	▪ no heli volume partition ▪ no harvesting of heli-operable landbase ▪
Biodiversity	▪ Impending Marbled Murrelet Land Use Order
Minimum harvest ages	▪ subtract 2cm to the minimum harvest criteria ▪ add 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.

The effect of climate change on timber supply is partially accounted for in this analysis through the proposed 1% yield reduction for non-recoverable losses (refer to Section 9). This 1% reduction is meant to reflect unsalvaged timber lost to wind, insects, disease and fires that are not addressed by other yield factors. Given the current AAC for TFL 19 is approximately 730,000 m^3, a 1% reduction equates to 73,000 m^3/decade or approximately 120 ha/decade. The amount of timber lost to these biotic and abiotic factors can be increased in subsequent analyses if climate change results in increases to the number of timber-damaging events and the timber is not recoverable.

In addition, to explore possible impacts of climate change, a sensitivity analysis will be running using UBC climate data modelling (https://cfcg.forestry.ubc.ca/projects/climate-data/climatebcwna/) that provides predicted biogeoclimatic (BEC) variant boundaries for the Campbell River and South Island Resource Districts for 2050.

Outside of the timber supply review process, WFP is actively addressing climate change via forest management practices, including, but not limited to:

- WFP is actively engaged in the provincial forest fertilization program, which includes a carbon sequestration initiative. Stands identified for treatment in this program will not be harvested for a minimum of 10 years post-treatment so that the trees take full advantage of the single fertilization treatment and remove additional carbon from the atmosphere.
- WFP is an early adopter of Climate Based Seed Transfer (CBST), led by the Forest Improvement and Research Management Branch of the Provincial Government[1]. Under CBST, seed is selected based on the new present and modeled future climates of the regeneration sites. The objective of CBST is to match the current new climate of the regeneration site to the climate of the seed source. By doing this, we expect the planted seedlings to develop into productive forests that support healthy and resilient ecosystems. Changes in seed transfer limits to date have been modest, but they will expand as climate continues to change.
- Forestry professionals engaged by WFP are mindful of climate change impacts when they develop regeneration strategies. Species are selected based on our understanding of ecological suitability in the new present and modeled future climates. We anticipate more information about ecological suitability from provincial ecologists and will continue to adapt our practices to reflect best available information.
- WFP actively manages forest fuels to reduce wildfire risks. The management of logging residue provides multiple benefits such as abating potential fire hazards by burning roadside accumulations and increasing the number of sites available for planting along roadsides.

As timber supply analyses are conducted at least every 10 years, the forest inventory is regularly updated to reflect the most recent disturbances and silviculture practices. As well, analysis methodology continues to evolve as new information is made available.

[1] Further details available at https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/tree-seed/seed-planning-use/climate-based-seed-transfer

4 HARVEST MODEL

The TFL 19 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 19 is based on 1:15,000 colour aerial photography flown in 1995 for an effective scale of 1:5,000. For the forthcoming timber supply analysis, the inventory has been updated to the end of 2018 for harvesting, silviculture activities and survey results.

5.1 Vegetation Resources Inventory

A Vegetation Resource Inventory (VRI) project was initiated in 2000. Phase I (forest cover polygon boundaries delineation and attributes estimated using aerial photography) was completed in 2002. The project specifications indicated that old growth delineation was to be accepted as is from a 1993 inventory as it was done in detail and was considered acceptable for operational purposes. Old growth areas were to be inspected for changes and updated as needed. A comparison of old growth in the 1993 inventory against the VRI indicates that old growth stands were re-delineated in the VRI – refer to Figure 2.

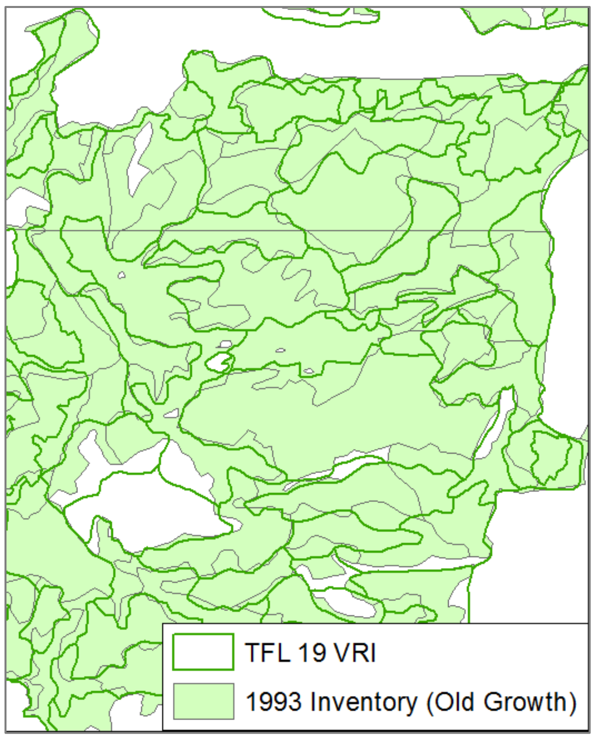

Figure 2 – Sample of Old Growth Stands Delineation Comparison between VRI and 1993 Forest Inventory

The green lines are the VRI inventory polygons whereas the green fill with grey outline are the previous inventory. This sample location indicates that the old growth stands were re-delineated, and this is true throughout the TFL.

5.2 VRI Attribute Adjustments

Between December 2002 and July 2003, one hundred 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 1982 were not adjusted as establishment attributes for these stands are known. Net volume adjustment factor (NVAF) sampling was conducted between October 2003 and August 2004.

J.S. Thrower and Associates completed the Phase II statistical adjustments in early 2006, with a revision of the report for minor typographical errors in January 2007. This process calculated statistical adjustments for age, height, and then volume based on comparisons of species composition, basal area, height, volume, and age between plot data and the photo-interpreted estimates (see Appendix A).

Standard adjustment methods were used to adjust volume, but non-standard methods were used for the age and height adjustment. The median age of the ground plots was used instead of the average age to provide more robust age estimates in old-growth stands. Using the median rather than the average age had little impact on site index and volume since these two variables are rather insensitive to a variation in age in old-growth stands. Non-standard top height trees (O and X trees) were used when no standard top height tree (T, L, and S trees) information existed. This significantly increased the number of valid height observations. Height adjustment ratios using the extra information were compared to the ratios based on the standard information only and shown to be similar in magnitude. The non-standard method therefore had little impact on the polygon-level height estimates. Using the extra information however provided more precise estimates and therefore a higher level of confidence that the average height in each stratum was reliable.

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

5.3 Inventory Volume Comparison to Billed Harvest Volume

An analysis of 2006-2017 harvesting was conducted to compare inventory estimates (generated using VDYP 7) to harvest billing system (HBS) data (see Table 4)

Table 4 –Inventory Volume by Species Compared to HBS

Species	Inventory		HBS[1]	
	Volume (m^3)	%	Volume (m^3)	%
Balsam (Ba)	1,378,438	17.7%	1,027,293	13.8%
Red cedar (Cw)	1,307,617	16.8%	1,612,274	21.6%
Yellow cedar (Yc)	742,964	9.5%	728,173	9.8%
Fir (Fd)	1,171,035	15.0%	1,341,921	18.0%
Hemlock (Hw/Hm)	3,170,898	40.7%	2,715,359	36.4%
Pine (Pl)	8,039	0.1%	10,027	0.1%
Spruce (Ss)	3,622	0.0%	8,762	0.1%
Deciduous (Dr)	12,397	0.2%	10,836	0.1%
Total	**7,795,010**	**100.0%**	**7,454,645**	**100.0%**

Overall for this sample, the inventory overestimated volume by 4.4%. At the species level, the inventory overestimated hemlock and balsam and underestimated cedar, cypress and fir. Given that 82% of the

[1] Production plus residue

harvested area was greater than 140 years old, the old strata inventory adjustments discussed in Section 5.2 and Appendix B reflect stand volumes.

5.4 LiDAR

WFP acquired Light Detection and Ranging (LiDAR) data for TFL 19 between 2015 and 2017. LiDAR is a remote sensing technique relies on measuring the time it takes a laser pulse to strike an object and return to the source. Typically, a laser scanner is flown in an airplane or helicopter, the exact location of which is tracked by a GPS satellite. State-of-the-art scanners can transmit and receive as many as 500,000 pulses of laser light per second, resulting in data that can be used to map the reflecting objects in three-dimensional detail.

In its early use within forestry, LiDAR was primarily used to generate an accurate digital elevation model (DEM) of the earth’s surface for forest road engineering and cutblock development. More recently it has become a powerful tool for assessing forest inventory attributes such as tree height, density and volume.

5.4.1 Stand Heights

The 2010 AAC determination for TFL 19 included discussion regarding site productivity estimates for immature natural stands (ages 46-120 years in 2006). For this analysis stands established between 1862 and 1960 (i.e. 58-156 years old) are considered immature natural stands. The upper end of the age range aligns with the young strata defined in the Phase 2 adjustments detailed in Appendix A and Appendix B.

Heights for these stands were generated using LiDAR data by determining the average height of the tallest 100 trees per hectare. This methodology of calculating a stand height is consistent with the VRI field sampling procedure for measuring top-height trees and represents dominant and co-dominant trees in the stand.

5.4.2 Site Index

For natural stands established between 1862 and 1960 (i.e. 58-156 years old) site index values are based on LiDAR height (see Section 5.4.1) and unadjusted age. This approach is applied to address the concerns expressed in the 2010 AAC determination regarding adjusted inventory site productivity estimates for immature natural stands (ages 46-120 years in 2006).

5.4.3 Crown closure

For natural stands established between 1862 and 1960 (i.e. 58-156 years old) crown closure values are based on LiDAR by applying the same methodology used to determine the Operational Adjustment Factor (OAF) for managed stands (refer to section 5.4.4 below): [Crown closure = 1 - OAF].

5.4.4 Operational Adjustment Factor

Using LiDAR data, a review of gaps in tree crown cover within 50-80-year-old operable polygons was conducted to determine the proportion of these stands not supporting tree growth. This factor is applied within TIPSY when generating managed stands yield tables to account for non-productive inclusions within the stands that are too small to be mapped in the forest inventory. Further details are in Section 8.3.1 and Appendix D.

5.5 Current Age Class Distributions

Table 5, Figure 3 and Figure 4 indicate the area-based age class distributions of the productive forest land base and the timber harvesting land base of TFL 19 as of December 31, 2018. Areas listed as zero years old are overstated because they include areas planted in 2018 but for which the species information was not yet available.

Table 5 – Forest Age Class Distribution

Age Class	Age range (years)	Forest Area (ha) Productive Forest	Forest Area (ha) THLB
1	0-20	20,212	18,534
2	21-40	20,783	15,699
3	41-60	7,086	4,796
4	61-80	3,851	1,911
5	81-100	1,270	581
6	101-120	940	378
7	121-140	3,634	1,217
8	141-250	14,024	4,571
9	>250	53,188	15,491
Total		**124,987**	**63,177**

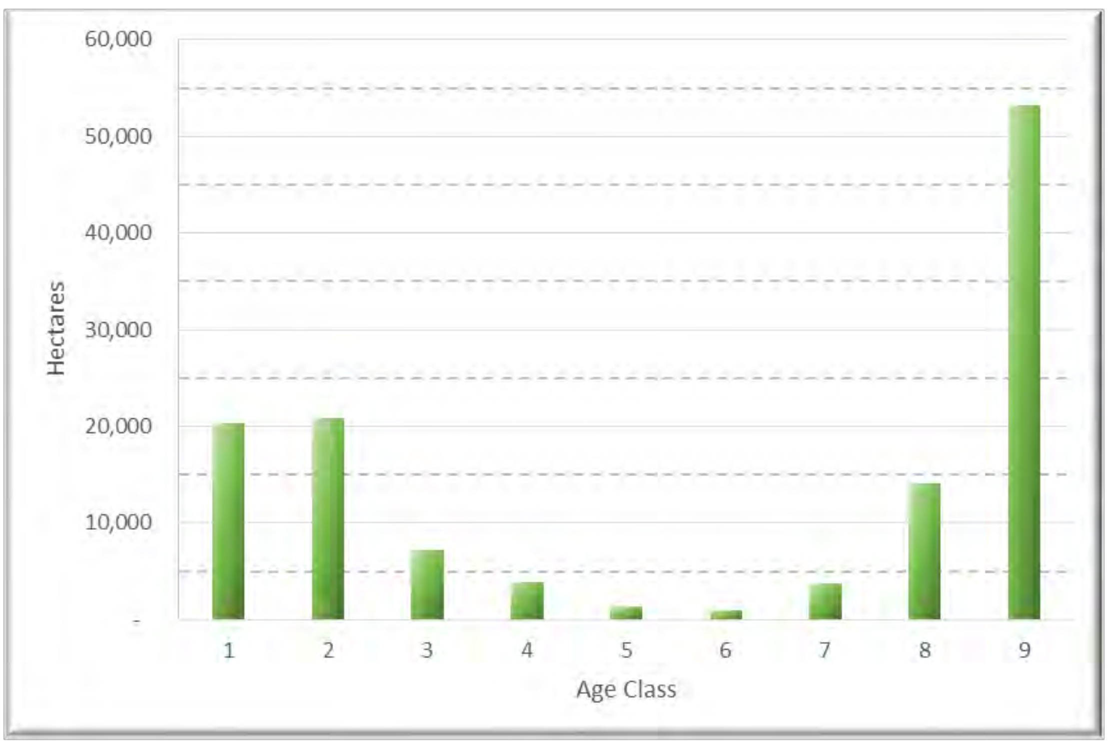

Figure 3 – Productive Forest Age Class Distribution

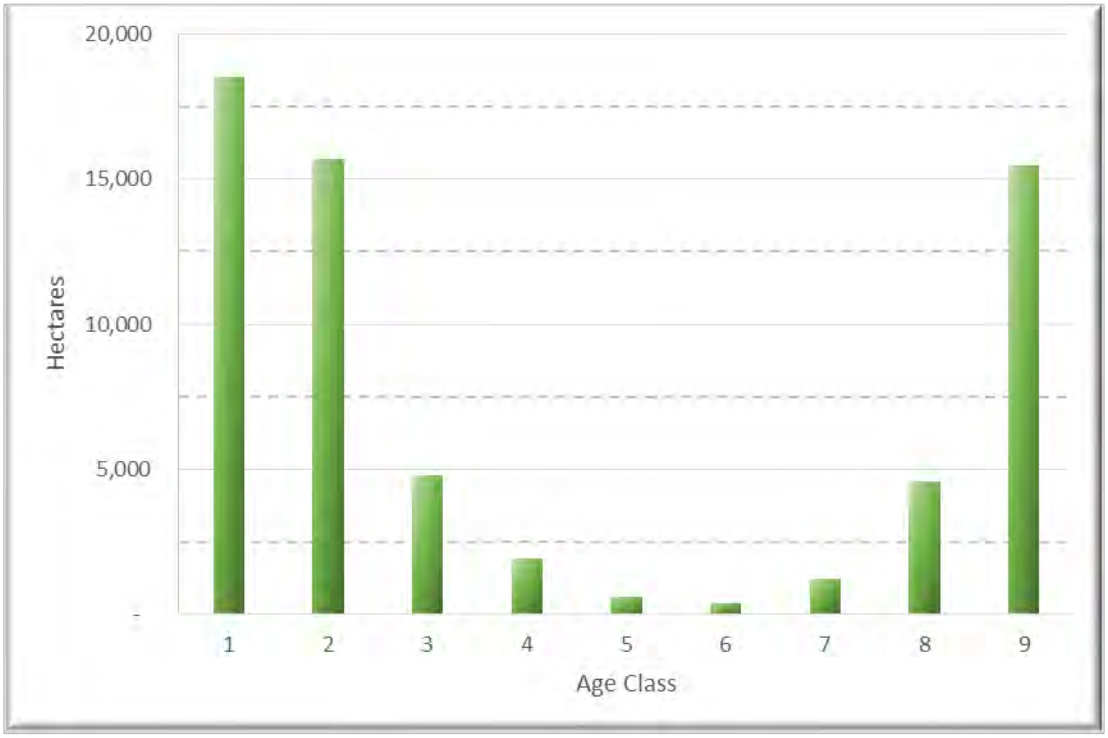

Figure 4 – THLB Age Class Distribution

5.6 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 2021: the mid-year of the first five-year planning period (i.e., 2019 – 2024). In areas recently harvested waiting reforestation the assumption is that that the new stand was established one year after harvest was completed (e.g., areas harvested in 2018 are reforested in 2019 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 19 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 19 was the reallocation of 41,837 m^3 of AAC from WFP to others: 19,385 m^3 to BCTS (for a new total of 65,253 m^3), 10,000 m^3 for woodlots and 12,152 m^3 to First Nations. WFP's AAC was reduced by 19,385 m^3 as of the end of 2004 and by a further 22,152 m^3 as of the end of 2005.

An area has been deleted from TFL 19 for the BCTS and woodlots allocations but not for the First Nations allocation. The Ehattesaht and Mowachaht/Muchalaht First Nations have been harvesting the First Nations allocation via non-replaceable forest licences.

In March 2012, 131.5 ha of land was deleted from TFL 19 and crown granted to WFP in exchange for transferring ownership of 179.8 ha of land in the vicinity of Scout and Antler Lakes to the Crown. The AAC for TFL 19 was reduced by 1,163 m^3/year to reflect the reduction in area.

6.2 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 19 are presented in Table 6, including the Schedule 'A' (Timber Licence) / Schedule 'B' (Crown land) split. Merchantable volume estimates are indicated in Table 7. Areas and volumes have been compiled from databases constructed for the preparation of this Information Package.

For MP #10 in 2008, land base reductions amounted to 54 percent of the total area of the TFL; however, there were forest cover constraints and aspatial netdowns applied that further reduced the effective THLB. Accounting for all netdowns being addressed spatially in MP #11, the effective THLB for MP #10 is estimated at 65,000 ha. For MP #11 the reductions are 107,942 ha or 63.1% percent of the total area, resulting in a THLB area of 63,177 ha. The largest changes are due to utilizing LiDAR to identify non-productive patches, low productivity patches and inoperable areas plus old growth management areas being spatially defined (rather than being an aspatial forest cover constraint as was done in MP #10).

The following sections show total area classified in each category noted in Table 6 and serve to summarize the area deducted from the land base in the order the categories appear in Table 6 (i.e., overlapping constraints are addressed in a hierarchy).

Table 6 - Land Base Netdown (ha)

Classification	Total Area (Ha)	Net Area (Ha)			% Total	% PFLB
		Schedule A	Schedule B			
		Timber Licence	Crown	Grand Total		
Total Land Base	**171,119**	**4,013**	**167,106**	**171,119**	**100.0%**	**-**
Less Non-forest	17,686	151	17,535	17,686	10.3%	-
Less Existing Roads & Powerlines	2,164	66	2,098	2,164	1.3%	-
Total Forested	**151,269**	**3,796**	**147,473**	**151,269**	**88.4%**	**-**
Less Non-productive	26,284	300	25,984	26,284	15.4%	-
Total Productive	**124,985**	**3,496**	**121,489**	**124,985**	**73.0%**	**100.0%**
Low Sites	44,393	410	16,237	16,647	9.7%	13.3%
Less Inoperable	68,965	549	16,826	17,375	10.2%	13.9%
Total Operable	**-**	**2,537**	**88,426**	**90,963**	**53.2%**	**72.8%**
Reductions:						
Riparian Management	7,154	82	2,536	2,618	1.5%	2.1%
Ungulate Winter Ranges	5,916	129	3,222	3,351	2.0%	2.7%
Old Growth Management Areas	22,238	203	7,366	7,569	4.4%	6.1%
Wildlife Habitat Areas - legal	2,520	24	150	174	0.1%	0.1%
Wildlife Habitat Areas - proposed	541	-	260	260	0.2%	0.2%
Uneconomic	78,396	119	3,196	3,315	1.9%	2.7%
Deciduous-leading	1,049	6	326	332	0.2%	0.3%
Recreation	6,874	3	86	89	0.1%	0.1%
Known Archaeological Sites	584	8	379	387	0.2%	0.3%
Unidentified Cultural Resource Features	-	4	39	43	0.0%	0.0%
Existing Stand-level Reserves	3,676	29	1,277	1,306	0.8%	1.0%
Karst	931	-	269	269	0.2%	0.2%
Terrain Stability	45,588	137	5,353	5,490	3.2%	4.4%
Future Stand-level Reserves	-	72	2,512	2,584	1.5%	2.1%
Total Operable Reductions	**-**	**816**	**26,971**	**27,787**	16.2%	22.2%
Current THLB	**-**	**1,721**	**61,455**	**63,177**	36.9%	50.5%
Less future roads	114	2	112	114	0.1%	0.1%
Long-term Land base	**-**	**1,719**	**61,343**	**63,062**	36.9%	50.5%

Table 7 – Timber Volume[1] Netdown ('000 m^3)

Classification	Total Volume	Net Volume: Schedule A Timber Licence	Net Volume: Schedule B Crown	Net Volume: Grand Total	% Total	% PFLB
Total Land Base	**55,128**	**1,419**	**53,709**	**55,128**	**100.0%**	**-**
Less Non-forest	458	37	420	457	0.8%	-
Less Existing Roads & Powerlines	386	11	375	386	0.7%	-
Total Forested	**54,284**	**1,371**	**82,914**	**54,285**	**98.5%**	**-**
Less Non-productive	3,780	43	3,737	3,780	6.9%	-
Total Productive	**50,504**	**1,328**	**49,177**	**50,505**	**91.6%**	**100.0%**
Low Sites	7,250	105	4,738	4,843	8.8%	9.6%
Less Inoperable	17,375	344	9,931	10,275	18.6%	20.3%
Total Operable	**-**	**879**	**34,508**	**35,387**	**64.2%**	**70.1%**
Reductions:						
Riparian Management	3,798	46	1,358	1,404	2.5%	2.8%
Ungulate Winter Ranges	4,185	108	2,584	2,692	4.9%	5.3%
Old Growth Management Areas	13,008	160	5,313	5,473	9.9%	10.8%
Wildlife Habitat Areas - legal	1,881	12	99	111	0.2%	0.2%
Wildlife Habitat Areas - proposed	245	-	82	82	0.1%	0.2%
Uneconomic	20,573	26	1,142	1,168	2.1%	2.3%
Deciduous-leading	313	2	83	85	0.2%	0.2%
Recreation	653	2	31	33	0.1%	0.1%
Known Archaeological Sites	321	2	219	221	0.4%	0.4%
Unidentified Cultural Resource Features	-	1	15	16	0.0%	0.0%
Existing Stand-level Reserves	2,350	16	851	867	1.6%	1.7%
Karst	273	-	105	105	0.2%	0.2%
Terrain Stability	20,884	59	2,833	2,892	5.2%	5.7%
Future Stand-level Reserves	-	21	986	1,007	1.8%	2.0%
Total Operable Reductions	-	**455**	**15,701**	**16,156**	**29.3%**	**32.0%**
Current THLB	-	**424**	**18,807**	**19,231**	**34.9%**	**38.1%**

[1] Data updated to the December 31, 2018 for logging and ages; therefore, volumes listed represent estimates at the end of 2018.

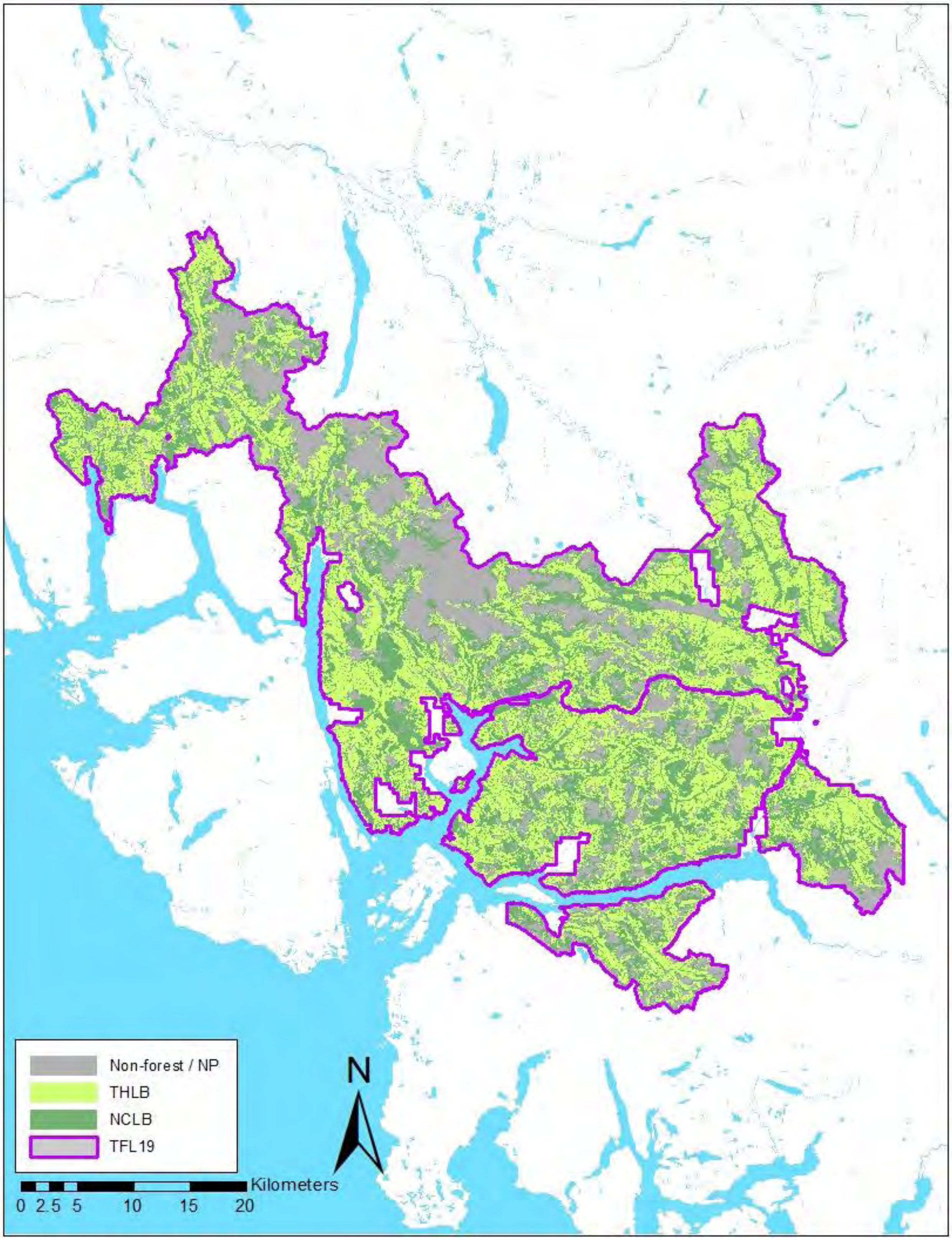

Figure 5 – Land Base Classification

6.3 Recently Harvested Cutblocks

Within cutblocks harvested or planned between 2006 and 2018 for which Site Plan Standard Unit (SU) spatial 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. 2006 was selected as this was the first year that harvest planning was conducted under the Western Forest Strategy (see Section 10.3.3)

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.

6.4 Non-Forest

The non-forest portion of TFL 19 includes areas where merchantable tree species are largely absent and most of the area is alpine, rock and wet areas (Table 8).

Table 8 - Non-forest Area

Description	Gross non-forest area (ha)	Area Reduction (ha)
Alpine	2,316	2,316
Brush	1,572	1,572
Industrial	197	197
Rock	11,205	11,205
Water	2,396	2,396
Total	***17,686***	***17,686***

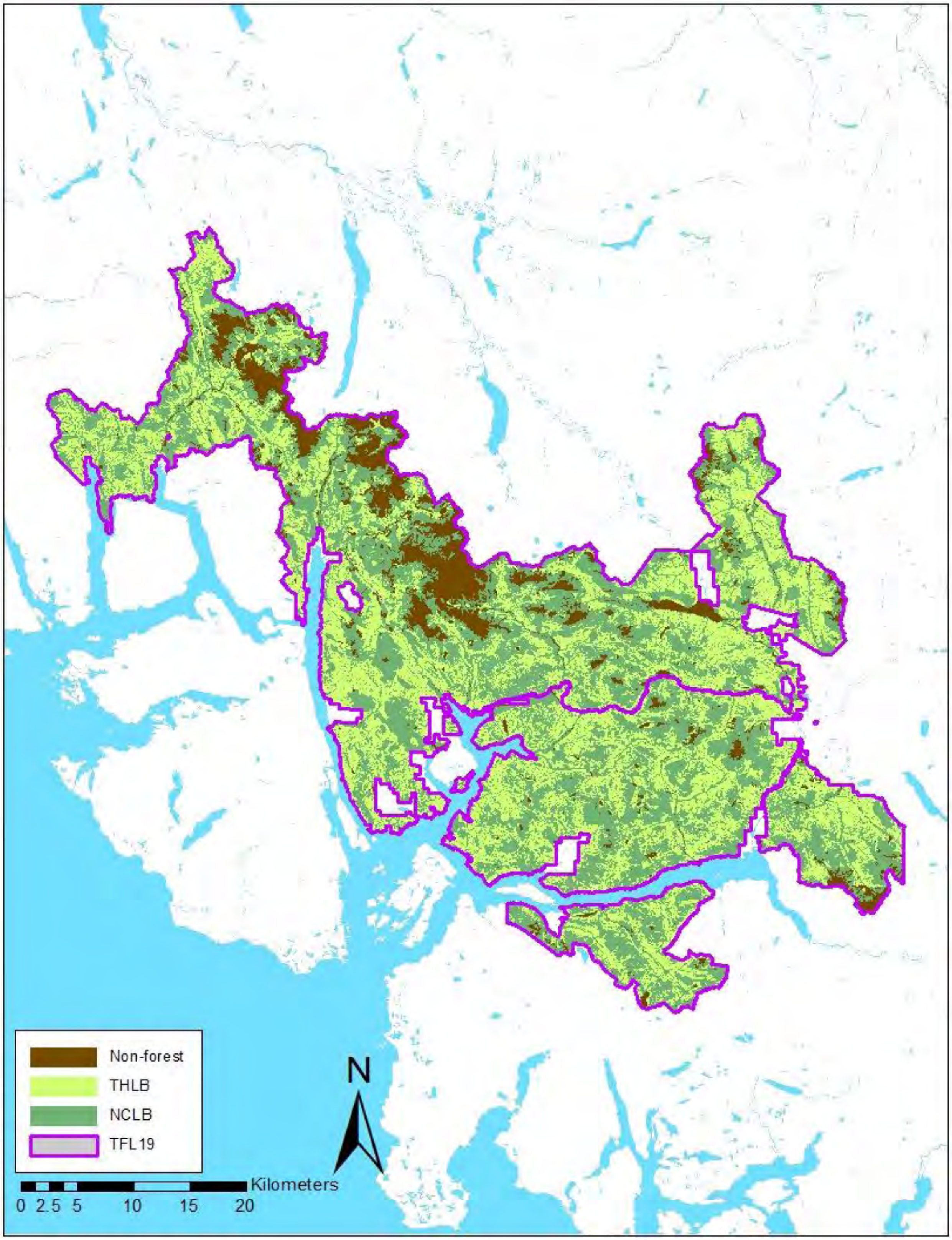

Figure 6 – Non-forest

6.5 Existing Roads and Powerlines

Existing roads and powerlines 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. A portion of Highway 28 south of Gold River is the only road 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:

- Highway – 30m
- Head Bay Forest Service Road – 12m
- Mainlines – 11m
- Spurs – 7m
- Unclassified – 2m
- Powerlines – 15m

The buffer widths applied for mainlines, spurs and unclassified roads are based on the results of a review conducted using LiDAR data acquired for TFL 19 between 2015 and 2017 included in Appendix C.

All trails and the majority of landings are rehabilitated and restocked following logging; therefore, the associated area reduction is considered to be insignificant. Table 9 summarizes the areas of existing roads in the TFL.

Table 9 - Existing Roads and Powerlines

Feature Class	Length (km)	Buffer Width (m)	Area Reduction (ha)
Highway 28	15	30	45
Head Bay FSR	89	12	107
Mainlines	558	11	492
Spurs	2,518	7	1,303
Unclassified roads	3	2	1
Powerlines	144	15	216
Total	***3,327***		***2,164***

6.6 Non-Productive Forests

TFL 19 includes 26,284 ha of non-productive forest (Table 10). These areas are mostly forest growing on poor sites. Non-productive forest was defined as immature forest with a site index of less than 5 m and mature and old forest with less than 200 m^3/ha standing volume. 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 10 - Non-productive Area

Description	Gross non-productive area (ha)	Area Reduction (ha)
Alpine Forest	15	15
Scrub forest	26,269	26,269
Total	***26,284***	***26,284***

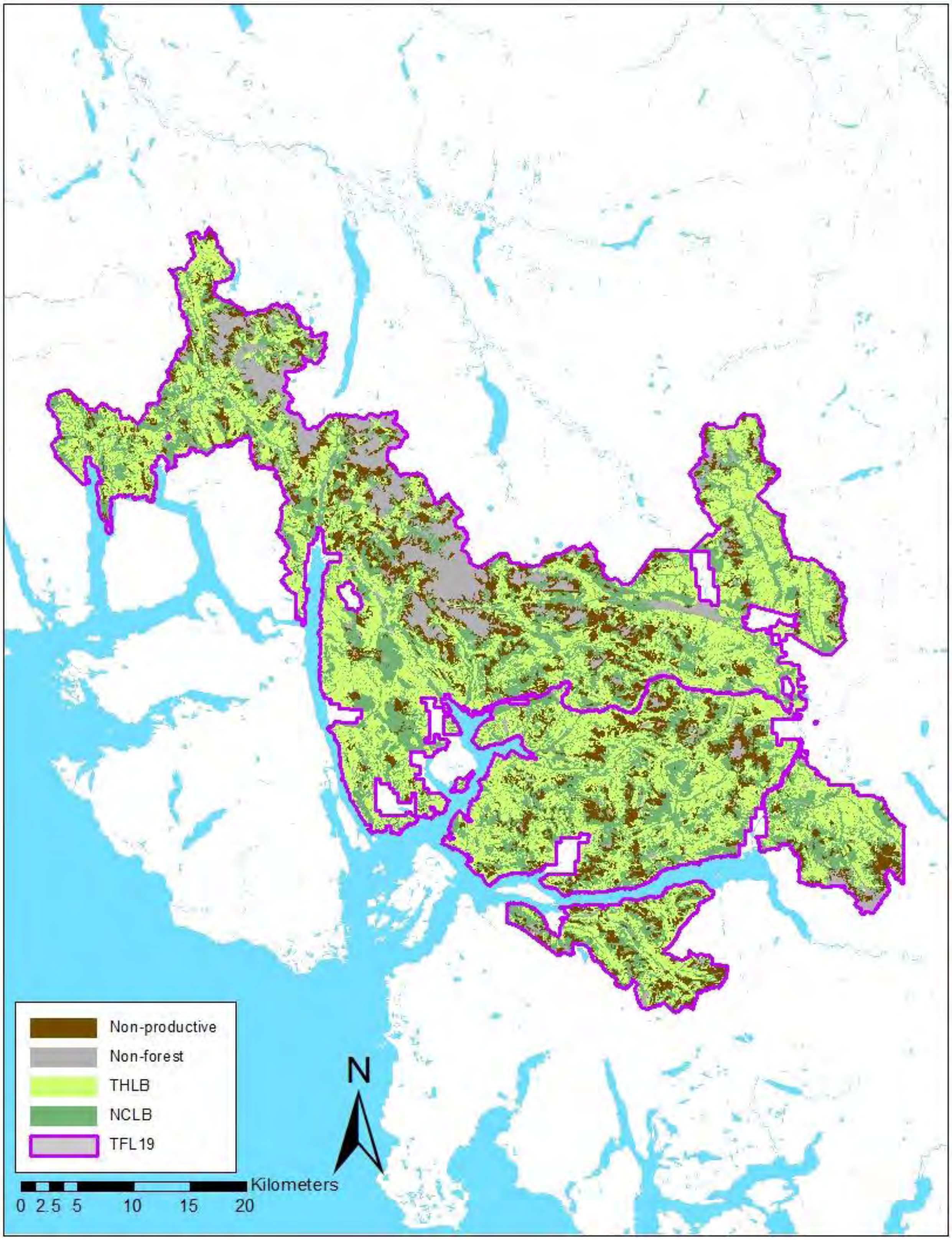

Figure 7 – Non-productive forest

6.7 Low Sites

Low sites are defined as old forest with volume less than 300 m^3/ha. These sites are considered productive forest but inoperable due to low stand volume.

Table 11 – Low Sites

Description	Gross low sites area (ha)	Area Reduction (ha)
Low sites	44,393	16,647
Total	***44,393***	***16,647***

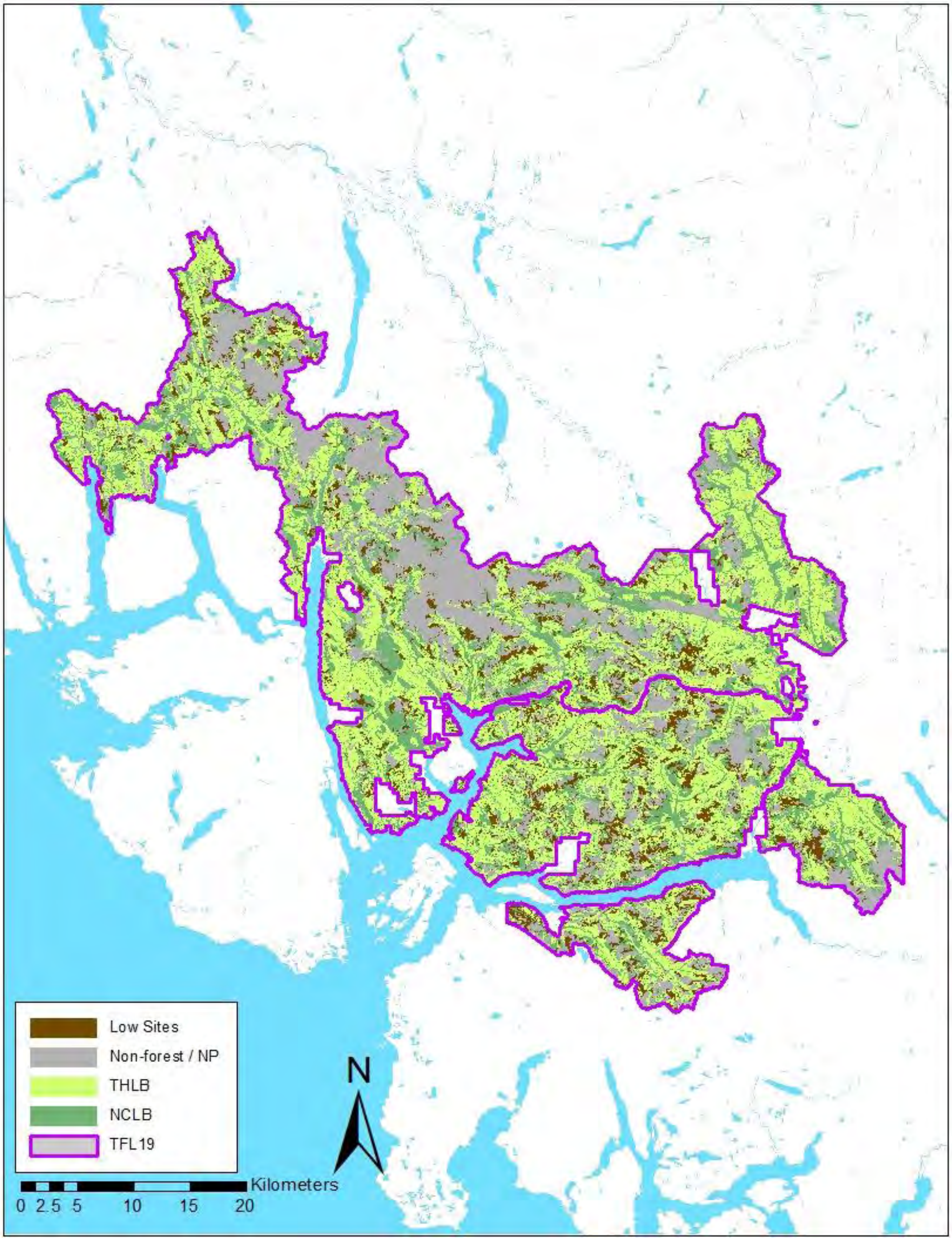

Figure 8 – Low Productivity Sites

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.

In preparation for MP #11, in 2018/19 mapping of physical operability was updated utilizing LiDAR data. Refer to Figure 9 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 12).

Table 12 - Area and Volume by Physical Operability Type

Description	Productive Area (ha)	Volume (000 m^3)	% of Productive Area	% of Productive Volume
Conventional	67,627	21,319	54%	42%
Non-conventional	23,332	14,076	19%	28%
Operable (subtotal)	***90,963***	***35,388***	***73%***	***70%***
Inoperable + Low Sites	34,014	15,117	27%	30%
Total	***124,987***	***50,505***	***100.0%***	***100.0%***

Table 13 compares the 2006-2018 harvest area by system against the MP #11 THLB area.

Table 13 – 2006-2018 Harvest Area by MP #11 Operability Type

Harvest System	% of Harvest Area	% of THLB Area
Ground	47.5%	31.1%
Cable	41.5%	52.4%
Conventional (subtotal)	***89.0%***	***83.4%***
Non-conventional	8.8%	16.6%
Inoperable	2.2%	-
Total	***100.0%***	***100.0%***

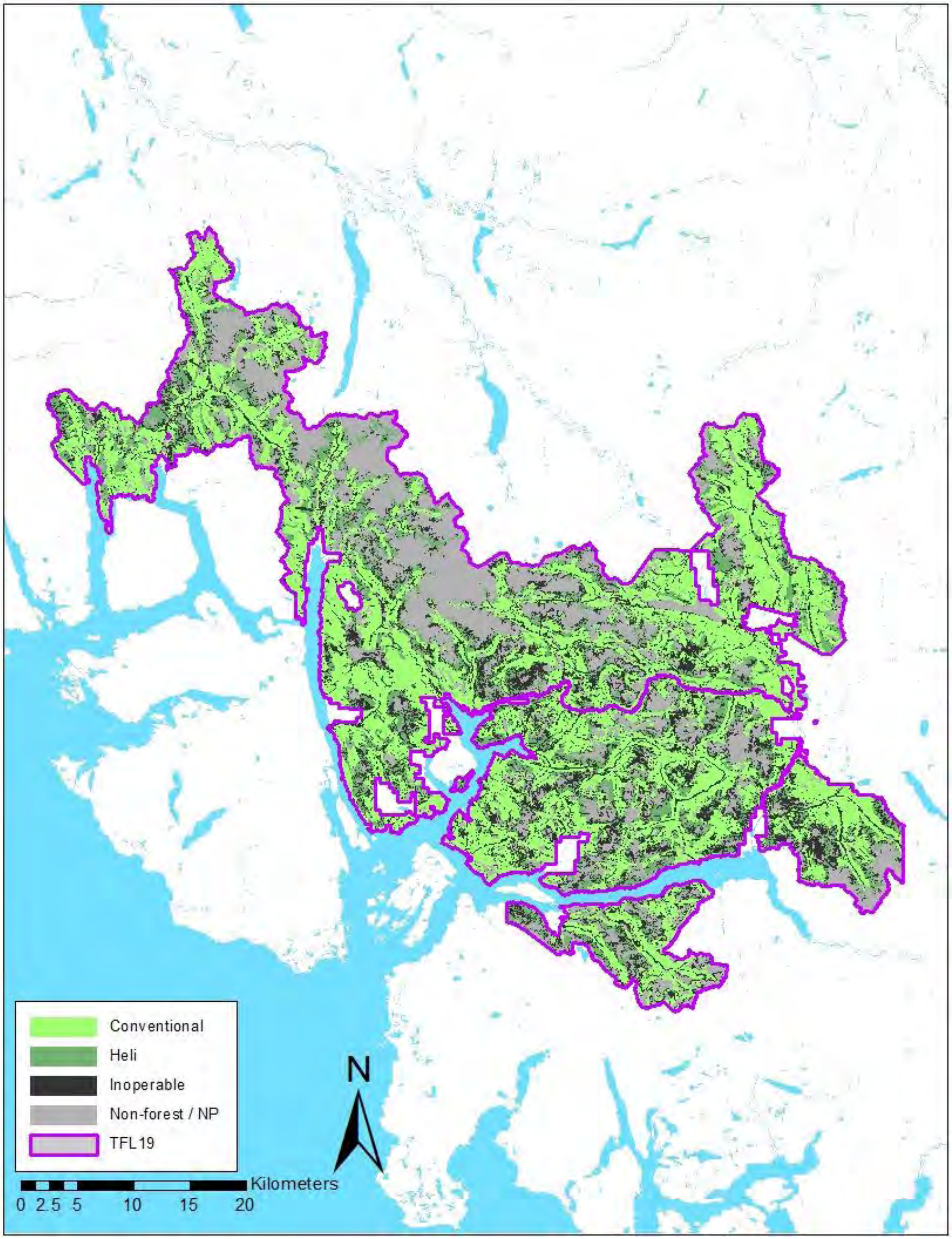

Figure 9 – Physical Operability Classes

6.9 Riparian Management Areas

Detailed riparian features mapping is on-going for TFL 19 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. 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 14. Retention levels were estimated based on a review of cutblocks harvested or planned between 1995 and 2017 plus classification of riparian features in and adjacent to the harvest area; nearly 1700 cutblocks totalling more than 23,500 hectares were reviewed. As most S2-S6 streams are represented by a line, effective management area widths also account for the stream body width.

A 40 m "reserve zone" will be applied to the ocean shoreline within TFL 19 to account for management of visual quality, operability issues and the presence of numerous eagle nests within this shoreline area.

Table 14 – Riparian Management Areas

Riparian Feature Class	Size Class	Reserve Zone (m)	Management Zone		Effective Management Area (m)[1]	Area Reduction (ha)
			Width (m)	Netdown (%)		
Streams	*Width (m)*					
S1-A	>=100	0	100	100	100	-
S1-B	>20.0 - 99.9	50	20	75	65	474
S2	>5.0 - 20.0	30	20	25	35	254
S3	>1.5 - 5.0	20	20	50	30	209
S4	<1.5	0	30	60	18	46
S5	>3.0	0	30	43	13	766
S6	<3.0	0	20	15	3	467
Lakes	*Area (ha)*					
L1-B	>5.0 - 999.9	10	0	0	10	30
L2 (dry zones)	1.0 - 5.0	10	20	90	28	-
L3 (wet zones)	1.0 - 5.0	0	30	50	15	8
Wetlands	*Area (ha)*					
W1	>5.0	10	40	75	40	15
W2 (dry zones)	1.0 - 5.0	10	20	45	19	4
W3 (wet zones)	1.0 - 5.0	0	30	43	13	6
W4 (dry zones)	0.5 - 1.0	0	30	17	5	1
W5	>5.0	10	40	18	17	2
Ocean	N/A	40	0	0	40	336

[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

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. The most recent revisions to the UWRs for TFL 19 were approved by government in December 2004 (U-1-014). 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. With the deletion of the private land from the TFL in January 2007, a total of 163 ha of UWR was removed from the TFL. A total of 189 ha of replacement UWR was identified within TFL 19 and was legally established on November 9, 2007.

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 15 and Figure 10 for the area currently designated as UWR and the associated reduction to the THLB.

Table 15 - Ungulate Winter Ranges

Ungulate Species	Productive UWR Area (ha)	Area Reduction (ha)
Deer	3,052	2,080
Elk	2,202	1,271
Total	***5,254***	***3,351***

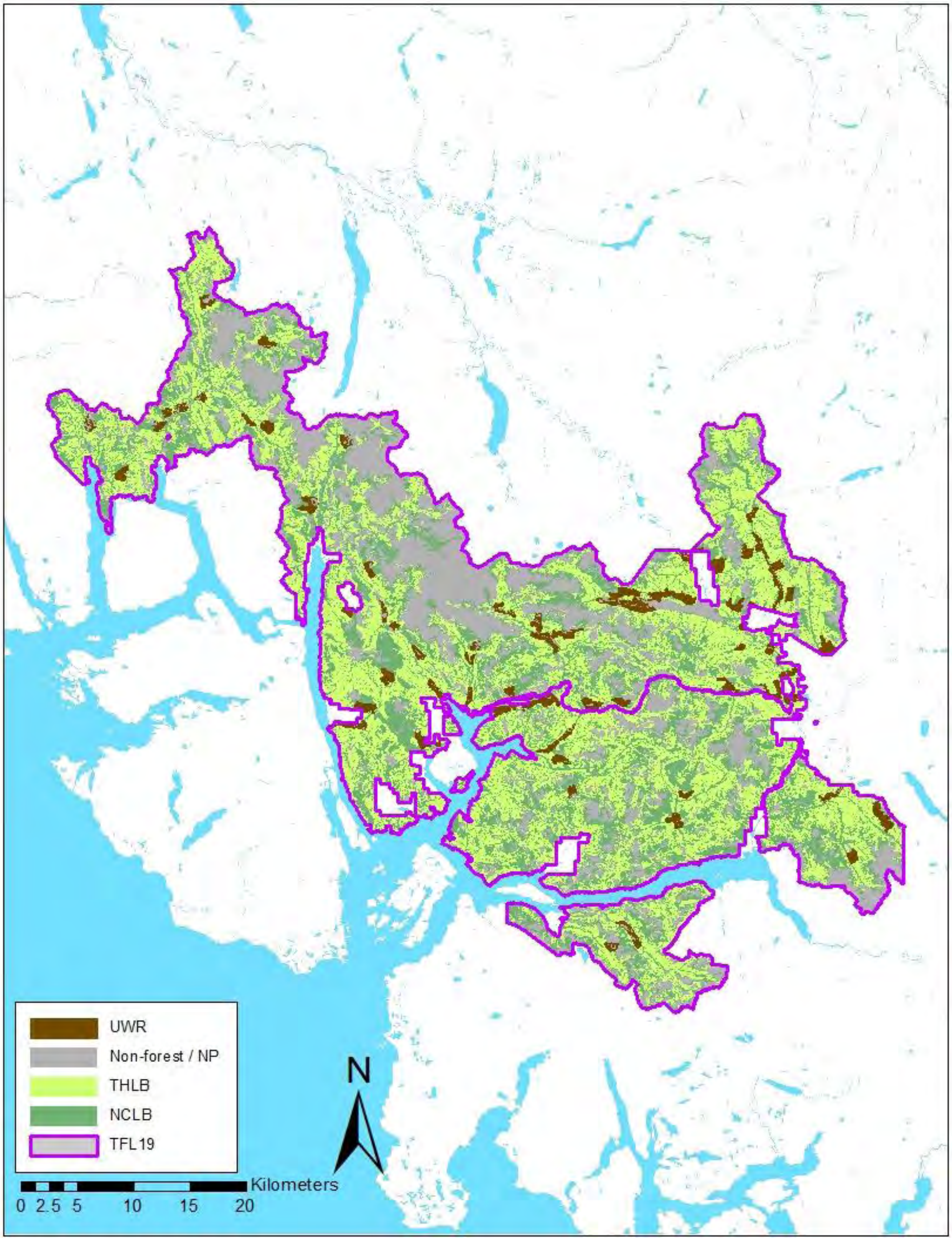

Figure 10 – Ungulate Winter Ranges

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 two-thirds to the extent necessary to address impacts on timber supply.

Seven landscape units are found within TFL 19. Proposed OGMAs have been identified to meet the NSOG order (see Figure 11), including recruitment of old forest to meet the full target in landscape units with a Low BEO. These areas do not contribute to timber supply in the model.

These proposed OGMAs will be used in the timber supply analysis but must complete a public and First Nations' review process before becoming legal. Refer to Table 16 for a summary of the area identified as OGMA and the impact to the THLB.

Table 16 - Old Growth Management Areas

Landscape Unit	BEO	OGMA Status (April 2019)	OGMA Area (ha)	
			Productive	Area Reduction
Burman	Low	Proposed	447	126
Eliza	Low	Proposed	793	432
Gold	High	Proposed	6,043	2,358
Kleeptee	Low	Proposed	1,790	749
Tahsis	Low	Proposed	3,062	1,603
Tlupana	Intermediate	Proposed	4,214	1,522
Zeballos	Low	Proposed	1,779	779
OGMAs Total			***18,128***	***7,569***

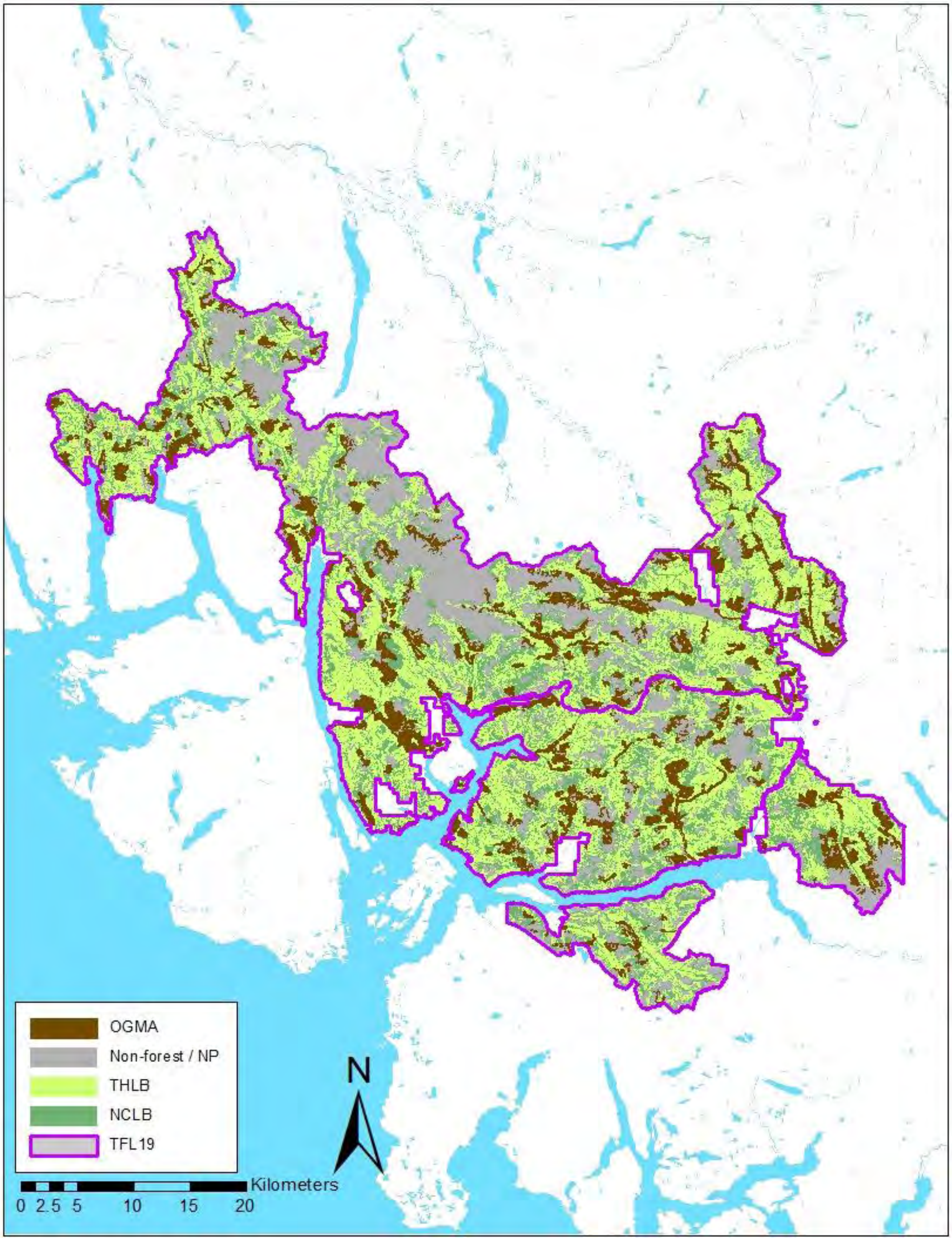

Figure 11 – Old Growth Management Areas

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.

6.12.1 Legally Established WHAs

At the time the timber supply analysis data set was put together a total of thirty-six WHAs had been approved within the boundaries of TFL 19 (Figure 12). The WHAs have a total area of 2,352 ha and encompass 2,327 ha of productive forest (see Table 17). The majority of the WHAs are incorporated into OGMAs, thereby reducing the incremental THLB netdown impact of the WHAs.

Table 17 – Established Wildlife Habitat Areas

WHA ID	Species	Productive Wildlife Habitat Area (ha)	Area Reduction (ha)
1-001	Keen's Long-eared Myotis	29	0
1-086	Northern Goshawk	32	0
1-088	Northern Goshawk	127	0
1-090	Northern Goshawk	146	0
1-094	Northern Goshawk	114	0
1-095	Northern Goshawk	163	0
1-225	Marbled Murrelet	15	0
1-230	Marbled Murrelet	129	0
1-231	Marbled Murrelet	61	0
1-232	Marbled Murrelet	66	0
1-232a	Marbled Murrelet	32	0
1-232b	Marbled Murrelet	11	0
1-238	Marbled Murrelet	58	0
1-239	Marbled Murrelet	142	0
1-242	Marbled Murrelet	47	0
1-243	Marbled Murrelet	71	0
1-244	Marbled Murrelet	111	0
1-245	Marbled Murrelet	44	0
1-246	Marbled Murrelet	31	0
1-247	Marbled Murrelet	37	0
1-272	Marbled Murrelet	78	0
1-395	Keen's Long-eared Myotis	54	48
1-539	Marbled Murrelet	28	3
1-547	Marbled Murrelet	19	1
1-548	Marbled Murrelet	42	27
1-555	Marbled Murrelet	69	35
1-559	Marbled Murrelet	49	0
1-560	Marbled Murrelet	38	6
1-562	Marbled Murrelet	157	3
1-563	Marbled Murrelet	105	34
1-564	Marbled Murrelet	75	15

WHA ID	Species	Productive Wildlife Habitat Area (ha)	Area Reduction (ha)
1-566	Marbled Murrelet	20	1
1-580	Marbled Murrelet	76	0
Total		***2,276***	***173***

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#9 data and is different than the impacts indicated in Table 17.

6.12.2 Pre-Approval WHAs

At the time the timber supply analysis data set was put together there were two pre-approval WHAs within the boundaries of TFL 19 (Figure 12 and Table 18). The pre-approval WHAs are moving through the approval process and should be approved in the near future.

Table 18 – Pre-Approval Wildlife Habitat Areas

WHA ID	Species	Productive Wildlife Habitat Area (ha)	Area Reduction (ha)
1-489	Quatsino Cave Amphipod	457	243
1-553	Marbled Murrelet	24	17
Total		***481***	***260***

6.12.3 Impending Land Use Order for Marbled Murrelet

The BC Marbled Murrelet Implementation Plan was released in February 2018. One of the key actions is issuing an Order under the *Land Use Objectives Regulation* for suitable Marbled Murrelet habitat protection. While originally schedule for fall 2018, it is now expected the Order will be in place by the end of 2019. The amount of suitable habitat being retained will increase with the Order. There will also be a requirement for 80% of the habitat to be spatialized and a currently undetermined proportion of the spatial polygons will have to be in patches greater than 20 ha with forest interior conditions. This Order will trigger a redesign of OGMAs to replace OGMAs that only have a representation value with OGMAs of sufficient size with suitable marbled murrelet habitat. If sufficient detail is available when the timber supply analysis is being conducted, a sensitivity analysis will be conducted to estimate the timber supply impact of the impending Order.

6.12.4 Northern Goshawk

The BC Northern Goshawk Implementation Plan was released in February 2018. The key short-term action item is increasing the number of WHAs on Vancouver Island by 30. At this time, we have 4 goshawk WHAs in TFL 19 and currently there are no new WHAs being discussed.

Other species identified in the FPPR Section 7 notice for Campbell River District include Red-legged frogs, Coastal tailed frogs and Great blue herons. While WHAs may be established within TFL 19 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 above existing retention areas.

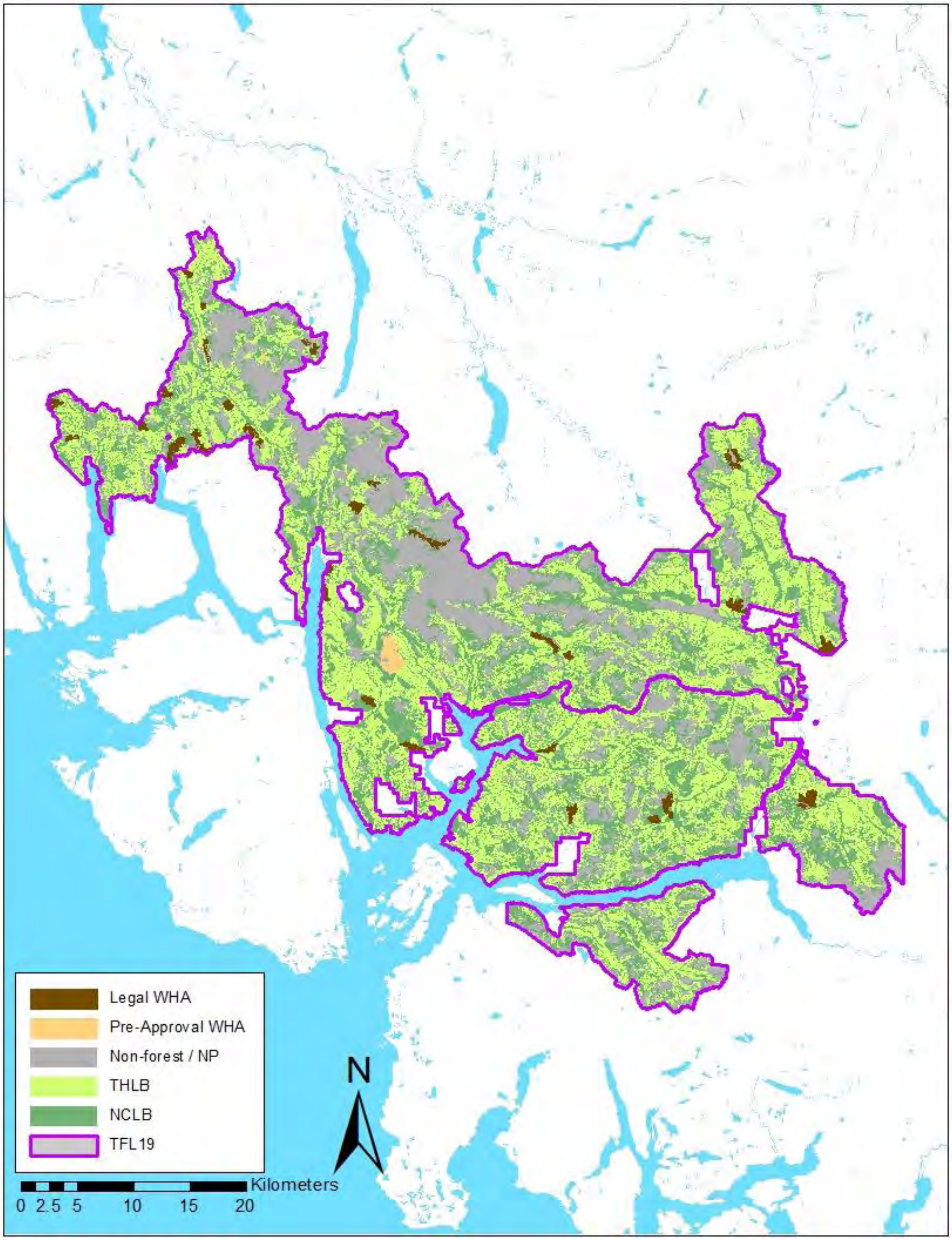

Figure 12 –Wildlife Habitat Areas

6.13 Economic Operability

Mapping of the economic operability was updated in 2018/2019 in preparation for MP #11. 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.

Utilizing the LiDAR-based physical operability (see Section 6.7), for this analysis all conventionally operable area is assumed to be economic to harvest at some point in the market cycle once minimum harvest criteria is met. To determine economically operable non-conventional area, an analysis of forest inventory attributes and flight distances for areas heli harvested between 2015 and 2018 was conducted. This time period was selected as it was the peak of the market cycle and should indicate the lowest value stands that can be expected to be harvested using non-conventional systems. The analysis results are presented in Table 19.

Table 19 – Inventory Attributes for Non-conventional Economic Operability

	Marginal		Economic	
Flight Distance (m)	**Minimum Volume (m3/ha)**	**Minimum Cw+Fd+Yc component**	**Minimum Volume (m3/ha)**	**Minimum Cw+Fd+Yc component**
0 - 499	300	25%	400	20%
500 – 999	380	20%	410	20%
1000 +	460	20%	500	20%

Stands removed from the THLB as uneconomic are summarized in Table 20 and indicated in Figure 13. A sensitivity analysis will test the impact of removing marginally economic stands from harvest.

Table 20 - 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	84,408	32,890	-	-
Marginal	2,494	1,004	-	-
Operable (subtotal)	***86,902***	***33,894***	**-**	**-**
Uneconomic	38,085	16,611	3,315	1,168
Total	***124,987***	***50,505***	***3,315***	***1,168***

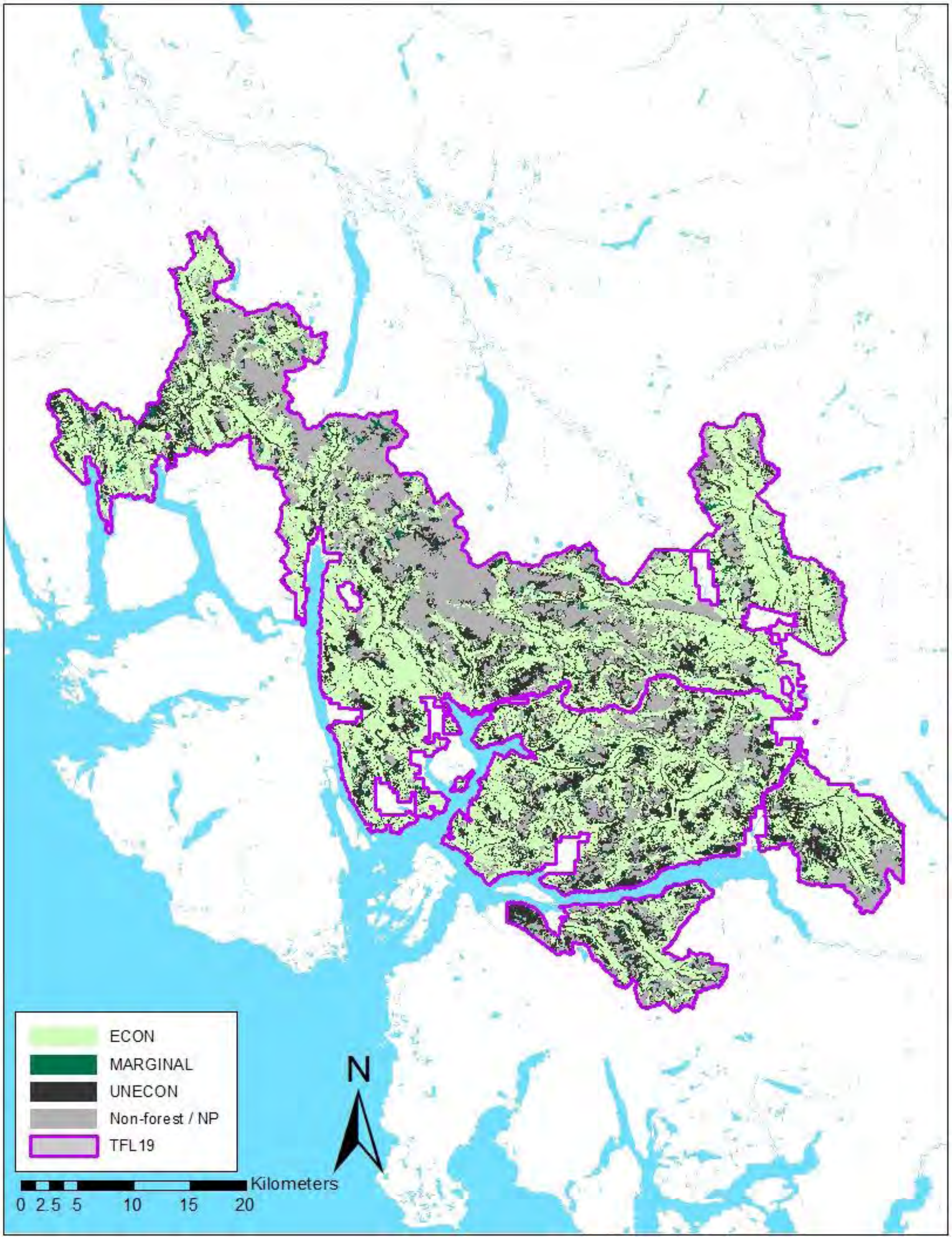

Figure 13 – Economic Operability Classes

6.14 Deciduous-leading Stands

Table 21 and Figure 14 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.

Table 21 - Area of Deciduous Forest Types

Description	Productive Deciduous Area (ha)	Area Reduction (ha)
Deciduous-leading stands	856	332

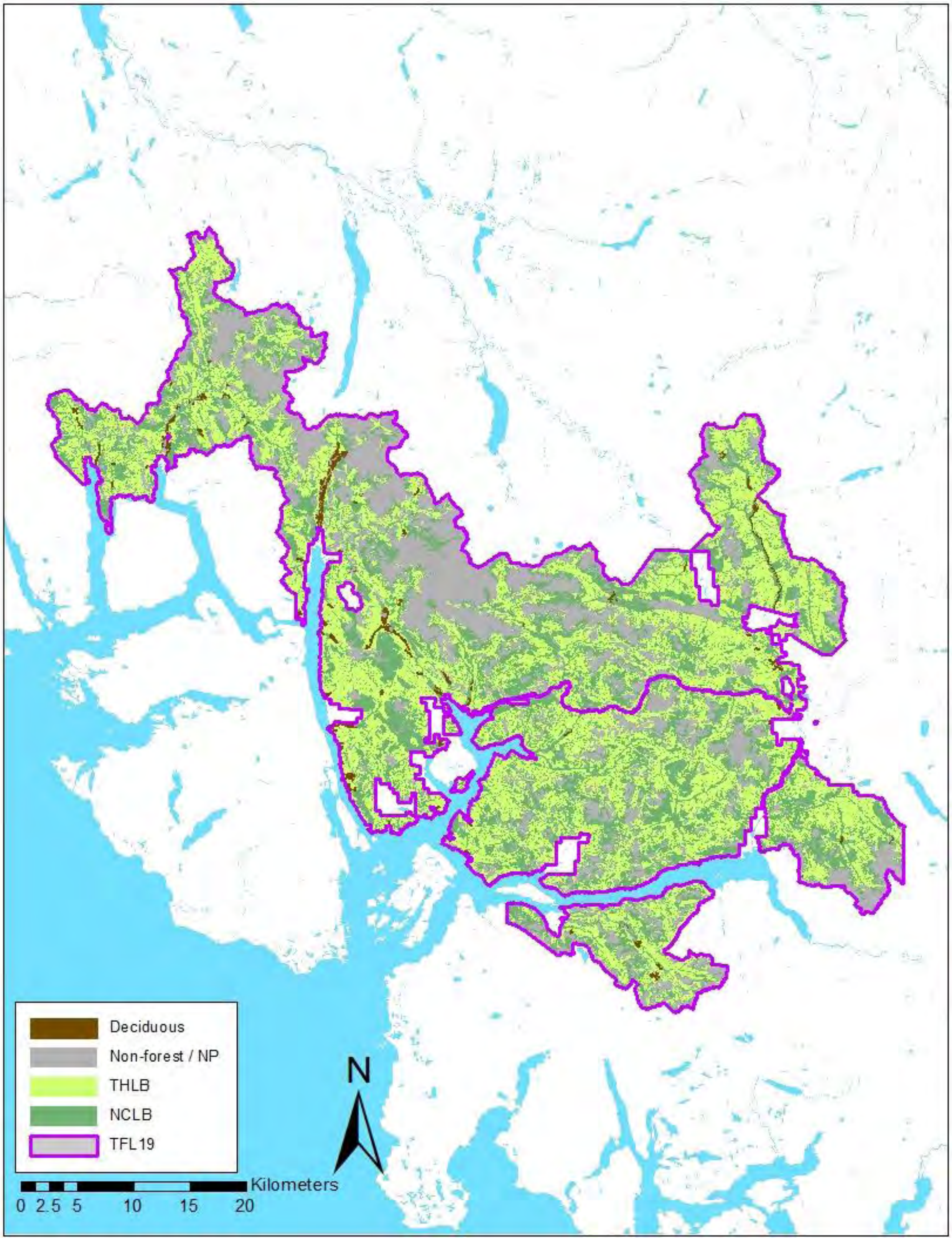

Figure 14 – Deciduous-leading stands

6.15 Recreation Features

On April 12, 2006, a Government Actions Regulation (GAR) Order was established to identify Recreation Resource Features for the Campbell River Forest District. Many of the TFL 19 polygons in the Order correspond to areas identified in the TFL 19 recreation features inventory, with the majority located in areas that are non-forested or non-productive forest. All recreation sites were removed from the THLB while trails had a 10m buffer added to each side to create an area to remove from the THLB.

Table 22 – Recreation Features

Description	Productive Recreation Area (ha)	Area Reduction (ha)
Sites	1,171	83
Trails	9	6
Total	***1,180***	***89***

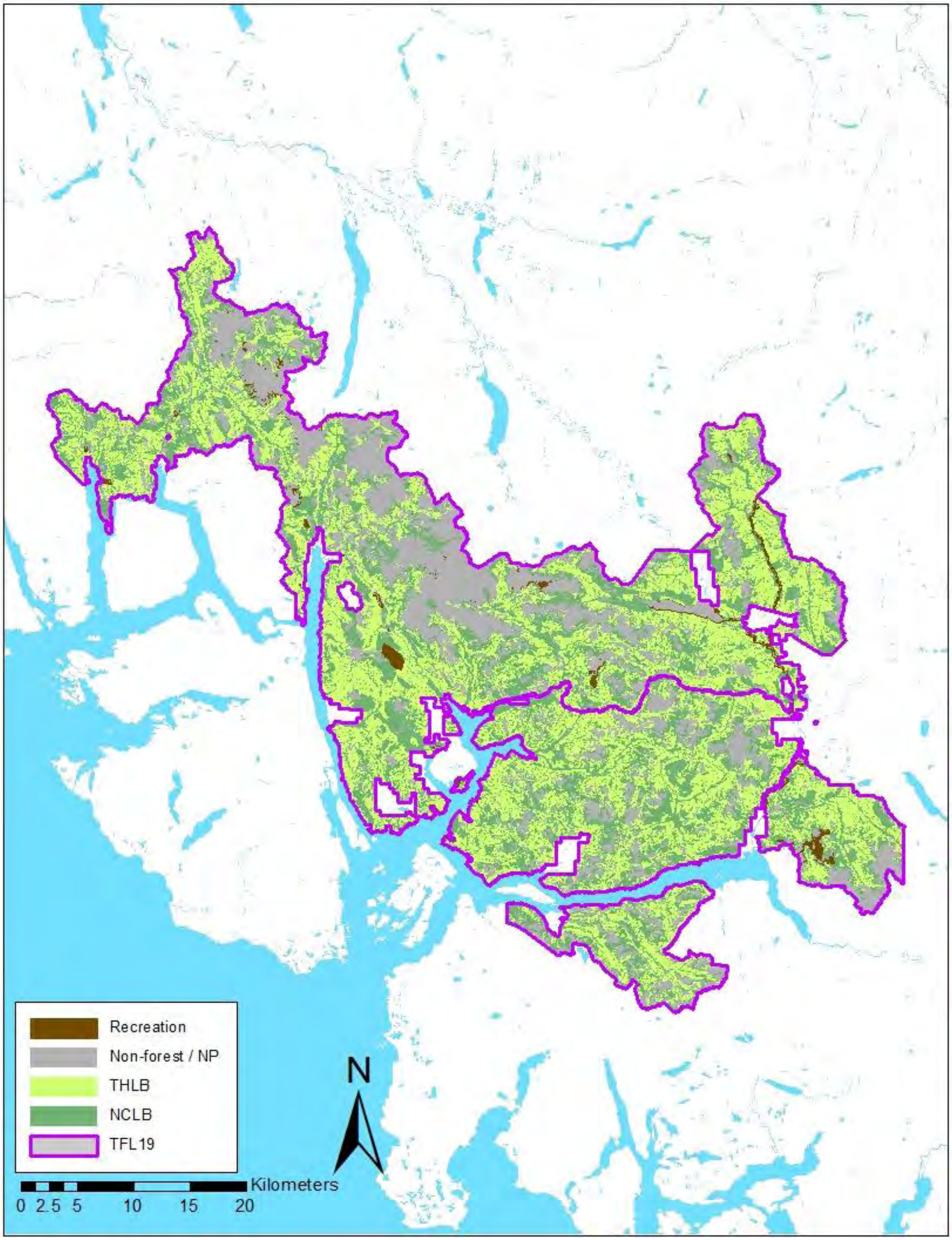

Figure 15 – Recreation Features

6.16 Cultural Heritage Resources

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 19 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 19 are culturally modified trees (CMTs). These are trees that have been modified by indigenous 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 23 and Figure 16). To address the THLB impacts of protecting unidentified cultural heritage resources a 1% incremental netdown will be applied to the portion of TFL 19 that is within 1 km of the ocean where no other netdowns apply; elsewhere it is assumed that management of cultural heritage resources is addressed by other netdowns (mainly stand-level retention). The 1% incremental netdown is an estimate of the incremental area retained specifically to conserve CMTs and other cultural heritage resources that is not addressed by other netdowns including stand-level retention discussed in the next section and in Section 6.20.

Table 23 – Cultural Heritage Resources

Description	Productive Area (ha)	Area Reduction (ha)
Archaeological Sites	534	387
1 km ocean buffer	-	43
Total	-	430

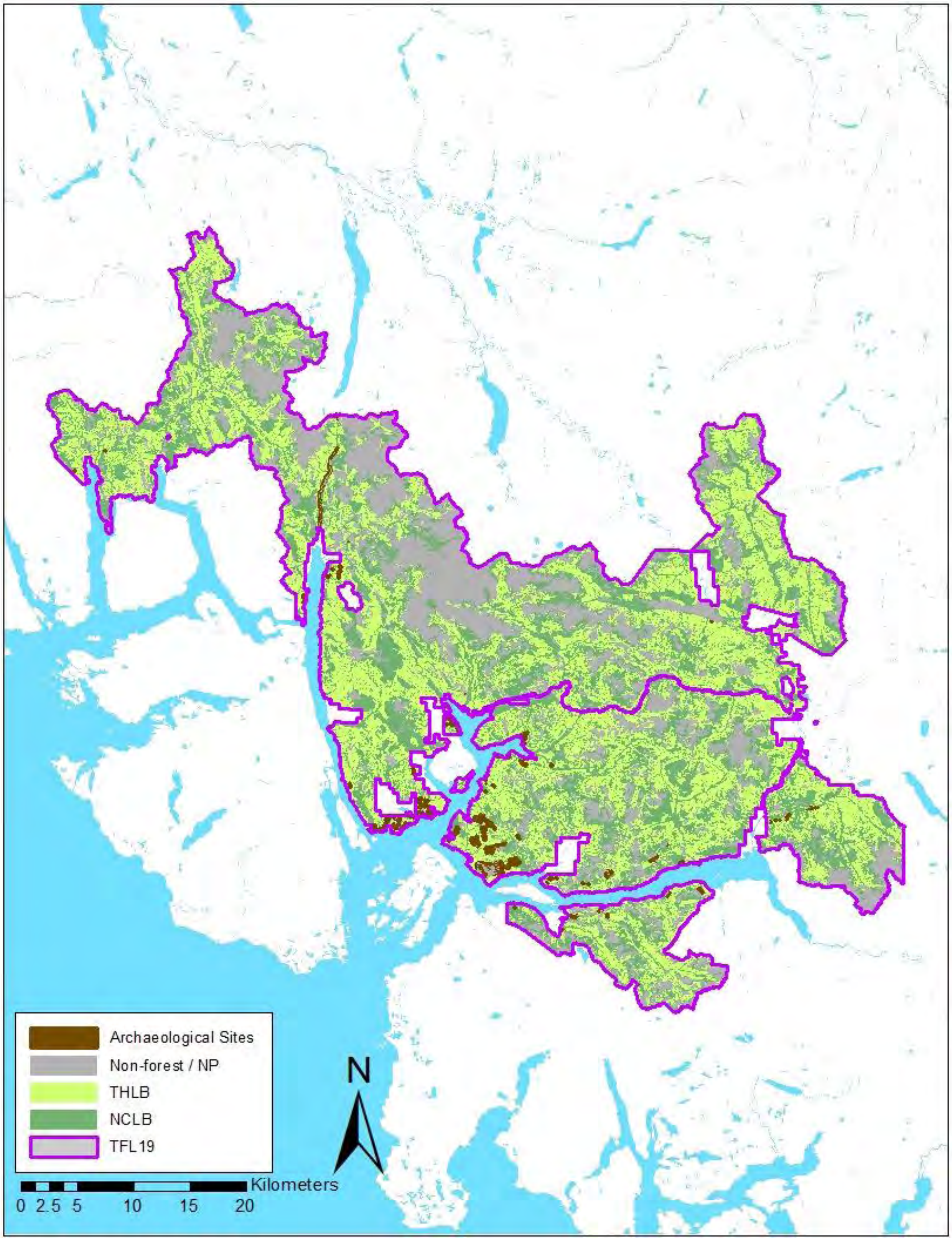

Figure 16 – Archaeological Sites

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 24 and Figure 17, the assumption being that these areas will be retained again in future harvest operations.

Table 24 – Existing Stand-level Retention

Description	Productive Retention Area (ha)	Area Reduction (ha)
Existing stand-level retention	3,340	1,305

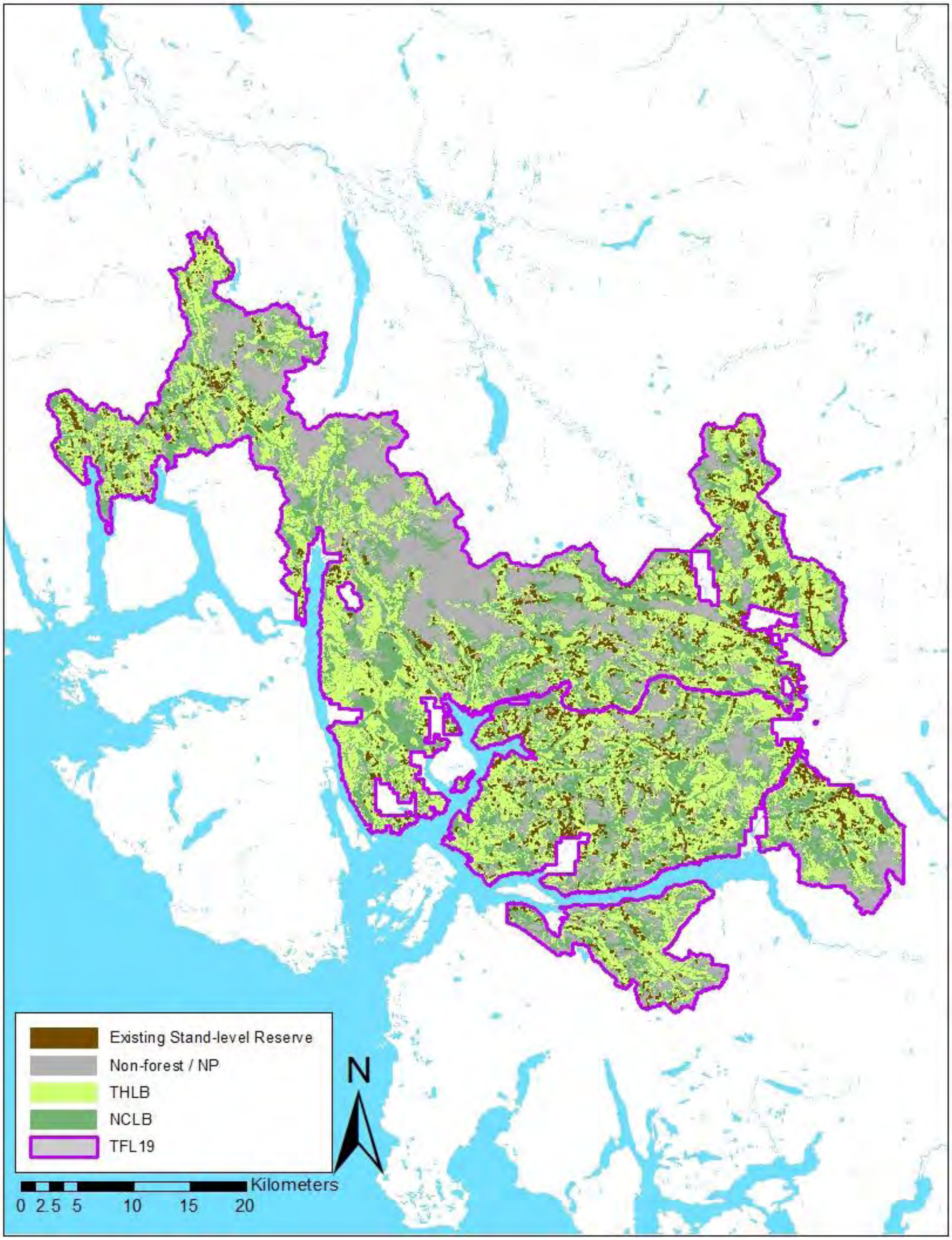

Figure 17 – Existing Stand-level Reserves

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 Campbell River Resource District (within which TFL 19 is located) issued a GAR Order in 2007 identifying the following as karst resource features:

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

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 2003, a planning-level karst inventory was completed for TFL 19 that identified, among other things, the karst vulnerability potential (KVP) of areas within the TFL (see Figure 18). For this analysis, karst polygons rated as very high and high vulnerability will be netted down at 100%. This is representative of possible impacts of managing karst resources as it is recognized that areas may be reserved in lower vulnerability classes and that not all areas will need to be reserved in very high and particularly high vulnerability classes. Table 25 presents the productive forest area by KVP class and the resulting area removed from the THLB.

Table 25 – Karst Inventory Netdowns

Karst Vulnerability	Productive Area (ha)	Area Reduction (ha)
High	476	242
Very high	109	27
Total	***585***	***269***

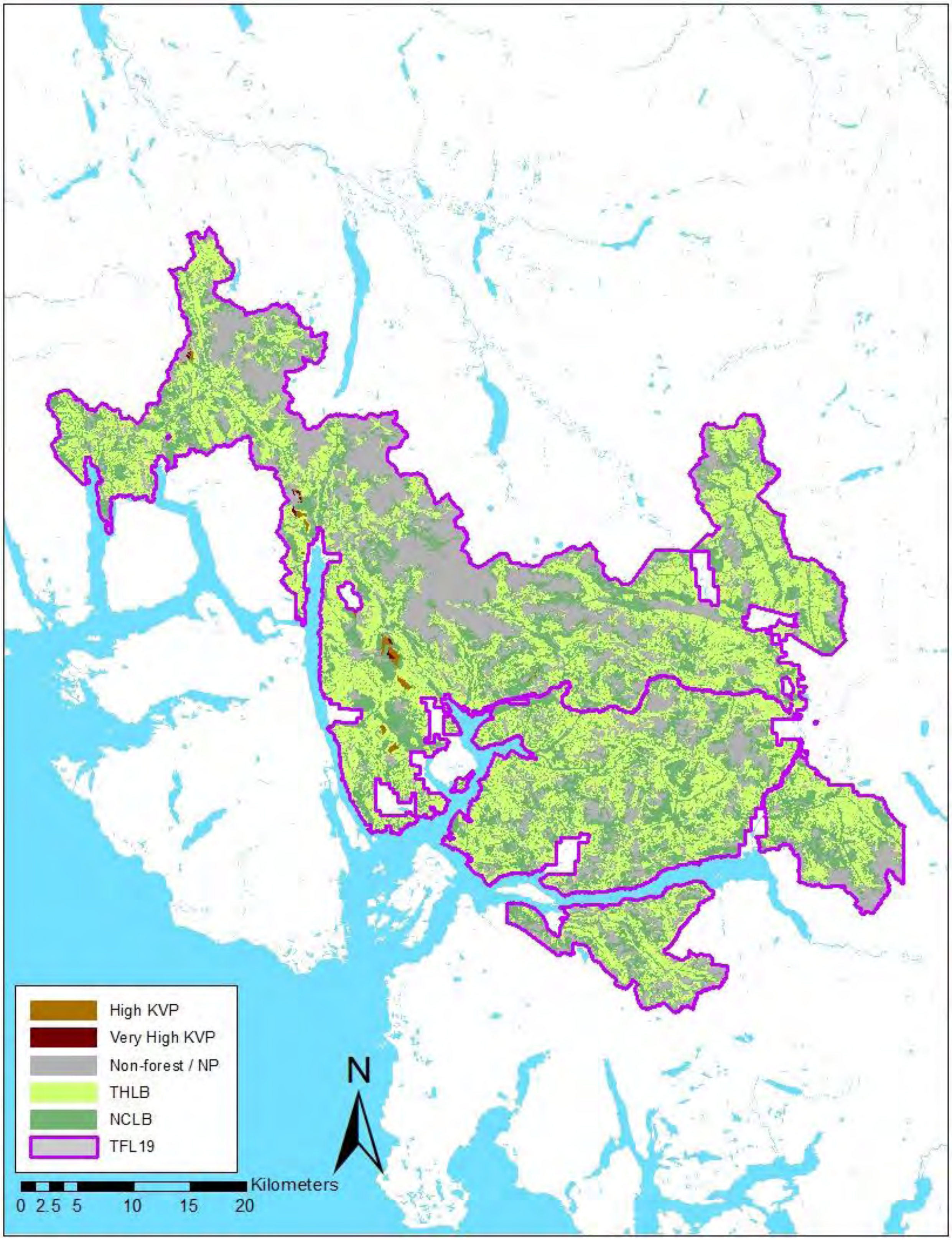

Figure 18 – Karst Vulnerability Classes

6.19 Terrain Stability

Detailed terrain stability mapping was completed for TFL 19 in 1997 at a scale of 1:20,000. Areas were classified into one of five classes of likelihood for post-harvest instability:

- Class 1 – no likelihood of post-harvest instability
- Class 2 – very low likelihood of post-harvest instability
- Class 3 – low likelihood of post-harvest instability
- Class 4 – moderate likelihood of post-harvest instability
- Class 5 – high likelihood of post-harvest instability

No netdowns are applied to Class 1, 2 and 3 polygons. Percent reductions for Classes 4 and 5 are based on recent operational experience and netdowns applied within other WFP TFLs. Cutblocks on class 4 terrain typically require 20% area reductions. Nearly all class 5 terrain is removed in the netdown process, with 570 ha remaining within the THLB.

Table 26 and Figure 19 indicate the area by stability class and the netdowns associated with various classifications.

Table 26 - Terrain Stability Netdowns

Terrain Stability Class (likelihood of post-harvest landslide)	Area Netdown %	Productive Area (ha)	Area Reduction (ha)
4 (moderate)	20%	29,270	2,934
5 (high)	90%	9,298	2,557
Total		***38,568***	***5,491***

Table 27 compares the 2006-2018 harvest area by terrain class against the MP #11 THLB area.

Table 27 – 2006-2018 Harvest Area by Terrain Stability Class

Terrain Class	% of Harvest Area	% of THLB Area
1	3.7%	7.1%
2	13.5%	9.6%
3	60.2%	60.1%
4	20.6%	22.2%
5	2.0%	1.0%
Total	***100.0%***	***100.0%***

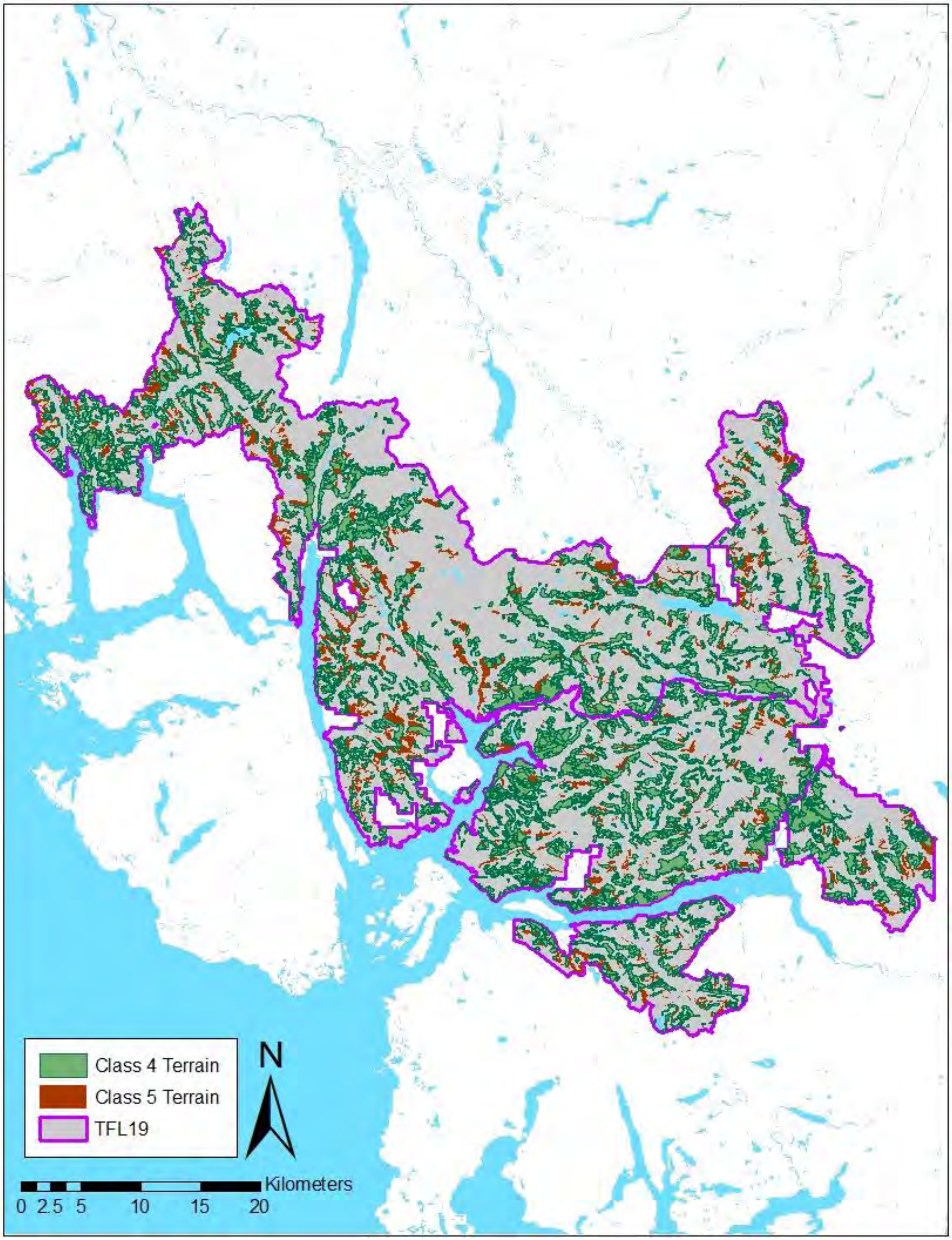

Figure 19 – Terrain Stability Classes

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 Class 4 and 5 terrain. As no land use orders nor landscape unit plans have established WTRA objectives, FPPR section 66 applies; therefore, a minimum 7% WTRA is required.

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 (1995-2017) used to derive the riparian management areas (Section 6.9) indicated that 30% of the stand-level retention was located on otherwise harvestable land base. Therefore a 2% area netdown (0.3 * 7% ≈ 2%) is applied to account for future WTRA requirements (see Table 28).

6.20.2 Additional Stand-level Retention

As detailed in Section 10.3.3 applying the retention silviculture system as part of WFP's Stewardship and Conservation Plan (WSCP) results in at least 42 percent of the harvest area in TFL 19 being within retention system cutblocks (with the remainder being clearcut or clearcut-with-reserves) As WSCP retention 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 (see Table 28).

Table 28 - THLB % Netdowns for Stand-level Retention

WFS Zone	Productive Area (ha)	THLB % reduction for WTRA	THLB % reduction for WSCP	Total THLB % reduction	Area reduction (ha)
Enhanced Windy	34,394	2%	2.4%	4.4%	1,368
General Basic	15,835	2%	3.5%	5.5%	791
General Dry	1,611	2%	4.8%	6.8%	101
General Windy	4,085	2%	3.1%	5.1%	186
Special	1,931	2%	6.0%	8.0%	138
Total	***57,856***	**-**	**-**	**-**	***2,583***

6.21 Future Roads

Utilizing LiDAR data, in 2018 and early 2019 WFP updated the physical operability inventory for TFL 19 (refer to Section 6.7). A key component of this update was the projection of future roads to develop conventional harvest opportunities. Any further conventional harvest development is 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 29 indicates future road areas in the TFL that have to be developed.

Table 29 - Future Roads

Description	Productive Area (ha)	Area Reduction (ha)
Future Roads	105	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 30 and Figure 20) and will be used to apply forest cover constraints (see Section 10.2 for details).

Table 30 - 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)
EMZ 24	Burman	Early	3,174	2,602	***Enhanced Forestry Zone*** suited for enhanced silviculture, as well as limited enhanced timber harvesting; due consideration and integration of riparian and wildlife values associated with Burman River corridor into Strathcona Park; integration of biodiversity, recreation and scenic values.
		Mid	325	122	
		Mature	394	181	
		Old	4,105	1,068	
		Total	**7,997**	**3,973**	
EMZ 18	Eliza	Early	1,470	1,216	***Enhanced Forestry Zone,*** particularly suited for enhanced timber harvesting in suitable areas (e.g. areas which are not visually sensitive), as well as enhanced silviculture on most productive sites; emphasis on scenic values along coast, and integration of associated recreation/tourism opportunities; objectives for biodiversity are to be integrated at the basic stewardship; adaptive road engineering/deactivation efforts are indicated to maintain terrain and watershed integrity.
		Mid	1,041	687	
		Mature	195	61	
		Old	2,182	575	
		Total	**4,888**	**2,539**	

[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 Stage	Productive Forest (ha)	THLB Area (ha)	Management Considerations (from Vancouver Island Summary Land Use Plan)
GMZ 22	Gold	Early	10,851	9,379	***General Management Zone***, with high fish, wildlife and biodiversity values, as well as significant timber values; landscape level development of riparian recovery plan for the Gold-Muchalaht-Oktwanch-Nimpkish riparian corridor recommended.
		Mid	4,858	2,994	
		Mature	4,830	1,550	
		Old	14,440	4,403	
		Total	**34,979**	**18,326**	
EMZ 23	Kleeptee	Early	4,173	3,523	***Enhanced Forestry Zone***, suited for enhanced timber harvesting and silviculture, while maintaining fish and wildlife, as well as watershed integrity; basic level of biodiversity conservation; integration of coastal scenic and recreation values.
		Mid	689	430	
		Mature	1,555	409	
		Old	5,426	1,491	
		Total	**11,843**	**5,853**	
SMZ 11	Schoen-Strathcona	Early	910	782	***Special Management Zone***, the 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; this SMZ should become a focal area for old growth retention at the landscape level.
		Mid	315	235	
		Mature	3	0	
		Old	916	179	
		Total	**2,144**	**1,196**	
EMZ 19	Tahsis	Early	3,147	2,443	***Enhanced Forestry Zone,*** with opportunity for enhanced timber harvesting, as well as enhanced silviculture on most productive sites; emphasis on integration of visual values along coastline; objectives for biodiversity are to be integrated at the basic stewardship level; adaptive road engineering/ deactivation efforts are indicated to maintain terrain and watershed integrity.
		Mid	1,462	1,105	
		Mature	1,568	703	
		Old	3,287	911	
		Total	**9,464**	**5,163**	
EMZ 21	Tlupana	Early	12,464	10,363	***Enhanced Forestry Zone***, with significant opportunity for enhanced timber harvesting and silviculture, while maintaining high fish, wildlife and intermediate biodiversity values; integration of scenic/recreation/tourism values along coastline.
		Mid	2,569	1,506	
		Mature	10,384	3,502	
		Old	15,539	4,652	
		Total	**40,956**	**20,023**	
SMZ 6	Woss-Zeballos	Early	118	112	This ***Special Management Zone*** should become a focal area for old growth biodiversity conservation; focus should also be on maintenance of recreation opportunities associated with lakes and alpine/subalpine, and maintenance of scenic values associated with recreation sites and access corridors.
		Mid	29	1	
		Mature	18	6	
		Old	1,982	656	
		Total	**2,148**	**775**	
GMZ 16	Zeballos	Early	3,585	2,961	***General Management Zone***, with lower biodiversity conservation objectives; sensitive development of timber values on unstable terrain
		Mid	767	436	
		Mature	616	258	
		Old	5,264	1,549	
		Total	**10,233**	**5,205**	

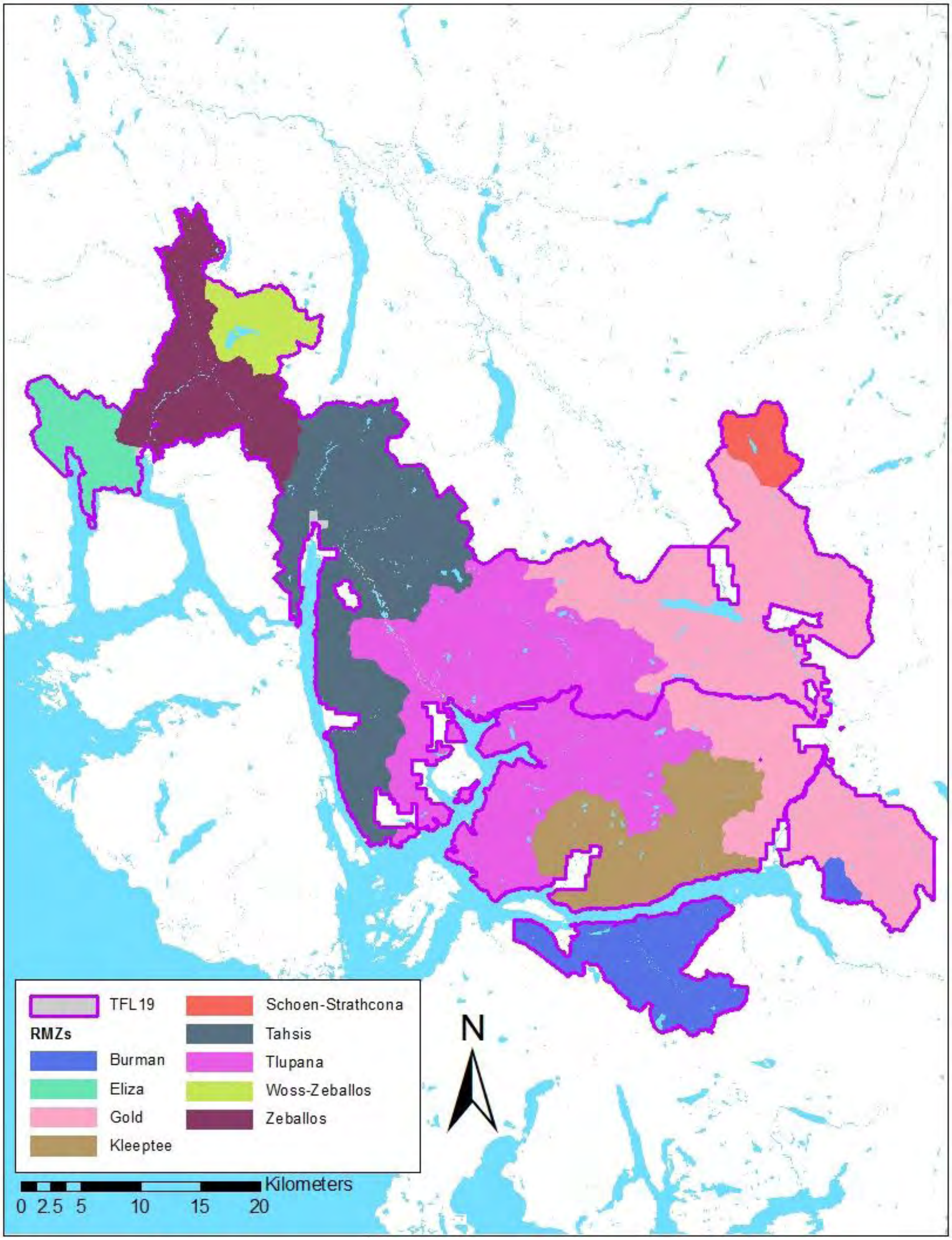

Figure 20 – Resource Management Zones

7.2 Landscape Units

As discussed in Section 6.11 seven landscape units are found within TFL19:

- Burman
- Eliza
- Gold
- Kleeptee
- Tahsis
- Tlupana
- Zeballos

Old seral targets and corresponding old growth management areas are based on landscape unit and biogeoclimatic variant (BEC). Table 31 presents the seral stage distribution of the productive forest by BEC within each landscape unit while Figure 21 indicates the boundaries of the landscape units.

Table 31 – Seral Stage Area by Landscape Unit and BEC Variant

Landscape Unit	BEC	Seral Stage	Productive Forest (ha)	Non Contributing Area		THLB Area	
				ha	%	ha	%
Burman	CWH vm 1	Early	2,808	496	18%	2,313	82%
		Mid	313	195	62%	117	38%
		Mature	366	202	55%	163	45%
		Old	2,085	1,571	75%	514	25%
	CWH vm 1 Total		5,572	2,464	44%	3,107	56%
	CWH vm 2	Early	363	76	21%	287	79%
		Mid	12	7	60%	5	40%
		Mature	24	9	38%	15	62%
		Old	1,546	1,125	73%	422	27%
	CWH vm 2 Total		1,945	1,218	63%	728	37%
	MH mm 1	Early	3	1	21%	2	79%
		Mid	-	-	-	-	-
		Mature	4	1	27%	3	73%
		Old	473	341	72%	133	28%
	MH mm 1 Total		480	343	71%	138	29%
Burman Total			**7,997**	**4,024**	**50%**	**3,973**	**50%**
Eliza	CWH vm 1	Early	1,248	221	18%	1,027	82%
		Mid	975	328	34%	647	66%
		Mature	160	128	80%	31	20%
		Old	1,561	1,154	74%	407	26%
	CWH vm 1 Total		3,943	1,831	46%	2,113	54%
	CWH vm 2	Early	160	26	16%	135	84%
		Mid	2	2	100%	-	-
		Mature	-	-	-	-	-
		Old	532	385	72%	147	28%
	CWH vm 2 Total		694	412	59%	282	41%
	MH mm 1	Early	4	0	0%	4	100%
		Mid	-	-	-	-	-
		Mature	-	-	-	-	-
		Old	56	43	76%	13	24%
	MH mm 1 Total		60	43	71%	17	29%
Eliza Total			**4,697**	**2,286**	**49%**	**2,411**	**51%**

Landscape Unit	BEC	Seral Stage	Productive Forest (ha)	Non Contributing Area		THLB Area	
				ha	%	ha	%
Gold	CWH vm 1	Early	854	75	9%	778	91%
		Mid	1,203	497	41%	706	59%
		Mature	1,278	792	62%	486	38%
		Old	347	313	90%	34	10%
	CWH vm 1 Total		3,682	1,677	46%	2,005	54%
	CWH vm 2	Early	6,228	997	16%	5,231	84%
		Mid	3,300	1,131	34%	2,169	66%
		Mature	1,327	845	64%	482	36%
		Old	3,281	2,580	79%	701	21%
	CWH vm 2 Total		14,136	5,554	39%	8,583	61%
	CWH xm 2	Early	3,888	462	12%	3,426	88%
		Mid	524	208	40%	316	60%
		Mature	1,593	1,101	69%	492	31%
		Old	6,790	4,452	66%	2,338	34%
	CWH xm 2 Total		12,796	6,223	49%	6,573	51%
	MH mm 1	Early	795	66	8%	729	92%
		Mid	130	107	83%	22	17%
		Mature	728	605	83%	123	17%
		Old	4,915	3,422	70%	1,493	30%
	MH mm 1 Total		6,568	4,200	64%	2,368	36%
Gold Total			**37,183**	**17,654**	**47%**	**19,529**	**53%**
Kleeptee	CWH vm 1	Early	123	18	14%	106	86%
		Mid	98	38	39%	60	61%
		Mature	272	208	76%	65	24%
		Old	67	48	71%	20	29%
	CWH vm 1 Total		561	311	55%	250	45%
	CWH vm 2	Early	2,890	436	15%	2,454	85%
		Mid	548	200	36%	348	64%
		Mature	550	424	77%	126	23%
		Old	1,944	1,425	73%	519	27%
	CWH vm 2 Total		5,932	2,484	42%	3,448	58%
	CWH xm 2	Early	1,137	195	17%	942	83%
		Mid	33	13	39%	20	61%
		Mature	592	410	69%	182	31%
		Old	2,603	1,819	70%	784	30%
	CWH xm 2 Total		4,364	2,436	56%	1,928	44%
	MH mm 1	Early	24	2	10%	21	90%
		Mid	10	9	89%	1	11%
		Mature	159	122	77%	36	23%
		Old	813	645	79%	168	21%
	MH mm 1 Total		1,005	779	77%	227	23%
Kleeptee Total			**11,862**	**6,010**	**51%**	**5,853**	**49%**

Landscape Unit	BEC	Seral Stage	Productive Forest (ha)	Non Contributing Area		THLB Area	
				ha	%	ha	%
Tahsis	CWH vm 1	Early	3,542	771	22%	2,771	78%
		Mid	1,841	681	37%	1,159	63%
		Mature	2,463	1,240	50%	1,222	50%
		Old	4,401	2,809	64%	1,592	36%
	CWH vm 1 Total		12,247	5,502	45%	6,745	55%
	CWH vm 2	Early	920	212	23%	709	77%
		Mid	329	84	25%	245	75%
		Mature	377	272	72%	105	28%
		Old	3,627	2,429	67%	1,198	33%
	CWH vm 2 Total		5,254	2,997	57%	2,257	43%
	MH mm 1	Early	52	10	19%	42	81%
		Mid	19	18	96%	1	4%
		Mature	31	30	99%	-	-
		Old	1,099	872	79%	227	21%
	MH mm 1 Total		1,200	931	78%	270	22%
Tahsis Total			**18,701**	**9,430**	**50%**	**9,271**	**50%**
Tlupana	CWH vm 1	Early	9,275	1,527	16%	7,748	84%
		Mid	1,790	581	32%	1,209	68%
		Mature	5,837	3,988	68%	1,849	32%
		Old	4,192	3,096	74%	1,095	26%
	CWH vm 1 Total		21,094	9,193	44%	11,901	56%
	CWH vm 2	Early	1,793	259	14%	1,534	86%
		Mid	117	92	79%	25	21%
		Mature	2,907	1,939	67%	968	33%
		Old	4,339	3,080	71%	1,259	29%
	CWH vm 2 Total		9,156	5,370	59%	3,786	41%
	MH mm 1	Early	28	24	86%	4	14%
		Mid	29	29	100%	-	-
		Mature	379	292	77%	87	23%
		Old	1,224	1,011	83%	213	17%
	MH mm 1 Total		1,660	1,356	82%	304	18%
Tlupana Total			**31,909**	**15,919**	**50%**	**15,991**	**50%**

Landscape Unit	BEC	Seral Stage	Productive Forest (ha)	Non Contributing Area		THLB Area	
				ha	%	ha	%
Zeballos	CWH vm 1	Early	2,778	462	17%	2,317	83%
		Mid	790	304	39%	486	61%
		Mature	603	322	53%	281	47%
		Old	2,765	1,981	72%	784	28%
	CWH vm 1 Total		6,937	3,069	44%	3,868	56%
	CWH vm 2	Early	915	154	17%	760	83%
		Mid	62	48	77%	14	23%
		Mature	55	37	68%	18	32%
		Old	3,453	2,289	66%	1,164	34%
	CWH vm 2 Total		4,485	2,529	56%	1,956	44%
	MH mm 1	Early	68	22	32%	47	68%
		Mid	38	37	98%	1	2%
		Mature	25	23	94%	1	6%
		Old	1,065	800	75%	266	25%
	MH mm 1 Total		1,196	882	74%	314	26%
Zeballos Total			**12,617**	**6,479**	**51%**	**6,138**	**49%**
GRAND TOTAL			**124,967**	**61,801**	**49%**	**63,166**	**51%**

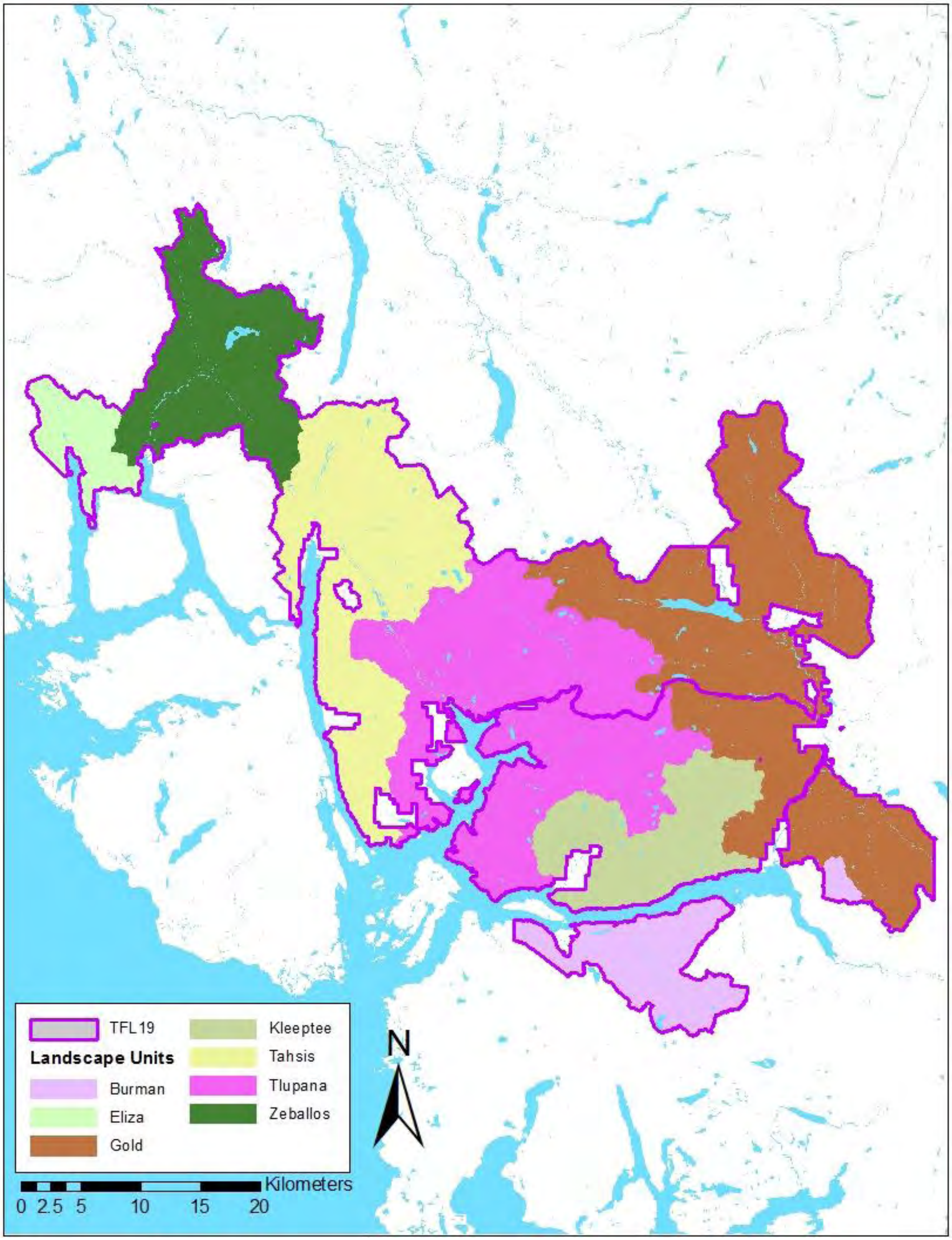

Figure 21 – Landscape Units

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 19 Terrestrial Ecosystem Mapping (TEM). The productive forest was assigned to one of four analysis unit level variants (Figure 22 and Table 32). A detailed breakdown by landscape unit and seral stage is indicated in Table 31.

Table 32 - Analysis Units Biogeoclimatic Variants

	Area (ha)	
Variant	**Productive Forest**	**THLB**
CWHxm2	4,244	2,255
CWHvm1	69,864	39,768
CWHvm2	38,698	17,511
MHmm1	12,181	3,642
Total	***124,987***	***63,177***

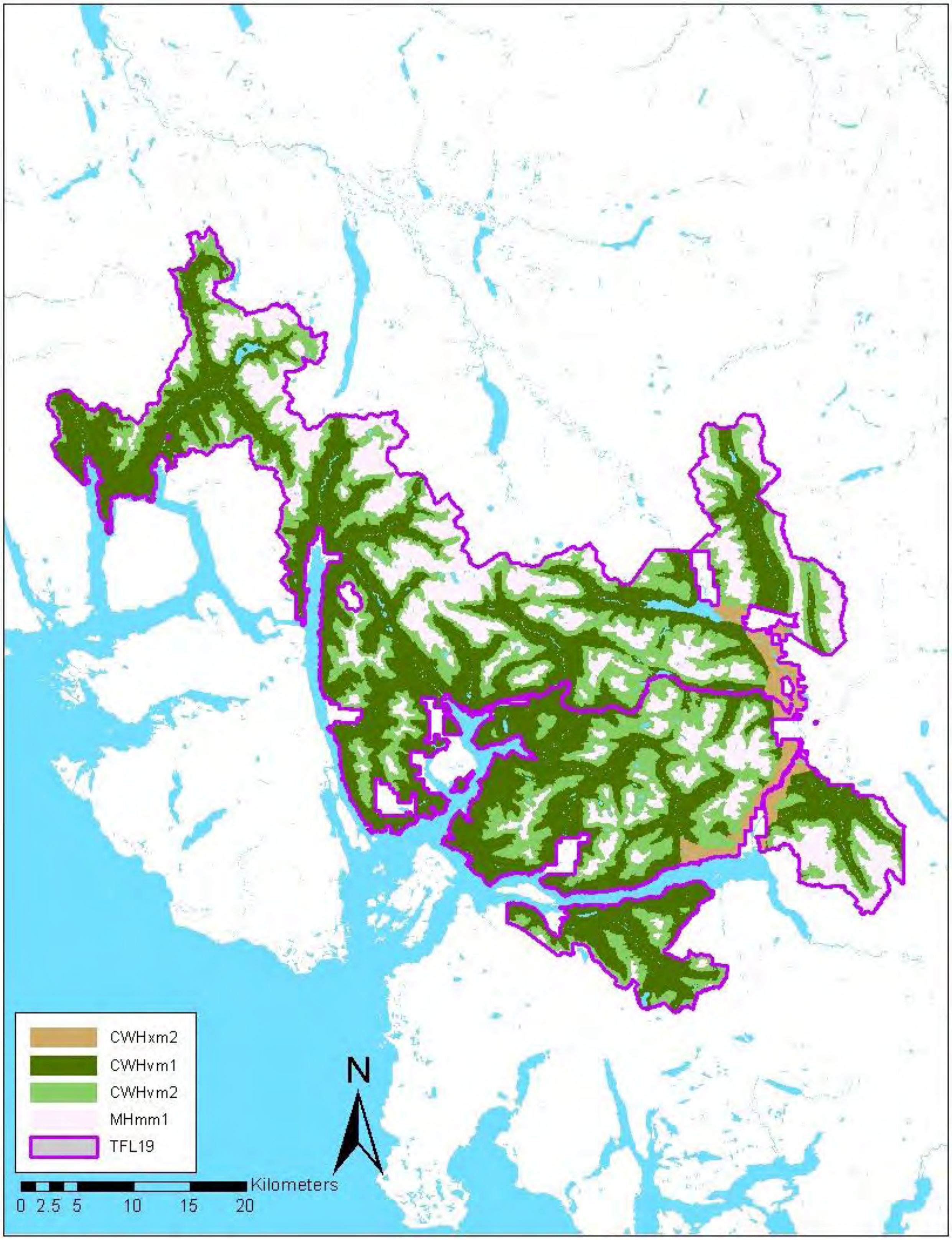

Figure 22 – Biogeoclimatic variants

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 three different sources:

- for natural stands established prior to 1862 (i.e.157 years old and older), adjusted inventory site index values will be applied. The adjustment is based on the Phase II VRI plots measured in 2003 (see Appendix A and B).
- for natural stands established between 1862 and 1960 (i.e. 58-156 years old) site index values are based on LiDAR height and unadjusted age.
- for managed stands (established since 1961), SIBEC values will be applied.

7.3.2.1 Natural Stands Site Classes

Natural stands will be grouped into 3 productivity classes (good, medium, poor) based on either the adjusted inventory site index value or the LiDAR-based 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 33.

Table 33 – Natural Stands Site Index Ranges

Leading Species	Site Index Range (m)		
	Poor Site	Medium Site	Good Site
Ba	< 10	10 – 15	> 15
Cw	< 10	10 – 13	> 13
Fd	< 15	15 – 22	> 22
Hw	< 10	10 – 14	> 14
Hm	< 6	6 – 8	> 8
Yc	< 8	8 – 10	> 10
Dr	< 20	20 – 27	> 27
Misc Conifer	< 7	7 – 11	> 11

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 34.

Table 34 – Species and Site Index Ranges Used to Define Managed Stand Site Productivity Class

Variant	Site Productivity Species	Site Index Range (m)		
		Poor Sites	Medium Sites	Good Sites
CWHxm2	Fd	< 29	29 – 35	> 35
CWHvm1	Fd	< 33	33 – <36	>= 36
CWHvm2	Hw	< 16	16 – 24	> 24
MHmm1	Hm	< 13	13 – 16	N/A

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, 2018.

7.3.3.1 Natural stands

Natural stands are 58 years and older (i.e. 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 FLNRORD'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 FLNRORD's *Table Interpolation Program for Stand Yields* (TIPSY) version 4.4.

7.3.3.2.1 Stands established between 1961 and 2006

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 (33 – 57 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 2006 benefit from the deployment of seedlings with increasing 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 2006 and 2018

These most recently established stands (ages 1-12 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 – 12 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 35).

Table 35 - Analysis Units Legend

First Digit *BEC Variant*		**Second Digit** *Site Class*		**Third Digit** *Establishment Year* **(2018 age range)**		**Fourth Digit** *Species Group*	
1	CWHxm2	1	Poor	1	Future (N/A)	0	Grouped or N/A
2	CWHvm1	2	Medium	2	2006 – 2018 (1-12 yrs)	1	Ba
3	CWHvm2	3	Good	3	1961 – 2005 (13 - 57 yrs)	2	Cw
4	MHmm1			4	1862 - 1960 (58 - 156 yrs)	3	Fd
				5	< 1862 (157+)	4	Hw
						5	Hm
						6	Yc
						7	Decid
						8	Other Conifer

For example, code 2344 identifies the CWHvm1/Good Site/Immature Natural/western hemlock analysis unit.

8 GROWTH AND YIELD

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

1) Existing natural 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.

Three approaches to assigning site index are employed:

- For natural stands established before 1862 (i.e.157 years old and older), results of the VRI Phase II ground samples are used to determine an adjusted inventory site index (see Appendix A and B);
- For natural stands established between 1862 and 1960 (i.e. 58-156 years old) site index values are based on LiDAR height (see Section 5.4) and unadjusted age. This approach is applied to address the concerns expressed in the 2010 AAC determination regarding site productivity estimates for immature natural stands (ages 46-120 years in 2006).
- For managed stands (existing and future), site index values by biogeoclimatic site series from FLNRORD's *Site Index Estimates by BEC Site Series* (SIBEC) will be used. 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 are employed. Site series data is from Terrestrial Ecosystem Mapping (TEM) for TFL 19.

Table 36 shows the mean managed stand site index for the TFL is 27.9 m.

Table 36 - Area-weighted Average Managed Stand Site Index Values

	Site Class			
BEC variant	**Poor**	**Medium**	**Good**	**Total**
CWHxm2	24.0	34.1	37.8	32.3
CWHvm1	30.9	35.8	36.0	34.3
CWHvm2	10.0	16.0	28.0	23.9
MHmm1	12.0	16.0	-	14.8
Total	***24.4***	***28.8***	***29.6***	***27.9***

8.1.1 Terrestrial Ecosystem Mapping Accuracy

The 2010 AAC determination requested an accuracy assessment of the TFL 19 TEM. An analysis was undertaken to compare field-based Site Plan (SP) ecological classification against TEM. A total harvest area of 9,232 ha was analysed with the following results:

- Leading site series in TEM was either leading or secondary site series in SP for 53% of area;
- Secondary site series in TEM was either leading or secondary site series in SP for 18% of area.

To determine the potential impact on site index of the variation in ecological classification an area weighted average SIBEC site index value for hemlock was calculated for all polygons where the TEM and SP leading site series did not match. The results were 23.2m for SP classification and 22.8m for TEM classification - a difference of 0.4m, or a site index underestimation of 1.8% for the sampled polygons. This difference is assumed insignificant and the TEM will be used to determine managed stand site indices.

Furthermore, SIBEC values based on the TFL 19 TEM were compared to the provincial site productivity layer, with results indicated in Table 37

Table 37 – Managed Stands Site Index Comparisons – SIBEC/TFL 19 TEM and Provincial Site Productivity layer

		BEC variant				
Species	SI Source	CWHxm2	CWHvm1	CWHvm2	MHmm1	Overall
Cw	TEM/SIBEC	23.6	21.4	19.1	13.8	20.4
	Site Prod layer	27.6	24.1	21.6	6.1	22.5
Fd	TEM/SIBEC	33.2	34.9	29.4	17.8	32.3
	Site Prod layer	34.0	32.9	27.0	6.3	29.8
Hw	TEM/SIBEC	24.5	25.7	25.3	15.7	25.0
	Site Prod layer	29.0	27.3	24.3	7.2	25.4
THLB area (ha)		2,257	39,711	17,477	3,590	63,036

The comparison indicates that SIBEC values based on the TFL 19 TEM are lower for cedar and hemlock and greater for fir.

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 38).

Table 38 - Utilization Levels

	Utilization			
Age Class	Minimum DBH (cm)	Stump Height (cm)	Top DIB (cm)	Firmwood Standard
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 the 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: 8 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. Since the standard OAF1 was developed in the mid-1990's, mapping of non-productive areas within cutblocks is done in much greater detail plus LiDAR now allows measurement of site occupancy rather than estimates based on random samples. For this analysis, a review of 50-80 year old operable polygons using LiDAR data was conducted to identify gaps in the crown cover (see Appendix D). The results indicate that, on average, an 8% OAF1 is appropriate for TFL 19.

8.3.2 OAF 2

OAF 2 increases with age and is intended to reflect the impact of decay, waste and breakage. 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 Natural 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 often found on 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 on good sites 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 2006 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 39 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 39 – 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	30%	56%	100%
Average yield impact to be applied	***0.6%***	***2.0%***	***5%***

8.5 Yield Tables for Natural Stands

Natural stands are 58 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.

For stands greater than 156 years old, the attribute adjustments discussed in Section 5.2 are applied. For stands 58-156 years old, LiDAR heights were used to determine a site index value. No volume adjustments are applied to these stands.

The large number of natural stand yield curves (10,577 VRI stands in the productive forest) were aggregated into 126 analysis unit yield curves.

Yield tables for each natural analysis unit are listed in Appendix E: Yield Tables for Mature Natural Stands and Appendix F: Yield Tables for Immature Natural Stands.

8.5.1 Natural Stands Volume Check

The results of comparing inventory polygon-specific volumes against the aggregated analysis unit volumes for natural stands are presented Table 40. Within the THLB total volumes are nearly identical. Analysis units for the non-contributing landbase result in approximately 4% less volume in total. This difference is a result of VDYP 7 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 40 – Natural Volumes Check

Land Base	Inventory Volume (m^3)	Analysis Unit Volume (m^3)	Difference (m^3)	Difference (%)
THLB	15,716,833	15,457,860	-258,973	-1.6%
Non-Contributing	29,906,633	28,747,966	-1,158,667	-3.9%
Total	45,623,466	44,205,826	-1,417,640	-3.1%

8.6 Yield Tables for Managed Stands

8.6.1 Stocking density

A significant planting program has existed in TFL 19 since 1961. For the last 20 to 25 years most of the harvested area has been planted, typically at planting levels of around 1,000 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 1,000 sph depending on the site, with higher densities typically utilized on more productive sites to mitigate competition from brush.

Stands currently aged 1 to 57 years are modelled as if planted at 1,000 sph. This is supported by recent practice and a review of free-growing stands. Across 8,500 ha of free-growing stands the average well-spaced stocking density (silviculture label) is 800 stems per hectare.

8.6.2 Fertilization

Since 1980, nitrogen fertilization (post-establishment) has occurred on approximately 9,000 ha in TFL 19. 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 be incorporated into the yield tables for current managed stands in the 13 – 57 year old age class for treated stands within analysis units:

- 1233
- 1234
- 1333
- 2132
- 2133
- 2134
- 2232
- 2233
- 2234
- 2330
- 2333
- 2334
- 3333
- 3334

Default TIPSY responses and effectiveness values will apply.

8.6.3 Volumes for Existing Managed Stands Aged 13 - 57 Years

Silviculture assumptions for existing managed stands aged 13 – 57 years (established 1961 – 2005) 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 41). No genetic gain was applied to stands in this age range.

Table 41- TIPSY Inputs for Existing Managed Stands Aged 13 – 57 Years

Existing AU	SPH	Spp[2] %	Spp1 SI	Spp2 SI	Spp3 SI	Spp4 SI	THLB Area (ha)
1133	1,000	Fd60 Hw35 Cw05	24	21	20	-	29
1230	1,000	Pl64 Fd33 Hw03	24	34	24	-	11
1233	1,000	Fd68 Hw27 Pl 03 Cw02	34	24	24	24	293
1234	1,000	Hw58 Fd33 Cw07 Ba02	24	34	24	22	94
1330	1,000	Hw56 Fd28 Cw16	32	36	24	-	11
1333	1,000	Fd61 Hw37 Cw02	37	33	25	-	30
2132	1,000	Cw55 Hw30 Fd10 Ba05	16	17	31	15	439
2133	1,000	Fd60 Hw30 Cw10	30	19	17	-	317
2134	1,000	Hw58 Cw21 Fd12 Ba09	18	16	31	16	1,845
2230	1,000	Hw65 Fd22 Cw13	28	36	23	-	20
2231	1,000	Ba50 Hw33 Cw17	29	28	23	-	313
2232	1,000	Cw56 Hw33 Fd06 Ba05	23	28	36	29	1,095
2233	1,000	Fd63 Hw30 Cw07	36	28	23	-	2,591
2234	1,000	Hw59 Cw17 Fd13 Ba11	28	23	36	29	11,258
2330	1,000	Hw70 Fd17 Cw09 Ss04	29	36	24	33	8
2332	1,000	Cw56 Hw31 Fd07 Ba06	23	28	36	29	135
2333	1,000	Fd64 Hw31 Cw05	36	29	24	-	416
2334	1,000	Hw59 Ba17 Cw14 Fd10	29	31	24	36	1,935
3134	1,000	Hw46 Ba32 Yc20 Fd02	11	10	11	12	115
3136	1,000	Yc59 Hw21 Ba18 Fd02	11	11	10	12	20
3231	1,000	Ba47 Hw35 Yc18	14	16	16	-	116
3233	1,000	Fd56 Hw31 Cw13	24	16	16	-	26
3234	1,000	Hw54 Ba23 Cw17 Fd06	16	14	16	24	404
3236	1,000	Yc55 Hw24 Ba21	16	16	14	-	48
3331	1,000	Ba53 Hw34 Yc13	26	28	20	-	860
3332	1,000	Cw48 Hw28 Ba18 Yc06	20	28	26	20	133
3333	1,000	Fd55 Hw40 Cw05	32	28	20	-	145
3334	1,000	Hw55 Ba27 Cw13 Fd05	28	26	20	32	3,482
3335	1,000	Hw56 Ba27 Cw17	28	26	20	-	32
3336	1,000	Yc54 Hw24 Ba22	20	28	26	-	144
4130	1,000	Hw40 Yc31 Ba17 Fd12	10	10	10	10	5
4231	1,000	Ba54 Hw27 Yc19	12	16	14	-	229
4234	1,000	Hw53 Ba24 Yc13 Fd10	16	12	14	18	88
4235	1,000	Hw48 Ba32 Yc20	16	12	14	-	38
4236	1,000	Yc47 Ba30 Hw23	14	12	16	-	54

Yield curves for each existing managed age 13 – 57 years analysis unit are listed and shown in Appendix G: Yield Tables for Existing Managed Stands Aged 13 – 57 Years.

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

8.6.4 Volumes for Existing Managed Stands Aged 1 - 12 Years

Silviculture assumptions for existing managed stands aged 1 – 12 years (established 2006 – 2018) 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, Fd, Hw and Yc are applied to stands in this age range based on average values for common seedlots planted in TFL 19 since 2013. Planting records indicate Hw is planted on good sites within CWHvm1 and CWHvm2 BEC variants to address brush competition. Elsewhere it is assumed the Hw is a result of natural regeneration with no genetic gain applied.

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 – 12 years are given in Table 42.

Table 42 - TIPSY Inputs for Existing Managed Stands Aged 1 – 12 years

Existing AU	SPH	Spp%	Spp1 SI	Spp2 SI	Spp3 SI	Spp4 SI	Genetic Gain %				THLB Area (ha)
							Cw	Fd	Hw	Yc	
1123	1,000	Fd64 Hw17 Cw14 Pl05	24	21	20	24	10	9	-	-	25
1223	1,000	Fd65 Hw20 Pl09 Cw06	34	24	24	24	10	9	-	-	416
1224	1,000	Hw63 Fd29 Pl08	24	34	24	-	-	9	-	-	91
1323	1,000	Fd69 Hw19 Pl07 Cw05	36	32	24	24	10	9	-	-	72
2122	1,000	Cw69 Hw22 Fd09	16	17	31	-	10	9	-	-	568
2123	1,000	Fd79 Cw12 Hw09	31	16	17	-	10	9	-	-	341
2124	1,000	Hw66 Cw21 Fd13	17	16	31	-	10	9	-	-	550
2126	1,000	Yc63 Hw17 Cw15 Fd05	15	17	15	30	10	-	-	-	56
2222	1,000	Cw70 Hw20 Fd05 Ba05	23	28	36	29	10	9	-	-	1,303
2223	1,000	Fd72 Hw14 Cw09 Ss05	36	28	23	31	10	9	-	-	1,497
2224	1,000	Hw60 Cw20 Ba11 Fd09	28	23	29	36	10	9	-	-	2,226
2228	1,000	Ss58 Fd20 Hw12 Cw10	31	36	28	23	10	9	-	-	66
2322	1,000	Cw70 Hw18 Ba13 Yc09	24	29	31	24	10	-	-	11	114
2323	1,000	Fd68 Hw14 SS10 Cw08	36	29	33	24	10	9	-	-	431
2324	1,000	Hw59 Ba19 Cw15 Fd07	29	31	24	36	10	9	-	-	297
2328	1,000	Ss65 Fd30 Hw05	33	36	29	-	-	9	-	-	71
3124	1,000	Hw40 Yc27 Ba19 Fd14	10	10	10	10	-	9	-	11	84
3126	1,000	Yc42 Hw27 Ba19 Cw12	11	11	10	11	10	-	-	11	50
3220	1,000	Yc32 Cw23 Ba23 Hw22	16	16	14	16	10	-	-	11	113
3224	1,000	Hw47 Yc28 Ba19 Fd06	16	16	14	24	-	9	-	11	176
3321	1,000	Ba49 Hw30 Yc14 Cw07	26	28	20	20	10	-	-	11	284
3322	1,000	Cw47 Hw21 Ba17 Yc15	20	28	26	20	10	-	-	11	172
3324	1,000	Hw56 Ba21 Yc14 Cw09	28	26	20	20	10	-	-	11	1,102
3326	1,000	Yc62 Hw22 Ba12 Fd04	20	28	26	32	-	9	-	11	314
4120	1,000	Hw38 Ba33 Yc29	10	10	10	-	-	-	-	11	10
4221	1,000	Ba57 Hw25 Yc18	12	16	14	-	-	-	-	11	174
4224	1,000	Hw57 Ba28 Yc15	16	12	14	-	-	-	-	11	85
4226	1,000	Yc47 Hw30 Ba23	14	16	12	-	-	-	-	11	104

Yield curves for each existing managed age 1 – 12 years analysis unit are listed and shown in Appendix H: Yield Tables for Existing Managed Stands Aged 1 – 12 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 2000 and 2018. Species composition reflects natural ingress of hemlock on most sites (Table 44). Species and stocking levels are portrayed at a broad average level to simplify modelling.

Stand density is represented by planting at 900 to 1,000 sph to reflect the continued practice to plant almost all harvested areas. 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 43

Table 43 – 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	CWHvm1	Poor	02, 14
2210	CWHvm1	Medium	01p, 01s, 03, 04, 06p, 06s, 12
2310	CWHvm1	Good	01, 05, 06, 07, 09, 10
3110	CWHvm2	Poor	02, 06s, 09, 10
3210	CWHvm2	Medium	01s, 03, 04, 06, 11
3310	CWHvm2	Good	01, 05, 07, 08
4110	MHmm1	Poor	02, 06, 07, 08, 09
4210	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. A one year delay is 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 and development plans and the Forest Genetics Council business plans. Gain is projected to increase somewhat over the period from 2016 to 2036; however for future stands within the analysis, values associated with 2017 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 44 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 I: 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 44 - 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[3]	Yc	
1110	1,000	-	-	80	20	-	-	-	24.2	21.3	-	-	19	-	-	274
1210	1,000	-	5	90	5	-	-	24.0	34.1	24.0	-	18	19	-	-	1,755
1310	1,000	-	5	85	10	-	-	24.4	36.8	32.7	-	18	19	-	-	227
2110	900	-	55	15	30	-	-	16.0	31.1	17.5	-	18	19	2	-	8,118
2210	1,000	-	65	10	25	-	-	22.6	35.8	27.7	-	18	19	2	-	27,309
2310	1,100	-	55	30	15		-	24.0	36.0	28.6	-	18	19	2	-	4,340
3110	900	30	20	-	35	15	10.0	10.3	-	10.4	10.3	-	-	2	20	976
3210	1,000	10	10	-	60	20	13.8	16.0	-	16.0	16.0	-	-	2	20	2,539
3310	1,000	20	15	-	40	25	25.9	20.3	-	28.0	20.3	-	-	2	20	13,996
4110	900	30	-	-	35	35	10.0	-	-	12.0	10.2	-	-	-	20	314
4210	1,000	20	-	-	40	40	12.2	-	-	16.0	14.1	-	-	-	20	3,329
Total		***7***	***43***	***11***	***30***	***9***	***21.3***	***20.8***	***34.8***	***25.0***	***18.2***	***-***	***-***	***-***	***-***	***63,177***

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

8.6.6 Not Satisfactorily Restocked Areas

The data set prepared for analysis includes 1,452 ha described as not satisfactorily restocked (NSR) and 1,442 ha of the “NSR” area is in the timber harvesting land base. The “NSR” area is larger than in operational records as it includes areas planted in 2018 for which planting data was not yet 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 45 - NSR Area

Description	Productive Area (ha)	THLB Area (ha)
NSR lands	1,452	1,442

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 estimated. 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 19 have been relatively free of major insect or disease infestations and therefore no losses are associated. There have been no major catastrophic outbreaks causing significant unsalvaged mortality or volume losses. The main active agents have been various defoliators and bark beetles. The last defoliator outbreak was in the mid-70’s by western black-headed budworm (*Acleris gloverana*) in stands above 600m near Zeballos. Douglas fir and mountain pine beetle caused pockets of mortality in the mid-60’s around Gold River.

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 2018 lighting ignited several fires that eventually impacted approximately 350 ha (300 ha productive forest; 90 ha of THLB).

The forest cover used to build the timber supply data set does not reflect these fires as data was not available as to the extent of the damage within the fire perimeters. Ninety hectares of THLB is approximately 0.1% of the total THLB. The inventory volume estimate within the fires perimeters is roughly 15,400 m^3 of THLB volume and 74,500 m^3 within the non-contributing land base. Given the current THLB inventory is estimated at 19.23 million m^3, a loss of 15,400 m3 is insignificant. Therefore, the impact of the 2018 fires is a negligible unaccounted downward influence on timber supply within TFL 19.

The affected plantations have been surveyed and will be re-planted in 2019/2020.

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 19.

10.1 Forest Resource Inventories

Table 46 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 46 - Forest Resource Inventory Status

Item	Status
Forest Inventory	2002 photo-interpretation done to VRI standards. Statistical adjustments applied based on 2002 - 2004 field plots. Updated for disturbance and silviculture to December 31, 2018.
Ecosystems	Mapping completed by Madrone Consulting Ltd (Nov 2000).
Terrain Stability	Completed in 1997 by Terence Lewis et al.
Karst	Planning-Level Karst Inventory of TFL 19 completed March 31, 2003 by Terra Firma Geoscience Services. Included refinements to the planning-level karst inventory procedures (RISC 2003).
Recreation Inventory	Recreation inventory completed in 2000 by Jeremy Webb of Recreation Resources Limited. Basis for the TFL 19 portion of the GAR Order to identify Recreation Resource Features for the Campbell River Forest District.
Visual Landscape Inventory	Completed by Recreation Resources Limited (Jeremy Webb) in 2000. Basis for the TFL 19 portion of the GAR Order to establish Scenic Areas and Visual Quality Constraints for the Campbell River Forest District.
Ungulate Winter Ranges (UWRs)	Established UWRs (U-1-014) 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)	Draft OGMAs maintained on an on-going basis.
Stream Classification	Operational stream inventories.
Archaeological	Archaeological Overview Assessment completed by Arcas in 1998. Updated in early 2007 by Baseline Archaeological Services Ltd. Site-specific maps and description on file (held in confidence at request of First Nations). Registered features and sites available via GeoBC.
Operability	Physical and economic operability updated in 2018/9 projects using LiDAR.

10.2 Forest Cover Requirements

10.2.1 Research Sites

There are 12 active government research sites within TFL 19, all associated with studying the growth of stands reforested with trial seedlings. Some sites were established as far back as 1973 but most date from the 1990's. 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 60 years after the research site was established.

10.2.2 Visual Quality

Via a Government Actions Regulation Order, the District Manager of the Campbell River Forest District established Visual Quality Objectives (VQOs) for the Forest District on December 14, 2005. This includes VQOs in TFL 19.

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:

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

The procedures document lists visually effective green-up (VEG) heights varying from 3 m to 8.5 m depending on slope class (Table 47).

Table 47 – 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 19. 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 19, the maximum allowable disturbance by VQO will set at the upper end of the range typically used to model visual quality management constraints. Table 48 outlines assumptions for dealing with visual quality management within the TFL.

Table 48 - Visual Quality Management Assumptions

Visual Quality Objective (VQO)	Productive Forest (ha)	THLB Area (ha)	Maximum Allowable Disturbance (% of productive area)
Retention (R)	1,214	422	5%
Partial Retention (PR)	19,074	9,532	15%
Modification (M)	29,096	14,096	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 2009 and 2013 not available in first 5 years;
- Adjacent to NSR areas and stands established between 2014 and 2018 not available in first decade.

10.2.4 Community Watersheds

McKelvie Creek, a tributary of the Tahsis River, is a designated community watershed for the village of Tahsis. As of 2014 McKelvie Creek is not the primary drinking water source for Tahsis but is kept as a backup supply. Table 49 lists the areas of the McKelvie community watershed within TFL 19.

Table 49 – McKelvie Creek Community Watershed Area within TFL 19

Total Area (ha)	Forested Area (ha)	Productive Forest Area (ha)	Operable Area (ha)	THLB Area (ha)	NCLB Area (ha)
2,199	1,696	1,109	805	547	562

Given the community watershed designation, a forest cover constraint will be applied limiting the equivalent clearcut area (ECA) in the rain-on-snow zone (300 m – 800 m elevation) to 30%. This ECA limit was recommended in a 2017 update to WFP's watershed management strategies for TFL 19. The ECA factors listed in Table 50 and TIPSY height projections will be applied to calculate the ECA for the rain-on snow zone within the McKelvie Creek Community Watershed and a maximum 30% ECA limit will be applied within the timber supply model.

Table 50 – Recovery and ECA factors for McKelvie Creek

Stand Height (m)	Recovery Factor (RF)	ECA Factor (1 – RF)
0 - 3	0.00	1.00
4 – 7	0.30	0.70
8 – 11	0.60	0.40
12 – 15	0.86	0.14
16 +	1.00	0.00

The recovery factors in Table 50 are based on the methodology detailed in FLNRORD Technical Report TR-032 (2007)[4] and using an elevation of 550 m (approximately the area-weighted average elevation of the THLB within the rain-on-snow zone) and a design storm of 120mm/24 hours.

10.2.5 Tahsis Watershed (other than McKelvie Creek)

Due to development in the Tahsis River floodplain, including the Village of Tahsis, the 2017 update to WFP's watershed management strategies for TFL 19 also recommended an ECA limit of 30% for the rain-on-snow zone for the Tahsis watershed outside of McKelvie Creek. The same methodology described for McKelvie Creek in section 10.2.4, including the factors in Table 50, will be applied to the rain-on-snow zone within the remainder of the Tahsis watershed

10.2.6 Fisheries Sensitive Watersheds

There are no Fisheries Sensitive Watersheds within TFL 19.

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.

As detailed in Table 30, portions of two Special Management Zones are found within TFL 19:

- SMZ 6 – Woss-Zeballos;
- 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. To safeguard the long-term sustainable harvest level of the TFL, the minimum harvest criteria applied in the timber supply analysis is adhered to operationally. Internal controls are in place whereby an approved rationale is required to harvest a stand prior to the minimum harvest criteria being reached.

The data set prepared for analysis includes logging system (e.g., ground, cable or heli) based on a combination of operability class (see Section 6.7) 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

[4] Accessed March 2019 from https://www.for.gov.bc.ca/rco/research/hydroreports/tr032.pdf

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 m^3/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. The log size distribution resulting from applying the DBH criteria supports WFP’s sawmill requirements and other domestic manufacturing facilities.

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 51 and Table 52 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. No ages are indicated for mature natural stands (157 years and older) as there is no need to delay harvesting of these stands within the timber supply model.

Table 51 - Minimum Harvest Ages (MHA) for Current Stands

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
Immature Natural Stands 58-156 years old (established 1862 - 1960)									
1143	5	120	247	250	341	250	341	250	341
1144	3	100	525	90	424	90	424	90	424
1243	134	90	355	90	355	105	414	125	479
1340	26	80	211	250	342	250	342	250	342
1343	476	120	854	70	428	95	652	110	776
1344	93	110	774	65	409	90	625	105	738
2143	167	105	147	250	225	250	225	250	225
2144	10	145	199	250	233	250	233	250	233
2243	199	85	272	110	351	110	351	120	382
2244	87	140	407	125	361	125	361	125	361
2340	21	80	314	90	350	250	444	250	444
2342	140	140	592	95	371	105	427	120	504
2343	898	135	889	75	424	100	632	115	751
2344	1,968	130	778	80	436	100	577	115	681
3140	7	145	220	250	269	250	269	250	269
3243	78	85	299	105	366	115	401	135	457

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
3244	25	120	298	145	358	145	358	235	407
3342	22	115	323	130	360	155	412	250	451
3343	77	115	631	75	398	100	546	120	658
3344	188	120	539	85	362	110	490	125	560
3345	9	155	604	110	360	125	446	140	535
3346	21	130	375	125	360	125	360	125	360
3348	4	90	165	250	251	250	251	250	251
4243	4	90	305	105	350	115	381	130	419
4244	6	160	238	250	280	250	280	250	280
4344	21	120	526	90	383	120	526	135	591
4346	2	90	285	115	356	115	356	115	356
Managed Stands 13-57 years old (established 1961 - 2005)									
1133	29	95	598	80	498	140	824	200	993
1230	11	65	564	60	515	100	762	155	869
1233	82	70	755	50	490	75	809	95	990
1233F[5]	211	75	821	50	498	75	821	95	1,007
1234	78	90	890	60	550	90	890	115	1,081
1234F	16	85	844	60	554	90	893	115	1,085
1330	11	65	835	50	593	70	899	85	1,071
1333	16	60	829	45	566	60	829	75	1,019
1333F	14	60	831	45	568	60	831	75	1,021
2132	411	115	569	105	515	190	815	250	896
2132F	28	115	572	100	488	190	818	250	898
2133	255	85	653	70	524	105	786	140	956
2133F	62	85	672	65	496	105	805	135	956
2134	1,693	110	600	100	541	170	867	250	1,034
2134F	152	110	604	100	544	170	871	250	1,034
2230	20	80	943	55	568	80	943	100	1,146
2231	313	80	924	55	564	85	946	110	1,228
2232	942	80	827	60	555	90	925	115	1,169
2232F	153	80	827	60	555	90	926	115	1,169
2233	1,623	70	870	50	572	70	870	85	1,034
2233F	968	70	872	50	574	70	872	85	1,036
2234	9,778	80	928	55	570	80	928	105	1,183
2234F	1,480	80	928	55	570	80	928	100	1,135
2330	7	75	952	50	554	75	952	95	1,180
2330F	1	75	954	50	556	75	954	90	1,127
2332	135	80	827	60	556	85	878	110	1,127

[5] 'F' indicates fertilized stand within the analysis unit

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
2333	345	70	897	45	504	65	829	80	1,011
2333F	71	70	899	45	506	65	831	80	1,013
2334	1,780	75	935	55	623	80	993	95	1,165
2334F	155	75	935	55	624	80	993	95	1,1166
3134	115	160	299	250	445	250	445	250	445
3136	20	150	281	250	398	250	398	250	398
3231	116	135	533	135	533	250	851	250	851
3233	26	105	526	100	500	180	778	250	881
3234	404	130	542	130	542	250	866	250	866
3236	48	125	525	120	502	250	817	250	817
3331	860	90	926	65	624	95	974	125	1,216
3332	133	95	846	70	579	105	928	140	1,160
3333	103	75	820	55	555	80	872	100	1,052
3333F	42	75	832	55	568	80	885	100	1,065
3334	3,395	85	908	60	586	90	960	115	1,187
3334F	87	85	909	60	587	90	961	115	1,188
3335	32	85	897	60	574	95	1,001	120	1,217
3336	144	95	839	70	573	105	920	140	1,152
4130	5	160	228	250	335	250	335	250	335
4231	229	160	519	165	536	250	723	250	723
4234	88	145	520	150	538	250	770	250	770
4235	38	150	532	150	532	250	769	250	769
4236	54	145	479	155	512	250	688	250	688
Managed Stands 1-12 years old (established 2006 - 2018)									
1123	25	85	557	75	489	135	803	200	948
1223	416	65	730	50	523	75	837	90	970
1224	91	85	830	60	554	90	875	120	1,080
1323	72	60	780	45	542	60	780	75	948
2122	568	110	569	95	481	185	804	250	880
2123	341	70	653	55	489	85	777	110	929
2124	550	110	587	100	530	180	862	250	989
2126	56	115	514	110	491	250	778	250	778
2222	1,303	100	1,048	60	568	85	881	110	1,137
2223	1,497	65	873	45	550	60	802	75	997
2224	2,226	75	875	55	573	80	934	105	1,194
2228	66	75	1,088	40	451	60	842	75	1,088
2322	114	95	1,082	55	541	80	892	105	1,180
2323	431	65	907	45	571	60	833	75	1,034
2324	297	75	945	55	634	75	945	95	1,180
2328	71	70	1,152	40	548	50	772	65	1,067
3124	84	160	232	250	338	250	338	250	338

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
3126	50	145	283	250	401	250	401	250	401
3220	113	125	544	115	497	250	827	250	827
3224	176	120	518	120	518	245	853	250	860
3321	284	90	908	65	609	95	955	125	1,194
3322	172	90	798	70	580	105	918	140	1,150
3324	1,102	85	893	60	570	90	945	120	1,212
3326	314	90	804	65	526	100	887	135	1,126
4120	10	185	306	250	392	250	392	250	392
4221	174	155	502	165	534	250	720	250	720
4224	85	155	571	150	553	250	794	250	794
4226	104	125	438	145	509	250	706	250	706

Table 52 - 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	274	75	516	75	516	125	788	185	940
1210	1,755	60	800	45	556	60	800	75	976
1310	227	60	926	40	549	55	846	65	997
2110	8,118	105	595	80	434	140	757	250	949
2210	27,309	95	1,014	55	509	85	901	105	1,111
2310	4,340	70	854	50	546	75	913	90	1,086
3110	976	170	283	250	392	250	392	250	392
3210	2,539	125	540	125	540	250	862	250	862
3310	13,996	90	886	65	590	95	934	125	1,178
4110	314	165	323	245	436	250	442	250	442
4210	3,329	130	482	140	518	250	749	250	749

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 harvesting of immature stands (i.e., <121 years old) in TFL 19. 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.

The harvesting of immature stands is mainly a result of seasonal constraints during the winter months – limited low elevation mature and old stands are available. A sensitivity analysis will be conducted that replaces the immature stands contribution requirement with seasonal volume constraints (modelled via elevation bands).

10.3.2.2 Non-conventional Harvesting Contribution

The last timber supply analysis attributed 50,000 m^3 to the non-conventional operable land base. With the AAC determined at 730,000 m^3, the non-conventional land base contributed 6.8% of the AAC. 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 2006-2017 indicate that 6.7% of the harvest area was from non-conventional stands. Therefore these stands have contributed their proportion of the harvest since the last AAC determination. An overall summary of 2006-2017 harvesting performance by operability categories from MP #10 is presented in Table 53.

Table 53 - Harvest Area for 2006 to 2017 by MP #10 Operability Class

MP #10 Operability Class	% of Harvest Area (2006-2017)
Conventional	87.6%
Non-conventional	6.7%
Inoperable/Uneconomic	5.7%
Total	***100.0%***

As indicated in Table 12, the non-conventionally operable land base is a significant portion of the land base. Table 54 provides details of the THLB area and volume by harvest system.

Table 54 – THLB Breakdown by Harvest System

Harvest System	THLB Area (ha)	THLB Volume (m3)	% of THLB Area	% of THLB Volume
Ground	19,625	3,832,173	31.1%	19.9%
Cable	33,088	9,316,505	52.4%	48.4%
Non-conventional	10,464	6,081,482	16.6%	31.6%
Total	***63,177***	***19,230,160***	***100.0%***	***100.0%***

This further demonstrates the significance of the non-conventional land base: it comprises 16.6% of the THLB area and contains 31.6% of the current THLB volume. The Base Case will be constructed with a non-conventional partition that harvests the remaining non-conventional old growth timber over roughly the same period that the remaining conventional old growth timber is harvested.

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).

10.3.3 Silviculture Systems

The application of the retention harvest system is one component of WFP's Stewardship and Conservation Plan (WSCP). The WSCP is designed to maintain values across the landscape through time and components include biodiversity, timber, water, carbon and climate change. Stand-level retention helps address biodiversity elements including, but not limited to:

- ecosystem representation,
- rare ecosystems,
- old forest,
- big trees.

WFP varies 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 23 indicates the resulting zones found within TFL 19.

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 55.

Table 55 – WSCP Retention Targets

Western Forest Strategy Zone	Ecosection	Resource Management Zone	Variants	THLB Area (ha)	Retention Strategy Use (% of harvest area)	Long Term Retention (% of harvest area)
General Basic	Northern Island Mountains	General	CWHvm1, CWHvm2, MHmm1	17,126	60%	15%
General Dry		General	CWHxm2	2,001	70%	20%
Enhanced Windy	Windward Island Mountains	Enhanced	All	37,651	30%	10%
General Windy		General	All	4,404	40%	15%
Special	All	Special	All	1,970	100%	20%
Total				***63,152***	***42.3%***	***12.3%***

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 19 will result in 42.3 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 13.5 percent.

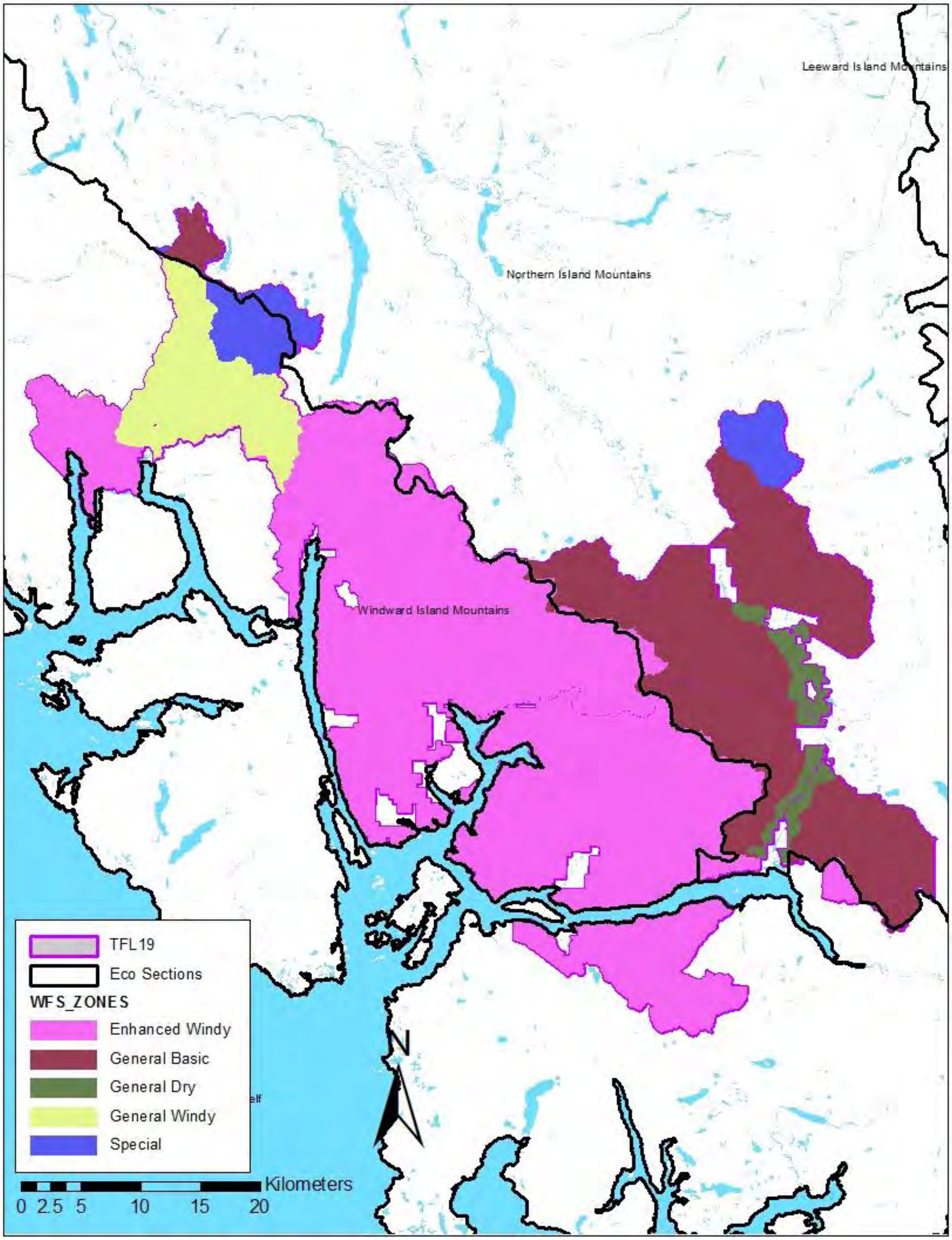

Figure 23 – Western Forest Strategy Zones

10.3.4 Initial Harvest Rate

The current AAC for the analysis area, 728,837 m^3, includes 716,685 m^3 for WFP and 12,152 m^3 for First Nations. The MP #10 Base Case forecast a 14% reduction between 2012-2021 and 2022-2031 periods. Given changes to THLB netdowns and growth and yield factors the timber supply dynamics for TFL 19 may be different than portrayed in MP #10. 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.

11 Glossary

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.
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.

11 Glossary

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.
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.

11 Glossary

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.
Timber harvesting land base (THLB)	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 19 MP #10 Timber Supply Analysis Information Package, Western Forest Products Inc., October 2008;

TFL 19 MP #10 Timber Supply Analysis, Western Forest Products Ltd., January 2009;

Tree Farm Licence 19 Rationale for Allowable Annual Cut Determination, BC Ministry of Forests and Range, Effective August 10, 2010;

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 April 2019;

Forest and Range Practices Act and regulations, current to April 2019;

Forestry Revitalization Act, current to April 2019;

Established Ungulate Winter Ranges, Ministry of Environment http://www.env.gov.bc.ca/wld/frpa/uwr/approved_uwr.html;

Established Wildlife Habitat Areas, 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 to Identify Recreation Resource Features for the Campbell River Forest District, effective April 12, 2006;

Order to Identify Karst Resource Features for the Campbell River Forest District, effective June 30, 2007;

Order to Establish Scenic Areas and Visual Quality Objectives for the Campbell River District, December 14, 2005;

Notice – Indicators of the Amount, Distribution and Attributes of Wildlife Habitat Required for the Survival of Species at Risk in the Campbell River Forest District, July 27, 2004;

Forest Stewardship Plan – Central Island Forest Operation of Western Forest Products Inc., Western Forest Products, May 2017;

Tree Farm Licence 19, Instrument 69, November 16, 2004;

Tree Farm Licence 19, Instrument 70, January 31, 2007;

Tree Farm Licence 19, Instrument 72, July 15, 2009;

Tree Farm Licence 19, Instrument 73, March 15, 2012;

Forestry Revitalization Act Order No. 3(2) 7-1, December 21, 2004;

Forestry Revitalization Act Order No. 3(2) 7-2, December 21, 2004;

Forestry Revitalization Act Order No. 3(4) 7-1, January 23, 2007;

Forestry Revitalization Act Order No. 3(4) 7-2, February 11, 2010;

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

2017 Summary of Forest Health Conditions in British Columbia. Ministry of Forests, Lands, Natural Resource Operations and Rural Development;

Tree Farm Licence 19 Watershed Management Strategies. Western Forest Products, 2010.

Update of Watershed Management Strategies – Tahsis Watershed and McKelvie Creek Community Watershed. Western Forest Products, 2017.

An Operational Method of Assessing Hydrologic Recovery for Vancouver Island and South Coastal BC, Research Section, Coast Forest Region, TR-032/2007.

APPENDICES

Appendix A: VRI Statistical Adjustments for VDYP 6

Tree Farm Licence 19
Vegetation Resources Inventory
Statistical Adjustment
Version 2

Prepared for

Dave Byng, RPF
Western Forest Products Ltd.
Campbell River, BC

Project: WPC-005

January 18, 2007

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

Executive Summary

In 2000, Western Forest Products Ltd. initiated a new Vegetation Resources Inventory (VRI) project on Tree Farm Licence (TFL) 19 to fulfill their commitments made in Management Plan 9 to have a new forest inventory in place for the next Management Plan. A Phase I inventory was completed in 2000 and projected to 2004. The Phase I inventory was stratified into three strata using age class and leading species: Young (age class 1 to 7), Old Cedar (age class 8 and 9, western redcedar leading), and Old Hemlock (age class 8 and 9, hemlock leading). One hundred sample plots were randomly located across the target population (107,347 ha).

Phase I height was over-estimated on average by 8%. The height over-estimation was the largest in the Old Cedar stratum (7.7 m or 24% over-estimation). Phase I age was under-estimated, especially in the Old Cedar (34%) and Young stratum (39%). Adjusting age in old-growth stands has little impact for timber supply analysis. Therefore, the age adjustment was more important in the Young stratum. Total volume increased from 55 to 59 million m^3 after adjustment (7% increase). Approximately 90% of the total volume was located in age class 8 and 9 stands.

Stratum	Area (ha)	Phase I			Adjusted Phase I			Difference		
		Ht. (m)	Age (yrs)	Vol. (m^3/ha)	Ht. (m)	Age (yrs)	Vol. (m^3/ha)	Ht. (m)	Age (yrs)	Vol. (m^3/ha)
Old Cedar	21,758	31.5	239	508	23.8	320	507	-24%	34%	0%
Old Hemlock	51,578	37.7	260	654	34.5	310	718	-8%	19%	10%
Young	34,011	22.3	57	297	23.9	79	319	7%	39%	6%
Total	*107,347*	*31.6*	*191*	*511*	*29.0*	*239*	*549*	*-8%*	*25%*	*7%*

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1. INTRODUCTION

1.1 BACKGROUND

In 2000, Western Forest Products Ltd. (Western) initiated a new Vegetation Resources Inventory (VRI) project on Tree Farm Licence (TFL) 19 to fulfill their commitments made in Management Plan 9 to have a new forest inventory for the next Management Plan.

The provincial VRI is a four-phase process (Figure 1) consisting of the following steps:

1. Phase I (unadjusted inventory data) – forest cover polygon boundaries are delineated and attributes estimated using aerial photography.
2. Phase II (ground sampling) – tree measurements are taken from randomly located ground plots.
3. Net Volume Adjustment Factor (NVAF) sampling – trees are randomly selected from the ground sample for stem-analysis to develop adjustment ratios that correct for taper and decay estimation bias.
4. Statistical Adjustment Phase – Phase I estimates are adjusted using the NVAF-corrected ground plots to provide an adjusted unbiased estimate of forest inventory attributes. The final product is the adjusted VRI database.

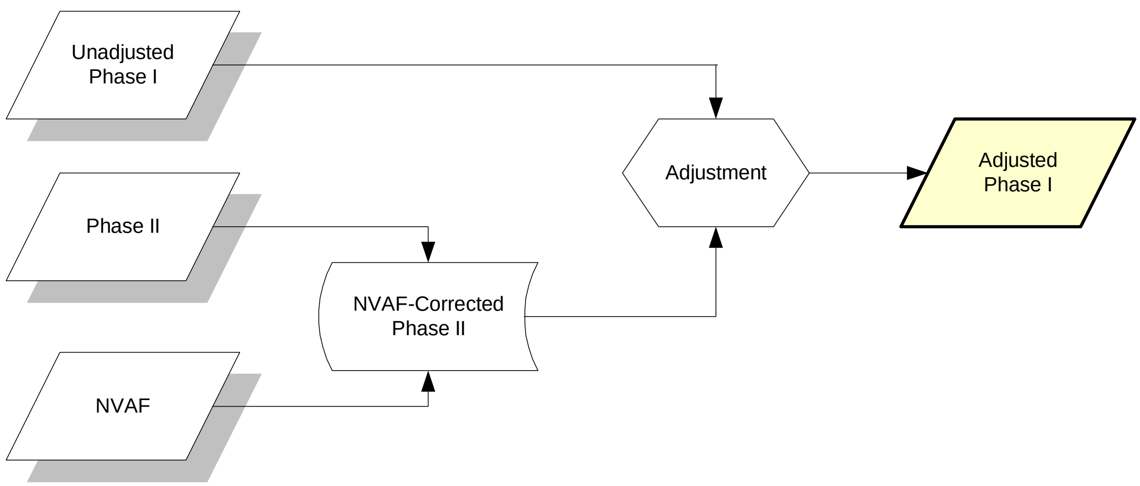


Figure 1. VRI flow-chart.

Olympic Resource Management (ORM) completed the Phase I inventory in 2001 using 1995 aerial photos. Prior to Phase II sample selection, the Phase I inventory was updated for depletions since the photo date. One hundred Phase II samples were selected and established between December 2002 and July 2003 by Kerley and Associates Ltd (KA). KA also completed the NVAF component between October 2003 and August 2004. The last component of the VRI program, the statistical adjustment, was completed in January 2006 and is documented in this report.

1.2 VRI Program Objective

The objective of the VRI program was to:[1]

> *"Install a number of VRI sample clusters sufficient to adjust the timber inventory in the TFL Vegetated Treed (VT) areas with a sampling error of ±10% (95% probability) for overall net timber volume in the VT areas."*

1.3 Terms of Reference

Guillaume Thérien, *PhD* and Tara McCormick, *BSc* of J.S. Thrower & Associates Ltd. (JST) prepared this VRI statistical adjustment report for Dave Byng, *RPF* of Western. The report documents the data preparation and statistical adjustment of the TFL 19 VRI Phase I database. This project was funded through Western's Forest Investment Account (FIA) funding allocation. In this second version, typographical errors identified in Section 4.4 in the previous version were corrected.

[1] Western Forest Products Limited. 2003. Tree Farm License 19 Nootka Sound – Vancouver Island Timber Emphasis VRI Ground Sampling. Unpublished Report, May 2003, 15 pp.

2. VRI DATA

2.1 LANDBASE

TFL 19 is located on the west side of Vancouver Island near Nootka Sound, 80 kilometres west of Campbell River (Figure 2). The TFL is bordered to the east by Strathcona Provincial Park and to the west by Tahsis Inlet and Nootka Island (Figure 2). The western border is characterized by a diverse shoreline dissected by several inlets including Espinosa, Zeballos, Tahsis, Tlupana, and Muchalaht.

Figure 2. TFL 19 location on the west side of Vancouver Island.

2.2 TARGET POPULATION

The target population was defined as the Vegetated Treed (VT) portion of the TFL, excluding private lands, parks and other protected areas, stands established after 1982,[2] and stands established before 1882[3] with less than 300 m^3/ha. This target population covered approximately 107,000 ha (56% of the total TFL area) and was slightly larger than the timber harvesting landbase (THLB, 94,702 ha) used in the last Timber Supply Review (TSR).

2.3 PHASE I (UNADJUSTED INVENTORY DATA)

The target population was stratified prior to sampling using three criteria:

1) Photo-interpreted Age: Old (established before 1862) and Young (established before 1983 but after 1861).
2) Species Group: Cedar (including western redcedar [Cw], yellow cedar [Yc], red alder [Dr], big leaf maple [Mb], and lodgepole pine [Pl]) and Hemlock (including western hemlock [Hw], mountain hemlock [Hm], Pacific silver fir [Ba], Douglas-fir [Fd], and Sitka spruce [Ss].
3) Site Class: Site productivity/class of biogeoclimatic site series for Young stands and volume class in Old stands (High [≥600 m^3/ha], Moderate [400-599 m^3/ha], and Low [<400 m^3/ha]).

The two species groups in the Young stratum were grouped to ensure that all strata represented at least 10% of the population. Site class was ignored in the VRI adjustment process to maintain a minimum sample size in each stratum. Stratum area is shown in Table 1.

[2] Stands that were less than 20 years old in 2002.

[3] Stands that were at least 120 years old in 2002.

Table 1. Area in ha (%) by age class, species group, and volume/site class.

Age Class	Spp Group	High/Good ha	High/Good %	Moderate/Medium ha	Moderate/Medium %	Low/Poor ha	Low/Poor %	Total ha	Total %
Old	Cedar	5,657	5	8,782	8	7,319	7	21,758	20
	Hemlock	29,792	28	16,548	15	5,238	5	51,578	48
	Total	*35,449*	*33*	*25,330*	*24*	*12,557*	*12*	*73,336*	*68*
Young	Total	4,038	4	24,462	23	5,511	5	34,011	32
Total	*Total*	*39,487*	*37*	*49,791*	*46*	*18,068*	*17*	*107,347*	*100*

Height and age were photo-interpreted and projected to 2004 using *VDYP version 6.6d*. Site index was computed using an in-house SAS program based on the DLL file *Sindex.dll version 1.41*. Net merchantable volume (utilization level 17.5 cm), projected to 2004, was generated using *VDYP version 6.6d.* The average unadjusted Phase I height and age were 31.6 m and 191 years, respectively (Table 2). The average site index ranged from 15.5 m to 26.1 m by age class and species group with an overall average of 19.4 m. The average volume ranged from 297 m^3/ha to 654 m^3/ha by age class and species group, with an overall average of 511 m^3/ha.

Table 2. Phase I statistics for the TFL 19 VRI target population (107,347 ha).

Age Class	Spp Group	Height (m) Mean	Height (m) Min	Height (m) Max	Age (yrs) Mean	Age (yrs) Min	Age (yrs) Max	Site Index (m) Mean	Site Index (m) Min	Site Index (m) Max	Volume (m^3/ha) Mean	Volume (m^3/ha) Min	Volume (m^3/ha) Max
Old	Cedar	31.5	9.0	59.1	239	152	802	15.5	5.0	30.0	508	32	1,282
	Hemlock	37.7	22.0	76.2	260	147	602	16.6	8.8	36.2	654	286	1,477
	Total	35.9	9.0	76.2	254	147	802	16.3	5.0	36.2	611	32	1,477
Young	Total	22.3	2.2	60.3	57	22	142	26.1	4.5	59.1	297	0	1,106
Total		*31.6*	*2.2*	*76.2*	*191*	*22*	*802*	*19.4*	*4.5*	*59.1*	*511*	*0*	*1,477*

Note: height, age, and site index are only reported for the leading species.

2.4 PHASE II (GROUND PLOT DATA)

2.4.1 Sample size and sampling weights

One hundred plots (100) were established in the VT area of the TFL. All samples had equal weighting because the sample allocation was proportional to area across age class, species group, and site class (Table 3). All Phase II plots were assumed to have been measured at the end of the 2003 growing season.

Table 3. Sample size by age class, species group, and site class.

Age Class	Spp Group	High/ Good	Moderate/ Medium	Low/ Poor	Total
Old	Cedar	5	8	7	20
	Hemlock	28	15	5	48
	Total	*33*	*23*	*12*	*68*
Young	Total	4	23	5	32
Total	*Total*	*37*	*46*	*17*	*100*

2.4.2 NVAF Ratios

The Ministry of Forests and Range (MOFR) computed the NVAF adjustment ratios and provided JST with the ratios.[4] Three ratios were computed: one each for dead, live immature, and live mature trees. Trees were considered mature if 121 years or older and immature otherwise. The Phase II volume used for

[4] Alf Kivari (MOFR), personal communication, August 23, 2005.

analysis in this report was defined as the live whole-stem volume less top, stump, NVAF-adjusted cruiser-called decay, waste, and breakage. Utilization level was 17.5 cm.

2.4.3 Data issues

Plot 4 was not included in the height and age adjustment analyses as the tree heights and ages were considered invalid. Plot 4 was located in a multi-layered stand and the heights, and ages of the ground sample were not taken from the main layer. Including this plot in the analysis would have distorted the results.

The MOFR standard procedure for estimating ground age at the plot level was modified for this project. Due to the large variation in age within some plots, it was considered more appropriate to use the median rather than the average age of all site trees. The median is less impacted by outliers and is more representative of the central tendency than the average when outliers are present. Also, the MOFR algorithm to link the Phase I height and age to Phase II estimates was not followed because too many Phase II plots would have provided no valid estimates. Instead, expert knowledge was used to match Phase I height and age with appropriate estimates taken from all recorded site trees.

2.4.4 Data summary

The Phase II ground plots in the Old age class were 29.7 m in height, 303 years old, 13.9 m in site index, and 636 m^3/ha in volume on average.[5] The average height, age, site index, and volume for the Young stratum plots were 22.9 m, 80 years, 24.3 m, and 283 m^3/ha, respectively.

Table 4. Phase II (ground plots) statistics for the sampled polygons (100 polygons).

Age	Spp	Height (m)			Age (yrs)			Site Index (m)			Volume (m^3/ha)		
Class	Group	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Old	Cedar	24.0	9.6	47.9	282	46	580	12.6	6.0	25.4	511	107	1,240
	Hemlock	33.6	11.2	51.0	316	52	633	14.3	5.6	31.6	715	131	1,301
	Total	30.8	9.6	51.0	305	46	633	13.7	5.6	31.6	655	107	1,301
Young	Total	23.9	7.2	58.3	77	19	317	24.9	10.3	38.9	284	5	856
Total		*28.6*	*7.2*	*58.3*	*236*	*19*	*633*	*17.4*	*5.6*	*38.9*	*536*	*5*	*1,301*

Note: height, age, and site index are only reported for the leading species.

In general, the sampled polygons were representative of the population (Table 2 and Table 5). Statistics for height, age, site index, and volume in the sampled polygons and the entire population were very similar for the Old strata. Sampled polygons in the Young stratum tended to be shorter and younger on average than the Young stratum in the whole population, while site index tended to be higher and volume smaller in the sampled polygons.

[5] In this report, ground volume refers to whole-stem volume less top, stump, cruiser-called decay, waste, and breakage, at the 17.5 cm utilization level.

Table 5. Phase I statistics for the sampled polygons (100 polygons).

Age Class	Spp Group	Height (m)			Age (yrs)			Site Index (m)			Volume (m^3/ha)		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Old	Cedar	31.6	22.0	45.2	224	152	302	15.9	10.8	23.4	500	309	830
	Hemlock	37.6	24.1	48.3	265	152	302	16.3	9.7	27.2	673	333	981
	Total	36.6	22.0	48.3	258	152	302	16.3	9.7	27.2	643	309	981
Young	Total	20.6	8.8	35.3	49	22	132	28.3	14.8	44.2	240	0	664
Total		*29.7*	*8.8*	*48.3*	*168*	*22*	*302*	*21.4*	*9.7*	*44.2*	*470*	*0*	*981*

Note: height, age, and site index are only reported for the leading species.

Table 6. Proportion of the population below or above the sampled range.

Attribute	Below Range (ha)	Below Range (%)	Above Range (ha)	Above Range (%)	Total (ha)	Total (%)
Height	3,390	3%	6,751	6%	10,141	9%
Age	22	0%	518	0%	540	1%
Volume	1,410	1%	4,330	4%	5,740	5%

The sampled polygons did not cover the full range of heights in the population (Table 6). Approximately 9% of the area had a Phase I height outside the sampled range. Age, however, was adequately covered by the sample. Polygons with large volumes (the top 4%) were above the sampled range.

3. METHODS

The most recent MOFR VRI statistical adjustment standards were used to adjust height, age, and live volume, except where noted.[6] The MOFR adjustment process assumes that the unadjusted (Phase I) inventory volume is biased due to two sources of error:

1. An attribute bias associated with the photo-interpreted height and age.
2. A model bias inherent to *VDYP version. 6.6d,* the model used to estimate volume.

Three attributes needed for volume prediction are not directly adjusted in this process. A new stocking class is derived by *VDYP* using adjusted age, while MOFR has not developed methods to adjust species composition and crown closure. Leaving these attributes unadjusted is assumed to create a negligible bias.

The attribute adjustment procedure is a two-step process called the Fraser Method (Figure 3) and is described as follows:

- Step 1: Phase I height and age bias are corrected using an adjustment ratio of means (ROM) calculated from the Phase I (height or age) and the Phase II plots. An attribute-adjusted volume is then estimated using *VDYP* with the adjusted height and age.
- Step 2: an adjustment ratio estimated from the attribute-adjusted volume and the Phase II volume is calculated, and this ratio is used to correct the model bias in the attribute-adjusted volume.

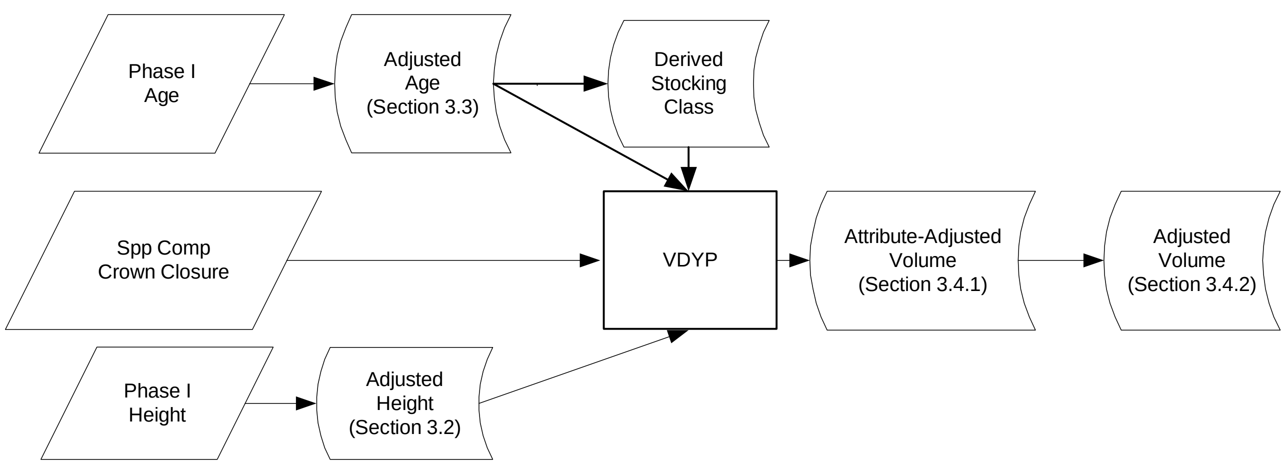


Figure 3. Fraser Method.

[6] Ministry of Sustainable Resource Management. 2004. Vegetation Resources Inventory Procedures and Standards for Data Analysis Attribute Adjustment and Implementation of Adjustment in a Corporate Database. Unpublished Report, March 2004. 77 pp.

4. RESULTS

4.1 HEIGHT ADJUSTMENT

Three observations had invalid height, leaving 97 observations for analysis (Table 7 and Figure 4). After adjustment, height decreased by 25% and 9% in Old Cedar and Old Hemlock, respectively. Height increased however by 7% in the Young stratum after adjustment. The 95% sampling error (E) for the three strata ranged from 7% to 18%. The overall impact on average height was a decrease of 8% with a sampling error of 6%.

Table 7. Height adjustment statistics.

Age Group	Spp Class	Area (ha)	Sample Size	Height (m)			ROM	Adj. Pop (m)	95% E	
				Pop Avg.	Sample Avg. Ground	Sample Avg. Map			(m)	%
Old	Cw	21,758	20	31.5	24.0	31.8	0.753	23.8	4.3	17.9
	Hw	51,578	47	37.7	33.6	36.7	0.916	34.5	2.4	7.0
Young	All	34,011	30	22.3	22.7	21.3	1.069	23.9	2.3	9.7
All	*All*	*107,347*	*97*	*31.6*	*28.2*	*30.8*	*0.917*	*29.0*	*1.6*	*5.6*

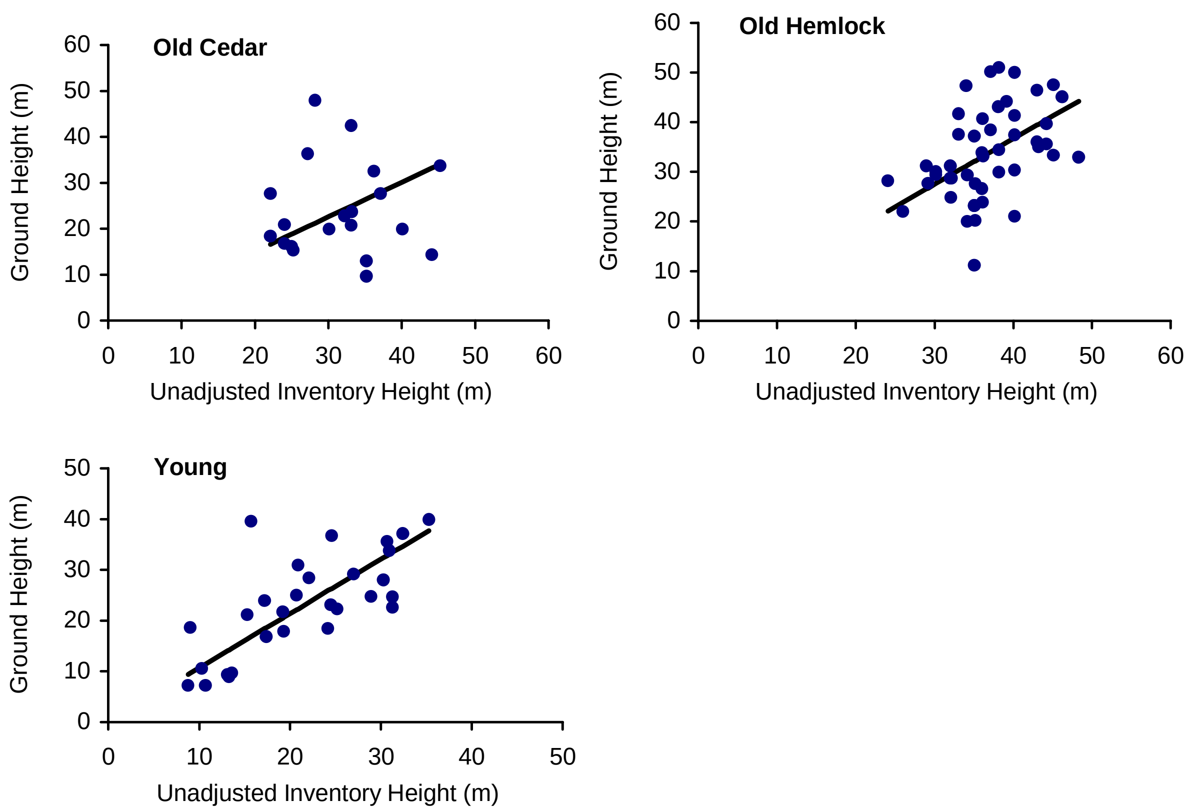


Figure 4. Ground vs. unadjusted inventory height.

4.2 Age Adjustment

Five observations had invalid height, leaving 95 observations for analysis (Table 8 and Figure 5). Age was under-estimated on average by 25%. The under-estimation was 34% and 20% in the Old Cw and Old Hw strata, respectively. This adjustment was however mostly irrelevant since modifying the age of old-growth stands has virtually no impact on volume or growth. The age in young stands increased by 39%. The 95% sampling error in each individual stratum was relatively large ranging from 13% to 24%. The overall 95% sampling error however was approximately 10%.

Table 8. Age adjustment statistics.

Age Group	Spp Class	Area (ha)	Sample Size	Age (yrs)			ROM	Adj. Pop (m)	95% E	
				Pop Avg.	Sample Avg. Ground	Sample Avg. Map			(m)	%
Old	Cw	21,758	20	239	282	210	1.338	320	75.4	23.5
	Hw	51,578	47	260	316	265	1.193	310	40.4	13.0
Young	All	34,011	28	57	76	55	1.389	79	14.7	18.6
All	*All*	*107,347*	*95*	*191*	*233*	*187*	*1.248*	*239*	*23.7*	*9.9*

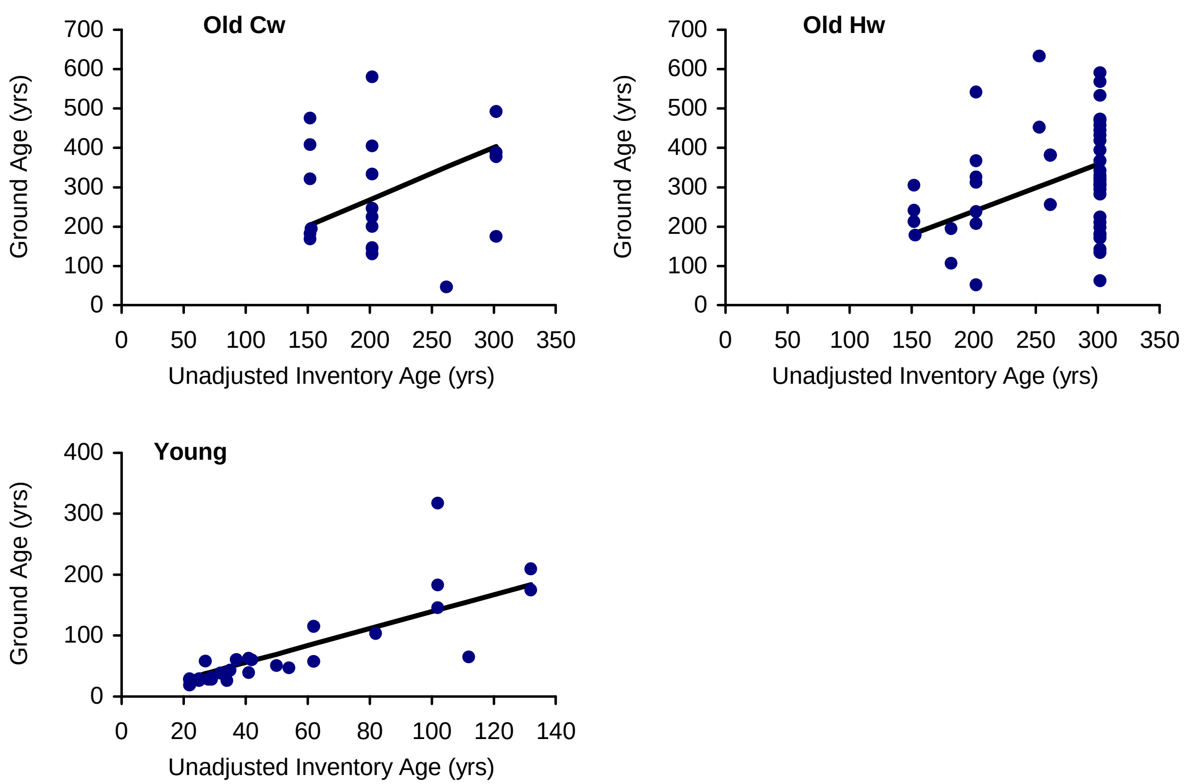


Figure 5. Ground vs. unadjusted inventory age.

4.3 Net Merchantable Volume Adjustment

After height and age adjustment, the inventory volume decreased from 511 (Table 2) to 437 m^3/ha (Table 9). This decrease was mostly due to the decrease in height in the Old-Cw stratum. This attribute-adjusted volume was then adjusted using the Phase II ground volume. After adjustment, the attribute-adjusted volume increased on average by approximately 60% and 27% in the Old-Cw and Old-Hw strata, respectively (Figure 6). On the other hand, the volume decreased in the Young stratum by less than 1% on average. The overall impact of the full adjustment on volume was an increase from 511 to 549 m^3/ha (7%). The overall 95% sampling error was 11%, slightly above the targeted 10% but sufficient for timber supply analysis purposes.

Table 9. Volume adjustment statistics.

Age Group	Spp Class	Area (ha)	Sample Size	Volume (m^3/ha)			ROM	Adj.	95% E	
				Pop Avg.	Sample Avg. Ground	Sample Avg. Map		Pop (m)	(m)	%
Old	Cw	21,758	20	317.0	513.0	320.5	1.600	507.3	172.7	34.0
	Hw	51,578	48	564.0	714.6	561.4	1.273	718.0	83.9	11.7
Young	All	34,011	32	321.3	284.9	286.7	0.994	319.4	57.5	18.0
All	*All*	*107,347*	*100*	*437.1*	*537.6*	*425.5*	*1.256*	*549.0*	*60.2*	*11.0*

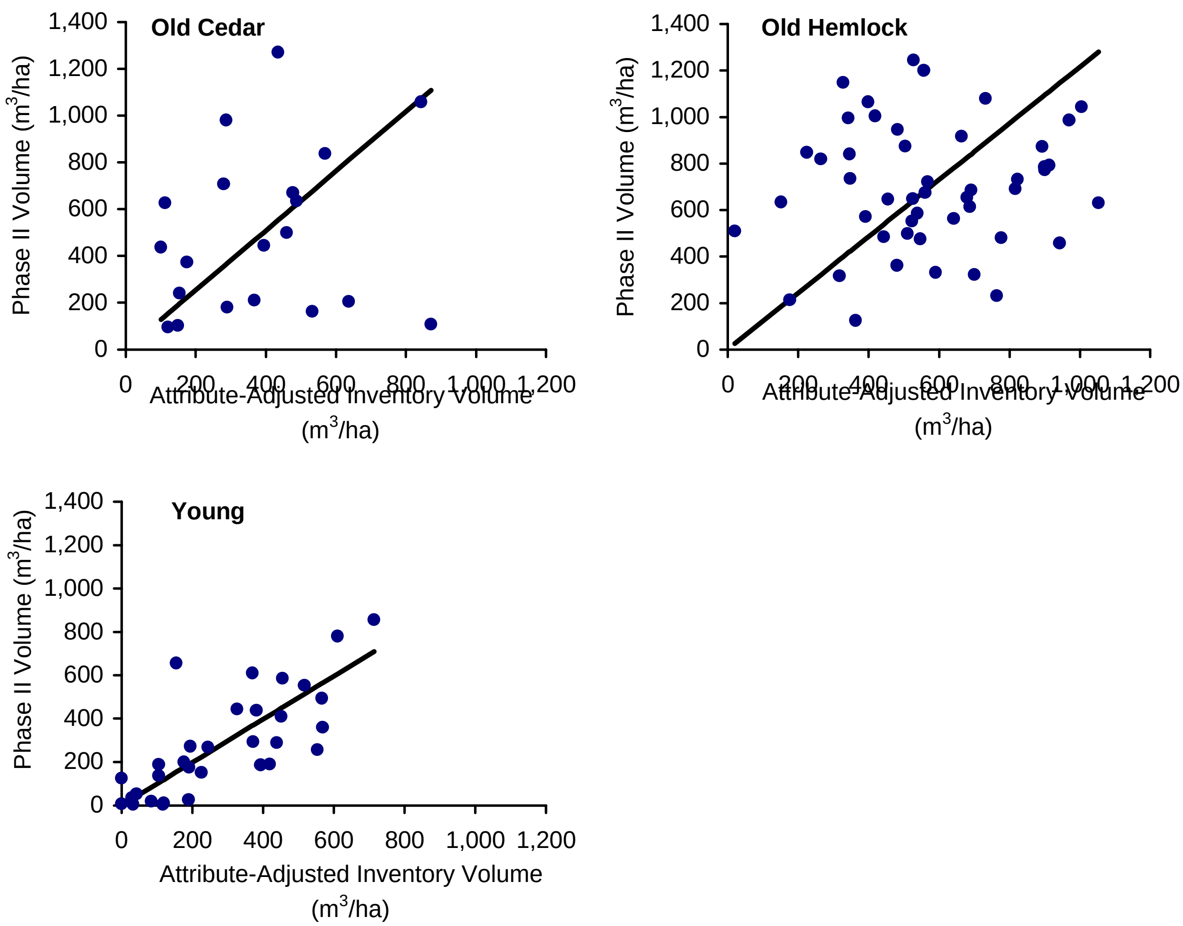


Figure 6. Ground vs. attribute-adjusted inventory volume.

4.4 ADJUSTED INVENTORY

Following adjustment, the overall average height decreased by 8%, overall average age increased by 25%, and overall average volume increased by 7% in the VT area (Table 10). The distribution of the adjusted population by height class, age class, and volume class is relatively similar to the relative distribution of the ground sample over these attributes. The height adjustment in Old Hemlock however generated about 9% of area in the 55-m class while there was only 3% of the area in the unadjusted population and 0% in the sample in that class. Overall, however, the different distributions provide a level-of-comfort that the final adjusted attributes represent well the actual conditions on the landbase.

Table 10. Comparison of unadjusted and adjusted inventory height, age, and volume.

Stratum	Area (ha)	Phase I			Adjusted Phase I			Difference		
		Ht. (m)	Age (yrs)	Vol. (m^3/ha)	Ht. (m)	Age (yrs)	Vol. (m^3/ha)	Ht. (m)	Age (yrs)	Vol. (m^3/ha)
Old Cedar	21,758	31.5	239	508	23.8	320	507	-24%	34%	0%
Old Hemlock	51,578	37.7	260	654	34.5	310	718	-8%	19%	10%
Young	34,011	22.3	57	297	23.9	79	319	7%	39%	6%
Total	*107,347*	*31.6*	*191*	*511*	*29.0*	*239*	*549*	*-8%*	*25%*	*7%*

5. DISCUSSION

5.1 SITE INDEX

Site index is usually not directly adjusted in this VRI adjustment. Instead, site index is derived from adjusted height and age. On TFL 19, site index decreased on average by 18% (Table 11). This was a result of the height decrease in the Old strata and relatively small height increase in the Young strata compared to a significant age increase across all strata. The decrease was relatively constant across all age classes. The site index decrease has no impact in old-growth stands (age class 8 and 9) for timber supply analysis since no growth is assumed in these stands. These stands represented approximately 75% of the landbase.

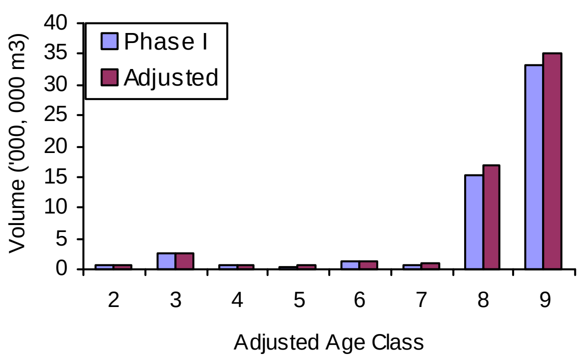
Table 11. Phase I and adjusted site index by age class.

Age Class	Area (ha)	Phase I SI (m)	Adjusted SI (m)	Difference %
2	9,635	26.3	20.2	-23%
3	10,976	29.7	24.3	-18%
4	1,427	31.3	26.7	-15%
5	945	26.6	23.4	-12%
6	2,409	23.9	21.4	-10%
7	1,499	23.5	21.3	-9%
8	25,506	19.3	16.4	-15%
9	54,950	15.5	12.3	-20%
Total	*107,347*	*19.4*	*15.8*	*-18%*

Note: Age class is based on adjusted age.

5.2 TOTAL VOLUME AND MEAN ANNUAL INCREMENT

Total volume and mean annual increment (MAI) are important consideration for timber supply analysis. Total volume increased by 7% (Figure 7) to 59 million m^3 after adjustment. Almost 90% of the total volume was located in stands in age class 8 and 9. Mean annual increment (MAI) decreased across all age classes, but the distribution across age classes remained similar before and after adjustment (Figure



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). The highest MAI was in age class 4.

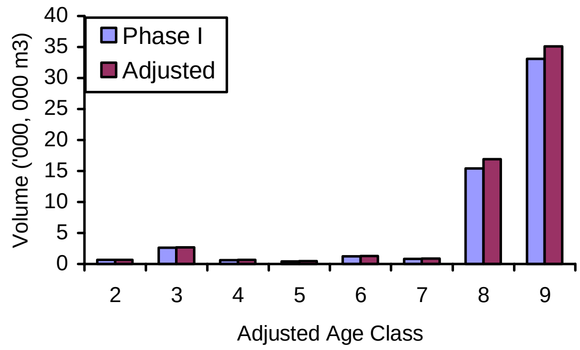


Figure 8. Total volume distribution by age class.

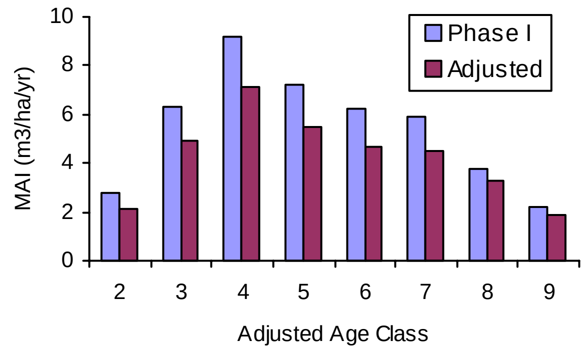


Figure 7. MAI distribution by age class.

5.3 Risk and Uncertainty for Timber Supply Analysis

The sample did not cover the full range of heights and volume observed in the population. Adjustment ratios were therefore extrapolated from the sampled range to the portion of the population that was not sampled. This creates some uncertainty in the adjustment that cannot be quantified.

About 70% of the landbase was located in old-growth stands where an adjustment in height and age has little impact on timber supply analysis. The net merchantable volume remained unchanged in the Old Cw stratum after adjustment, while it increased by approximately 10% in the Old Hw stratum. The confidence around the adjusted volumes was relatively low in the Old Cw stratum but very good in the Old Hw stratum. More work would be needed to explained the variation observed in the Old-Cw strata.

Both height and age increased after adjustment in the Young stratum and the confidence around both adjustments was very good (height) and good (age). Site index decreased following the height and age adjustments, but it is quite likely that this will have little impact on timber supply analysis if site index of managed stands are predicted using a bio-physical approach rather than derived from the forest inventory. The real impact of the decrease on site index in Young stands will only be known when a decision is made about site index modeling for the next Management Plan. Volume in Young stands increased by approximately 6% after adjustment. The volume increase was mainly due to the age adjustment. It is not possible at this stage to assess the impact of the volume adjustment in Young stands on timber supply analysis. The impact will depend largely on what age cut-off will be used for stands modeled with VDYP. The impact will likely be minimal since most stands in that stratum will be modeled using TIPSY rather than VDYP since approximately 75% of the area in the Young stratum is in age class 2 and 3.

6. CONCLUSION

In MP 9, Western committed to completing a new forest inventory for the next MP. The VRI statistically adjusted inventory provides unbiased forest inventory information and represents a better inventory than the current unadjusted VRI Phase I inventory. Therefore, we recommend that

Western use the adjusted VRI inventory for TSR and planning purposes.

Appendix B: VRI Statistical Adjustments for VDYP 7

Background

The TFL 19 VRI photo interpretation work was done in 2002 with 100 ground sample plots established in 2003. Using this data, JS Thrower calculated adjustment factors for use in VDYP 6. This work resulted in the following effective volume adjustments (2003) by strata:

- Old Cedar: 0%
- Old Hemlock: +10%
- Young: +6%

In 2016, Forest Ecosystem Solutions Ltd. (FESL) was contracted to calculate adjustment factors for use in VDYP 7. This work resulted in the following effective volume adjustments (2003) by strata:

- Old Cedar: -7.6%
- Old Hemlock: -1.7%
- Young: +31.8%

Process used for MP #11 Yield Tables

1) Obtained compiled plot data for one hundred 2003 VRI ground sample plots from FESL, who had obtained this data from FAIB.
2) Projected original Phase 1 delivered VRI (2002) to 2003 to match the ground plot date.
   a) This is a different copy of the TFL 19 VRI than was provided to FESL to determine VDYP 7 adjustment factors. The version provided to FESL appeared to have updates applied when compared to the version used by WFP.
3) Overlaid the sample plot locations (based on UTM coordinates included in plot data) on projected Phase 1 delivered VRI.
4) Using plot data and projected VRI data, calculated R1 average age, height, basal area and stems-per-hectare ratio of means (ROM) by strata.
   a) WFP strata were inadvertently slightly different than applied by Thrower and FESL.
      i) Old Cw strata defined as 140 and older and Cw leading
      ii) Old Hw strata defined as 140 and older and all other species leading
      iii) Young strata defined as greater than 30 years old
   b) The above strata criteria resulted in the following distribution of the ground sample plots:
      i) Old Cw – 16
      ii) Old Hw – 53
      iii) Young – 19
      iv) Not used – 12 (including plot 4 that was not used by Thrower or FESL)
5) Applied adjustment ratios to the four attributes at date of ground sampling and re-ran VDYP.
6) Compared output from Step 5 to both JS Thrower and FESL adjusted volumes by strata at the forest level. Significant differences were identified when compared to FESL adjusted inventory. This cast further suspicion that the starting inventories were in fact different.
7) Using JS Thrower adjusted inventory volumes by strata as “correct”, volume adjustment ratios were calculated. No Lorey height adjustments were applied.

8) Applied volume adjustment factors to following volumes:

    a) R1_VOL_PER_HA_75
    b) R1_VOL_PER_HA_125
    c) R1_CLOSE_UTIL_VOL_125
    d) R1_CLOSE_UTIL_DECAY_VOL_125
    e) R1_CLOSE_UTIL_WASTE_VOL_125

9) Populated VDYP input file with adjusted attributes (age, height, basal area, stems per hectare, volumes) and re-ran VDYP.

Comparison of Results

2003 Volumes

	Thrower (VDYP 6)		FESL (VDYP 7)		WFP (VDYP 7)	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Old Cw	508	507	536	495	484	503
Old Hw	654	718	719	707	495	709
Young	297	319	255	336	287	337

Comparison to Cruise

A comparison of WFP adjusted inventory volumes to cruise volumes was made. The following table presents the results by VRI leading-species for age classes 7 – 9:

VRI Sp1	Cruise Volume	WFP Unadjusted (VDYP 7)	VRI P1 Vol to Cruise%	Cruise Volume	WFP Adjusted (VDYP7)	VRI P2 Vol to Cruise%
Ba	187,679	191,307	102%	190,897	279,878	147%
Cw	622,035	464,689	75%	637,408	495,636	78%
Fd	77,595	47,833	62%	176,334	176,079	100%
Hm	154,184	119,255	77%	151,598	159,197	105%
Hw	2,083,376	1,719,668	83%	2,185,276	2,538,073	116%
Pl	4,828	261	5%	5,617	427	8%
Yc	428,769	242,585	57%	429,886	349,188	81%
Grand Total	**3,558,465**	**2,785,597**	**78%**	**3,777,017**	**3,998,477**	**106%**

The difference in total cruise volume used as a base is due to the use of VRI age classes to define the data. WFP Adjusted has the phase 2 age adjustment applied so the polygons are a slightly different set then the Unadjusted.

The comparison of adjusted inventory to cruise results indicates the adjusted inventory overestimates mature stands volume by 6%. Part of this difference is likely explained by larger loss factors applied in the cruise compilations than within VDYP.

Appendix C: LiDAR Review of Road Widths in Managed Stands

SUMMARY

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

For TFL 19, LiDAR indicates that within managed stands approaching harvestable age the road area not covered by tree crowns at least 10m tall is much less than assumed in MP #10.

PROCESS

A review of LiDAR data and orthophotos was conducted to update the lines representing roads within TFL 19. Figure 24 shows a mainline (road to left) and a spur road (road to right) in a 45-year-old stand.

Figure 24 – Example roads and orthophoto

Apply a 20 m buffer (10 m per side) to the lines representing the roads – see Figure 25.

Figure 25 – Road buffer and orthophoto

Intersect road buffers with forest cover so have forest age. Then intersect through crown height model (CHM). Figure 26 presents the same area with the crown height model.

Figure 26 – Road buffer with crown height model

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

Figure 27 – Percentage of road buffer with crowns less than 10m tall

Figure 27 illustrates polygons assigned to crown openings inside the uniform buffer. In this example 40% of the mainline road buffer polygon has crown cover less than 10 m tall. In other words an 8 m buffer would accurately represent this area. For the spur road, 17% of the buffer has crown cover less than 10 m tall; therefore a 3.4m buffer would accurately represent this area.

RESULTS

Only roads within 40 – 70 year old stands were used to indicate the extent to which trees will occupy road buffer areas within managed stands approaching rotation ages. This approach recognizes perpetual roads (e.g. mainlines) within these stands.

Table 56 – LiDAR derived road buffers within 40 – 70 year old stands

Road Class	Buffer width (m)	Length (km)	Proportion with crown cover < 10m tall	Implied width (m)	Implied Area (Ha)	Applied Buffer (m)	Area Netdown (Ha)
Forest Service Road	20	34.3	0.620	12.4	42.5	12.0	41.1
Mainline	20	91.1	0.458	11.4	103.8	11.0	100.2
Spur	20	230.3	0.335	6.7	154.3	7.0	161.2
Unknown	20	6.6	0.122	2.4	1.6	2.0	1.3
Total	-	*362.3*	-	-	*302.3*	-	*303.9*

Implied buffer widths were rounded to the nearest metre for creating polygons to represent existing roads. As Table 56 indicates, this rounding has a negligible effect on the overall area removed from the productive landbase.

DISCUSSION

When left to nature, a proportion of roads will support tree growth indistinguishable from the adjacent area. Figure 28 and Figure 29 provide an example of a road barely identifiable in air photos. This example is a 42 year old stand.

Figure 28 - Example of roads barely identifiable in photo

Figure 29 – Road location

Figure 30 presents the road location on the crown height model from LiDAR data. There is no discernible variation in the height of the trees growing along the road compared to the trees growing in the adjacent area. In fact it appears that the trees growing along the road are taller than the adjacent area.

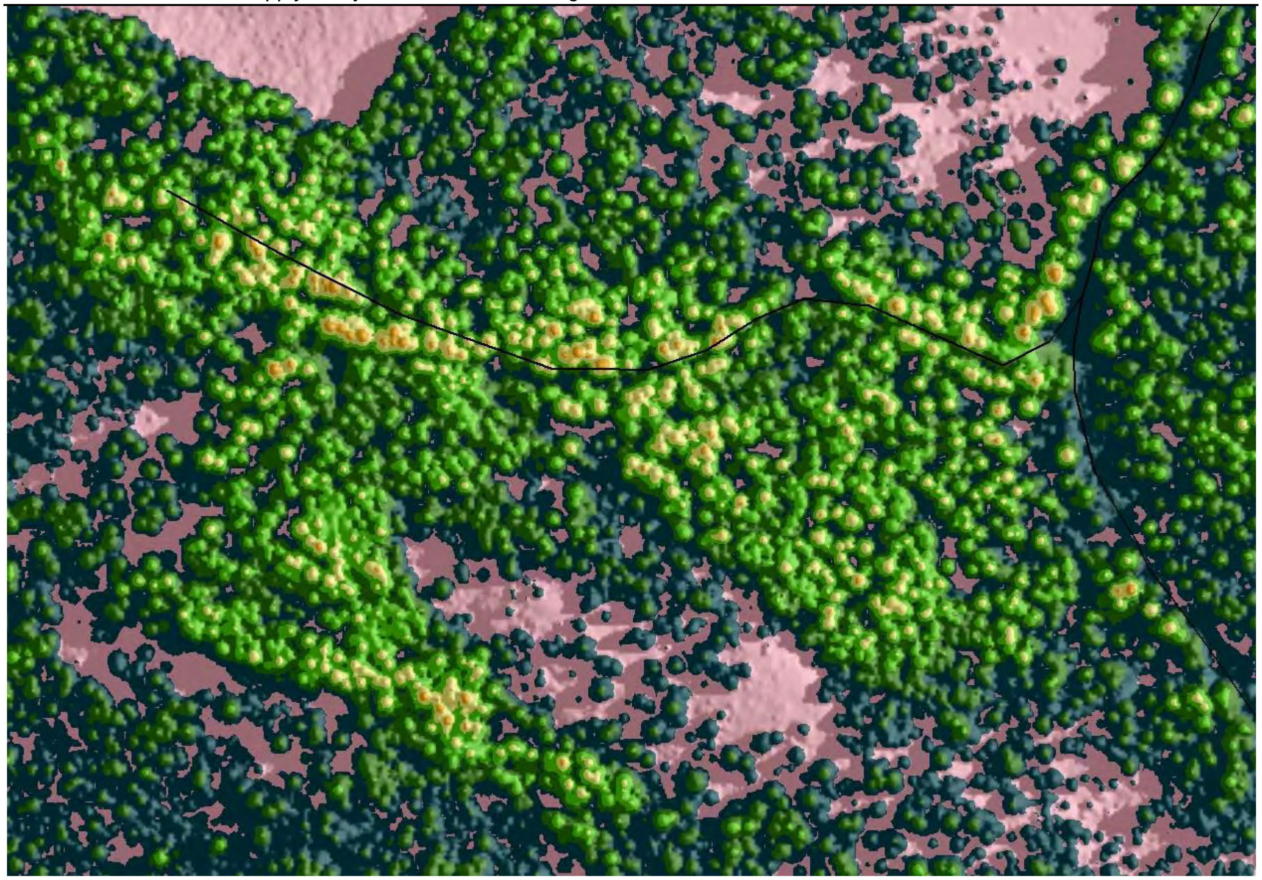


Figure 30 – Road locations on crown height model

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.

Appendix D: LiDAR Review of OAF1 in Managed Stands

SUMMARY

LiDAR data acquired for TFL 19 was used to analyze gaps in crown cover as a proxy for the extent of non-productive area (OAF1) within managed stands. The results indicate that the TIPSY default OAF1 of 15% overstates the extent of non-productive area within stands in TFL 19. Where there is good alignment between the forest inventory polygons and LiDAR data the results indicate that 8% is a more appropriate OAF1.

PROCESS

Using Forest Cover polygons as base data, select operable stands 50 to 80 years old in order to analyze stands within which trees have likely occupied the site to the extent they ever will, have regenerated after harvesting, and are near rotation age (see Figure 31 for an example). Gaps in such stands are assumed to represent low/non-productive area within the stand. Operable stands were selected such that the results would be applicable to the timber harvesting land base (THLB).

Figure 31 - Orthophoto and Inventory Data

It should be noted that current reforestation standards result in higher stocking levels (greater site occupancy) than the stands analysed so the outcomes of this analysis are likely conservative when applied to future stand yields.

Generate LiDAR-based crown height model for selected stands - see example in Figure 32.

Figure 32 - Crown Height Model from LiDAR

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, accounting for roads (as discussed in Appendix C) within the stand. 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 33). Figure 34 indicates the area where crown cover is less than 10m tall and the overall percentage for the sample VRI polygon after accounting for the road.

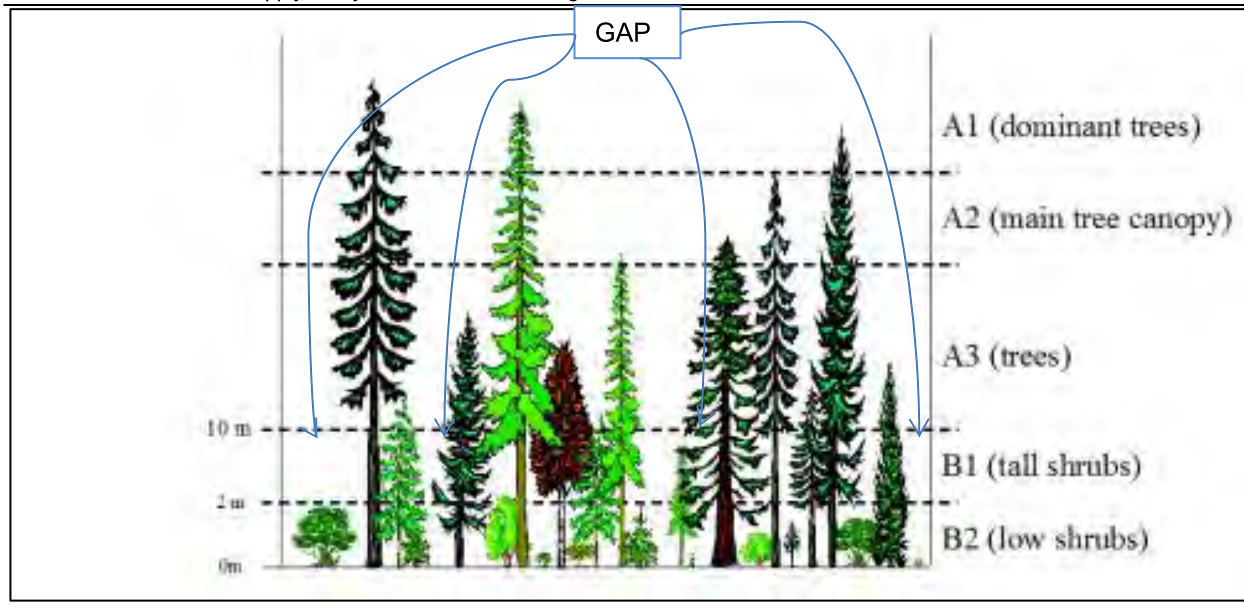


Figure 33 - Diagram of concept for identifying gaps
(adapted from Figure 7.8 in VRI Ground Sampling Procedures Version 5.4, March 2017)

Figure 34 - Orthophoto with inventory polygon and gap factor recognizing road corridor

RESULTS

The results indicate that within 50-80 year old operable stands, the area-weighted average gap factor (i.e. OAF1) is 8%. There is little variation between poor, medium and good site productivity classes so a single OAF1 value of 8% is suitable.

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 50 and 80 years was determined as a proxy for the amount of non-productive area within the polygon. When modelling growth and yield for managed stands with TIPSY, OAF1 is intended to account for these non-productive areas. A “default” OAF1 of 15% is applied unless better information is available.

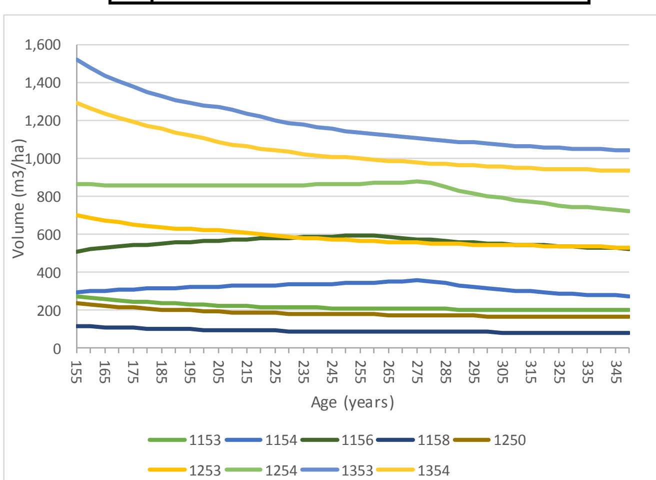
The results indicate that on an OAF1 of 8% is appropriate.

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.

Appendix E: Yield Tables for Mature Natural Stands

Net Merchantable Volume Yield Tables
Mature Natural Stands
CWHxm2 Variant – All Sites

	Analysis Unit								
Age	**1153**	**1154**	**1156**	**1158**	**1250**	**1253**	**1254**	**1353**	**1354**
155	270	295	512	119	238	699	864	1,518	1,291
160	263	299	521	116	231	686	863	1,476	1,265
165	257	303	528	113	225	674	861	1,438	1,238
170	251	306	535	110	219	663	860	1,405	1,213
175	246	310	541	108	214	654	859	1,376	1,191
180	242	313	547	105	209	646	859	1,351	1,171
185	238	316	552	103	205	639	859	1,329	1,154
190	235	319	557	101	202	633	859	1,310	1,138
195	231	322	562	99	199	628	859	1,295	1,120
200	229	324	566	98	196	624	860	1,281	1,104
205	226	326	568	96	193	620	859	1,268	1,089
210	223	327	571	95	191	615	859	1,254	1,075
215	221	329	574	94	189	607	859	1,235	1,063
220	219	331	577	93	187	600	859	1,218	1,052
225	217	333	580	92	186	593	860	1,203	1,042
230	216	335	582	91	184	587	860	1,189	1,033
235	214	337	585	90	183	582	861	1,177	1,024
240	213	339	587	90	182	577	862	1,165	1,017
245	212	341	590	89	181	573	864	1,155	1,010
250	211	344	592	89	180	570	865	1,145	1,004
255	210	346	595	88	179	566	867	1,137	998
260	209	348	595	88	178	563	870	1,129	993
265	208	351	588	87	177	560	872	1,121	988
270	208	353	581	87	176	558	875	1,115	983
275	207	356	575	86	175	555	877	1,108	978
280	206	353	570	86	174	553	870	1,102	974
285	206	342	565	86	173	551	850	1,095	970
290	205	332	561	85	172	549	832	1,088	966
295	205	324	557	85	171	547	817	1,083	962
300	204	316	554	85	170	545	803	1,077	958
305	204	310	550	84	170	544	791	1,072	955
310	204	304	547	84	169	542	780	1,067	952
315	203	299	544	84	168	541	771	1,063	949
320	202	294	541	84	168	539	762	1,059	946
325	202	290	538	83	167	537	754	1,056	944
330	201	286	535	83	167	536	747	1,053	942
335	201	283	533	83	166	535	741	1,050	940
340	200	279	530	83	166	534	735	1,047	938
345	200	277	528	82	165	533	730	1,045	936
350	199	274	526	82	165	531	725	1,042	934

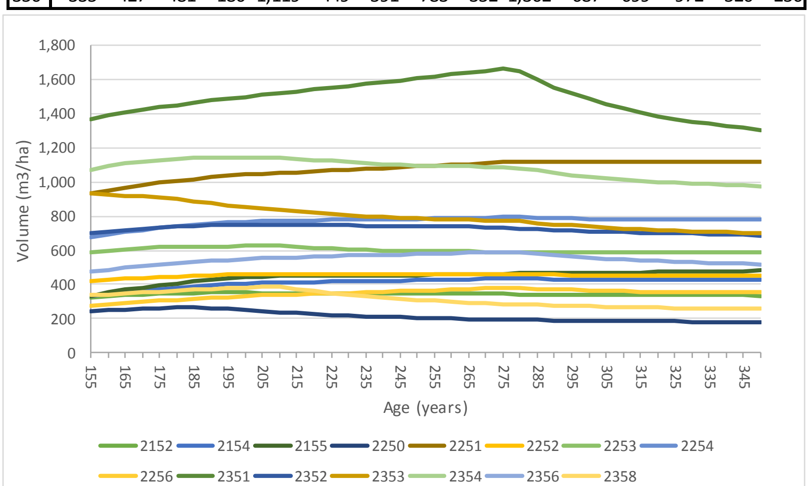


Net Merchantable Volume Yield Tables

Mature Natural Stands

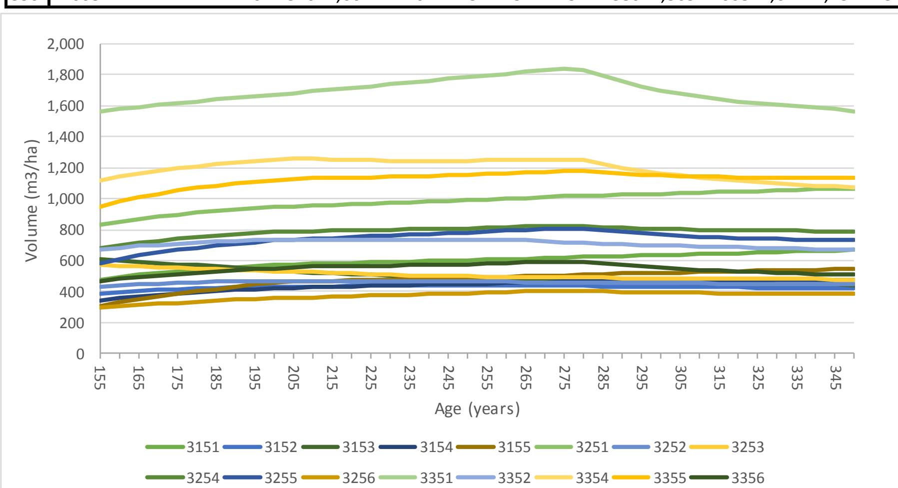
CWHvm1 Variant – All Sites

	Analysis Unit														
Age	**2152**	**2154**	**2155**	**2250**	**2251**	**2252**	**2253**	**2254**	**2256**	**2351**	**2352**	**2353**	**2354**	**2356**	**2358**
155	323	333	333	244	933	417	590	674	273	1,368	701	932	1,073	476	336
160	330	346	352	249	952	426	599	690	281	1,389	711	928	1,093	487	343
165	336	356	368	253	968	433	605	705	289	1,407	719	920	1,107	497	348
170	341	366	382	257	983	438	611	718	297	1,422	727	914	1,117	507	354
175	345	375	395	261	995	443	617	729	304	1,436	733	908	1,126	516	359
180	349	383	407	264	1,006	447	621	739	310	1,449	739	900	1,133	525	364
185	351	390	417	264	1,017	451	623	748	316	1,462	744	888	1,138	532	369
190	352	396	426	262	1,026	454	624	756	322	1,474	748	877	1,143	540	374
195	353	401	434	257	1,034	456	624	762	327	1,487	751	864	1,143	544	378
200	352	406	442	249	1,042	457	625	767	332	1,498	750	853	1,144	549	383
205	351	409	446	243	1,047	457	625	770	336	1,509	749	843	1,143	553	387
210	351	411	449	238	1,052	457	625	773	339	1,520	748	834	1,141	556	388
215	350	412	448	232	1,056	457	619	774	342	1,530	746	826	1,134	557	373
220	349	414	449	227	1,061	458	613	776	345	1,541	746	818	1,129	566	360
225	349	416	449	223	1,066	458	609	777	348	1,551	745	811	1,123	567	349
230	348	417	450	219	1,071	458	605	778	351	1,562	745	806	1,116	569	339
235	348	419	451	215	1,076	459	602	779	354	1,572	744	800	1,110	570	330
240	347	420	452	212	1,081	459	600	780	358	1,583	744	795	1,105	572	323
245	347	422	453	209	1,086	459	598	782	361	1,594	744	791	1,100	575	316
250	347	424	455	206	1,091	460	596	783	364	1,605	744	787	1,097	577	309
255	347	426	456	204	1,095	460	595	785	367	1,616	744	783	1,094	580	304
260	346	428	458	201	1,100	460	594	787	370	1,627	743	780	1,092	583	299
265	345	430	459	199	1,105	459	593	789	374	1,638	738	778	1,090	586	294
270	345	433	461	197	1,110	458	592	791	377	1,649	733	775	1,088	589	290
275	344	435	463	196	1,115	458	592	793	380	1,660	729	773	1,088	592	286
280	343	436	464	194	1,118	457	591	793	380	1,646	725	769	1,081	589	283
285	343	433	465	193	1,117	456	591	790	375	1,597	721	760	1,066	579	280
290	342	431	466	191	1,117	456	590	787	371	1,554	718	752	1,053	570	277
295	341	430	467	190	1,117	455	589	785	368	1,516	715	745	1,041	563	274
300	341	428	468	189	1,118	455	589	784	365	1,483	712	739	1,031	556	272
305	340	427	469	188	1,119	454	589	783	363	1,455	709	733	1,023	551	270
310	340	427	470	187	1,118	454	589	782	361	1,429	707	728	1,014	546	268
315	340	426	471	186	1,117	453	589	781	359	1,406	704	723	1,007	541	266
320	339	426	472	185	1,117	453	589	781	357	1,385	702	719	1,000	537	264
325	339	426	473	184	1,117	452	589	781	356	1,368	700	715	994	533	263
330	338	426	475	183	1,117	452	589	781	354	1,352	697	711	989	530	261
335	337	426	476	182	1,118	451	589	781	354	1,338	694	708	985	527	260
340	337	426	478	182	1,119	451	590	782	353	1,325	692	705	981	525	258
345	336	427	479	181	1,120	450	590	782	353	1,314	690	702	977	523	257
350	335	427	481	180	1,119	449	591	783	352	1,302	687	699	972	520	256



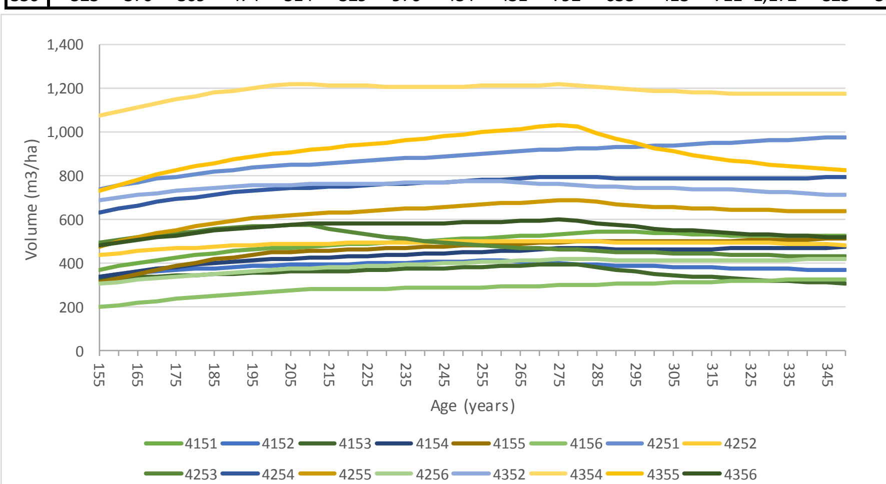
Net Merchantable Volume Yield Tables
Mature Natural Stands
CWHvm2 Variant – All Sites

	Analysis Unit															
Age	**3151**	**3152**	**3153**	**3154**	**3155**	**3251**	**3252**	**3253**	**3254**	**3255**	**3256**	**3351**	**3352**	**3354**	**3355**	**3356**
155	478	390	607	344	306	832	433	573	680	583	296	1,558	673	1,121	948	468
160	494	398	597	357	329	852	440	567	697	611	305	1,576	684	1,143	980	480
165	508	405	589	369	350	869	446	561	713	633	313	1,591	694	1,163	1,007	492
170	521	410	582	379	368	884	452	556	726	651	321	1,604	702	1,180	1,030	503
175	532	416	576	388	386	897	457	552	739	668	328	1,616	710	1,196	1,050	513
180	542	420	571	397	402	908	461	548	750	683	335	1,626	717	1,210	1,068	522
185	550	424	563	404	417	919	465	543	760	696	341	1,638	723	1,223	1,084	531
190	558	428	556	411	432	928	468	539	769	709	347	1,648	728	1,235	1,098	538
195	565	430	546	417	446	937	470	535	776	720	352	1,660	732	1,242	1,108	545
200	572	432	538	423	459	944	469	532	783	730	357	1,672	732	1,250	1,118	551
205	575	433	530	426	463	949	468	529	787	736	361	1,682	732	1,255	1,124	556
210	578	434	523	430	466	954	467	526	790	742	364	1,693	732	1,259	1,131	560
215	581	435	517	432	469	958	466	521	792	746	367	1,704	732	1,254	1,132	561
220	585	436	512	435	472	963	465	516	794	751	370	1,715	732	1,250	1,134	562
225	588	437	507	437	475	968	465	512	796	756	374	1,726	733	1,247	1,136	564
230	591	438	503	440	478	972	464	509	799	761	377	1,738	733	1,245	1,139	566
235	594	439	499	442	481	977	464	506	801	766	380	1,749	734	1,244	1,142	569
240	597	440	495	445	484	982	464	503	804	771	383	1,761	735	1,243	1,146	571
245	601	441	492	448	487	986	463	501	806	776	386	1,772	735	1,244	1,150	574
250	604	442	490	451	490	991	463	499	809	782	390	1,784	736	1,245	1,154	577
255	607	443	487	453	493	996	463	497	812	787	393	1,795	737	1,246	1,158	581
260	610	443	485	456	496	1,001	463	496	815	792	396	1,807	737	1,248	1,163	584
265	613	441	483	459	500	1,005	461	495	819	798	400	1,818	730	1,250	1,168	587
270	616	439	481	462	503	1,010	460	494	822	803	403	1,830	724	1,252	1,173	591
275	620	437	480	465	506	1,015	459	493	825	809	406	1,842	718	1,254	1,178	595
280	623	436	477	466	513	1,019	458	492	824	807	407	1,831	713	1,246	1,177	592
285	626	434	474	466	515	1,021	457	490	818	794	402	1,791	708	1,221	1,168	580
290	629	433	470	466	517	1,024	456	488	812	783	399	1,756	704	1,200	1,161	569
295	632	432	467	466	519	1,027	456	487	808	774	396	1,726	700	1,181	1,155	560
300	636	431	464	466	521	1,030	455	486	804	766	394	1,700	697	1,164	1,150	553
305	639	430	462	467	524	1,034	455	485	801	760	392	1,678	694	1,149	1,146	546
310	642	429	459	468	526	1,037	454	484	798	754	391	1,658	691	1,136	1,143	540
315	645	428	457	468	529	1,041	453	483	796	749	389	1,641	688	1,125	1,140	534
320	649	427	455	469	531	1,044	453	482	794	745	388	1,627	685	1,115	1,138	529
325	652	426	453	470	534	1,048	452	481	793	742	388	1,615	682	1,106	1,137	525
330	655	425	451	472	536	1,052	451	481	792	739	387	1,604	679	1,098	1,137	521
335	658	424	449	473	539	1,056	450	480	792	737	387	1,595	676	1,091	1,136	518
340	661	423	447	474	542	1,060	449	480	791	735	387	1,587	673	1,085	1,137	515
345	665	422	446	476	545	1,064	448	479	791	733	387	1,580	671	1,080	1,137	512
350	668	422	444	476	546	1,064	446	479	791	731	386	1,565	668	1,074	1,131	510



Net Merchantable Volume Yield Tables
Mature Natural Stands
MHmm1 Variant – All Sites

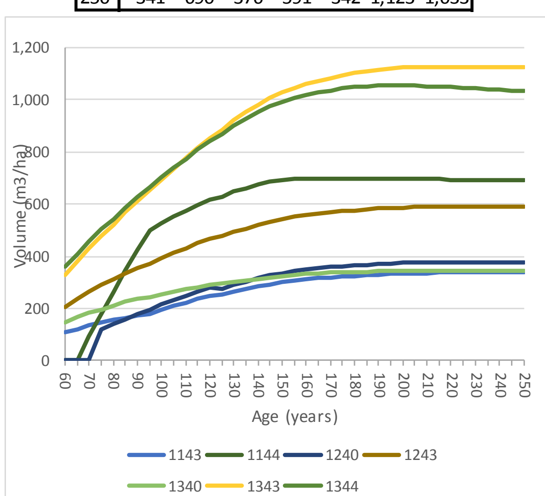
	Analysis Unit															
Age	**4151**	**4152**	**4153**	**4154**	**4155**	**4156**	**4251**	**4252**	**4253**	**4254**	**4255**	**4256**	**4352**	**4354**	**4355**	**4356**
155	373	341	329	341	311	199	740	438	496	634	476	307	689	1,073	732	482
160	389	349	333	353	334	210	757	447	508	651	499	317	701	1,096	759	495
165	403	357	337	364	354	220	772	455	518	666	519	325	711	1,115	783	507
170	416	363	341	375	372	229	785	462	528	680	537	333	721	1,133	805	518
175	427	369	344	384	389	238	797	467	538	692	553	340	729	1,150	824	529
180	437	374	348	392	404	246	808	473	547	703	568	347	736	1,164	842	539
185	446	379	351	400	417	253	818	478	556	714	581	353	743	1,178	858	549
190	455	383	354	407	429	260	827	482	564	723	593	359	749	1,190	873	558
195	462	387	357	413	440	267	835	485	568	730	604	365	755	1,200	887	565
200	469	390	359	419	449	273	843	487	572	737	613	370	757	1,209	899	572
205	473	392	361	422	453	278	848	488	575	742	619	374	758	1,216	908	579
210	477	394	363	426	457	282	853	489	575	746	625	378	760	1,220	917	583
215	482	396	365	429	460	282	858	491	559	749	629	381	761	1,215	926	582
220	486	398	367	432	463	283	863	492	544	753	634	383	763	1,212	935	581
225	490	400	369	435	465	284	869	493	532	756	638	386	764	1,209	943	581
230	494	402	372	438	468	285	874	495	521	760	643	390	766	1,208	952	581
235	498	404	374	441	471	286	879	496	511	764	648	393	768	1,207	961	582
240	503	406	377	444	474	287	884	497	503	767	653	396	769	1,206	970	583
245	507	408	379	447	477	289	890	498	495	771	658	399	771	1,207	979	585
250	511	410	382	450	481	290	895	500	488	775	663	402	773	1,207	988	587
255	516	412	384	454	484	292	900	501	482	779	668	406	775	1,209	997	589
260	520	413	387	457	487	293	905	502	477	784	673	409	775	1,210	1,006	591
265	524	408	390	460	490	295	911	501	473	788	678	412	770	1,212	1,015	594
270	529	404	393	464	494	297	916	500	468	792	684	416	765	1,214	1,024	597
275	533	400	395	467	497	299	921	499	465	796	689	419	760	1,216	1,034	600
280	537	397	392	468	499	301	926	498	461	797	688	420	756	1,214	1,026	597
285	542	394	381	467	498	303	928	498	458	794	679	418	753	1,206	996	585
290	546	391	371	466	498	305	931	497	454	791	671	416	749	1,199	970	575
295	545	389	362	465	498	307	934	497	451	789	665	415	746	1,193	948	567
300	540	387	354	465	499	309	937	496	449	788	659	414	744	1,189	928	560
305	536	385	347	465	500	311	940	496	447	787	655	414	742	1,185	911	553
310	532	383	341	466	501	313	944	496	445	786	651	414	739	1,181	896	548
315	530	381	336	466	502	316	948	495	442	786	648	414	737	1,179	883	542
320	528	379	330	467	503	318	952	495	440	786	645	414	735	1,177	871	538
325	526	378	326	468	505	320	956	495	438	787	643	415	733	1,175	861	533
330	524	376	322	469	507	322	960	492	436	788	642	415	728	1,174	853	530
335	524	375	318	470	508	325	964	490	435	789	641	416	723	1,174	845	527
340	523	373	314	471	510	327	969	488	433	790	640	417	719	1,173	838	524
345	523	372	311	473	512	329	973	486	432	792	639	418	715	1,173	832	522
350	523	370	309	474	514	329	976	484	431	792	638	418	711	1,172	825	519



Appendix F: Yield Tables for Immature Natural Stands

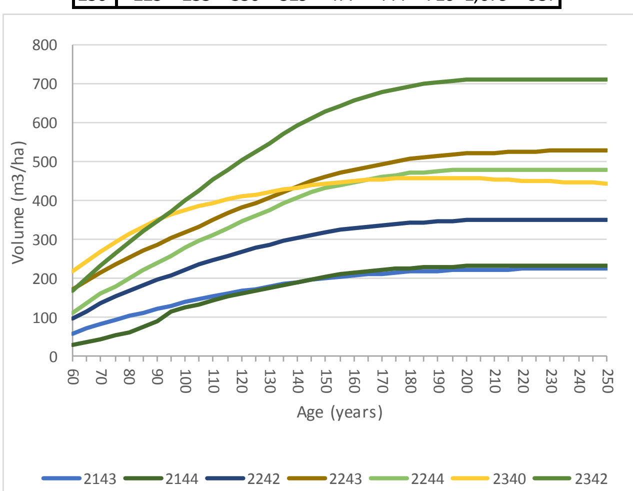
Net Merchantable Volume Yield Tables
Immature Natural Stands
CWHxm2 Variant – All Sites

	Analysis Unit						
Age	1143	1144	1240	1243	1340	1343	1344
60	108	0	0	203	147	328	360
65	122	0	0	238	165	379	409
70	134	91	0	265	182	428	456
75	145	177	121	290	197	476	502
80	155	263	140	313	211	522	544
85	164	345	159	334	224	567	586
90	173	424	178	355	235	610	625
95	181	498	196	373	244	652	663
100	195	525	214	394	255	694	702
105	209	550	231	414	265	736	738
110	222	574	248	432	274	776	774
115	235	597	263	450	282	816	808
120	247	617	278	466	290	854	841
125	255	629	274	479	296	886	870
130	266	646	289	494	302	919	900
135	276	660	302	507	308	951	928
140	285	674	315	520	314	980	954
145	293	684	326	532	319	1,005	975
150	300	691	335	541	324	1,027	993
155	306	695	343	550	328	1,045	1,007
160	311	697	349	557	331	1,060	1,019
165	315	698	354	563	334	1,073	1,029
170	318	699	358	568	336	1,084	1,036
175	322	699	362	572	338	1,093	1,042
180	324	699	365	576	340	1,101	1,047
185	327	698	368	579	341	1,108	1,051
190	329	698	370	582	342	1,114	1,053
195	331	698	372	585	343	1,119	1,055
200	333	698	374	587	344	1,123	1,056
205	334	697	374	588	344	1,123	1,054
210	335	696	375	588	344	1,123	1,051
215	336	695	375	589	344	1,124	1,049
220	337	694	375	589	344	1,124	1,047
225	337	694	375	590	343	1,124	1,045
230	338	693	376	590	343	1,124	1,042
235	339	692	376	590	343	1,124	1,040
240	339	691	376	591	343	1,124	1,038
245	340	691	376	591	343	1,123	1,035
250	341	690	376	591	342	1,123	1,033



Net Merchantable Volume Yield Tables
Immature Natural Stands
CWHvm1 Variant – All Sites

	Analysis Unit								
Age	**2143**	**2144**	**2242**	**2243**	**2244**	**2340**	**2342**	**2343**	**2344**
60	60	29	96	172	113	218	169	286	280
65	73	37	117	195	137	245	202	333	320
70	84	45	136	216	160	270	234	379	360
75	94	53	153	236	181	293	264	424	398
80	103	62	169	255	202	314	293	467	436
85	112	77	183	272	223	333	321	509	473
90	121	91	196	288	241	350	346	550	508
95	131	117	207	303	259	366	371	590	542
100	139	125	221	319	278	376	400	632	577
105	147	134	235	334	296	386	427	673	612
110	154	144	247	351	313	395	454	712	647
115	161	153	259	367	330	403	479	751	681
120	168	162	270	382	347	411	504	788	715
125	172	167	278	395	361	416	524	821	746
130	179	175	287	409	377	423	547	856	778
135	185	183	296	423	392	429	570	889	807
140	190	191	304	437	407	434	592	920	834
145	196	199	312	449	420	439	611	947	859
150	200	205	318	460	431	443	629	970	880
155	204	210	324	470	440	447	644	989	897
160	208	214	329	480	448	450	658	1,005	911
165	211	218	333	487	455	453	669	1,019	922
170	213	221	337	494	461	455	678	1,030	932
175	215	224	340	501	466	456	686	1,041	939
180	217	226	343	506	470	457	693	1,049	946
185	219	228	345	511	473	457	698	1,057	950
190	220	230	347	515	476	458	703	1,063	954
195	221	231	348	518	479	458	706	1,069	956
200	222	233	350	521	480	457	709	1,073	957
205	223	233	350	522	480	456	710	1,074	956
210	223	233	350	523	480	454	710	1,075	954
215	223	233	350	524	480	453	710	1,076	951
220	224	233	350	525	480	452	710	1,076	949
225	224	233	350	526	479	450	710	1,077	947
230	224	233	350	527	479	449	710	1,077	945
235	225	233	350	528	479	448	710	1,078	943
240	225	233	350	528	478	447	710	1,078	941
245	225	233	350	529	478	445	710	1,078	939
250	225	233	350	529	477	444	710	1,079	937

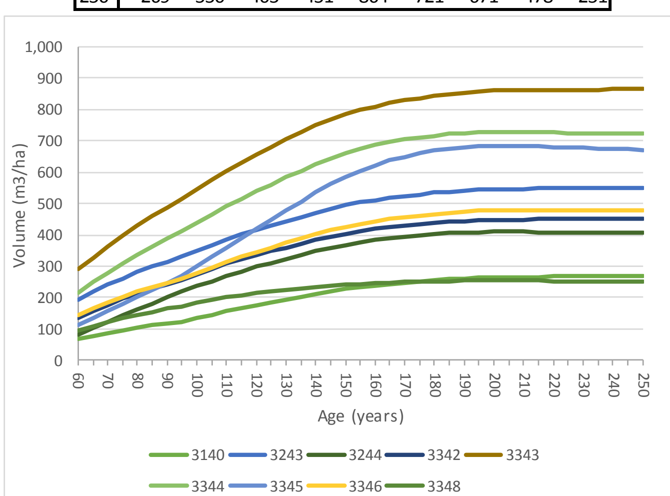


Net Merchantable Volume Yield Tables

Immature Natural Stands

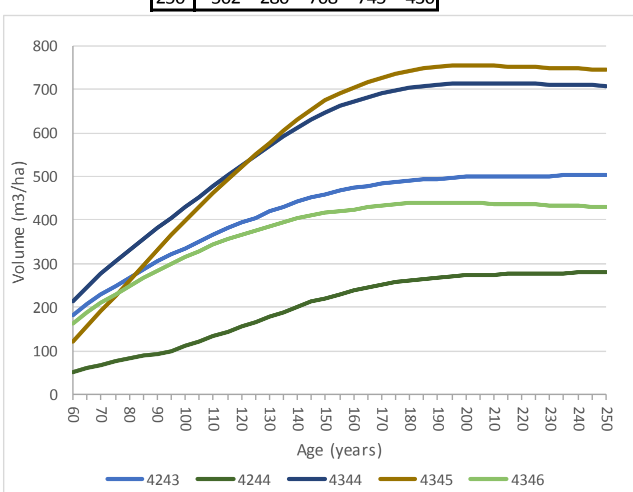
CWHvm2 Variant – All Sites

	Analysis Unit								
Age	**3140**	**3243**	**3244**	**3342**	**3343**	**3344**	**3345**	**3346**	**3348**
60	68	194	83	136	290	217	115	143	94
65	78	219	102	157	328	249	135	165	109
70	88	241	123	177	364	279	157	184	122
75	97	262	143	196	398	308	178	202	134
80	104	281	163	213	429	336	201	218	145
85	112	299	182	229	460	362	223	233	155
90	118	315	201	244	488	389	245	247	165
95	124	330	219	257	516	413	270	260	173
100	136	349	236	275	546	440	301	278	183
105	146	366	253	292	574	465	330	295	192
110	157	384	268	308	603	490	360	313	200
115	167	401	283	323	631	515	389	330	208
120	177	416	298	337	658	539	419	346	215
125	185	429	307	347	680	560	446	360	218
130	194	443	321	360	705	583	476	375	223
135	203	457	334	372	728	605	506	389	228
140	212	471	347	384	750	626	535	402	233
145	220	483	358	394	768	645	561	414	237
150	227	494	368	404	784	661	584	424	240
155	233	503	376	412	798	675	604	434	243
160	239	511	383	419	809	686	622	442	246
165	244	518	389	425	819	696	637	450	248
170	248	524	394	430	828	704	649	457	250
175	252	529	398	434	835	711	659	462	251
180	255	534	402	438	842	716	668	467	252
185	258	537	405	441	847	721	675	471	253
190	260	541	407	444	852	723	680	475	254
195	263	544	409	446	856	726	683	477	254
200	264	546	410	448	859	728	685	479	255
205	265	547	410	449	860	727	685	480	254
210	266	547	410	449	861	727	683	480	254
215	266	548	409	450	861	726	682	479	254
220	267	548	409	450	862	726	680	479	253
225	267	548	408	450	863	725	679	479	253
230	268	549	408	450	863	724	677	479	252
235	268	549	407	451	863	723	675	479	252
240	268	549	406	451	864	723	674	478	252
245	269	549	406	451	864	722	672	478	251
250	269	550	405	451	864	721	671	478	251



Net Merchantable Volume Yield Tables
Immature Natural Stands
MHmm1 Variant – All Sites

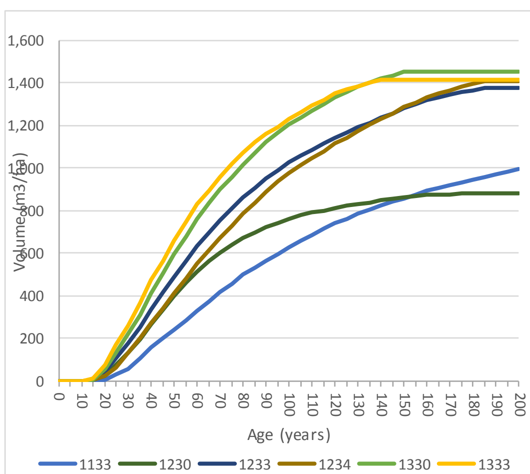
	Analysis Unit				
Age	**4243**	**4244**	**4344**	**4345**	**4346**
60	182	51	215	120	163
65	206	60	246	155	187
70	229	68	276	190	210
75	250	75	305	225	231
80	269	82	332	262	250
85	288	88	358	297	268
90	305	94	383	332	285
95	321	99	406	366	300
100	336	111	429	399	315
105	350	122	453	431	328
110	366	134	478	462	343
115	381	145	503	493	356
120	395	156	526	523	367
125	406	166	547	550	377
130	419	178	569	578	387
135	431	189	591	605	396
140	442	201	612	631	404
145	452	212	631	654	411
150	460	221	647	674	417
155	468	230	661	690	422
160	474	238	672	705	425
165	479	245	682	717	430
170	483	251	690	726	434
175	487	257	697	735	437
180	490	261	703	741	439
185	493	265	707	747	441
190	495	269	710	751	441
195	497	272	713	754	441
200	499	274	715	756	441
205	500	275	714	755	440
210	500	275	714	754	438
215	500	276	713	753	437
220	501	277	713	752	436
225	501	277	712	751	435
230	501	278	711	750	434
235	502	278	710	748	433
240	502	279	710	747	432
245	502	279	709	746	431
250	502	280	708	745	430



Appendix G: Yield Tables for Existing Managed Stands Aged 13 – 57 Years

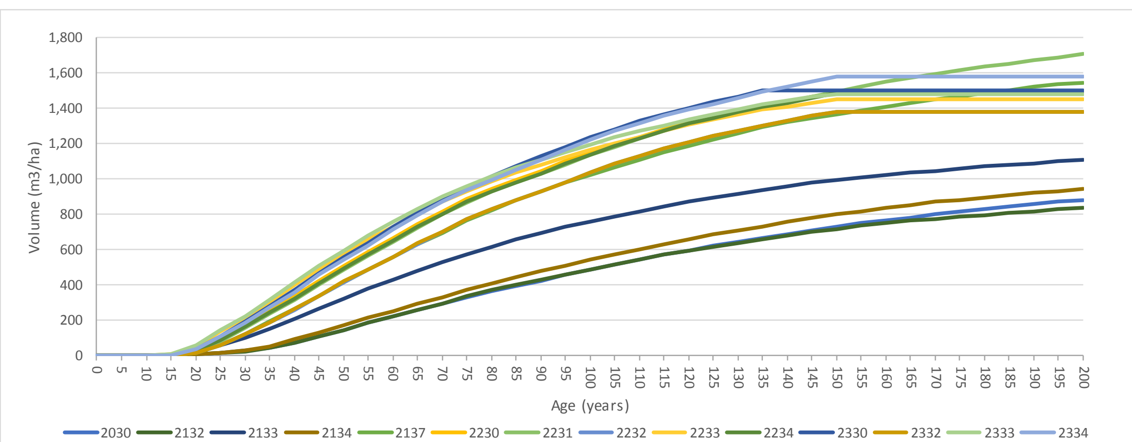
Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 13 – 57 Years Old
CWHxm2 Variant – All Sites

	Analysis Unit					
Age	1133	1230	1233	1234	1330	1333
0	0	0	0	0	0	0
5	0	0	0	0	0	0
10	0	0	0	0	0	0
15	0	2	3	2	5	10
20	3	24	43	22	53	76
25	28	72	105	65	134	169
30	59	131	178	130	219	261
35	108	196	254	199	310	364
40	155	266	336	271	410	472
45	199	336	417	343	504	566
50	243	400	490	411	593	661
55	285	460	562	479	680	750
60	330	515	633	550	762	829
65	373	564	697	615	835	897
70	417	604	755	674	899	960
75	459	640	809	732	961	1,019
80	498	672	860	788	1,018	1,072
85	532	699	907	840	1,071	1,120
90	565	724	951	890	1,122	1,161
95	598	744	990	936	1,167	1,196
100	629	762	1,027	979	1,205	1,229
105	659	777	1,058	1,015	1,238	1,261
110	687	790	1,087	1,049	1,271	1,292
115	714	802	1,114	1,081	1,303	1,322
120	739	812	1,140	1,114	1,333	1,349
125	764	822	1,165	1,145	1,360	1,369
130	785	831	1,190	1,175	1,383	1,385
135	805	839	1,213	1,204	1,403	1,401
140	824	847	1,236	1,232	1,420	1,416
145	842	855	1,259	1,259	1,436	1,416
150	859	862	1,281	1,285	1,452	1,416
155	876	869	1,302	1,309	1,452	1,416
160	892	875	1,321	1,332	1,452	1,416
165	906	877	1,333	1,350	1,452	1,416
170	920	878	1,345	1,366	1,452	1,416
175	934	880	1,356	1,381	1,452	1,416
180	947	882	1,367	1,395	1,452	1,416
185	959	884	1,377	1,409	1,452	1,416
190	971	884	1,377	1,409	1,452	1,416
195	982	884	1,377	1,409	1,452	1,416
200	993	884	1,377	1,409	1,452	1,416



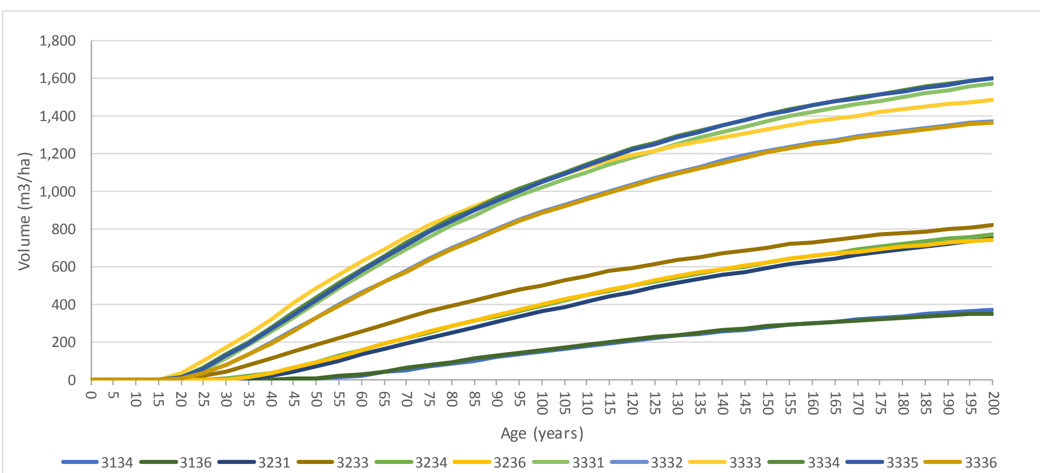
Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 13 – 57 Years Old
CWHvm1 Variant – All Sites

	Analysis Unit													
Age	2030	2132	2133	2134	2137	2230	2231	2232	2233	2234	2330	2332	2333	2334
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	2	0	1	6	1	2	1	6	2
20	5	4	22	5	12	29	18	12	52	24	34	13	55	31
25	12	10	55	13	57	94	79	55	131	85	109	55	138	103
30	24	20	102	28	123	170	153	117	213	160	192	118	223	184
35	42	38	152	52	193	251	231	186	302	238	278	187	314	269
40	72	69	205	90	263	334	312	258	396	320	368	260	411	358
45	106	107	265	130	335	420	399	337	485	405	464	338	504	453
50	145	145	323	172	411	508	487	416	572	492	554	418	592	541
55	182	183	379	212	488	586	564	484	653	570	636	486	674	623
60	219	220	428	252	558	664	643	555	730	648	725	556	756	711
65	255	257	477	290	624	743	723	630	803	726	807	631	829	793
70	291	295	524	330	694	815	796	701	870	800	884	702	897	868
75	326	333	569	368	760	883	865	767	931	868	952	768	958	935
80	360	368	612	404	821	943	924	827	986	928	1,011	827	1,011	993
85	391	398	653	441	879	995	976	877	1,034	981	1,067	878	1,061	1,050
90	423	428	689	476	930	1,045	1,027	925	1,079	1,031	1,126	926	1,109	1,109
95	454	456	724	509	976	1,097	1,080	978	1,121	1,084	1,180	979	1,152	1,165
100	485	485	756	541	1,018	1,146	1,132	1,032	1,162	1,135	1,232	1,032	1,193	1,219
105	515	515	786	571	1,063	1,193	1,181	1,082	1,200	1,183	1,280	1,082	1,232	1,268
110	543	543	815	600	1,107	1,237	1,228	1,128	1,236	1,229	1,326	1,127	1,268	1,314
115	570	569	843	627	1,147	1,279	1,272	1,169	1,270	1,271	1,364	1,168	1,300	1,353
120	595	593	869	655	1,186	1,318	1,313	1,207	1,304	1,311	1,399	1,206	1,333	1,389
125	619	616	893	682	1,222	1,350	1,346	1,240	1,335	1,344	1,432	1,239	1,364	1,423
130	642	638	915	708	1,257	1,381	1,377	1,271	1,364	1,375	1,464	1,270	1,394	1,456
135	665	659	937	731	1,289	1,409	1,407	1,301	1,389	1,404	1,496	1,300	1,420	1,490
140	686	679	956	754	1,317	1,436	1,436	1,329	1,409	1,431	1,496	1,327	1,441	1,521
145	707	698	974	776	1,341	1,462	1,465	1,356	1,429	1,459	1,496	1,354	1,461	1,550
150	727	716	990	796	1,364	1,488	1,494	1,381	1,448	1,486	1,496	1,380	1,481	1,578
155	746	733	1,005	816	1,385	1,488	1,522	1,381	1,448	1,486	1,496	1,380	1,481	1,578
160	764	748	1,019	834	1,406	1,488	1,548	1,381	1,448	1,486	1,496	1,380	1,481	1,578
165	781	761	1,032	851	1,426	1,488	1,572	1,381	1,448	1,486	1,496	1,380	1,481	1,578
170	798	773	1,044	867	1,446	1,488	1,593	1,381	1,448	1,486	1,496	1,380	1,481	1,578
175	813	784	1,056	881	1,466	1,488	1,613	1,381	1,448	1,486	1,496	1,380	1,481	1,578
180	828	795	1,067	894	1,484	1,488	1,632	1,381	1,448	1,486	1,496	1,380	1,481	1,578
185	843	805	1,077	906	1,501	1,488	1,650	1,381	1,448	1,486	1,496	1,380	1,481	1,578
190	856	815	1,088	918	1,518	1,488	1,668	1,381	1,448	1,486	1,496	1,380	1,481	1,578
195	869	824	1,098	930	1,533	1,488	1,685	1,381	1,448	1,486	1,496	1,380	1,481	1,578
200	880	832	1,108	941	1,545	1,488	1,704	1,381	1,448	1,486	1,496	1,380	1,481	1,578



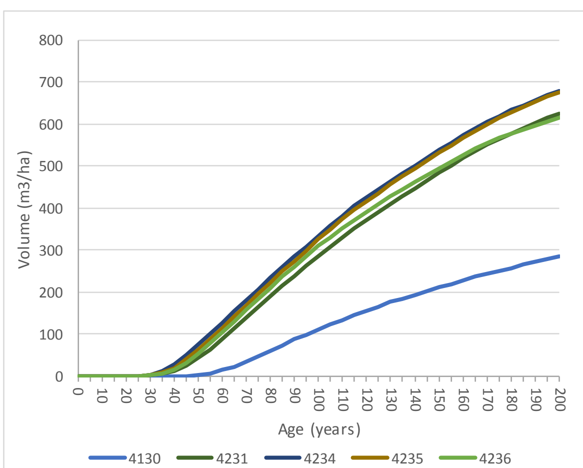
Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 15 – 54 Years Old
CWHvm2 Variant – All Sites

	Analysis Unit											
Age	**3134**	**3136**	**3231**	**3233**	**3234**	**3236**	**3331**	**3332**	**3333**	**3334**	**3335**	**3336**
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
10	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	1	0	0	0
20	0	0	0	2	0	0	9	6	35	15	12	6
25	0	0	0	23	2	0	52	33	97	64	59	32
30	0	0	1	43	6	1	115	79	170	131	124	77
35	0	0	8	76	18	11	184	137	243	202	194	134
40	0	0	22	110	37	31	256	198	321	276	267	195
45	2	3	45	147	66	60	330	262	403	354	344	259
50	7	8	70	184	95	89	406	329	484	434	423	325
55	14	18	101	219	127	123	484	398	555	512	500	394
60	23	29	131	257	159	155	556	463	626	586	574	458
65	38	45	162	292	190	188	624	522	695	658	646	517
70	52	61	193	328	222	223	692	579	759	727	715	573
75	69	78	222	362	252	256	758	641	820	794	782	634
80	85	94	252	394	282	288	818	697	872	854	843	690
85	101	110	280	422	311	316	873	749	920	908	897	742
90	117	126	306	449	337	342	926	799	965	960	950	792
95	133	142	332	474	364	368	974	846	1,010	1,011	1,001	839
100	148	157	360	500	392	396	1,019	889	1,052	1,058	1,049	882
105	162	171	387	526	420	424	1,061	928	1,090	1,102	1,093	920
110	177	184	413	551	447	451	1,102	965	1,126	1,145	1,137	956
115	191	198	440	574	473	477	1,143	1,000	1,160	1,187	1,178	991
120	205	212	465	595	497	502	1,181	1,034	1,191	1,225	1,217	1,025
125	218	225	489	615	520	525	1,216	1,069	1,216	1,259	1,251	1,060
130	231	237	511	634	542	546	1,249	1,101	1,241	1,291	1,284	1,092
135	243	249	533	652	563	567	1,282	1,131	1,264	1,321	1,315	1,123
140	254	260	553	669	582	586	1,313	1,160	1,286	1,351	1,346	1,152
145	266	270	573	686	602	604	1,343	1,189	1,308	1,381	1,376	1,180
150	278	281	592	702	621	622	1,372	1,213	1,329	1,408	1,404	1,205
155	289	290	610	717	640	639	1,396	1,234	1,349	1,433	1,429	1,226
160	299	300	628	731	657	654	1,419	1,255	1,368	1,457	1,453	1,246
165	309	307	644	743	673	667	1,441	1,274	1,385	1,478	1,475	1,265
170	318	314	660	755	689	679	1,460	1,291	1,401	1,498	1,494	1,282
175	328	321	677	767	705	692	1,480	1,307	1,417	1,516	1,513	1,298
180	337	327	692	778	719	703	1,499	1,322	1,432	1,535	1,531	1,314
185	346	334	706	788	733	714	1,518	1,337	1,446	1,553	1,549	1,329
190	355	340	720	798	747	724	1,537	1,352	1,460	1,570	1,566	1,343
195	364	346	734	808	759	734	1,555	1,364	1,474	1,586	1,582	1,356
200	373	352	747	817	772	744	1,572	1,373	1,486	1,602	1,598	1,365



Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 15 – 54 Years Old
MHmm1 Variant – All Sites

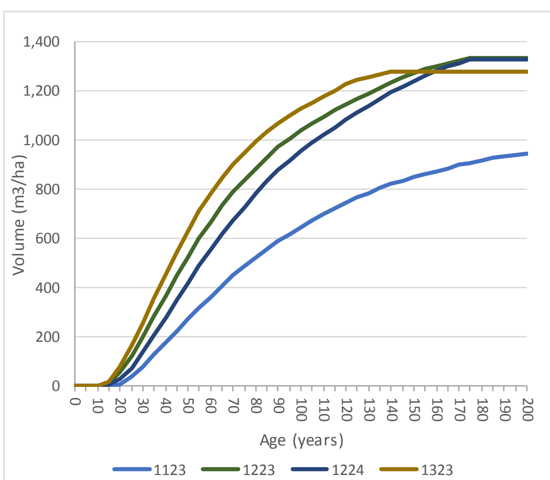
	Analysis Unit				
Age	4130	4231	4234	4235	4236
0	0	0	0	0	0
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	0	0
20	0	0	0	0	0
25	0	0	0	0	0
30	0	1	3	1	1
35	0	5	13	8	5
40	0	12	27	20	14
45	0	26	50	40	32
50	3	44	75	63	54
55	7	64	101	88	78
60	14	87	127	114	103
65	23	113	155	142	130
70	33	138	181	169	157
75	47	163	207	195	182
80	61	189	234	222	209
85	74	214	260	249	236
90	87	238	284	274	261
95	99	262	309	299	286
100	111	286	334	325	310
105	123	308	359	350	331
110	134	330	382	373	352
115	145	351	405	395	372
120	156	371	425	416	390
125	166	390	445	436	408
130	176	409	464	456	427
135	185	428	483	475	444
140	194	447	501	494	462
145	203	466	520	513	479
150	212	484	538	532	496
155	220	502	556	550	512
160	228	519	573	567	528
165	236	536	590	584	542
170	243	551	605	600	556
175	250	565	619	614	567
180	258	578	633	628	578
185	265	590	645	640	588
190	271	602	657	653	597
195	278	614	669	665	607
200	284	625	680	676	616



Appendix H: Yield Tables for Existing Managed Stands Aged 1 – 12 Years

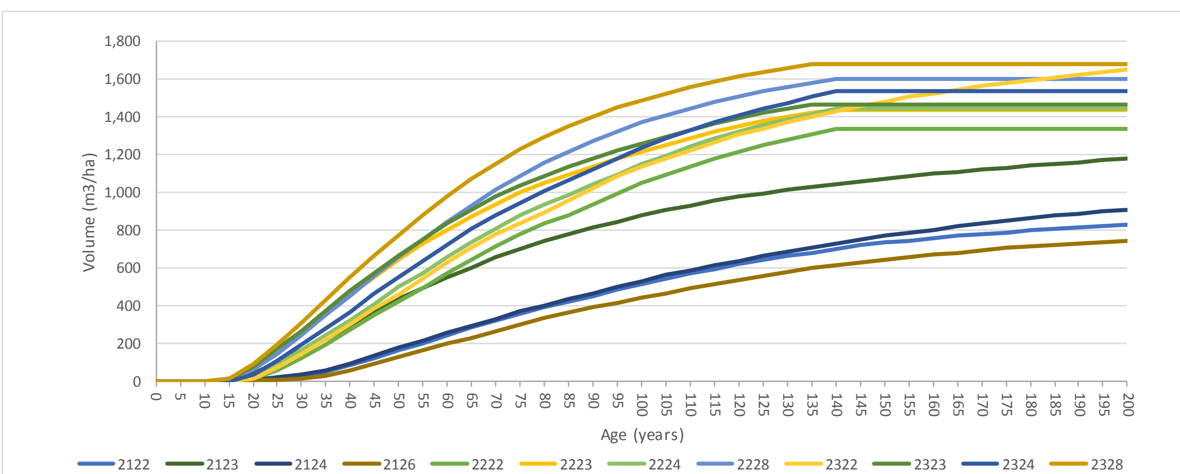
Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 12 Years Old
CWHxm2 Variant – All Sites

	Analysis Unit			
Age	**1123**	**1223**	**1224**	**1323**
0	0	0	0	0
5	0	0	0	0
10	0	0	0	0
15	0	8	3	14
20	7	52	25	78
25	38	121	69	165
30	78	197	136	253
35	128	281	207	353
40	177	368	279	453
45	223	448	348	542
50	269	523	417	628
55	317	597	486	709
60	362	667	554	780
65	405	730	616	843
70	448	786	672	898
75	489	837	726	948
80	524	885	780	993
85	557	929	830	1,033
90	588	970	875	1,068
95	618	1,007	918	1,099
100	646	1,039	956	1,126
105	673	1,067	989	1,152
110	697	1,094	1,021	1,177
115	721	1,119	1,050	1,202
120	744	1,144	1,080	1,225
125	765	1,167	1,110	1,244
130	785	1,190	1,138	1,256
135	803	1,213	1,166	1,266
140	819	1,235	1,192	1,276
145	835	1,255	1,217	1,276
150	848	1,274	1,240	1,276
155	861	1,287	1,261	1,276
160	874	1,300	1,281	1,276
165	885	1,311	1,297	1,276
170	897	1,321	1,311	1,276
175	907	1,331	1,325	1,276
180	917	1,331	1,325	1,276
185	926	1,331	1,325	1,276
190	934	1,331	1,325	1,276
195	940	1,331	1,325	1,276
200	946	1,331	1,325	1,276



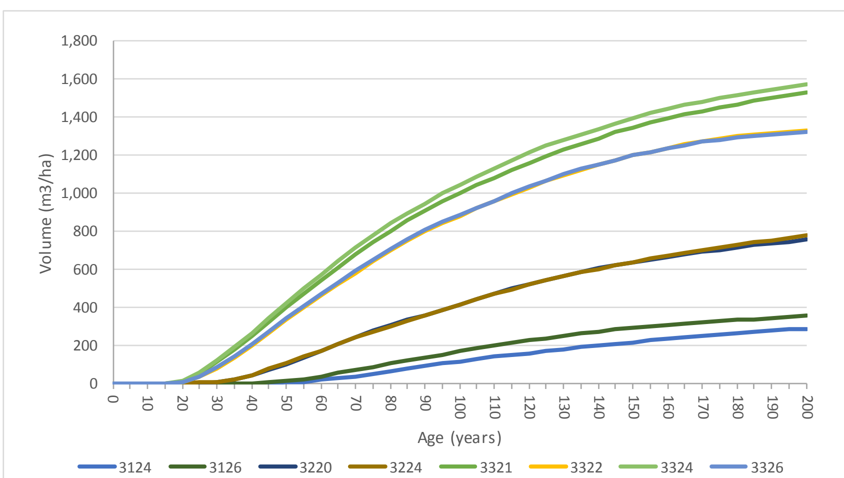
Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 12 Years Old
CWHvm1 Variant – All Sites

	Analysis Unit											
Age	**2122**	**2123**	**2124**	**2126**	**2222**	**2223**	**2224**	**2228**	**2322**	**2323**	**2324**	**2328**
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
10	0	0	0	0	0	0	0	0	0	0	0	0
15	0	3	0	0	1	14	2	6	0	14	2	13
20	5	44	7	3	13	77	24	61	16	80	32	91
25	11	100	17	6	56	162	86	140	69	170	106	193
30	23	161	32	12	122	253	161	243	140	264	188	309
35	46	222	56	27	193	356	241	348	217	370	275	426
40	82	294	94	55	267	457	323	451	301	475	365	548
45	122	365	135	90	348	550	409	557	386	571	461	663
50	162	431	176	125	422	641	496	658	459	665	549	772
55	202	489	216	161	490	725	573	751	541	752	634	875
60	240	547	255	196	568	802	653	842	624	833	722	974
65	282	602	294	229	642	873	733	929	704	907	805	1,067
70	322	653	330	266	713	938	807	1,012	776	975	880	1,152
75	359	699	367	302	778	997	875	1,088	837	1,034	945	1,227
80	391	740	400	336	832	1,049	934	1,155	892	1,087	1,004	1,293
85	421	777	431	364	881	1,095	986	1,216	959	1,136	1,064	1,352
90	450	812	465	391	938	1,137	1,039	1,271	1,023	1,180	1,124	1,402
95	481	845	498	416	995	1,177	1,094	1,323	1,082	1,221	1,180	1,446
100	513	876	530	440	1,048	1,215	1,146	1,368	1,133	1,259	1,233	1,486
105	542	904	560	465	1,094	1,250	1,194	1,407	1,180	1,294	1,283	1,520
110	569	929	587	491	1,137	1,284	1,239	1,445	1,224	1,328	1,329	1,553
115	594	953	613	514	1,176	1,319	1,282	1,478	1,265	1,362	1,369	1,584
120	618	975	638	537	1,213	1,350	1,322	1,508	1,303	1,393	1,405	1,612
125	640	994	660	557	1,246	1,378	1,355	1,535	1,338	1,420	1,439	1,637
130	660	1,011	683	577	1,276	1,398	1,385	1,559	1,371	1,441	1,471	1,658
135	680	1,028	706	596	1,305	1,417	1,414	1,581	1,402	1,460	1,504	1,678
140	699	1,043	728	613	1,332	1,434	1,441	1,601	1,430	1,460	1,535	1,678
145	717	1,058	749	628	1,332	1,434	1,441	1,601	1,457	1,460	1,535	1,678
150	732	1,072	768	643	1,332	1,434	1,441	1,601	1,481	1,460	1,535	1,678
155	745	1,084	786	656	1,332	1,434	1,441	1,601	1,503	1,460	1,535	1,678
160	756	1,096	802	669	1,332	1,434	1,441	1,601	1,523	1,460	1,535	1,678
165	767	1,107	818	681	1,332	1,434	1,441	1,601	1,542	1,460	1,535	1,678
170	777	1,118	833	692	1,332	1,434	1,441	1,601	1,560	1,460	1,535	1,678
175	787	1,128	848	703	1,332	1,434	1,441	1,601	1,577	1,460	1,535	1,678
180	796	1,139	862	713	1,332	1,434	1,441	1,601	1,592	1,460	1,535	1,678
185	804	1,149	875	722	1,332	1,434	1,441	1,601	1,607	1,460	1,535	1,678
190	813	1,158	888	728	1,332	1,434	1,441	1,601	1,622	1,460	1,535	1,678
195	820	1,167	899	734	1,332	1,434	1,441	1,601	1,635	1,460	1,535	1,678
200	827	1,176	909	739	1,332	1,434	1,441	1,601	1,648	1,460	1,535	1,678



Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 12 Years Old
CWHvm2 Variant – All Sites

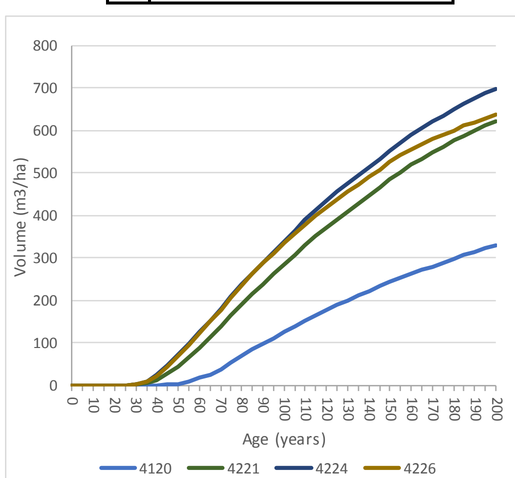
	Analysis Unit							
Age	3124	3126	3220	3224	3321	3322	3324	3326
0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
20	0	0	0	1	8	5	12	7
25	0	0	0	3	48	31	58	35
30	0	0	4	9	110	78	123	83
35	0	0	17	23	178	137	193	144
40	0	0	40	45	248	199	266	207
45	1	5	70	76	321	263	342	271
50	4	12	101	106	397	333	422	342
55	9	23	136	141	473	401	499	409
60	17	36	168	173	543	460	570	469
65	26	53	205	207	609	517	641	526
70	37	69	241	241	677	580	712	589
75	52	86	274	272	742	641	779	649
80	65	103	303	301	802	697	839	704
85	78	120	331	329	856	749	893	756
90	90	136	357	356	908	798	945	804
95	103	152	386	384	955	842	996	848
100	115	167	416	414	998	881	1,042	887
105	127	181	444	442	1,039	918	1,086	923
110	138	196	471	468	1,079	953	1,129	958
115	149	210	497	494	1,120	992	1,172	997
120	159	224	521	518	1,159	1,029	1,212	1,034
125	169	237	544	540	1,194	1,063	1,246	1,066
130	179	249	565	562	1,227	1,094	1,278	1,097
135	189	261	585	582	1,258	1,124	1,309	1,126
140	198	272	604	601	1,288	1,150	1,337	1,151
145	207	283	622	620	1,317	1,174	1,366	1,174
150	216	293	638	638	1,344	1,196	1,393	1,196
155	224	301	652	654	1,367	1,216	1,417	1,215
160	232	307	665	670	1,390	1,235	1,440	1,234
165	239	314	678	685	1,410	1,253	1,462	1,251
170	246	320	690	700	1,430	1,269	1,481	1,267
175	254	326	702	714	1,448	1,284	1,498	1,281
180	261	332	713	727	1,466	1,298	1,516	1,294
185	268	338	724	739	1,482	1,306	1,530	1,301
190	275	344	734	752	1,498	1,313	1,545	1,308
195	281	350	744	763	1,514	1,321	1,559	1,315
200	287	355	753	774	1,529	1,328	1,573	1,321



Net Merchantable Volume Yield Tables
Existing Managed Stands Aged 1 – 12 Years Old

MHmm1 Variant – All Sites

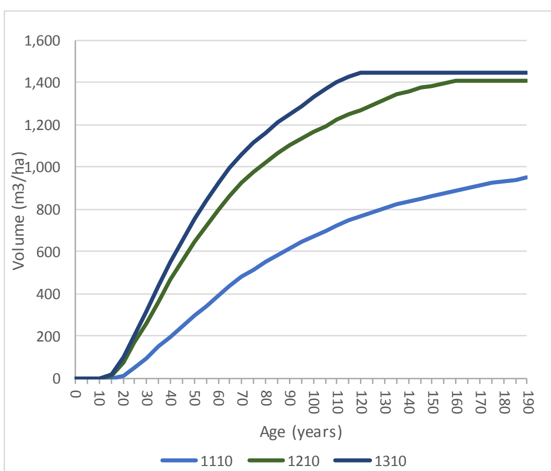
	Analysis Unit			
Age	4120	4221	4224	4226
0	0	0	0	0
5	0	0	0	0
10	0	0	0	0
15	0	0	0	0
20	0	0	0	0
25	0	0	0	0
30	0	1	2	1
35	0	5	10	8
40	0	13	24	22
45	1	27	47	44
50	3	45	72	69
55	8	65	98	95
60	17	88	125	122
65	26	114	153	151
70	37	139	181	178
75	54	164	208	206
80	69	190	236	235
85	84	216	263	262
90	98	239	289	288
95	112	263	313	312
100	127	286	340	335
105	140	308	365	357
110	153	329	389	378
115	166	351	412	398
120	178	371	434	418
125	190	391	456	438
130	201	410	476	457
135	212	428	495	474
140	223	447	514	492
145	234	466	533	509
150	244	484	553	526
155	254	502	571	542
160	263	519	589	556
165	272	534	605	569
170	280	549	621	580
175	289	563	636	591
180	298	576	650	601
185	306	588	663	611
190	314	600	675	620
195	322	611	688	629
200	330	622	699	638



Appendix I: Yield Tables for Future Managed Stands

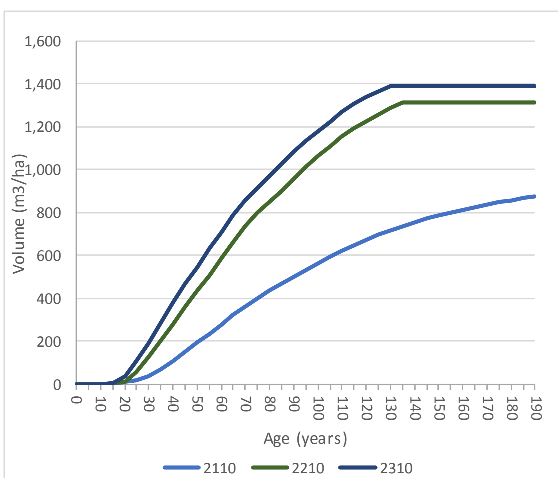
Net Merchantable Volume Yield Tables
Future Managed Stands
CWHxm2 Variant – All Sites

	Analysis Unit		
Age	1110	1210	1310
0	0	0	0
5	0	0	0
10	0	0	0
15	0	10	19
20	10	76	101
25	49	168	204
30	95	258	315
35	149	362	437
40	198	467	549
45	246	556	656
50	295	644	756
55	344	726	846
60	392	800	926
65	437	865	997
70	479	923	1,059
75	516	976	1,114
80	551	1,022	1,163
85	582	1,066	1,209
90	614	1,104	1,252
95	645	1,136	1,291
100	673	1,167	1,332
105	699	1,195	1,371
110	724	1,222	1,404
115	746	1,247	1,427
120	768	1,272	1,450
125	788	1,297	1,450
130	806	1,321	1,450
135	822	1,344	1,450
140	836	1,361	1,450
145	850	1,374	1,450
150	864	1,385	1,450
155	877	1,397	1,450
160	890	1,407	1,450
165	901	1,407	1,450
170	913	1,407	1,450
175	923	1,407	1,450
180	932	1,407	1,450
185	940	1,407	1,450
190	949	1,407	1,450
195	956	1,407	1,450
200	964	1,407	1,450



Net Merchantable Volume Yield Tables
Future Managed Stands
CWHvm1 Variant – All Sites

	Analysis Unit		
Age	**2110**	**2210**	**2310**
0	0	0	0
5	0	0	0
10	0	0	0
15	0	2	6
20	9	14	39
25	20	59	108
30	37	127	192
35	66	202	283
40	107	279	377
45	150	362	466
50	193	438	546
55	236	509	632
60	278	587	712
65	322	662	788
70	363	733	854
75	401	797	913
80	434	852	970
85	466	901	1,029
90	499	958	1,086
95	534	1,014	1,135
100	566	1,066	1,181
105	595	1,111	1,224
110	623	1,153	1,266
115	648	1,192	1,304
120	672	1,227	1,337
125	696	1,259	1,366
130	718	1,288	1,392
135	738	1,315	1,392
140	757	1,315	1,392
145	773	1,315	1,392
150	788	1,315	1,392
155	801	1,315	1,392
160	814	1,315	1,392
165	826	1,315	1,392
170	837	1,315	1,392
175	848	1,315	1,392
180	858	1,315	1,392
185	867	1,315	1,392
190	875	1,315	1,392
195	883	1,315	1,392
200	890	1,315	1,392

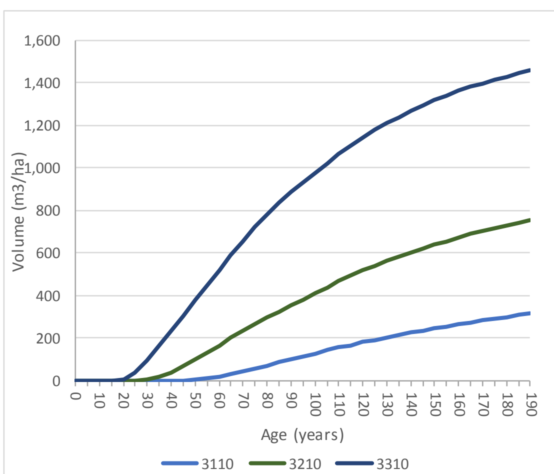


Net Merchantable Volume Yield Tables

Future Managed Stands

CWHvm2 Variant – All Sites

	Analysis Unit		
Age	3110	3210	3310
0	0	0	0
5	0	0	0
10	0	0	0
15	0	0	0
20	0	0	6
25	0	0	39
30	0	3	97
35	0	15	162
40	0	36	231
45	1	68	303
50	4	100	379
55	10	134	452
60	18	167	521
65	28	201	590
70	41	234	656
75	56	265	722
80	71	295	781
85	85	324	836
90	99	352	886
95	114	381	934
100	128	411	979
105	142	440	1,022
110	155	467	1,065
115	167	493	1,105
120	180	518	1,144
125	192	540	1,178
130	203	562	1,209
135	215	582	1,238
140	225	602	1,267
145	236	620	1,294
150	246	639	1,319
155	256	656	1,342
160	265	673	1,364
165	274	688	1,382
170	283	703	1,399
175	292	717	1,415
180	300	731	1,430
185	309	743	1,445
190	317	755	1,458
195	324	767	1,472
200	332	778	1,485



Net Merchantable Volume Yield Tables
Future Managed Stands
MHmm1 Variant – All Sites

	Analysis Unit	
Age	4110	4210
0	0	0
5	0	0
10	0	0
15	0	0
20	0	0
25	0	0
30	0	1
35	0	9
40	0	24
45	4	49
50	9	76
55	17	103
60	30	132
65	45	162
70	59	191
75	75	221
80	92	250
85	108	278
90	123	303
95	139	327
100	154	351
105	169	375
110	183	397
115	196	421
120	210	443
125	223	463
130	236	482
135	248	500
140	260	518
145	271	536
150	282	553
155	293	568
160	303	583
165	313	597
170	323	610
175	333	622
180	343	633
185	352	644
190	361	654
195	370	664
200	378	674