Integrated Stewardship Strategy for the Invermere TSA

Analysis Report

Version 1.0

November 28, 2019

Project 419-38

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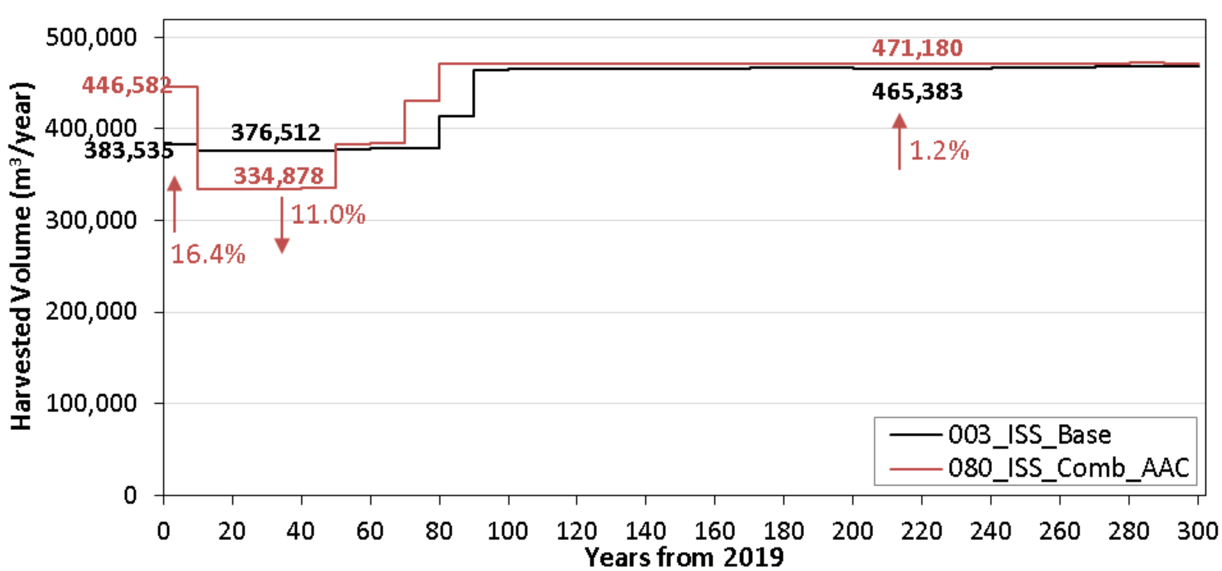
Executive Summary

This report summarizes the analysis results for five scenarios conducted under the Integrated Stewardship Strategy (ISS) Invermere Timber Supply Area:

- ISS Base Case Scenario - mimics current management practices and most modelling assumptions applied in the recent Timber Supply Review. Results from this scenario provide the baseline from which to compare other scenarios.
- Silviculture Scenario - designed to explore alternative silviculture practices that would benefit long-term timber and non-timber objectives. In particular, this scenario aimed to enhance timber quantity and quality over the mid- and long-term, as well as, improve biodiversity, wildlife habitat, and cultural interests.
- Wildlife Scenario - designed to assess habitat quality and quantity for a range of wildlife species while continuing to meet all other timber and non-timber objectives. In this ISS iteration, the Project Team elected to explore two tactics: wildlife habitat and species at risk.
- Reserve Scenario - aimed to identify where and how we should reserve forested stands to address landscape-level biodiversity and where possible, non-timber values, while minimizing impacts to the working forest.
- Combined Scenario - aimed to guide development, implementation, and monitoring of tactical plans over the first 20 years of the planning horizon. Key elements from the three scenarios (ISS Base Case, Silviculture, and Reserve) were included to provide an integrated strategy to this first iteration of the ISS process.

After more than 40 model runs, this work culminated with a Combined Scenario that considered key elements from the other scenarios to develop an appropriate timber harvest flow that reflects the interactions of all the tactics explored. Compared to the ISS Base Case Scenario, this harvest flow was 16.4% more in the first decade (i.e., set at the current AAC), 11.0% less over the mid-term, and 1.2% more over the long-term. Meanwhile, the forest-level model addressed all non-timber objectives within their assigned parameters.



Results from the Combined Scenario were used to develop a tactical plan to monitor activities over the first 20 years of the planning period; thus providing an integrated strategy with guidance to forest resource planners and decision makers.

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List of Acronyms

BCTS	BC Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BIOD	Biodiversity
CT	Commercial Thinning
ECA	Equivalent Clearcut Area
ENH	Enhanced Basic Silviculture
ERDZ	Enhanced Resource Development Zone
FERT	Fertilization
FMER	Fire-Maintained Ecosystem Restoration
FMLB	Forest Management Land Base
FPPR	Forest Planning and Practices Regulation
FRPA	Forest and Range Practices Act
FSC	Forest Stewardship Council
IRMZ	Integrated Resource Management Zone
ISS	Integrated Stewardship Strategy
KBLUPO	Kootenay-Boundary Land Use Plan Order
LU	Landscape Units
MHA	Minimum Harvest Age
MINDY	Maximum Initial Non-Declining Yield (timber harvest flow)
MMA	Mature Management Area
NDT	Natural Disturbance Type
NDY	Non-Declining Yield (timber harvest flow)
NHLB	Non-Harvestable Land Base
NRL	Non-Recoverable Losses
OGMA	Old Growth Management Area
THLB	Timber Harvesting Land Base
TSA	Timber Supply Area
TSR	Timber Supply Review
UWR	Ungulate Winter Range
VEG	Visually-Effective Green-Up
VRI	Vegetation Resource Inventory

Document Revision History

Version	Date	Notes/Revisions
0.1	Aug 29, 2018	○ First version distributed to project team for review and comment. ○ Only included results for Base Case Scenario plus twelve sensitivity analyses (including Mature/Old Seral and Landscape Unit Grouping scenario elements).
0.2	Dec 21, 2018	○ Described results for the Silviculture Scenario (section 4) and incorporated comments/suggestions from the project team.
0.3	May 7, 2019	○ Described results for the preliminary Wildlife Scenario (section 5) that mimics – as a first step - other processes for modelling wildlife habitat for 14 species/habitat types and aspects of the federal caribou recovery strategy.
0.4	Oct 6, 2019	○ Reorganized some of the subsections in sections 3. ○ Described results for the Reserve Scenario (section 6) that aimed to identify Candidate Reserves that address landscape-level biodiversity and where possible, non-timber values, while minimizing impacts to the working forest. ○ Described results for the Combined Scenario (section 7) that aimed to guide development, implementation, and monitoring of tactical plans over the first 20 years of the planning horizon. ○ Added key observations and recommendations in section 8.2.
0.5	Nov 25, 2019	○ Corrected minor errors throughout the document. ○ Included discussion for two additional sensitivities (i.e., silviculture tactics off and business as usual) in the Combined Scenario (section 7).
1.0	Nov 28, 2019	○ No further edits at this time. Made available for distribution on website. https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/silviculture/silviculture-strategy-areas

1 Introduction

This document summarizes the results for the Integrated Stewardship Strategy (ISS) scenarios conducted for the Invermere Timber Supply Area (TSA). This includes the following scenarios: Base Case, Wildlife, Reserve, Silviculture, Forest Health, and Carbon.

The ISS Base Case Scenario was developed as a two-step process that first developed a model to mimic the assumptions applied in the latest Timber Supply Review (TSR). The TSR Benchmark Scenario was used to compare results and confirm that the model configuration is consistent with TSR. Some TSR assumptions were adjusted to correct errors and include new or updated information. These adjustments aimed to better-reflect the current situation while improving model configuration for other ISS scenarios. These ISS scenarios introduced and explored tactics aimed to achieve the following objectives:

- Silviculture Scenario - enhance timber quantity and quality over the mid- and long-term, as well as, improve biodiversity, wildlife habitat, and cultural interests.
- Wildlife Scenario – mitigate adverse impacts that timber extraction activities can have on key wildlife species populations.
- Reserve Scenario - maintain the harvest area while providing a wide range of values on the land base (i.e. co-location).
- Forest Health – mitigate adverse impacts to forest resources significant high-risk pests and climate change.
- Carbon - develop strategies to sequester carbon and/or reduce emissions.

The Combined Scenario included tactics from each of the previous scenarios to develop a comprehensive tactical plan that can be used to monitor activities over the first 20 years of the planning period and to provide further guidance to forest resource planners and decision makers.

Assumptions for these forest-level modelling exercises were described in a separate document called a data package[1].

Note that some graphs presented below were copied directly from reports generated by the model and are intentionally kept small as they are intended to easily compare and demonstrate how the target levels (red/blue) are being respected and how patterns continue over time. They are not intended to focus on actual numbers – hence the small font – but target levels are described in the text or data package.

1.1 Project Area

The Invermere TSA is located in the southeastern corner of British Columbia within the Kootenay-Boundary Natural Resource Region – Rocky Mountain Natural Resource District (Figure 1). It is bordered by the Golden TSA and Tree Farm Licence (TFL) 14 to the north, the Rocky Mountains and Alberta border to the east, the Skookumchuck Valley and Cranbrook TSA to the south and the Purcell Mountains to the

[1] Forsite Consultants Ltd. 2018. Integrated Stewardship Strategy for the Invermere TSA – Data Package. Version 0.3. Project 419-38. August 15, 2018. 72 pg. with appendices.

west. It includes the cities of Invermere, Windermere, Canal Flats, and Edgewater and the smaller communities of Wilmer, Radium Hot Springs, and Parsons. The project (Invermere TSA) covers an area of approximately 1.316 million hectares out of which 151,784 hectares is covered by TFL14.

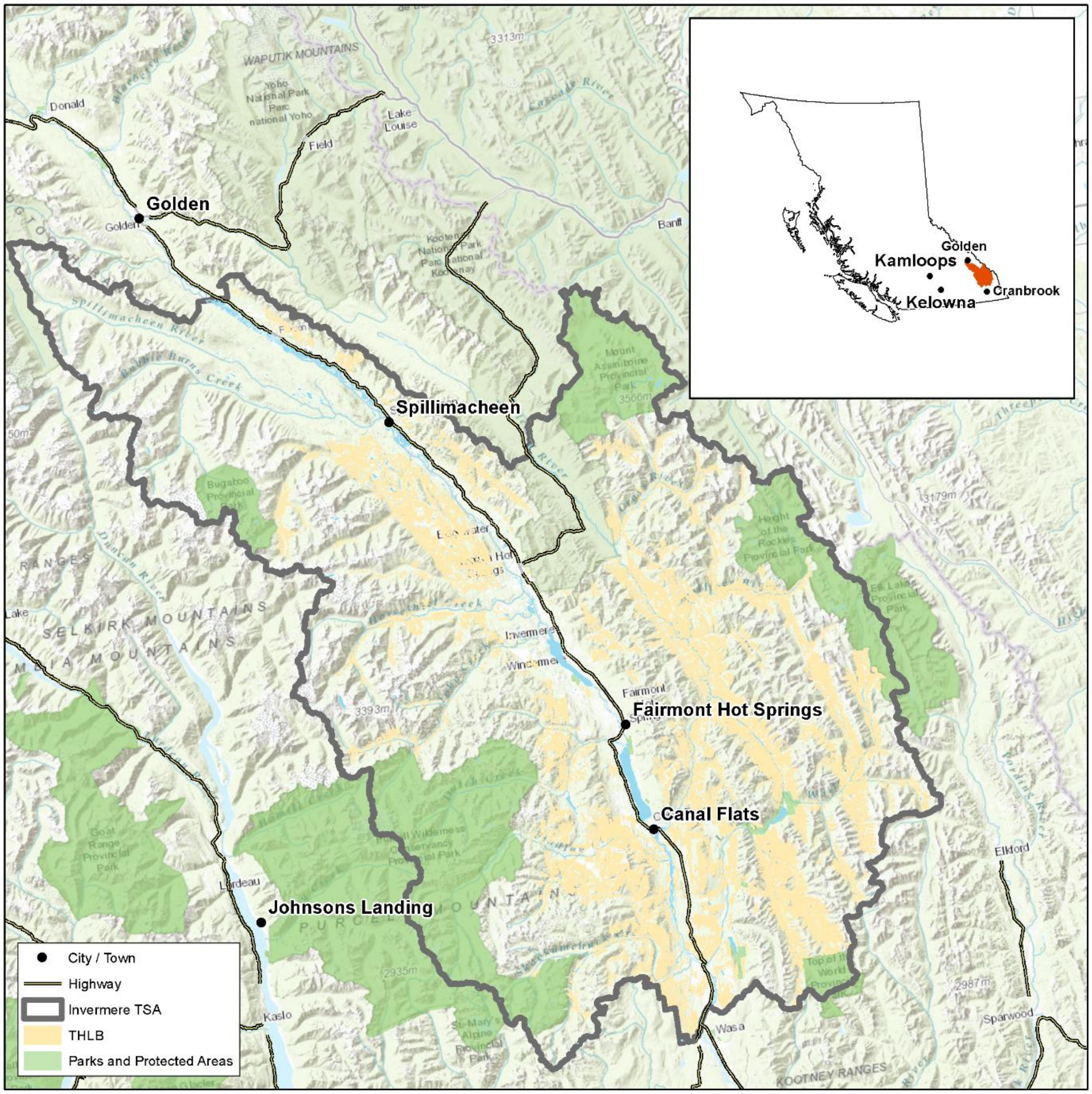


Figure 1 Invermere TSA

1.2 Context

This document is the fourth in a series of documents developed through the ISS process.

1) Situation Analysis – describes in general terms the situation for the project area – this could be in the form of a PowerPoint presentation with associated notes or a compendium document.

2) Scenario Development - describes the development of a Combined Scenario based on multiple scenarios explored through forest-level modelling and analysis scenarios.
3) Data Package – describes the information that is material to the analysis including the model used, data inputs and assumptions.
4) **Analysis Report** – provides modeling outputs and rationale for choosing a preferred scenario.
5) Tactical Plan – direction for the implementation of the preferred scenario.
6) Implementation Monitoring Plan – direction on monitoring the implementation of the ISS; establishing a list of appropriate performance indicators, developing monitoring responsibilities and timeframe, and a reporting format and schedule.
7) Final Report – summary of all project work completed.

1.3 Land Base Definition

The land base definition of the ISS Base Case (Table 1) shows the Forest Management land Base (FMLB) is 605,006 ha; approximately 55,500 ha (10.1%) more than the TSR Benchmark Scenario. The current effective Timber Harvesting Land Base (THLB) is 173,042, or 12.1% less than the TSR Benchmark Scenario while the long-term effective THLB is 167,368 ha; approximately 27,600 ha (or 14.2%) less than the TSR Benchmark Scenario. Differences between the two land bases are mentioned throughout this document.

Table 1 Invermere ISS Base Case Scenario Land Base Definition

Factor		Total Area (ha)	Effective Area (ha)	% of Total Area	% of FMLB
Total Area		1,315,602	1,315,602	100.0%	
Less:	TFL 14	150,911	150,911	11.5%	
	Private	83,704	83,704	6.4%	
	Christmas Trees Permit	6,398	6,398	0.5%	
	Indian Reserves	8,730	8,730	0.7%	
	National Parks	41,275	41,275	3.1%	
	Woodlots	9,704	9,704	0.7%	
	Misc leases	773	773	0.1%	
	Special Permit	84	64	0.0%	
	Mines	469	371	0.0%	
	Vegetated, non FMLB	0	0	0.0%	
	Non-treed	131,184	64,964	4.9%	
	Non-vegetated	358,476	328,562	25.0%	
	Not typed	9,359	9,178	0.7%	
	Factored Roads		5,961	0.5%	
Total Forest Management Land base (FMLB)		***(in FMLB)***	**605,006**	**46.0%**	**100.0%**
Less:	Parks	79,297	79,297	6.0%	13.1%
	Inoperable	309,240	235,336	17.9%	38.9%
	Steep Slopes (>70%)	65,249	6,767	0.5%	1.1%
	Terrain Class V in CWS	4,449	618	0.0%	0.1%
	ESA	70,186	5,821	0.4%	1.0%
	Non Merchantable	49,819	4,979	0.4%	0.8%
	Low Sites	155,746	2,116	0.2%	0.3%
	Misc Reserves	94	42	0.0%	0.0%
	Crown UREP	800	648	0.0%	0.1%
	UWR Caribou	26,421	998	0.1%	0.2%
	Wildlife Management Area	6,180	2,586	0.2%	0.4%

Factor		Total Area (ha)	Effective Area (ha)	% of Total Area	% of FMLB
	WHA	182	107	0.0%	0.0%
	OGMA +MMA	73,782	16,075	1.2%	2.7%
	Scenic Preservation	211	0	0.0%	0.0%
	Recreation Polygons	0	1	0.0%	0.0%
	FSC Endangered Forests	37,922	1,969	0.1%	0.3%
	FSC Rare and Uncommon Ecosystems	4,397	1,644	0.1%	0.3%
	Existing WTRAs	4,399	2,352	0.2%	0.4%
	100% InBlock Retention	2,833	2,833	0.2%	0.5%
Gross Timber Harvesting Land Base (THLB)			**240,817**	**18.3%**	**39.8%**
Less:	Partial Removals				
	Slopes 40-70% (50%)	223,639	40,227	3.1%	6.6%
	Terrain Class V outside CWS (95%)	40,604	1,688	0.1%	0.3%
	Terrain Class IV outside CWS (5%)	102,846	2,379	0.2%	0.4%
	Terrain Class IV in CWS (95%)	5,094	273	0.0%	0.0%
	PFT Pine >80yrs (29%)	34,251	1,270	0.1%	0.2%
	PFT Pine 61-80yrs (18%)	11,112	415	0.0%	0.1%
	PFT Pine 41-60yrs (35%)	772	57	0.0%	0.0%
	PFT Pine <40yrs (80%)	6,989	196	0.0%	0.0%
	Isolated	695	695	0.1%	0.1%
	In-Block Retention*		20,575	1.6%	3.4%
Current Effective THLB			**173,042**	**13.2%**	**28.6%**
Less:	Future Reductions				
	Open Range Conversion		1,305	0.1%	0.2%
	Future Roads (3.8%)		4,369	0.3%	0.7%
Long-term Effective THLB			**167,368**	**12.7%**	**27.7%**

** In-Block Retentions include FSC Rare Ecosystems, (50%), WTRA (6% for existing natural stands and 3.5% for existing managed stands), and Riparian (% determined spatially for each polygon).*

2 Important Differences between TSR Benchmark and ISS Base Case

Table 2 summarizes key differences observed between the TSR Benchmark and ISS Base Case Scenarios. The harvest impact is depicted as increasing (green up arrow), decreasing (red down arrow), or relatively neutral (yellow circle). The important differences between the TSR Benchmark and latest TSR 4 (2016) are summarized in the TSR Benchmark report[2].

Table 2 Important differences between TSR Benchmark and ISS Base Case

Assumption/Factor	TSR Benchmark	ISS Base Case	Harvest impact
Land Base Definition			
Over-depletion	Depletion of fire/insects disturbances from RESULTS. Ignoring VRI field "REFERENCE_YEAR" relative to Disturbance year from RESULTS.	Only clear- and partial-cuts were depleted. In addition, depletions were applied where disturbance year from the consolidated cutblocks layer was more recent than the VRI field "REFERENCE_YEAR". While no impact on THLB, there is a positive impact in initial growing stock and harvest rate compared to TSR Benchmark.	

[2] Forsite Consultants Ltd. 2018. TSR Benchmark Scenario for Cranbrook and Invermere TSAs – Analysis Report. Version 1.0. Project 419-38. January 18, 2018. 8 pg.

Assumption/Factor	TSR Benchmark	ISS Base Case	Harvest impact
Non-Forest and Non-Productive	Used Forest Management Land Base (FMLB) field from the VRI and logged history as the only criteria.	A more complex algorithm using the BC Land Classification Level fields in the VRI, logging history, height, and crown closure from all layers (except 'D'). TSR Benchmark removed approximately 62,000 ha more than ISS.	↑
Existing Roads	Aspatial, 5.3% to FMLB area <70 yrs	Spatially explicit, then factored in for each FMLB polygon. TSR Benchmark removed approximately 3,500 ha more than ISS.	↑
Partial Netdowns	Slopes 40-70%, unstable terrain, and problem forest types were aspatially removed.	A spatially explicit algorithm was used to meet the partial netdown quota by selecting the closest to existing THLB and the most productive stands. It is expected that a better spatial representation of the THLB could have a negative impact on the harvest, compared to an aspatial representation.	↓
Riparian	Used FRPA rules, and spatially netted out.	Used FSC rules, and factored in for each THLB polygon. THLB decreases by 4.1% due to application of FSC standards in Canfor operating areas.	↓
OGMA + MMA	Used DataBC data source.	Used a consolidated dataset from the licensees which was approximately 10,000 ha (gross) more than the TSR Benchmark.	↓
FSC No Harvest Areas	Not considered.	Endangered Forests and Rare and Uncommon Ecosystems within Canfor operating areas are excluded from the THLB (approximately 3,600 ha)	↓
Isolated stands	Not considered.	Approximately 695 ha were identified as isolated stands and excluded from THLB.	●
WTRA	6% applied to entire THLB (existing and future)	Existing WTRAs were spatially identified from RESULTS. In addition, a 2.5% WTRA was applied to reflect current practice. The WTRA for unharvested stands was 6%.	●
FMER	Used DataBC source.	Used TSR4 layer as the DRMM staff considered it more accurate. TSR Benchmark found approximately 10,000 ha more in the FMER Open Range.	↑
Non-Timber Objectives			
Landscape-Level Biodiversity	The KBLUPO targets for mature plus old, and for old forests were maintained	Used only OGMA+MMA to meet landscape-level biodiversity. The sensitivity analyses indicated that KBLUPO targets were more constraining compared to OGMA+MMA.	↑
BEC dataset	Presumably BEC v10 or older	BEC v11	●
ECA	The ECA targets were not prorated relative to the FMLB area. Used the Biodiversity Guidebook ECA curve.	The ECA targets were prorated relative to the FMLB area, which overall were more restrictive. Used ECA curves from Winkler and Boon, 2015 where a maximum height of 25m was assumed. These ECA curves are generally more restrictive than Biodiversity Guidebook ECA curves.	↓
UWR (Management)	Ignored the young seral objective.	Applied the young seral objective, maximum 33% <21 years for each habitat class and LU combination. Overall, this was not constraining because of the overlap with IRM Green-up requirements.	●
TIPSY	V 4.3., Ministry Standard Database, January 2016.	v. 4.4, Ministry Standard Database, September 2017. One to one comparison of yield curves indicated that TIPSY 4.4 estimated overall lower volumes than 4.3.	↓
NRL	14,811 m^3/year.	40,194 m^3/year.	↓
NHLB Disturbance	Ignored.	Random disturbance of 1,539 ha/year (0.39% of all NHLB).	↓

3 ISS Base Case Scenario

3.1 Timber Objectives

3.1.1 Even-Flow Harvest Profile

Even-flow harvest profiles were compared for TSR Benchmark and ISS Base Case in Figure 2. The harvest rate for the ISS Base Case was approximately 57,700 m^3/year (13.2%) less than the TSR Benchmark, resulting mainly from differences in FMLB and NRLs.

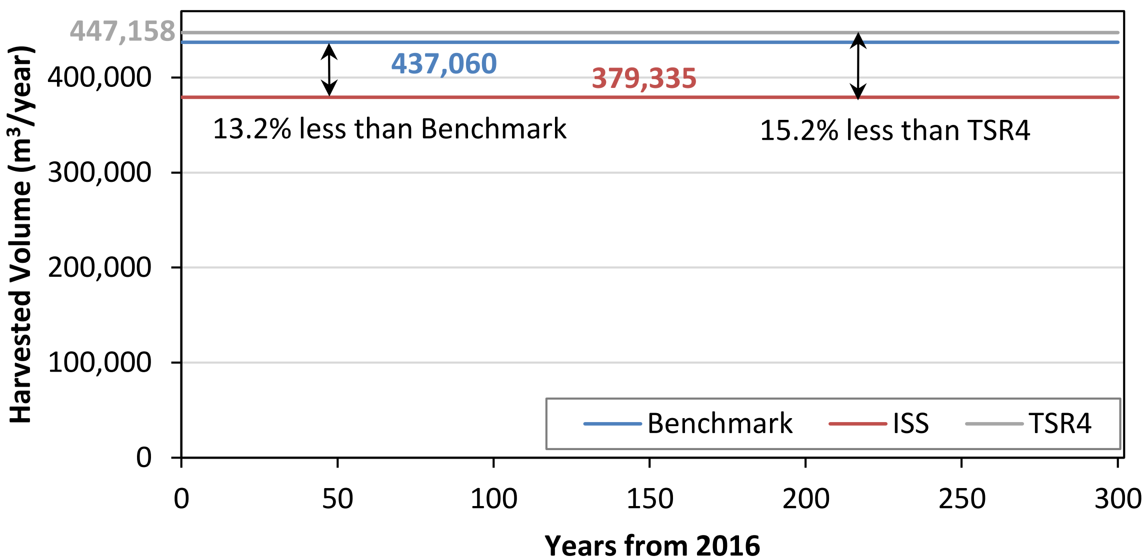


Figure 2 ISS Base Case Scenario – Harvest Forecast (Even-Flow)

Compared to the TSR Benchmark, the ISS Base Case FMLB was 10.1% larger while the long-term THLB was 14.2% smaller. The model applied the larger NHLB (22.5%) in the ISS Base Case to meet non-timber objectives while the smaller THLB was used more efficiently to meet the timber objectives. The latter was confirmed by the growing stock trend, which declined significantly more than the TSR Benchmark over the 300-year planning horizon, despite the similar starting values (Figure 3).

The even-flow harvest profiles accounted for NRLs of 14,811 m^3/year in the TSR Benchmark, and 40,194 m^3/year in the ISS Base Case. The higher NRLs applied in the ISS Base Case reduced the harvest flow difference by 20.4% (i.e., without NRLs, the ISS Base Case harvest rate would be 7.2% higher than the TSR Benchmark).

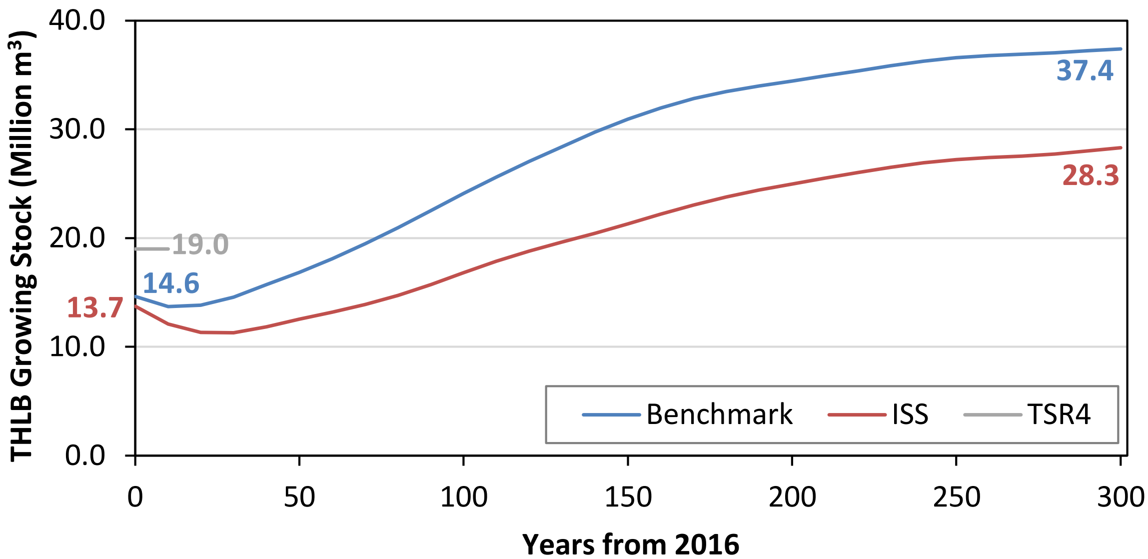


Figure 3 ISS Base Case Scenario – THLB Growing Stock (Even-Flow)

3.1.2 MINDY Harvest Profile

Due to the wide range of factors involved, an even-flow harvest rate, adopted initially in TSR4, is not suitable for the complex analyses developed for the ISS, as it only examines the impact of one key factor over the period(s) where all constraints converge to the lowest harvest rate (i.e., the "pinch point"; which occurs in 40 to 60 years). Typically, the lowest harvest rate becomes the even-flow harvest rate. Harvest opportunities that exist before and after the pinch-point are not fully examined, leaving many questions unanswered. Therefore, these ISS scenarios will focus on the maximum initial, non-declining yield (MINDY) harvest flow that can fully explore a range of factors. The MINDY harvest profile is shown below; ***it was used to compare subsequent analyses as the ISS Base Case harvest flow***.

The MINDY harvest profile was developed in 3-stages:

1) An even-flow harvest profile was determined, similar to the TSR4 and ISS Base Case discussed above in section 3.1.1.
2) A non-declining yield (NDY) was imposed, such that the harvest rate was always above the even-flow harvest rate determined in stage 1 and it does not decline over the planning horizon. In addition, to ensure long-term sustainability, the THLB growing stock does not decline over the last 100 years of the 300-year planning horizon.
3) A maximum harvest rate was developed over the first period without decreasing the harvest rates developed in stage 2. Again, the THLB growing stock does not decline in the last 100 years of the planning horizon.

3.1.3 Harvest Flow and THLB Growing Stock

Compared to the TSR Benchmark, the ISS Base Case (MINDY) harvest profile was approximately 17.3% less in the first decade, 15.2% less over the mid-term, and 21.5% less over the long-term (Figure 5). As discussed in section 3.2, these differences reflected a range of non-timber objectives (e.g., UWR, ECA, VQO, and green-up,) applied over approximately 96% of the THLB. The remaining THLB (4%) within FMER open forest/open range were not subject to any non-timber objectives.

One of the main differences between the ISS Base Case and TSR Benchmark was, in the former case, the NHLB disturbance modelled. Approximately 1,500 ha/year disturbance of the NHLB was applied as a pre-determined forecast and, in some periods for heavily constrained reporting units, the model needed to maintain appropriate forest cover from the THLB, where disturbance could be controlled. Meanwhile, the continuous aging of the NHLB into the long-term helped the TSR Benchmark Scenario to meet non-timber objectives without affecting the THLB.

Note that the even flow harvest rate in Figure 2 did not exactly match the mid-term harvest rate in Figure 4. This was likely due to the heuristic nature of the forest estate model used in this analysis, which requires significantly more solving time to improve solutions by <1%. Thus, any variations within 1% are generally accepted as insignificant. To achieve more realistic solutions, the solving time could be adjusted for selected scenarios used for tactical and operational planning purposes. The significant long-term difference of 8.3% (21.5% - 13.2%) can be explained by the relatively smaller THLB and complex interaction of factors that constrained the model to achieve the non-timber objectives.

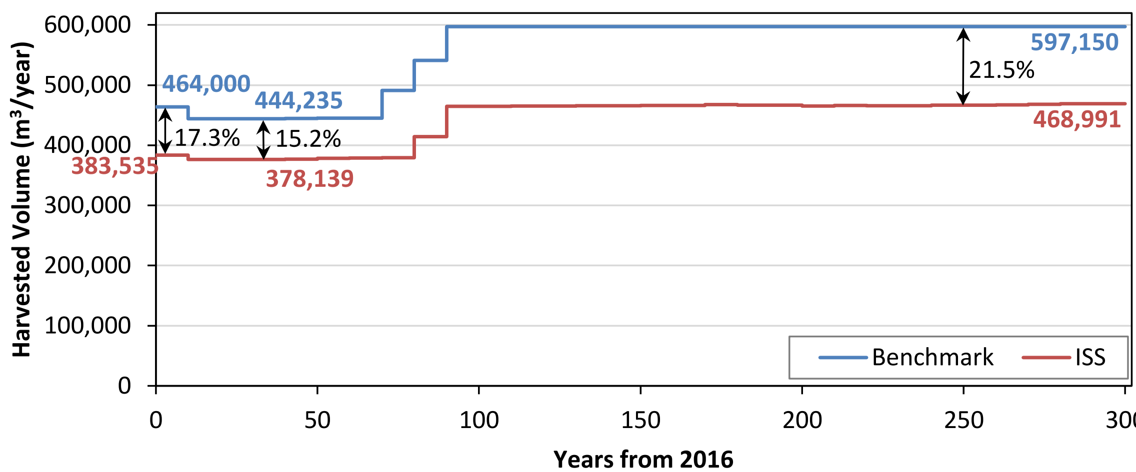


Figure 4 ***ISS Base Case Scenario – Harvest Forecast (MINDY)***

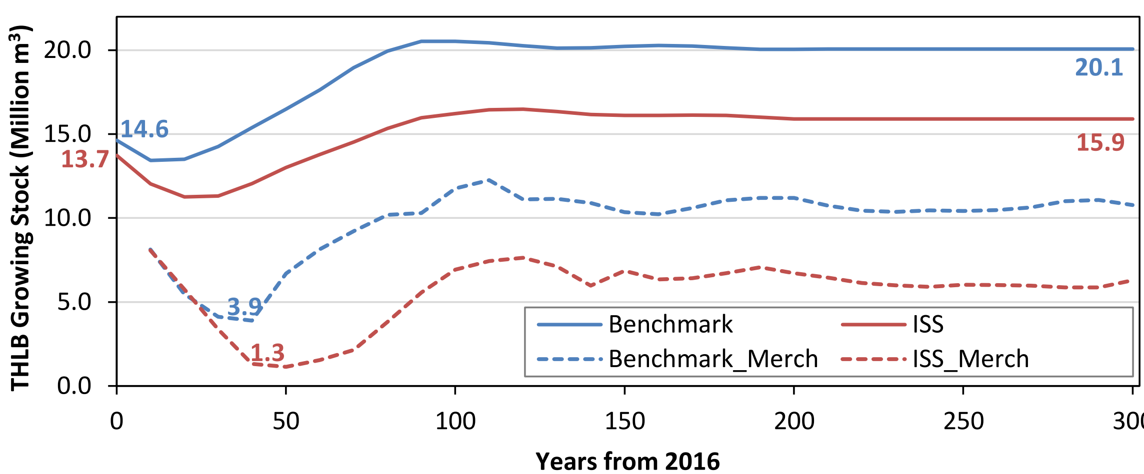


Figure 5 ***ISS Base Case Scenario –THLB Growing Stock (MINDY)***

3.1.4 Management State

The harvest profile reported by management state (Figure 6) indicates that for the first 30 years, the harvested volume was sourced exclusively from existing natural (EN) stands. Existing managed (EM) stands started to significantly contribute to the harvest rate in the fourth decade. By the twelfth decade most of the harvested volume came from future managed stands (FM). The stands impacted by wildfires in 2017 contributed to the harvest rate mostly between years 61 and 120. In the long-term, some minor volumes were still sourced from existing stands that the model likely recruited to achieve non-timber objectives, or were poor stands with relatively old minimum harvest ages.

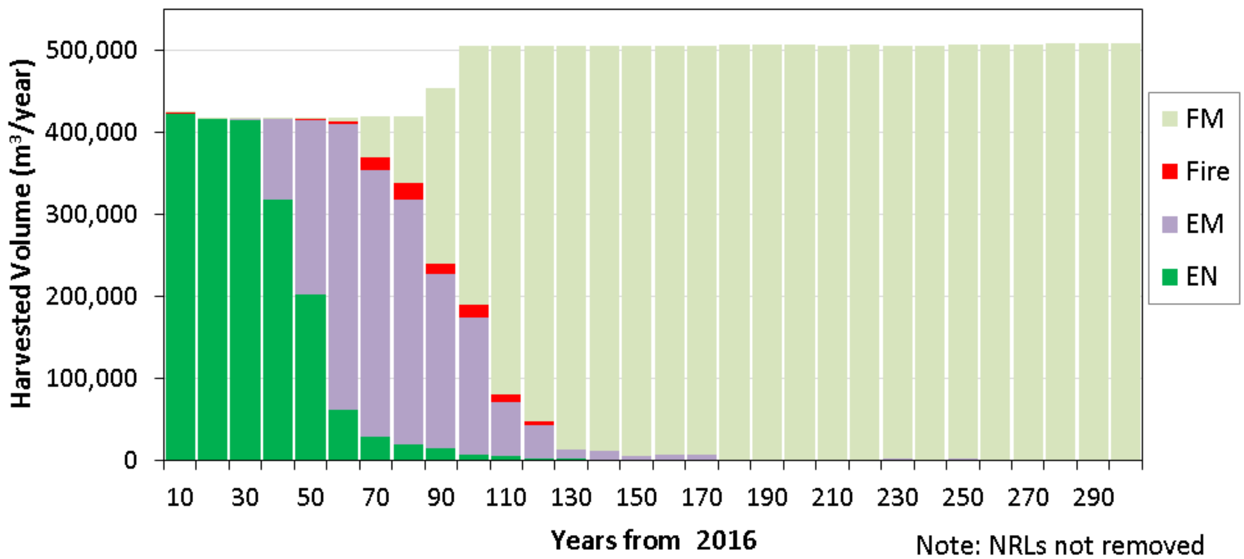


Figure 6 ISS Base Case Scenario – Harvest Volume by Management State

3.1.5 Age Class Distribution

The age class distribution over time (Figure 7) shows that the THLB transitions from a relatively young and mature structured forest to a relatively young forest structure where most of the THLB is evenly distributed in age classes under 80 years. This aligns with the expected changes over time, as the model converts the THLB to a regulated forest estate. Disturbance in the NHLB area (approximately 1,500 ha/year) cycles through age classes over time and by the end of the 300-year planning horizon, most of the NHLB area (74%) was evenly distributed in age classes under 240 years. Exceptions include in-block retention, which is never disturbed, so by year 300, it all becomes older than 240 years. Note that by the end of the planning horizon there are over 4,000 ha of THLB older than 240 years. These areas were likely retained to address ECA and VQO objectives within heavily constrained reporting units.

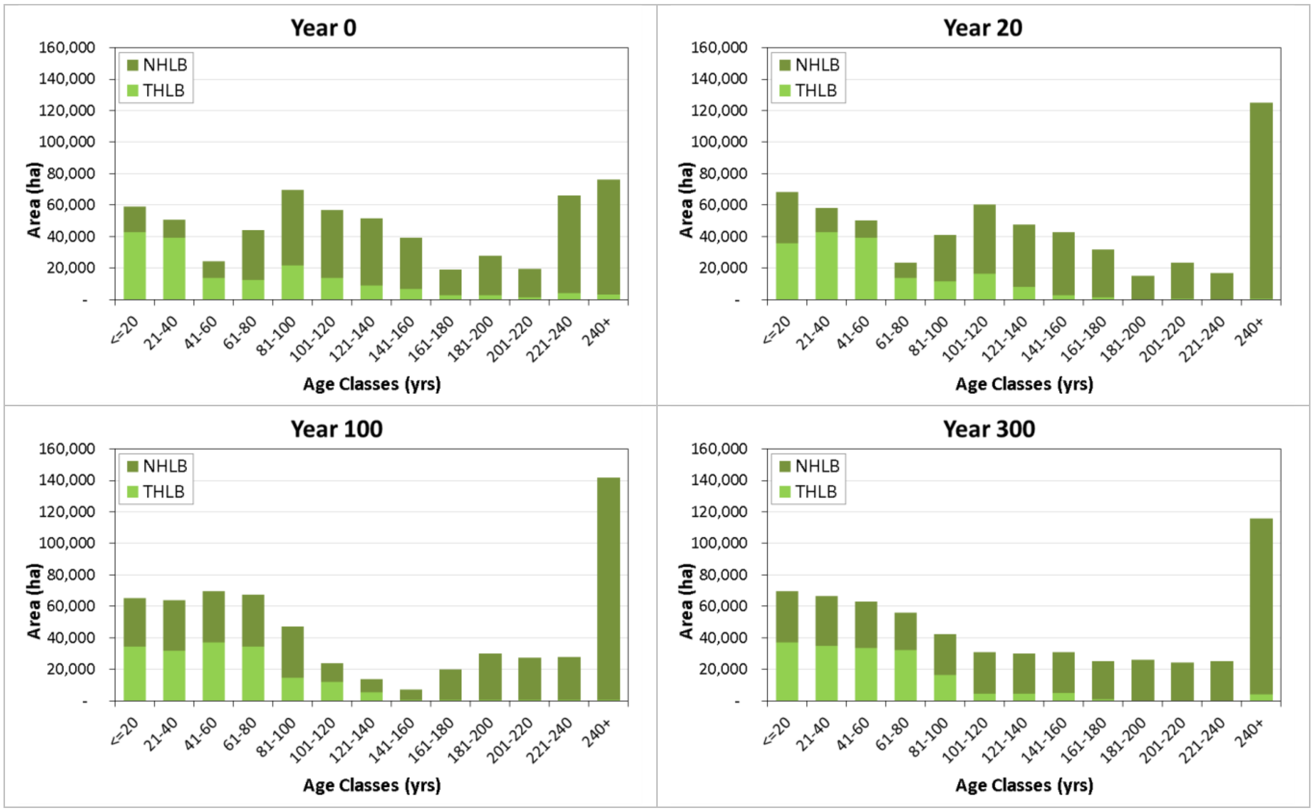


Figure 7 ISS Base Case Scenario – Age Class Distribution at Years 0, 20, 100, and 300

3.1.6 Age Class

The harvest profile reported by age class (Figure 8) shows that a significant amount of harvest from stands <80 years began after 30 years, which is consistent with results observed in Figure 5 and the observed 'pinch point' period (years 40-60). By year 30, most of the volume was harvested from stands in the 80-120 year age class; consistent with the minimum harvest ages applied. However, yield curves estimates of future managed stands continued to increase significantly 10-20 years past these minimum harvest ages. This explains the visibly higher volumes at harvest and suggests that the minimum harvest criteria may be revised to include an indicator of annual growth, such as mean annual increment.

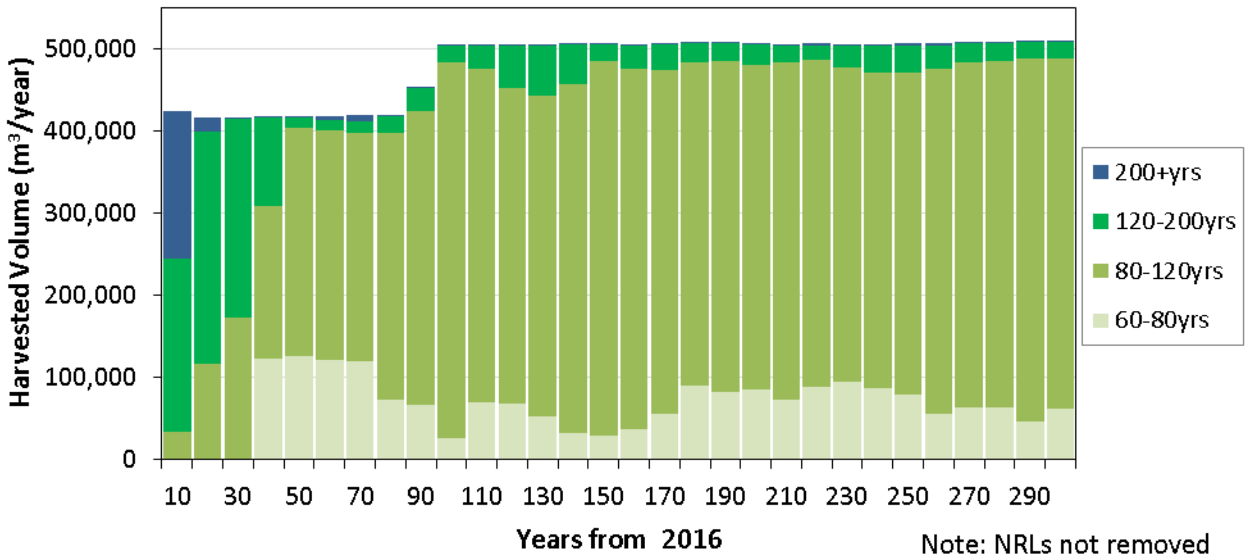


Figure 8 ISS Base Case Scenario – Harvest Volume by Age Class

3.1.7 Average Harvest Volume and Age

The average volume at harvest (solid black line and left axis in Figure 9) fluctuates over time, while the general trend showed it increases from approximately 221 m^3/ha to 262 m^3/ha by year 100, and becomes fairly stable at around 250 m^3/ha for the rest of the 300-year planning horizon. Note that these values are considerably higher than the minimum harvest volume criterion set between 100 m^3/ha and 200 m^3/ha based on slope and leading species.

The average age of stands harvested (dotted black line and left axis in Figure 9) began at 187 years and declines to 88 years after 5 decades, as the harvest transitioned from existing to future stands (i.e., post-harvest regenerated stands). For the rest of the 300-year planning horizon, the average age at harvest stabilized at around 100 years.

The average area harvested each year (solid red line and right axis in Figure 9) is quite stable over the 300-year planning period, fluctuating between ~1,800 ha/yr and ~2,100 ha/yr.

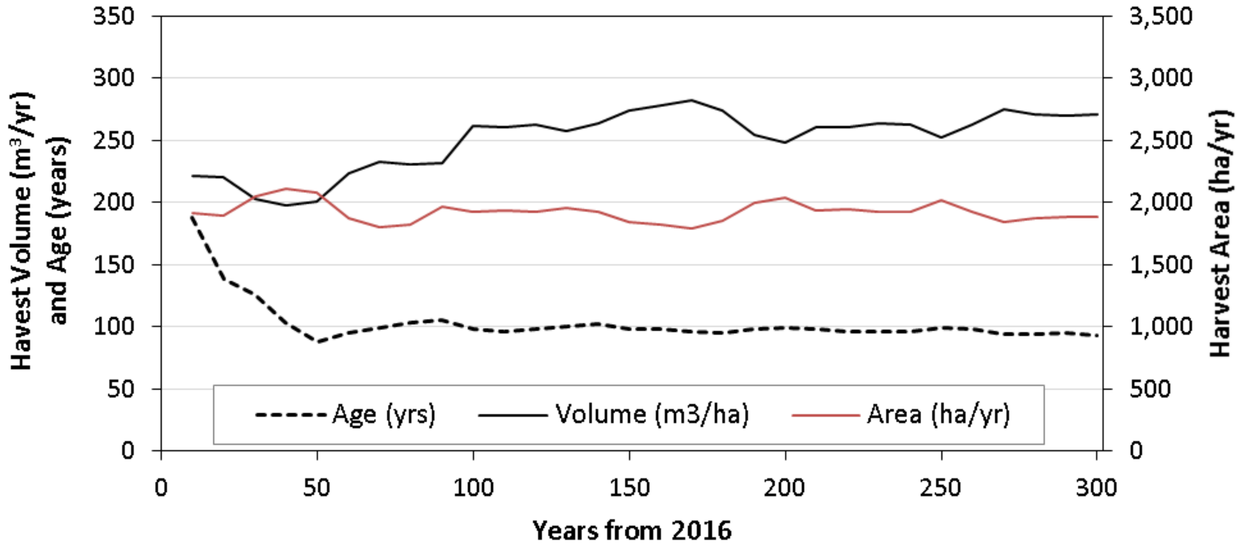


Figure 9 ISS Base Case Scenario – Average Age and Volume at Harvest

3.1.8 Species Groups

The harvest profile reported by species group (Figure 10) shows that most of the harvested volume is white wood from lodgepole pine and spruce, followed by red wood from Douglas-fir and larch, and white wood from subalpine fir and hemlock. There are minor contributions of red volume from yellow pine and cedar.

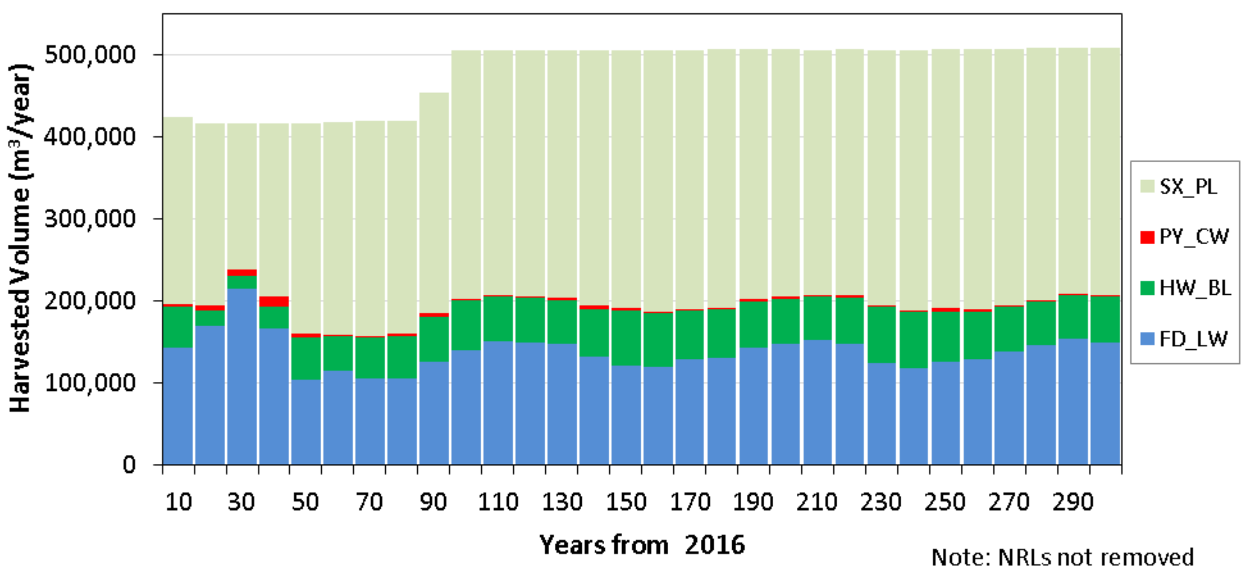


Figure 10 ISS Base Case Scenario – Harvest Volume by Species Groups

3.1.9 Individual Tree Species

The harvest profile reported by individual species (Figure 11) shows that most of the volume is sourced from lodgepole pine, spruce, and Douglas-fir, with important contributions from subalpine fir and western larch.

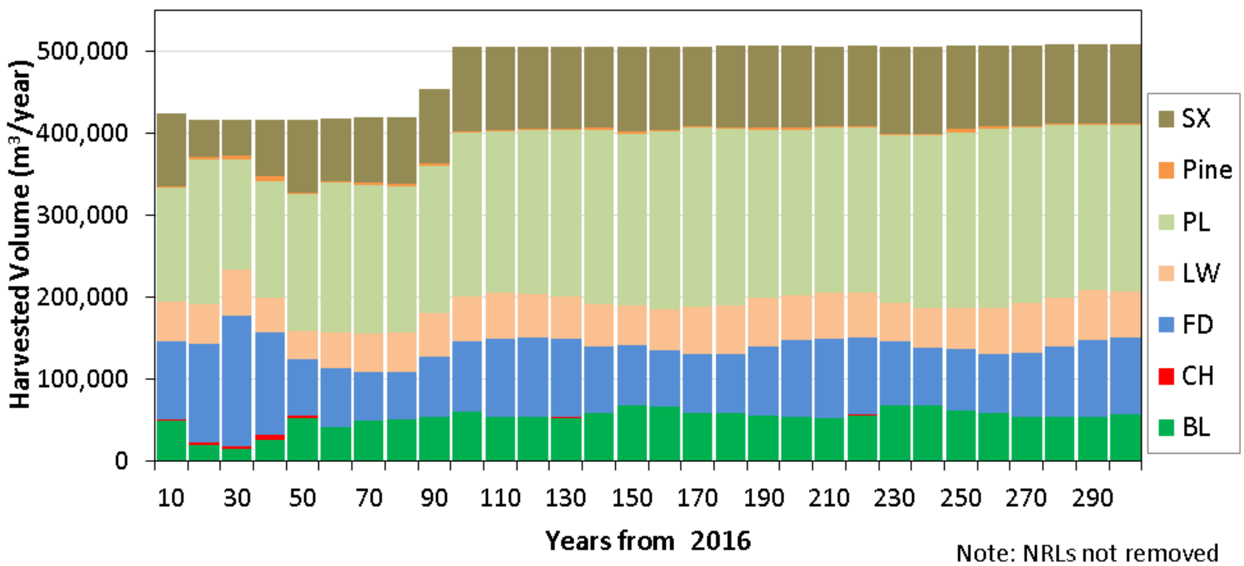


Figure 11 ISS Base Case Scenario – Harvest Volume by Individual Species

3.1.10 Haul Time

The harvest profile reported by one-way haul time (Figure 12) shows that most of the harvested volume came from stands less than one-hour (green+blue) away from a processing facility. Important volume contributions are sourced from stands that are between 1 hour and 1.5hour haul distance.

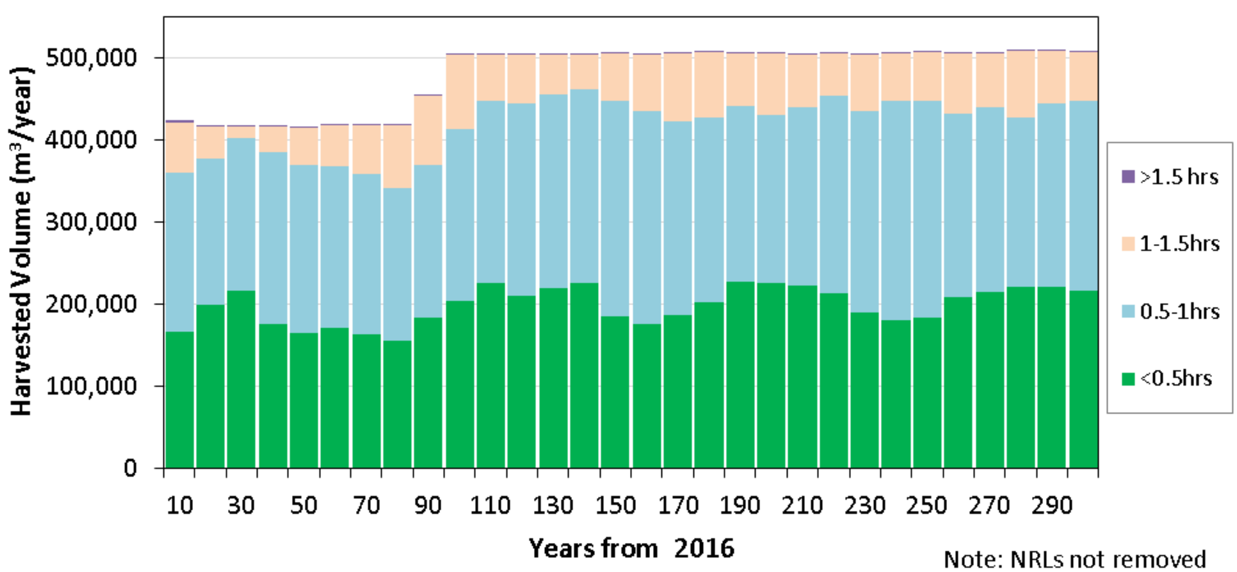


Figure 12 ISS Base Case Scenario – Harvest Volume by Haul Distance (one-way)

3.1.11 Harvest System

The harvest profile reported by harvesting system (Figure 13) shows that most of the harvested volume is sourced from the ground harvesting system where slopes are <=40%.

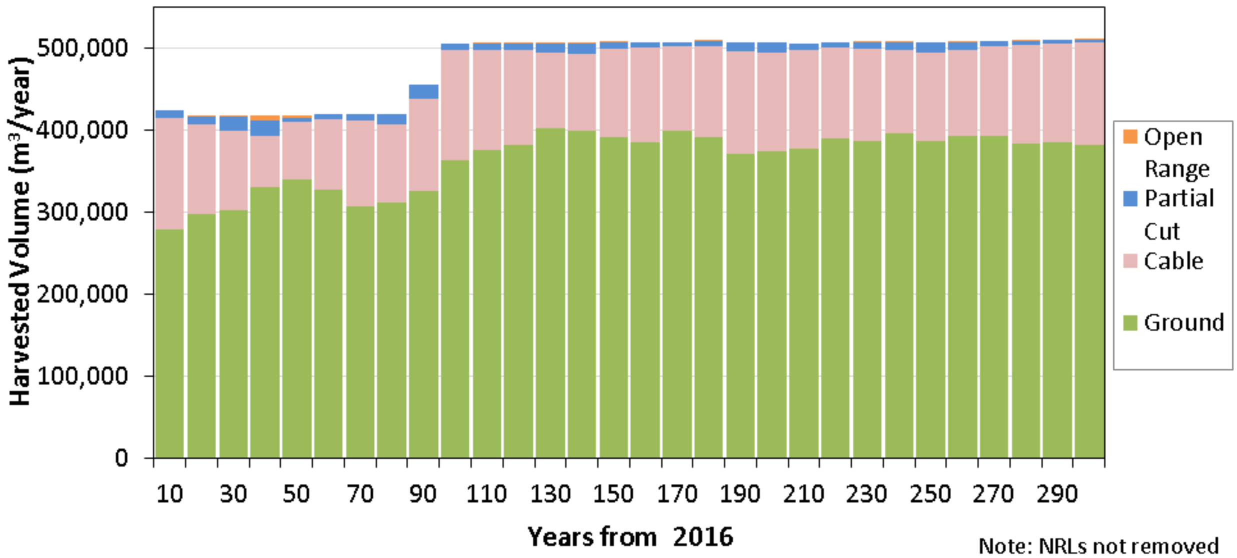


Figure 13 ISS Base Case Scenario – Harvest Volume by Harvest System

3.2 Non-Timber Objectives

3.2.1 Seral Stage

These results described in section 3.1.5 corroborate with the seral stage distribution over the entire 300-year planning horizon (Figure 14), where most of the THLB is evenly distributed in early and mid seral stages. Approximately half of the NHLB is in old seral stage while the other half is well distributed in early, mid, and mature seral stages.

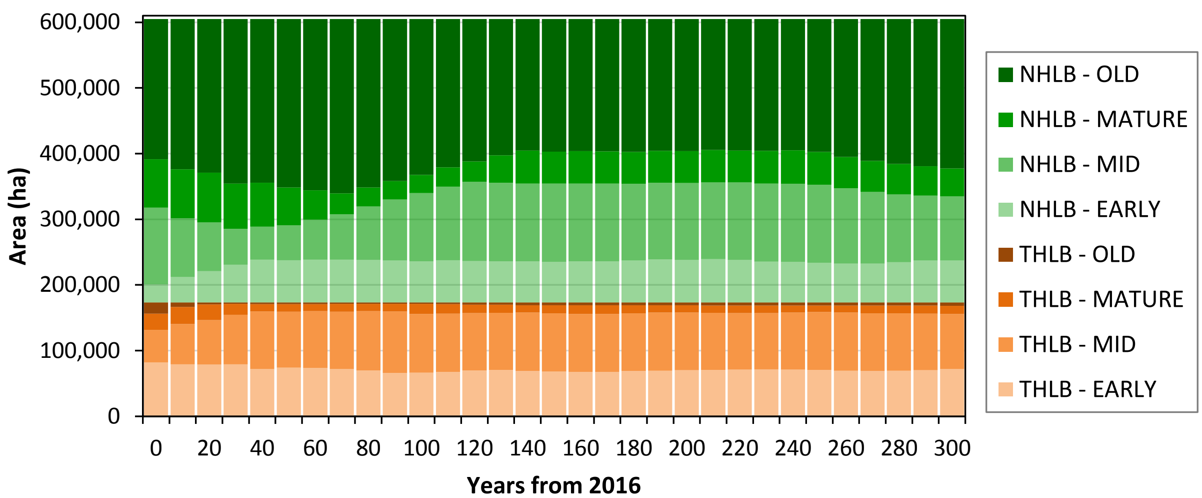


Figure 14 ISS Base Case Scenario – Area Distribution by Seral Stage over the Planning Horizon

3.2.2 Green-up

- Block level green-up targets are specified in the KBLUPO based on Operational Planning Regulation (section 68(4)). These targets restrict harvest as follows:
- Maximum 33% at <2 years within each Landscape Unit (LU) and Enhanced Resource Development Zone (ERDZ) (Timber) combination, and
- Maximum 33% at <12 years within each Landscape Unit (LU) and Integrated Resource Management Zone (IRMZ) combination.

The ERDZ is defined spatially by the KBLUPO, while the IRMZ includes the remaining THLB area that is not designated as Fire Management Ecosystem Restoration (FMER) Open Forest or Open Range.

Results for the ISS Base Case Scenario indicate that these green-up targets were not constraining overall. Targets were closer to being constraining within relatively small modelled reporting units modelled (combination of LU and ERDZ or IRM). Some examples are shown in Figure 15 (largest reporting units in each combination category). Here, the blue-shaded zone indicates the maximum target and the black line shows the actual percentage of THLB area disturbed within the reporting unit; the aim was to remain below the blue-shaded (target) zone. Note that were a few reporting units with areas <100 ha.

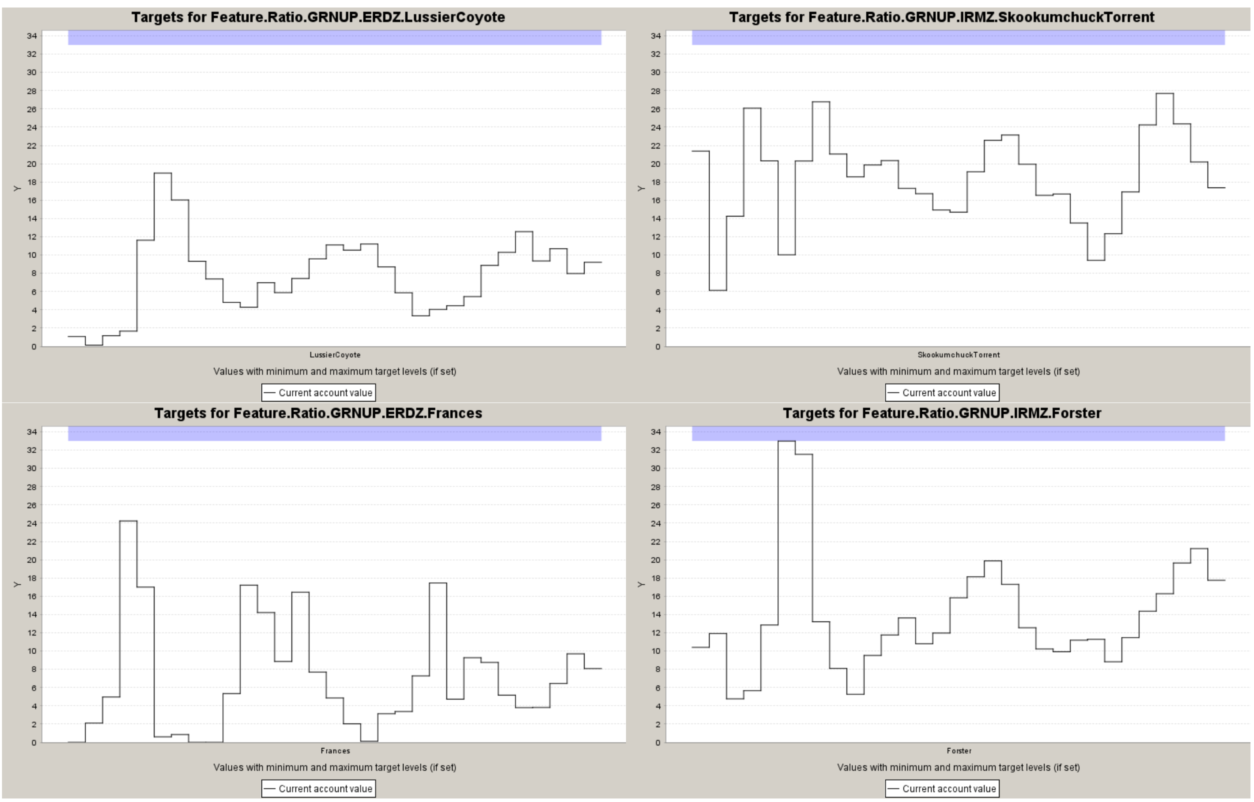


Figure 15 ISS Base Case Scenario – Green-Up Targets (examples)

3.2.3 Ungulate Winter Range

Ungulate winter range (UWR) general wildlife measures require, within each LU and designated UWR, minimum forest cover requirements (i.e., snow interception 10-30% >60 years, and/or mature 10-20% >100 years), including young stands cover (<21 years) should not exceed 33% of the FMLB area.

Results show that minimum seral cover targets were constraining the harvest rate in some of the medium- and small-size UWR reporting units (FMLB < 2,800 ha); some examples are included in Figure 16. Here, the red-shaded area indicates the minimum target that must be maintained over time and the black line indicates the actual proportion of FMLB area in each period that was older than the seral cover (60 or 100 years). The target is not achieved where the black line is shown within the red-shaded zone. For some of the largest reporting units (FMLB area 3,900 to 5,400 ha), young seral targets were constraining over some periods in (see examples in Figure 17).

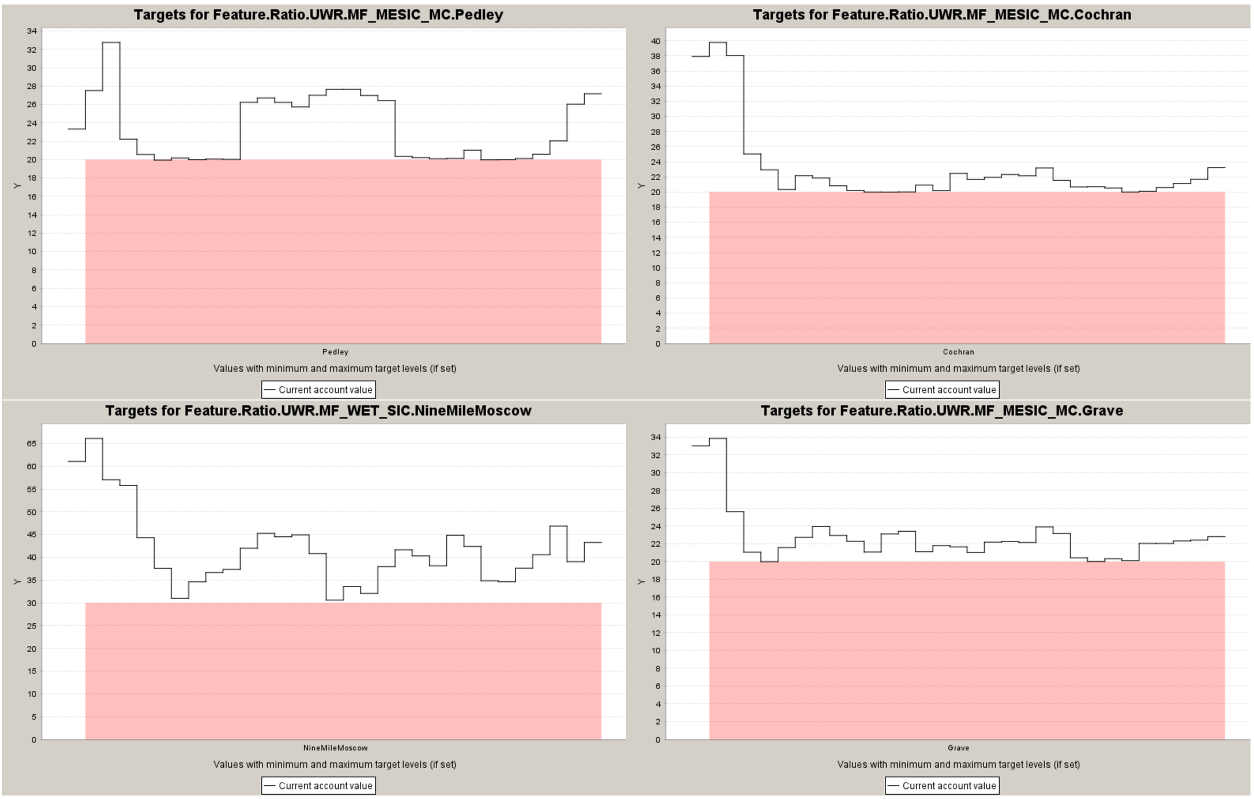


Figure 16 ISS Base Case Scenario – UWR Snow Interception and Mature Cover Objectives (examples)

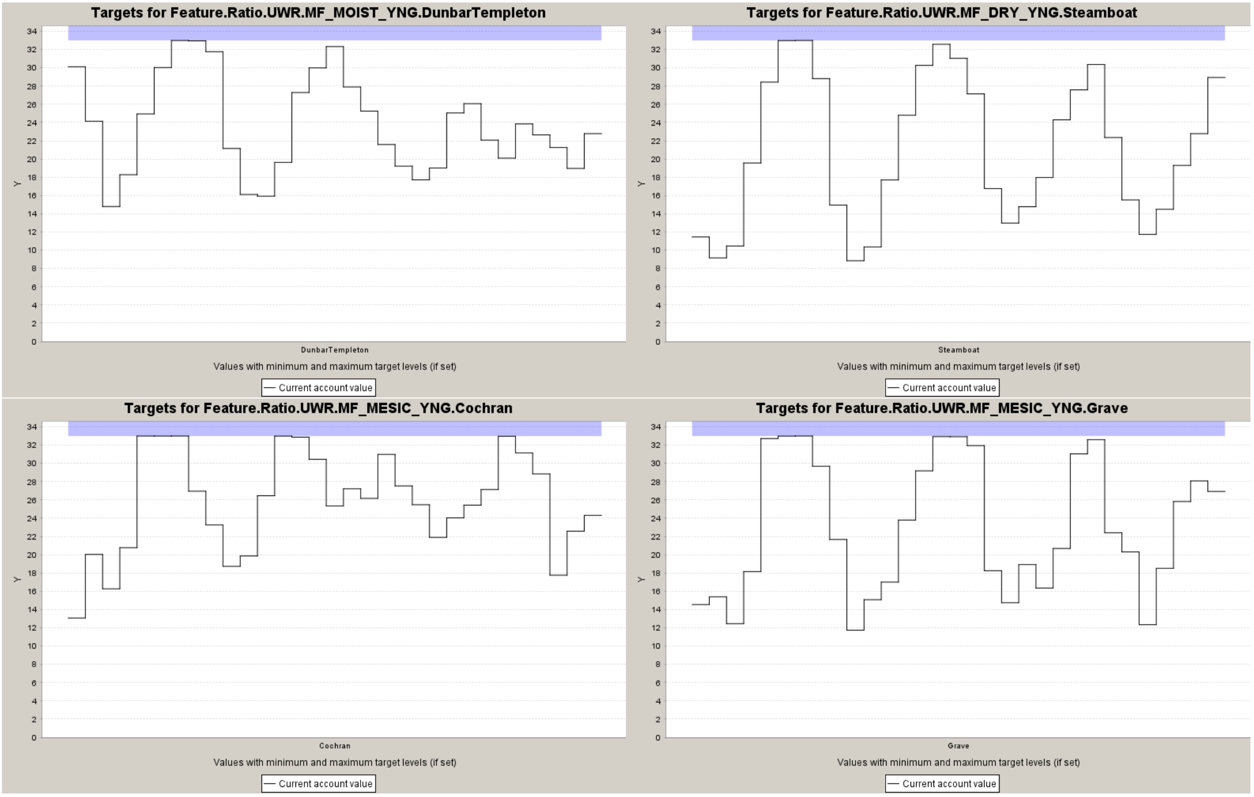


Figure 17 ISS Base Case Scenario – UWR Young Seral Cover Objectives (examples)

3.2.4 Community and Domestic Watersheds (ECA)

Disturbance (natural and anthropogenic) within the 9 community and 150 domestic watersheds was modelled with a maximum 30% Equivalent Clearcut Area (ECA). Within each watershed, the ECA was calculated relative to the modelled FMLB area (with targets factored relative to total watershed area). The results showed the Madias (FMLB = 1,136 ha, THLB = 273 ha) and Tatley (FMLB = 697 ha, THLB = 7 ha) Community Watersheds were the most constrained (Figure 18). Note that the THLB area component is relatively small which indicates that natural disturbance within the NHLB portion is likely causing these watersheds to be constraining. In addition to being disturbed, the NHLB area regenerates to the original existing natural yield, which takes longer to fully recover hydrologically, compared to managed yields.

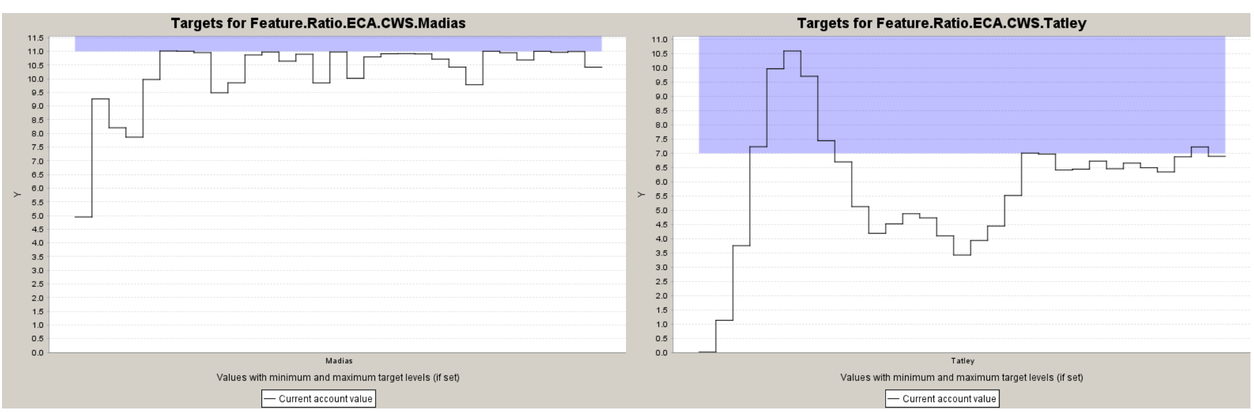


Figure 18 ISS Base Case Scenario – Community Watershed Targets (examples)

Some of the relatively large domestic watersheds (>500 ha) were constrained, including: Mud Creek (FMLB = 1,483 ha, THLB = 910 ha), Emily Creek (FMLB = 931 ha, THLB = 692 ha), Thorold Creek (FMLB = 913 ha, THLB = 685 ha), Brady Creek (FMLB = 828 ha, THLB = 335 ha), Hardie Creek (FMLB = 765 ha, THLB = 252 ha), and Copper Creek (FMLB = 641 ha, THLB = 467 ha). The top four are included in Figure 19.

Note that the THLB for some of the relatively large domestic watersheds prevented harvesting over some periods because the prorated ECA target was zero (e.g., Brady Creek). A similar trend was observed for domestic watersheds under 500 ha. Overall, the ECA thresholds applied to domestic watersheds had a negative impact on the harvest rate. Note that natural disturbance modelled within the NHLB exacerbated the negative impact on harvest rate by reducing the THLB area that could be disturbed.

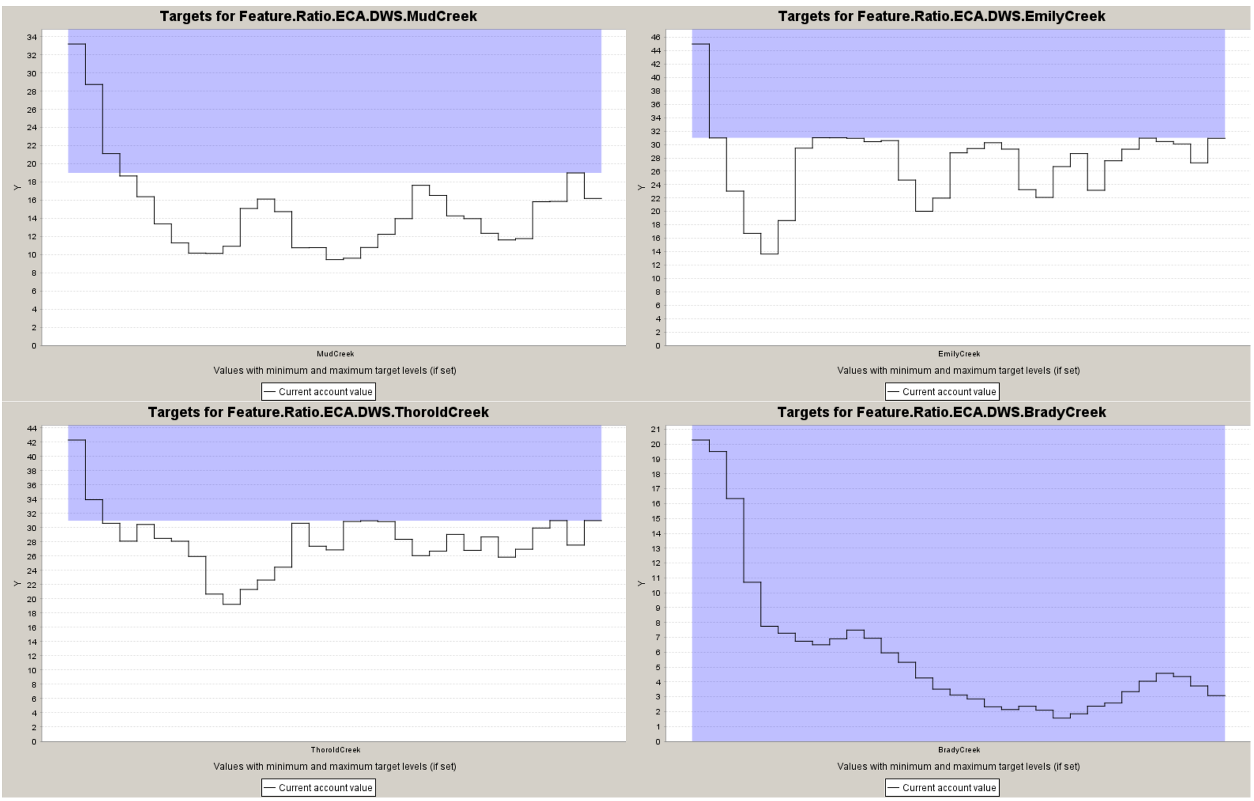


Figure 19 ISS Base Case Scenario – Domestic Watershed Targets (examples)

3.2.5 Visual Quality Objectives

Visual quality objectives (VQO) were applied to restrict the disturbance (natural and anthropogenic) in 131 Visual Landscape Inventory (VLI) polygons, where the maximum target disturbance ranged between 0.2% and 84.2% of the FMLB area. The maximum target disturbance for many of the VLI polygons was not maintained due to the relatively high proportion of disturbance within the NHLB area. Recall that the NHLB area was disturbed at a rate of 1,500 ha/year and then reverted to the same existing natural yield, which took longer to achieve visually effective green-up heights compared to managed yields. For example, only natural disturbance occurred for the largest VLI polygon (#107822, FMLB = 4,077 ha, THLB = 5 ha), which violated the maximum disturbance target (Figure 20).

In many of the VLI polygons with a relatively large component of THLB (500 to 1,000 ha), the maximum target disturbance was overall constraining. Some examples are included in Figure 20 (#107529 – FMLB = 1,693 ha, THLB = 918 ha; #107534 – FMLB = 1,378 ha, THLB = 844 ha; #107654 – FMLB = 1,750 ha, THLB = 722 ha). In particular, note VLI #107534 and #107654 where the target disturbance was relatively low and the natural disturbance on the NHLB component was sufficient to lock from harvesting significant THLB area.

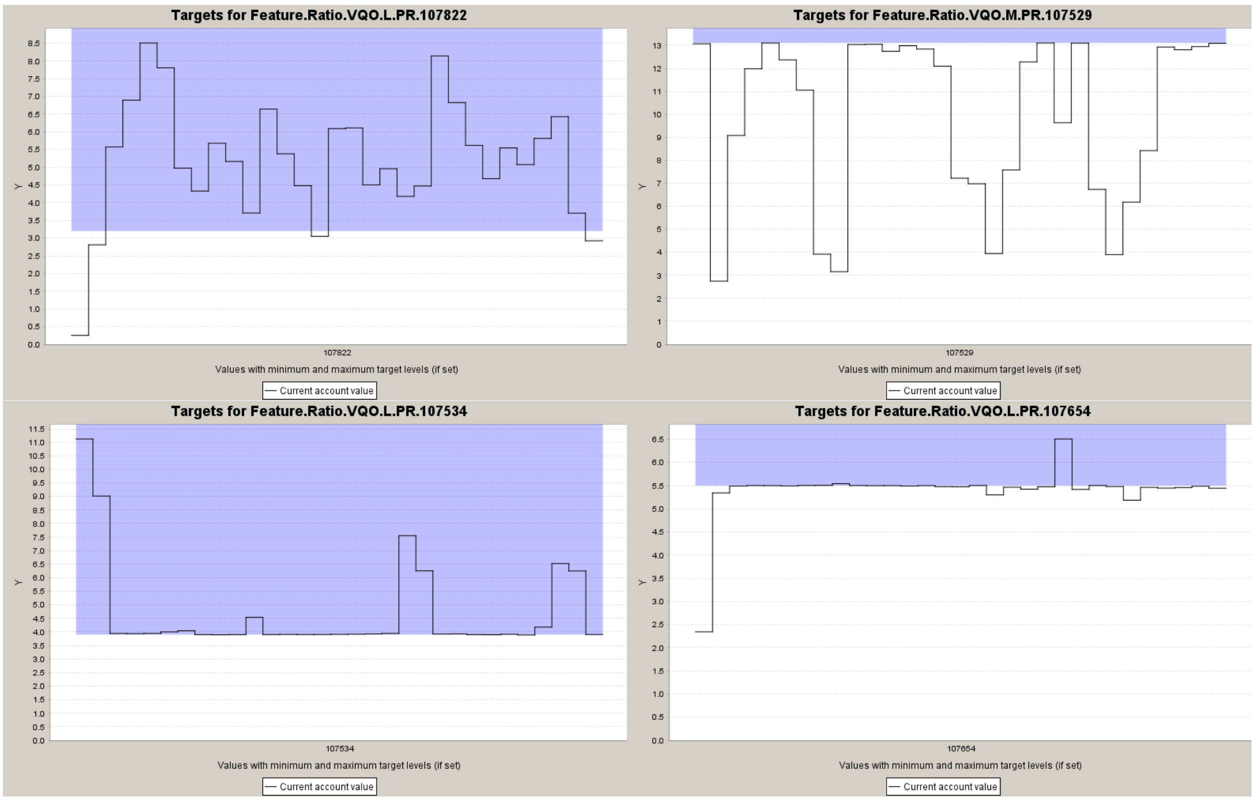


Figure 20 ISS Base Case Scenario – VQO Objectives (examples)

3.3 Sensitivity Analyses for the ISS Base Case Scenario

A total of 10 runs were modelled in the ISS Base Case Scenario. The first 3 runs explored different harvest flows: even-flow (001), non-declining yield (NDY) (002), and MINDY (003) (Table 3). The other seven sensitivity runs explored adjustments of various assumptions:

- Change the maximum ECA threshold from 30% to 25% (004),
- Apply KBLUPO landscape-level biodiversity (BIOD) full targets (no 2/3 draw-down), in addition to, the established OGMAs and MMAs (005),
- Maintain current slope and hauling distance profiles for the first 40 years (006),
- Turn off OGMAs and MMAs and exploring landscape-level biodiversity objectives by applying:
    - only the old seral requirements, including 2/3 draw-down (007),
    - mature and old seral requirements, including 2/3 draw-down (008),
    - mature, old (including 2/3 draw-down), and very early seral (<=20yrs) patches (009), and
- Turn off FSC requirements for Canfor operating areas (FPPR applies instead) (010).

For consistency, the harvest profiles for runs 004 to 008 and010 were developed similar to the approach used for 003 MINDY (maximum initial and non-declining), as discussed in section 3.1.2. Here, the THLB growing stock was constrained to be non-declining over the last 100 years of the 300-year planning horizon. Throughout these analyses, it was observed that minor changes to the harvest profile might have resulted in an identical harvest profile as 003 if the model were run longer. However, for consistency, the model was run for a similar number of iterations.

Table 3 ISS Base Case Scenario – Summary of Sensitive Analyses

Sens ID	Description	THLB		Harvest rate (m^3/year)				Harvest rate % from 003		
		(ha)*	%from 003	First decade	Mid-term	9th decade)	Long-term	First decade	Mid-term	Long-term
000a	TSR4 Even Flow	195,516	13.0%	447,158	447,158	447,158	447,158	16.6%	18.8%	-4.7%
000b	Benchmark MINDY	195,511	13.0%	464,000	444,027	541,006	597,150	21.0%	18.0%	27.3%
001	Even flow	173,088	0.0%	379,335	379,344	379,637	379,604	-1.1%	0.8%	-19.1%
002	NDY	173,088	0.0%	377,736	377,647	414,829	469,066	-1.5%	0.4%	0.0%
003	**MINDY**	**173,088**	**0.0%**	**383,535**	**376,314**	**414,515**	**468,991**	**0.0%**	**0.0%**	**0.0%**
004	ECA 25pct	173,088	0.0%	379,848	369,553	412,971	467,023	-1.0%	-1.8%	-0.4%
005	Slope/Haul	173,088	0.0%	378,724	368,649	417,836	468,652	-1.3%	-2.0%	-0.1%
006	BIOD on	173,088	0.0%	372,340	362,196	414,598	468,147	-2.9%	-3.8%	-0.2%
007	OGMA/MMA off, BIOD old	188,037	8.6%	417,783	407,135	454,715	505,844	8.9%	8.2%	7.9%
008	OGMA/MMA off, BIOD mature/old	188,037	8.6%	405,454	394,479	437,176	501,751	5.7%	4.8%	7.0%
009**	OGMA/MMA off, BIOD mature/old, early seral patches on	188,037	8.6%	364,227	364,129	433,514	496,913	-10.2% (008)	-7.7% (008)	-1.0% (008)
010	FSC off	180,123	4.1%	398,716	388,299	438,241	494,537	4.0%	3.2%	5.4%

**Effective THLB area in the model; it differs slightly from the THLB area reported in Table 1 because of the rounding errors. All percentages are calculated relative to sensitivity ID 003 (i.e., sensitivity ID is the denominator).*
***It was more appropriate to compare these results to sensitivity 008, as denoted in brackets.*

The sensitivity analyses produced the following outcomes:

- (001-003) Adopting the MINDY harvest profile added 1.1% more harvest volume in the first decade, and 19.1% more in the long-term compared to an even-flow approach. Volume availability in the first decade was heavily constrained by the relatively young (<60 years) age class distribution of the THLB at year zero (Figure 7). The NDY harvest rate was similar to the even-flow (001) in the first decade, and similar to MINDY in the mid- and long-term.
- (004) Decreasing the maximum disturbance threshold permitted within key watersheds (from 30% ECA to 25%) resulted in 1.0% less volume available in the first decade, 1.8% less in the mid-term, and no significant negative impacts in the long-term.
- (005) Maintaining the current slope and haul distance profiles for the first 40 years resulted in a decrease of 1.3% in harvest level in the first decade, 2.0% over the mid-term, and very little change over the long-term. The slope and haul distance (one-way) profiles established for the first 40 years included:
    - Ground harvesting systems constrained to 78% of the harvested area.

- Harvested area within ½ hour constrained to 54%, and between ½ hour and 1 hour, constrained to 38% of the total harvested area.

- (006) Applying the full landscape-level biodiversity requirements for mature and old seral forests over the entire planning period (i.e., no 2/3 draw-back), as well as, the established OGMAs and MMAs, reduced harvest rates by 2.9% in the first decade and 3.8% in the mid-term, but there was no negative impact in the long-term. This suggests that the established OGMAs and MMAs, alone, are not sufficient to meet the full targets for mature and old seral forest in the short- and mid-terms. To meet these targets, the model recruited stands into the long-term when some of these stands could be released.

- (007-008) Turning off the OGMAs and MMAs increased the THLB by 7.4%. Despite this increase, gains in harvest rates were less in the first decade (up to 4.5%) and mid-term (up to 4.3%). In the long-term, as the model successfully recruited stands to meet the mature and old seral forest targets, the harvest rate bounced back closer to the level of the THLB increase.

- (007-008) Turning off the OGMAs and MMAs increased the THLB by 8.6%, which contributed to similar harvest rate increases across the planning horizon.

- (009) Very early seral patches were modelled in 30 reporting units with THLB area (only) >500ha. These results were more appropriately compared to sensitivity 008 configured with the same THLB area and seral requirements.
  - Influencing the model to trend towards desired patch size distributions reduced harvest rates in the first period and mid-term by 10.2% and 7.7, respectively. The long-term harvest rate was reduced by only 1.0%.
  - Examples of very early seral patch targets were compared to the 003 MINDY run (Figure 21 – top 2 largest units THLB area for Canfor and BCTS/Galloway; detailed results are included in Appendix 1). These examples show improvements – including creating larger patches - when controls are turned on (009). However, smaller reporting units were unable to develop larger patches for the simple fact that they are too small – whether or not targets were implemented (e.g., East Columbia with THLB ~500 ha).
  - While old seral patch targets were not specifically modelled, results were tracked and reported. Examples for old seral patch were compared to the 003 MINDY run for the same reporting units as the point above (Figure 22 – 009 versus 003) with detailed results included in Appendix 2. Without targets applied, there are little differences between these runs. Interestingly, large patches were exceeded while smaller patches met or were below target thresholds. Note that the definition of old seral patches is significantly more variable compared to the definition of early seral patches (i.e., all FMLB area older than a certain age (based on BEC and NDT) compared to all THLB area less than 20years in age).

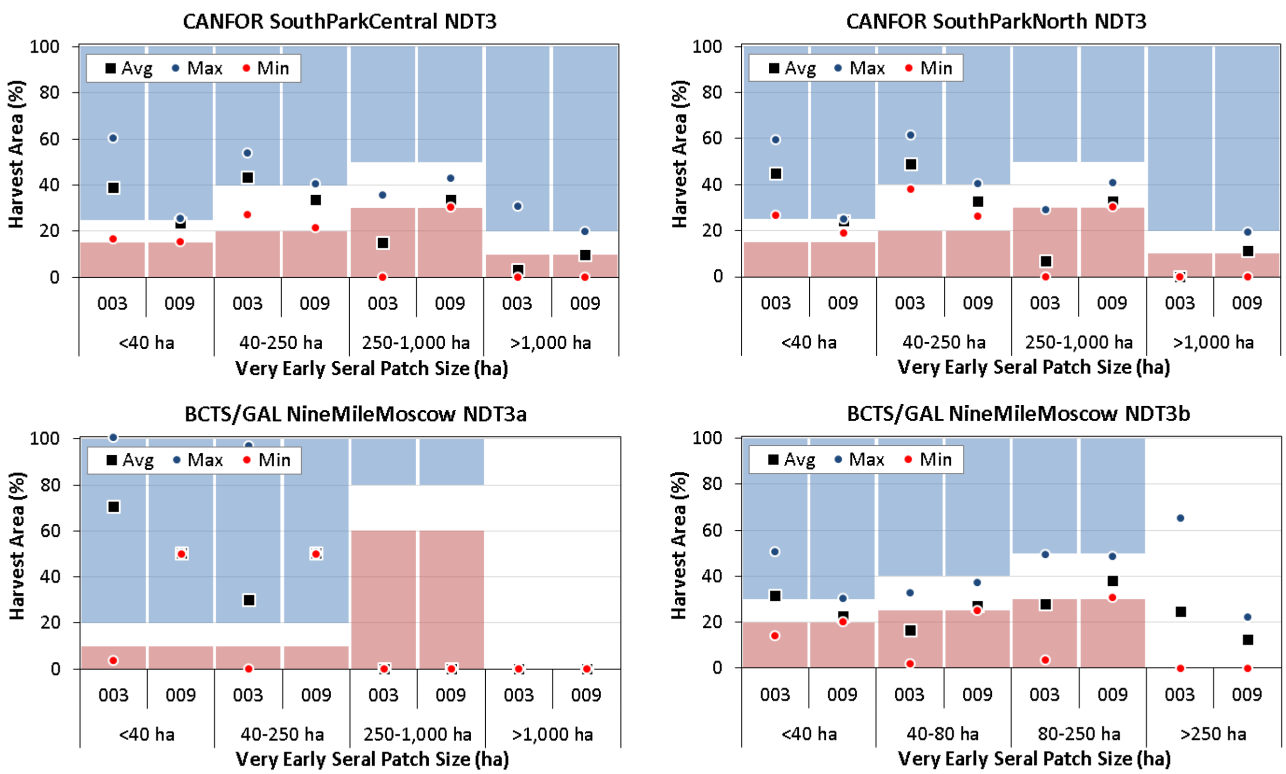


Figure 21 ISS Base Case Scenario – Very Early Seral Patch Objectives (examples)

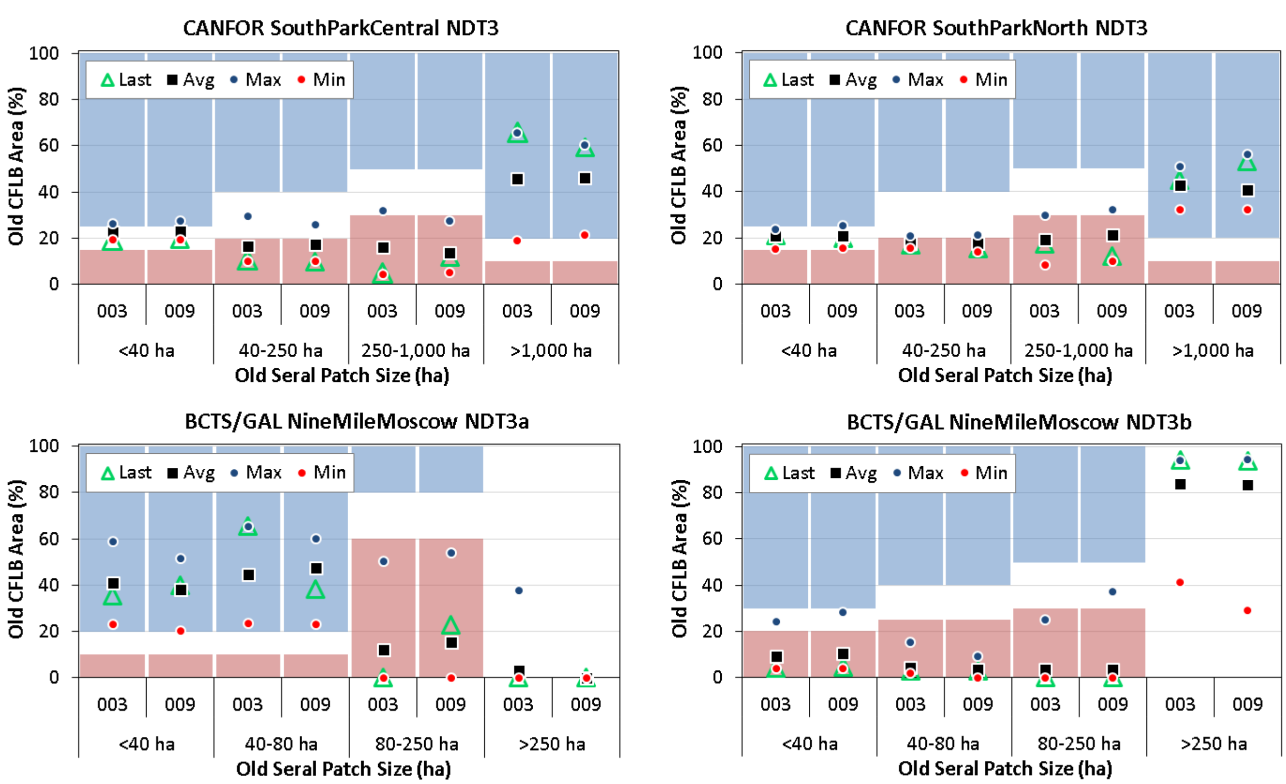


Figure 22 ISS Base Case Scenario – Old Seral Patch (examples)

- (010) Turning off FSC standards in the Canfor operating areas and applying FRPA standards, increased the THLB by 4.1%. This gain translated into positive impacts on harvest levels: 4.0% more in the first decade, 3.2% in the mid-term, and 5.4% in the long term.

4 Silviculture Scenario

4.1 Description

The Silviculture Scenario explored alternate silviculture tactics to enhance timber quantity and quality over the mid- and long-term, as well as, improve biodiversity, wildlife habitat, and cultural interests. The Project Team allocated an expected funding level of $0.3 over the first 20 years of the planning horizon to explore 3 tactics: 1) enhanced basic silviculture (ENH), 2) commercial thinning (CT), and 3) fertilization (FERT).

Additional sensitivity analyses were explored to better understand how these silviculture tactics interact and where they influence non-timber requirements and harvest flow. These included:

- Increase funding from $0.3 to $1.0 million per year, and
- Extend the funding of $0.3 million per year from 20 to 60 years (CT and FERT only available on existing managed stands).

4.2 Treatment Responses

The three tactics (ENH, CT, FERT) were applied in the model as alternative yield curve options. Figure 23 shows an example for managed stands where the three tactics overlap.

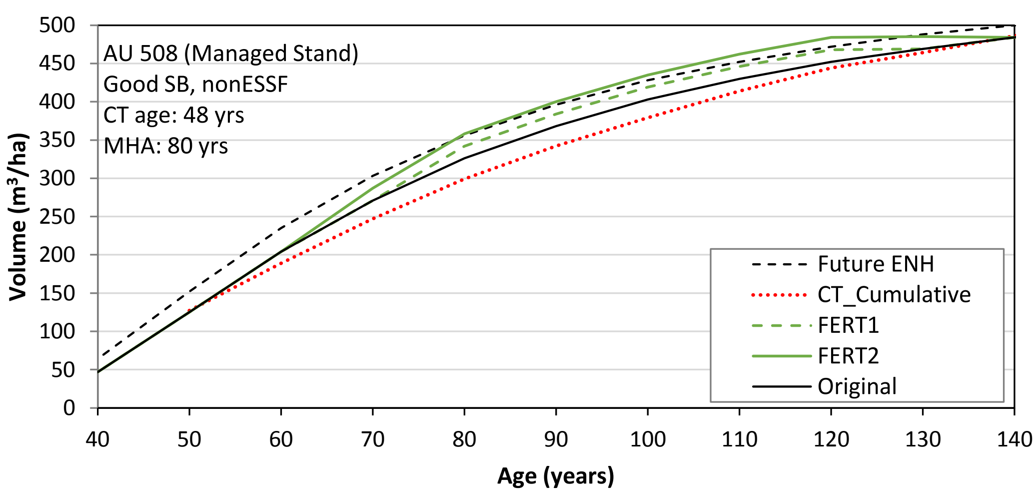


Figure 23 Example of Adjusted Yields for Silviculture Tactics

Note that with this example:

1) The highest gain in yield occurred with the ENH treatment (i.e., ~30 m³/ha at minimum harvest age (MHA)). Note that the full potential of enhanced yields in Fd-leading stands was not explored

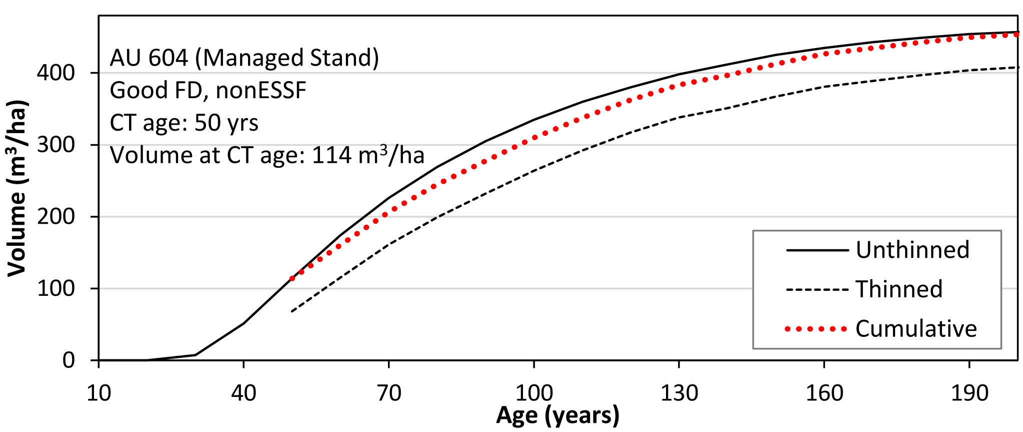
because the MHA was restricted to a minimum of 80 years regardless of the potentially higher volumes and mean annual increments at younger ages.

2) The next highest gain in yield occurred with the FERT treatment (i.e., ~16 m³/ha for 1 application and 32 m³/ha for two applications).

3) The response for CT is shown as a cumulative yield (i.e., CT harvest volume minimum of 40 m³/ha + volume of remaining stand + growth, including CT response, of remaining stand), which was less than the original, unthinned yield at MHA.

Several key points regarding CT warrant further discussion to better understand the results.

- On richer sites, there was a smaller gap between the cumulative CT yield (i.e., CT harvest volume + volume of remaining stand + growth, including CT response, of remaining stand) and the original, unthinned yield at MHA. In addition, depending on CT eligibility (i.e., timing when a stand becomes eligible for CT), the thinned volume harvested could be significantly higher than the minimum of 40 m³/ha, especially when CT was applied at the end of the 10-year timing window.
- The gap between original and cumulative CT yield could have been significantly reduced if the timing window was extended to an older age (e.g., closer to the culmination of mean annual increment). This would provide higher thinning volumes of better quality with likely, a higher financial return.
- Equivalent Clearcut Area (ECA) curves to account for disturbances within key watersheds were not applied for managed stands treated with CT. Similarly, thinned volumes were harvested while stand age remained the same. So in effect, CT can increase volume without affecting constraints.
- The primary opportunity with CT is providing the model with an option to harvest a portion of the stand, while it is still growing well, to address periods when available volume is low. The rest of the stand is then harvested later, when much more merchantable volume is available across the landscape.
- In all cases, the thinned stands experienced a higher growing rate compared to the unthinned stands. However, the cumulative yield typically does not recover to unthinned levels for a very long time (e.g., ~80 years for AU 508 and never for AU 604 as shown in Figure 24).



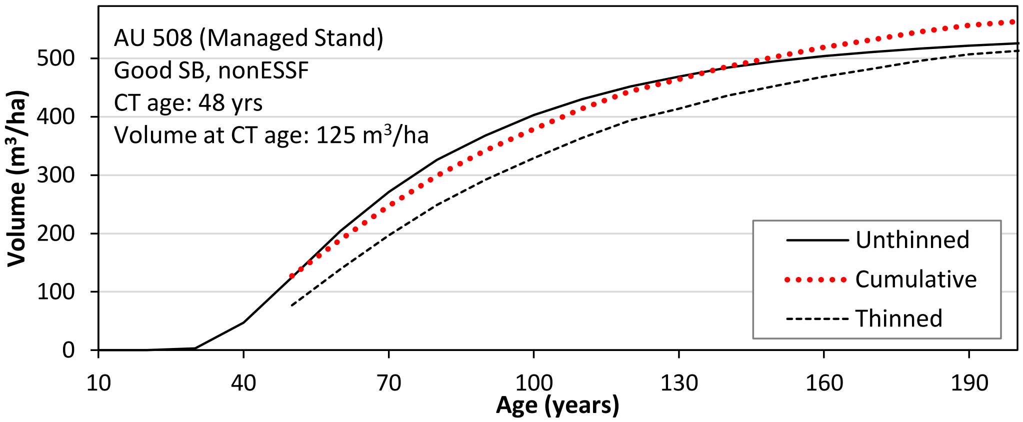


Figure 24 Examples of Commercial Thinning

Analysis units developed in the recent TSR and applied in the ISS Base Case did not align with the criteria to identify eligible stands for treatments in this scenario. Consequently, a Silviculture Baseline model was prepared with adjusted analysis units. With treatments turned off, this model produced harvest flows that were less than 1% different from the ISS Base Case scenario. This Baseline was subsequently used for comparing against other silviculture runs.

To compare sensitivities appropriately, it is important to maintain the same modelling criteria except for the one being examined. For instance, when the funding period was extended to 60 years, treatment options were only available to existing stands and opportunities to increase the long-term harvest rate were not explored.

4.3 Results

4.3.1 Funding at $300,000 per Year

When the funding level was set to $0.3 million per year for the first 20 years of the planning horizon, the harvest rate increased over the mid-term by 1.4% and by shortened the mid-term period by 10 years, or increased the rise to the long-term by 9.6%, compared to the Silviculture Baseline (Figure 25). This shift was due to the harvest contribution from enhanced stands beyond the mid-term period, combined with the additional volume from fertilized stands.

Total and merchantable growing stock on the THLB, followed similar patterns as the Silviculture Baseline; ending in lower levels than the Silviculture Baseline (~0.8 million m³ lower) to maintain a sustainable, non-declining growing stock over the last 100 years of the planning horizon. To reduce the mid-term shortage period, the model used more of the growing stock, which increased to a lower long-term level compared to the Silviculture Baseline. After applying silviculture tactics, the THLB merchantable growing stock did not improve during the mid-term. This is because any improvement in the THLB merchantable growing stock was used by the model to improve the harvest level for the relatively constrained land-base.

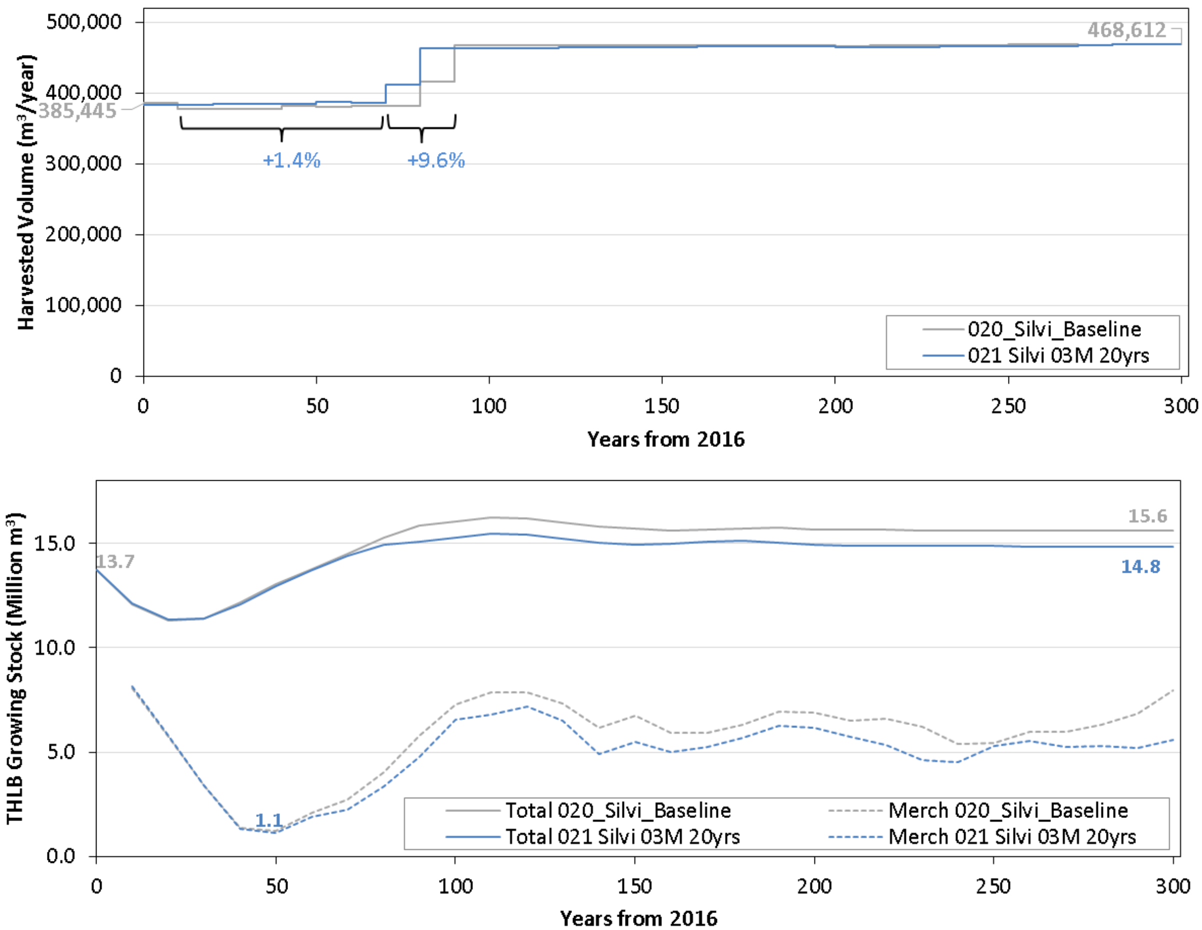
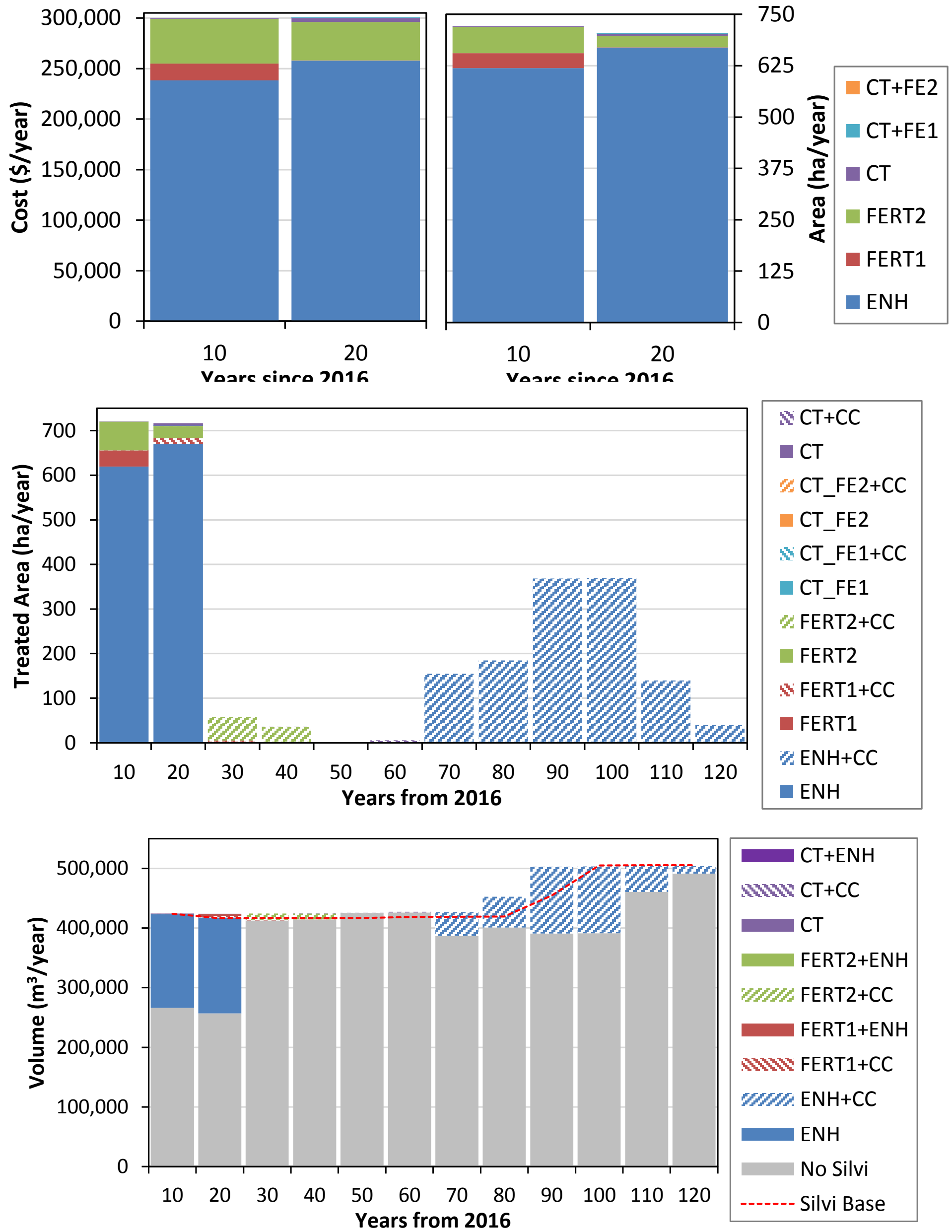


Figure 25 Silviculture Scenario – Harvest Flow and THLB Growing Stock for Combined Tactics

The model allocated all of the $0.3 million per year budget over the first 20 years ($6 million - Figure 26). Most of the funding was spent on ENH (~$248,000/year), while much less was spent on FERT (~$50,000/year) and even less on CT (~$2,000/year). The model treated approximately 644 ha/year with ENH and approximately 64 ha/year with FERT, while CT was applied at approximately 4 ha/year. Where stands were eligible for two fertilizer applications, the model tended to select two applications over one. This suggests that increased volume on existing stands was a primary driver for the FERT tactic. Fertilized stands were clearcut over the 3rd and 4th decade (~36 ha/year), followed by thinned stands between the 4th and 6th decade (~2ha/year), then enhanced stands between the 7th and 12th decade (~209 ha/year).



(Note: hatched symbology depicts the timber harvest for each tactic)

Figure 26 Silviculture Scenario – Results, $0.3 million per year for 20 years

The ENH tactic had the most significant impact on improving the harvest rate and shortening the mid-term. To achieve the harvest rate improvements described above, the model treated a relatively small fraction of the eligible stands for the three tactics (i.e., 26% of eligible ENH, 8% of eligible FERT, and 9% of eligible CT). However, the ENH tactic provided more flexibility in scheduling the harvest. In the Base Case, harvesting of some older stands was delayed to maintain a non-declining harvest rate, whereas these stands could be scheduled for harvest earlier in the planning horizon as they were replaced by stands growing on enhanced yields. Recall, the enhanced stands had higher yields and younger MHAs. This dynamic is illustrated by the average ages and volumes harvested (Figure 27). Note that while the average harvest age and average harvest volumes are similar, stands harvested past the 9^{th} decade are slightly older with lower average volumes in the Silviculture Baseline. The increased harvest rate beginning in the 2nd decade and throughout the mid-term was attributed to the additional volume from harvesting fertilized stands (decades 3 and 4), as well as, enhanced stands (decades 7 to 9 illustrated by the higher volume and younger age at harvest).

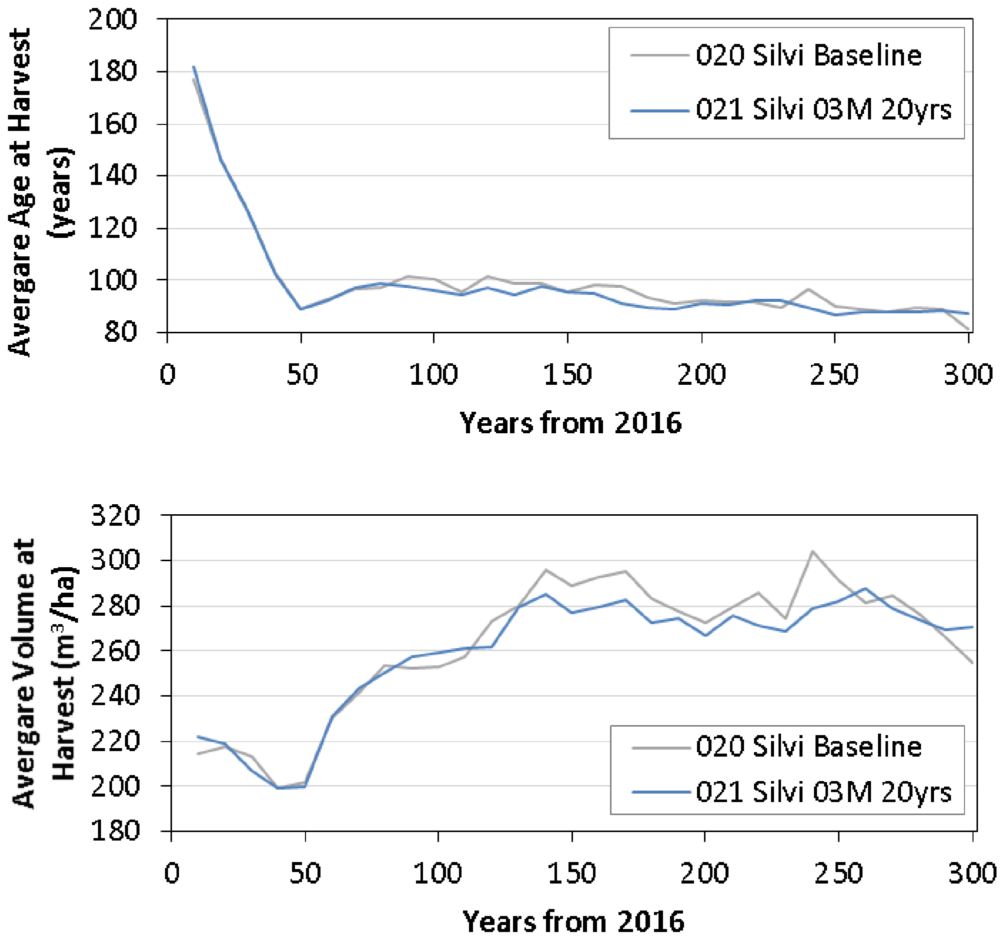


Figure 27 Silviculture Scenario – Average Age and Volume at Harvest

4.3.2 Funding at $1 Million per Year

Increasing the funding level to $1 million per year over the first 20 years of the planning horizon led to an increase in the mid-term harvest rate by an additional 0.3-0.9% compared to the 021_Silvi_03M run shown in Figure 25, and a total increase of up to 2.9% compared to the ISS Base Case. The increased funding did not result in further shortening of the mid-term period. The higher funding level did not correlate with a similar increase in harvest rate because the land base was relatively constrained over the short- and mid-term and harvest rates were already maximized with the lower funding level.

In developing a harvest rate for this run, the analyst increased weights set on volume targets to encourage the model to produce a higher harvest rate. As a result, the slightly higher harvest rate caused targets for some non-timber objectives to be violated, especially the VQOs. The discussion in section 3.2 described that VQOs were among the most constraining of the non-timber objectives.

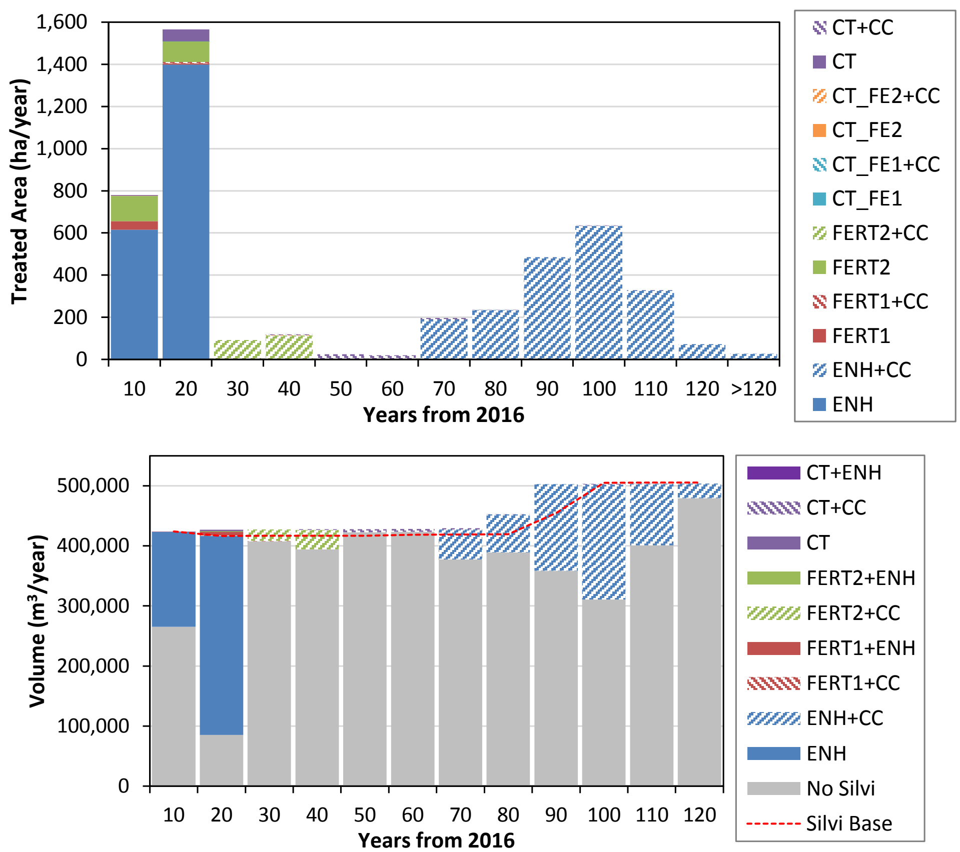
The long-term growing stock on the THLB was 0.4 million m³ higher than the 021_Silvi_03M run. This suggests that the model applied the additional funding towards increase the long-term growing stock rather than improving the mid-term harvest rate. This observation also supports the fact that the land base was relatively constrained and opportunities to increase the mid-term harvest rate are limited. The primary outcome of providing a higher funding level was an increase to the growing stock.

The model allocated only 52% (i.e., $10.3 million) of the $1 million per year budget over the first 20 years for the following reasons:

1) The land base was relatively constrained over the first two periods with few alternative harvest opportunities over the short term.
2) Both CT and FERT treatments were configured with relatively narrow opportunity windows making eligibility highly dependent on age.
3) There was a limit to the amount of ENH area that the model could shift to other stands earlier in the planning period, and
4) Compared to ENH, costs to treat CT and FERT were higher while the relative volume gains were lower (see Figure 23 where only FERT2 has slightly higher volume gains than ENH). It was observed that compared to the lower funding level, the FERT treatments contributed more to the harvest rate over the 3rd and 4th decades.

On average, most of the funding was spent on ENH (~$387,000/year), while much less was spent on FERT (~$108,000/year) and even less on CT (~$18,000/yr). Accordingly, the model treated approximately 1,007 ha/year for ENH and approximately 133 ha/year to FERT, while CT was applied at approximately 30 ha/year (Figure 28). Fertilized stands were clearcut over the 3rd and 4th decade (~71 ha/year), followed by thinned stands between the 4th and 8th decade (~11ha/year), then enhanced stands between the 7th and 12th decade (~324 ha/year) of the planning horizon.

Again, the ENH tactic had the highest impact in improving the harvest rate. To achieve the increased harvest rates described above, the model treated a relatively small fraction of the eligible stands for the three tactics (i.e., 38% of eligible ENH, 16% of eligible FERT, and 75% of eligible CT).



(Note: hatched symbology depicts the timber harvest for each tactic)

Figure 28 Silviculture Scenario – Results, $1 million per year for 20 years

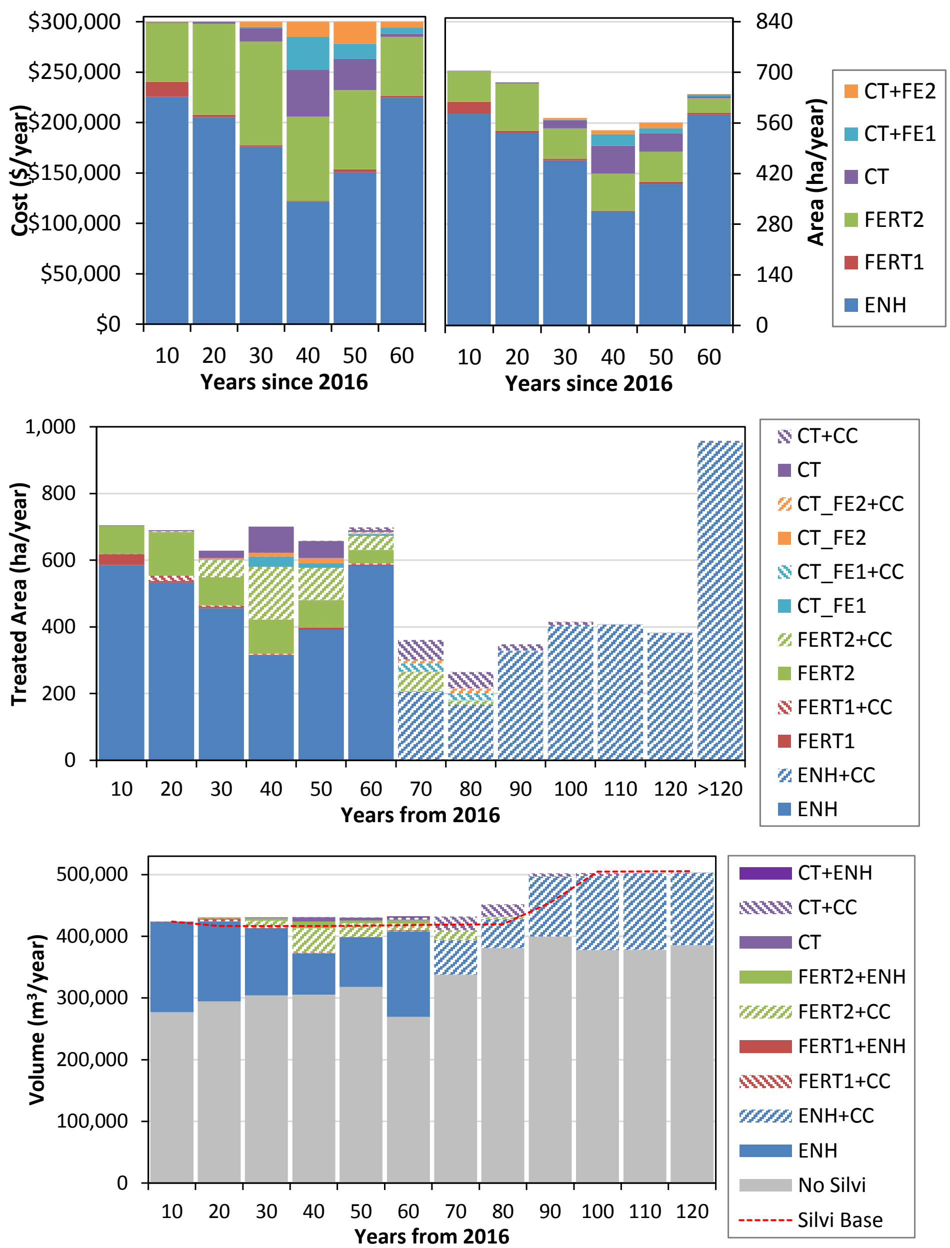
4.3.3 Funding Extended to 60 Years

Extending the funding level of $0.3 million per year from 20 to 60 years provided more treatment opportunities for ENH, FERT and CT. Yet, the harvest rate remained similar to the 021_Silvi_03M run shown in Figure 25. The harvest rate increased by an additional 1.3-1.8% (total increase of 3.7% compared to the ISS Base Case). While the harvest flow was slightly less (-0.1%) than the 021_Silvi_03M run over the long-term, growing stock on the THLB was higher at 0.6 million m³. This suggests that applying higher target levels might increase the harvest level in the long term and the extended funding period did not exclusively improve the mid-term harvest rate.

The model allocated the entire $0.3 million per year budget over the first 60 years ($18 million). On average, it spent most of the funding on ENH (~$183,000/year), less on FERT (~$91,000/year) and even less on CT (~$24,000/yr). Accordingly, the model treated approximately 478 ha/year for ENH, approximately 103 ha/year for FERT, and approximately 34 ha/year for CT (Figure 29). Compared to 020_Silvi_0.3M run, the model treated a slightly higher proportion of eligible stands for the three tactics (35% of eligible ENH, 34% of eligible FERT, and 52% of eligible CT).

Over the mid-term period (years 20-50), the FERT and CT tactics had a more significant impact on harvest rate than previous runs, particularly during periods when timber availability was lowest. It was more efficient for the model to trade long-term volume losses from thinned stands with the immediate benefit from CT (i.e., relatively small amounts of harvested volume that was immediately available). The model recovered some, if not all, of the CT losses in the long-term by the additional volume generated from ENH stands.

The area harvested under the ENH tactic increased approximately 2.2 times (~309 ha/year), while the area harvested under the FERT tactic increased approximately 4.6 times (~51 ha/year). Between the 7th and 13th decades, the total area harvested under the CT tactic (final entry) increased to ~2,180 ha (~35 ha/year).



(Note: hatched symbology depicts the timber harvest for each tactic)

Figure 29 Silviculture Scenario – Silviculture Tactics Results, $0.3 million per year for 60 years

4.3.4 Additional Observations

The silviculture tactics explored here also provided improved flexibility to address forest cover requirements (e.g., biodiversity, wildlife habitat, watershed, and cultural interests). This analysis was not set-up with specific metrics to track stand structure related to biodiversity, wildlife habitat, and cultural interests. However, one might apply CT and some uneven-aged silvicultural systems to more stands, especially those within relatively constrained areas such as visually sensitive areas, UWR habitat, and watersheds. Such tactics could deliver similar volumes spread over cutting cycles while not altering stand age. Recall, the non-timber objectives that constrain the THLB are age-related indices where typically, an older age relates to a lower penalty. Moreover, one might apply silviculture tactics such as FERT or ENH to overcome potential volume gaps incurred by the CT or uneven-aged silvicultural system.

The proportion of eligible stands where the silviculture tactics were applied was relatively modest. This occurred because: (1) the landbase was relatively constrained, (2) relative cost tactics were different; favouring the ENH tactic, and (3) timing windows for the FERT and CT tactics or the combination of the two were relatively narrow.

An extensive quality check of the silviculture scenario identified that the harvest rate increases described above were achieved by considering each silviculture tactic on its own. In addition, the budget used to achieve similar harvest rate increases using one tactic at a time could be less. For example, applying only the CT or FERT tactic for the first 60 years of the planning horizon achieved similar harvest rate increases at a fraction of the allocated budget of $0.3 million per year (i.e., higher use of the budget for FERT tactic compared to CT). These observations support at least two alternative approaches to the silviculture tactics explored in this analysis: (1) expand the CT tactic to the areas covered by non-timber objectives such as VQOs, UWR, ECA, and (2) control the budget allocated for each tactic rather than applying one budget for all tactics, as implemented in current analysis.

4.3.5 Exploratory Runs

Besides the model runs described above, we conducted several exploratory runs to examine questions that arose from our preliminary analysis (i.e., Series 1). Changes were made to subsequent models so not all runs can be compared appropriately, but key observations are briefly summarized below.

Commercial Thinning

The model rarely applied CT treatments where funding was available for only 20 years (sections 4.3.1 and 4.3.2). This was appropriate since, for this TSA, the CT tactic benefits the harvest flow by capturing additional thinning volume during periods when the available volume is particularly low – in this case between the third and seventh decades (Figure 25). To explore this further, we modeled two runs that made CT available over these critical periods, while applying various treatment costs to test the sensitivity of this particular assumption:

- $0.3 M/yr for 60 years and set CT cost @ $600/ha (same; half of total)
- $0.3 M/yr for 60 years and set CT cost @ $0/ha (break-even)

For these exploratory runs, we also had to develop new yields and analysis units as we identified additional eligible stands for CT over the first 60 years. These were limited to existing natural and managed stands (not future).

Extending CT throughout the mid-term significantly increased the area treated. These results led to sensitivity discussed in section 4.3.3. In contrast, decreasing treatment cost did not significantly affect the area treated.

Separate Tactics

To understand the combined impact of the silviculture tactics, we explored each tactic separately using the same budget allocation of $0.3 million/yr for 60 years. Results showed that independently, each tactic achieved similar harvest flow increases.

Table 4 shows results for runs with each individual tactic compared to a silviculture base (Run 000) where tactics were effectively turned off. In this comparison, CT was clearly the most cost-effective silviculture tactic when considering the increased harvest rates between the 2nd and 4th decades relative to the budget spent. However, this lone tactic also produced lower harvest rates over the long-term. Combining CT with the ENH tactic would likely recover this loss in harvest over the long-term.

Table 4 Silviculture Scenario – Summary of Results for Individual Tactics compared to Silv Base (no tactics prior to addressing issue with analysis units)

Tactic	Total Budget Spent *	Change in Harvest Rates Compared to the 000 Silv Base Run		
		2nd to 4th Decade	5th Decade	≥6th Decade
024 ENH	$17.1 M	5.3%	1.3%	-0.3%
025 FERT	$11.3 M	6.8%	3.3%	-1.2%
026 CT	$3.7 M	5.9%	1.3%	-1.4%

**M = million ($0.3 million budget over 60 years = $18 million max)*

Analysis Units

In the ISS Base Case, we grouped stands into analysis units using the same criteria as TSR but in most cases, these criteria did not match those used to identify eligible stands for various silviculture tactics. Our initial approach to create analysis units for silviculture treatments involved splitting the Base Case analysis units according to the parameters defined for each silviculture tactic. Ultimately, this led to inconsistent impacts on yields and modelled results. Therefore, we revised our method by first identifying eligible stands then, rather than developing new yields, kept the averaged Base Case yields and adjusted these according to relative changes associated with each tactic. We tested this new Silviculture Base model by effectively turning off the silviculture tactics and demonstrating very similar results as the ISS Base Case (i.e., Run 020). This prompted a new series of model runs (i.e., Series 2) presented above in sections 4.3.1, 4.3.2 and 4.3.3.

5 Wildlife Scenario

The Wildlife Scenario was designed to assess habitat quality and quantity for a range of wildlife species while continuing to meet all other timber and non-timber objectives. In this ISS iteration, the Project Team elected to explore three tactics: wildlife habitat, species at risk, and access. Due to time and budget constraints, the Project Team decided not to proceed with the access tactic.

5.1 Wildlife Habitat Tactic

5.1.1 Description

The wildlife habitat tactic explored effects of future forest harvest on wildlife habitat. Without specific thresholds, we configured the model to maintain the current area identified as wildlife habitat in classes 1, 2, and 3 for 14 habitat types (i.e., combination of 7 wildlife species and their life requisites). A curve was developed for each of the 14 habitat types to portray the habitat class rating – 1 (highest) to 6 (Nil) – by structural stage. Madrone developed information on these curves in 2016 to model wildlife habitat for DIN and DCB TSAs. Linkages between structural stage and age were developed for each PEM unit, slope/aspect, and stand composition (broadleaf, mixed, conifer) combination. Thus, habitat classes could be assigned based on stand age (or structural stage) for each habitat type and each PEM unit, slope/aspect, and stand composition combination. Finally, the habitat class for each habitat type was translated into a binary curve (0 or 1) and used to build area accounts in Patchworks (up to 168 area accounts (84 managed, 84 unmanaged); 14 habitat types x 6 habitat classes x 2 land types). For each of the managed accounts, the total area in the top three habitat classes at time zero was set as the wildlife habitat target over the planning horizon.

Four model runs were developed:

- [030] – No harvest treatments and no habitat targets. This run simply tracks the status of wildlife habitat classes under a 'no harvest' scenario. Note that fire disturbances on the non-THLB still apply; thus, some foraging habitat (or habitat needing young ages) might be present in the long-term.
- [031] – Maintain ISS Base Case harvest flow (accept max 1% change in harvest level) and apply lower weights to encourage the model wildlife habitat targets; not necessarily maintain them.
- [032] – Apply habitat targets (i.e., maintain current distribution of 'at least habitat class 3' (i.e., combine class 1, 2, and 3) and apply a MINDY harvest flow (Maximum Initial Non-Declining Yield).
- [033] – Apply habitat targets (i.e., maintain current distribution of 'at least habitat class 3' (i.e., combine class 1, 2, and 3) without harvest targets. Model determines the harvest necessary to achieve appropriate foraging habitat (or habitat needing young ages).

Note applying that the 2016 wildlife habitat rating curves highlighted several interesting trends:

- Some PEM units did not correspond with the wildlife habitat models.
- Non-FMLB areas (CONTCLAS = 'X') were stripped from non-TSA lands (e.g., private lands); where there was no age, the habitat class for age zero was applied.
- Some habitat classes did not develop continuously with age. Foraging habitat types, for example, show that class 2 habitat occurs between ages 0-40 and then again at ages 80+, while a different habitat class was assigned between ages 40 and 80. This is in line with species account description from the 2016 work.
- The area summary tables in the 2016 report did not match well with outputs from the wildlife habitat model. Our investigation of the issue did not produce a clear solution so we continued to use the consolidated model outputs CSV files (as opposed to the data that produced the 2016 reports), as the consolidated outputs matched with the individual models run for each habitat type.

5.1.2 Results

The model was configured to replicate the 2016 reports (Muhly, et al. 2016) prepared using the latest TSR5. Patchworks produced wildlife habitat rating charts (Figure 30) for each of the 14 habitat types. In most cases, these results were similar to those developed in the latest TSR5 (Figure 31). In other cases, it appeared that the errors were introduced in the process used in the latest TSR5.

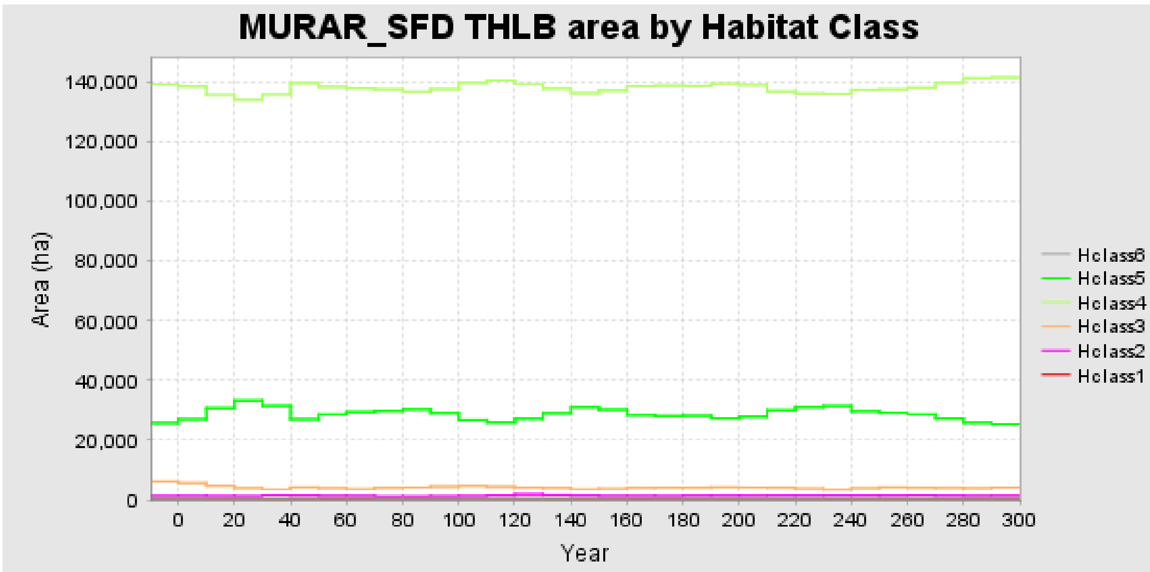


Figure 30 Distribution of grizzly bear habitat class (summer forage) over time (run 031)

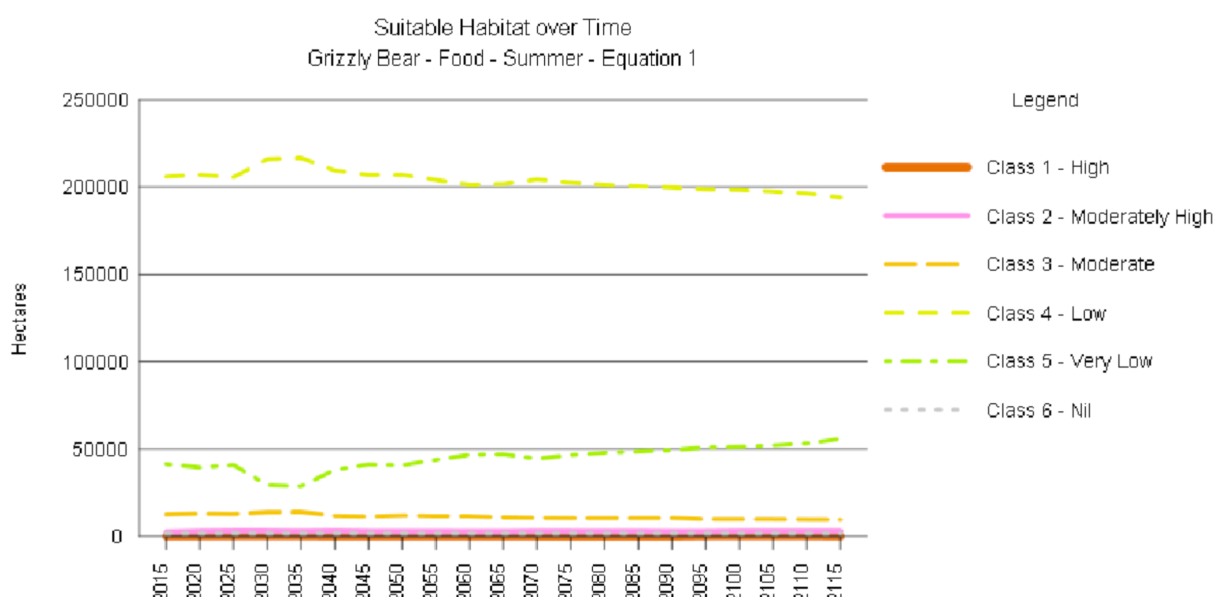


Figure 31 Matching example using the latest TSR5 (Muhly, et al. 2016): Distribution of grizzly bear habitat class (summer forage) over time (simulated timber harvest)

Figure 32 shows an example of the maps produced by the model. These maps illustrate the spatial distribution of habitat classes across the landbase at a specific year along the planning horizon (i.e., years 0, 20, 50, and 100). NHLB darker and THLB lighter shades for the different colours assigned to each habitat class. Similar maps were replicated in ArcMap to include non-FMLB areas (CONTCLAS = 'X').

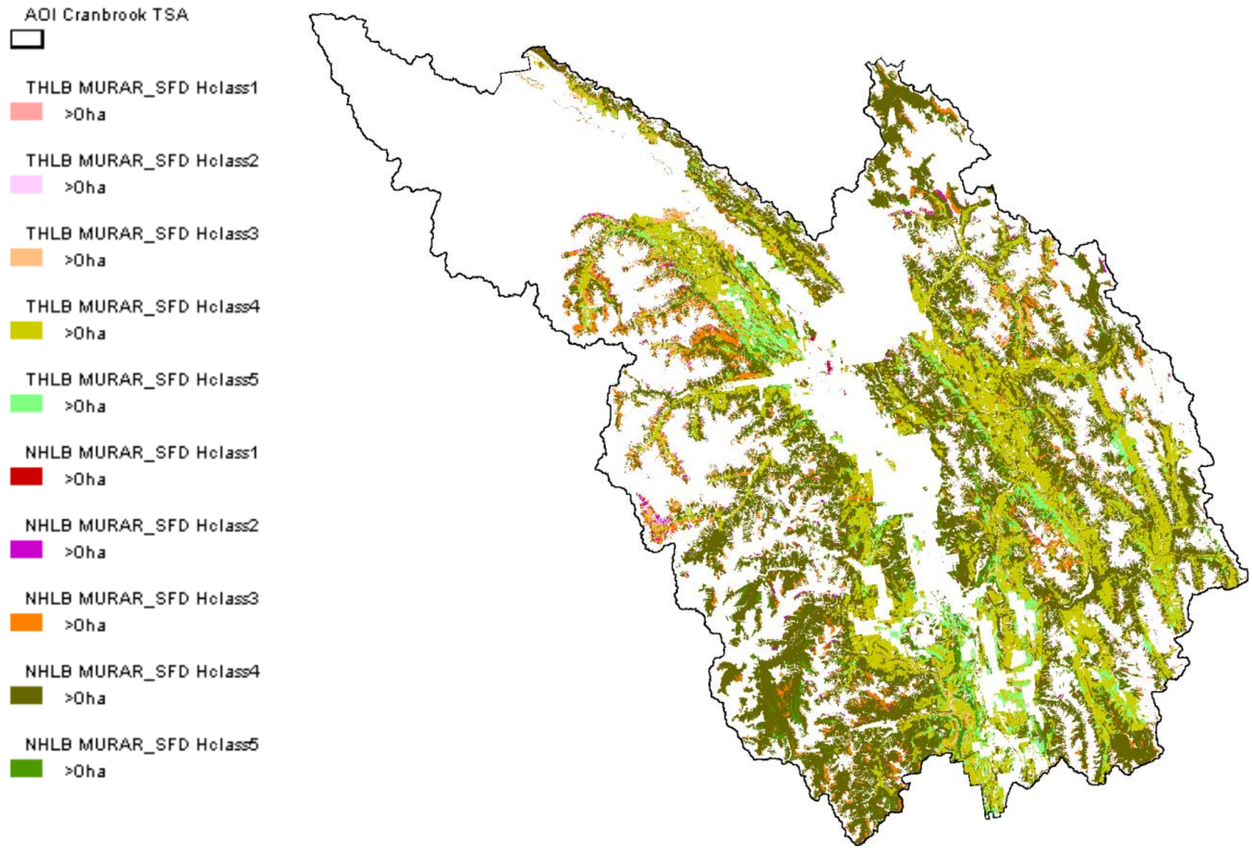


Figure 32 Spatial distribution of grizzly bear habitat classes (1 to 6) at year 0

We observed that, in some cases, the habitat classes did not appear to flow appropriately across TSA boundaries (Figure 33). This was likely resulted from different slope/aspect, Eco section, or PEM unit attributes.

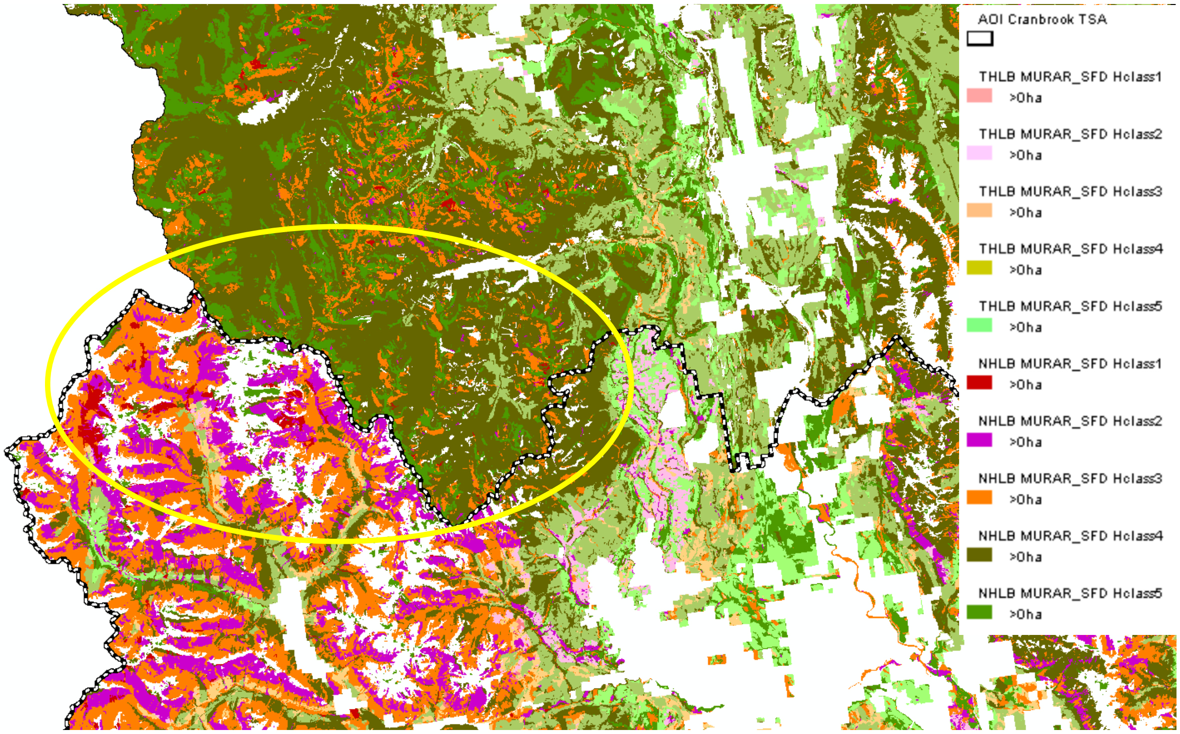


Figure 33 Example of inconsistent habitat classes assigned across TSAs (grizzly bear summer food habitat classes at year 0)

The following observations were made from the harvest flows (Figure 34) and growing stock (Figure 35) charts for the four model runs:

- [031] - Despite an increase in 'blocks' (~50% more) required to accommodate the PEM units, the harvest flow and growing stock for the Wildlife Base Case was almost identical to those developed for the ISS Base Case (Figure 5).
- [032] – Applying targets for combined habitat classes 1,2,3 (i.e., current level) resulted in only a 4% reduction in harvest rate over the entire planning horizon. Accordingly, the decreased harvest led to slight increases in growing stock (12% total and 52% merchantable).
- [033] – Applying targets for combined habitat classes 1,2,3 (i.e., current level) without imposing a desired harvest flow resulted in an even lower (23%) harvest rate over the entire planning horizon. Accordingly, the decreased harvest led to increases in growing stock (43% total and 206% merchantable).

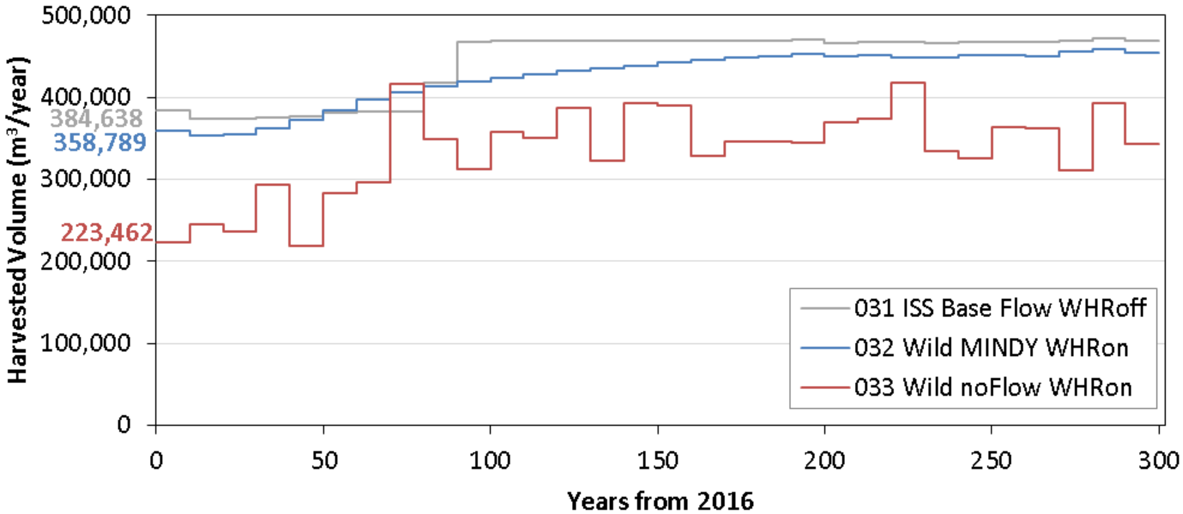


Figure 34 Harvest flows for the model runs

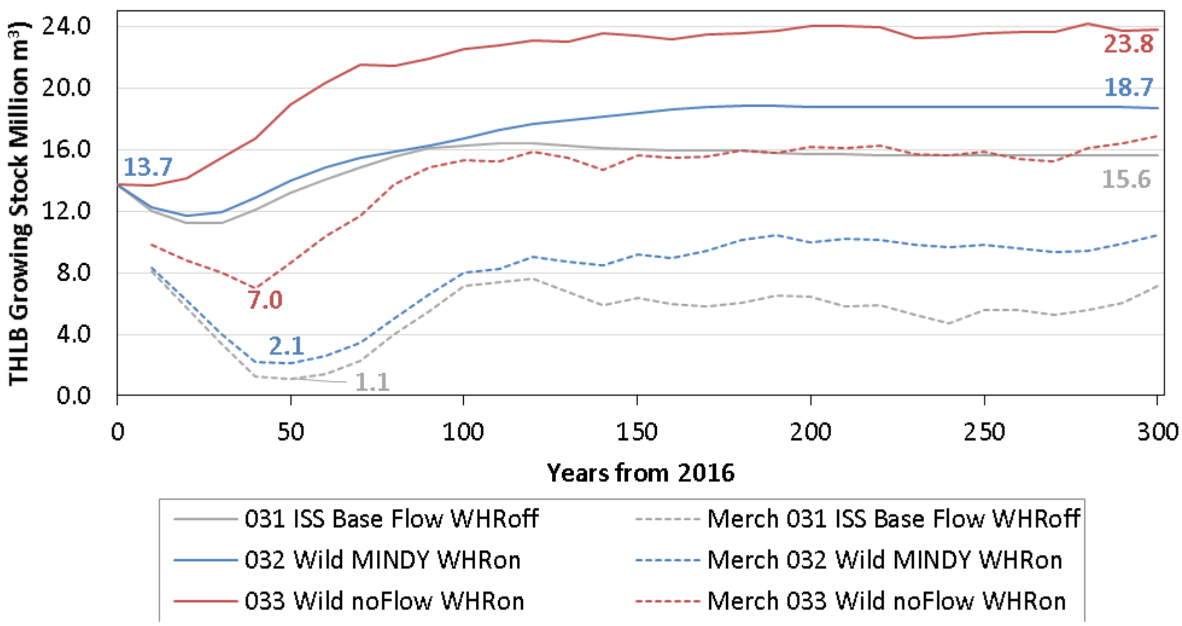


Figure 35 Growing stock on the THLB

5.2 Species At Risk Tactic – Caribou Habitat

5.2.1 Description

This tactic examines potential impacts on timber harvest from implementing the federal caribou recovery strategy for the Purcells South herd area and combines the results across both, Cranbrook and Invermere TSAs. The federal caribou recovery strategy aims to reduce the disturbance levels within High/Low Elevation Range and Matrix Range in the context of recovery plan thresholds (65% undisturbed). Anthropogenic disturbances include permanent (e.g., hydro transmission lines, camps, mines, roads etc.) and temporarily (i.e., <40 yrs old harvests and temporary roads) disturbed areas, including their associated 500 m buffer. Areas disturbed naturally (i.e., wildfire) were also considered temporary disturbances for 40 yrs following the event but no buffers were applied.

Three model runs were developed:

- [040] – No harvest throughout the entire TSA.
- [041] – Apply the harvest schedule from the ISS Base Case scenario and assess disturbance levels within the Purcells South herd area.
- [042] – Reduce the disturbance levels within the Purcells South herd area by controlling the area under 40 years (for each range – Low/High Elevation and Matrix) and grouping harvest openings within each range and for the rest of the TSA (i.e., 3 sets of harvest opening control).

5.2.2 Results

The assessment of critical Caribou habitat under the federal recovery strategy (CH 638) indicates that disturbance within the High or Low Elevation range (Figure 36) is currently below the maximum allowed of 35%. Disturbance remained fairly steady at approximately 35% over the first 20 years of the 300-year planning horizon and decreased after 50 years as the 500m buffers of the temporary roads were only accounted if they were used for hauling over the previous 40 years. In addition, most of the High or Low Elevation range overlapped with the UWR orders for Caribou (#U-4-013 and U-4-014) which had a 'No Harvest' constraint (i.e., excluded from THLB). While the area of random fires (SUCC) within the NHLB appears to have been increased after year 50, it actually reflects road buffers being accounted for prior to fires on the NHLB. Many of the NHLB fires were located within the temporary road buffers over the first 50 years of the planning horizon.

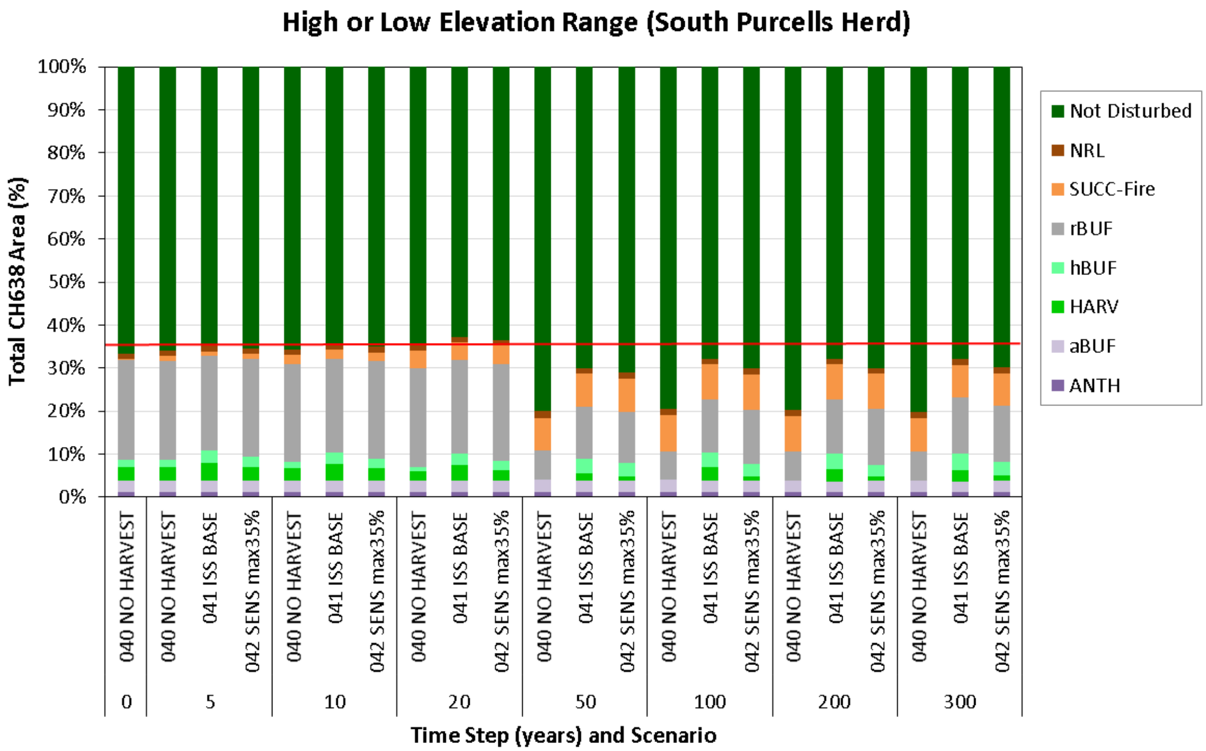


Figure 36 Disturbance categories over time within High/Low Elevation Range for the 3 scenarios

Due primarily to the extensive road network and permanent anthropogenic features, disturbance within the Matrix range (Figure 37) exceeded the maximum threshold of 35% (applied as a surrogate for low predation risk) across the entire planning horizon for all three modelling scenarios – including the [040] No Harvest run.

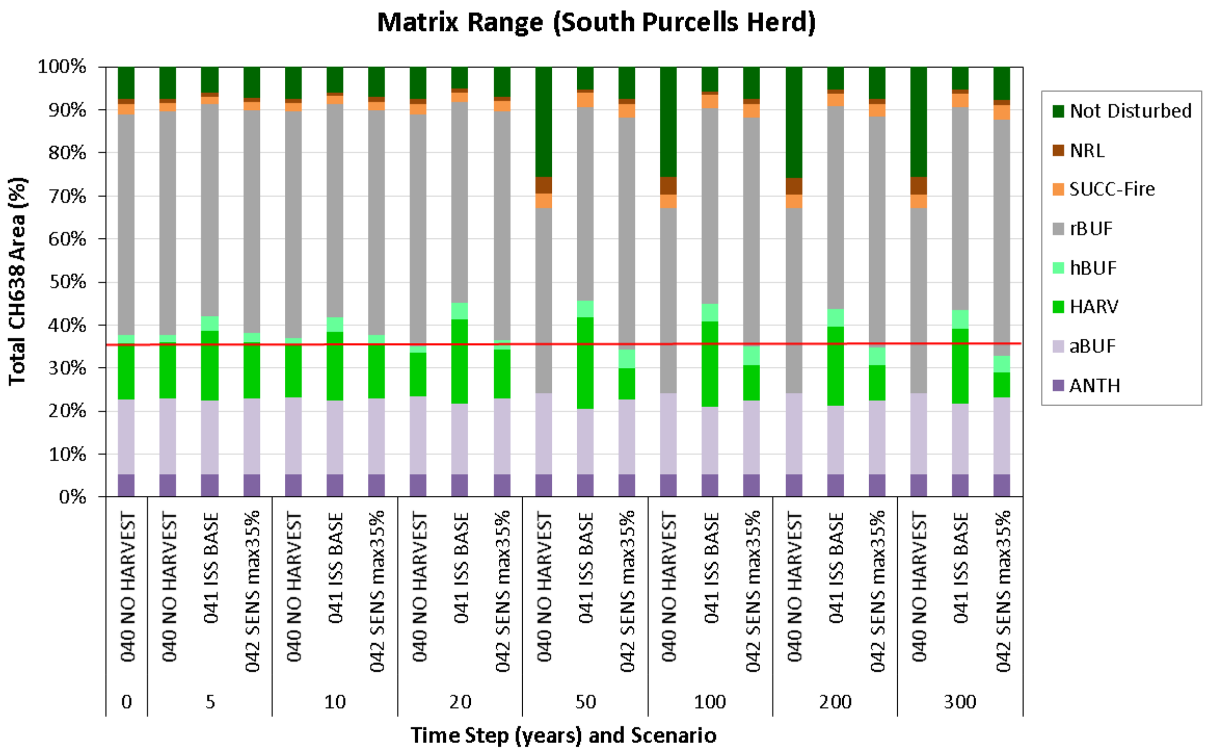


Figure 37 Disturbance categories over time within Matrix Range for the 3 model runs

Model run [042] attempted to decrease disturbance over time by applying a forest cover requirement and controlling harvest opening size distributions. Since the Base Case results already maintained the maximum threshold for disturbed habitat for High or Low Elevation Range (Figure 36), this tactic resulted in only slight improvements to maintain undisturbed habitat while it decreased the harvest rate (Figure 38) by 11.3% in the first decade, 0-12.7% over the mid-term, and 5% over the long-term.

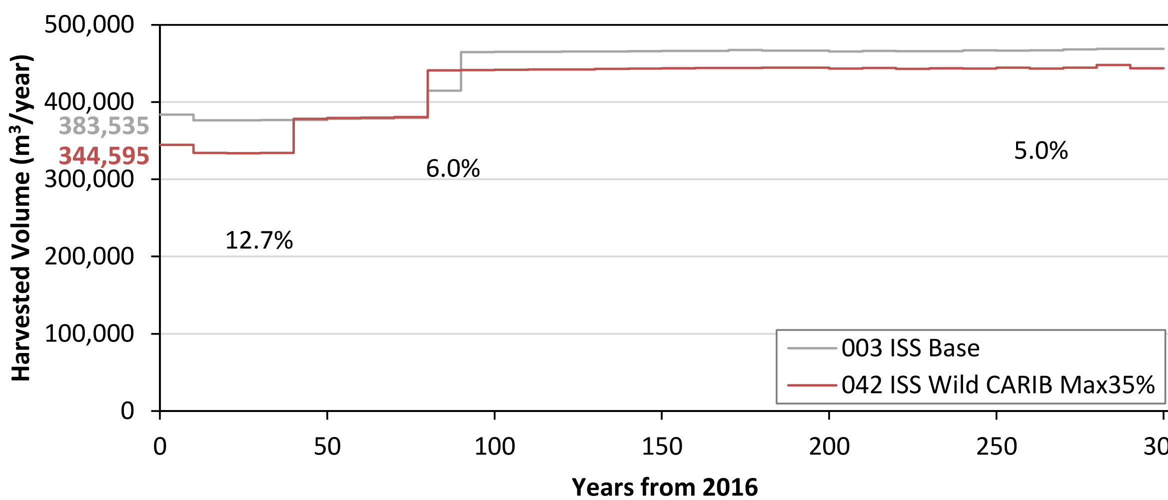


Figure 38 Harvest rate comparison for the Base Case and Caribou habitat control runs (Invermere TSA)

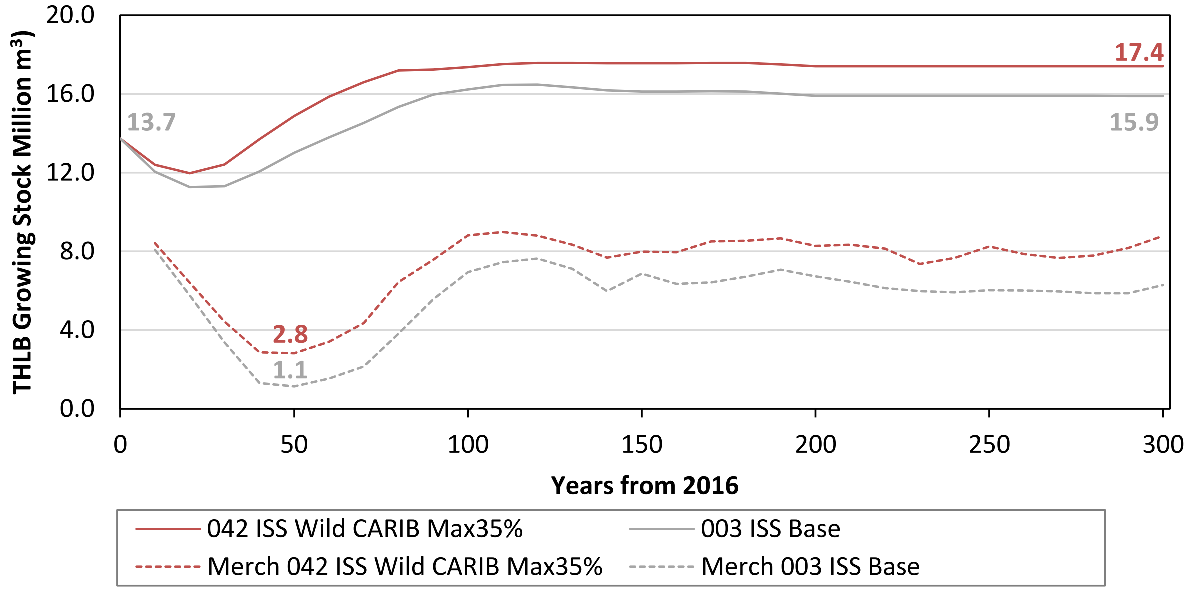


Figure 39 Growing stock comparison for the Base Case and Caribou habitat control runs (Invermere TSA)

6 Reserve Scenario

6.1 Description

The reserve scenario aimed to identify where and how we should reserve forested stands to address landscape-level biodiversity and where possible, non-timber values, while minimizing impacts to the working forest. While it considers strategies already in place (e.g., spatial OGMAs and MMAs), this scenario incorporates operational factors to identify alternative areas to maintain for non-timber values.

The Reserve Scenario focused on meeting the biodiversity targets and involved three general steps: 1) assign relative scores to each stand; 2) run two modelling stages (old then mature-plus-old) to select candidate stands that meet landscape-level thresholds; and 3) undertake a post-processing exercise to assess how the Candidate Reserves address targets for old interior forest.

We prepared and incrementally ran several models to explore the various controls designed to influence the selection of Candidate Reserves (Table 5). However, the results presented below incorporated all of these controls.

Table 5 Controls Applied in the Reserve Scenario

Sequence	Objective/Lever	Description	Weight
1	Old & Mature-Plus-Old Seral	○ minimum and maximum targets set on each LU/BECvar ○ only a subset of LU/BECvar for mature-plus-old (per KBLUP)	Hard
2	Score	○ minimum target set on combined score/ha ○ no target set on total combined score (track only)	Moderately Hard
3	THLB	○ maximum target set on THLB (entire TSA)	Moderate
4	Old Interior	○ minimum target set on areas identified as Old Interior + Edges (total area)	Moderate
5	Reserve Size Distribution	○ minimum or maximum targets set on NDT/Reserve Size class	Moderately Hard

6.2 Results

Candidate Reserves were prepared as a spatial layer to display on maps and compare against existing OGMA/MMAs (Figure 40). Statistics for old forest, mature-plus-old forest, reserve size distribution, interior old forest, and resource management areas were summarized from reports created in Patchworks™.

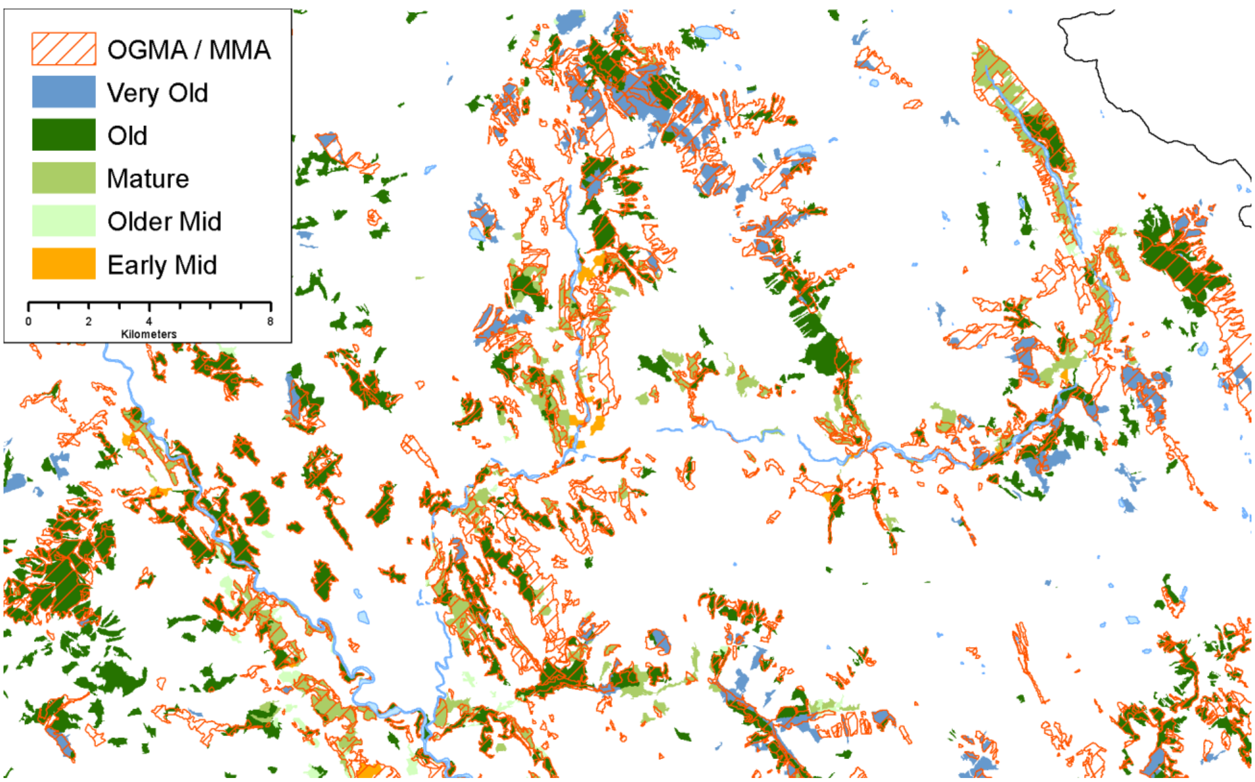


Figure 40 Example of Candidate Reserves selected by the model

The FMLB selected as Candidate Reserves totalled 109,744 ha (18.0%); 32,300 ha more area than the current OGMA/MMA. The ISS Base Case THLB selected as Candidate Reserves was 6,178 ha (3.6%). After considering the current OGMA/MMAs that do not overlap with the Candidate Reserves, are not otherwise constrained, and are now available for timber harvesting, these Candidate Reserves resulted in a net loss in THLB of 4,912 ha or 2.8%.

The average score per hectare of 46.6 for the Candidate Reserves was 80% higher than the average score (25.9) across the entire FMLB. While these figures are not absolute or field-verified, this suggests that the Candidate Reserves provide higher relative value as old and mature-plus-old forests.

An accompanying Excel file (Invermere_ISS_Resv_Resultsv4.xls) provides detailed statistics for the Candidate Reserves selected by the model, while the subsections below summarize the results.

6.2.1 Old Forest Retention

Overall, the landscape-level biodiversity objectives are currently below the minimum target levels for old seral by 10,399 ha (11%) in 54 of the 202 reporting units.

The Candidate Reserves addressed the targets for old forest retention on all but one of the reporting units (i.e., Premier Diorite, Low BEO, NDT4, IDFxk with only 23 ha of FMLB), by selecting the better old seral stands or younger stands for future recruitment as old seral forest. Note that to incorporate more operational flexibility in this analysis, we applied the full target rather than the 2/3 drawdown for old seral in LUs with low BEO. In order to meet the additional criteria described in the subsections below, a total of approximately 14,687 ha selected from 42 reporting units exceeded the minimum old forest requirement.

6.2.2 Mature-Plus-Old Forest Retention

Overall, the landscape-level biodiversity objectives are currently below the minimum target levels for mature-plus-old seral by 2,259 ha (7%) in 6 of the 24 reporting units.

The Candidate Reserves addressed the targets for mature-plus-old forest retention on all (within 0.7%) of the reporting units by selecting the better old seral stands or younger stands for future recruitment as mature-plus-old seral forest. Note that mature-plus-old targets only apply to specific LU/BEC Variant combinations; not all of them. The Candidate Reserves did not exceed the minimum mature-plus-old forest requirement for any of the reporting units.

6.2.3 Reserve Size Distribution

One of the goals of the Reserves Scenario was to develop relatively large, contiguous areas of mature and old forest to maximize the area of the interior forest habitat. In the absence of established criteria, we influenced the model to combine reserves according to reserve size distributions shown by the white regions in Figure 41, with blue and red regions respectively showing maximum and minimum targets. The bars in the chart depict the current size distribution for the Candidate Reserves. These reserve size distribution targets were adapted from Habitat Branch document – Guidance for OGMA Implementation. Note that these patch criteria were developed for reserves and differ from patches for cutblocks in the Biodiversity Guidebook.

Clearly, the Candidate Reserves do not meet all of the target reserve sizes – particularly for large classes. While further refinement of this indicator may be required, it did have considerable influence on the selection of Candidate Reserves. The reserve size distribution across the TSA appears to be fairly well balanced (Figure 42).

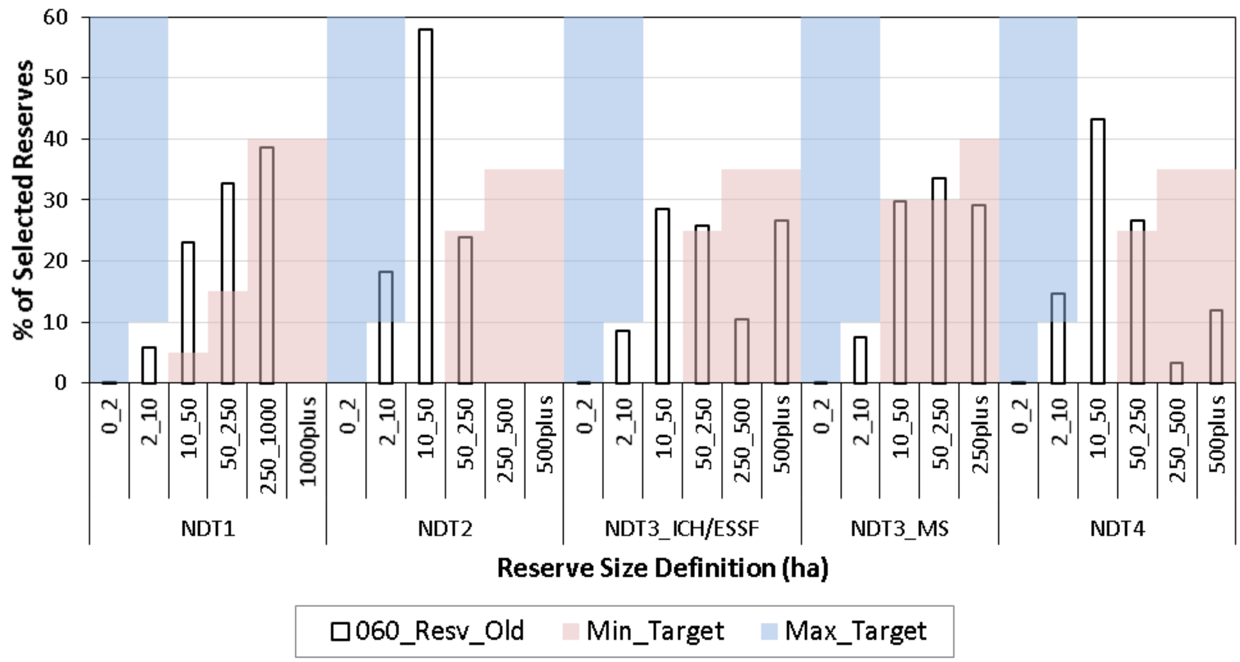


Figure 41 Reserve Size Distribution by Natural Disturbance Type

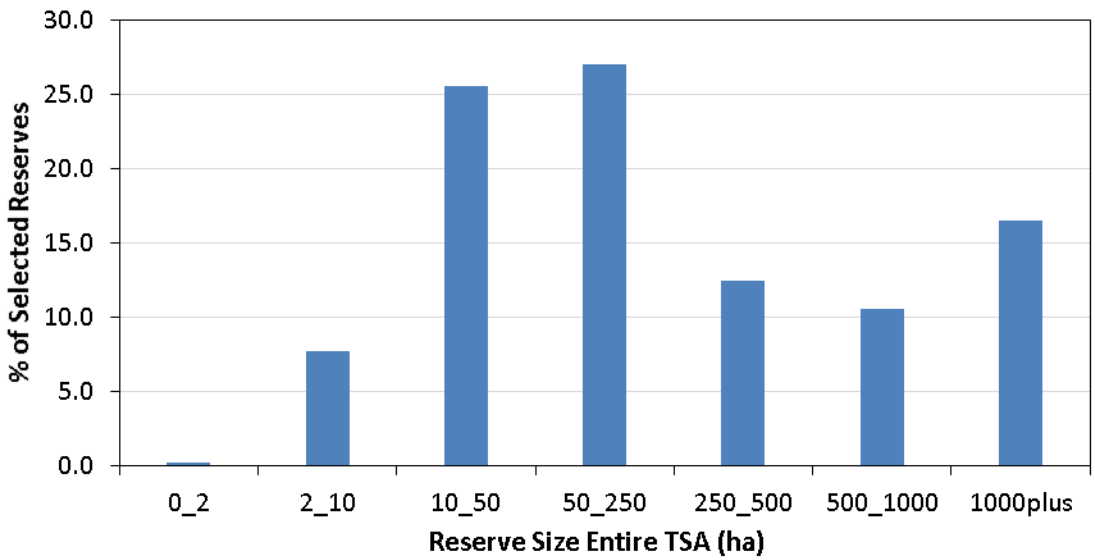


Figure 42 Reserve Size Distribution across the Invermere TSA

6.2.4 Interior Old Forest

Specific criteria for interior old forest were not established for the Invermere TSA. For this analysis, interior old forest was identified as the area of 'old seral' forest or natural forest area that is uninfluenced by the microclimate of biotic edge effects (i.e., 100m buffer from adjacent stands less than 60 years or any permanent anthropogenic disturbance). We implemented controls to influence the selection of stands identified as interior old forest along with a minimum size criteria of 20 ha.

Candidate Reserves selected by the model included a total of 71,963 ha (41.0%) identified as interior old forest.

6.2.5 Resource Management Areas as Candidate Reserves

Together with stand feature scoring, we incorporated resource management areas into the overall stand-level scoring used to influence the selection of Candidate Reserves. Resource management areas include areas that restrict harvesting completely (i.e., anchors) or partially (i.e., constraints). Table 6 provides a breakdown of resource management areas selected as Candidate Reserves. Note that this is not a netdown table, as overlaps may exist between various factors.

Table 6 Summary of Resource Management Areas as Candidate Reserves

Resource Management Area	Area (ha)	% of Candidate Reserve*
PARKS	26,471	24%
FSC_HCVF	17,053	16%
FSC_RARE	1,179	1%
WHAa	123	0%
WHAp	653	1%
RIPARIAN	8,917	8%
WTRA	677	1%
CORRIDORS	50,547	46%
UWR_CARIBOU	9,307	8%
UWR_MULEDEER	17,268	16%
CWS	3,511	3%
DWS	7,820	7%
VQO_R	688	1%
VQO_PR	6,869	6%
VQO_M	2,352	2%
WUI	0	0%
FUEL_BREAKS	0	0%
INOP_PHYS	90,761	83%
ISOLATED	38	0%
INOP_ECON	37,107	34%
NON_MERCH	12,248	11%
THLB	6,178	6%

** Candidate Reserves Total 109,744 ha*

6.2.6 Comparing Candidate Reserves with Current OGMA/MMAs

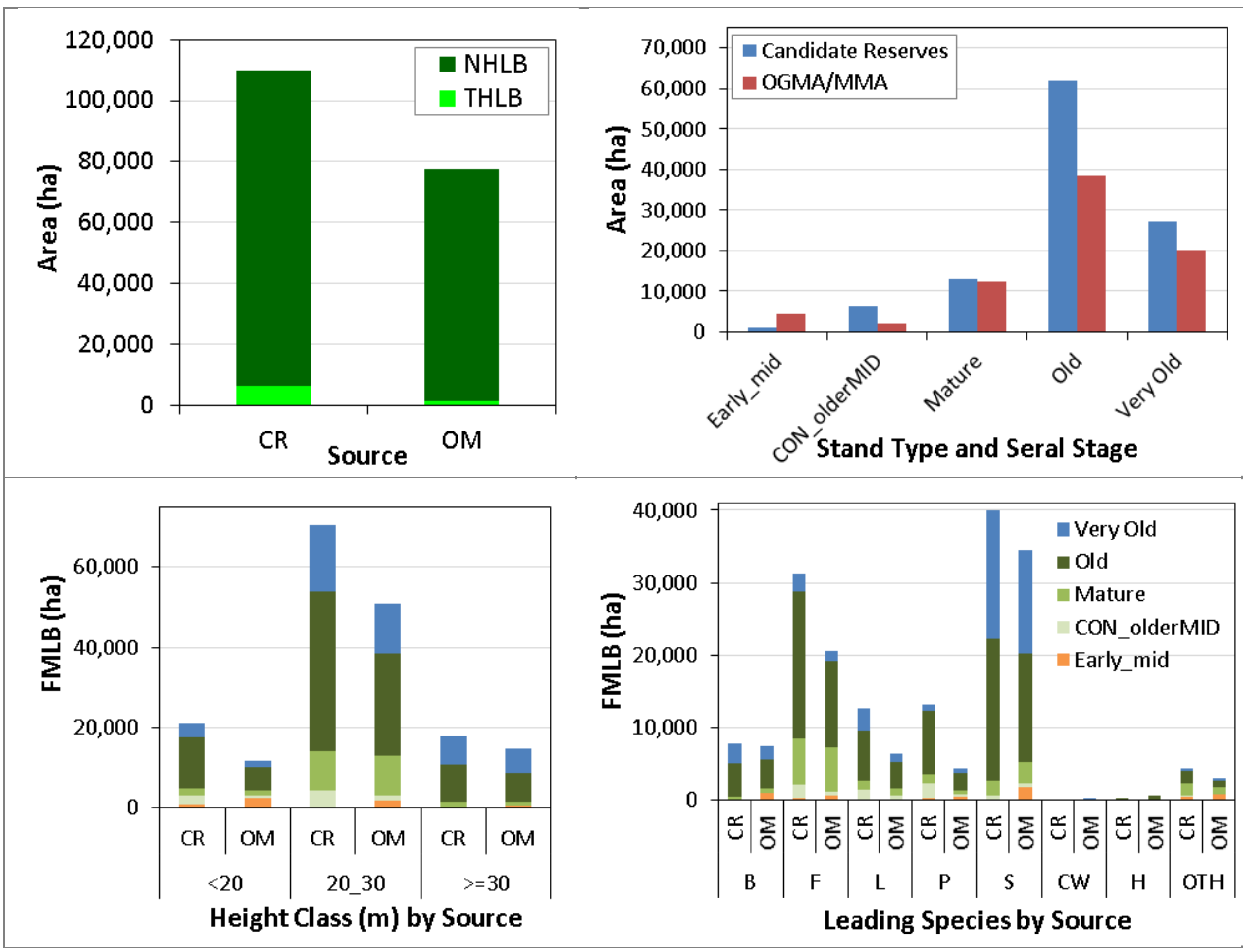
The non-legal, spatial OGMA/MMAs currently managed within the Invermere TSA were developed through a similar, systematic process involving forest licenses and government. Initially completed in 2003, then further refined in 2004, this process implemented detailed local planning and inventory work, and applied a cursory examination of the script-driven OGMA/MMAs to refine selections within a limited scope. In contrast, this Reserve Scenario applied a modelled approach of several objectives with a priority on achieving landscape-level biodiversity thresholds. It is not surprising, then, that these disparate approaches produced significantly different results. This section provides a brief comparison of the non-legal, spatial OGMA/MMAs and the Candidate Reserves selected through this Reserve Scenario.

As mentioned above, with an example shown in Figure 40, Candidate Reserves selected through this analysis identified 32,300 ha more area than the existing OGMA/MMAs, including an overlap of 62.6%.

Applying the full target rather than the 2/3 drawdown for old seral in LUs with low BEO likely contributed to this difference in area selected.

Figure 43 shows results for several indicators that describe the overall quality of reserves selected from both approaches. Compared to the OGMA/MMAs (OM), Candidate Reserves (CR) exhibited the following trends:

- 16% increase in the average score per hectare
- significantly more area with old seral forest and less area with early-mid seral forest (Stand Type)
- more area with taller stands plus more area with shorter stands (Height Class)
- more area with Douglas-fir, larch, pine, and spruce (Leading Species)
- more area within the ESSF and MS (BEC Zone)
- more area with stands in lower productivity classes (Site Index Class)



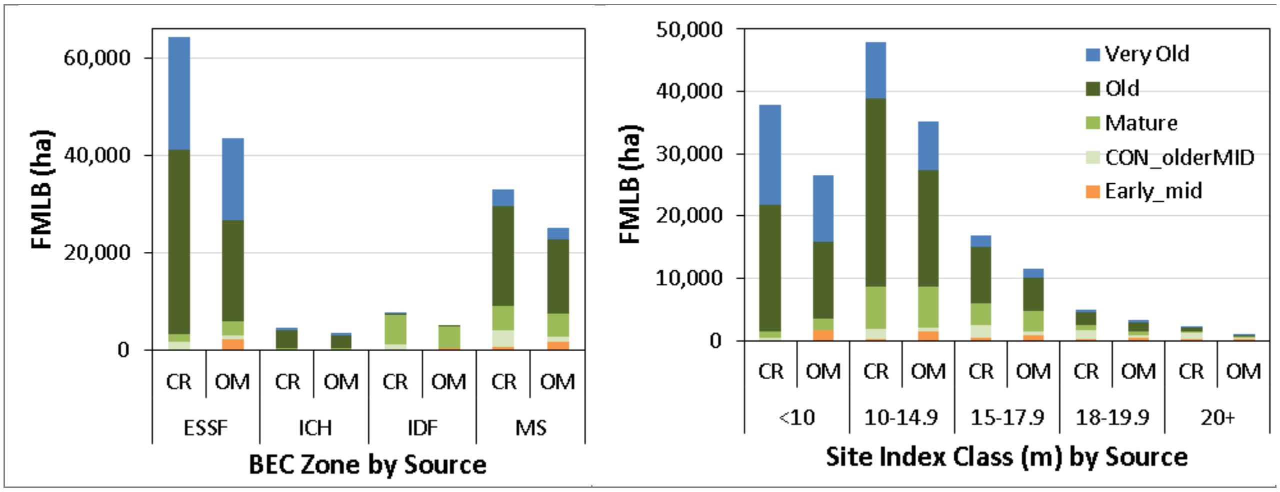


Figure 43 Indicators Comparing Candidate Reserves (CR) and current OGMA/MMAs (OM)

7 Combined Scenario

7.1 Description

The Combined Scenario aimed to guide development, implementation, and monitoring of tactical plans over the first 20 years of the planning horizon. Key tactics from the three scenarios (ISS Base Case, Silviculture, and Reserve) were included to provide an integrated strategy to this first iteration of the ISS process. The project team omitted potential tactics from the Wildlife Scenario, as it was not yet complete.

Table 7 summarizes the six different model runs completed for the Combined Scenario. We then developed a seventh, Run 080 – Comb_AAC, as the most appropriate harvest forecast to describe in detail (section 7) and to use for the ISS Tactical Plan.

Table 7 Criteria Applied in the Combined Scenario Runs

Scenario	Criteria
Run 070 – CR20 MINDY	○ utilized the spatially defined candidate reserves developed through the reserve scenario (i.e., full old seral target in LUs with low BEO). ○ locked the reserves from being harvested over the first 20 years and applied aspatial seral targets afterwards (i.e., included 2/3 drawdown). ○ developed a MINDY harvest profile as described in section 3.1.2.
Run 071 – CR20 AAC	○ utilized the spatially defined candidate reserves developed through the reserve scenario (i.e., full old seral target in LUs with low BEO). ○ locked the reserves from being harvested over the first 20 years and applied aspatial seral targets afterwards (i.e., included 2/3 drawdown). ○ set the harvest level for the first period at the current AAC and developed a NDY harvest profile beyond the first period.
Run 072 – OGMA20 MINDY	○ utilized the current spatially defined OGMA/MMA areas (i.e., included 2/3 drawdown). ○ locked the reserves from being harvested over the first 20 years and applied aspatial seral targets afterwards (i.e., included 2/3 drawdown). ○ developed a MINDY harvest profile as described in section 3.1.2.

Scenario	Criteria
Run 073 – OGMA20 AAC	○ utilized the current spatially defined OGMA/MMA areas (i.e., included 2/3 drawdown). ○ locked the reserves from being harvested over the first 20 years and applied aspatial seral targets afterwards (i.e., included 2/3 drawdown). ○ set the harvest level for the first period at the current AAC and developed a NDY harvest profile beyond the first period.
Run 074 – CR300 AAC	○ utilized the spatially defined candidate reserves developed through the reserve scenario (i.e., full old seral target in LUs with low BEO). ○ locked the reserves from being harvested over the entire planning horizon and applied aspatial seral targets (i.e., included 2/3 drawdown). ○ set the harvest level for the first period at the current AAC and developed a NDY harvest profile beyond the first period.
Run 075 – OGMA300 AAC	○ utilized the current spatially defined OGMA/MMA areas (i.e., included 2/3 drawdown). ○ locked the reserves from being harvested over the entire planning horizon and applied aspatial seral targets (i.e., included 2/3 drawdown). ○ set the harvest level for the first period at the current AAC and developed a NDY harvest profile beyond the first period.
Run 080 – Comb_AAC	○ utilized the spatially defined candidate reserves developed through the reserve scenario (i.e., full old seral target in LUs with low BEO). ○ removed these reserves from the THLB. ○ set the harvest level for the first period at the current AAC and developed a NDY harvest profile beyond the first period.
Run 081 – Comb_SilviOFF	○ made silviculture treatments unavailable to the model by dropping the silviculture budget to zero dollars. ○ set the harvest level for the first period at the current AAC and developed a NDY harvest profile beyond the first period.
Run 083 – Comb_BAU	○ aimed to demonstrate timber and non-timber impacts if the tactical plan were ignored (i.e., Business As Usual). ○ made silviculture treatments unavailable to the model by dropping the silviculture budget to zero dollars. ○ adjusted the harvest profile for cable harvest system at 16.3%, to reflect performance over the last 10 years. We disregarded other harvest profiles that would not have no effect. ○ deactivated haul time and patch size distribution targets. ○ targeted higher volume stands over the first 20 years. ○ set the harvest level for the first period at the current AAC and developed a NDY harvest profile beyond the first period.

The key tactics from each of the Base Case, Silviculture and Reserve Scenarios are briefly summarized in Table 8.

Table 8 Key Tactics Applied in the Combined Scenario Runs

Scenario	Key Tactics
ISS Base Case	○ Updated spatial delineation for BECv11, OGMA/MMA, FSC HCVF, proposed WHAs, 2018 wildfires, and recent harvest depletions. ○ Included 2/3 drawdown on old seral targets for LUs with low BEO and applied mature-plus-old seral targets only to reporting units designated in the KBLUP. ○ Applied the current harvest profiles for harvest system (ground/cable/partial) and haul distance over the first 40 years, plus harvest opening size criteria to reduce the amount of small (<5 ha) openings.
Silviculture	○ Implemented ENH and FERT treatments over the first 20 years but extended CT to 60 years. ○ Limited the area treated for ENH and CT to 10% and 5%, respectively, of the treated area over each period. Also limited the budget for all treatments to $300,000 per year.
Reserve Scenario	○ Prepared one model that utilized the spatially defined candidate reserves developed through the reserve scenario and a second model that utilized the current spatially defined OGMA/MMAs (Table 7).

7.2 Land Base Definition

The land base definition for the Combined Scenario (Table 9) shows the Forest Management land Base (FMLB) is 603,828 ha; ~14,927 ha (6.2%) more than the ISS Base Case Scenario. The current effective Timber Harvesting Land Base (THLB) of 173,350 ha is ~308 ha (0.2%) greater than the ISS Base Case Scenario, while the long-term effective THLB is 167,741 ha; ~374 ha (or 0.2%) more than the ISS Base Case Scenario.

Table 9 Land Base Definition for the Combined Scenario – Invermere TSA

Factor		Total Area (ha)	Effective Area (ha)	% of Total Area	% of FMLB
Total Area		**1,315,601**	**1,315,601**	**100.0%**	
Less	TFL 14	150,877	150,877	11.5%	
	Private	83,697	83,697	6.4%	
	Christmas Trees Permit	6,412	6,412	0.5%	
	Indian Reserves	8,730	8,730	0.7%	
	National Parks	41,245	41,245	3.1%	
	Woodlots	9,686	9,686	0.7%	
	Misc leases	765	765	0.1%	
	Special Permit	65	61	0.0%	
	Mines	472	377	0.0%	
	Not typed	9,336	9,188	0.7%	
	Non-vegetated	359,163	329,117	25.0%	
	Non-treed	131,339	65,635	5.0%	
	Factored Roads		5,982	0.5%	
Total Forest Management land Base (FMLB)		***(in FMLB)***	**603,828**	**45.9%**	**100.0%**
Less:	Parks	79,283	79,283	6.0%	13.1%
	Inoperable	309,603	235,728	17.9%	39.0%
	Steep Slopes (>70%)	58,755	5,509	0.4%	0.9%
	Terrain Class V in CWS	4,227	552	0.0%	0.1%
	ESA	69,679	5,682	0.4%	0.9%
	Non Merchantable	50,160	5,281	0.4%	0.9%
	Low Sites	156,963	2,212	0.2%	0.4%
	Misc Reserves	97	44	0.0%	0.0%
	Crown UREP	815	668	0.1%	0.1%
	UWR Caribou	26,450	1,049	0.1%	0.2%
	Wildlife Management Area	5,817	2,290	0.2%	0.4%
	WHA	179	84	0.0%	0.0%
	WHA Proposed	2,275	1,896	0.1%	0.3%
	Scenic Preservation	213	0	0.0%	0.0%
	FSC Endangered Forests	36,248	1,460	0.1%	0.2%
	FSC Rare and Uncommon Ecosystems	3,318	1,847	0.1%	0.3%
	Existing WTRAs	5,604	3,578	0.3%	0.6%
	100% InBlock Retention	918	918	0.1%	0.2%
Gross Timber Harvesting Land Base (THLB)			**255,744**	**19.4%**	**42.4%**
Less Partial Removals	Slopes 40-70% (50%)	234,875	39,090	3.0%	6.5%
	Terrain Class V outside CWS (95%)	39,641	1,538	0.1%	0.3%
	Terrain Class IV outside CWS (5%)	103,427	1,215	0.1%	0.2%
	Terrain Class IV in CWS (95%)	5,005	200	0.0%	0.0%
	PFT Pine >80yrs (29%)	34,181	1,149	0.1%	0.2%
	PFT Pine 61-80yrs (18%)	11,150	445	0.0%	0.1%
	PFT Pine 41-60yrs (35%)	900	91	0.0%	0.0%
	PFT Pine <40yrs (80%)	7,179	301	0.0%	0.0%
	Isolated	169	169	0.0%	0.0%
	In-Block Retention*		21,634	1.6%	3.6%
	Candidate Reserves		16,562		
Current Effective THLB			**173,350**	**13.2%**	**28.7%**
Less Future Reductions	Open Range Conversion	1,808	1,316	0.1%	0.2%
	Future Roads (3.8%)		4,293	0.3%	0.7%
Long-term Effective THLB			**167,741**	**12.8%**	**27.8%**

** In-Block Retentions include FSC Rare Ecosystems, (50%), WTRA (6% for existing natural stands and 3.5% for existing managed stands), and Riparian (% determined spatially for each polygon).*

7.3 Results

For the Combined Scenario we developed Run 080 – Comb_AAC as the most appropriate harvest forecast to describe in detail and to develop the ISS Tactical Plan for the Invermere TSA. It is hereafter referred to as the 'Combined Scenario'. The following points outline our rationale for this selection:

- While the Candidate Reserves require further review, they reflect a systematic process that identifies the most appropriate areas that meet the landscape-level biodiversity objectives.
- The Candidate Reserves reflect full old seral targets, while the current OGMA/MMAs incorporated a 2/3 drawdown of old seral targets in LUs with low BEO (~half of the TSAs). While this approach is more conservative, it helps to ensure that biodiversity objectives can be maintained over the planning horizon.
- Locking Candidate Reserves from being harvest in the model demonstrates that similar areas can be maintained over the entire planning horizon. In reality, these reserves may be adjusted provided the same or better quality OGMA/MMAs are maintained.
- This model run results in retaining more merchantable volume on the landbase as a greater cushion for addressing catastrophic events (e.g., wildfire, forest health).
- The harvest flows are quite similar to those that include the current OGMA/MMAs rather than the Candidate Reserves. Other than the potential loss of field-confirmed OGMA/MMAs, there does not appear to be any significant advantage to maintaining the existing OGMA/MMAs.

7.3.1 Non-Timber Values

7.3.1.1 Seral Stage

The seral stage distribution (Figure 44) shows that after transitioning from harvesting natural to managed stands over the first century, seral stage distributions are stable over the rest of the planning period. Approximately half of the NHLB is in old seral stage and the rest is well distributed in early, mid, and mature seral stages.

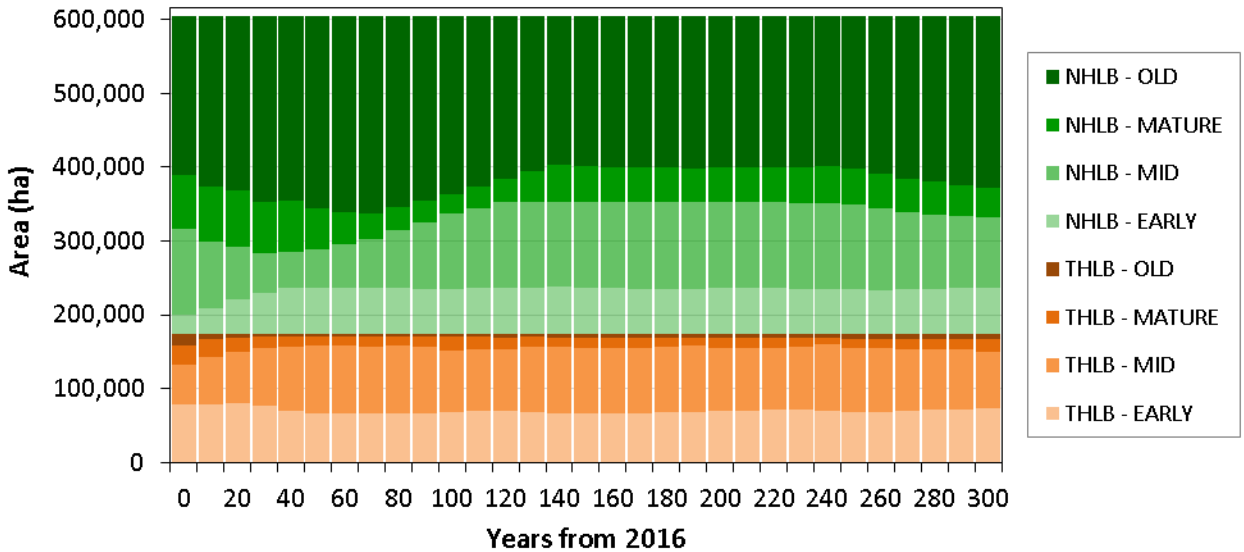


Figure 44 Combined Scenario – Seral Stages by Landbase Type

Summarizing old seral target status across all reporting units (Figure 45) shows a couple of interesting trends. Most importantly, incorporating the candidate reserves and implementing old seral targets in the model reduced the area (left axis) and most of the units (right axis) under the minimum target to nearly zero over the first century. Secondly, the amount of old seral area ranges between 111% and 244% more than the minimum target levels across the planning period.

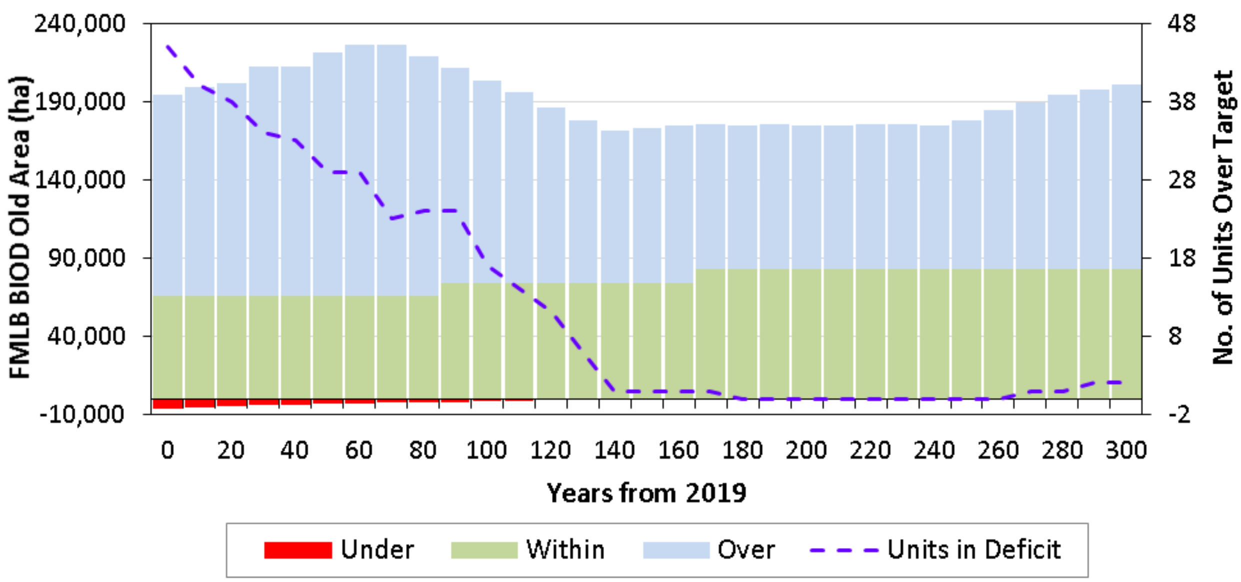


Figure 45 Combined Scenario – Old Seral Target Status Across All Reporting Units

Mature-plus-old seral target status across all reporting units (Figure 46) shows similar trends as the old seral. Incorporating the candidate reserves and implementing mature-plus-old seral targets on appropriate LU/BEC variant units reduced the area (left axis) and most of the units (right axis) under the minimum target to nearly zero over the first decade. In addition, the amount of mature-plus-old seral area ranges between 21% and 66% more than the minimum target levels across the planning period.

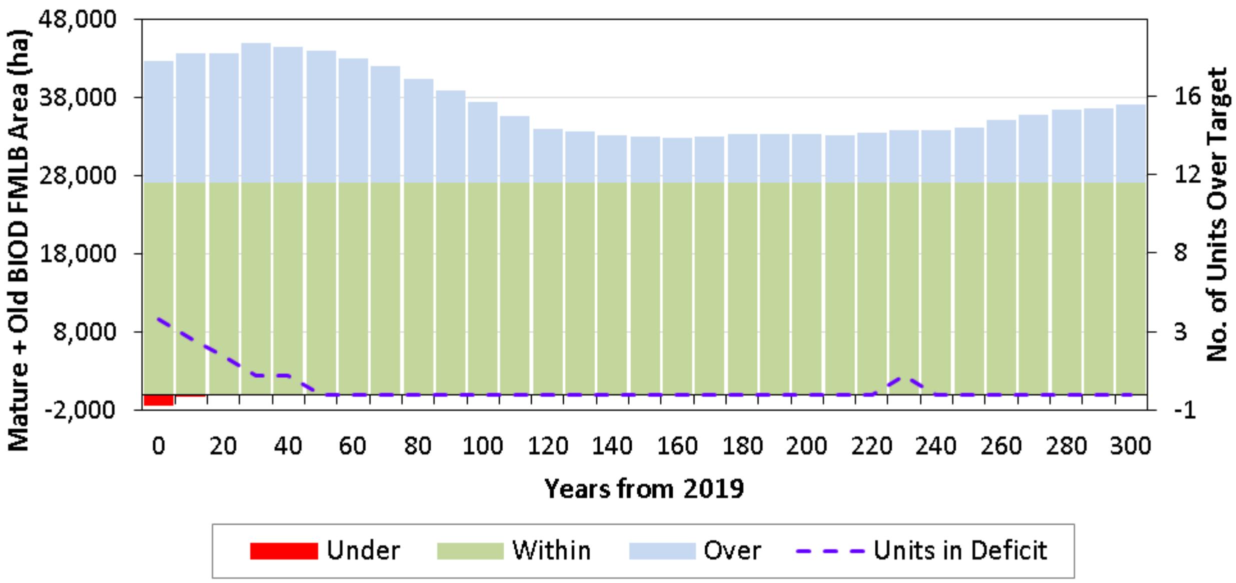


Figure 46 Combined Scenario – Mature-Plus-Old Seral Target Status Across All Reporting Units

Examples for some units are shown in Figure 47, where the black line represents the percentage of THLB area of old and mature-plus-old seral forest within the reporting unit in each period. The model aimed to remain above the red-shaded zone (i.e., minimum target level). Note that targets for old seral within LUs designated with low BEO included draw-downs over established periods (top right).

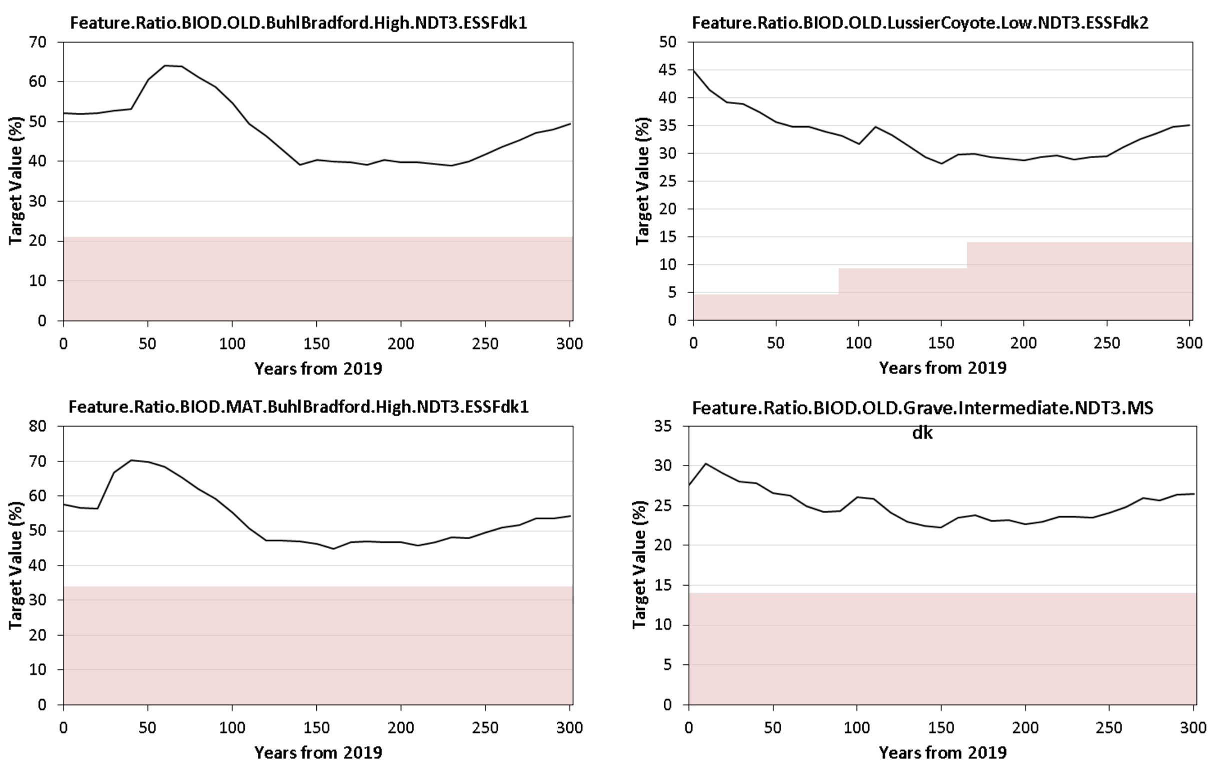


Figure 47 Combined Scenario – Old and Mature-Plus-Old Seral Objectives (examples)

7.3.1.2 Interior Old Forest

Criteria for interior old forest were not directly applied in the model but post-processed spatial summaries were prepared at four periods (i.e., years 0, 20, 100, and 300) (Figure 48). This aimed to support the process developed for the Reserve Scenario (section 6.2.4), without implementing targets. Interior old forest varies on the THLB from harvesting and on the NHLB from natural disturbance events scheduled in the model. The total amount of interior old forest fluctuated between ~114,000 and ~186,000 ha, with 1.8% to 4.5% within the THLB, and remained well distributed within each of the size classes.

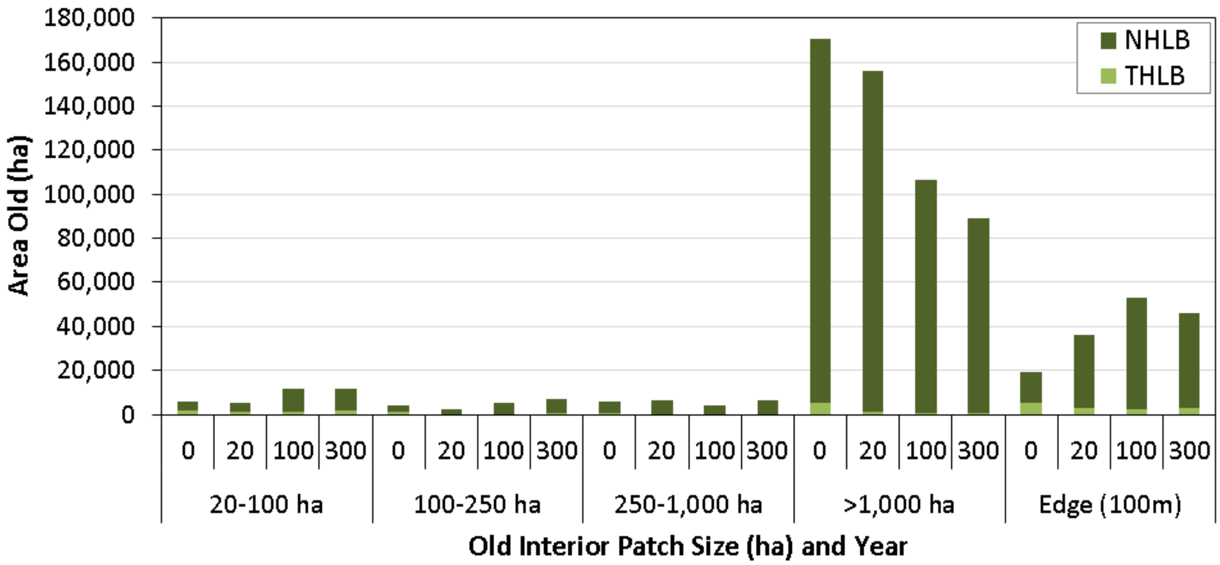


Figure 48 Combined Scenario –Interior Old Forest Size Classes at Years 0, 20, 100, and 300

7.3.1.3 Patch Size Distribution (Very Early Seral)

The patch size distribution summarized for very early seral and all reporting units (Figure 49) shows the average and range for each patch size category relative to the targets, while comparing results from the ISS Base Case (003 – targets not applied) with results from the Combined Scenario (074 – targets applied). Results for the Combined Scenario trend much closer towards the target distributions (white space between blue/maximum and red/minimum targets). Patch size requirements certainly influenced the harvest schedule and had a significant impact on the harvest flow.

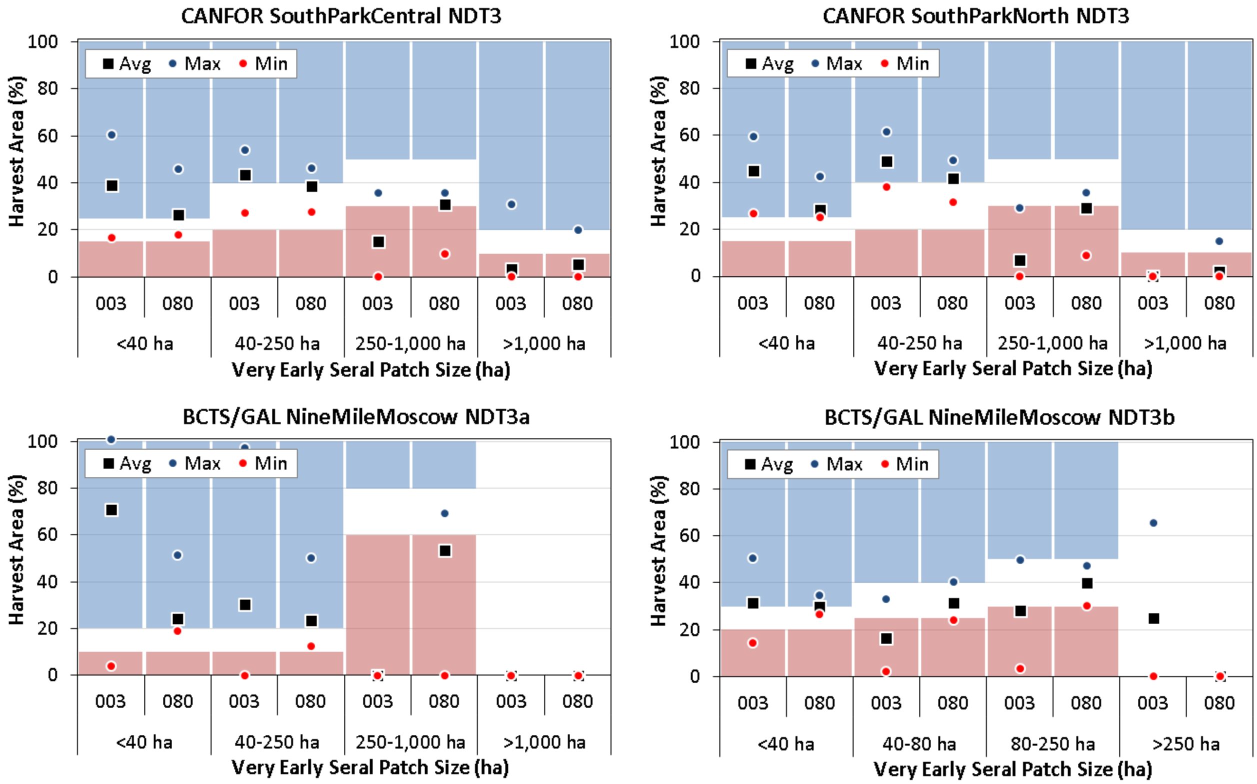


Figure 49 Combined Scenario – Very Early Seral Patch Objectives (examples)

7.3.1.4 Green-up

Maximum target levels for green-up were not constraining in the Combined Scenario. Cumulative results across all reporting units (Figure 50) show that implementing green-up requirements reduced the area (left axis) and the number of units (right axis) over the maximum target to zero after the first decade. Examples for some units are shown in Figure 51 (largest reporting units in each combination category), where the black line represents the percentage of THLB area disturbed within the reporting unit in each period. The model aimed to remain below the blue-shaded zone (i.e., maximum target level).

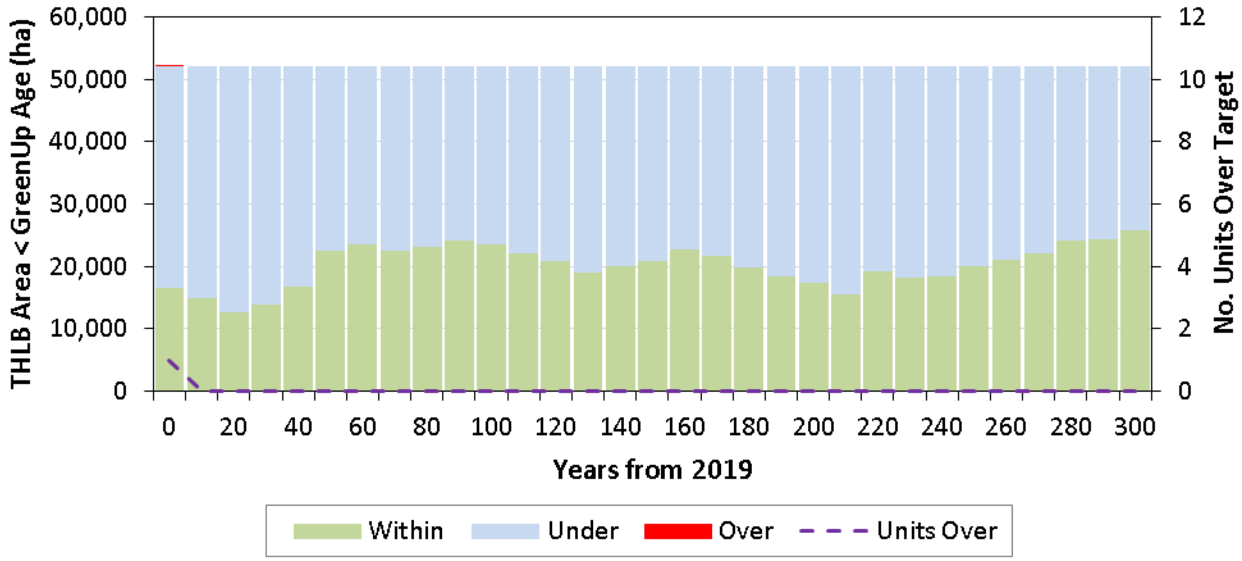


Figure 50 Combined Scenario – Cumulative Target Status for Green-Up

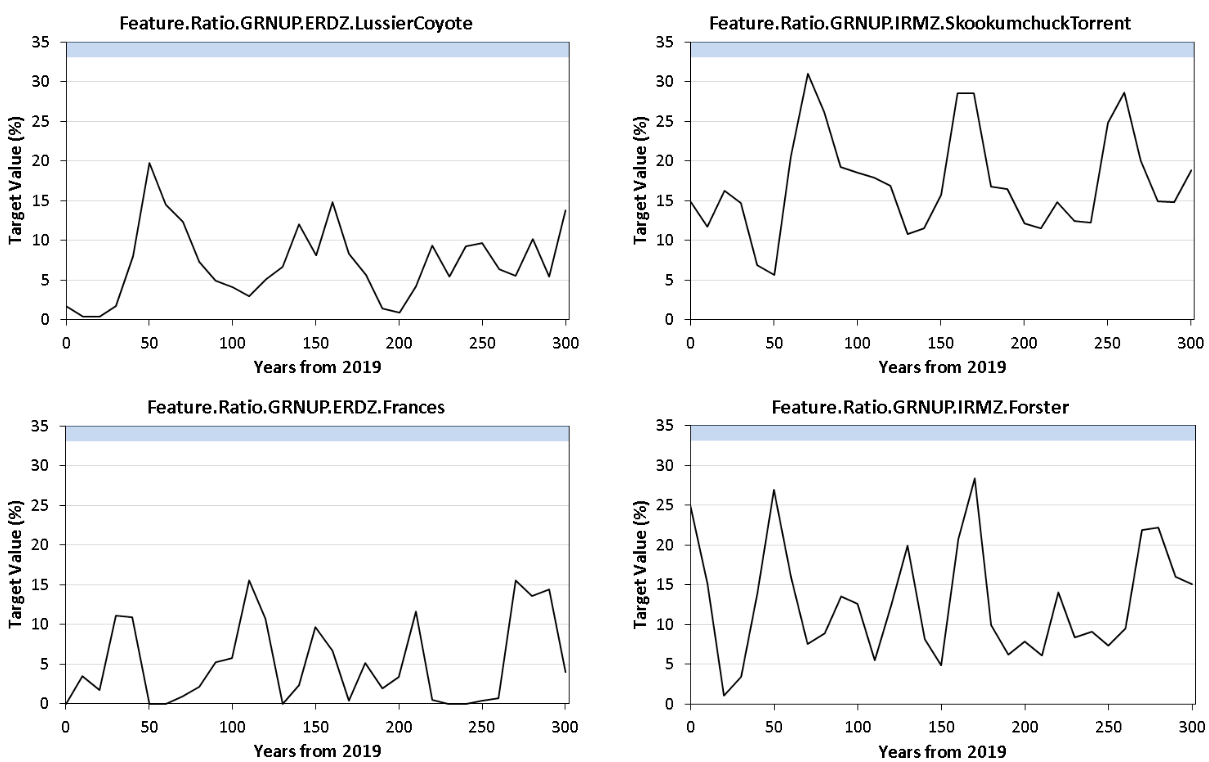


Figure 51 Combined Scenario – Green-Up Targets (examples)

7.3.1.5 Ungulate Winter Range

Minimum target levels for snow interception and mature forest cover requirements within UWRs were moderately constraining in the Combined Scenario. Cumulative results across all reporting units (Figure 52) show that implementing the forest cover requirements reduced the FMLB area (left axis) and the number of units (right axis) under the minimum target after the first 2 decades (i.e., 41 ha to5 ha under). Given the small size of some reporting units, minor amounts of area were occasionally violated throughout the 300 year planning period. Examples for some units are shown in Figure 53 (largest reporting units in each combination category), where the black line represents the percentage of FMLB area that meet the forest cover requirements within the reporting unit in each period. The model aimed to remain above the red-shaded zone (i.e., minimum target level).

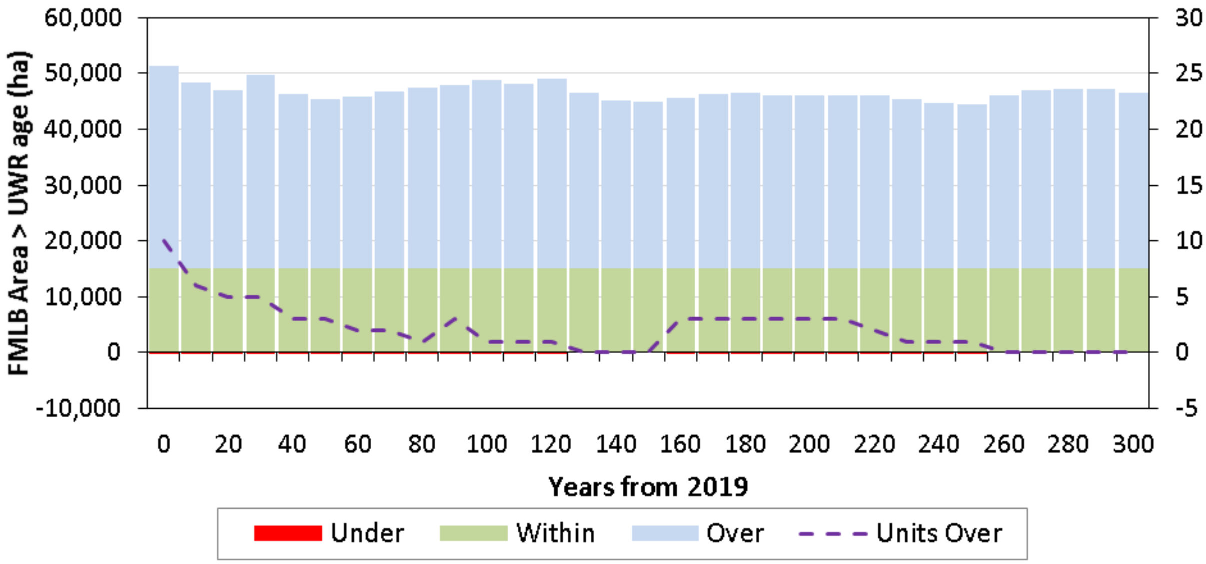


Figure 52 Combined Scenario – Cumulative Target Status for UWR (Cover Requirements)

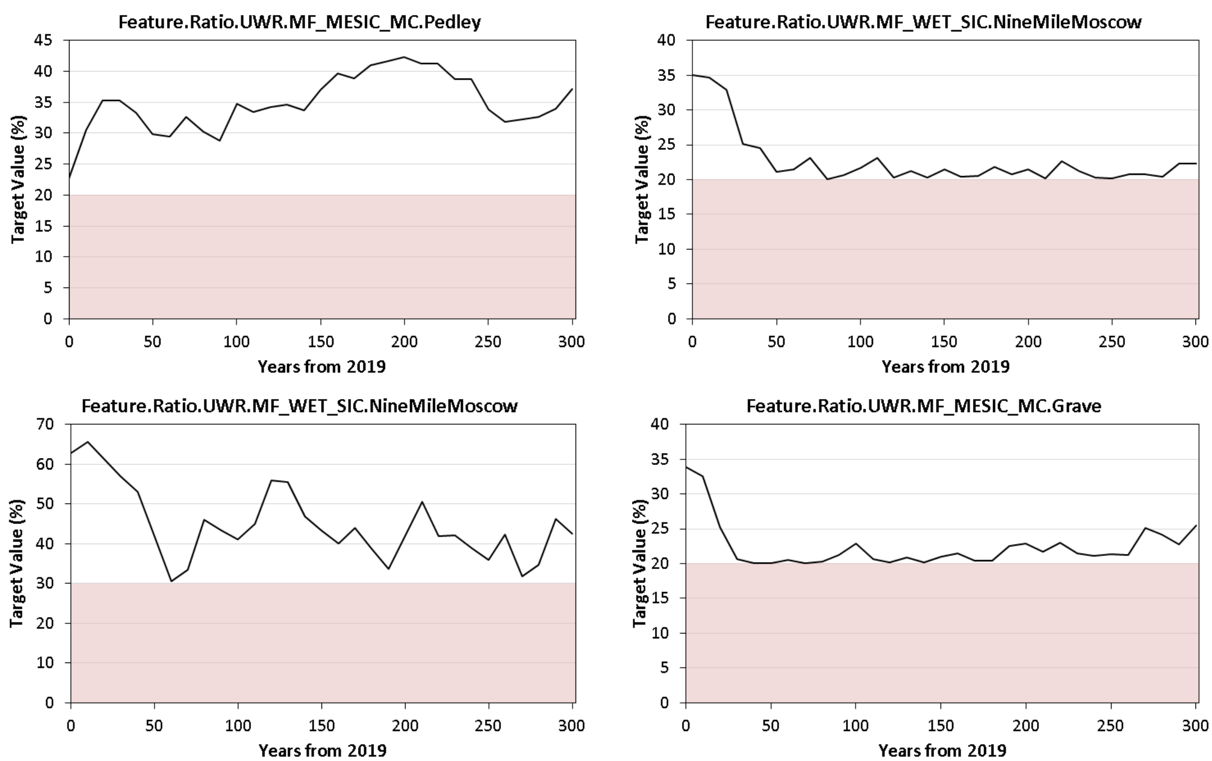


Figure 53 Combined Scenario – UWR Snow Interception and Mature Cover Requirements (examples)

Maximum target levels for very early seral cover requirements within UWRs were not constraining in the Combined Scenario. Cumulative results across all reporting units (Figure 54) show that implementing the forest cover requirements significantly reduced the FMLB area (left axis) and the number of units (right axis) over the maximum target after the first 2 decades. Given the small size of some reporting units, minor amounts of area were occasionally violated throughout the 300 year planning period. Examples for some units are shown in Figure 55 (largest reporting units in each combination category), where the black line represents the percentage of FMLB area that meet the very early seral cover requirements within LU/UWRs in each period. The model aimed to remain below the blue-shaded zone (i.e., maximum target level).

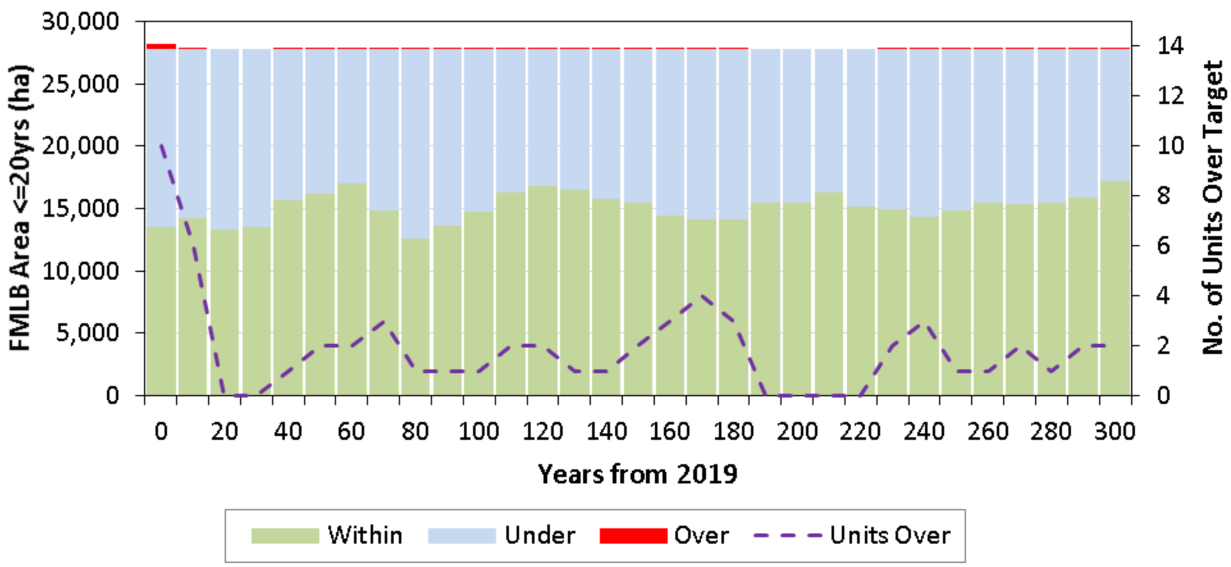


Figure 54 Combined Scenario – Cumulative Target Status for UWR (Very Early Seral)

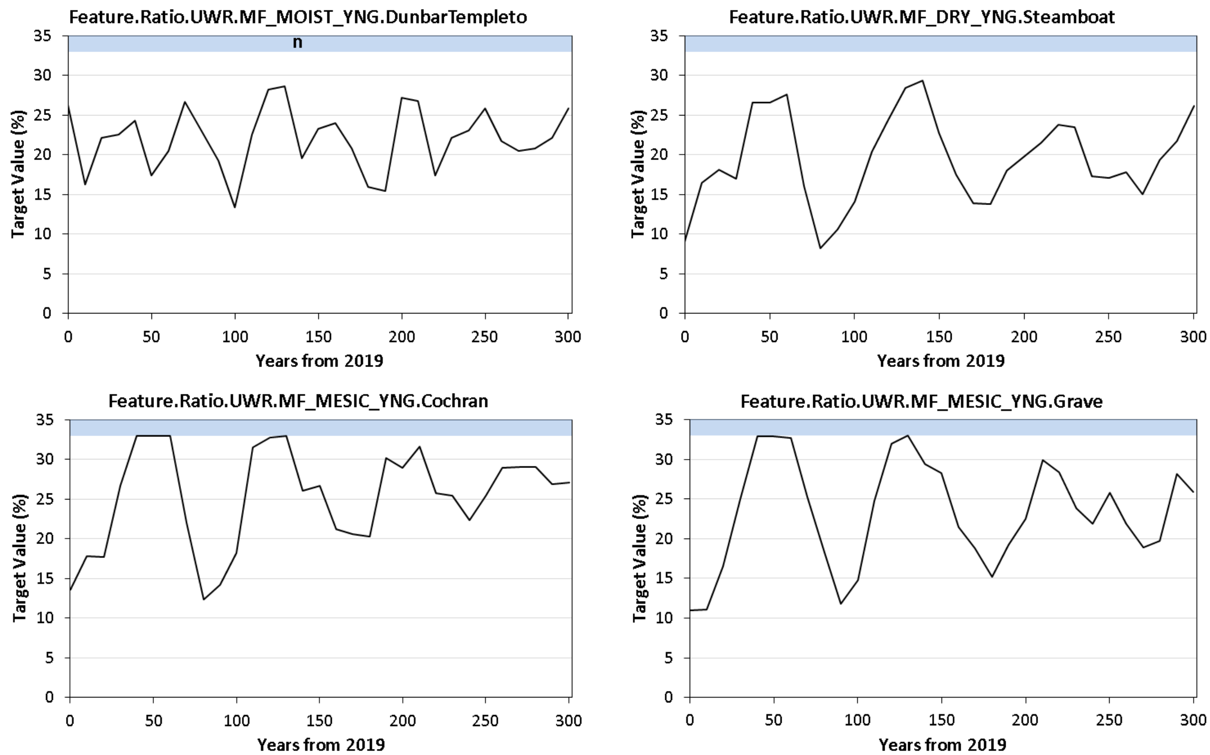


Figure 55 Combined Scenario – UWR Very Early Seral Cover Objectives (examples)

7.3.1.6 Community and Domestic Watersheds

Maximum target levels for ECA requirements were significantly constraining for some community and domestic watersheds in the Combined Scenario. Cumulative results across all reporting units (Figure 56) show that implementing the ECA requirements significantly reduced the FMLB area (left axis) over the maximum target after the first 2 decades. While the number of units (right axis) over the maximum target remained constant throughout the 300 year planning period the associated area was minor. Examples for some units are shown in Figure 57 for Community Watersheds and Figure 58 Domestic Watersheds (largest reporting units in each combination category), where the black line represents the percentage of FMLB area that meet the ECA requirements within watersheds in each period. The model aimed to remain below the blue-shaded zone (i.e., maximum target level).

Note that the THLB for some of the relatively large watersheds prevented harvesting because the prorated ECA target – after removing non-FMLB area – was zero (e.g., Brady Creek). Natural disturbance modelled within the NHLB exacerbated these constraints by reducing the FMLB area that could be disturbed.

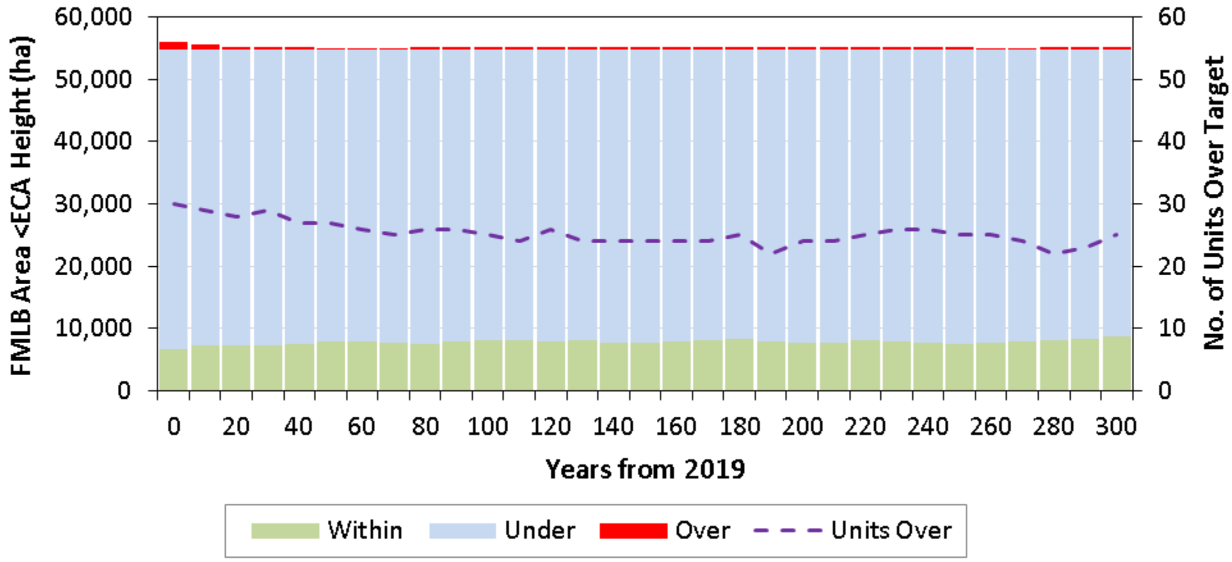


Figure 56 Combined Scenario – Cumulative Target Status for Watersheds

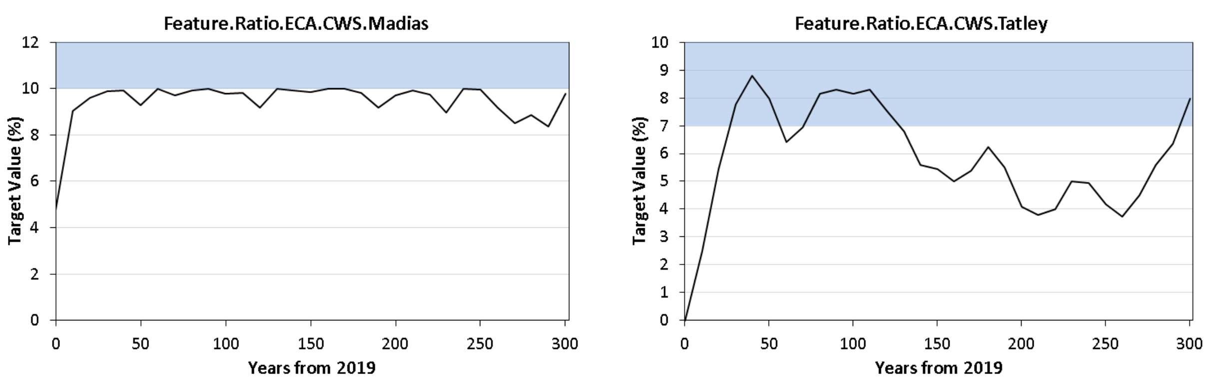


Figure 57 Combined Scenario – Community Watershed Targets (examples)

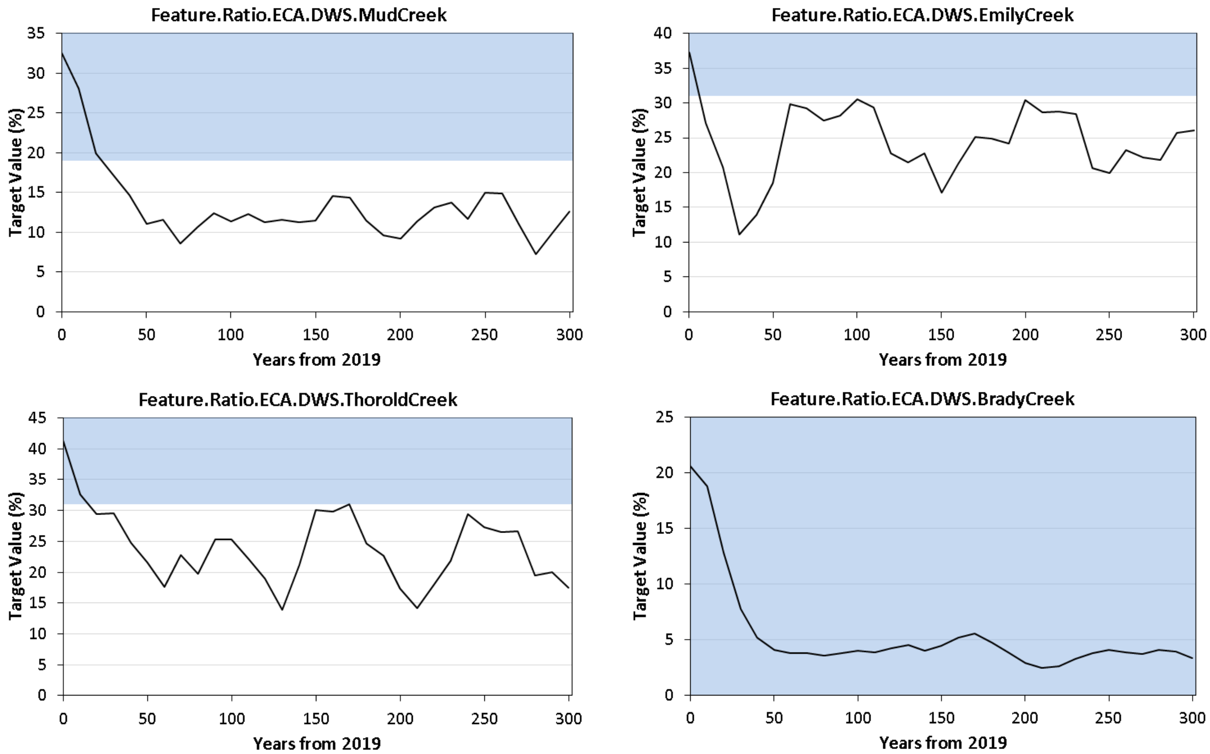


Figure 58 Combined Scenario – Domestic Watershed Targets (examples)

7.3.1.7 Visual Quality Objectives

The Combined Scenario applied a visually-effective green-up (VEG) height to each analysis unit within VLI polygons rather than applying an average VEG height for the VLI polygon. Maximum disturbance levels applied for visual were constraining for some visual polygons throughout the planning horizon. Cumulative results across all reporting units (Figure 59) show that implementing visual requirements significantly reduced the area (left axis) and the number of units (right axis) over the maximum disturbance targets after the third decade. Examples for some units are shown in Figure 60 (largest reporting units in each combination category), where the black line represents the percentage of FMLB area disturbed by period within the visual polygon. The model aimed to remain below the blue-shaded zone (i.e., maximum target level) and adjusted harvest patterns to avoid violating these targets.

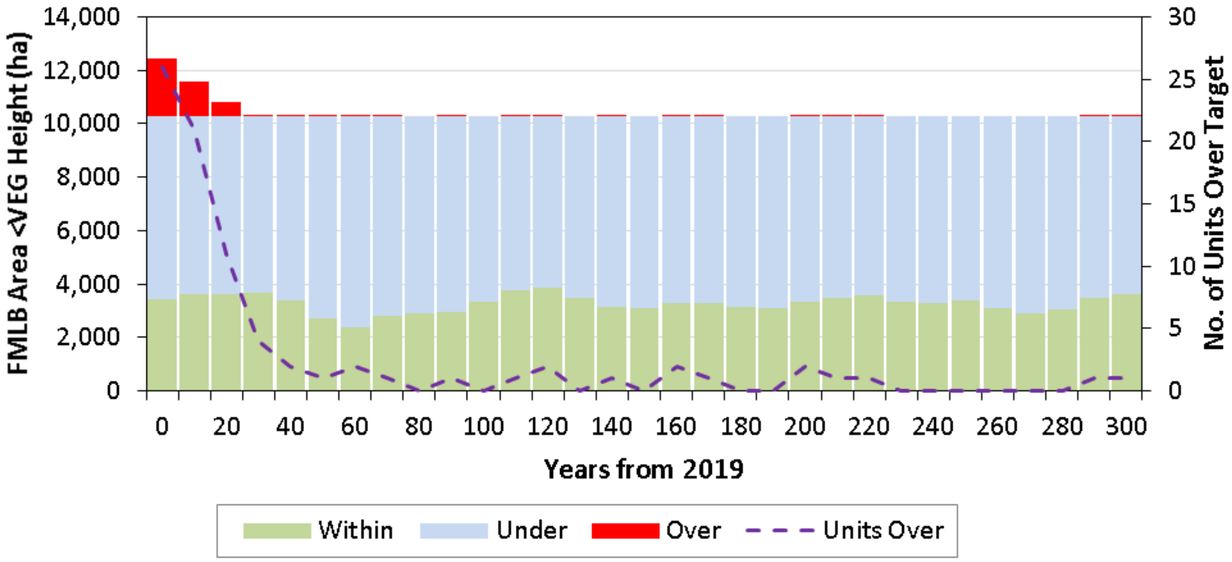


Figure 59 Combined Scenario – Cumulative Target Status for Visual Quality

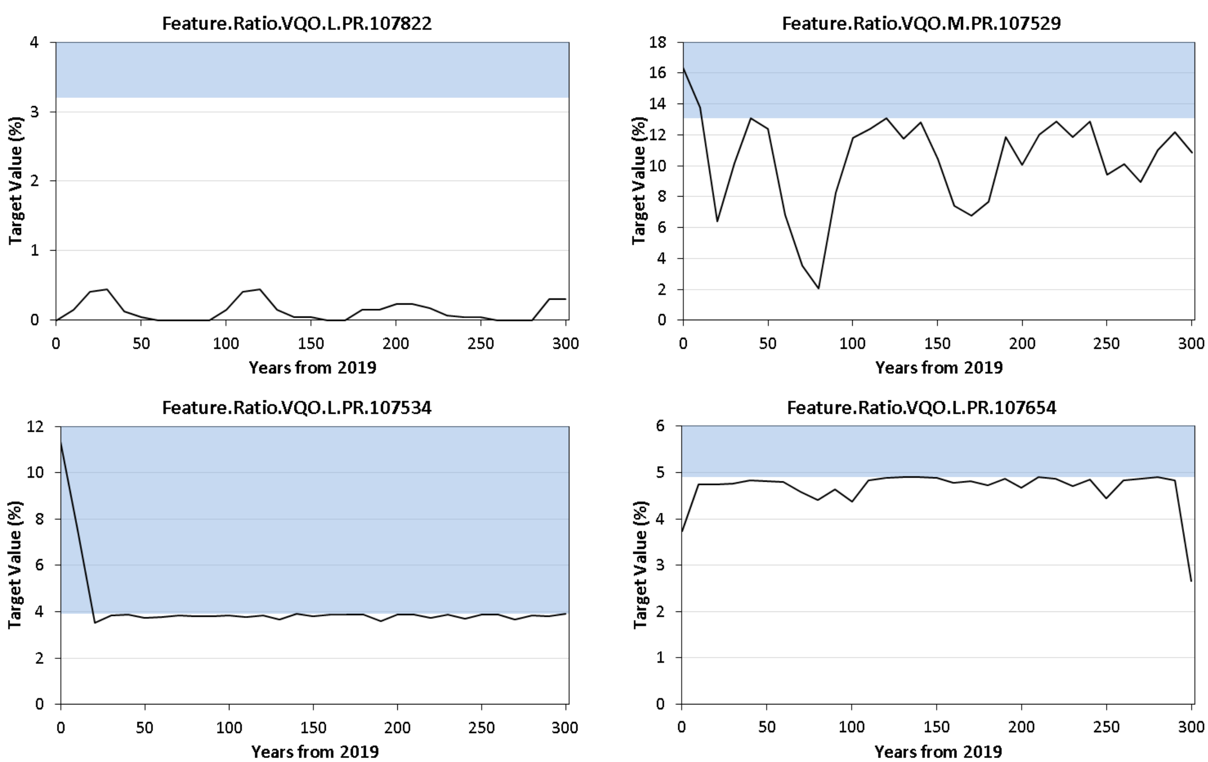


Figure 60 Combined Scenario – VQO Objectives (examples)

7.3.2 Timber Values

7.3.2.1 Harvest Forecast

Compared to the ISS Base Case (MINDY), the Combined Scenario (080_Comb_AAC) harvest profile was approximately 16.4% more in the first decade (i.e., at current AAC), 11.0% less over the mid-term, and 1.2% more over the long-term (Figure 62).

The significant drop in harvest rate following the first period aligns with results described in section 3.1.2 that reflects both the THLB reduction and a greater reduction in initial growing stock – compared to the TSR Benchmark. Increasing the harvest rate to the current AAC in the first period results in a deeper trough over the mid-term. Implementing spatial criteria (i.e., in descending order, patch size distribution, harvest opening size, harvest system profile, and haul time profile) contributed to creating nearly all of the trough below the mid-term level in the ISS Base Case. To simplify comparisons with other harvest forecasts, there was no attempt to step the harvest rate down from the first to subsequent periods. Otherwise, any step-down progression would likely result in a deeper trough than shown in Figure 62.

The slight increase in the long-term harvest level was attributed to the slight increase in the THLB (i.e., ~374 ha or 0.2%) plus improved yields associated with the enhanced basic silviculture tactic.

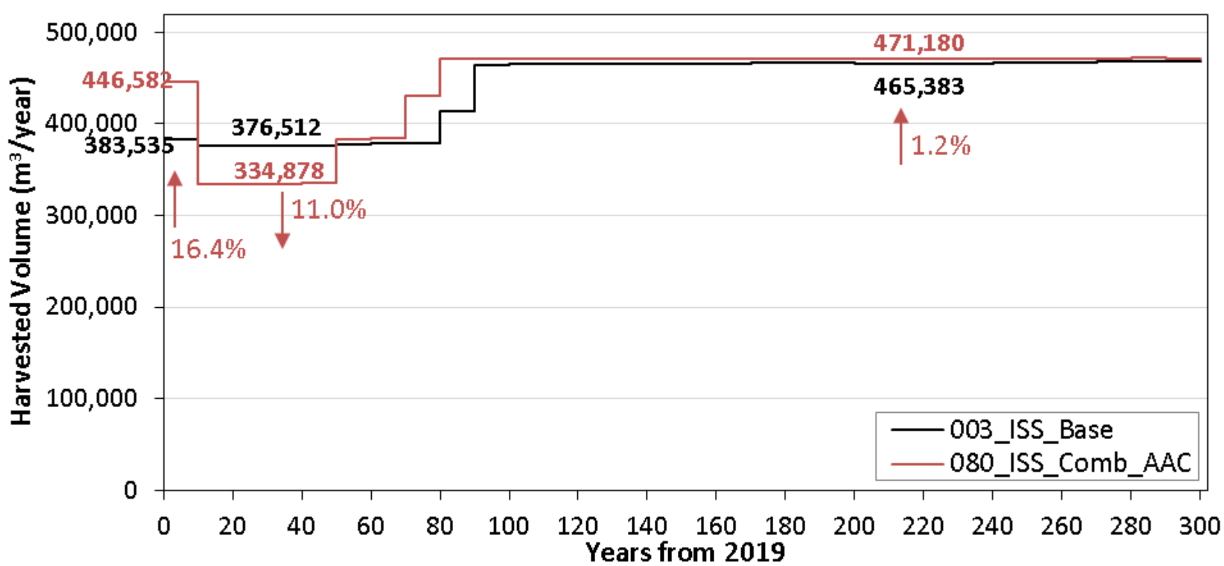


Figure 61 Combined Scenario – Harvest Forecast

7.3.2.2 Growing Stock

To demonstrate a sustained harvest flow we implemented a key criterion that forced the model to maintain a non-declining total growing stock over the last 100 years of the planning horizon (Figure 62). This constraint had been applied on the merchantable growing stock in all of the other sensitivity analyses but changed back to total growing stock to be consistent with the ISS Base Case.

Both the total and merchantable growing stock followed similar patterns but were higher in the Combined Scenario compared to the ISS Base Case. This reflected the implementation of seral and patch size requirements, that provides a larger merchantable volume cushion of 3.1 million m³, or over 8 years of AAC, at the start of the fourth period – the 'pinch point' or lowest level of merchantable timber, which is a significant increase compared to the ISS Base Case.

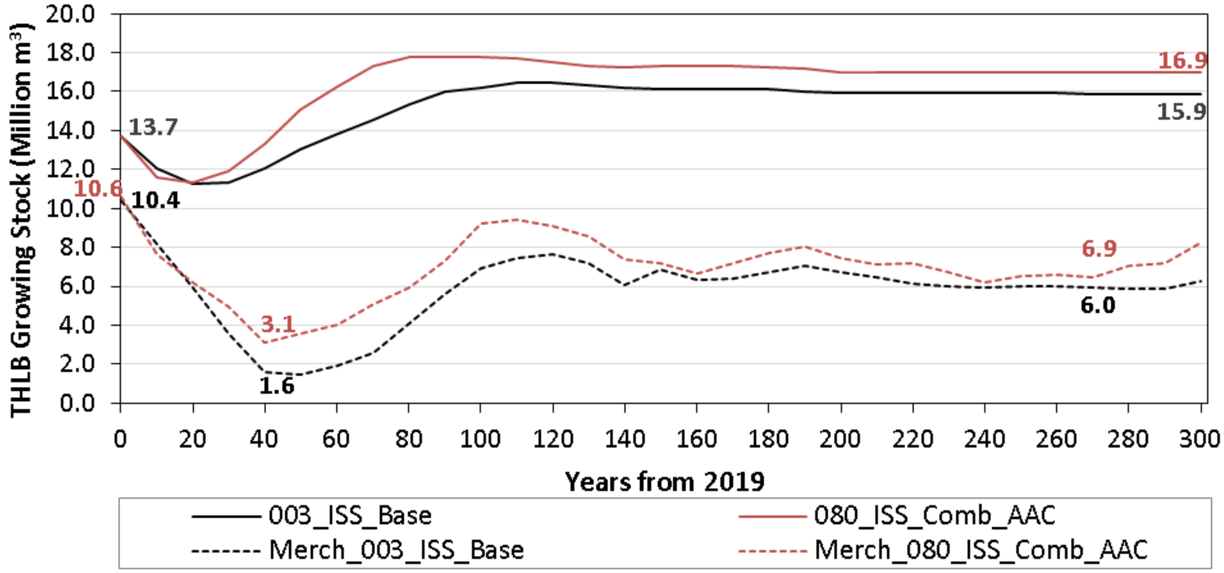


Figure 62 Combined Scenario –THLB Growing Stock

7.3.2.3 Management State

The harvest profile reported by management state (Figure 63) shows that for the first 30 years, the volume was harvested almost exclusively from existing natural (EN) stands. Existing managed (EM) stands begin to contribute significantly to the harvest rate in the fourth decade. By the tenth decade most of the volume harvested is from future managed stands (FM). Stands impacted by wildfires in 2017 and 2018 contributed to the harvest rate mostly between decades 7 and 12.

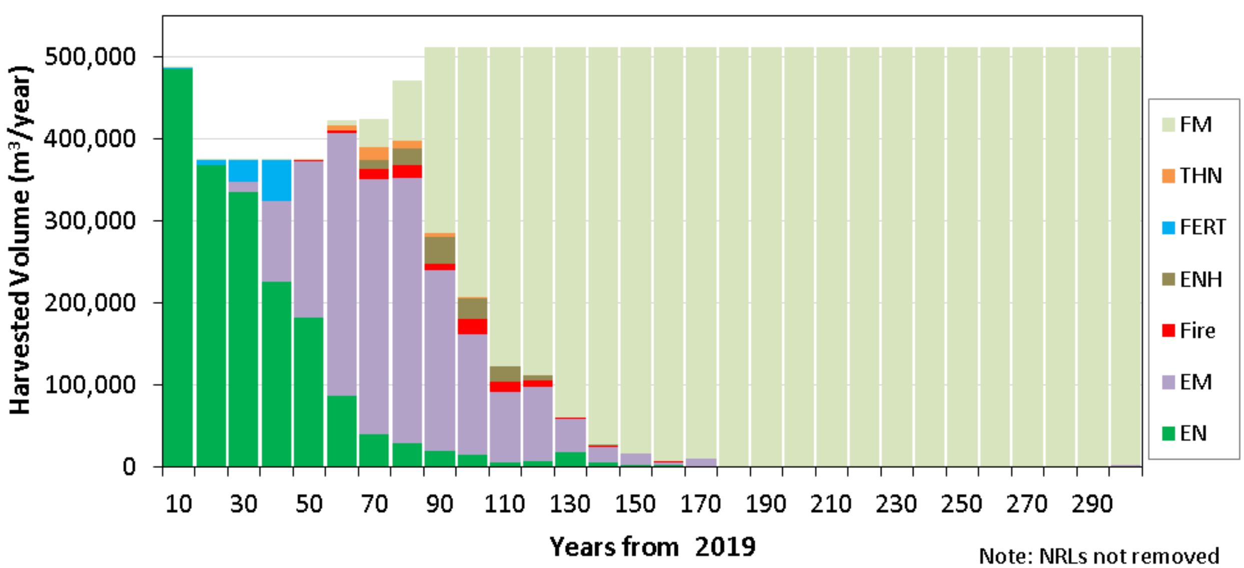


Figure 63 Combined Scenario – Harvest Volume by Management State

7.3.2.4 Age Class Distribution

The age class distribution over time (Figure 64) shows that the THLB is already reasonably distributed across all age classes. A normalized forest is achieved and maintained over the long-term (>100 years). By the end of the planning period ~5,000 ha of THLB are older than 240 years. Most of these areas were retained to meet ECA requirements on community and domestic watersheds. Meanwhile, disturbance throughout the NHLB (approximately 1,500 ha/year) cycled through age classes over time and by the end of the 300-year planning horizon, 77% of the NHLB is evenly distributed in age classes under 240 years. Exceptions include in-block retention (THLB_ret @ ~21,600 ha), which was never affected by either harvesting or natural disturbance.

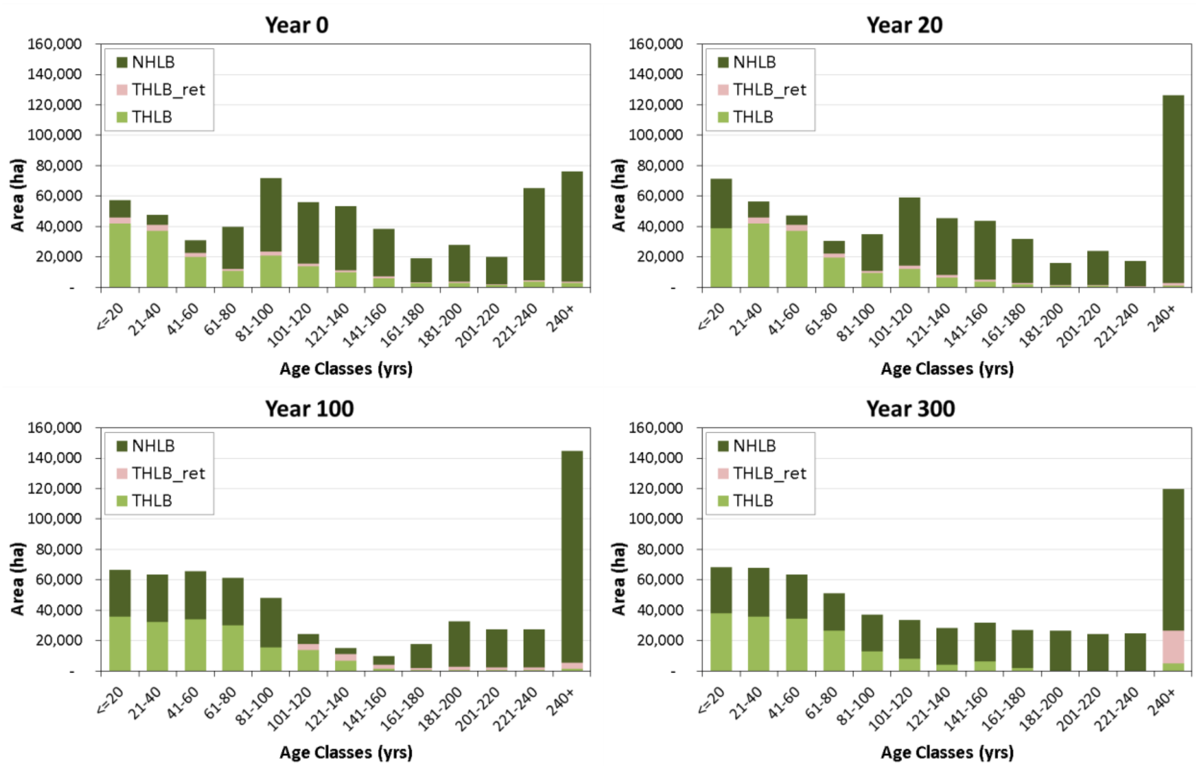


Figure 64 Combined Scenario – Age Class Distribution at Years 0, 20, 100, and 300

7.3.2.5 Age Class

The harvest profile reported by age class (Figure 65) shows that after 30 years most of volume is harvested from mature stands (60 to 120 years), which is consistent with results observed in Figure 62 by the observed 'pinch point' (fourth and fifth decades) and in Figure 63 by the introduction of harvesting EM stands (fourth decade). The volume harvested from stands aged >200 years averaged 19% over the first two periods, and less than 1% thereafter.

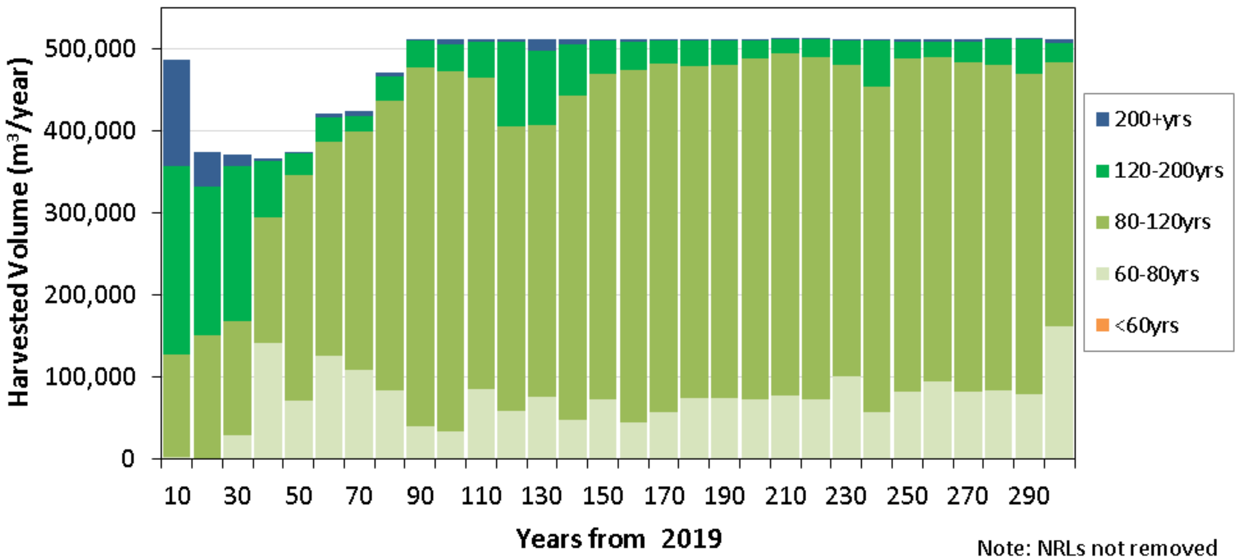


Figure 65 Combined Scenario – Harvest Volume by Age Class

7.3.2.6 Volume Class

The harvest profile reported by volume class (Figure 66) shows that the FM yields that support long-term harvest levels are projected to produce a larger proportion of higher volumes (i.e., 300-450 m³/ha). Only small fractions of the volume is harvested from the highest volume class (>450 m³/ha). The volume harvested at less than 150 m³/ha results from partial cut stands and commercial thinning.

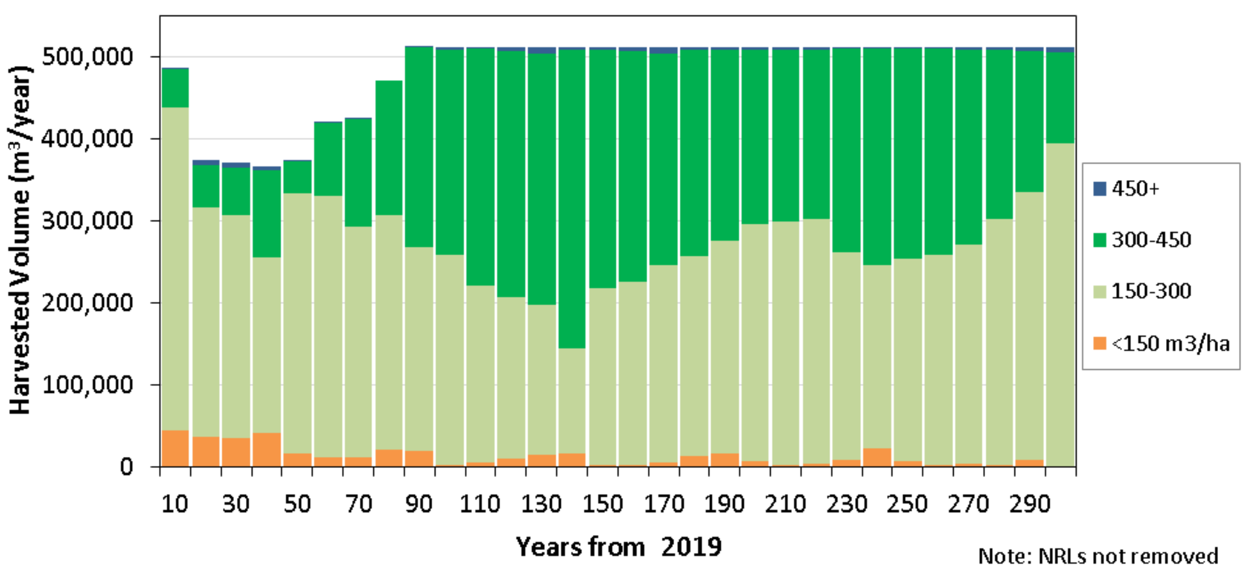


Figure 66 Combined Scenario – Harvest Volume by Volume Class

7.3.2.7 Average Harvest Volume, Age, and Area

The average age of harvested stands (dotted line and left axis in Figure 67) starts at 155 years and declines to 92 years after 5 decades, as the harvest transitioned from existing to future stands (i.e., post-harvest regenerated stands). For the rest of the 300-year planning horizon, the average age at harvest stabilized at around 100 years.

The average volume of harvested stands (solid black line and left axis in Figure 67) gradually increases from 196 m³/ha to 294 m³/ha in the sixteenth decade. Average volumes are quite stable over the rest of the 300-year planning horizon at around 266 m³/ha. Note that these values are considerably higher than the minimum harvest volume criterion set between 100 m³/ha and 200 m³/ha based on slope and leading species.

The average area harvested each year (solid red line and right axes in Figure 67) is highest at ~2,500 ha/yr in the first decade to meet the current AAC. Afterwards, this indicator stabilizes at ~2,000 ha/yr.

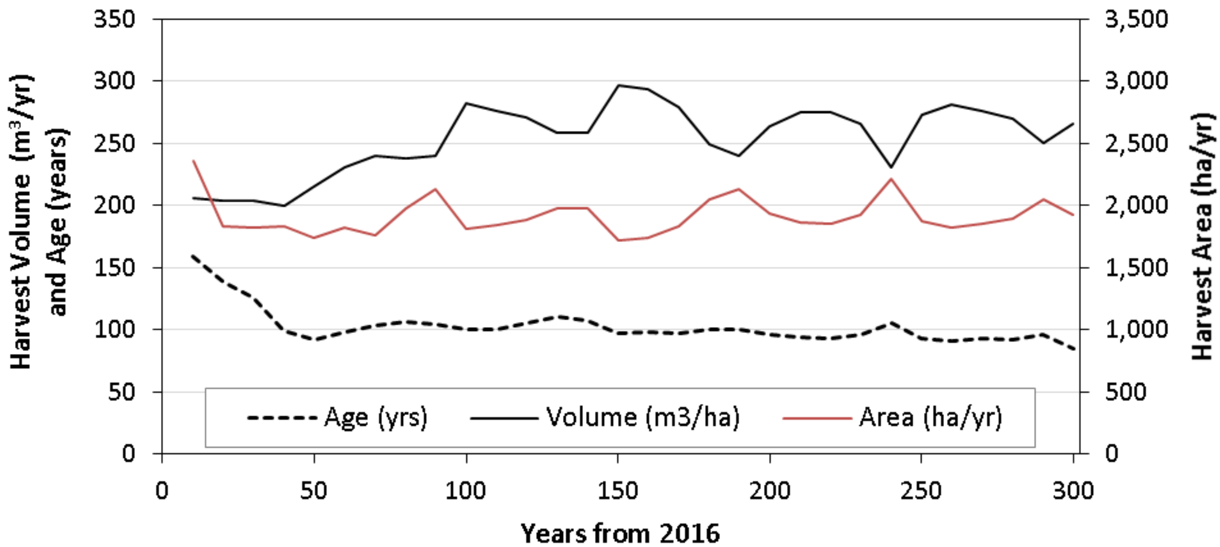


Figure 67 Combined Scenario – Average Age and Volume at Harvest

7.3.2.8 Species Groups

The harvest profile reported by species group (Figure 68) shows that most of the harvested volume is white wood from spruce and lodgepole pine, followed by red wood from Douglas-fir and larch, and white wood from balsam/subalpine fir and hemlock. There are minor contributions of red wood volume from yellow pine and cedar.

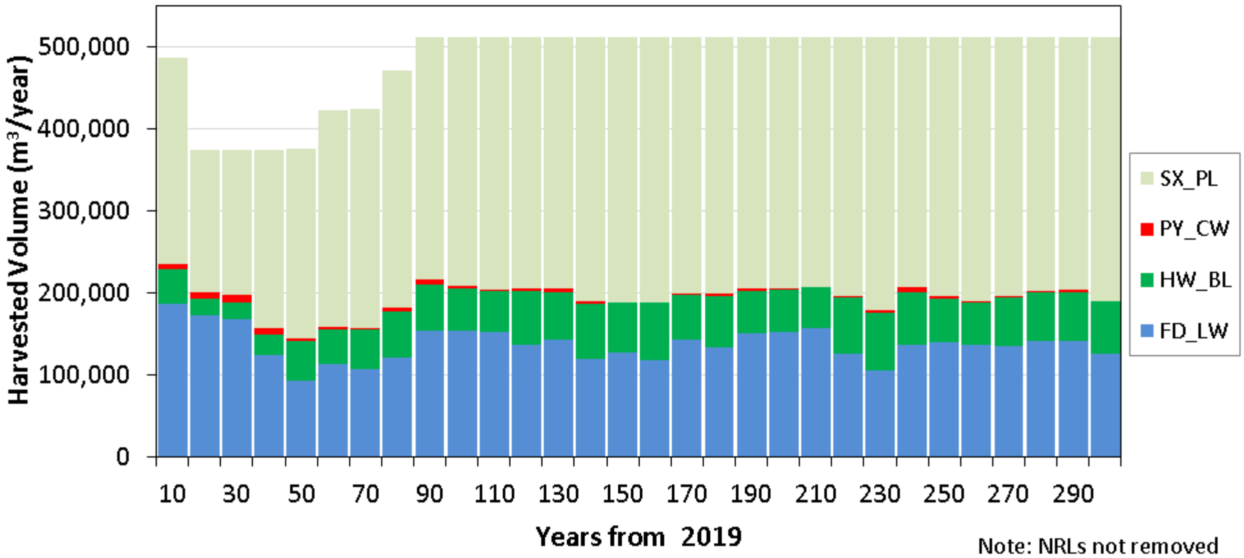


Figure 68 Combined Scenario – Harvest Volume by Species Groups

7.3.2.9 Individual Tree Species

The harvest profile reported by individual species (Figure 69) shows that most of the harvested volume was comprised of lodgepole pine and spruce, with important contributions from Douglas-fir, subalpine fir, and western larch.

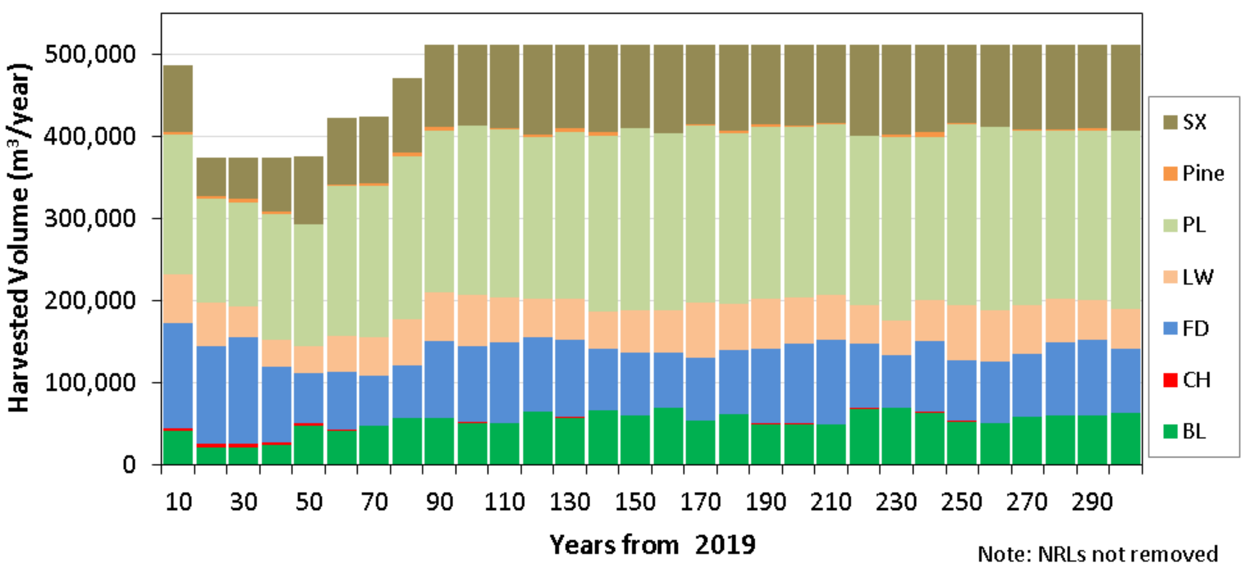


Figure 69 Combined Scenario – Harvest Volume by Individual Species

7.3.2.10 Haul Time

The harvest profile reported by one-way haul time (Figure 70) shows that most of the harvested volume came from stands less than one-hour (green + blue) away from the closest processing facility. Over the first 40 years, minimum targets were applied according to the THLB profile (i.e., <0.5 hrs @ 54% and 0.5-

1.0 hrs @ 38%). While this requirement influenced the harvest schedule, it had little impact on harvest flow.

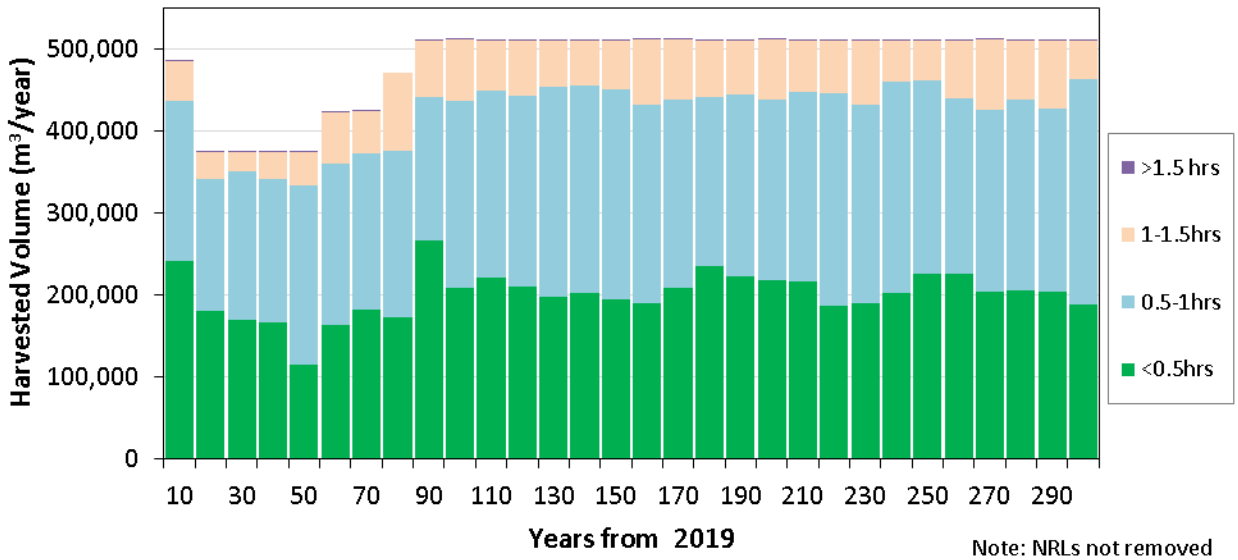


Figure 70 Combined Scenario – Harvest Volume by Haul Distance (one-way)

7.3.2.11 Harvest System

The harvest profile reported by harvesting system (Figure 71) shows that most of the volume was harvested from ground-based harvest systems where slopes are ≤40%. Over the first 40 years, a minimum target was applied according to the THLB profile (i.e., ≤40% slope @ 78%). This requirement certainly influenced the harvest schedule but had little impact on harvest flow.

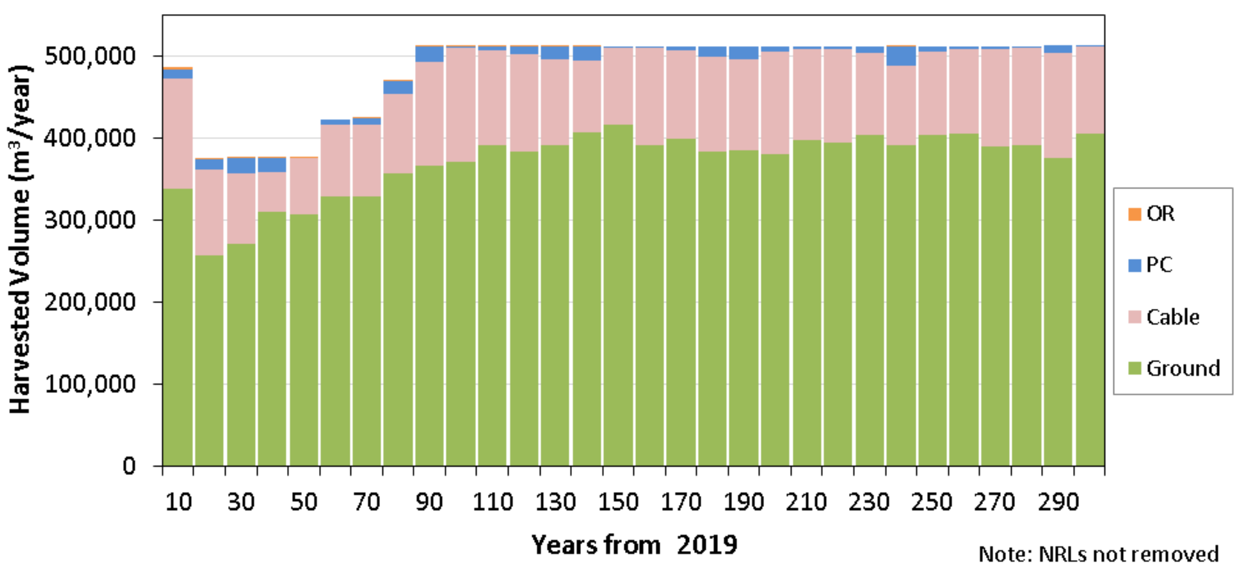


Figure 71 Combined Scenario – Harvest Volume by Harvest System

7.3.2.12 Harvest Opening Size

The harvest profile reported by harvesting opening size (Figure 72), shows that the applied targets successfully restricted the harvest proportion from small blocks. Over the entire planning period, maximum targets were applied to restrict the harvest of small blocks (i.e., 1-5 ha @ 5% and <1 ha @ 0%). This requirement certainly influenced the harvest schedule and moderately impacted the harvest flow.

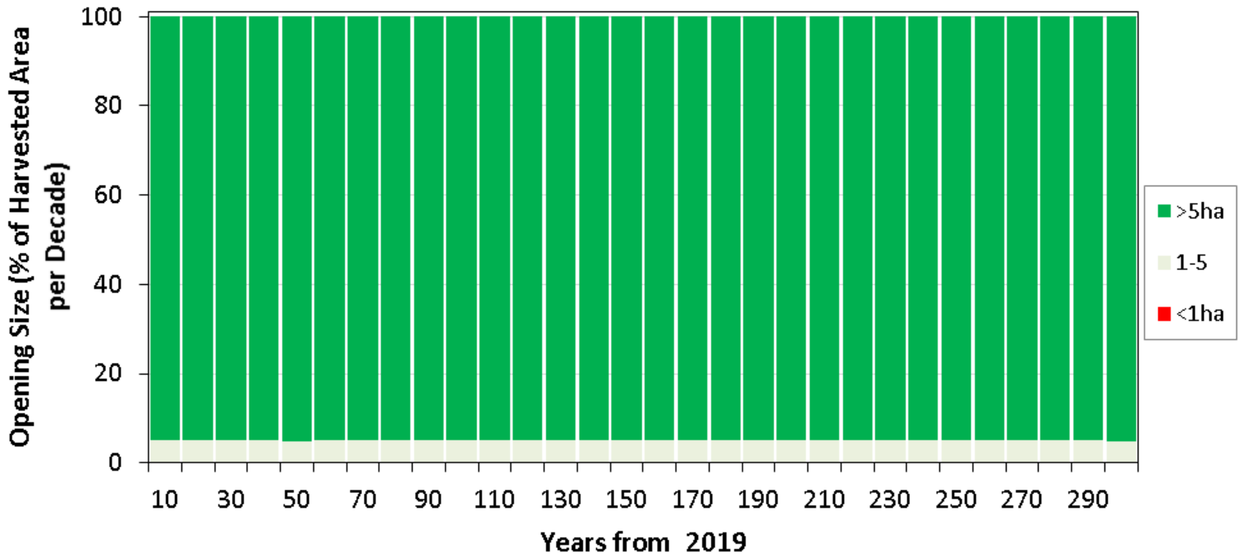
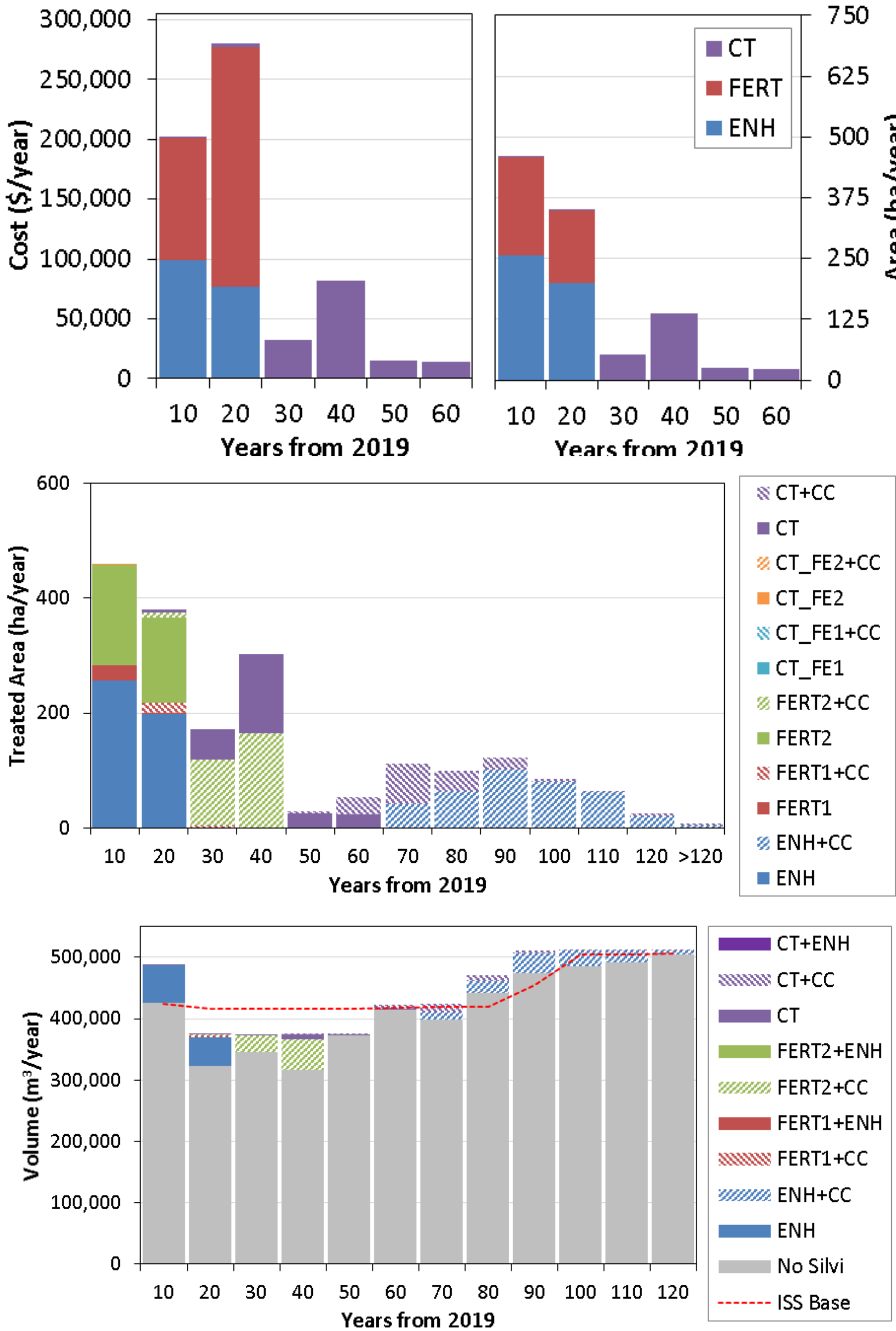


Figure 72 Combined Scenario – Percent of Harvest Area by Opening Size

7.3.3 Silviculture Treatments

The model did not allocate all of the $0.3 million per year budget over the first 20 years (i.e., $6 million total - Figure 73). Unlike the ISS Base Case that favoured ENH, the model focused funding towards FERT (~$151,700/year treating ~175 ha/year) and ENH (~$87,600/year treating ~228 ha/year). Where stands were eligible for two fertilizer applications, the model tended to select two applications over one. The budget was extended over the first 60 years for CT (~$24,300/year treating ~40 ha/year). Fertilized stands contributed directly to the mid-term as they were harvested between the 2nd and 4th decades, while harvesting of ENH stands started to get harvested in the 7th decade (i.e., rise from the mid- to long-term).



(Note: hatched symbology depicts the timber harvest for each tactic)

Figure 73 Combined Scenario - Silviculture Treatments

7.3.4 Sensitivity Analyses for the Combined Scenario

Six runs were modelled in the Combined Scenario (Table 10) to explore the following adjustments:

1) Spatially defined areas to meet old seral requirements (i.e., OGMA/MMAs versus Candidate Reserves),
2) Number of periods to restrict these spatially defined areas from being harvested (i.e., first 20 years versus entire planning period), and
3) Harvest profiles (i.e., MINDY versus AAC+NDY).

Table 10 Combined Scenario – Summary of Sensitivity Analyses

Run	Description	THLB		Harvest rate (m^3/year)			Harvest rate % from 003		
		(ha)	%from 003	First decade	Mid-term	Long-term	First decade	Mid-term	Long-term
000a	TSR4 Even Flow	195,616	13.0%	447,158	447,158	447,158	16.6%	18.8%	-4.7%
001	TSR Benchmark (Even Flow)	197,025	13.8%	437,060	437,060	437,060	14.0%	16.1%	-6.1%
003	**ISS Base Case (MINDY)**	173,088	0.0%	383,535	376,512	465,383	0.0%	0.0%	0.0%
070	ISS Comb CR20 MINDY	186,784	7.9%	427,541	383,752	508,248	11.5%	1.9%	9.2%
071	ISS Comb CR20 AAC	186,784	7.9%	446,725	380,577	508,354	16.5%	1.1%	9.2%
072	ISS Comb OGMA20 MINDY	186,784	7.9%	439,038	394,877	508,362	14.5%	4.9%	9.2%
073	ISS Comb OGMA20 AAC	186,784	7.9%	446,631	393,273	508,420	16.5%	4.5%	9.2%
074	ISS Comb CR300 AAC	186,784	7.9%	446,517	332,845	485,143	16.4%	-11.6%	4.2%
075	ISS Comb OGMA300 AAC	186,784	7.9%	446,479	337,053	477,607	16.4%	-10.5%	2.6%
080	ISS Comb AAC	173,380	0.2%	446,582	334,878	471,180	16.4%	-11.1%	1.2%
081	ISS Comb AAC SilviOFF	173,380	0.2%	446,426	312,828	471,445	16.4%	-16.9%	1.3%
083	ISS Comb AAC BAU	173,380	0.2%	446,917	317,776	475,462	16.5%	-15.6%	2.2%

The sensitivity analyses produced the following outcomes:

Locking reserves over the first 20 years (071_CR20_AAC & 073_OGMA20_AAC)

- Compared to the ISS Base Case, the harvest volume increased substantially over the mid- (especially) and long-terms with both Candidate Reserves and OGMA/MMAs. When the harvest timing constraint are removed, the model generally seeks to harvest stands with the most volume and growth capacity over time. As a result, we expect that the model will eventually meet seral objectives with the worst stands from both a harvesting and biodiversity perspective, which does not align with the biodiversity objectives.
- By the end of the planning horizon, less than 2% (only ~500 ha) of the current OGMA/MMAs or Candidate Reserves remained unharvested. While it is generally accepted that these spatial reserves can and should move across the landbase to respond to natural disturbances, this turnover may not be appropriate from a biodiversity perspective (i.e., not the 'best old growth').

Locking reserves over the entire planning horizon (074_CR300_AAC & 075_OGMA300_AAC)

- We set up the model such that these runs show erroneously high levels of merchantable growing stock on the THLB because these volumes include OGMA/MMAs and Candidate Reserves that are not actually available for harvest.

Turning off silviculture tactics (081_Comb_SilviOFF)

- Turning off these tactics reduced mid-term harvest level by 9.0% (5.1% over periods 2 to 8), which accounted for approximately 1.7 million m³ at a cost of $3.65/m³ (not discounted).

Business as usual (083_Comb_BAU)

- The business as usual sensitivity reduced the mid-term harvest level by 5.1%.
- Maintaining patch size distribution targets would have resulted in a greater reduction. Deactivating this objective caused patch sizes to trend away from their target distribution.

8 Discussion

8.1 Differences from TSR

Compared to the TSR Benchmark Scenario harvest flow, the ISS Base Case was 17.3% lower in the first decade, 15.2% lower during the mid-term, and 21.5% lower over the long-term.

Major differences between the TSR Benchmark and ISS Base Case scenarios (section 2) involved elements of the land base definition (e.g., non-forest and non-productive, depletions, FSC, partial netdowns), non-timber objectives (e.g., UWR, landscape-level biodiversity, ECA), growth and yield models (e.g., newer TIPSY version (4.4)), non-THLB disturbance, and NRL estimates. The THLB for the ISS Base Case was 12.2% less than the TSR Benchmark Scenario, but the NHLB was significantly larger (22.5%).

8.2 Key Observations

These ISS analyses generated numerous reports and spatial outputs associated with the modelling of various resource management tactics. The key observations for completed scenarios are briefly summarized in Table 11 based on discussions from the sections above.

Table 11 Summary of Key Observations

Topic	Key Observations
Harvest rate strategy	○ The MINDY harvest profile is a better approach for comparing results and analyzing a range of assumptions.
Non-timber Objectives	○ ECAs (particularly for domestic watersheds), VQOs, and UWRs were most constraining for some THLB areas.
NRL	○ Higher NRLs in the ISS Base Case had a direct impact that lowered the even-flow harvest level relative to the TSR Benchmark Scenario.
NHLB	○ The significantly larger NHLB (22.5%) in the ISS Base Case alleviated constraints applied over the smaller THLB (-12.2%).
NHLB disturbance	○ Including disturbance on the NHLB resulted in disproportional impacts to highly constrained reporting units dominated by NHLB. Here, harvest opportunities over some significant THLB areas were reduced. Still, NHLB disturbance eventually produced a relatively even area distribution of early, mid, and mature stands for half of the NHLB, while the other half remained undisturbed.
2017 wildfires	○ Wildfires that occurred in 2017 throughout the TSA had little impact on harvest rates.
Minimum Harvest Age	○ Average volume at harvest was significantly higher than the minimum harvest criteria implemented in the model.

Topic	Key Observations
Harvest opening size	o Assess impacts and trade-offs associated with creating operationally feasible harvest opening sizes. This could be done to ensure that harvested blocks are more operationally feasible.
Visual Quality	o While VQOs generally constrained the harvest flow, we can implement proper visual landscape design and partial cut harvest systems to alleviate these constraints. We did not model specific tactics to mitigate visual quality constraints.
ECA	o Overall, the ECA thresholds applied to domestic watersheds had a negative impact on the harvest rate. o Current management can support a more constraining ECA (i.e., 30% to 25%).
OGMA+MMA	o OGMAs and MMAs were relatively successful in meeting the landscape-level biodiversity constraints since implementing seral requirements, in addition to these spatial reserves, did not have a significant impact on harvest rate. However, removing OGMAs and MMAs, while maintaining landscape-level biodiversity requirements (seral and spatial early seral patches), increased the THLB and in turn, increased harvest levels.
Unharvested THLB	o Some stands in the THLB are retained from being harvested because they are needed to address forest cover requirements (Figure 7). An artefact of this particular model is that stands retained may be relatively poor, and least likely to contribute to the harvest flow.
Very Early Seral Patch Sizes	o While implementing patch size targets for very early seral forests (THLB only) improved the patch size distribution over time, it significantly reduced harvest rates over the short- and mid-terms. o Whether or not targets were implemented, smaller reporting units were unable to develop larger patches for the simple fact that they are too small (i.e., difficult to create 250 ha patches within a 500 hectare reporting unit).
Old Seral Patch sizes	o Implementing patch size targets for very early seral forests (THLB only) did not influence old seral patch size distributions. This is because most of the old seral patches exist within the NHLB that is the same whether or not patch targets are implemented.
FSC	o Removing FSC criteria while maintaining FPPR requirements increased the THLB by 4.1%, which increased harvest levels across all periods by nearly as much.
Silviculture Tactics	o Implementing silviculture tactics (FERT, CT, ENH) with a funding level set at $0.3 million per year for the first 20 years of the planning horizon (Figure 25) combined to improve the transition from harvesting natural to managed stands by shortening the mid-term period by 10 years. Meanwhile, the harvest rate increased over the short-term by 1.9 to 2.3%. o Increasing the available funding over the short-term did not correlate with a similar increase in harvest level because the land base was relatively constrained over the short- and mid-term and the harvest rates were already maximized at the lower funding level. o The ENH tactic provided the most significant improvements to the harvest flow. The additional volume generated by harvesting the enhanced stands after year 70 allowed the model to shift the harvest of other merchantable stands earlier in the planning horizon. o The primary opportunity with the CT tactic is providing the model an option to harvest a portion of the stand, while it is still growing well, to address periods when available volume is low. The rest of the stand can be harvested later, when much more merchantable volume is available across the landscape. Extending funding well into mid-term provided more options for the model to leverage the CT tactic. o The model tended to treat stands eligible for two fertilizer applications over one. This suggests that increased volume on existing stands is a primary driver for this tactic. o Both CT and FERT treatments were configured with relatively narrow windows of opportunity, making treatment eligibility highly dependent on age. o The silviculture tactics explored (FERT, CT, ENH) provided the model with more flexibility to address forest cover requirements like biodiversity, wildlife habitat, watershed, and cultural interests.
	Generally, the silviculture tactics demonstrated the anticipated benefits when planning them: o FERT provided incremental volume over the mid-term. o CT provided incremental volume later in the mid-term over periods when available harvest volume was lowest, but at some cost later on when the remaining stands were harvested at lower volume. o ENH provided incremental volume early in the long-term, which replaced merchantable stands that could then be harvested earlier (late mid-term).
Wildlife Habitat	o In most cases, results were similar to those developed in the latest TSR5. In other cases, it appeared that errors were introduced in the process used in the latest TSR5. o In some cases, the habitat classes did not appear to flow appropriately across TSA boundaries. This likely resulted from different slope/aspect, Eco section, or PEM unit attributes. o The project team was unable to validate the wildlife habitat modelling in time to incorporate any aspects into the Combined Scenario.

Topic	Key Observations
Caribou Habitat	○ While this proof-of-concept analysis provided appropriate summaries of critical caribou habitat over time, the project team did not feel that the current linework from the federal caribou recovery strategy was appropriate to incorporate into the Combined Scenario.
Reserve Tactics	○ The model process can easily manage further refinement of the Candidate Reserves, such as additional information/inventories, new values, revised stand-level scoring, or different reserve size classes/thresholds. ○ Preparing the resultant file used in the Reserve Scenario (i.e., combination of splitting larger polygons and 'blocking' stands together) produced a much more appropriate baseline for the model to improve the selection of Candidate Reserves. ○ Splitting the selection of candidate reserves into two separate stages (old forest first; then mature-plus-old and other criteria) aligned with the KBLUP intent to retain the best stands for old growth management. ○ Incrementally exploring each control in the model allowed the analyst to develop appropriate weights on targets. ○ Setting targets on score/ha rather than total score, removed an inappropriate influence of stand area. ○ Where it is available, additional detail on the quality of existing OGMA/MMAs (e.g., field assessment) could be incorporated into the reserve selection process.
Key Observations with Combined Scenario	
20-Year Lock on Candidate Reserves	○ Locking the candidate reserves for 20 years did not produce the desired results using stand age as the only criterion for managing old seral. Once the 20-year lock was removed, the model generally sought to harvest stands with the most volume and growth capacity over time. We expect that eventually, the seral objectives will be met with the worst stands from both a harvesting and biodiversity perspective – not at all aligned with the biodiversity objectives. ○ By the end of the planning horizon, less than 2% (only ~500 ha) of the current OGMA/MMAs or Candidate Reserves remained unharvested. Besides increasing timber harvesting opportunities, this may be beneficial from a wildfire management perspective but may not be appropriate from a biodiversity perspective (i.e., not the 'best old growth').
Spatial Constraints	○ As observed above, implementing spatial criteria (i.e., patch size distribution (section 7.3.1.3), harvest opening size (section 7.3.2.12), harvest system profile (section 7.3.2.11), and haul time profile (section 7.3.2.10)) significantly reduced harvest rates over the short- and mid-terms. Removing these non-legal criteria would nearly eliminate the mid-term trough; to 1.6% of the ISS Base Case Scenario mid-term.
Harvest Forecast	○ The significant mid-term trough reflected two key modelling assumptions: setting the initial period at the current AAC (16.4% higher than the ISS Base Case Scenario) and implementing the spatial criteria as described directly above.
Visuals	○ After modelling was complete, we discovered that the updated visual assessment applied the wrong values for maximum alteration in perspective view that significantly relaxed target levels (e.g., increased maximum disturbance levels from 1.1% to 4.8%). We corrected this in the Combined Scenario run.
Silviculture Tactics	○ Turning off these tactics reduced mid-term harvest level by 9.0% (5.1% over periods 2 to 8), which accounted for approximately 1.7 million m^3 at a cost of $3.65/$m^3$ (not discounted).
Business As Usual	○ The business as usual sensitivity reduced the mid-term harvest level by 5.1%. ○ Maintaining patch size distribution targets would have resulted in a greater reduction. Deactivating this objective caused patch sizes to trend away from their target distribution.

8.3 Recommendations

Opportunities to improve future analyses or explore new tactics were identified through these analyses. Specific recommendations are briefly summarized in Table 12.

Table 12 Summary of Recommendations

Topic	Recommendation
Minimum Harvest Age	○ Refine the minimum harvest criteria for managed stands by including a criterion based on mean annual increment. While this new criterion may constrain harvest levels, it should improve harvest profiles (e.g., age and products).
Disturbance in the NHLB	○ Refine the approach for disturbing the NHLB to mimic areas and spatial patterns disturbed naturally.
OGMA+MMA	○ Apply these spatial reserves for a limited time only (e.g., 40-60 years) and then allow the model to explore alternative ways to meet landscape-level biodiversity objectives, while maintaining or enhancing reserve.
FSC Criteria	○ Continue to assess impacts and trade-offs associated with implementing FSC standards.
Early Seral Patches	○ Continue to assess impacts and trade-offs associated with implementing early seral patches. This might include merging reporting units across the TSA, application of target weights within an acceptable impact to harvest levels.
Harvest opening size	○ Assess impacts and trade-offs associated with creating operationally feasible harvest opening sizes. This could be done to ensure that harvested blocks are more operationally feasible.
Non-timber objectives	○ Continue to explore modelling approaches to address highly constraining non-timber objectives (e.g., ECAs, VQOs and UWRs).
Commercial Thinning	○ The timing window set for treating and harvesting CT was relatively narrow. Increasing the timing window for CT might improve a stand's ability to recover volume, presenting more opportunities when the CT option is available for older managed stands. ○ Increase the eligibility of CT to apply to future managed stands. The analyses completed considered only existing managed stands for this treatment but some future managed stands will be available over the next 60 years.
Partial harvest in Constrained Areas	○ In addition to providing available volume during the most constraining periods, the CT treatment can provide other benefits to improve stand structure within UWRs and to lower fire risk. Future silviculture scenarios could explore CT and/or partial-cut silviculture systems to treat stands within constrained areas (e.g., UWRs, Visuals, ECAs, Seral, Wildland Urban Interfaces, etc.) provided these treatments can maintain or improve the structural characteristics, or reduce forest health risks, right away or shortly after the treatment.
Silviculture Treatments	○ Consider evaluating treatments based on net present value rather than cost alone. For example, the net cost for CT and ENH tactics were \$600/ha and \$385/ha, respectively, while the Net Present Value for the same tactics would be +\$221/ha and -\$231/ha. This new account would likely influence the model to select different tactics at different times.
Wildlife Habitat	○ Complete validation for the wildlife habitat modelling and explore appropriate recommendations. ○ Develop appropriate thresholds to maintain over time (e.g., maintain current level of habitat classes 1 to 3). ○ Continue to work towards developing spatial criteria to apply in the model (e.g., area and shape required for specific habitat types).
Caribou Habitat	○ Revisit the caribou habitat analysis once the new linework from the joint provincial and federal caribou recovery strategy is available.
Reserve Tactics	○ Conduct a post-processing GIS analysis to identify edges and determine – more precisely – the amount of interior old forest for each assessment unit. We did not re-assess interior old forest with the Candidate Reserves within the Reserve Scenario as it was planned within the Combined Scenario. ○ Utilize the Candidate Reserves to provide context and a draft set of polygons for further analysis (i.e., Combined Scenario). ○ Assess Candidate Reserves at tactical- and eventually, operational-levels; involving stakeholders to verify values are addressed appropriately for each LU.
Combined Scenario	○ Develop an alternative harvest forecast that aims to mitigate the severe drop (16.4%) from the initial harvest rate to the mid-term trough.

Topic	Recommendation
Outstanding Tactics	o Continue work on scenarios and tactics identified but not examined in this iteration. This includes additional wildlife tactics (spatial criteria for specific habitat types and revised caribou strategy), Forest Health (fire and climate change), Carbon (carbon stocks), and Range (forage production). o Examine changes in results from incorporating a vegetation inventory with LiDAR-derived attributes.

Appendix 1 Very Early Seral Patch Results

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Unit	NDT	Patch Size (ha)	Target Min (%)	Target Max (%)	003 MINDY (Patch not controlled) THLB (ha)	Min (%)	Max (%)	Avr (%)	009 Patch Controlled THLB (ha)	Min (%)	Max (%)	Avr (%)
Brewer Dutch	NDT3b	0_40	20	30	528	26	100	66	707	21	45	38
		40_80	25	40	528	0	69	26	707	0	55	36
		80_250	30	50	528	0	66	8	707	0	60	26
		250plus	0	100	528	0	0	0	707	0	0	0
	NDT4	0_40	30	40	470	7	100	62	584	38	51	50
		40_80	30	40	470	0	93	31	584	28	52	49
		80_250	20	30	470	0	86	7	584	0	34	1
		250plus	0	100	470	0	0	0	584	0	0	0
Bugaboo	NDT2	0_40	30	40	926	3	100	51	972	31	100	49
		40_80	30	40	926	0	74	31	972	0	50	44
		80_250	20	30	926	0	73	18	972	0	37	7
		250plus	0	100	926	0	0	0	972	0	0	0
	NDT3a	0_40	10	20	1,388	11	100	60	1,476	16	50	46
		40_250	10	20	1,388	0	73	33	1,476	10	50	45
		250_1000	60	80	1,388	0	67	7	1,476	0	70	9
		1000plus	0	100	1,388	0	0	0	1,476	0	0	0
	NDT3b	0_40	20	30	705	21	100	58	843	20	45	33
		40_80	25	40	705	0	54	14	843	0	55	28
		80_250	30	50	705	0	79	27	843	0	60	39
		250plus	0	100	705	0	0	0	843	0	0	0
Cross	NDT3b	0_40	20	30	1,345	10	100	35	1,425	21	45	28
		40_80	25	40	1,345	0	71	32	1,425	25	55	33
		80_250	30	50	1,345	0	73	27	1,425	0	49	38
		250plus	0	100	1,345	0	62	6	1,425	0	0	0
Doctor Fir	NDT3a	0_40	10	20	747	31	100	73	761	50	55	50
		40_250	10	20	747	0	69	27	761	45	50	50
		250_1000	60	80	747	0	0	0	761	0	0	0
		1000plus	0	100	747	0	0	0	761	0	0	0
	NDT3b	0_40	20	30	2,682	11	54	30	2,758	19	30	26
		40_80	25	40	2,682	0	59	19	2,758	23	39	31
		80_250	30	50	2,682	0	73	38	2,758	29	50	42
		250plus	0	100	2,682	0	84	13	2,758	0	29	1
Dunbar Templeton	NDT3b	0_40	20	30	888	6	100	50	1,003	21	45	32
		40_80	25	40	888	0	63	24	1,003	0	55	26
		80_250	30	50	888	0	82	26	1,003	0	60	42
		250plus	0	100	888	0	0	0	1,003	0	0	0
East Columbia	NDT3b	0_40	20	30	518	100	100	100	523	45	100	67
		40_80	25	40	518	0	0	0	523	0	55	33
		80_250	30	50	518	0	0	0	523	0	0	0
		250plus	0	100	518	0	0	0	523	0	0	0
Fenwick	NDT3b	0_40	20	30	1,615	3	83	36	1,723	21	30	27
		40_80	25	40	1,615	0	55	16	1,723	24	40	32
		80_250	30	50	1,615	0	81	27	1,723	30	50	41
		250plus	0	100	1,615	0	97	22	1,723	0	0	0
Invermere	NDT3b	0_40	20	30	887	29	100	75	891	20	46	35
		40_80	25	40	887	0	48	22	891	0	56	35
		80_250	30	50	887	0	49	3	891	0	60	31
		250plus	0	100	887	0	0	0	891	0	0	0
Kindersley Macauley	NDT3b	0_40	20	30	657	15	100	45	657	25	45	39

Unit	NDT	Patch Size (ha)	Target		003 MINDY (Patch not controlled)				009 Patch Controlled			
			Min (%)	Max (%)	THLB (ha)	Min (%)	Max (%)	Avr (%)	THLB (ha)	Min (%)	Max (%)	Avr (%)
		40_80	25	40	657	0	71	20	657	0	55	29
		80_250	30	50	657	0	81	34	657	0	60	32
		250plus	0	100	657	0	0	0	657	0	0	0
Kootenay	NDT3b	0_40	20	30	468	29	100	78	781	24	46	35
		40_80	25	40	468	0	71	16	781	0	55	24
		80_250	30	50	468	0	51	6	781	0	60	41
		250plus	0	100	468	0	0	0	781	0	0	0
Nine Mile Moscow	NDT3a	0_40	10	20	948	4	100	70	977	50	50	50
		40_250	10	20	948	0	96	30	977	50	50	50
		250_1000	60	80	948	0	0	0	977	0	0	0
		1000plus	0	100	948	0	0	0	977	0	0	0
	NDT3b	0_40	20	30	8,158	14	50	31	8,605	20	30	24
		40_80	25	40	8,158	2	33	16	8,605	25	39	27
		80_250	30	50	8,158	3	49	28	8,605	30	47	37
		250plus	0	100	8,158	0	65	25	8,605	0	24	12
Premier Diorite	NDT4	0_40	30	40	2,217	11	100	22	2,887	30	50	37
		40_80	30	40	2,217	0	82	12	2,887	21	50	34
		80_250	20	30	2,217	0	47	5	2,887	0	38	29
		250plus	0	100	2,217	0	85	61	2,887	0	0	0
Toby	NDT3b	0_40	20	30	1,278	30	100	66	1,343	20	45	32
		40_80	25	40	1,278	0	51	19	1,343	0	55	27
		80_250	30	50	1,278	0	59	15	1,343	0	60	41
		250plus	0	100	1,278	0	0	0	1,343	0	0	0

Yellow highlights identify records with no early seral patch area within the reporting unit and patch size class.

Licensee: Canfor

Unit	NDT	Patch Size (ha)	Target		003 MINDY (Patch not controlled)				009 Patch Controlled			
			Min (%)	Max (%)	THLB (ha)	Min (%)	Max (%)	Avr (%)	THLB (ha)	Min (%)	Max (%)	Avr (%)
Eastern Purcell Central	NDT3	0_40	15	25	15,191	33	67	45	16,421	21	43	25
		40_250	20	40	15,191	33	66	50	16,421	26	57	39
		250_1000	30	50	15,191	0	24	5	16,421	0	45	35
		1000plus	10	20	15,191	0	0	0	16,421	0	20	1
	NDT4	0_40	30	40	3,208	28	100	58	3,367	25	55	41
		40_80	30	40	3,208	0	63	28	3,367	26	50	37
		80_250	20	30	3,208	0	49	14	3,367	0	49	21
		250plus	5	15	3,208	0	0	0	3,367	0	0	0
Eastern Purcell North	NDT1	0_40	30	40	764	17	100	65	822	34	52	47
		40_80	30	40	764	0	56	10	822	28	52	46
		80_250	20	30	764	0	83	22	822	0	38	7
		250plus	0	100	764	0	80	3	822	0	0	0
	NDT3	0_40	15	25	6,535	40	85	61	7,193	23	43	27
		40_250	20	40	6,535	15	60	39	7,193	25	58	40
		250_1000	30	50	6,535	0	19	1	7,193	0	50	33
		1000plus	10	20	6,535	0	0	0	7,193	0	0	0
	NDT4	0_40	30	40	462	42	100	84	554	49	100	63
		40_80	30	40	462	0	58	16	554	0	51	37
		80_250	20	30	462	0	0	0	554	0	0	0
		250plus	5	15	462	0	0	0	554	0	0	0
EK Trench North	NDT3	0_40	15	25	14,336	21	63	35	14,858	16	25	23
		40_250	20	40	14,336	29	64	49	14,858	24	41	35
		250_1000	30	50	14,336	0	38	17	14,858	30	49	38

Unit	NDT	Patch Size (ha)	Target		003 MINDY (Patch not controlled)				009 Patch Controlled			
			Min (%)	Max (%)	THLB (ha)	Min (%)	Max (%)	Avr (%)	THLB (ha)	Min (%)	Max (%)	Avr (%)
		1000plus	10	20	14,336	0	0	0	14,858	0	20	5
	NDT4	0_40	30	40	14,175	23	70	47	14,781	30	40	36
		40_80	30	40	14,175	10	38	24	14,781	30	39	34
		80_250	20	30	14,175	9	43	27	14,781	20	30	25
		250plus	5	15	14,175	0	24	2	14,781	0	15	6
South Park Central	NDT3	0_40	15	25	50,078	16	60	39	53,139	17	25	24
		40_250	20	40	50,078	27	54	43	53,139	24	40	34
		250_1000	30	50	50,078	0	36	15	53,139	30	41	32
		1000plus	10	20	50,078	0	31	3	53,139	0	19	10
	NDT4	0_40	30	40	3,789	21	91	44	3,878	32	40	38
		40_80	30	40	3,789	7	44	19	3,878	31	40	37
		80_250	20	30	3,789	0	58	27	3,878	20	30	26
		250plus	5	15	3,789	0	31	10	3,878	0	0	0
South Park North	NDT3	0_40	15	25	28,998	27	59	44	32,118	20	25	24
		40_250	20	40	28,998	38	61	49	32,118	25	40	32
		250_1000	30	50	28,998	0	29	7	32,118	30	41	32
		1000plus	10	20	28,998	0	0	0	32,118	0	18	12
Upper Columbia Radium	NDT3	0_40	15	25	19,174	27	67	49	20,508	21	26	25
		40_250	20	40	19,174	26	54	42	20,508	25	41	36
		250_1000	30	50	19,174	0	32	10	20,508	30	39	34
		1000plus	10	20	19,174	0	0	0	20,508	0	20	5
	NDT4	0_40	30	40	11,352	21	76	43	12,830	30	40	34
		40_80	30	40	11,352	6	27	15	12,830	30	34	31
		80_250	20	30	11,352	6	46	24	12,830	20	30	23
		250plus	5	15	11,352	0	53	19	12,830	0	15	12

Yellow highlights identify records with no early seral patch area within the reporting unit and patch size class.

Appendix 2 Old Seral Patch Results

Licensee: BCTS/Galloway

Unit	NDT	Patch Size (ha)	Target		003 MINDY (Early Patch not controlled)						009 Early Seral Patch Controlled					
			Min (%)	Max (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)
Brewer Dutch	NDT3a	0_40	0	100	1,185	238	1	49	16	16	1,185	238	0	62	21	11
		40_250	0	100	1,185	238	16	97	60	84	1,185	238	0	95	44	89
		250_1000	0	100	1,185	238	0	79	24	0	1,185	238	0	100	34	0
		1000plus	0	100	1,185	238	0	0	0	0	1,185	238	0	0	0	0
	NDT3b	0_40	20	30	1,457	524	0	46	16	11	1,457	701	1	68	22	17
		40_80	25	40	1,457	524	0	12	3	0	1,457	701	0	28	5	27
		80_250	30	50	1,457	524	0	89	33	89	1,457	701	0	68	30	56
		250plus	0	100	1,457	524	0	88	48	0	1,457	701	0	96	43	0
	NDT4	0_40	30	40	1,092	464	26	100	61	49	1,092	576	19	100	62	33
		40_80	30	40	1,092	464	0	46	10	0	1,092	576	0	63	14	29
		80_250	20	30	1,092	464	0	74	29	51	1,092	576	0	64	24	38
		250plus	0	100	1,092	464	0	0	0	0	1,092	576	0	0	0	0
Bugaboo	NDT2	0_40	30	40	3,017	909	17	60	36	45	3,017	954	18	65	37	33
		40_80	30	40	3,017	909	0	30	12	0	3,017	954	0	26	11	12
		80_250	20	30	3,017	909	0	75	43	0	3,017	954	11	59	40	55
		250plus	0	100	3,017	909	0	55	9	55	3,017	954	0	45	12	0
	NDT3a	0_40	10	20	7,455	1,369	29	48	39	39	7,455	1,457	31	46	39	31
		40_250	10	20	7,455	1,369	12	32	21	14	7,455	1,457	9	36	22	19
		250_1000	60	80	7,455	1,369	0	48	26	0	7,455	1,457	0	46	22	0
		1000plus	0	100	7,455	1,369	0	52	13	48	7,455	1,457	0	55	17	49
	NDT3b	0_40	20	30	1,717	692	14	53	30	31	1,717	829	13	57	30	26
		40_80	25	40	1,717	692	0	40	16	40	1,717	829	0	26	15	12
		80_250	30	50	1,717	692	0	64	34	29	1,717	829	16	67	39	16
		250plus	0	100	1,717	692	0	53	20	0	1,717	829	0	52	16	45
Cross	NDT3a	0_40	0	100	2,426	202	29	71	48	55	2,426	202	27	83	50	39
		40_250	0	100	2,426	202	29	71	52	45	2,426	202	17	73	50	61
		250_1000	0	100	2,426	202	0	0	0	0	2,426	202	0	0	0	0
		1000plus	0	100	2,426	202	0	0	0	0	2,426	202	0	0	0	0
	NDT3b	0_40	20	30	2,810	1,316	13	100	27	20	2,810	1,396	11	100	29	25
		40_80	25	40	2,810	1,316	0	34	6	0	2,810	1,396	0	9	4	8
		80_250	30	50	2,810	1,316	0	68	24	0	2,810	1,396	0	66	22	24
		250plus	0	100	2,810	1,316	0	82	42	80	2,810	1,396	0	84	46	42
Doctor Fir	NDT3a	0_40	10	20	4,510	742	5	18	13	15	4,510	756	6	47	19	6
		40_250	10	20	4,510	742	17	87	43	27	4,510	756	15	53	28	29
		250_1000	60	80	4,510	742	0	69	44	58	4,510	756	0	69	45	0
		1000plus	0	100	4,510	742	0	0	0	0	4,510	756	0	66	8	66
	NDT3b	0_40	20	30	3,753	2,633	7	33	19	14	3,753	2,707	5	37	19	14
		40_80	25	40	3,753	2,633	0	14	5	7	3,753	2,707	0	18	5	5
		80_250	30	50	3,753	2,633	0	26	7	9	3,753	2,707	0	30	11	13
		250plus	0	100	3,753	2,633	65	77	69	69	3,753	2,707	57	73	65	67
	NDT4	0_40	0	100	443	423	0	100	93	100	443	429	0	100	93	100
		40_80	0	100	443	423	0	0	0	0	443	429	0	0	0	0
		80_250	0	100	443	423	0	0	0	0	443	429	0	0	0	0
		250plus	0	100	443	423	0	0	0	0	443	429	0	0	0	0
Dunbar Templeton	NDT3a	0_40	0	100	1,454	320	36	81	50	59	1,454	327	25	70	46	70
		40_250	0	100	1,454	320	19	64	50	41	1,454	327	30	75	54	30
		250_1000	0	100	1,454	320	0	0	0	0	1,454	327	0	0	0	0
		1000plus	0	100	1,454	320	0	0	0	0	1,454	327	0	0	0	0
	NDT3b	0_40	20	30	1,058	866	1	100	19	3	1,058	980	1	100	17	3

Unit	NDT	Patch Size (ha)	Target		003 MINDY (Early Patch not controlled)						009 Early Seral Patch Controlled					
			Min (%)	Max (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)
		40_80	25	40	1,058	866	0	36	4	0	1,058	980	0	84	8	0
		80_250	30	50	1,058	866	0	99	77	97	1,058	980	0	99	75	97
		250plus	0	100	1,058	866	0	0	0	0	1,058	980	0	0	0	0
East Columbia	NDT3a	0_40	0	100	1,700	92	7	58	37	41	1,700	96	12	71	38	54
		40_250	0	100	1,700	92	36	75	58	59	1,700	96	0	82	50	46
		250_1000	0	100	1,700	92	0	57	5	0	1,700	96	0	58	12	0
		1000plus	0	100	1,700	92	0	0	0	0	1,700	96	0	0	0	0
	NDT3b	0_40	20	30	1,053	514	5	27	15	13	1,053	518	8	37	20	15
		40_80	25	40	1,053	514	0	30	10	0	1,053	518	0	46	11	0
		80_250	30	50	1,053	514	60	88	75	87	1,053	518	39	86	69	85
		250plus	0	100	1,053	514	0	0	0	0	1,053	518	0	0	0	0
	NDT4	0_40	0	100	471	294	0	100	38	11	471	349	0	100	42	20
		40_80	0	100	471	294	0	77	8	0	471	349	0	77	9	0
		80_250	0	100	471	294	0	90	39	89	471	349	0	81	43	80
		250plus	0	100	471	294	0	86	11	0	471	349	0	75	2	0
Fenwick	NDT3a	0_40	0	100	955	107	6	34	20	19	955	107	15	53	30	40
		40_250	0	100	955	107	66	94	80	81	955	107	47	85	70	60
		250_1000	0	100	955	107	0	0	0	0	955	107	0	0	0	0
		1000plus	0	100	955	107	0	0	0	0	955	107	0	0	0	0
	NDT3b	0_40	20	30	2,157	1,595	6	67	15	9	2,157	1,702	1	67	13	9
		40_80	25	40	2,157	1,595	0	37	4	0	2,157	1,702	0	33	3	0
		80_250	30	50	2,157	1,595	0	72	7	0	2,157	1,702	0	75	6	0
		250plus	0	100	2,157	1,595	0	94	74	91	2,157	1,702	0	99	79	91
Invermere	NDT3a	0_40	0	100	1,249	373	11	35	20	12	1,249	380	3	70	27	41
		40_250	0	100	1,249	373	0	89	75	88	1,249	380	11	94	59	59
		250_1000	0	100	1,249	373	0	75	5	0	1,249	380	0	78	14	0
		1000plus	0	100	1,249	373	0	0	0	0	1,249	380	0	0	0	0
	NDT3b	0_40	20	30	1,211	860	1	100	13	1	1,211	863	1	100	16	2
		40_80	25	40	1,211	860	0	52	4	0	1,211	863	0	29	3	0
		80_250	30	50	1,211	860	0	84	17	0	1,211	863	0	94	23	0
		250plus	0	100	1,211	860	0	99	65	99	1,211	863	0	99	58	98
	NDT4	0_40	0	100	452	281	0	100	69	32	452	306	0	100	70	42
		40_80	0	100	452	281	0	70	17	68	452	306	0	67	17	58
		80_250	0	100	452	281	0	0	0	0	452	306	0	0	0	0
		250plus	0	100	452	281	0	0	0	0	452	306	0	0	0	0
Kindersley Macauley	NDT3a	0_40	0	100	1,206	160	44	88	65	69	1,206	160	45	83	66	71
		40_250	0	100	1,206	160	12	56	35	31	1,206	160	17	55	34	29
		250_1000	0	100	1,206	160	0	0	0	0	1,206	160	0	0	0	0
		1000plus	0	100	1,206	160	0	0	0	0	1,206	160	0	0	0	0
	NDT3b	0_40	20	30	956	636	2	25	7	6	956	636	2	25	8	3
		40_80	25	40	956	636	0	21	1	21	956	636	0	21	2	0
		80_250	30	50	956	636	0	98	69	73	956	636	0	97	48	97
		250plus	0	100	956	636	0	98	23	0	956	636	0	98	43	0
Kootenay	NDT3a	0_40	0	100	1,603	17	41	90	61	66	1,603	23	50	82	63	62
		40_250	0	100	1,603	17	10	59	39	34	1,603	23	18	50	37	38
		250_1000	0	100	1,603	17	0	0	0	0	1,603	23	0	0	0	0
		1000plus	0	100	1,603	17	0	0	0	0	1,603	23	0	0	0	0
	NDT3b	0_40	20	30	2,558	466	7	17	12	11	2,558	773	5	29	13	27
		40_80	25	40	2,558	466	0	18	5	0	2,558	773	0	19	7	4
		80_250	30	50	2,558	466	0	27	10	13	2,558	773	0	67	14	19
		250plus	0	100	2,558	466	62	90	73	76	2,558	773	0	95	66	49
Nine Mile Moscow	NDT3a	0_40	10	20	6,580	934	23	58	41	35	6,580	963	20	51	38	40
		40_250	10	20	6,580	934	23	65	44	65	6,580	963	23	59	47	38

Unit	NDT	Patch Size (ha)	Target		003 MINDY (Early Patch not controlled)						009 Early Seral Patch Controlled					
			Min (%)	Max (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)
		250_1000	60	80	6,580	934	0	50	12	0	6,580	963	0	53	15	23
		1000plus	0	100	6,580	934	0	38	3	0	6,580	963	0	0	0	0
	NDT3b	0_40	20	30	11,823	7,994	4	24	9	4	11,823	8,439	4	28	10	4
		40_80	25	40	11,823	7,994	2	15	4	3	11,823	8,439	0	9	3	3
		80_250	30	50	11,823	7,994	0	25	3	0	11,823	8,439	0	37	4	0
		250plus	0	100	11,823	7,994	41	93	83	93	11,823	8,439	29	94	83	93
	NDT4	0_40	0	100	247	186	0	100	46	2	247	194	0	100	22	0
		40_80	0	100	247	186	0	100	38	98	247	194	0	100	61	100
		80_250	0	100	247	186	0	0	0	0	247	194	0	0	0	0
		250plus	0	100	247	186	0	0	0	0	247	194	0	0	0	0
Premier Diorite	NDT4	0_40	30	40	5,001	2,191	0	61	34	31	5,001	2,855	0	52	35	37
		40_80	30	40	5,001	2,191	0	55	22	13	5,001	2,855	0	73	18	13
		80_250	20	30	5,001	2,191	0	71	35	28	5,001	2,855	0	57	19	12
		250plus	0	100	5,001	2,191	0	29	2	29	5,001	2,855	0	54	21	38
Toby	NDT3a	0_40	0	100	8,720	429	41	77	54	44	8,720	432	36	71	54	48
		40_250	0	100	8,720	429	23	59	38	34	8,720	432	26	62	42	52
		250_1000	0	100	8,720	429	0	27	8	21	8,720	432	0	17	4	0
		1000plus	0	100	8,720	429	0	0	0	0	8,720	432	0	0	0	0
	NDT3b	0_40	20	30	4,032	1,245	18	69	28	23	4,032	1,308	11	77	29	11
		40_80	25	40	4,032	1,245	0	33	13	8	4,032	1,308	3	27	12	3
		80_250	30	50	4,032	1,245	0	56	26	16	4,032	1,308	0	58	24	27
		250plus	0	100	4,032	1,245	0	53	34	53	4,032	1,308	0	60	34	59
	NDT4	0_40	0	100	229	55	0	100	90	100	229	59	0	100	90	100
		40_80	0	100	229	55	0	0	0	0	229	59	0	0	0	0
		80_250	0	100	229	55	0	0	0	0	229	59	0	0	0	0
		250plus	0	100	229	55	0	0	0	0	229	59	0	0	0	0
Horsethief	NDT3a	0_40	0	100	95	90	0	100	87	100	95	90	100	100	100	100
		40_250	0	100	95	90	0	0	0	0	95	90	0	0	0	0
		250_1000	0	100	95	90	0	0	0	0	95	90	0	0	0	0
		1000plus	0	100	95	90	0	0	0	0	95	90	0	0	0	0
Lower Spillimacheen	NDT3b	0_40	0	100	2	1	0	100	87	100	2	1	0	100	87	100
		40_80	0	100	2	1	0	0	0	0	2	1	0	0	0	0
		80_250	0	100	2	1	0	0	0	0	2	1	0	0	0	0
		250plus	0	100	2	1	0	0	0	0	2	1	0	0	0	0
Skookumchuck Torrent	NDT3b	0_40	0	100	3	2	0	100	83	100	3	2	0	100	83	100
		40_80	0	100	3	2	0	0	0	0	3	2	0	0	0	0
		80_250	0	100	3	2	0	0	0	0	3	2	0	0	0	0
		250plus	0	100	3	2	0	0	0	0	3	2	0	0	0	0

Yellow highlights identify records with no early seral patch area within the reporting unit and patch size class.

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Unit	NDT	Patch Size (ha)	Target		003 MINDY (Early Patch not controlled)						009 Early Seral Patch Controlled					
			Min (%)	Max (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)
Eastern Purcell Central	NDT3	0_40	15	25	94,135	14,842	10	21	16	13	94,135	16,057	10	20	16	14
		40_250	20	40	94,135	14,842	10	29	21	19	94,135	16,057	12	27	21	22
		250_1000	30	50	94,135	14,842	12	27	18	22	94,135	16,057	9	31	20	23
		1000plus	10	20	94,135	14,842	30	69	44	46	94,135	16,057	28	67	43	41
	NDT4	0_40	30	40	4,648	3,150	39	100	58	41	4,648	3,308	43	100	60	58
		40_80	30	40	4,648	3,150	0	59	21	26	4,648	3,308	0	39	17	6
		80_250	20	30	4,648	3,150	0	53	20	33	4,648	3,308	0	43	23	36
		250plus	5	15	4,648	3,150	0	0	0	0	4,648	3,308	0	0	0	0

Unit	NDT	Patch Size (ha)	Target		003 MINDY (Early Patch not controlled)						009 Early Seral Patch Controlled					
			Min (%)	Max (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)	FMLB (ha)	THLB (ha)	Min (%)	Max (%)	Avr (%)	Last (%)
Eastern Purcell North	NDT1	0_40	30	40	4,356	750	29	49	36	47	4,356	808	28	45	37	42
		40_80	30	40	4,356	750	5	20	14	19	4,356	808	2	16	8	8
		80_250	20	30	4,356	750	7	31	18	7	4,356	808	4	33	16	24
		250plus	0	100	4,356	750	24	46	33	27	4,356	808	25	53	39	26
	NDT2	0_40	0	100	2,813	193	44	100	77	82	2,813	234	39	89	56	89
		40_80	0	100	2,813	193	0	26	13	18	2,813	234	0	48	18	11
		80_250	0	100	2,813	193	0	29	6	0	2,813	234	0	49	18	0
		250plus	0	100	2,813	193	0	33	4	0	2,813	234	0	31	8	0
	NDT3	0_40	15	25	35,518	6,329	22	37	30	28	35,518	6,979	21	36	30	29
		40_250	20	40	35,518	6,329	16	33	24	33	35,518	6,979	16	33	26	18
		250_1000	30	50	35,518	6,329	10	29	19	16	35,518	6,979	13	31	22	30
		1000plus	10	20	35,518	6,329	9	45	28	23	35,518	6,979	12	40	23	23
	NDT4	0_40	30	40	804	454	0	100	49	47	804	546	0	100	67	69
		40_80	30	40	804	454	0	70	35	53	804	546	0	58	20	31
		80_250	20	30	804	454	0	34	2	0	804	546	0	0	0	0
		250plus	5	15	804	454	0	0	0	0	804	546	0	0	0	0
EK Trench North	NDT3	0_40	15	25	34,446	14,061	11	17	14	11	34,446	14,576	9	16	13	13
		40_250	20	40	34,446	14,061	9	23	15	14	34,446	14,576	6	24	14	9
		250_1000	30	50	34,446	14,061	5	39	17	7	34,446	14,576	9	33	19	16
		1000plus	10	20	34,446	14,061	30	68	54	68	34,446	14,576	36	65	54	62
	NDT4	0_40	30	40	20,765	13,830	33	100	48	33	20,765	14,431	30	100	45	39
		40_80	30	40	20,765	13,830	0	42	17	11	20,765	14,431	0	49	19	13
		80_250	20	30	20,765	13,830	0	45	24	45	20,765	14,431	0	39	26	26
		250plus	5	15	20,765	13,830	0	28	11	11	20,765	14,431	0	34	11	22
South Park Central	NDT3	0_40	15	25	121,070	48,776	19	26	22	19	121,070	51,809	19	27	23	19
		40_250	20	40	121,070	48,776	10	29	17	11	121,070	51,809	10	26	17	10
		250_1000	30	50	121,070	48,776	4	32	16	5	121,070	51,809	5	27	14	12
		1000plus	10	20	121,070	48,776	19	65	45	65	121,070	51,809	21	60	46	59
	NDT4	0_40	30	40	4,970	3,708	10	100	35	15	4,970	3,794	5	100	32	5
		40_80	30	40	4,970	3,708	0	78	17	0	4,970	3,794	0	56	19	6
		80_250	20	30	4,970	3,708	0	62	14	0	4,970	3,794	0	70	19	0
		250plus	5	15	4,970	3,708	0	86	33	85	4,970	3,794	0	89	31	89
South Park North	NDT3	0_40	15	25	104,534	28,236	15	23	21	21	104,534	31,319	16	25	21	20
		40_250	20	40	104,534	28,236	16	21	18	17	104,534	31,319	14	21	17	15
		250_1000	30	50	104,534	28,236	8	30	19	17	104,534	31,319	10	32	21	12
		1000plus	10	20	104,534	28,236	32	51	43	45	104,534	31,319	32	56	40	53
	NDT4	0_40	0	100	1,508	303	36	100	69	89	1,508	352	42	100	73	71
		40_80	0	100	1,508	303	0	64	22	11	1,508	352	0	38	21	29
		80_250	0	100	1,508	303	0	31	9	0	1,508	352	0	28	6	0
		250plus	0	100	1,508	303	0	0	0	0	1,508	352	0	0	0	0
Upper Columbia Radium	NDT3	0_40	15	25	43,661	18,687	15	24	21	19	43,661	20,001	17	25	21	20
		40_250	20	40	43,661	18,687	14	24	17	16	43,661	20,001	14	24	19	16
		250_1000	30	50	43,661	18,687	7	35	21	13	43,661	20,001	10	29	19	12
		1000plus	10	20	43,661	18,687	30	53	41	53	43,661	20,001	26	52	41	52
	NDT4	0_40	30	40	16,707	11,065	19	100	56	20	16,707	12,527	19	100	54	20
		40_80	30	40	16,707	11,065	0	28	9	8	16,707	12,527	0	20	9	7
		80_250	20	30	16,707	11,065	0	33	13	17	16,707	12,527	0	30	11	10
		250plus	5	15	16,707	11,065	0	62	22	55	16,707	12,527	0	64	26	63

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