Alberta-Pacific FMA Area

2015 Forest Management Plan

Timber Supply Analysis Annex

2015

ALBERTA PACIFIC FOREST INDUSTRIES INC

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1 Introduction

The TSA annex contains the documentation on the technical TSA process, the development of the PFMS and the complete required reports and metrics for 12 FMUs. The document is composed of four distinct parts:

- TSA Process and Assumptions
- Synopsis of the FMUs' PFMS
- Two Appendices on the required sensitivity analysis
- 12 Appendices detailing FMU reports and metrics

2 Background on the TSA model

The Timber Supply Analysis (TSA) is a rational, methodical and repeatable process to determine a sustainable rate of harvest and a spatial harvest sequence (SHS) that implements that rate of harvest. The essence of the process is that forecasts of growth, harvest volumes and response to management treatments are applied to the starting forest condition of the FMA area and projected through time in to the distant future. The outcome of the analysis is reasonably simple: based on our best available information, we seek to confirm an explicit short-term plan of action that will deliver a predictable supply of short-term benefits and maintain the forest in a condition allowing a sustainable supply of future benefits.

The process is complicated by a number of factors, including the large area of the FMA; the long time frames over which sustainability is evaluated; the error and uncertainty inherent in the input data sets; and the determination of what constitutes sustainability. These factors are addressed by using computer simulation models to perform the calculations and carry out a careful analysis of options. Besides the influence of the quality of the input data sets, the reliability of the analysis depends to some degree on how the modeling is implemented and carried out: to the degree that the modeling mimics real world factors that matter, the forecast will more closely reflect real world outcomes.

The Patchworks spatially explicit wood supply model was used for TSA modeling in the development of the Al-Pac FMA DFMP. Patchworks has been used in Alberta for TSA and policy analysis purposes since 2002, and is a well understood modeling platform. Patchworks has been selected for this TSA because it is able to incorporate many operational factors that are of key importance in getting viable and effective short term (20-year) spatial harvest sequence (SHS), while at the same time being able to balance multiple issues of sustainability over a long-term (200-year) strategic horizon.

Patchworks has several important characteristics that make it highly suitable for this type of analysis:

- The spatial resolution of the model is homogeneous stand polygons, typically with an average size of 5 to 10 hectares. The homogeneous stratification of each polygon provides a consistent basis for assigning yield curves and determining eligible management actions and responses to treatments. In addition, this spatial resolution means an exact and direct link to the location of the required set of treatments.
- The solver component of Patchworks uses a goal programming formulation, allowing simultaneous consideration of multiple objectives. This allows the model to find equilibrium solutions for achieving a larger suite of goals than simply timber supply.
- Goals used in the modeling process include harvest volumes, long-term retained growing stock, access and transportation development and economics, landscape pattern, and retention of forest characteristics within a range of natural variation. The solver is able to explore a large decision space and consider many SHS options in order to best achieve the combined set of goals. It is highly likely that this will result in more efficient and higher achieving management outcomes than by optimizing the solution for a narrow range of goals, and then applying a set of constraints during the refinement stage.
- The spatial objectives that can be applied within the model (harvest and disturbance opening sizes, road construction and transportation requirements) include factors that are critically important to being able to successfully implement the proposed PFMS.
- The model supports a TSA process that allows for operational planners to review and refine the tentative SHS. To begin with, the model will include in the SHS blocks that are highly likely to be selected based on company observations (in the FHP, GDP, Quota Holder selections). During this phase forest company operational planners will be able to check the draft SHS for feasibility (access, timing, suitability, isolation), and make small corrective adjustments. The model will be rerun in order to balance out and measure the impact of these changes over the full sustainability period.

Overall, the purpose of using the Patchworks spatial model is to design a PFMS having an operationally efficient SHS, with excellent long-term sustainability characteristics and a degree of alignment between what is being modeled and what will actually happen on the ground during implementation. The characteristics of the TSA model are being designed to fully meet with Government of Alberta planning standard requirements.

Attached to this TSA documentation is the 12 FMU analytical reports (Appendices 3…14) that illustrate the required reports and metrics (maps, tables and figures) for the FMA area TSA. Each FMU report provides:

- Proposed AAC
- Conifer profile
- Landbase information
- Growing stock metrics
- SHS ownership
- Age-class information

- SHS strata tables
- SHS – period 1 and 2 maps
- Seral stage metrics and maps
- Forest patch metrics and maps
- Old interior core metrics and maps
- Five Songbird HSI metrics and maps
- Barred Owl metrics and maps
- Marten metrics and maps
- ECA assessment values and maps

3 Modeling Assumptions

This section describes the standard input assumptions and parameters that were used to implement the rules in the simulation model. One set of assumptions and parameters were developed, and were applied uniformly to each of the 12 FMUs, except where noted.

The parameters and assumptions that were used in this study are typical of timber supply analysis in Alberta. These parameters describe length of the planning horizon and the number of time steps used, the stratification of stand types for management, eligibility for harvest, transitions after harvest, etc.

These assumptions and other input parameters were coded in digital files, and scripts were used to automatically and consistently generate the simulation model input files required for each FMU. A highly standardized process was developed and followed for all FMUs in order to reduce the chance of a manually introduced error.

3.1 Planning period

The simulations were carried out with the base inventory updated as best as possible to reflect conditions on the ground as of the NLB effective date of May 1, 2013 (see Landbase Annex for more details). The Patchworks model was advanced to the start date of May 1, 2015 by aging the FMA area inventory and adding two years of harvest activity. All forecasting was done over a 200-year planning horizon, using 10-year planning periods.

- Planning start date: May 1, 2015
- Planning horizon: 200 years
- Planning period length: 10 years
- 20 planning periods

3.2 Stratification for management

Patchworks is a spatially explicit model, and tracks stand development attributes on an individual polygon basis. To reduce model size, groups of polygons having identical stratification values and ages are sometimes grouped together, depending on size and adjacency (for example, small slivers with identical stratification attributes may be dissolved into adjacent polygons). Also, groups of identically stratified polygons will share sets of development attributes and treatment options.

The following values were used to stratify the polygons in the modeling database:

Landbase attribute	Description
FMU	The FMU identifier
F_CONDITION	Identifies if the polygon is on the active or passive landbase
F_LANDBASE	Identifies if the polygon is on the conifer or deciduous landbase
YC_NUM	The yield curve stratification number
STEM_SIZE	An estimate of stem density, used to determine eligibility for UP treatments
TOWNSHIP	Included for use in allocation decision, but ultimately not used in the model
SHS2007	Identifies if stand selected in the SHS for the previous FMP. Ultimately not used in the model
CBFA	Identification of potential caribou deferral zones
FIRE	The location of major fires that occurred since the AVI update. This was ultimately not required since these were identified and recoded in the classified landbase.
HRF	The location of the Horse River fire, used to modify eligibility and initial age
PREBLOCK	Locations identified by Al-Pac and Quota Holders where operations were occurring or were scheduled to occur in the 2015 – 2017 time frame
OWNERSHIP	The name of the operator (Al-Pac, Quota Holder or AAF) that was associated with the pre-block assignment
MPB	Identification of mountain pine beetle priority stands
UPD2015	Stands that were indicated as being harvested in 2015
UPD2016	Stands that were indicated as being harvested in 2016
MartStrata	A code derived from the algorithm in the Marten NTA TSA integration model, used to implement the Marten model within Patchworks
ABMIStrata	A code derived from the algorithm in the Songbird NTA TSA integration model, used to implement the Songbird models within Patchworks
TRP	Timber Productivity Rating
WATERSHED	The watershed identifier, used to stratify values for the ECA indicator

Adjacent polygons with identical stratification criteria and identical ages were candidates to be joined together to form a reduced number of polygons in the modeling dataset. The Patchworks support program 'Group Fragments' was used to identify the polygons to join. Besides the stratification criteria listed above, the tool was set to consider joining polygons within 20m adjacency of each other to create larger polygons up to 50 hectares in size. The intent is that the resulting modeling data set will have a reduced number of polygons, with no change in area or yield summaries.

3.3 Seismic line net down

The approach used in the 2006 TSA was that the area of non-forest resulting from seismic line cuts was permanently withdrawn from the forest landbase. This approach does not reflect the gradual conversion of legacy seismic cutlines back to the forested landscape after harvest and renewal activities. By considering seismic cutline to be permanent withdrawals this approach underestimates the future productive capacity of the forest for timber and ecological values.

In light of this deficiency, an alternate approach was used to include the impact of seismic lines in the current harvest estimates, but assumes renewal to operable forest after the first harvest. To allow the return of these areas to the productive land base in the second and subsequent rotation the loss of volume to seismic lines in the first rotation will be estimated using an operation adjustment factor (OAF) calculated by FMU and yield curve type, and applied to first rotation volumes. In subsequent rotations the OAF will not be applied, and stand volumes will be based on the full yield curve values (less cull and retention deductions).

A sensitivity analysis was carried out to assess the differences in sustainability between these two approaches on the final PFMS. The outcome showed negligible difference, and is summarized later in this chapter.

For more details about this approach refer to the document in TSA annex Appendix I.

3.4 Natural breakup

Quantitative timber supply models have traditionally modeled the development of older late-successional stands with the paradigm that the old stand collapses and a young stand takes its place. In the Al-Pac 2006 FMP spatial analysis these rules were defined as follows (adjusted for differences in stratification codes):

Type	Break up age	Renewal age
Aw	185	0
AwU	185	60
AwSw	250	0
SwAw	250	0
Pj	210	0
PjMx	210	0
Sb	250	0
Sw	250	0

This modeling approach assumes that older forests abruptly change to young forest as a result of stand senescence. In reality, older stands undergo a slow change of overstory breakup and emergence of a mid-canopy layer to a dominant position. During this transition the stand will have a high level of standing dead trees, coarse woody debris, vertical structure, and other characteristics of old forest. The assumption of breakup and renewal to age 0 does a poor job of characterizing the long and complex late successional process.

The alternative used in this TSA is to assume, in the absence of a disturbance, that stands will not revert to an even-aged condition, but instead will prevail with equilibrium of individual tree senescence and recruitment of new overstory trees from advanced understory candidates. Timber volumes will never recover to full stocking of an even-aged overstory condition, and will be modeled at 50% of peak condition on the even-aged yield curve.

A sensitivity analysis was carried out to assess the differences in sustainability between these two approaches on the final PFMS. The outcome showed negligible difference, and is summarized later in this chapter.

For more details about this approach refer to the document in TSA annex Appendix II.

3.5 Operability criteria

Minimum harvest ages define the youngest age that the model will allow for simulated harvest. The minimum harvest age is similar in concept to rotation age, but the simulations deal with unregulated forests and will select harvesting from forest strata and age class to best achieve management goals. Although the highest AAC values are achieved when the harvest age is coincident with the maximum MAI value, other operational considerations such as piece size and stand density are used to limit harvest to older ages where the harvest economics are more favourable.

The following minimum harvest ages were used in all scenarios as a reflection of average stand operational characteristics. These ages represent the strict lower limit on age of harvest. The simulation model was free to choose to harvest stands at any age at or above this limit. Some of the non-timber goals had requirements for retention of older forest types. To satisfy these older forest requirements the simulation model often chose to harvest at older ages, or in some cases to avoid harvest.

Cover Group and leading species	Minimum harvest age (years)	Stems per ha	Treatment
D - Aw	60		Clearcut
D - AwU	60	< 600	Clearcut
		>= 600	Understory protection
DC	80		Clearcut
CD	80		Clearcut
C Pj	90		Clearcut
C Sw	100		Clearcut
C Sb	120		Clearcut

Stands that were eligible for harvest (active landbase, at or above minimum age) could be treated with a clearcut harvest treatment. When treated, harvest volumes would be calculated based on current yield and appropriate deductions (retention, seismic OAF).

AwU type stands that had 600 or more stems per hectare were eligible for an understory protection treatment.

3.6 Post-harvest transitions

In this analysis the assumption is that all stands receiving a clearcut treatment will remain in the same yield curve strata after harvest. Stands that are eligible to receive an understory protection treatment (yield curve 2, AwU, 600 or more stems per hectares) will be assumed to regenerate to different yield curves with the following proportions:

Future YC	Proportion
AwSw – UP	15%
SwAw – UP	15%
Aw	70%

3.7 Regeneration delay

The length of time between harvest and onset of volume was inherently included in the development of the yield curves. All stands will regenerate to age 0 on the designated yield curve. No additional regeneration delay has been applied.

3.8 Cull and retention deductions

The following cull and retention deductions have been applied:

	Cull	Retention
Conifer	2%	5% Al-Pac 3% Quota holders
Deciduous	4%	5% Al-Pac

Cull factors have been applied to the yield curves on input to the model so that all reported volumes consistently report this deduction. Conifer retention deductions are variable depending on the operator (in Al-Pac harvested stands 5% retention will be left, in Quota Holder harvested stands 3% will be left). These deduction factors are applied to the outputs of the simulation model depending on the proportion of conifer allocation in each FMU.

Deciduous cull factor of 4% used to remain consistent with previous timber supply analysis.

3.9 Implementation of LARP outcomes

All new protected areas due to LARP are no longer available for harvest in the TSA. No additional actions were required.

3.10 Utilization standards

The 15/10 utilization standard was used for both conifer and deciduous volume (see Yield Curve Annex).

3.11 Mountain Pine Beetle

High to moderate SSI Pj stands (with and SSI > 60) were initially included in the 10-year SHS for all preliminary scenarios. Few stands meet this criteria on the Al-Pac FMA. In the later scenarios the caribou deferral zones were excluded from this requirement. In the final refinement scenarios leading to the PFMS Quota Holders reviewed and revised the allocations, including in some cases eyes on the ground inspections.

3.12 Harvest opening size criteria

Harvest patch size distribution was controlled to ensure operational efficiencies and to move the landscape disturbance towards NRV disturbance event sizes (as informed by Dr. D. Andison[1]). Harvest patch size is the mechanism in the model to control fragmentation on the landscape and help achieve disturbance event size ranges.

The criteria for harvest opening patches used a 10-year disturbance duration, and a 100m adjacency criteria.

Harvest patch sizes have been developed to correspond with disturbance events, as well limit the smallest disturbances and largest disturbances sizes (as large fires on the landscape have accounted for the extremes and energy sector footprint contributes to the smallest).

Young forest patches will be reported as an output of the simulation and determined as a post process (see VOITs).

3.13 Productivity losses from road etc.

Roads are restored with prescriptions as specified in the Al-Pac Silviculture Matrix. No action is taken within the TSA.

[1] Andison, D. Modelling Historical Landscape Patterns on the Alberta-Pacific FMA. Bandaloop Landscape-Ecosystem Services, 2015.

3.14 FireSmart

Since the last FMP no new FireSmart communities have been identified by GoA. High risk areas within community zones were addressed in the previous plan. No new high risk areas within zones have been provided by AAF for this plan.

3.15 Horse River Fire

Stands that were within the area of the Horse River fire have burned and must be removed from contributing to AAC calculations until they have been re-inventoried. However, it is reasonable to assume that this area will successfully re-vegetate and contribute to non-timber objectives in future years.

All stands within the perimeter of the provisional boundary of the Horse River Fire will be assigned to the passive land base. All stand ages will be assigned to 0, and a 5-year regeneration delay will occur before these stands will transition back on to stand development yield curves for ECA and non-timber assessment purposes.

3.16 Recent harvest activities on the FMA

Steps were taken to account for activity on the forest since the production date of the net land base. The modeling data base was updated with recent harvest up to 2015 in order that the spatial model not select areas for harvest that have already been harvested. In addition, harvest carried out in 2016 is identified in 'pre-defined blocks' and are forced to have simulated harvest in period 1 of the planning model.

3.17 Final Harvest Plan (FHP) and General Development Plan (GDP)

Areas with prior investment in block planning (e.g. survey work, road construction, etc.) were included in early modeling scenarios as preferred locations for harvest in period 1 in order to account for operational planning of blocks. These locations were subject to review and adjustment during the refinement scenarios.

3.18 Transportation

The TSA model included a transportation sub-model so that stands were not allocated in areas before road access has been developed, and to balance cycle times between planning periods. An objective to reduce the extent of the active road network was used to consolidate harvest areas and reduce fragmentation. This strategic approach within the TSA is compatible with the general access plan.

The transportation network is based upon the existing road infrastructure within the FMA, and is densified with a regular lattice of candidate segments (see Figure 1). Candidate roads that cross water features were discarded, as were redundant segments. The cost values in the transportation model are in units of hours of transit time (cycle time), and appropriate travel times were assigned to each segment based on the segment length and anticipated travel speed.

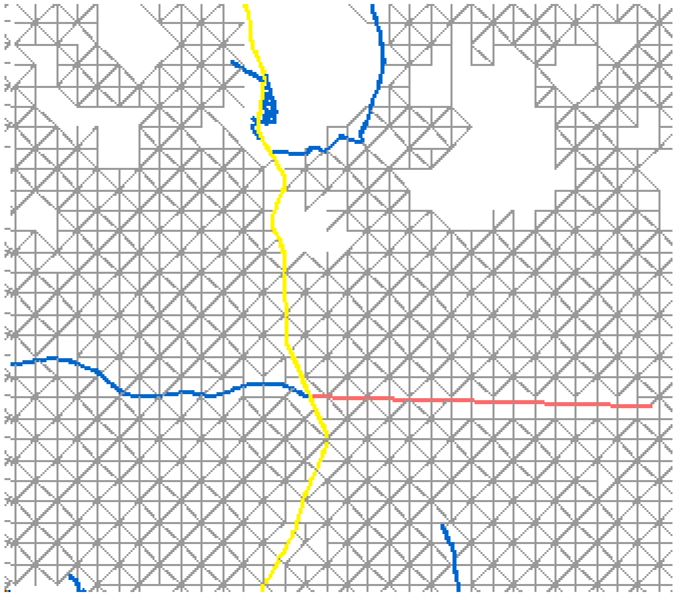


Figure 1. Sample of the road network used in the transprotation sub-model.

To simplify the model all wood (conifer and deciduous) is assumed to be transported to a single destination, that being the Al-Pac mill.

4 Management Objectives, VOITs and Non-Timber Assessment

A range of factors were included in the analysis to identify a preferred forest management scenario. These objectives were added to the analysis incrementally in order to both validate the model and to isolate the impact of individual factors.

Adjustments to objectives were made on an FMU basis to achieve a balanced strategic management outcome. Patchworks uses a goal-programming type of formulation to set the degree to which objectives compete with each other. Both targets and weights can be adjusted independently, with the target values specifying the desired level of achievement, and weights indicating the priority that achievement of one goal has over another.

Weights are adjusted relative to the other targets in a subjective fashion. Where more than two objectives are simultaneously active and compete for a mutual resource, the level of weights required to obtain a suitably balanced outcome may be elusive and require experimentation. As a priority weight is increased on one objective, other objectives may be adjusted in response (e.g. increasing the priority of maintaining a songbird objective, requiring late seral stage conifer habitat, may cause conifer harvest levels to decrease).

This section describes the objectives and how they were set in the model, and provides some examples of the indicators that are presented in the appendices that document the results of the set of preferred forest management scenarios for each FMU.

4.1 Harvest volume objective

In almost all scenarios the timber harvest objective was to achieve the maximum 200-year even-flow harvest of net primary deciduous and net primary conifer volume, subject to other objectives. For the initial scenarios, the even-flow criterion in most cases was restricted to variations of less than 1% per 10-year planning period from the 200-year average.

During the refinement scenarios, the harvest rate in the first 20 years was allowed to vary according to the operational schedules that were selected on the ground, but in all cases a best attempt was made to coordinate with quota holders to stay as close to the 70-year average AAC as possible. The small variations that did occur were a result of the nature of designing operational harvest plans: it is sometimes difficult to plan operationally feasible road access and harvest openings to meet an exact volume target.

A wide range of indicators were produced to describe harvest volume in each of the preferred forest management scenarios, including

- Harvest by conifer/deciduous and landbase
- Harvest by landbase and species group (see Figure 2)

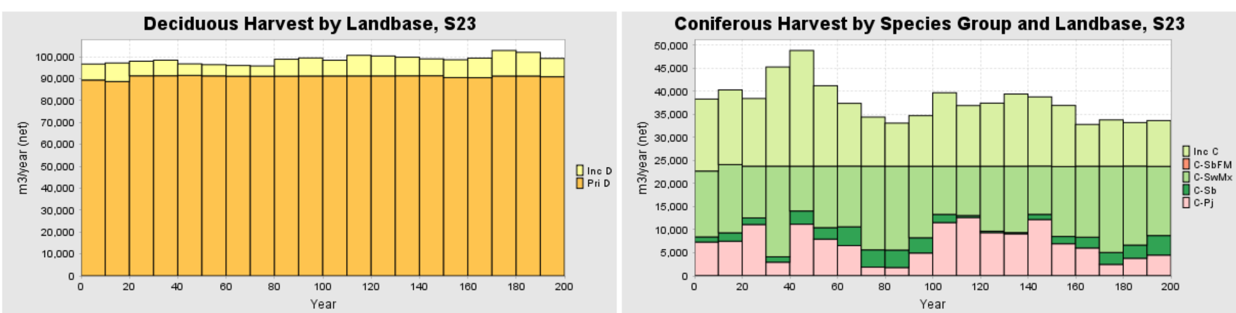


Figure 2. Sample of harvest volume indicator by species over time.

Other harvest indicators include

- Average piece size by conifer/deciduous
- Average harvest age by species group
- Area harvested by species group
- Area harvested by age class

Several sets of maps were produced to assist in clearly depicting the spatial harvest sequence. Within the Patchworks model output are sets of PNG image maps showing the location of harvest by cover class, and the location of harvest by harvest patch size class, for selected time periods. These maps are useful for a quick look, but have limited resolution to display smaller features.

An additional map was produced for each FMU in PDF format. These maps show the first 20 years of the SHS along with base map features. The PDF format is useful because it supports interactive features to navigate around the map, such as zooming, panning and selective enabling and disabling of mapping layers. The PDF maps are also in a larger format suitable for printing.

4.2 Residual growing stock

Long-term sustainability was also approached by using an objective to maintain non-declining primary available growing stock by conifer/deciduous for the last 50 years of the 200 year planning horizon. The intent was to avoid an 'end of the model' artifact, where the available supply would be exhausted in the year following the end of the planning horizon.

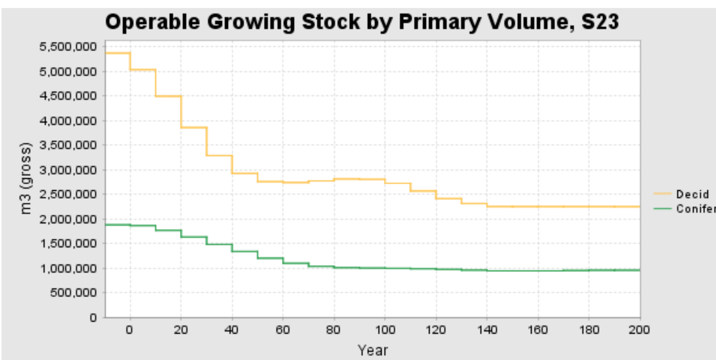


Figure 3. Sample of operable growing stock indicator.

4.3 Transportation objectives

Objectives were set on components of the transportation sub-model in an attempt to coerce compact harvest patch allocations. These objectives were to minimize the cost of road construction, road maintenance, and hauling, as expressed in a dollar cost per cubic metre of total harvest (both conifer and deciduous, primary and incidental). The weight values on the objectives were adjusted high enough so that the road footprint was compact, and the harvest pattern was clustered, but not so high that harvest rates were reduced.

A capital budget constraint was also set to limit the amount of road building that was allowed to occur within the first two planning periods. In some forest management units where access was not yet fully developed, this would limit the model from attempting an unrealistically rapid road build-out program.

A number of indicators are available within the PFMS outputs that describe the transportation characteristics of the model (see Table 1).

Table 1. Sample transportation indicators.

Period	Year	Length of road (m)		Costs				Product	Average haul	Average costs (per unit product)		
		Active	Built	Build	Haul	Maintain	Total	Total	distance (Km)	Build	Haul	Maintain
0	0	0	0	0	0	0	0	0				
1	10	387,699	269,124	13,456,223	9,710,699	344,879	23,511,801	1,404,173	109.55	9.58	6.92	0.25
2	20	425,249	184,195	9,209,756	9,289,388	377,632	18,876,775	1,428,889	108.65	6.45	6.5	0.26
3	30	546,301	196,729	9,836,458	9,885,270	500,827	20,222,556	1,419,600	109.27	6.93	6.96	0.35
4	40	534,370	108,671	5,433,532	9,647,824	488,754	15,570,110	1,492,735	104.02	3.64	6.46	0.33
5	50	746,987	133,384	6,669,203	10,364,734	705,001	17,738,939	1,511,732	110.15	4.41	6.86	0.47
6	60	735,165	69,706	3,485,303	9,675,218	691,245	13,851,766	1,431,493	105.7	2.43	6.76	0.48
7	70	712,199	46,538	2,326,890	9,086,545	668,373	12,081,808	1,389,438	103.87	1.67	6.54	0.48
8	80	719,344	24,855	1,242,768	9,093,732	681,391	11,017,891	1,357,579	108.82	0.92	6.7	0.5
9	90	682,813	12,000	600,000	9,006,505	639,447	10,245,951	1,375,050	107.11	0.44	6.55	0.47
10	100	699,628	6,414	320,711	9,255,900	658,886	10,235,497	1,397,291	107.08	0.23	6.62	0.47
11	110	685,886	6,000	300,000	9,683,179	645,831	10,629,011	1,436,463	107.54	0.21	6.74	0.45
12	120	669,600	4,414	220,711	9,827,798	623,593	10,672,102	1,431,175	108.36	0.15	6.87	0.44
13	130	726,989	0	0	9,681,747	684,558	10,366,306	1,433,488	108.36	0	6.75	0.48
14	140	795,308	15,845	792,256	9,645,600	828,262	11,266,118	1,447,539	106.21	0.55	6.66	0.57
15	150	743,555	0	0	9,665,482	702,437	10,367,919	1,433,767	108.16	0	6.74	0.49
16	160	759,652	0	0	9,310,636	718,864	10,029,500	1,410,759	105.5	0	6.6	0.51
17	170	740,138	0	0	9,024,396	698,095	9,722,491	1,377,092	104.72	0	6.55	0.51
18	180	701,238	0	0	9,497,082	662,636	10,159,718	1,422,095	108.67	0	6.68	0.47
19	190	709,317	0	0	9,317,226	665,510	9,982,736	1,407,839	105.67	0	6.62	0.47
20	200	768,167	0	0	9,348,767	729,633	10,078,400	1,384,244	107.39	0	6.75	0.53

4.4 Seral stages

Objectives were established to fulfill VOIT 1.1.1.1 (Maintain biodiversity by retaining the full range of cover types and seral stages). Cover classes and seral stages were defined in accordance with Dr. Andison's analysis of historical landscape patterns of the FMA (Table 2).

NRV were developed for the cover class by seral stage combinations based on three broad geographic groupings in the FMA: East (L11, L3, A14, A15), West (S14, S18, S22, S11), and South (L1, L2, L8, S23). The NRV values for these zones were applied proportionally to each respective FMU.

Table 2. Class and Seral Stage Definitions used in 2015 TSA (Source: Andison, 2015).

Strata	*Label*	*Juvenile*	*Immature*	*Mature*	*Over-mature*
Hardwood	D	1- 10 yrs	11 - 60 yrs	61 - 80 yrs	> 80 yrs
Pine	C-Pj	1 - 20 yrs	21 - 60 yrs	61 - 80 yrs	> 80 yrs
Black Spruce	C-Sb	1 - 20 yrs	21 - 70 yrs	71 - 120 yrs	> 120 yrs
Mixedwood & White Spruce	Mx / Sw (C)	1- 10 yrs	11 - 60 yrs	61 - 100 yrs	> 100 yrs

Targets were set to not allow the over-mature seral stage types to drop below the first quartile value of the natural range, at any time in the simulation (see Figure 4). No limits were placed on the upper limit, or on any of the other seral stage types.

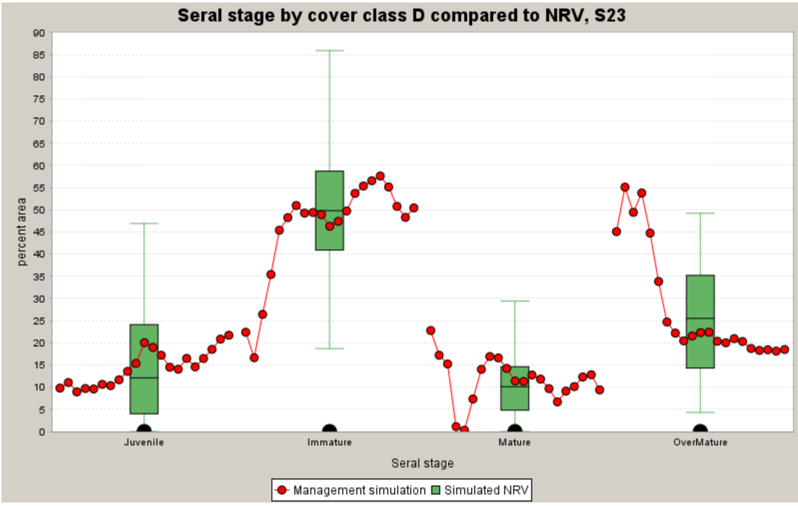


Figure 4. Sample of distribution of cover class D by seral stage over time, showing simulated values (red line, each dot represents a planning period). The green box and whisker diagram shows the min, max, median and inter-quartile range for each cover class and seral stage category.

These targets were set on the gross forest, and summaries were produced for both the net and gross forest.

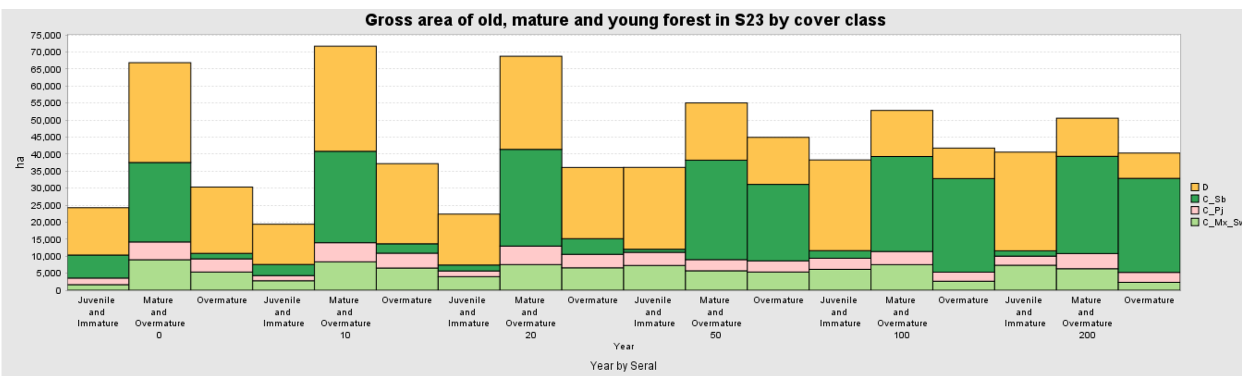


Figure 5. Sample of the distribution of all seral stage by cover class areas over time.

Maps were also produced showing the distribution of forest by cover class and seral stage category at times 0, 10, 20 and 50.

4.5 NRV Disturbance Patches

Harvest patch size controls were used to distribute the pattern of harvest on the landscape similar to the natural range of variation. The patch size targets that were used were informed by a study carried out by Dr. D. Andison on the Al-Pac FMA1).

Patch size (ha)	Target % of disturbed area
0 - 20	Max 7%
20 - 300	Max 25%
300 – 2500	Min 42%
2500 - 5000	Min 25%

This distribution is a truncation of the NRV of disturbance patch sizes from a natural landscape, and leaves out the large number of very small disturbance patches expected to occur from natural agents (e.g. small fires that quickly extinguish), and the few number of large fires. Harvest is the only disturbance mechanism in our simulation model, and harvest of small patches (<1 ha) or exceptionally large patches (> 10000 ha) is neither viable nor socially acceptable. In the real world these events will still occur, but there is no intent to use forest management to fill in the ends of the distribution.

The patch size targets were applied for the first four planning periods of the simulation (40 years). This duration was chosen to strongly influence the development of the SHS over the time horizon where it has a reasonable likelihood of being applied, but not constraining the situation in distant planning periods where changing policy and natural events would require a completely new layout.

The priority weights were set to attempt to best meet these objectives without causing significant reductions to wood supply. In addition, the NRV size targets were representative of larger portions of the FMA, and were difficulty to fulfill on some smaller FMUs or those with recent large disturbances (i.e. Horse River Fire). A series of scenarios were run for each FMU to estimate a suitable priority weight to use. We were not attempting to precisely meet the target size distribution in every planning period, but instead accepted some variation around the targets as being an expected part of natural variability.

The range of disturbance event sizes drives the pattern of the residual forest on the landscape. VOIT 1.1.1.2 (Maintain biodiversity by avoiding landscape fragmentation) was assessed based on the size distribution of young forest that would arise from the application of the NRV disturbance pattern.

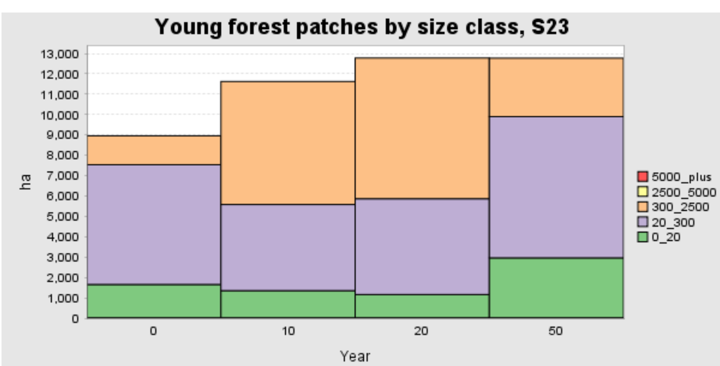


Figure 6. Sample indicator showing the area of young forest by patch size class.

Maps were also produced showing the location of young forest patches over time, colour coded by patch size class.

4.6 Large Interior Old Forest

Old interior forest metrics were calculated at time 0, 10, 20 and 50 years in the future from the PFMS results.

The old interior forest area was calculated using the following rule set:

- Using both gross and net landbase values
- maximum 8m separation allowed between adjacent old forest areas
- old age is defined by the 'Over-mature' seral stage condition by cover class
- edge disturbance criteria was as follows:

Type	***Edge effect distance***
Non-forest Forest less than 40 years	60m
Forest greater than 40 years and less than mature	30m
Mature forest	0m

This metric was calculated using a raster GIS operator, resulting in some degree of approximation. Interior core area is presented as maps and in tabular summaries of area by cover class for interior old forest in patches larger than 100 hectares at the end of Time 0, 10 and 50 years.

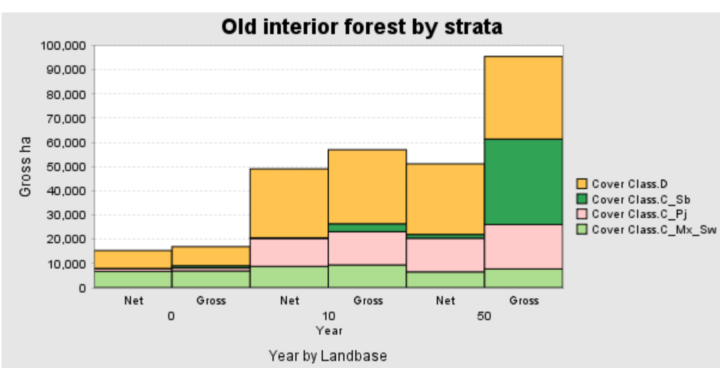


Figure 7. Sample old interior forest indicator, showing the area of large interior by cover class, in both the net and gross land base.

Maps were produced showing the locations of the old interior forest at selected time periods. The maps portrayed the interior and edge old forest by cover class, and show the location of mature and older forest to provide context to understanding the potential for old forest recruitment.

4.7 Caribou zone strategies

The approach for avoidance of impact to current caribou range locations has been the development of a strategic deferral zone strategy (see Figure 8). Eligible forest stands within these zones were deferred from harvest for 20 years. However, in A15 some Quota Holder pre-planned blocks within the deferral zones were scheduled for harvest within period 1. In S14 a few stands are scheduled in period 2.

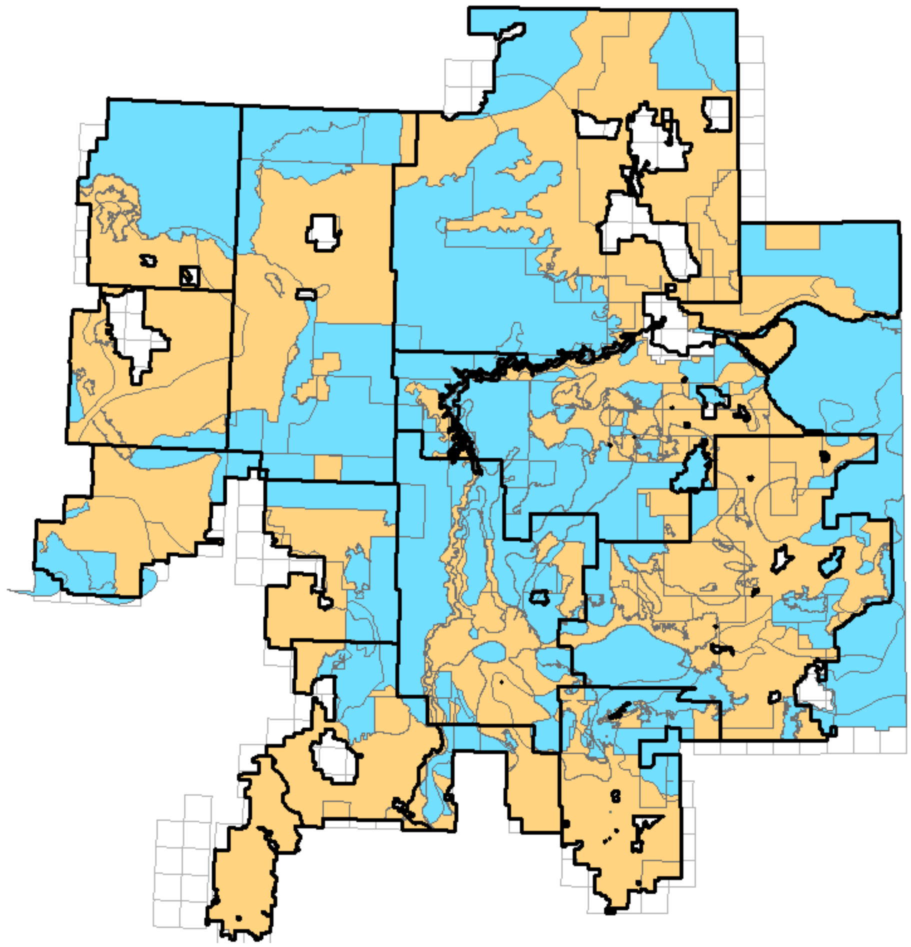


Figure 8. Caribou deferral zones (blue areas deferred for 20 years).

4.8 Aboriginal Viewscapes

Aboriginal viewscapes were identified within the classified landbase in FMU L1 and L11. The deciduous stands within these view-shed areas were deferred from harvest for 20 years. During the refinement the conifer quota holders elected to not harvest in these areas within the first 20 years of the SHS. These stands remained in the active landbase for future harvest and contributed to the calculation of AAC.

4.9 Equivalent Clearcut Area (ECA)

Equivalent Clearcut Area (ECA) indicators were implemented based on the provincial values by B10 class. Values were applied at a polygon level, and summed by watershed. Polygons in the modeling landbase were not intersected with the watershed boundaries. Instead, a majority area assignment was used (if a polygon spanned more than one watershed, it was assigned to the watershed where the majority of its area was located).

For each scenario and each planning period, the ECA value was calculated as a percent of the gross watershed area within the FMU. Results were presented as raw "percent ECA by watershed" (see Table 3), and as a summary of the watershed area by percent ECA threshold class (see Figure 9).

Table 3. Sample indicator for percent of ECA out of the gross watershed area, by watershed. Lower values represent less disturbance.

		Year					
		0	10	20	50	100	200
Watershed	150	4.58	3.55	24.99	6.24	15.76	14.21
	155	10.4	10.86	3.77	9.2	8.55	10.85
	159	2.28	0.66	4.68	7.18	6.53	9.01
	162	7.06	11.55	8.06	5.09	8.57	10.37
	1638	7.32	4.11	1.67	4.78	9.72	7.78
	164	2.02	2.05	0.78	5.34	3.32	7.79
	453	0.57	0.14	0.04	5.13	0.39	2.71
	494	5.98	22	6.64	4.94	10.21	5.72
	496	7.54	16.97	13.32	14.56	15.26	11.8
	498	3.7	7.08	6.96	5.6	9.4	10.7
	499	0.3	0.05	0	4.7	2.17	3.24
	500	16.58	39.21	12.94	5.45	14.84	11.73
	512	13.29	8.73	3.17	5.39	1.24	3.21
	549	9.17	10.34	12.31	8.93	12.67	13.43
	553	0.77	2.85	1.78	5.35	2.96	4.25

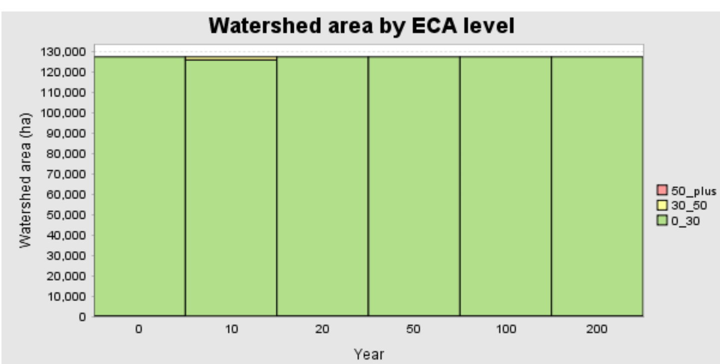


Figure 9. Sample summary indicator of the amount of gross watershed area within the FMU by disturbance threshold class.

Some unusual discrepancies sometimes show up with this indicator. Due to the uncoordinated alignment of FMU and watershed boundaries, some watersheds only have a fraction of their area overlapped by an FMU. A small overlapping watershed area that is coincidentally harvested will result in a very high disturbance threshold value.

This may be a false indicator, with the real disturbance level being determined based on the ECA values in the adjacent area, which might not even be part of the FMA. Small amounts of high threshold area, such as seen in Figure 9 usually indicate this type of artifact.

Maps were also produced to show the locations of polygons with non-zero ECA values, along with the watershed boundaries and other base map features. These maps were produced at times 0, 10, 20 and 50, and are useful for interpreting and diagnosing indicator values.

4.10 Songbirds

Songbird indicators were defined within the model based on coefficients provided by AAF based on the Songbird TSA integration model for Bay breasted Warbler, Brown Creeper, Black-throated Green Warbler, Canadian Warbler and Ovenbird.

The TSA integration method was implemented in Patchworks by adding the HLIN area of influence and Alberta Biodiversity Monitoring Institute (ABMI) strata values to each modeling polygon record. During the model building process steps were taken to ensure that polygons had homogeneous ABMI strata values. The HLIN value was calculated by generating the 7 hectare hard linear features grid, and calculating the area of intersection of the dissolved grid with each modeling land base polygon. Songbird indicator reports then used these values to apply the correct ratios of HLIN and other RA curves for each polygon.

Reports were generated for Year 10, 20, 50, 100 and 200, and compared to the initial Time 0 conditions. Reports showed the composite of all species as a percentage of time zero values (see Figure 10), and also by individual species showing the actual HSI values (see Figure 11).

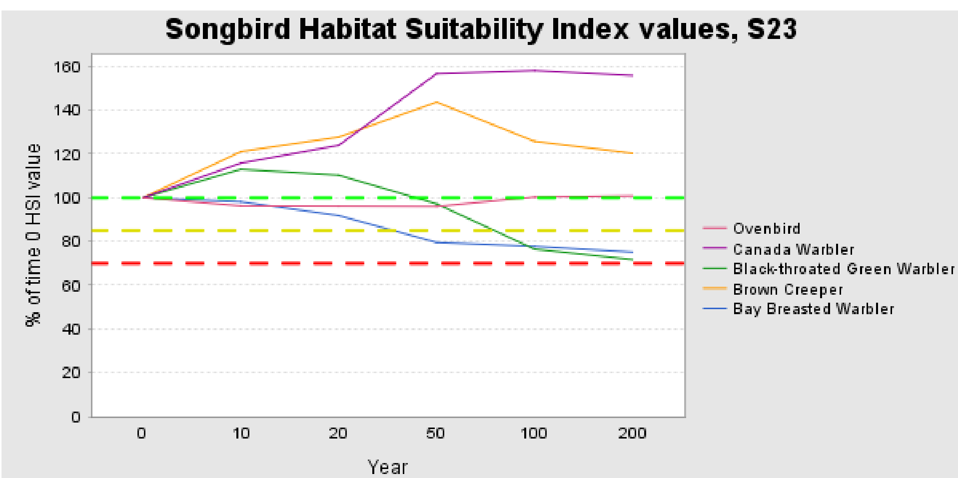


Figure 10. Sample songbird indicator showing values over time as a percent of time zero values. The green, yellow and red dashed lines show the 100%, 85% and 70% levels respectively.

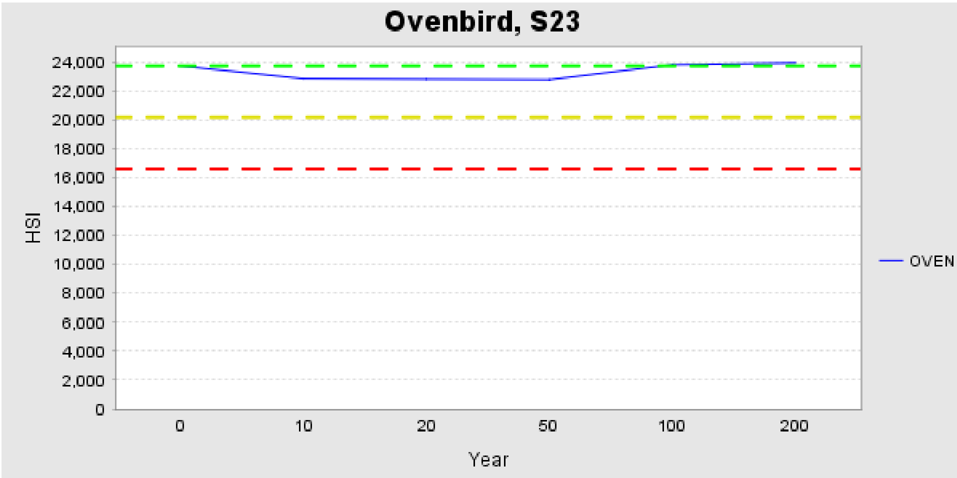


Figure 11. Sample songbird report showing calculated HSI values. The green, yellow and red dashed lines show the 100%, 85% and 70% levels respectively.

Maps were also produced for each songbird species at times 0, 10 20 and 50, showing the spatial distribution of HSI values. These maps were colour-coded by HSI value, and were helpful to understand abundance and concentration.

Some scenarios had targets set on the specific songbird indicators in order to control the change in HSI over time. These controls were used to prevent the HSI values from dropping below the 70% level.

It is reasonable to expect that values for some of the songbird indicators will vary over time based on naturally occurring shifts in forest composition and structure (for example, during the recovery from a large fire event). This may result in a situation where it is not possible to maintain HSI values at time zero levels through forest management actions. In addition, targets for maintaining songbird HSI values may be in conflict with VOIT 1.1.1.1, the objectives to maintain biodiversity by retaining the full range of cover types and seral stages.

4.11 Marten

Marten habitat suitability indices are included within the model using the TSA integration method based on algorithms and coefficients provided by AAF. Each polygon was assigned a marten model stratification code, which was used to link with the marten RA curves.

HSI values were summed for time periods 0, 10, 20, 50, 100 and 200. Values were shown over time and compared to Time 0 conditions (see Figure 12).

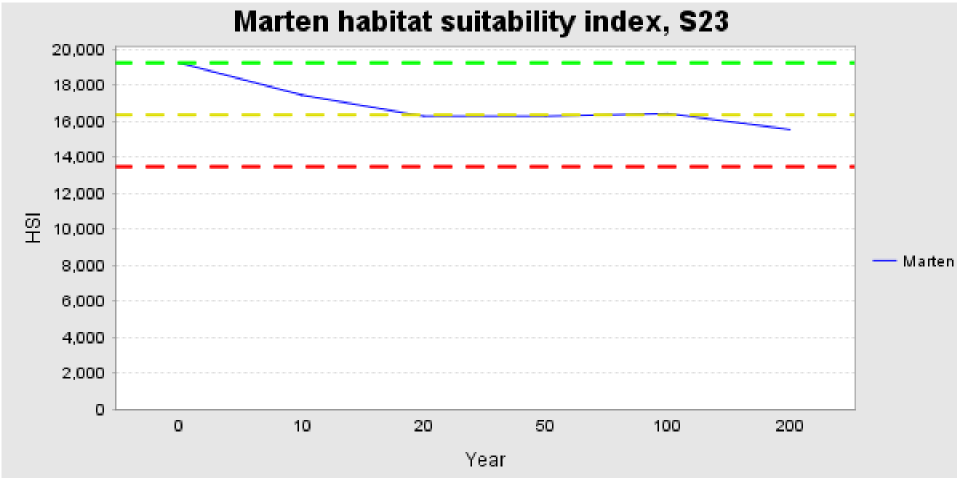


Figure 12. Sample marten HSI indicator. The green, yellow and red dashed lines show the 100%, 85% and 70% levels respectively.

A table was also produced to show the sum, mean and standard deviation of HSI values (see Table 4). These univariate statistics were generated from polygon values without weighting.

Table 4. Sample of summary statistics describing the marten HSI indicator.

		Statistic		
		Mean	Stdev	Sum
Year	0	1.0594	2.6826	19,244
	10	0.9614	2.4389	17,464
	20	0.8962	2.2992	16,279
	50	0.8961	2.4033	16,278
	100	0.9045	2.4466	16,431
	200	0.8558	2.3028	15,546

Maps were produced showing the spatial distribution of marten HSI values at times 0, 10 20 and 50. These maps were colour-coded by HSI value, and were helpful to understand abundance and concentration.

Some scenarios had targets set on the marten HSI indicator in order to control the change in value over time. These controls were used to prevent the HSI values from dropping below the 30% level.

4.12 Barred owl

The barred owl model was implemented in Patchworks as an automated assessment after the simulation was completed, primarily for efficiency and data integrity: we can ensure that we are using the correct datasets in the barred owl model by having the Patchworks model complete the assessment as the last step in the simulation, thus reducing the opportunity for human error while exporting and importing data sets. The assessment was done for 12 FMUs and 4 time steps.

The model was implemented using the same algorithms, parameters and coefficients as the AAF reference model that was coded for ArcGIS. A copy of the Patchworks barred owl model script is provided with the TSA digital submission.

The Patchworks barred owl model was verified by comparing results of all intermediate and final raster calculations with the intermediate and final raster results of a reference model done in ArcGIS (provided by Greg Greidanus of AAF). Values were identical in most steps, except for:

- the Patchworks model had slightly more accurate Euclidean distance calculations; and
- some numeric values were different in the least significant digits, likely due to differences in internal representations of numbers. The Patchworks version of the model uses double precision values, typically with 16 decimal digits of precision.

These differences were negligible, and the breeding pair indicators were identical.

A table was also produced to show the sum of the breedpair values, and the mean and standard deviation of RSF values (see Table). These univariate statistics were generated from uniformly sized pixel values.

Table 5. Sample summary statistics for the barred owl model.

		Breedpair	RSF	
		Sum	Mean	StDev
Year	0	704,719	0.11109	0.10209
	10	548,138	0.1042	0.09555
	20	384,177	0.09794	0.0889
	50	352,113	0.09239	0.08323

Maps were also produced to show the RSF values and breedpair locations at each of the time steps.

Since these indicators were produced as a post-analysis assessment, it was not possible to set objectives to directly control RSF or breedpair outcomes.

5 Analysis process leading to the PFMS

The Timber Supply Analysis was carried out independently on each of the 12 Forest Management Units (FMUs) within the Al-Pac FMA area. This approach allowed for devising specific strategies for each FMU, and helped to address quota holder challenges within a specific local context.

The TSA and SHS development process was carried out in four stages for each FMU. Each stage represents a set of simulations runs carried out using the Patchworks wood supply model, each with increasing levels of spatial detail and operational realism. The four stages were:

1. Calibration of the baseline wood supply

2. Implementation of non-timber policies
3. Operational adjustments to the draft SHS resulting in PFMS
4. Sensitivity analysis comparing PFMS for seismic and succession alternatives

Within each of these phases a controlled sequence of scenarios was run (see Table 6). Each of the scenario options shown in Table 6 was run multiple times for each FMU, adjusting the weights and target levels in order to achieve a balanced outcome.

For example, in the maxEven scenario, harvest target levels representing the maximum biological production level were determined through experimentation. The next step was to determine the weight values to use on the even flow targets, in order for the model to reasonably approximate an even flow harvest (+/- 1%) without being too restrictive or too lenient. In general, the best practice is to set the priority weights to the lowest level that is required to achieve the desired outcome. Low priority weight settings will allow the scheduler more latitude to explore trade-offs between competing goals, and will often result in higher valued solutions.

The following sections describe the purpose of each of these stages and the scenarios that were run within them in more detail.

Table 6. Scenario design matrix used in the TSA analysis.

Stage	Model Controls	Model Control Description	Scenario Name													
			Max Even	OPGS	Seral	Silv	Planned	Roads	NRV	Caribou	Refine V2	Refine V3	Refine V4	PFMS	Seismic sens	Succn sens
I. Base Model	Maximum even flow primary harvest	Maximum even flow volume for the FMU for primary conifer and primary deciduous. No control on incidental volume.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	NDY operable growing stock	Closing 50 year non-declining operable growing stock objective (as stated in planning standard) for primary conifer and primary deciduous.		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Over-mature seral stages	Over-mature minimum objective set to the 25th percentile of the range of variation for the applicable zone. Applied for each over-mature cover type on the gross landbase.			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Silviculture ratios	Silviculture ratios applied in the FMU for the understorey protection (AwU 70/15/15) and any other mixedwood quota ratios where Al-Pac shares a percentage of the conifer quota.				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Planned harvest	Pre-planned harvest blocks identified by Al-Pac and QHs for Period 1 (first 10 years). Provided prior to analysis and updated within the modeling landbase (SHS_V1).					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Transportation	Transportation objectives to balance the development of the road network overtime with the amount of harvest (using round trip cycle time as the unit of measure).						✓	✓	✓	✓	✓	✓	✓	✓	✓
II. Non-timber	NRV Harvest Patches	Harvest patch size ranges for 40 years to ensure an operable distribution for the SHS, the development of planning units and the achievement of a range of natural disturbance patch sizes on the landscape.							✓	✓	✓	✓	✓	✓	✓	✓
	Caribou deferrals	Caribou deferral zones for 20 years where applicable in each FMU.								✓	✓	✓	✓	✓	✓	✓
	NTA	Specific non-timber assessment targets as required									✓	✓	✓	✓	✓	✓
III. Refinement	SHS_V2	Add Al-Pac selected FHP blocks to pre-planned harvest block schedule for Period 1 (10 year).									✓					
	SHS_V3	Add Al-Pac selected FHP and GDP blocks to pre-planned harvest block schedule for Period 1 (10 year).										✓				
	SHS_V4	Manual operational adjustments to 20 year SHS based on review by Al-Pac and additional controls for NTA/ECA achievements if required by FMU.											✓			
	SHS_V5	Manual operational adjustments to 20 year SHS based on review by Al-Pac and QHs. Additional controls for NTA/ECA achievements if required by FMU.												✓	✓	✓
VI. Sensitivity	Seismic	Use a permanent netdown of seismic line area within each polygon to assess impacts to objective achievement.													✓	
	Succession Breakup	Use the conventional breakup at old and renew to young dynamics from 2007 FMP to assess impacts to objective achievement.														✓

5.1 Stage 1 - Calibration of the baseline wood supply

The first stage involved calibrating a baseline wood supply including common baseline TSA objectives, similar to those used in the approved Al-Pac 2006 FMP/ TSA. The purpose of this analysis was to explore and understand the impacts of using the new net landbase and yield curves as compared to the previous TSA. A number of the simulations carried out in this stage were used to isolate the factors that have changed and explain the reasons for any change in wood supply levels. In addition, this stage also helped to validate that the input data sets and model were set up correctly.

The primary controls in the wood supply analysis in this stage were:

- Wood flow policy to control a maximum even-flow of primary conifer and primary deciduous within each FMU. In the goal programming formulation this was accomplished using both maximization and even-flow objectives on both primary conifer and primary deciduous. The even-flow objective priority weights were relaxed to allow an approximate +/- 1% deviation in periodic harvest volume over all periods.
- Non-declining operable growing stock controlled residual available volume within the last 50 years of the 200 year simulation. Priority weights were adjusted to the minimum level required to achieve non-declining status.
- Maintain the area of over-mature forest by cover class above the first quartile level in the natural range of variation.
- Restrict the application of understory protection silviculture in the AwU strata to only those stands that have stand densities of greater than 600 stems per hectare, with renewal success ratios of 70% Aw/15% AwSw UP/15% SwAw UP.
- A pre-defined harvest sequence was implemented that included
    - Blocks identified as already harvested in the 2015/16 season, to be included in simulated harvest of the first planning period;
    - Blocks that are currently in the Al-Pac Final Harvest Plan (FHP) and General Development Plan (GDP) for which inspections, on the ground survey work, and road access development make these sites highly likely for inclusion in the period 1 SHS; and
    - Blocks identified by quota holders as highly likely period 1 selections.

  These actions were implemented in the model as harvest actions that occurred during period 1, and consisted of actual harvests that had already occurred, and proposed harvests that had been vetted by planners. The model will accept manually defined harvest treatments, but they must follow the operability rules appropriate for the yield strata. In cases where the inventory recorded stand age was younger than the operable age, the age in the model data base was adjusted to be the minimum operable age so the treatment could be applied.
- Transportation objectives to balance haul distances between planning periods (reduce fluctuations in haul distances over time), to maintain a minimum active road footprint that clusters harvest blocks on to the same road segments, and to ensure that harvest location is coordinated with incremental road access development (avoid infeasible pattern of harvest).

The intent was to have the transportation objective influence the distribution and clustering of harvest, but not to cause any reduction to harvest levels (i.e. spend the least amount necessary on road construction, maintenance and hauling required to bring in the maximum harvest levels).

The stage 1 analysis validated inputs, was used to update indicators and diagnostic reports, and resulted in baseline 'aspatial' harvest levels. SHS harvest maps from this stage show a 'shotgun' harvest pattern and are only generally indicative of what may become the final SHS pattern.

5.2 Stage 2 – Implementation of non-timber objectives

The second stage of analysis built upon the stage 1 baseline, and added NRV harvest patches, caribou deferral zones, and addressed specific NTA indicators for marten, songbirds and ECA (hydrologic recovery).

The following objectives were implemented during stage 2:

- All objectives from the final baseline scenario in stage 1.
- 20-year caribou deferrals were implemented according to the Al-Pac caribou zone deferral plan. No harvest was allowed in these zones for the first two 10-year planning periods.
- Harvest patch size objectives were implemented during the first 4 planning periods (40 years) to create harvest openings similar in size to the NRV disturbance size range.
- Selective targets on marten and songbird NTA targets that were approaching threshold levels (threshold levels were only limiting in the 100-year and 200-year forecasts).

Implementation of these objectives required careful adjustments of weights. For example, the NRV patch size objectives were difficult to implement on the smaller FMUs where there was less flexibility to arrange the larger size classes within the FMU boundaries. In these cases, the priority weights were relaxed to allow some degree of variance in harvest opening sizes from period to period.

5.3 Stage 3 - Operational adjustments to the first 20-year SHS

The purpose of stage 3 was to review and refine the SHS allocation that was created by the final scenario in stage 2 to make it suitable for operational implementation (feasible to implement and economically efficient). The type of issues considered during this stage included consolidating nearby harvest blocks, deferring isolated harvests, deferring harvests in areas with no current or planned road access, and assigning ownership to blocks. Many of the proposed sites received aerial surveys or other eyes on the ground assessments to confirm their suitability for harvest.

The following steps were followed during this stage:

- Al-Pac, the quota holders and regional AAF were provided with draft SHS shapefiles and interactive PDF maps. The attribute information provided with the shapefiles included stand age, net areas, cover class, expected primary and incidental volumes, and distance to mill.

Polygons in the shapefile included the draft SHS selections for the first 20-years, and other polygons eligible for harvest during the first 20-years.

- Al-Pac, the quota holders and regional AAF reviewed the draft 20-year SHS and edited the copies of the draft SHS shapefiles to change the timing and selections of blocks for harvest to address the issues they identified.
- The edited shapefiles were combined and tabulated to extract a new draft 20-year SHS. Conflicts between operators (selections of the same stands) were resolved. Ownership was assigned to blocks according to the source of the selections. Age adjustments were made on a small number of stands, within large aggregations of harvest blocks, that had been pre-blocked by QHs in SHS selection in order to bring them to the minimum operable ages usually by only a few years.
- The new draft SHS was loaded in to the Patchworks model. All other objectives from the final scenario from stage 2 remained unchanged.
- The first 2 planning periods (20 years) of SHS selections were 'locked down' and the Patchworks model was run to rebalance the remaining 180-years of harvest schedule to achieve the long term objectives.

After the above refinement steps, the harvest levels resulting from the 20-year draft SHS were compared to the sustainable levels. If over-harvest or under harvest had occurred, or if one quota holder had too large or too small an allocation, then the above process was repeated. On most FMUs this process had to be repeated several times to converge to a suitably balanced outcome (meeting the sustainable harvest levels, and appropriately balanced harvest levels between quota holders).

The output from stage 3 represents the proposed PFMS solutions for each FMU.

5.4 Stage 4 - Sensitivity analysis for seismic and succession alternatives

After the proposed PFMS was developed, the final step was to carry out a sensitivity analysis to assess the difference in long-term AAC between the PFMS modeling formulation, and two alternative formulations. These formulations are described here, and the analysis was carried out on all FMUs. The results of these sensitivity analyses are documented with the PFMS results for each FMU.

1) **An alternate method to account for the loss of productive forest land due to seismic cutlines.** The approach that was used in the PFMS model was to use an operational adjustment factor to reduce the yield curves (harvest volume, growing stock, non-timber attributes) during the first harvest. After the first harvest, the seismic areas would be considered restored, and the second growth would occupy the full site with no reduction. The alternative method to be compared to was to permanently net out the seismic cutline areas from all calculations, in both the current and future forest. More details about the rational for this approach are described in TSA annex, Appendix I

   This sensitivity analysis was implemented by creating an alternate model formulation with netted out areas and no operational adjustment factor. The 200-year SHS from the proposed

PFMS was loaded in to this alternative model, the new harvest levels were calculated, and the results were saved out. Note that the SHS from the proposed PFMS was used unchanged. In general, the results showed very little difference between the two alternatives.
The method used in the proposed PFMS showed a small uplift in sustainable harvest (<0.5%), due to the higher yields in future harvests.

2) **An alternate method account for late seral stage senescence and decline.** The approach used in the PFMS model was that older stands would decline in volume, but individual tree senescence and replacement from the understory or mid-canopy would result in older stands that had standing dead trees, fallen dead material, and high vertical structure. Harvestable volumes would not decline to zero, but would be maintained at a reduced level relative to peak even-aged conditions. The alternative method to be compared was that used in the 2006 model, where stands reaching a death age would be restated at age zero on their yield curves. More details about the rational and construction of this approach are described in TSA annex, Appendix II.

   This sensitivity analysis was implemented by creating an alternate model formulation that implemented death ages and renewal to age zero. The 200-year SHS from the proposed PFMS could not be successfully loaded in to this scenario, because a number of the stand harvest timings in the proposed PFMS occurred where the alternative model considered the stands to have broken up and renewed to a juvenile state, and were thus unharvestable. For this reason the assessment was run by trying to load the 20-year SHS, and then running the simulation model to rebalance the remaining 180 years. Because of the difference in the definition of older forest, some of the over-mature seral stage targets were difficult to meet, but the long term sustainable harvest rates were within 1% difference.

6 PFMS results

The following synopsis briefly describes the highlights of the complete analysis of each of the 12 FMUs, focusing on the PFMS results and the sensitivity analyses for alternative methods for assessing seismic cutlines and natural succession. The full results for the required indicators and reports for each FMU are provided in the TSA annex digital submission and selected metrics are in hard-copy in Appendices 3…14 (64 pages / FMU) following the TSA synopsis (highlight package) for all 12 FMUs.

Table 7 is the proposed Annual Allowable Cut levels for all 12 FMUs, including Al-Pac, Quota Holder, CTP/MTU and "unallocated" allocations. The Surface Mineable Area (SMA) of FMU A15 is not included within Table 7, for the fibre situation analysis of SMA (see Chapter 7) presents a proposed 20-year harvest level, not a sustainable AAC.

Table 7 – Proposed Annual Allowable Cuts (AAC) for Al-Pac FMA Area – 12 Forest Management Units.

	Alberta-Pacific FMA Area - 2015 TSA (AAC)											
	m3/year - 70 year avg.											
	Deciduous AAC m3 - 70 year avg.			Coniferous AACs m3			70 year average					
	Primary	Secondary	Total	Primary		(<3% SS)				Alberta-Pacific (<5% SS)		Secondary
FMU	Deciduous	Deciduous	Deciduous	Conifer	Quota Holder AAC			CTPs		Primary Conifer		Conifer
	AAC	AAC	AAC	AAC	Company	%	m3	%	m3	%	m3	AAC
L1	158,680	9,266	167,946	54,872	Northland F.P.	60.80%	33,362			-	-	31,939
					Alberta For. Ind.	12.88%	7,067			-	-	
					Bobocel Lumber	26.32%	14,442			-	-	
L2	127,382	17,029	144,411	69,420	Vanderwell	58.05%	40,298	0.07%	49	-	-	25,441
					Vanderwell	19.62%	13,623			-	-	-
					Bobocel Lumber	22.26%	15,451					
L3	68,758	32,424	101,182	148,992	Northland F.P.	100.00%	148,992			-	-	15,619
				9,900	Sb - F/M	100.00%	9,900					
L8	57,550	5,184	62,734	24,942	Bobocel Lumber	83.29%	20,774			-	-	10,340
					Northland F.P.	16.71%	4,168					
L11	287,826	17,899	305,725	106,922	MTU			Directed	15,000	-	90,084	62,982
A14	92,027	28,192	120,219	129,066	Northland F.P.	63.33%	81,737	2.20%	2,839	34.47%	41,344	25,441
				3,937	Sb - F/M	52.67%	2,074					
A15 SMA	na	-	na	na	Northlands	na	-	na	-	-	na	na
A15 Green	289,787	35,633	325,420	146,202	Northlands	53.17%	77,736	11.37%	16,623	35.46%	50,806	76,103
S23	90,646	6,402	97,048	23,684	Bobocel Lumber	68.18%	16,148			-	-	17,738
					CTPP (MTU)			31.82%	7,536			
S11	142,388	23,092	165,480	92,038	S11 Logging	91.86%	84,546			-	-	28,460
					Unallocated (MTU)	8.14%	7,492					
S18	216,950	28,843	245,793	124,174	Vanderwell	22.85%	28,374			-	-	52,845
					Alberta-Ply	77.15%	95,800			-	-	-
S22	340,136	19,353	359,489	99,683	Unallocated (MTU)	21.00%	20,935			26.09%	25,487	82,368
					Retained CTP			3.22%	3,209			-
					Vanderwell	48.00%	47,848					-
					FMA Local Use			0.26%	259			
S14	147,127	20,360	167,487	83,516	Kee Tas Kee Now	50.00%	41,758			-	West Fraser	*34,488*
					West Fraser (Ab-Ply)	50.00%	41,758					
Total FMA Area	2,019,257	243,677	2,262,934	1,117,348	-	-	854,283	-	45,516	-	207,721	463,764

7 2015 Alberta-Pacific Forest Management Plan - Timber Supply Analysis Synopsis for 12 Forest Management Units

7.1 Forest Management Unit A14

PFMS folder name: V1_A14_refinement_v5e

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	138,726	100,909
2015 Patchworks AAC (net m3/yr)	129,066	92,027

Conifer Quota Holder – Northland Forest Products

The complete set of detailed timber, VOIT and NTA indicators for the A14 PFMS are presented in the TSA annex. Both Al-Pac and NLFP have conifer quota in A14. Highlights for A14 are as follows:

A large portion of FMU A14 was burned by the Horse River Fire (HRF) in 2016. The modeling landbase was updated so that all forest stands within the preliminary fire boundary were designated to be on the passive landbase, and their ages were set to a 5-year regeneration delay before they would start growing along the yield curves of their existing strata. This change removed these stands from contributing to the AAC for the duration of the plan, but allowed non-timber values (including ECA) to contribute on the gross area as these stands developed.

Several factors caused a reduction in harvest levels in A14 since the 2011 assessment, including the HRF, the 20-year caribou deferrals zones, and the scattered distribution of mature pine and fair medium black spruce. The available conifer landbase was reduced to 109,315 hectares from 154,244 in the previous TSA. The deciduous landbase was also reduced to 41,586 hectares from 90,213 in the previous TSA. The large reduction in available area was the major cause of the reduction in AAC for this unit.

The contributing landbase contains a significant amount of scattered mature jack pine. In addition to the Pj, A14 has a harvest allocation for SbFM (fair medium black spruce) which also occurs in smaller patches scatter around the FMU and within the caribou deferral zones. These initial fragmented conditions conflict with the NRV harvest patch objectives applied in the TSA scenarios: the model was reluctant to harvest many small patches, and had difficulty making the full Pj/SbFM allocation. These spatial constraints resulted in a reduction in volume harvested, as well as a reduction in the amount of jack pine that was able to be harvested. Very little SbFM could be included in the allocation as a majority occurred within the caribou deferral zones and was therefore unavailable for the 20 year SHS. During refinement planners were able to allocate some SbFM that occurred adjacent to sequenced harvest blocks.

Non-timber values were somewhat constrained at time zero, in part due to the impact of the Horse River Fire. As the Gypsy-Gordon Park and the Horse River Fire areas mature over the 200 year planning horizon they are able to significantly contribute to mature seral stage VOITs and NTA indicators (marten and bird models).

The PFMS is based upon the caribou baseline scenario, with operational refinements to the 20-year SHS. This particular scenario achieves the long term sustainability of wood flow for both primary conifer and deciduous, non-decline growing stock for the remaining 50 years of the 200 year planning horizon as well as achievement of additional non-timber values (over-mature seral stages, NTA birds and marten). The caribou baseline scenario was selected as the basis for refinement to the PFMS as it moves the landscape towards a natural range of disturbance patch sizes and does not violate the caribou deferrals during the 20 year SHS. The short term allocation refinements and ownership assignments did not impact the long-term sustainability achieved during the strategic sensitivity analysis of TSA parameters.

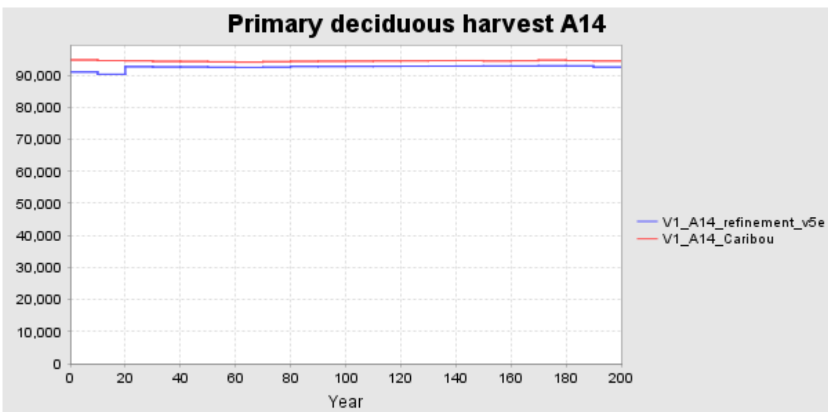
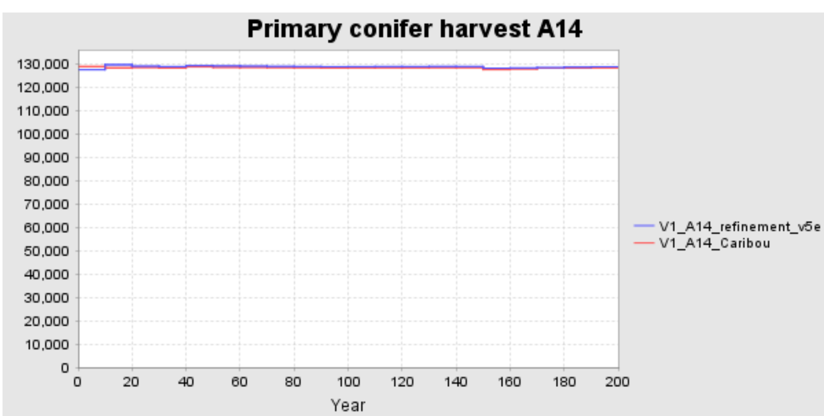


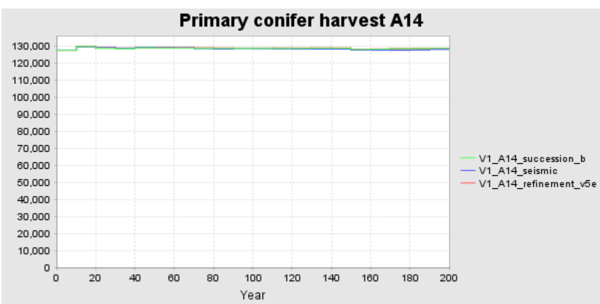
Figure 13. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue)



A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Figure 14 and Table 7). Final deciduous growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 7. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	129,066	129,022	-0.03%	128,851	-0.17%
Primary deciduous AAC (70-year average m3/year)	92,027	92,018	-0.01%	92,486	0.50%
Primary conifer growing stock (final 50-year average m3)	4,666,901	4,641,868	-0.54%	4,654,885	-0.26%
Primary deciduous growing stock (final 50-year average m3)	2,494,507	2,482,835	-0.47%	2,840,287	13.86%



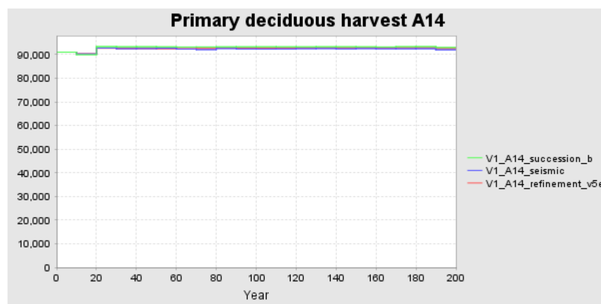


Figure 14. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.2 Forest Management Unit A15

PFMS folder name: V1_A15_refinement_v5e

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	174,398	316,412
2015 Patchworks AAC (net m3/yr)	146,202	289,787

Conifer Quota Holder – Northland Forest Products

The complete set of detailed timber, VOIT and NTA indicators for A15 PFMS are presented in the TSA annex. Both Al-Pac and NLFP have conifer quota in A14. Highlights for A15 are as follows:

Numerous changes have occurred to the A15 land base since the 2011 interim analysis was conducted, making comparisons to previous numbers difficult. The largest impact to AAC has been the reduction in the available landbase due to changes in the SMA boundary, the Horse River Fire and the 20-year deferral of caribou zones.

The harvest patch size controls significantly reduced AAC, and the 20 year caribou deferral caused an even further reduction. Mature jack pine and black spruce stands are dispersed in small patches across the landscape in the initial landbase conditions. The jack pine and black spruce harvest was significantly reduced in the first 40 years of the simulation when harvest patch objectives were active, in part due to the reluctance of the model to fragment the landbase by harvesting small patches. The 20-year caribou deferrals temporarily removed a large portion of the available black spruce and mature jack pine forest, and this short-term reduction reduced the even-flow Pj/Sb harvest even further. The size distribution of the potential jack pine harvest areas (many small dispersed areas) conflicts with the NRV landscape-level disturbance goals (create larger disturbances). During the refinement stage the operational planners were able to allocate some mature jack pine adjacent to other selected stands, however very little black spruce was available outside the caribou deferrals.

Some harvest is selected to occur within the Richardson burn in the northern portion of the unit. Although this is within caribou deferral zone, the area burned in a fire and salvage is underway. MPB stands were targeted within this area as part of the 20-year SHS for Northlands and the CTP. Operational planners choose to allocate some conifer blocks in the southern portion of the caribou deferral zone as part of an overall plan to access planned blocks within the northern part of FMU A14. The additional area scheduled within the caribou zone helped to increase the long term conifer AAC levels as compared to the strict deferrals that were applied in the Caribou scenario (Figure 15).

Due to the disturbance caused by the HRF some watersheds exceeded the 50% ECA threshold levels during the first 50 years. Beyond 50 years all watersheds ECA values remained less than the 30% threshold. Marten and songbird NTA indicators did not drop below 85% of time 0 values for the entire 200-year planning horizon. This can be attributed to the HRF area developing to mature and over-mature conditions over the 200-year planning horizon, and being unavailable for harvest. Over-mature seral stage objectives are maintained above the lower 25th percentile of NRV for all cover types.

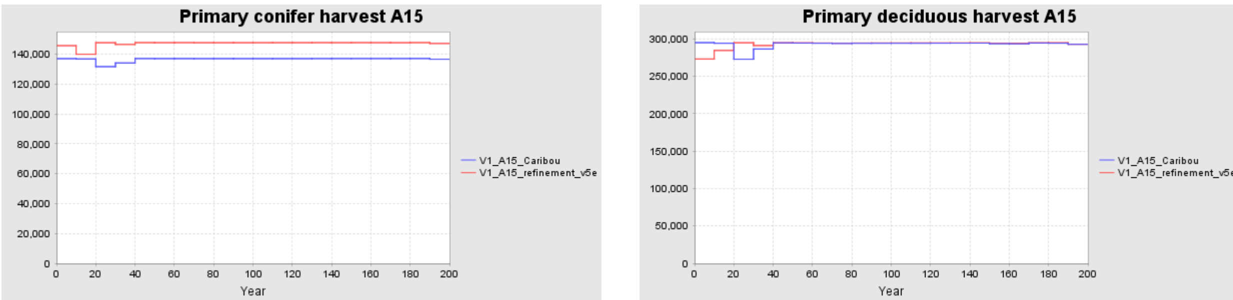


Figure 15. A comparison of primary harvest levels between the caribou baseline scenario (blue) and PFMS (red).

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession within the model. There was a less than 1% difference in the long term AAC between the PFMS and the seismic and succession scenarios (see Table 8, Figure 16). For more information on the sensitivity analysis see Chapter 6 Appendix II.

Table 8. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	146,202	146,194	-0.01%	146,828	0.43%
Primary deciduous AAC (70-year average m3/year)	289,787	289,804	0.01%	287,503	-0.79%
Primary conifer growing stock (final 50-year average m3)	6,871,414	6,849,993	-0.31%	6,916,612	0.66%
Primary deciduous growing stock (final 50-year average m3)	8,376,024	8,352,490	-0.28%	9,643,200	15.13%

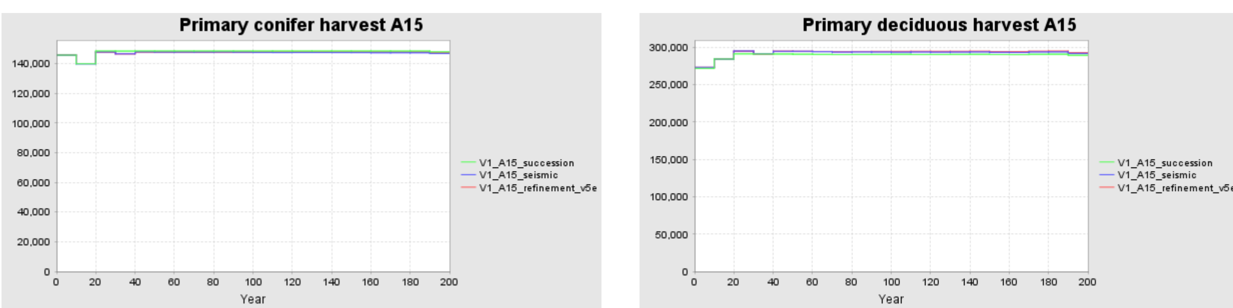


Figure 16. A comparison of primary harvest levels between PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.3 Forest Management Unit L1

PFMS folder name: V1_L1_refinement_v5b

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	58,342	163,811
2015 Patchworks AAC (net m3/yr)	54,872	158,680

Conifer Quota Holders – Northland Forest Products, Ed Bobocel Lumber, Alberta Forest Industries

The complete set of detailed timber, VOIT and NTA indicators for L1 PFMS are presented in the TSA annex. Highlights for L1 are as follows:

The available area in FMU L1 did not change significantly as compared to the 2011 updated landbase. AAC levels for both primary conifer and deciduous remained similar to the 2011 approved numbers for all phases of the TSA. Al-Pac's deciduous allocation in L1 includes DC stands. The conifer allocation is shared by 3 conifer operators (Northland, Bobocel and AFI) and ownership of conifer blocks in the 20-year SHS was assigned to represent current quota proportions as closely as possible.

A caribou deferral zone covers a large area in the northern half of FMU L1. The deferral zone overlaps a large burned area that had not been re-inventoried and was not part of the contributing landbase. There was very little impact on long-term AAC due to this constraint, since the caribou deferral did not overlap much area that was available for harvest in the first 20-year period.

An area on the south east side of Heart Lake was deferred from deciduous harvest in the first 20 years; “Aboriginal viewscape”. This area did not restrict conifer allocations; however the conifer operators choose to make a majority of their allocations elsewhere during the refinement stage.

The initial age class distribution of the contributing landbase contains a significant amount of pine within the 1-20 and 80-100 year age classes. During the refinement phase conifer operators were able to sequenced additional jack pine to meet spatial constraints, target high risk MPB stands and respect deferral boundaries (Heart Lake and caribou). As a result 50% of the 70-year average conifer allocation is composed of jack pine.

The amount of over-mature pine on the gross landbase in L1 is well above NRV levels for most of the planning horizon. This relatively steady supply of mature pine resulted in the marten NTA indicator remaining above 85% of time 0 values for all planning periods. Songbird indicators did not decline below 70% of time 0 values at any point in the forecasts. Over-mature seral stage objectives were met for all cover types in the PFMS, and ECA levels did not exceed the 30% threshold in any watersheds. A comparison of the PFMS to the base Caribou scenario showed little change in long term strategic levels as a result of short term operational refinements (Figure 17).

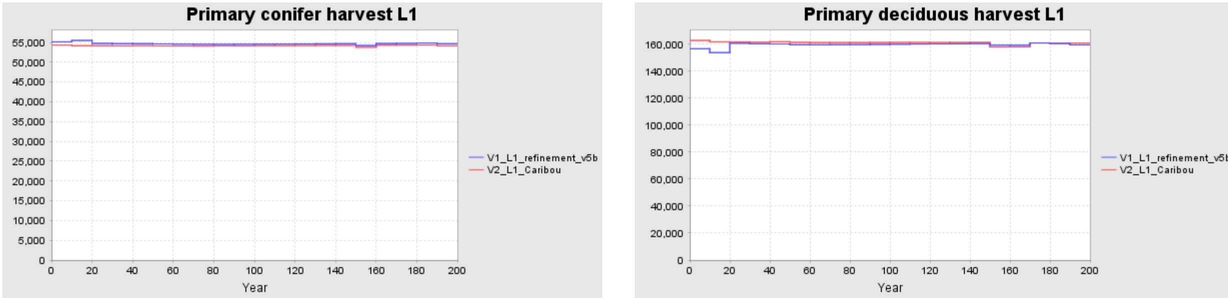


Figure 17. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue).

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 9, Figure 18). Final conifer growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 9. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	54,872	54,853	-0.03%	54,626	-0.45%
Primary deciduous AAC (70-year average m3/year)	158,680	158,853	0.11%	158,449	-0.15%
Primary conifer growing stock (final 50-year average m3)	2,007,219	1,995,976	-0.56%	2,033,500	1.31%
Primary deciduous growing stock (final 50-year average m3)	3,923,354	3,896,875	-0.67%	3,782,270	-3.60%

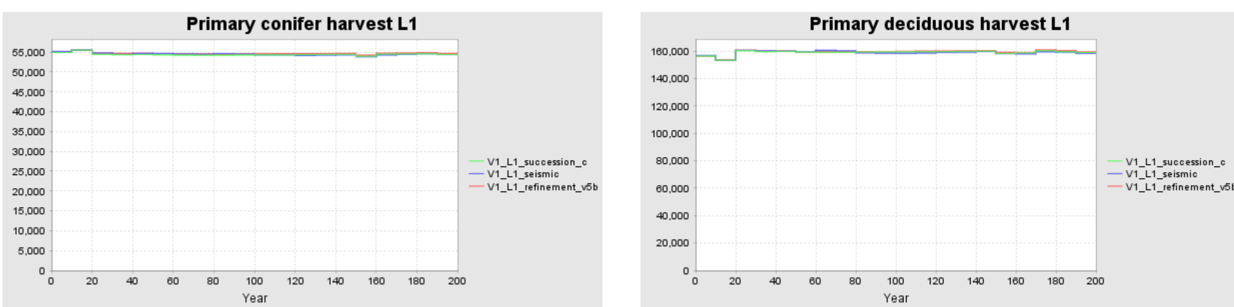


Figure 18. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.4 Forest Management Unit L2

PFMS folder name: V1_L2_refinement_v5c

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	73,376	137,244
2015 Patchworks AAC (net m3/yr)	69,420	127,382

Conifer Quota Holders - Ed Bobocel Lumber and Vanderwell Contractors

FMU L2 also has a small conifer CTP allocation.

The complete set of detailed timber, VOIT and NTA indicators for L2 PFMS are presented in the TSA annex. Highlights for the PFMS for FMU L2 are as follows:

There was little change in available landbase area (both conifer and deciduous) between the 2011 assessment and the 2015 TSA. It appears that changes to yield curves are contributing to most of the difference in AAC between the current approved levels and the results of 2015 TSA. In all scenarios including the PFMS the conifer AAC was below the current approved and the deciduous AAC was above the current approved.

Due to legacy harvest patterns and scattered conifer in L2 the large size classes of the NRV harvest patches were difficult to develop within the first 40 years, and this had a significant impact on wood supply. The weighting on the largest harvest patch size class objective was relaxed to lessen the impact on AAC while still acting to move the landscape towards the NRV disturbance pattern. The caribou deferral in the northern portion of the unit had a small impact on wood supply in this unit. Harvest activities in the first 20 years of the simulation were concentrated in the southern portion of the FMU.

The over-mature seral stage targets were easily met in all cover types over all time periods. Objectives were set in the PFMS to maintain marten, bay breasted warbler, and brown throated green creeper. The marten NTA indicator was maintained above the 15% decline from initial conditions and all songbirds were maintained above the 30% decline for the 200 year planning horizon.

Initial forest conditions show a significant amount of over-mature Mx_Sw that is well above NRV levels. Over-mature Mx_Sw correlates closely with the BTGW habitat model. The over-mature Mx_Sw steadily declines over time but remains well above the 25th percentile. Coincidentally the black-throated green warbler (BTGW) declined between 100 and 200 years but did not drop below the 30% threshold value. Old Mx_Sw cover type is present in higher levels than NRV at the start of the simulation, and it appears that the reduction in BTGW HSI values between time 0 and year 200 represents a shift towards a more natural representation of the landscape in this zone.

Starting with the strategic caribou scenario, several operational refinements rounds were carried out to balance the 20-year SHS by the conifer quota holders, ultimately leading to the PFMS. After review of the initial allocations several configurations were tested to ensure the allocation was operable by QHs and that the split of primary conifer met requirements. Small operational changes to the deciduous allocation were also incorporated after refinement review and the assignment of the CTP from the conifer allocation. The refined SHS was tested in the model and compared to the strategic objective achievements of the Caribou scenario. No long term deviations from strategic levels resulted from the short term refinements (Figure 19). Deciduous harvest levels declined between the Caribou and PFMS as a result of the operational refinement. This small decrease was able to improve TSA indicator achievement as well as maintain long term even-flow with the 20 year SHS.

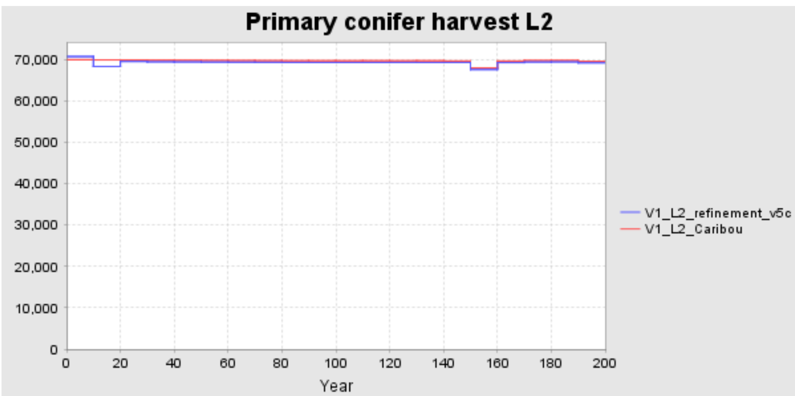
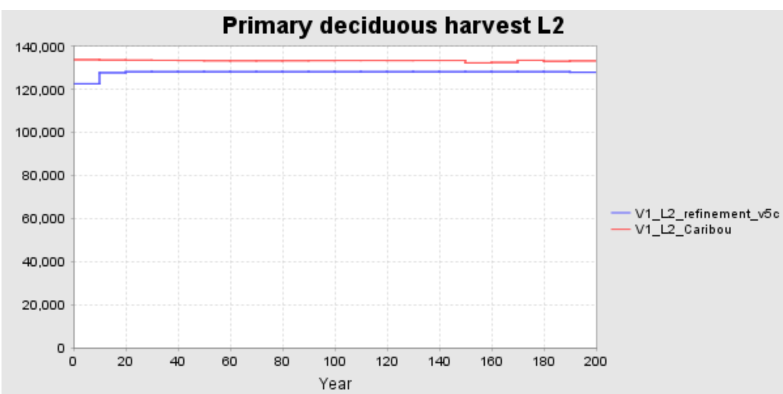


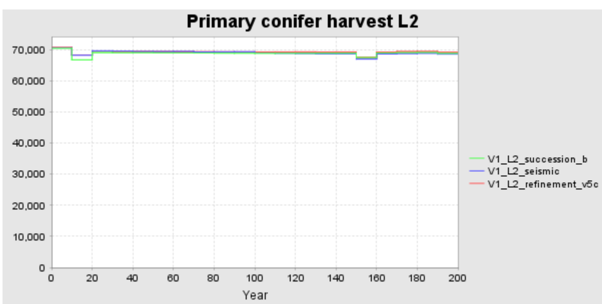
Figure 19. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue)



A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 10, Figure 20). Final deciduous and conifer growing stock levels were lower than the succession scenario (less than 4%), due to the change in breakup ages.

Table 10. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	69,420	69,433	0.02%	68,877	-0.78%
Primary deciduous AAC (70-year average m3/year)	127,382	127,598	0.17%	126,843	-0.42%
Primary conifer growing stock (final 50-year average m3)	2,492,861	2,472,932	-0.80%	2,591,539	3.96%
Primary deciduous growing stock (final 50-year average m3)	3,627,576	3,596,364	-0.86%	3,747,472	3.31%



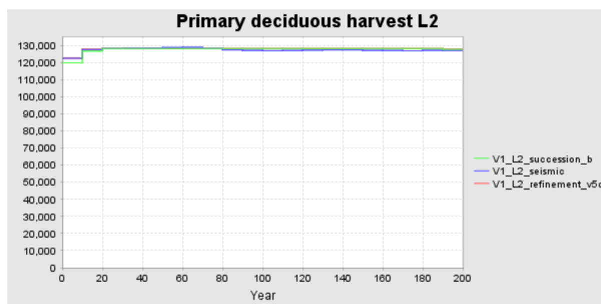


Figure 20. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.5 Forest Management Unit L3

PFMS folder name: V1_L3_refinement_v5e

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	161,436	73,711
2015 Patchworks AAC (net m3/yr)	148,992	68,758

Quota Holder – Northland Forest Products

The complete set of detailed timber, VOIT and NTA indicators for L3 PFMS are presented in the TSA annex. Highlights for L3 are as follows:

In the previous plan Millar Western Forest Products Ltd held the primary conifer quota in this FMU, but in 2015 these rights were purchased by Northland Forest Products Ltd. During the NLB preparation for the TSA MWFP provided pre-blocks selections and these were used in the initial stages of analysis. NFPL reviewed these allocation and made changes during the refinement stage of the PFMS development.

L3 includes a separate NLFP quota and sustainable harvest level calculation for Sb-FM that is not included in the primary conifer sustainable harvest level estimates. The SbFM AAC has declined from the previous plan.

The area of the available landbase remains the same as the 2011 update, except that the current landbase includes additional Pj that had been previously excluded due to the subjective deletion site index.

The initial distribution of area by age class (see Figure 21) contains a large amount of younger (less than 40 year) pine and white spruce and a large amount of black spruce and white spruce in the older age classes (greater than 100 years). There is a gap within the 40 to 100 year age classes. There is a large area of juvenile conifer which is due to a comprehensive silviculture treatment program and the subsequent approved RSI inventory performed by Millar Western in the 1990s.

This initial distribution is advantageous as it is set up to allow an easy transition to a well regulated age class structure, with the initial harvest derived from the current mature forest, and the future harvest in 40 years coming from the current immature forest. In all scenarios the average harvest age drops after 60 years when younger stands become available for harvest.

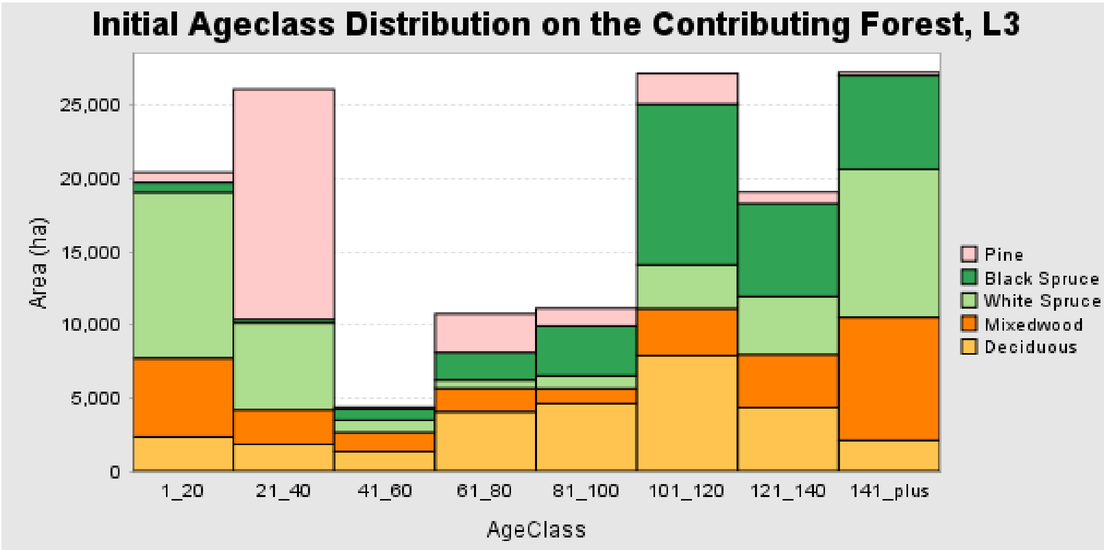


Figure 21. Initial distribution of area by age and cover classes.

Both conifer and deciduous primary AAC were above current approved AAC levels in all phases of analysis. The primary deciduous and conifer levels showed little change as the management objectives were cumulatively added during the first two phases of analysis. The resilience of the wood supply in the face of compounding objectives is a result of the initial age class conditions.

The over-mature D and MxSw cover types were well above the NRNV maximum at time 0. At no time were any of the over-mature cover types a limiting factor. The D, Pj and Sw_Mx over-mature types decline into the natural range over the 200 year planning horizon, but Sb increases to well above NRV levels.

The caribou deferral in this unit covers about half of the area and restricts the available area to the south, east and along narrow river valleys and the major transportation routes for the first 20 years. Several of the initial pre-block selections included in the NLB were located inside the caribou deferral boundaries. NFPL reviewed these areas during refinement and made substitutions with stands outside the deferral zones for the 20 year SHS. A majority of the available mature jack pine and fair-medium black spruce was contained within the caribou deferral zones. As result, very little SbFM was included in the 20 year SHS. Additional available jack pine stands were included where operationally feasible during the refinement phase.

The marten NTA indicator is maintained above 85% of time 0 values for all time periods, as are the songbird HSI values with the exception of the Black Throated Green Warbler (BTGW) which dips below 85% but remains above the 70% threshold in year 200. ECA levels were also maintained below the 30% threshold for all planning periods evaluated.

The Caribou base scenario provided the strategic long-term direction for the unit and was used as a starting point for refinements to the 20-year SHS. Several iterations of development and refinement were carried out to ensure compliance with the deferrals and to balance the conifer profile. The resulting refined 20-year SHS formed the basis of the PFMS; results were compared to the long term indicator achievement of the Caribou scenario. No significant deviations were identified as a result of the short term refinements to the allocation.

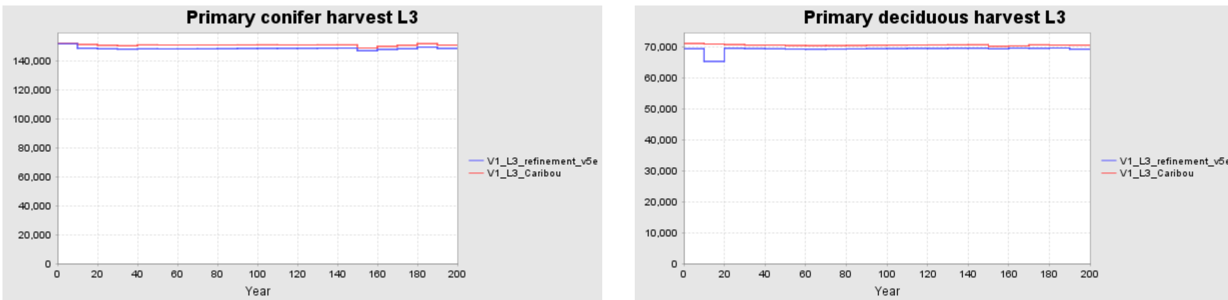


Figure 22. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue).

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 11, Figure 23). Final deciduous growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 11. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	148,992	149,063	0.05%	149,860	0.58%
Primary deciduous AAC (70-year average m3/year)	68,758	68,752	-0.01%	68,155	-0.88%
Primary conifer growing stock (final 50-year average m3)	5,574,852	5,545,315	-0.53%	5,388,230	-3.35%
Primary deciduous growing stock (final 50-year average m3)	1,805,068	1,796,245	-0.49%	1,828,839	1.32%

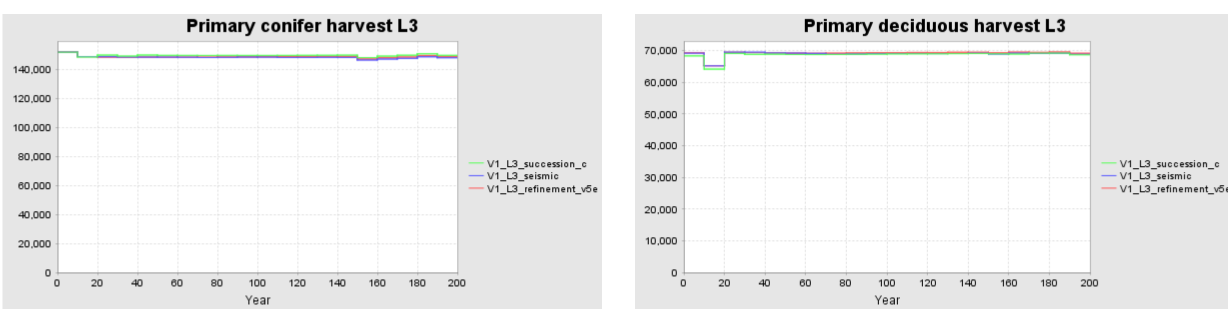


Figure 23. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.6 Forest Management Unit L8

PFMS folder name: V1_L8_refinement_v5b

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	27,096	61,347
2015 Patchworks AAC (net m3/yr)	24,942	57,550

Conifer Quota Holders – Ed Bobocel Lumber and Northland Forest Products

The complete set of detailed timber, VOIT and NTA indicators for L8 PFMS are presented in the TSA annex. Highlights for L8 are as follows:

There were minimal changes to the amount of contributing landbase in FMU L8 since the last TSA assessment, and harvest levels in the PFMS remained relatively close to the current approved levels.

The conifer AAC dropped significantly when the NRV harvest patch objectives were strictly applied. L8 is a small FMU, and it was not possible to locate a range of large harvest patches through multiple time periods without severe wood supply consequences. To mitigate these losses the targets for the largest harvest patch sizes were removed.

A large portion of the northern and western FMU is overlapped by the caribou deferral zones. The 20-year harvest was concentrated in the eastern portion of the unit, and implementation of the caribou deferral had no impact on conifer and deciduous AAC levels.

The PFMS was based on the strategic Caribou scenario, and several rounds of operational refinements were carried out with Northland and Bobocel to come up with the final SHS. Al-Pac operational planners also participated in the refinement and made adjustments to the deciduous blocks. Several iterations were carried out with interim results compared to the strategic results while the conifer quota holders balanced the profile and quota. The short term SHS adjustments for refinement did not impact the long term achievement of other indicators and all were comparable to the previous Caribou scenario (see Figure 24).

Figure 24. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue).

During refinement additional objectives were added to mitigate the decline of bay breasted warbler and black throated green warbler HSI levels in the latter part of the planning horizon. These additional objectives had a small but noticeable impact on conifer harvest levels, as the habitat models attempted to retain additional mature conifer to increase BBWA and BTGW HSI values. These additional NTA objectives and the short term SHS refinements were able to prevent the songbird HSI indicators from dropping below 70% of the time 0 conditions.

During refinement the conifer quota holders selected larger and more compact harvest patches for the first 20 years. This strategy helped achieve the patch objectives as well as mitigate some of the NTA indicator decline, but resulted in higher profile of Sb and Pj. MPB high risk stands were added to the SHS where they were operationally feasible.

The ECA indicators were all below the 30% threshold level, except for two watersheds representing 0.69% of the FMU which were above the 30% disturbance threshold. These watersheds span the FMU boundaries of L1 and L8, with the majority of area within L1. When the ECA indicator is taken in the context of the entire watershed area the impact does not appear to warrant corrective actions (see Table 12).

Table 12. ECA disturbance levels by watershed.

Watershed	Total watershed area (ha)	Area of watershed in L8 (ha)	Area disturbed in L8 (ha)	ECA as percent of total watershed
152	15,156	544	276.6	1.4%
489	19,945	332	110.3	0.6%

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 13, Figure 25). Final conifer growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 13. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	24,942	24,948	0.02%	24,871	-0.28%
Primary deciduous AAC (70-year average m3/year)	57,550	57,541	-0.02%	56,984	-0.98%
Primary conifer growing stock (final 50-year average m3)	1,092,196	1,084,493	-0.71%	1,112,339	1.84%
Primary deciduous growing stock (final 50-year average m3)	1,575,028	1,563,893	-0.71%	1,561,349	-0.87%

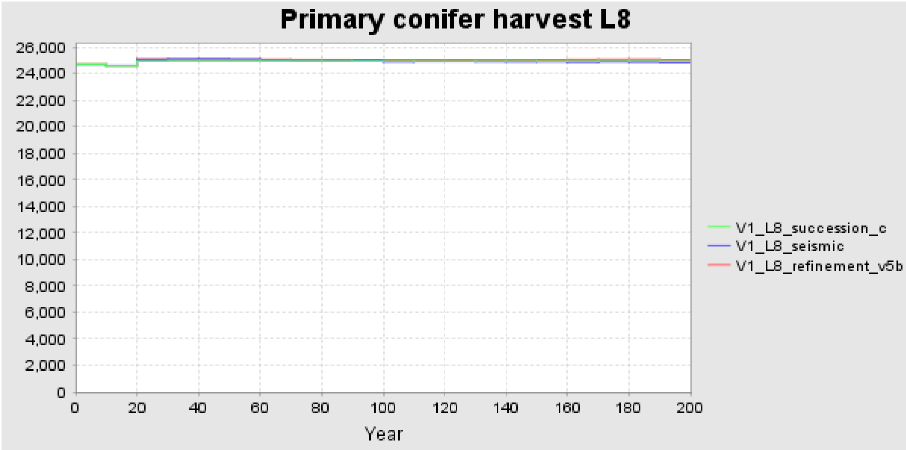
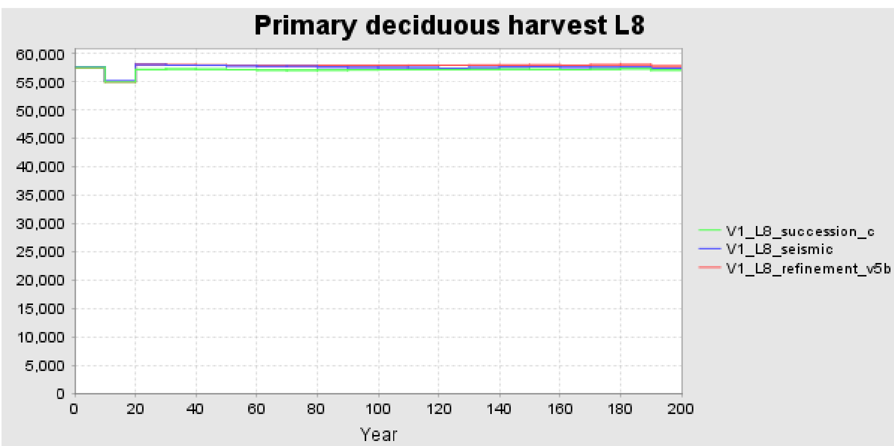


Figure 25. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.



7.7 Forest Management Unit L11

PFMS folder name: V1_L11_refinement_v5b

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	114,911	300,747
2015 Patchworks AAC (net m3/yr)	106,922	287,826

The complete set of detailed timber, VOIT and NTA indicators for L11 PFMS are presented in the TSA annex. Highlights for L11 are as follows:

Al-Pac holds the conifer quota in this unit where D/DC contributes to the deciduous landbase and C/CD cover groups contribute to the conifer landbase. There is a “Directed Conifer CTP” of 15,000 m^3/year that is managed by GOA that was identified during the SHS refinement.

The area and composition of the L11 landbase changed significantly as compared to the 2006 TSA. The Horse River Fire (HRF) burned in the northern portion of the FMU, and in the modeling landbase this area was classified as regenerating and unavailable. The Dillon River Wildland Park is no longer part of the contributing landbase, but continues to contribute to non-timber objectives. The available conifer landbase was reduced to 87,855 hectares from 162,480 in the previous TSA. The deciduous landbase was also reduced to 117,987 hectares from 168,179 in the previous TSA. The large reduction in available area was the major cause of the reduction in AAC for this unit.

There is an abundance of isolated mature jack pine scattered through the FMU, and the current amount of over-mature jack pine in L11 is well above the seral stage NRV for this zone (see Figure 26). As with other FMUs, harvest levels were sensitive to the NRV harvest patch size objectives because of the conflict between harvesting Pj and creating a large number of small harvest patches. Targeted harvest of priority MPB stands outside the caribou zone also created additional fragmentation in the first planning period.

The inherent structure and composition of the landbase made it difficult to lay out a harvest pattern that conformed to the NRV patch size targets without drastically reducing AAC. The NRV patch size targets were relaxed to prevent AAC decline, and this resulted in more small size harvest patches than indicated by the NRV distribution.

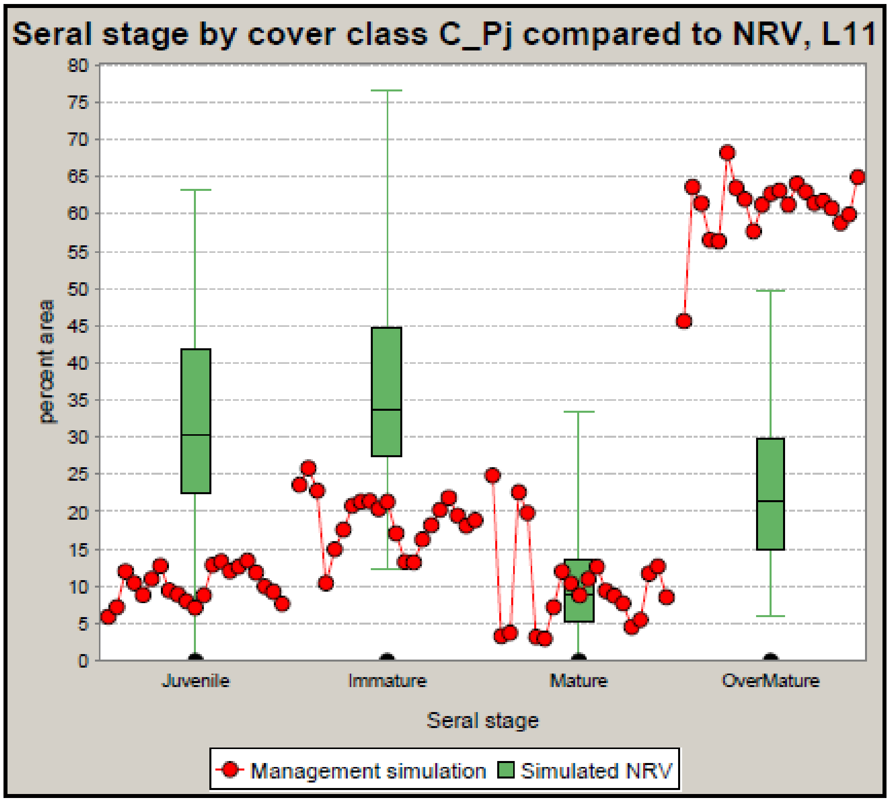


Figure 26. The seral stage by C_Pj cover class from the PFMS indicates that the amount of over-mature jack pine is above the natural range of variation in L11.

Harvest of Pj made up approximately 50% of the conifer profile. Several iterations of refinement were carried out by operational planners to create a harvest pattern that would reduce the fragmentation while still maintaining a balanced conifer profile. MPB stands were included in the SHS where operationally feasible. These adjustments to the first 20 years of the SHS were tested to ensure consistency with the long term sustainability indicators determined in the Caribou scenario (see Figure 27).

The Horse River Fire contributed to a significant amount of area within the largest classes (5000+ ha) of young forest patch sizes during the first two planning periods. In addition, several watersheds in the same area are above the 30% and 50% disturbance threshold levels during the first few planning periods. Both of these conditions abated in the third planning period as the burned area began to mature. The SHS was not a contributing factor to the elevated levels of either of these indicators.

Other non-timber indicators were maintained above the 85% decline from time 0 values in all periods. The large non-contributing areas that reduced harvest levels contributed to an abundance of over-mature conifer, and this led to higher outcomes in the marten and songbird models.

Figure 27. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue).

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 14,

Figure 25). Final conifer and deciduous growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 14. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	106,922	106,870	-0.05%	106,676	-0.23%
Primary deciduous AAC (70-year average m3/year)	287,826	288,019	0.07%	288,281	0.16%
Primary conifer growing stock (final 50-year average m3)	4,042,352	4,006,263	-0.89%	4,256,124	5.29%
Primary deciduous growing stock (final 50-year average m3)	6,813,840	6,767,412	-0.68%	6,906,194	1.36%

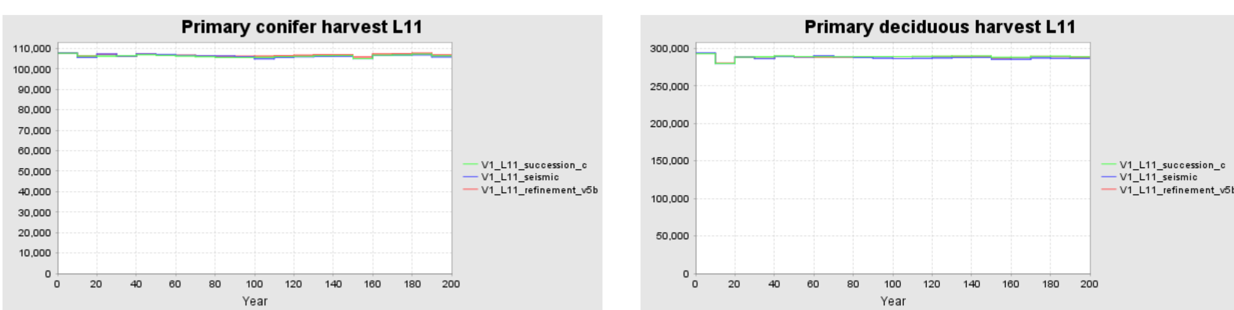


Figure 28. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.8 Forest Management Unit S11

PFMS folder name: V1_S11_refinement_v5c

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	99,698	188,203
2015 Patchworks AAC (net m3/yr)	92,038	142,388

Conifer Quota Holder – S-11 Logging.

There is also an unallocated MTU conifer disposition within FMU S11.

The complete set of detailed timber, VOIT and NTA indicators for S11 PFMS are presented in the TSA annex. Highlights for S11 are as follows:

The gross landbase area in S11 was almost unchanged between the approved TSA and 2015. The contributing conifer landbase increased slightly with the inclusion of Pj that was no longer excluded due to the site index subjective deletion.

Estimated harvest levels in the base scenarios were close to current approved AAC from 2011. The PFMS AAC was slightly above the current approved level.

Alberta Plywood participated in the refinement of the PFMS on behalf of S11 Logging. The small unallocated MTU conifer allocation exists within S11. No specific stands were allocated for the CTP, but these can be assigned at a later date through agreements between S11 Logging and GoA. 100% of the conifer SHS has been assigned to S-11 logging (through Alberta-Plywood).

The over-mature D seral stage objective was a limiting factor for deciduous harvest levels. The over-mature D declines to the 25th percentile of the natural range at 130 years before it begins to increase again for the remaining planning periods. When the seral stage objectives were added to the strategic base model the deciduous harvest levels showed a 15% decline relative to the unconstrained maximum even-flow scenarios. The over-mature seral stage targets had little impact on the conifer wood supply, likely due to the abundance of black spruce on the noncontributing landbase and conifer maturing in stream and lakeside protected areas.

Two small areas in the south-east and west of the FMU were overlapped by caribou deferral zones. These small deferrals had little impact on wood supply, since there were ample opportunities for alternate harvest locations within the first 20 year. The deferrals did impact the conifer profile, as the southern zone contained a significant proportion of the contributing mature PJ and some high risk MPB that were unavailable to include in the SHS for the first 20 years.

Large contiguous areas of mature deciduous stands occurred on the contributing landbase at time 0. These areas made it possible to select sufficient large harvest blocks to meet the NRV targets of the larger patch size classes during the first 40 years of the planning horizon. The model was successfully able to move towards the larger disturbance pattern, and in doing so reduced future fragmentation in southern portion of the unit.

The initial distribution of conifer on the contributing landbase represents a more fragmented condition due to legacy (second pass) harvest and scattered mature jack pine. Most of the smaller harvest patches are made up of conifer allocations, and deciduous allocations make up most of the mid to large size disturbance classes in the 20 year SHS.

Several rounds of refinements took place with operational planners from Al-Pac and Alberta Plywood reviewing and making adjustments to the 20-year SHS, and then assessing the resulting profile and impacts to wood supply. During these scenarios objectives were set to bolster the marten and bay breasted warbler HSI values that were dropping in towards the 70% level in 100 years, and this reduced harvest levels. Large contiguous deciduous areas were refined for the 20 year SHS to correspond with access development plan from Al-Pac. Some of the larger Pj stands identified as MPB adjacent to Al-Pac SHS were included where operationally feasible for conifer quota. This refinement exercise was able to successfully reduce some of the isolated conifer allocation to schedule adjacent to the larger deciduous blocks for the first planning periods.

Due to the songbird and marten objectives and the impact of operational adjustments, the refined 20-year SHS resulted in short-term harvest levels that were lower than the strategic Caribou scenario upon which the SHS was based. The PFMS scenario maintained these harvest levels over the planning due to even-flow volume constraints. This reduction from the refinement phase brought the 2015 AAC to levels similar to 2011 levels and improved non-timber objectives for the unit.

The marten and all songbird HSI indicators in the PFMS were maintained above 70% of time 0 values through all planning periods.

The ECA indicators in the PFMS were all below the 30% threshold levels for all planning periods. The highest ECA level (13%) occurred within watershed 302 during planning period 2, and was the result of large harvest patches in period 1 and period 2 overlapping the watershed. This evaluation shows that large harvest patches can be laid out on the landscape without exceeding the thresholds of these other indicators.

The over-mature seral stage objectives were maintained above the 25th percentile levels, and began to increase by the end of the 200 year planning horizon.

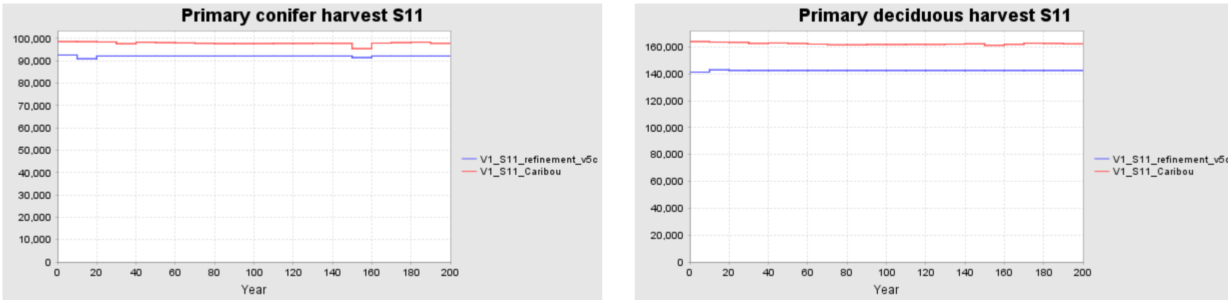


Figure 29. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue).

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 15, Figure 30). Final deciduous and conifer growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 15. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/ha)	92,038	92,009	-0.03%	92,023	-0.02%
Primary deciduous AAC (70-year average m3/ha)	142,388	142,469	0.06%	142,403	0.01%
Primary conifer growing stock (50-year average m3)	3,448,433	3,398,902	-1.44%	3,567,645	3.46%
Primary deciduous growing stock (50-year average m3)	7,492,007	7,384,616	-1.43%	7,865,507	4.99%

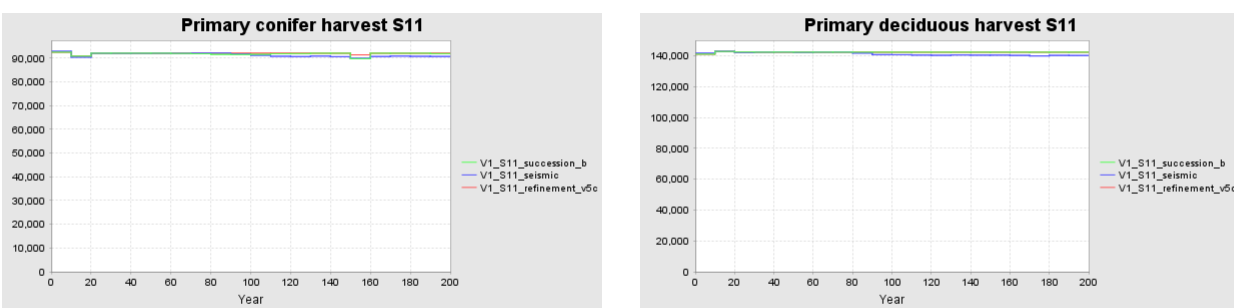


Figure 30. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.9 Forest Management Unit S14

PFMS folder name: V1_S14_refinement_v5c

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	99,991	202,229
2015 Patchworks AAC (net m3/yr)	83,516	147,127

Conifer Quota Holders – Alberta Plywood and Kee Tas Kee Now.

The complete set of detailed timber, VOIT and NTA indicators for S14 PFMS are presented in the TSA annex. Highlights for S14 are as follows:

S14 has been recently added to the far northwest corner Al-Pac FMA. No prior results were available to compare to the 2015 TSA. Alberta Plywood participated in the planning and refinement process for the conifer quota in this unit. Alberta-Plywood contractually represented Kee Tas Kee Now in the preparation of the SHS; accordingly all conifer SHS is assigned to Ab-Ply.

The AVI did not contain a classification of the stems per hectare of the understory. As a result it was not possible to determine which AwU stands were eligible for understory protection treatments. During the simulations AwU stands were only eligible for clear cut silviculture, and no understory protection treatments were used.

Both the primary conifer and deciduous AAC harvest volumes were above the current approved levels for all scenarios.

Caribou deferral zones extend over all areas north of the Wabasca River for the first 20 years, covering the northern two thirds of the FMU. This posed a challenge for both conifer and deciduous planners to develop a 20-year SHS that could be allocated south of the river. The first two phases of the analysis projected significantly higher harvest volumes than the current approved levels. In the refinement stage additional information (flights, photography, etc.) revealed poorer quality stands than recorded in the net land-base and significant work was undertaken to ensure the feasibility of the SHS in this remote and expensive to access northern unit.

The contributing landbase contains a large area of pine, however much of it is less than 80 years old and not available to harvest until the second planning period. A significant amount of this area is in the far north of the FMU within the caribou deferral zone. As a result few pine stands were available for harvest in the 20-year SHS. Very few high risk MPB stands are S14. Most of these are scattered north of the river in the caribou deferral zone and were not feasible to access and harvest in the first 20 years. A similar situation exists that most SbG stands are not operable or available in the first two planning periods. As a result, the conifer harvest is dominated by the white spruce - mixedwood cover type during the 20 year SHS until the caribou deferral is removed, the mature pine becomes available and the existing black spruce matures.

Prior to the start of the FMP analysis Alberta Plywood had been planning and surveying harvest block selections north of the river within the caribou deferral zone. This site recci and planning occurred before the development and adoption of the Al-Pac caribou deferral strategy, and because of the investment these blocks have been included in the second 10 year period of the SHS. No other conifer or deciduous blocks were scheduled north of the river within the caribou deferral zone for the 20 year SHS.

The objective to maintain the over-mature D seral stage forest above the lower 25th percentile of NRV was a limiting factor to deciduous harvest. During refinement deciduous harvest levels were reduced to increase the amount of over mature D remaining on the landscape in the later 100 years of the planning horizon.

An objective was set to ensure that the marten HSI indicator remained about 85% of the time 0 values through all planning periods.

The bay breasted warbler HSI indicator declined to near 70% of time 0 values in the strategic Caribou scenario. An objective was set during the refinement scenarios to reduce this decline. This objective was successful and in the PFMS the bay breasted warbler HSI only dropped to 78% at 100 years and recovered to 83% by year 200. No other songbird HSI indicator declined below the 85% threshold in any planning period.

A single watershed (223) exceeded the ECA threshold levels, and this was only during the second planning period when the ECA was 35%. Watershed 223 is only 1742 hectares in size, and the available conifer in this planning period is contained within the steep southern river valley. Disturbance has been kept to the southern portion of this watershed.

During refinement the deciduous AAC levels decreased significantly as compared to the strategic baseline scenarios, and conifer AAC dropped less so (see Figure 31). The AAC decline is a result of several factors, including:

- The objectives to maintain marten and bay breasted warbler HSI values above threshold levels increased the amount of retained mature forest types, and increased rotation ages;
- A large area of mature contributing forest in the caribou deferral zone was unavailable for harvest during the first 20 years.
- The planners had difficulty laying out an operationally feasible 20-year SHS in the southern portion of the FMU.
- The even flow objectives maintained harvest levels at the initial 20-year levels.

As the AAC reduced in the PFMS, the non-timber indicators that were dependent on mature forest or reduced disturbance improved.

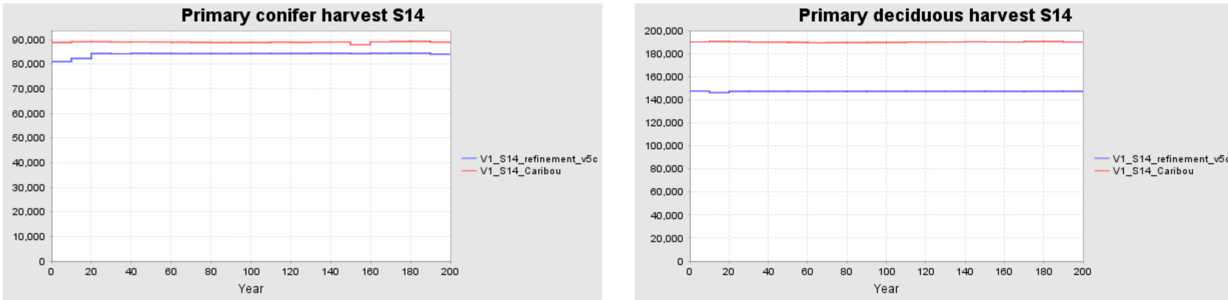


Figure 31. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue)

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1.5% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 16, Figure 32). Final deciduous and conifer growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 16. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	83,516	83,449	-0.08%	84,584	1.28%
Primary deciduous AAC (70-year average m3/year)	147,127	147,130	0.00%	146,767	-0.24%
Primary conifer growing stock (final 50-year average m3)	3,927,993	3,867,668	-1.54%	4,016,256	2.25%
Primary deciduous growing stock (final 50-year average m3)	9,855,657	9,683,358	-1.75%	10,331,713	4.83%

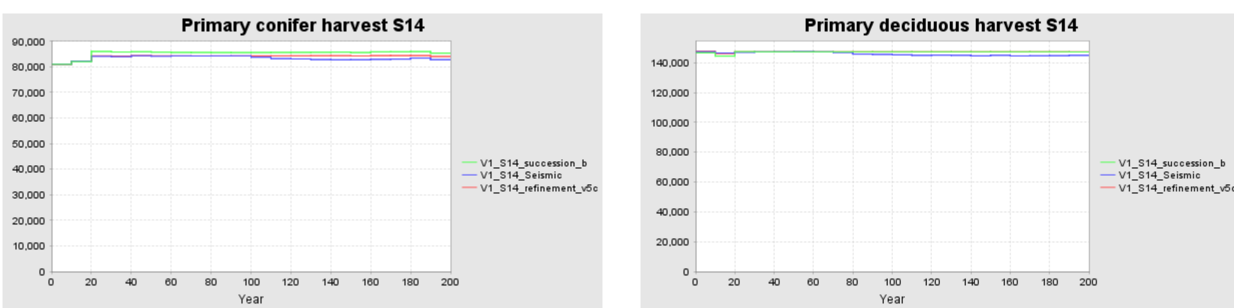


Figure 32. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.10 Forest Management Unit S18

PFMS folder name: V1_S18_refinement_v5d

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	125,705	232,873
2015 Patchworks AAC (net m3/yr)	124,174	216,950

Conifer Quota Holders – Alberta-Plywood and Vanderwell Contractors

The complete set of detailed timber, VOIT and NTA indicators for S18 PFMS are presented in the TSA annex. Highlights for S18 are as follows:

There has been very little change to the size of the 2015 contributing landbase as compared to the 2011 TSA update.

Alberta Plywood Ltd and Vanderwell Contractors Ltd are the conifer operators in S18, and both participated in the operational refinement of the 20-year SHS.

All base scenarios showed conifer harvest levels that were approximately 20% below the current approved AAC. There was little change to conifer harvest levels between successive base scenarios as additional objectives were applied. There is a significant amount of Sw in the contributing conifer landbase, and it appears that the changes to the Sw yield curves between the 2011 TSA update and now are having the most impact on sustainable conifer harvest levels as compared to 2011.

The over-mature D seral stage objective dropped below the 25th percentile in an unconstrained base scenario. An objective was applied to enforce the 25th percentile as the lower limit, and this caused a reduction in sustainable deciduous harvest levels. The result was that in all remaining scenarios the over-mature D seral stage forest was maintained at or above the 25th percentile threshold, and deciduous harvest levels were reduced to close to current approved levels. No further decreases to deciduous harvest levels occurred during the refinement stage.

The caribou deferral zones occur on the eastern, western and northern edges of the FMU. The deferral zones cover 35% of the gross forest, but only 25% of the contributing landbase. A large portion of the eastern area within the unit that overlaps the caribou deferral zone is not part of the contributing landbase. The 20-year SHS allocation is located within the center and along major transportation routes. There was little change to the primary AAC with the application of the 20 year deferral, as there were sufficient mature areas to allocate within the first 20 years.

Most of the Pj contributing area that is outside caribou deferral zone is less than 80 years old, and this made it difficult to make Pj allocations during the first planning period. Jack pine becomes old enough to harvest in the second 10-year planning period, but it is located in small dispersed patches, and in conflict with the NRV harvest patch targets.

As a result the conifer harvest is skewed towards the SwMx cover group during the first planning period. Several large areas of jack pine are located in the caribou deferral zones and become available for harvest in the third planning period. There are very few high risk MPB stands identified in FMU S18.

The refinement process began with the strategic Caribou scenario, and added planned blocks from Al-Pac, Vanderwell and Alberta Plywood in to the 20-year SHS. These were adjusted to exclude harvest in the caribou deferral zone and to assign ownership of harvest blocks between conifer operators that was representative of their quota. In some cases blocks were substituted in order to reduce small isolated harvests and to form larger, more contiguous harvest blocks (including locating deciduous and conifer harvest in the same operating areas). Small and isolated harvest blocks were reduced significantly and helped to clean up second pass harvest within cut blocks and reduce landbase fragmentation moving forward.

The refinements that were applied to produce the PFMS SHS did not significantly impact long term objectives as compared to the Caribou scenario (see Figure 33). There was a slight decline in the 200 year deciduous AAC level as the small isolated stands were removed from the allocation and dropped the even-flow levels. This reduction in deciduous AAC contributed to achievement of the over-mature deciduous seral stage objectives for the PFMS. There was a slight short term increase in the conifer AAC as compared to the Caribou scenario as quota holders attempted to pick up second pass stands within deciduous block allocations in hopes of preventing isolation, and avoiding reentry and continued fragmentation. The slight increase conifer harvest in the first 20 years of the planning horizon is within 10% of long term even-flow levels.

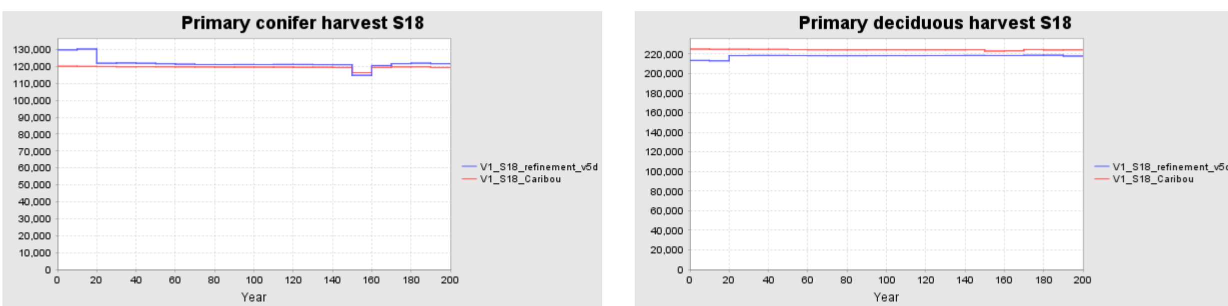


Figure 33. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue).

Three of the songbird HSI indicators were at or above the 100% threshold, and one was near the 85% threshold. The HSI indicator for the black throated green warbler declined below 70% of time 0 levels at 100 to 200 years in to the future, and this was consistent across all scenarios. The MxSw over-mature seral stage area is well above NRV levels at time 0 (Pj over-mature is also above), and it appears that this is correlated with high BTGW values. As the over-mature SwMx declines into a more natural range over the 200 year simulation, BTGW also declines. It may be that BTGW HSI is at an exceptionally high level at time 0, and reverts to more natural levels in 100 years.

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 17, Figure 34). Final deciduous growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 17. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	124,174	124,160	-0.01%	123,222	-0.77%
Primary deciduous AAC (70-year average m3/year)	216,950	217,019	0.03%	214,811	-0.99%
Primary conifer growing stock (final 50-year average m3)	4,191,008	4,162,264	-0.69%	4,262,097	1.70%
Primary deciduous growing stock (final 50-year average m3)	6,992,231	6,931,128	-0.87%	6,892,809	-1.42%

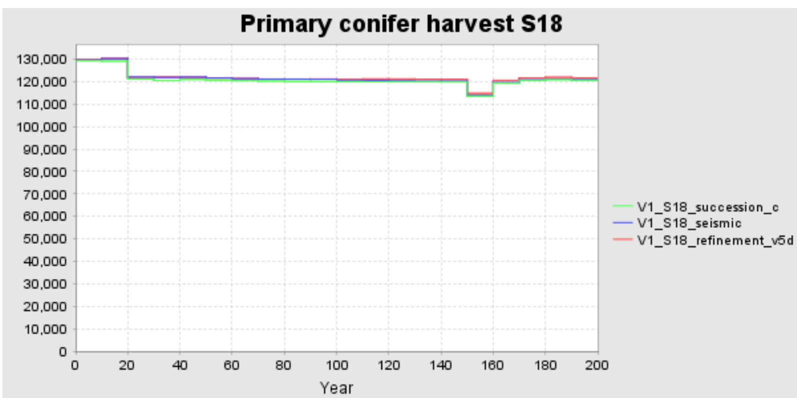
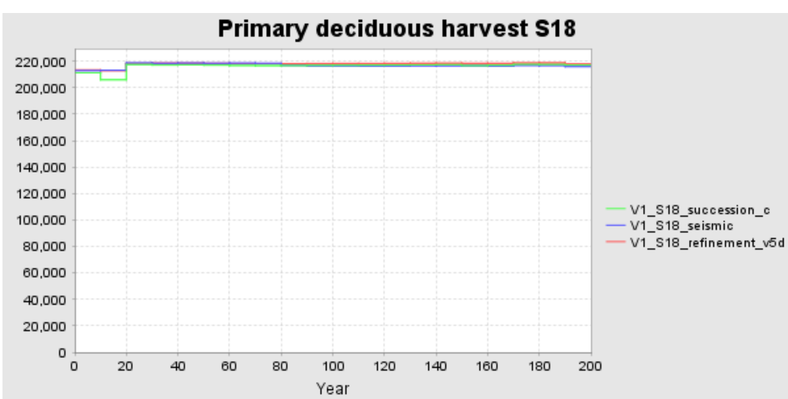


Figure 34. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.



7.11 Forest Management Unit S22

PFMS folder name: V1_S22_refinement_v5d

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	106,065	431,613
2015 Patchworks AAC (net m3/yr)	99,683	340,136

Conifer Quota Holders – Vanderwell Contractors and a small CTP.

The complete set of detailed timber, VOIT and NTA indicators for S22 PFMS are presented in the TSA annex. Highlights for S22 are as follows:

S22 is a northern FMU with poor access to some locations due to remote distances, lack of permanent roads and major geographic barriers.

Al-Pac has ~26% of the conifer quota in S22, with the remainder to Vanderwell Contractors Ltd, a small CTP and an unallocated MTU. In this FMU C/CD stands are on the conifer landbase and D/DC on deciduous landbase.

There was little difference in contributing area between the updated 2011 landbase and the current TSA, other than SbFM. SbFM was deferred in the contributing landbase in the 2011 TSA, and is not part of the contributing landbase for 2015. The areas of the other strata types are relatively similar to 2011 levels.

The objective to maintain the over-mature D seral stage at the 25th percentile level limited the sustainable deciduous harvest. The deciduous harvest level was 450,000 m3/year without the objective to maintain the seral stage classes, and dropped to approximately 400,000m3/year when the objective is applied. With the objective the over-mature area of all cover classes was maintained above the 25th percentile in all planning periods in all scenarios.

Another drop in sustainable harvest levels occurs in the Phase 2 analysis when spatial objectives (transportation, patching and caribou) are applied.

Large caribou deferral zones occur in the north and south ends of the FMU. The northern deferral zone contains very little contributing area, and had an insignificant impact on AAC. The area west of the Liege River is also deferred however access to this area is currently difficult and did not impact short term SHS allocations.

A significant amount of pine is either below operable in the first planning period or located within the 20 year caribou deferral zone. The remaining pine is scattered within the central part of the unit. The objective to limit the area of small harvest patches to NRV levels conflicted with the ability to allocate pine stands, and resulted in a significant drop in pine harvest for the first 40 years of the planning horizon. The amount of over-mature Pj on the gross landbase is well above NRV for this zone. The amount of over-mature Pj declines over the planning horizon however it remains above the 75th percentile for all planning periods. There is very little high risk MPB stands in S22.

The refinement process reduced the number of small isolated harvest patches significantly. This reduced the overall AAC for both conifer and deciduous but results in a feasible 20 year allocation. Harvest blocks were refined to encompass both conifer and deciduous stands from both operators and pick up mature jack pine where accessible.

Conifer and deciduous AAC declined in the PFMS as compared to strategic Caribou scenario due to the reduction in 20-year jack pine harvest and the removal of small isolated allocation, and the even flow objective that maintained these levels through the remaining planning periods (see Figure 35).

With a reduction in the long term AAC all non-timber indicator achievement was improved. None of the songbird or marten HSI indicators declined below 70% of time 0 levels. Only a single watershed (277) exceeded the 30% ECA threshold (period 2 value of 37%). One tenth of the area of this watershed is in S22, and the remaining 9/10's are located in S14 and S11. It may be that there the overall watershed ECA is below the 30% threshold, and this will require examining combined ECA contributions from the other participating FMUs.

There is an unallocated MTU conifer component to S22 (~21%) along with the assigned quotas to Vanderwell and Al-Pac. During refinement the conifer stand allocation was finalized however only Al-Pac was able to assign ownership completely. Due to the unallocated MTU it was difficult to determine where these stands would be. Ownership of exact Vanderwell stands would need to be determined from the remaining pool of conifer stands in collaboration with GoA. The small CTP portion of the conifer allocation has been assigned.

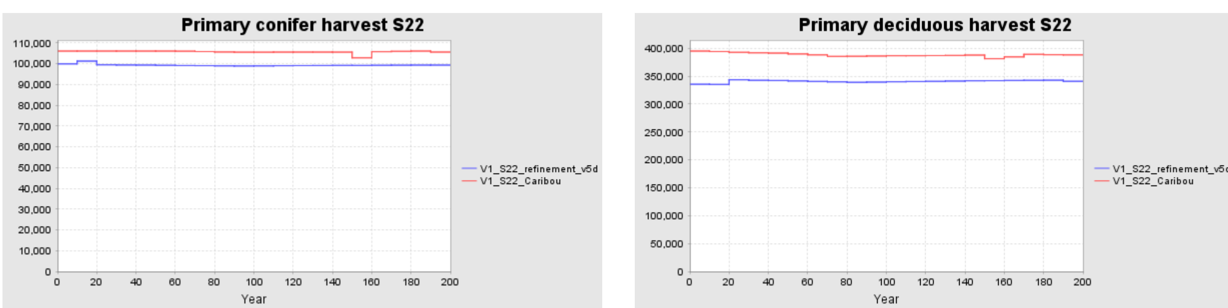


Figure 35. A comparison of primary harvest levels between the caribou baseline scenario (red) and the PFMS (blue).

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 18, Figure 36). Final deciduous growing stock levels were lower than the succession scenario, due to the breakup ages.

Table 18. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	99,683	99,664	-0.02%	99,177	-0.51%
Primary deciduous AAC (70-year average m3/year)	340,136	340,163	0.01%	341,794	0.49%
Primary conifer growing stock (final 50-year average m3)	3,896,692	3,870,300	-0.68%	4,046,541	3.85%
Primary deciduous growing stock (final 50-year average m3)	18,885,770	18,752,660	-0.70%	17,225,630	-8.79%

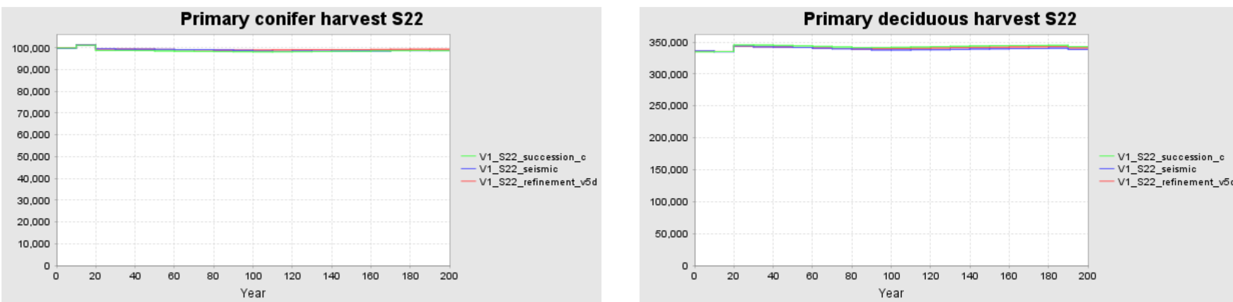


Figure 36. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.

7.12 Forest Management Unit S23

PFMS folder name: V1_S23_refinement_v5c

	Primary conifer	Primary deciduous
Initial LRSY (net m3/yr)	25,765	93,399
2015 Patchworks AAC (net m3/yr)	23,684	90,646

Conifer Quota Holders - Ed Bobocel Lumber Co Ltd and an GOA CTP.

The complete set of detailed timber, VOIT and NTA indicators for S23 are presented in the TSA annex. S23. Highlights of the S23 TSA are as follows:

FMU S23 is a small, well accessed unit that is close to the mill.

There was no significant difference in contributing area from the 2011 TSA update landbase. Several lakes within the unit have large buffers to protect trumpeter swan habitat. A deciduous deferral zone was implemented within the Crooked Creek Watershed for the first 20 years of the planning horizon. This zone was managed through a deferral strategy to assist in meeting local community ecological values. Despite the relatively similar contributing areas, the conifer AAC was below the current approved as a result of changes to yield curve (particularly Sw), retention factors, and understory protection success ratios.

Harvest levels were reduced when the NRV harvest patch objectives were applied. Due to the small size of the unit the simulation model had a difficult time allocating large harvest patches, and reduced the harvest rather than allocating excess small patches. There was no effort to allocate the largest harvest patch size class from the natural range of variation, because S23 is too small to accommodate that size of disturbance (socially or operationally).

There are no caribou deferral zones in S23.

The refinement process began with the 20-year SHS from the strategic NRV base scenario. Operational planners from Al-Pac and Bobocel made substitutions to the SHS to eliminate small isolated harvest patches and concentrate disturbances in the 300 to 2,500 ha range by combining deciduous and conifer harvest blocks. The SHS was reviewed and further adjusted to make sure that the conifer harvest profile was representative of the profile of the available conifer landbase. (See Figure 37)

ECA indicators were all below the 30% threshold level except for a single watershed in period 1 that was at the 39% level. Half of this watershed extends outside the FMA, and further investigation is required to determine if the ECA for the entire watershed is of concern.

Several MPB high risk stands were identified in S23 and scheduled within the first planning period. These selections were reviewed during refinement: most were feasible and included in the SHS.

No songbird or marten HSI values declined below 70% of time 0 levels in any planning period.

The over-mature seral stage by cover class objectives were all maintained above the 25th percentile NRV levels in all planning periods.

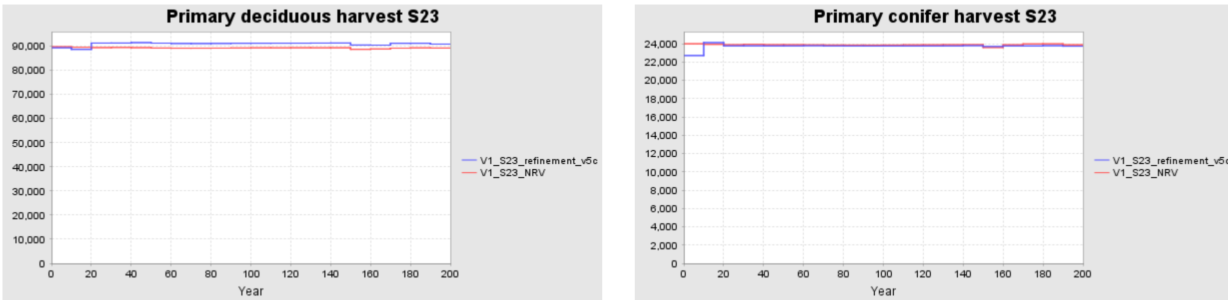


Figure 37. A comparison of primary harvest levels between the NRV baseline scenario (red) and the PFMS (blue).

A sensitivity analysis of model inputs was performed on the PFMS to test the sustainability of alternate approaches to seismic area net down and natural succession. There was a less than 1% difference in the average 70-year primary harvest levels between the PFMS and the seismic and succession scenarios (see Table 19, Figure 38). Final deciduous growing stock levels were lower in the succession scenario, due to the breakup ages.

Table 19. A comparison of indicators between the PFMS and the seismic and succession alternative scenarios.

Indicator	PFMS	Seismic	diff	Succession	diff
Primary conifer AAC (70-year average m3/year)	23,684	23,699	0.06%	23,665	-0.08%
Primary deciduous AAC (70-year average m3/year)	90,646	90,790	0.16%	90,757	0.12%
Primary conifer growing stock (final 50-year average m3)	946,930	933,647	-1.40%	951,316	0.46%
Primary deciduous growing stock (final 50-year average m3)	2,247,624	2,214,202	-1.49%	2,195,938	-2.30%

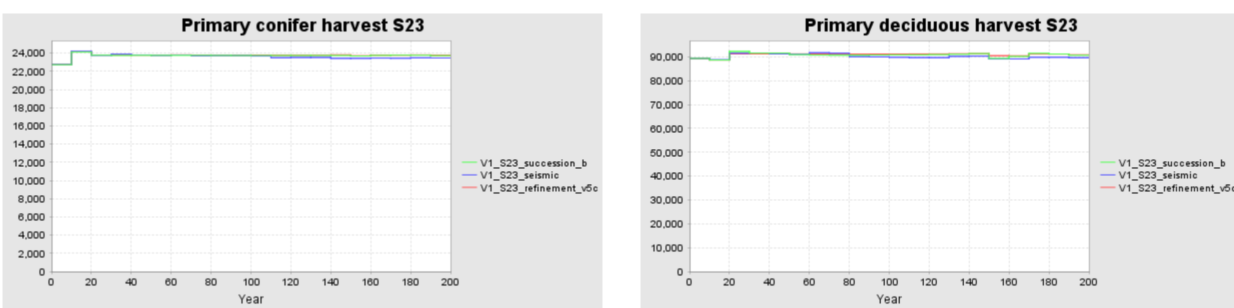


Figure 38. A comparison of primary harvest levels between the PFMS (red) and the seismic (blue) and succession (green) sensitivity alternate scenarios.