

**TFL 49 Silviculture Type II
Analysis Report
And
Preferred Strategy Summary**

Version 1.2

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Executive Summary

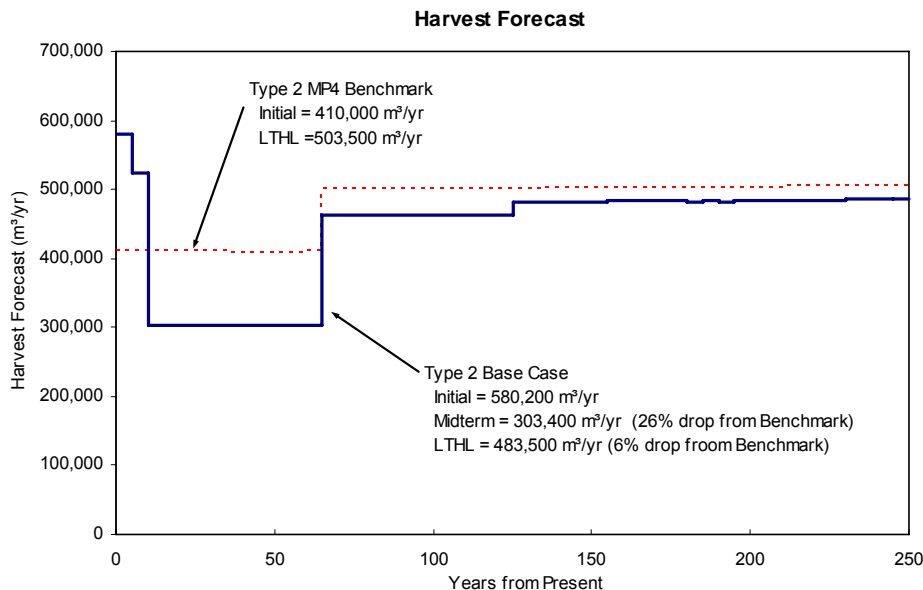
Tolko Industries Ltd (TFL 49) and BCTS staff initiated an Integrated Type 1 and 2 Silviculture Strategy for TFL 49 in September 2006. The TFL's Management Plan 4 (MP4) was recently completed and provides a good base from which to pursue silviculture strategy development and explore critical issues such as mountain pine beetle (MPB) related salvage strategies/priorities. Mountain Pine Beetle (MPB) related issues have been integrated in this strategy because they have such a significant impact on the major issues addressed by this strategy (timber supply, timber quality, and habitat supply).

Unlike a TFL management plan process, which is based on exploring future implications of 'current practices', this project is focused on exploring the implications of proposed management practices (i.e. "what if" questions). A kick-off workshop was held in Lumby on November 1, 2006 where the current situation, potential silviculture treatments, analysis options, input assumptions, and indicators were reviewed and discussed. Information from the workshop was summarized and used in preparation of a data package. After the data package was completed, it was reviewed and approved by participants to guide the analysis. This analysis was designed to provide feedback on potential management options in order to identify strategies that should be included in the final preferred silviculture strategy for the TFL. Strategies were evaluated on their ability to move the TFL toward its stated targets for timber supply, timber quality, and habitat supply.

In order to fully understand the issues facing the TFL, a forest estate model (Patchworks) was used to benchmark MP4 assumptions and then a revised base case was created to reflect our best understanding of the current and future circumstances under which forest management will occur in the TFL. The following MP4 assumptions were updated in the modeling approach:

- All anticipated impacts of the current MPB epidemic were incorporated,
- Disturbance was incorporated in the non-timber harvesting land base,
- Spatially explicit Old Growth Management Areas (OGMAs) were implemented for 80 yrs,
- Long-term retention (from Tolko's retention plan) was implemented for 80 yrs,
- Current AAC uplift was implemented for 5 years.

The timber supply forecast for the benchmark and the revised base case scenarios are provided below. The revised base case shows an AAC uplift for the first 2 periods and then a midterm trough 26% below the benchmark flow and a long term flow 6% below the benchmark.



In an effort to identify strategies capable of addressing timber supply, timber quality, and non-timber issues in the TFL, numerous scenario analyses were completed. The table below illustrates the key findings of the scenario modeling.

Scenario	Timber Supply			Timber Quality	Habitat	Watershed H40 ECA's	Visuals
	Short	Mid	Long				
No Gains	-	↓3.2%	↓14-17%	-	↑	↑	↑
Reduced Planting	-	-	↓11.1%	↓	↑/↓	↑	↑
Enhanced Reserves	↓32.7%	↓70.0%*	-	-	↑	↑	↑
Enhanced Reserves with Limited Harvest	↓12.3%	↓26.0%	-	-	↑	↑	↑
PI Intermediate Harvest	-	↑5.0%	↓0.8%	-	↑	↑	↑
Leave Advanced Regen	-	-	-	-	-	-	-
Multiple Fertilization	-	↑7.4%	↓1.1%	-	-	↓	↑
Late Fertilization	-	↑6.9%	↓0.6%	-	-	↓	-
Loss of Marginal (<20cm)	↓14.4%	↓5.1%	↓2.1%	↑	-	-	-
Loss of Marginal (<25cm)	↓28.6%	↓24.6%	↓14.2%	↑	-(↑)	-	-
Rehab of Impacted/Unsalvaged	-	↑2.1%	↓0.74%	-	-(↓)	↑	↑
Acceptance of Deciduous	-	-	↓0.8%	-	↑	-	-
Extended Uplift	↑	-	-	-	-	-	-

*Only for the front end of the mid-term trough, remainder is the same as the revised base case

The following recommended strategies were derived from the scenario analysis:

Recommended Timber Supply Strategies:

1. Ensure volume gains associated with **class A seed** continue to be realized. The mid- and long-term harvest flows are highly dependant on these volume gains.
2. **Maximize planting** wherever class A seed is available and regeneration delays can be shortened. There is a financial incentive not to plant when natural regen is expected but there are mid- and long-term timber supply implications of delaying harvest and not realizing the volume gains provided by class A seed.
3. **Avoid using spatially fixed short term retention areas** for the next 30 years. Their impact on timber supply is very large and they provide only small improvements to non-timber values. All LRMP objectives are already being met in the revised base case without these reserves but they do speed hydrological/visual recovery by dramatically reducing harvest in the early midterm. It is likely possible to achieve a similar result more efficiently by minimizing harvest or partial harvesting in highly impacted watersheds in the short term (Cain, Munro, Nash, Naswhite, Twig, Weyman, and Whiteman).
4. **Intermediate harvest in mixed PI stands** (30-60% PI) to ensure green timber is retained for non-timber values in the short term and for timber supply in the midterm (potential to treat 1200-1300 ha in next 10 years).
5. Where MPB impacted stands area are found to have significant advanced regeneration, **protect the advanced regeneration** or make these stands low priority for salvage. There appears to be limited opportunity to implement this strategy in the TFL but where it is possible it will benefit timber supply in the future.
6. To optimize financial efficiency, implement only a small program of **late rotation fertilization** in candidate Fd or Lw or Sx stands in the short term (~75 ha/yr) while developing the required infrastructure to deliver a much larger late fertilization program beginning in 45-50 years from now (1000 ha/yr). If FFT dollars are available for fertilization in the short-term, maximize their use as any form of fertilization will help timber supply in the midterm and there are is no guarantee of funding 45-50 yrs from

now. Fd or Lw are slightly preferred over Sx stands for treatment because of better volume response and less risk of losses to pests.

7. **Rehabilitate MPB impacted stands that do not get salvaged.** Rehabilitation is assumed to be practical if the impacted stands are almost completely killed or where treatment can target concentrations of mortality. These stands are typically younger stands that have little to no salvage value. There were 3,085 ha treated in the first 15 years for a total expenditure of \$3.7 million.
8. **Salvage in marginal stands** wherever possible. If these stands are not utilized there are significant timber supply implications and/or costs associated with rehabilitation. Marginal stands from 20-25cm dbh are important to any AAC extension beyond the current 5 years uplift.
9. Look to **extend the current AAC uplift** for an additional 5 years in order to capture more MPB impacted volume and regenerate these sites. Without the uplift, a significant increase in rehabilitation treatments (and costs) may be required to enter previously merchantable stands and assist the regeneration process. Harvest (or rehab) of productive PI stands is key to getting volume online in the back end of the midterm trough (50-70 years from now).

Recommended Timber Quality Strategies:

No specific timber quality strategies were evaluated but the following general recommendations can be made as a result of evaluating the modeling results:

1. Look to **diversify regenerated species** to reduce risks associated with changing markets and/or forest health concerns.
2. **Manage for longer rotations in constrained areas.** Purposefully managing for longer rotations once out of the midterm could provide a more diverse product base for the TFL in the future. Current expectations are for high volumes of small piece size PI.

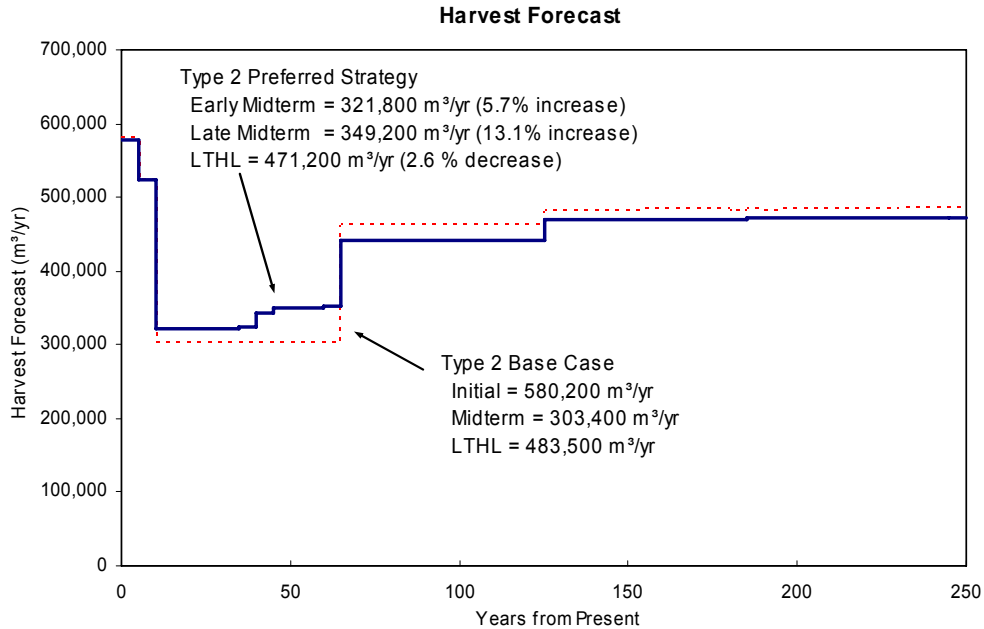
Recommended Watershed/ Ecosystem and Habitat Strategies:

1. Continue to **maintain habitat related requirements from LRMP.**
2. **Minimize harvest in highly impacted watersheds** to speed hydrologic recovery (Cain, Munro, Nash, Naswhito, Twig, Weyman, and Whiteman). This may involve implementing portions of the Short Term Retention Plan for up to 20 years.
3. Any strategy that reduces the harvest during the midterm will help almost all non-timber related values. Any new harvesting in the midterm slows hydrological recovery.
4. Implement **intermediate harvests in mixed PI stands** instead of clearcutting. This is the only strategy that worked to reduce the ECA peak post-MPB.
5. Work to **maintain habitat for conservation listed species** such as Lewis's Woodpecker, Flammulated Owl, and Williamsons Sapsucker.
6. Similar to quality strategies, **diversifying managed stand species and ages** is important.

Based on a review of these findings at a final workshop, a preferred strategy was defined for the TFL and it includes:

- Intermediate harvesting in mixed PI stands (30-60% PI).
- Rehabilitation of unsalvaged MPB impacted stands.
- No harvesting in smallest diameter marginal PI stands (< 20m dbh).
- Late rotation fertilization of Sx, Fd, Lw in short term and also PI in midterm.
- Maintain uplift as necessary to salvage MPB mortality.

The timber supply projection for this preferred strategy is shown below:



The harvest flow is consistent with the base case for the first two periods and then the front end of the mid-term trough is 5.7% higher and the back end of the trough is 13.1% higher. The improvements in the midterm trough are muted by the removal of the marginal PI stands (<20cm dbh) and causes a reduction in the long term harvest levels (-2.6%) because they are not all rehabilitated. Even though marginal PI stands were removed from short term harvest eligibility, the harvest level in the first two periods remains unchanged because a small amount of non-PI leading stands and lower % PI stands are now harvested. Some of this harvest comes from intermediate entries into PI stands that allow harvesting in areas that would have otherwise been unavailable due to non-timber objectives.

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1. Introduction

Tolko Industries Ltd (TFL 49) and BCTS staff initiated an Integrated Type 1 and 2 Silviculture Strategy for TFL 49 in September 2006. The TFL's Management Plan 4 (MP4) was recently completed and provides a good base from which to pursue silviculture strategy development and explore critical issues such as mountain pine beetle (MPB) related salvage strategies/priorities. Mountain Pine Beetle (MPB) related issues have been integrated in this strategy because they have such a significant impact on the major issues addressed by this strategy (timber supply, timber quality, and habitat supply).

1.1. Type II Silviculture Process

Unlike a TFL management plan process, which is based on exploring future implications of 'current practices', this project is focused on exploring the implications of proposed management practices (i.e. "what if" questions). Prior to the development of this package, a kickoff workshop was held in Lumby on November 1, 2006 where the current situation, potential silviculture treatments, analysis options, input assumptions, and indicators were reviewed and discussed. Information from the workshop was summarized and used in preparation of a data package. After the data package was completed, it was reviewed and approved by participants and used to guide the analysis. This analysis was designed to provide feedback on potential management options in order to identify strategies that should be included in the final preferred silviculture strategy for the TFL. Strategies were evaluated on their ability to move the TFL toward its stated targets for timber supply, timber quality, and habitat supply. The resulting preferred strategy is outlined at the end of this report.

1.2. Project Objectives

Consistent with the BC Ministry of Forest and Range (MoF) Type II Silviculture Strategy Development Standards¹, the main objectives of the project are to produce:

- A fully rationalized plan to guide the expenditure of public silviculture funds to improve the future Timber and Habitat Supply of TFL 49;
- Information that can be utilized by industry and government in related decision-making processes.
- Silviculture regimes and associated standards that may potentially be adopted in forest stewardship plans as required standards for basic silviculture operations.

1.3. Description of the Study Area

1.3.1 Location

Tolko's TFL 49 is situated west of Okanagan Lake and covers approximately 144,000 ha in the Okanagan Forest District (Figure 1). The TFL was designated in 1984 as a result of an amalgamation of TFL 9 (block A), 16 (block B), and 32 (block C). Blocks A and B are continuous while block C is separate and is located north of Falkland and east of Pillar lake towards the Salmon River.

¹ Type II Silviculture Strategy Development Standards available online at:
http://www.for.gov.bc.ca/ftp/external/!publish/FIA%20Documents/standards/sdFS_type2_analysis.pdf

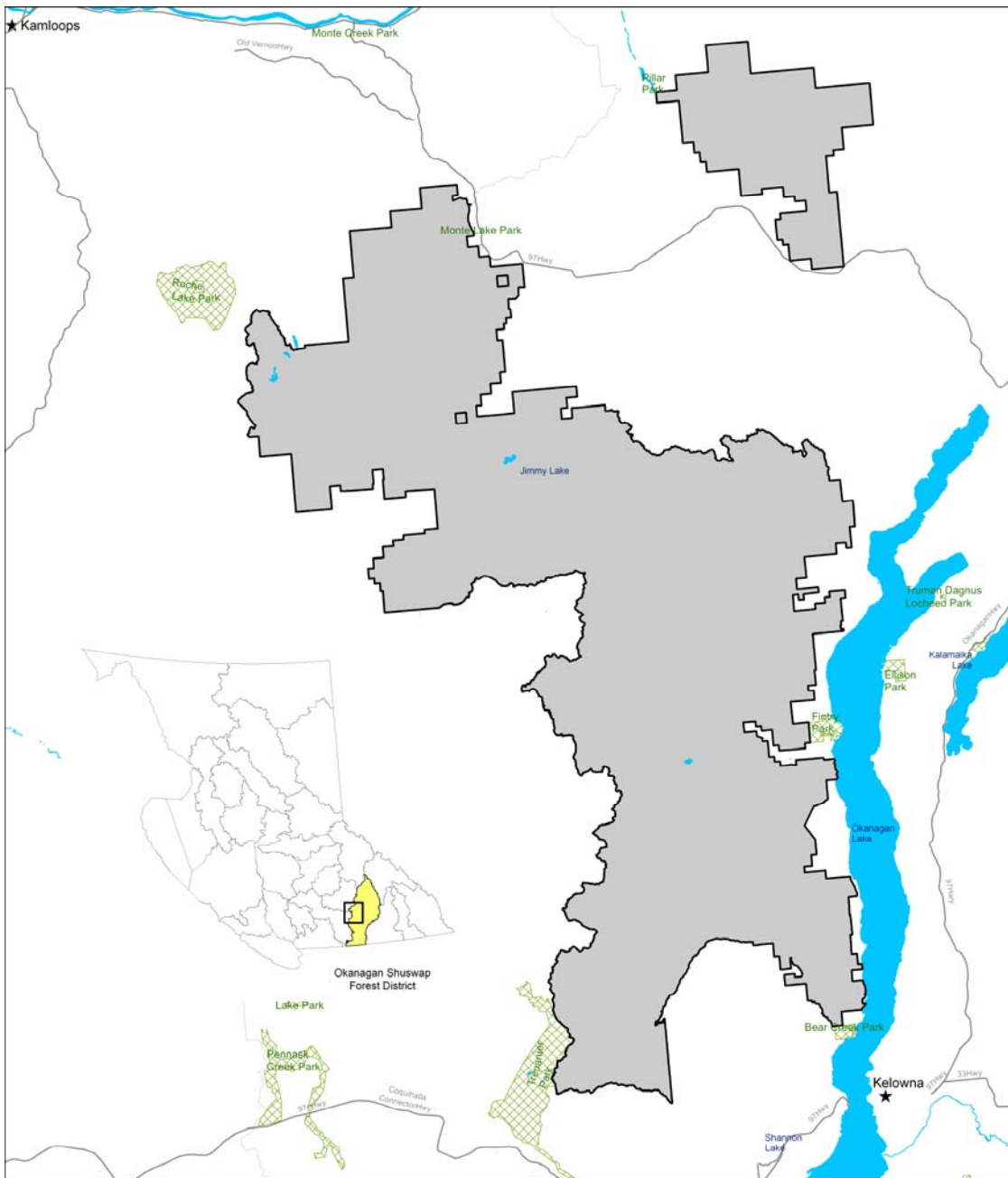


Figure 1. TFL 49 Location Map.

1.3.2 Timber Harvesting Land Base Determination

Assumptions used to define the crown forested land base (CFLB) and timber harvesting land base (THLB) are provided below. The THLB is designated to support timber harvesting while the CFLB is identified as the broader land base that can contribute toward meeting non-timber objectives (i.e. wildlife habitat). The land base assumptions used in this project are based on those defined in MP4 (Table 1). For further detail in regards to how these netdowns were derived, refer to the MP4 information package.

Table 1. Land Base Area Netdown Summary

Description	Area (ha)	Percent of TFL (%)	Percent CFLB (%)
Total Area	144,345	100%	
Parks	2,951	2%	
Non-Forest-Non-Productive	7,133	5%	
Existing Roads & Trails	1,778	1%	
Existing Landings	48	0%	
Productive forested land base	132,435	92%	100%
Reductions to the productive forest			
Non-Commercial	75	0%	0%
Recreation reserves	306	0%	0%
Deciduous	1,195	1%	1%
Low Volume	1,100	1%	1%
Low Productivity	210	0%	0%
Overstocked pine	285	0%	0%
ESAs	1,710	1%	1%
Riparian Reserves	3,116	2%	2%
Wildlife tree patches	670	0%	1%
Kelowna Dirt Bike Club	11	0%	0%
Current THLB	123,757	86%	93%
Less Future Roads	730	1%	1%
Plus Kelowna Dirt Bike Club	11	0%	0%
Long-term THLB	123,038	85%	93%

1.3.3 Age Class Distribution

The age class distribution has changed slightly since MP4. Harvesting depletions have been incorporated and ages now reflect these disturbances.

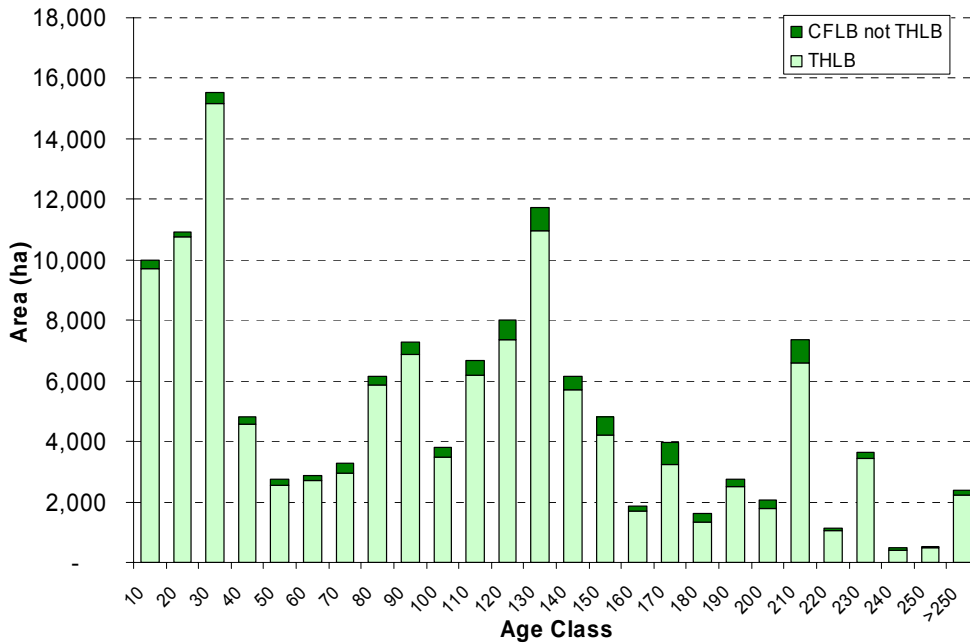


Figure 2. TFL49 age class distribution on the CFLB and THLB.

1.3.4 Leading Tree Species Profile

The TFL is dominated by pine leading (41%), Douglas-fir leading (27%), and to a lesser extent spruce (13% area) and balsam fir (12% area) leading species. Deciduous species, cedar, and larch make up minor components of the TFL area.

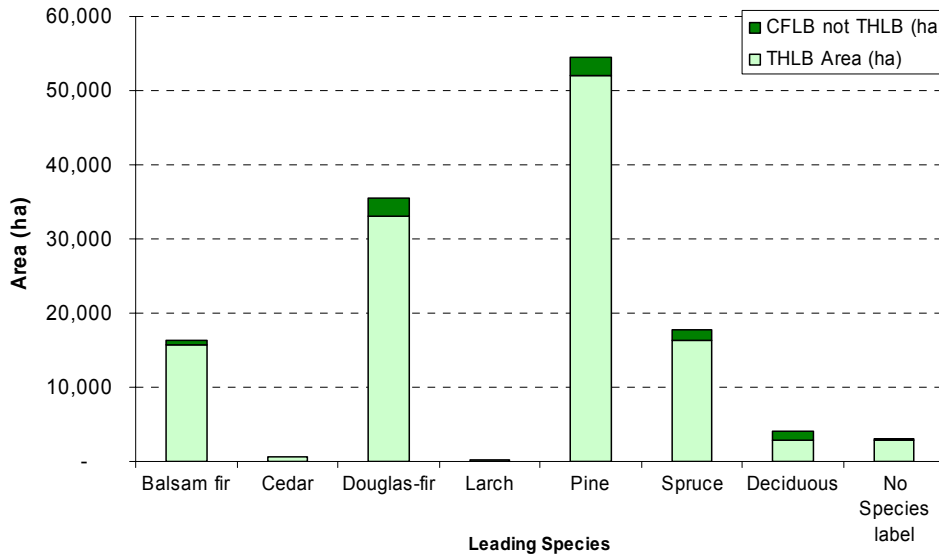


Figure 3. Leading trees species profile on the CFLB and THLB.

1.3.5 Site Index

Inventory site indexes on the THLB ranges from 7 m to 23 m with the majority of the area falling between 13 and 19 (weighted average = 14.9 m). All future managed stands received site index adjustments based on SIBEC work completed in 2002 (Timberline, 2002). As a result, the weighted average site index of all future managed stands increases to 18.7 m (3.8m increase).

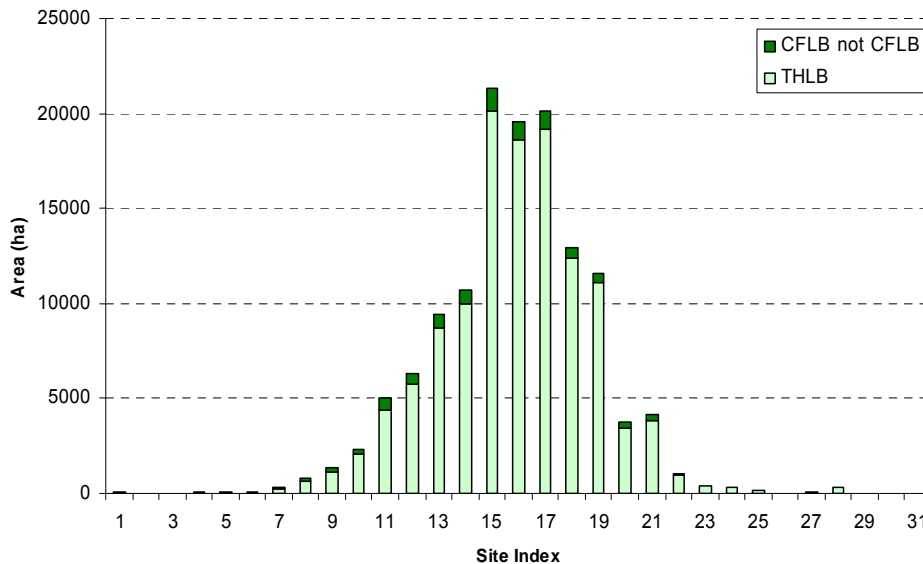


Figure 4. TFL 49 inventory (VRI) site index distribution on the CFLB and THLB

1.3.6 Biogeoclimatic Variants

The TFL is dominated by MS (39%), IDF (33%), and ESSF (22%), and to a lesser extent ICH (6%) biogeoclimatic zones. Figure 5 shows an area breakdown of these biogeoclimatic zones at the variant level while Figure 6 gives a spatial representation.

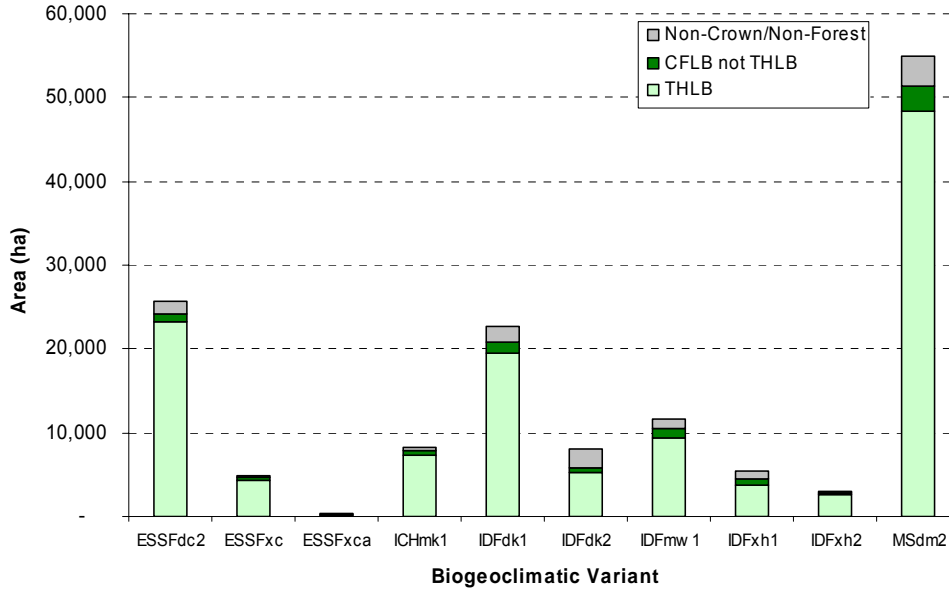


Figure 5. TFL 49 biogeoclimatic variants by land base type.

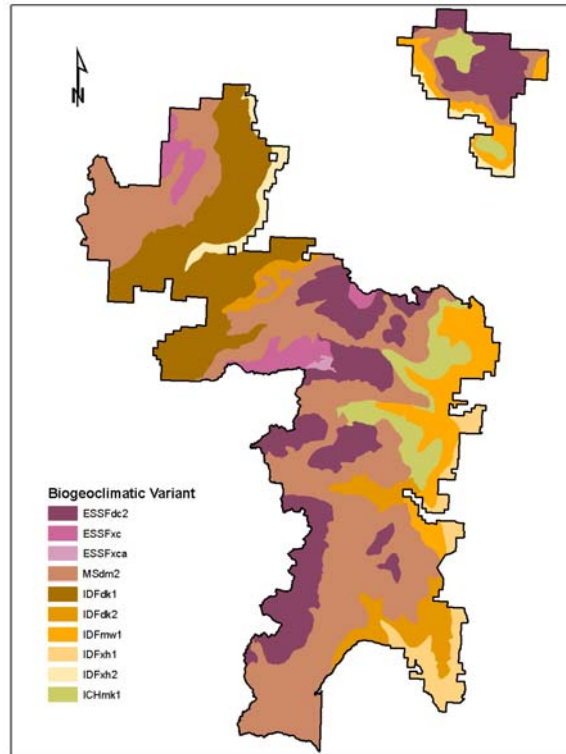


Figure 6. Map of biogeoclimatic variants in TFL 49.

1.3.7 Integrated Resource Management Values

The Okanagan Shuswap LRMP has identified the following non timber values for management in TFL 49.

Table 2. OK-LRMP Non Timber Values for Management in TFL 49

Resource Emphasis Area	Total	Forested	THLB (ha)	Forested not THLB
VQO	22,352	20,271	18,944	1,327
Lakeshore	1,745	1,550	1,298	252
Blackwell Lake SMZ	259	181	157	24
Community watershed	28,867	26,738	25,040	1,698
Bighorn Sheep	14,138	10,263	9,169	1,094
Mule Deer	25,884	21,429	19,256	2,173
Mountain Goat	8,231	5,232	4,275	957
Moose	28,318	26,162	24,500	1,662
OGMA	6,093	6,093	2,769	3,324

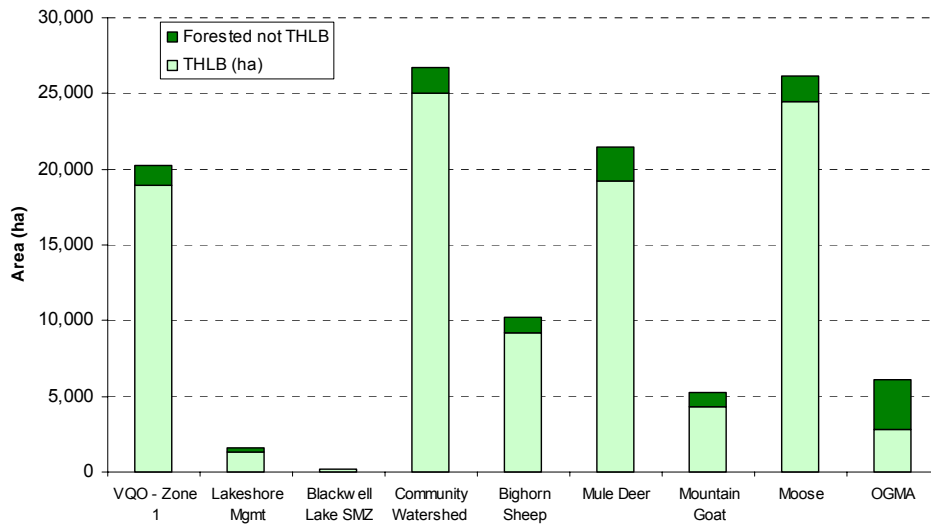


Figure 7. OS-LRMP Non Timber values for management in TFL 49.

A small amount of pine marten RMZ also occurs in the TFL (4% of the RMZ area).

Other Species Specific Habitat

Numerous other species exist in the TFL but the Ministry of Environment identified the following species as of particular concern:

- Flammulated Owl
- Lewis’s Woodpecker
- Williamson’s Sapsucker

2. Current Situation

2.1. Timber Supply Issues

Due to the current predictions of mountain pine beetle (MPB) impacts and the prevalence of pine-leading stands on TFL 49 (~42% of the current growing stock), there are potentially severe implications to timber supply:

2.1.1 Midterm Dip in Harvest Levels

As a result of the anticipated reduction in growing stock over the next 10-20 years from MPB, harvest flow will exhibit a significant midterm trough for 50-60 yrs. The speed at which managed stands can be brought online will have a large impact on the depth and duration of this trough.

2.1.2 Unsalvaged MPB-killed Timber with Poor/No Regeneration

Salvage harvesting is currently focused on capturing MPB impacted stands in the TFL but a significant area of the land base will likely die and not be salvaged. This could potentially result in a period of high fire hazard and/or impaired regeneration if fires are avoided. The regeneration delay occurring on these stands will adversely affect timber supply in the midterm.

Additionally, it is highly probable that many immature PI stands could be impacted by the mountain pine beetle and this area could also have little or no natural regeneration. To avoid regeneration delays, these sites may require intervention to remove existing stems and establish regeneration.

2.1.3 Reliance on non-pine leading stands

Because of the losses expected in PI stands it is anticipated that harvesting will be focused on other species in the mid-term period where timber availability is at it's lowest. These stands will be needed both for timber supply and to support non-timber values.

2.1.4 Impacts on Age Class Distribution

Given the magnitude of area affected by the mountain pine beetle across many age classes (from 30 years to 200+ years old) there will be a large shift of area into a narrow range of age classes. This area will in turn become available for harvest again at the same period in the future. From a timber supply perspective, it will be important to break up this age class cohort by accessing it as early as possible and minimizing harvest after culmination age.

2.2. Timber Quality Issues

The current provincial target for premium logs to be produced is 10% of AAC. Premium logs in the TFL are defined as large sawlogs, peelers, house logs, and Cedar poles. Logs capable of producing MSR (Machine Stress Rated) lumber may be a premium product in the future but are not currently utilized in the TFL.

Log size is one factor that can influence timber quality and can be directly correlated with harvest ages – longer rotations/old stands tend to produce larger logs. In general, the average age of harvested stands is declining over time as we move into the harvest of second growth managed stands (70 year old stand on average in the MP4 Base Case in the long-term). As a result, timber quality associated with large logs will likely decrease over time.

2.3. Habitat Supply Issues

Pressures on the environment will come through direct impacts of pine mortality due to the MPB epidemic and indirect impacts of pine and non-pine mortality due to salvage logging and efforts to minimize reductions in AAC during the “fall down” period. The loss of mature and old forest (pine and pine mixed with other species) over the next 5 – 10 years will have significant impacts on associated aquatic and terrestrial values. The following summarizes Landscape/Watershed values placed at increased risk due to the MPB in TFL 49.

2.3.1 Aquatic Ecosystems, Species and Domestic Water Supply

Changes in hydrology can be estimated by equivalent clear cut area (ECA) and road density. Significant increases in ECA, road density, kilometers of road ditches, and numbers of stream crossings, increase the risk of increased peak flows and changes to channel morphology. Risk can be reduced through speeding hydrological green-up and increased emphasis on maintaining vegetation within riparian ecosystems. This is especially important in the following areas.

1. All fish-bearing streams
2. Wetlands
3. Community watersheds

2.3.2 Loss of Mature and Old Pine

Old growth areas have been drafted for the Okanagan-Shuswap TSA, consistent with the Okanagan Shuswap LRMP. These areas are being avoided for harvest, but resources are lacking to field check, monitor or respond to forest health considerations in OGMA's. In sites where pine is currently a component of OGMA's because there is little to no non-pine species available, replacing OGMA's infested by MPB may be difficult. Silviculture strategies may provide an opportunity to improve future condition of OGMA's or help recruit old stand attributes in younger stands.

2.3.3 Loss of Large Older and mature sized Forest Patches

There are no legal objectives for managing old seral patch size in TFL 49. Chief Forester policy and other large cutblock related direction incorporates some of the concepts related to patch size, but these do not substitute for patch size management. MPB has the advantage of promoting larger patch sizes in landscapes that traditionally experienced large scale disturbances. However, salvage harvesting is in many ways different from what would occur in nature, and the extent and intensity of current infestations may be exceeding historical scales of disturbance. Managing to maintain a continuous supply of the various patch sizes over space and time poses a daunting task when overlaid by MPB patterns of infestation. Nevertheless, this deserves to be considered as part of silviculture planning.

2.3.4 Wildlife Trees and Coarse Woody Debris

Wildlife trees are managed in the TFL through provisions in the Forest and Range Practices Act and LRMP objectives/strategies. Direct impacts of the MPB infestation can enhance supplies of wildlife trees and CWD, at least in the short to medium term but, actions such as salvage, road building, and safety issues associated with roads, replanting and stand tending may result in the loss of higher value large diameter fir, larch, ponderosa pine and deciduous wildlife trees and CWD. Wildlife trees and CWD are also vulnerable to intensive fires promoted by climate change and large supplies of MPB killed pine. Strategies to retain coarse woody debris, wildlife trees and wildlife tree supply through time are a critical part of silviculture planning.

2.3.5 Increase in Roads and Access

Many species at risk or of management concern are negatively affected by roads. Road building is expected to increase significantly to manage forest health and salvage MPB. The potential for impacts to many species including mule deer, moose, mountain goat, and bighorn sheep is of serious concern. Given the concentration of species at risk in this TFL and the vulnerability of key forest-dependent species like Bighorn Sheep, increased emphasis on managing road impacts is warranted.

2.3.6 Cattle Use

Cattle use in association particularly with riparian areas and newly planted areas will continue to be a concern for managing both habitat and timber supply. When designing silviculture treatments, consider, retain and enhance existing barriers to cattle access associated with riparian areas.

2.3.7 Species Impacted by the MPB

The Okanagan-Shuswap LRMP (OS-LRMP) provides a framework for land use in the TFL. Approved in 2001, the LRMP provided for increased protected areas, as well as increased areas for Enhanced Riparian Protection, increases to Caribou Reserves, and draft Old Growth Management Areas in the Timber Harvest Land Base (THLB). These reserves will help species and ecosystems sustain the impact of habitat changes resulting from Mountain Pine Beetle and associated salvage harvesting.

TFL 49 has many of the characteristics of the Okanagan TSA. The Okanagan Type 1 Silviculture strategy identified representative examples of wildlife species and ecosystems in the Okanagan TSA that could be negatively affected by MPB salvage logging. Those considered absent from the TFL have been removed from Table 3 below.

Table 3. Old and Mature forest associated species likely to occur in TFL 49.

Species	CDC Status	COSEWIC Status	Identified in OS-LRMP as regionally important?
Lewis's woodpecker	Red	Special Concern	No
Williamson's Sapsucker	Red	Endangered	No
Wolverine (rare)	Blue	Special Concern	No
Northern goshawk	Yellow	Threatened	No
Flammulated owl	Blue	Special Concern	No
Pine marten	Yellow	N/A	No
Moose	Yellow	N/A	Yes
Mule deer	Yellow	N/A	Yes
Elk	Yellow	N/A	No
Salmon Resident trout streams	Yellow	N/A	No
Big horned Sheep	Blue	N/A	Yes
Ecosystem	CDC Status	COSEWIC Status	Identified in OS-LRMP as regionally important?
<i>Pinus contorta</i> / <i>Alnus viridis</i> ssp. <i>sinuata</i> / <i>Calamagrostis rubescens</i>	Blue	N/A	No
<i>Pinus contorta</i> / <i>Calamagrostis rubescens</i> - <i>Arctostaphylos uva-ursi</i>	Yellow	N/A	No
<i>Pinus contorta</i> / <i>Calamagrostis rubescens</i> - <i>Lupinus arcticus</i>	Yellow	N/A	No
<i>Pinus contorta</i> / <i>Juniperus communis</i> / <i>Calamagrostis rubescens</i>	Yellow	N/A	No
<i>Pinus contorta</i> / <i>Juniperus communis</i> / <i>Lupinus arcticus</i>	Yellow	N/A	No
<i>Pinus contorta</i> / <i>Juniperus communis</i> - <i>Paxistima myrsinites</i>	Blue	N/A	No
<i>Pinus contorta</i> / <i>Vaccinium caespitosum</i> / <i>Sphagnum</i> spp.	Blue	N/A	No
<i>Pinus contorta</i> / <i>Vaccinium membranaceum</i> / <i>Cladonia</i> spp.	Yellow	N/A	No
<i>Pinus contorta</i> / <i>Vaccinium scoparium</i> - <i>Calamagrostis rubescens</i>	Yellow	N/A	No
<i>Pseudotsuga menziesii</i> - <i>Pinus contorta</i> / <i>Calamagrostis rubescens</i> / <i>Pleurozium schreberi</i>	Yellow	N/A	No

3. Working Targets

The following working targets were created using the current TFL situation as outlined in Section 2. The targets reflect what the TFL would like to achieve through the implementation of this silviculture strategy. It is recognized that it may not be possible to achieve all of the targets because of limited budgets or conflicts between targets, but they are presented to help frame high level objectives of the TFL.

3.1. Timber Supply Targets

Short term (0-20 years):

- Harvest at a level that minimizes non-recoverable losses.

Midterm (20-100):

- Minimize the depth and duration of the midterm trough.

Long term (100 yrs):

- LTHL of 488,600 m³/yr (inherent capability +–5%) (midterm seen as more important)

3.2. Timber Quality Targets

Mid and Long Term:

- Maintain diversity of stand types and ages across the land base – range of products including cedar poles/house logs/peelers/MSR grade lumber.

3.3. Habitat Supply Targets

Overall Objective

- Minimize negative impacts on water resources, ecosystems and species:

Short Term

- Manage consistently with LRMP guidelines.
- Increased levels of broad leaf trees and other appropriate species to increase stand level diversity across the land base.
- Manage to meet hydrologist recommended ECA thresholds.

Midterm and Long Term

- Maintain or improve the conservation status of all species where possible. (Ensure forestry practices do not make species status worse).

4. Analysis Issues / Scenarios Overview

The following 15 analysis options were derived from the initial project workshop held in Tolko's Lumby office on November 1, 2006 and represent a wide range of silviculture/management options to address the timber quantity, timber quality, and habitat related issues discussed above. All options below #2 build on the inputs/assumptions used in the Revised Base Case. An overview of each scenario is provided below with details provided in section 5 through 18.

1. Management Plan No.4 Benchmark Base Case

This scenario mimics the Management Plan No.4 (MP4) base case scenario in order to benchmark the model and dataset being used in this project.

2. Revised Base Case

This scenario updates the MP4 scenario to reflect the current and expected future conditions on the TFL. Changes include implementing all anticipated MPB impacts, disturbance in the inoperable land base, retention of spatially explicit Old Growth Management Areas (OGMAs), long-term retention areas (from Tolko's retention plan), and the current AAC uplift for 5 years.

Exploratory Scenarios

(Several of these scenarios make use of the Patchworks model's ability to optimize treatment choices. Treatments were never hardwired into scenarios, they were simply made available for the model to select where it could best meet the objectives defined for the scenario (timber and non timber).

3. No Incremental Silviculture

The implications of removing incremental silviculture practices currently applied on the land base is explored in this scenario. This translates into the removal of any volume gains from planting improved seed as no other incremental silviculture is occurring.

4. Reduced Planting Densities

Where natural regeneration is expected to occur, this scenario illustrates the financial and timber supply implications of reducing planting densities.

5. Enhanced Reserves

The impacts and/or benefits of excluding harvest for 30 years from the short term reserves proposed in Tolko's current Retention Plan is explored under this scenario.

6. Enhanced Reserves – Limited Harvesting Allowed

A penalty is placed on harvesting the short-term reserves in the Retention Plan but it allows the model to harvest these areas where a significant benefit to timber supply is provided and little or no impacts to non-timber objectives occurs.

7. Intermediate Harvest in Mixed PI Stands

This scenario provides options to clearcut, intermediate harvest or leave mixed PI blocks during the MPB salvage period. Blocks on slopes <40% with 30-60% PI will have the option of having an intermediate harvest entry followed by a clearcut at least 10 yrs later, or longer if required to achieve 100 m³/ha.

8. Leave Impacted PI Stands with Advanced Regeneration

The impacts of foregoing short term harvest volume from salvaging dead PI stands with advanced regeneration is explored in this scenario. The objective is to provide enhance midterm flows and mitigate habitat impacts. If left unsalvaged, the stand is assumed to come online 30 years sooner than if it was harvested because the regeneration delay is avoided and the stand is already advanced in age.

9. Fertilization

The impacts of implementing various fertilization regimes on candidate stands in an attempt to improve midterm timber supply is explored in this scenario. Two scenarios will be investigated:

1. Early/Multiple (stands between 15 and 80 years eligible, can be treated up to three times.)
2. Late Rotation (stands eligible 10 years prior to harvest)

Existing and future Sx and Fd stands are eligible while only future managed PI stands (post MPB) are eligible.

10. Impeded Stands

Mapping of impeded stands will be completed to define locations and allow review. The assumption is that no action will be required on many of these stands and the area where treatment is required would not make enough of an impact to warrant modeling. This scenario will test this assumption.

11. Loss of Marginal Stands

The impacts of excluding marginal PI stands from the THLB is explored under this scenario. These stands currently have poor economics because of younger ages or low volumes/low productivity. When MPB impacts occur in these already marginal stands, they are unlikely to be

harvested and may not contribute meaningfully in the future unless treated. This is designed as a worst case scenario for these stands.

12. Rehab of Impacted/Unsalvaged THLB Stands

The impact of rehabilitating unsalvaged THLB stands impacted by MPB if % mortality is >80% is assessed under this scenario. The intent is to evaluate the impacts of having these stands regenerate promptly and avoid a prolonged regeneration delay. Rehabilitation is defined as site prep to address existing dead stems (snag falling or pile/burning) and planting.

13. Enhanced Acceptance of Broadleaf Species

The impacts of allowing higher levels of broadleaf species (aspen, birch, cottonwood) to be accepted in specific site series of the ICH and IDF biogeoclimatic zones for biodiversity reasons and, to a lesser degree, root rot mitigation reasons are explored in this scenario.

14. Increased AAC Uplift to Capture MPB Mortality

The impact of extending the uplift by 5 years in order to capture the majority of PI mortality while minimizing impacts on other resource values (i.e. how much can we harvest before we start to impact other resources) is explored in this scenario. The current 5yr AAC uplift is designed to only capture the PI volume in severely impacted stands.

5. Methods

A detailed accounting of the assumptions and methods used for this analysis can be found in the TFL 49 Silviculture Type II Data Package. This section provides a brief summary of these assumptions and describes the models used. For further information on analysis methodology refer to the Data Package.

5.1. Landscape-Level Forest Estate Model

For forecasting and analysis, the PATCHWORKS™ modeling software was used. This suite of tools is sold / maintained by Spatial Planning Systems Inc. of Deep River, Ontario (Tom Moore-www.spatial.ca).

Patchworks is a fully spatial forest estate model that can incorporate real world operational considerations into a strategic planning framework. It utilizes a goal seeking approach and an optimization heuristic to schedule activities across time and space in order to find a solution that best balances the targets/goals defined by the user. Targets can be applied to any aspect of the problem formulation. For example, the solution can be influenced by issues such as mature/old forest retention levels, young seral disturbance levels, patch size distributions, conifer harvest volume, growing stock levels, snag densities, CWD levels, ECA's, specific mill volumes by species, road building/hauling costs, delivered wood costs, net present values, etc. Patchworks continually generates alternative solutions until the user decides a stable solution has been found. Solutions with attributes that fall outside of specified ranges (targets) are penalized and the goal seeking algorithm works to minimize these penalties – resulting in a solution that reflects the user objectives and priorities.

Patchworks' flexible interactive approach is unique in several respects:

- Patchworks' interface allows for highly interactive analysis of trade-off's between competing sustainability goals.
- Patchworks integrates operational-scale decision-making within a strategic-analysis environment: realistic spatial harvest allocations can be optimized over long-term planning horizons. Patchworks can simultaneously evaluate forest operations and log transportation problems using a multiple-product to multiple-destination formulation. The model can identify in precise detail how wood will flow to mills over a complex set of road construction and transportation alternatives.
- Allocation decisions can be made considering one or many objectives simultaneously and objectives can be weighted for importance relative to each other. (softer vs. harder constraints)

- Allocation decisions can include choices between stand treatment types (Clearcut vs. partial cut, fertilization, rehabilitation, etc).
- Unlimited capacity to represent a problem – only solution times limit model size.
- Fully customizable reporting on economic, social, and environmental conditions over time. Reports are built web-ready for easy sharing of analysis results – even comparisons of multiple indicators across multiple scenarios.

5.2. Modeling Assumptions

Much of the data used in this analysis is derived from the recently completed MP4 and its timber supply analysis². Where input assumptions and data varied from MP4, it has been documented in this report or the data package (see Appendix).

Modeling outcomes were explored over a 250 year planning horizon and assumptions were required in 4 key areas:

Land Base Assumptions: Used to define the timber harvesting land base (THLB) and the portion of the land base that can be used to meet non-timber objectives. The landbase is defined in Table 1 above.

Management Assumptions: Used to define how non-timber values are reflected / addressed in the model and how forest management will occur.

Table 4. Modeling of non timber resources objectives

Resource Issue	Portion of Landbase Applied To	Constraints Applied to Address Issue
Visual Management	CFLB of each VQO polygon	Based on VQO and VAC: VQO = R (10-20% max <5-3m ht) VQO = PR (15-25% max <5-3m ht) VQO = M (25-35% max < 5-3m ht)
Lakeshore Management Zone	CFLB of each LMZ	Based on Lake Class and VAC: Class A (3.5-4.5% max < 4.5-6.5m ht) Class B (7.5-12.5% max < 4.5-6.5m ht) Class C (12.5-17.5% max < 4.5-6.5m ht) Class D (13.8-21.3% max < 4.5-6.5m ht)
Community Watersheds	Hope Creek CFLB	Max. 30% < 6 m
	Lambly Creek CFLB	Max. 34% < 6 m
	Norris Creek CFLB	Max. 30% < 6 m
	Powers Creek CFLB	Max. 42.5% < 6 m
	Silver Creek CFLB	Max. 30% < 6 m
Bighorn Sheep Habitat	CFLB of Sheep RMZ	Min. 33% >16 m
Mule Deer Winter Range	Shallow snowpack CFLB by LU	Max 30%<20 yrs + Min 15%>140 yrs
	OK_Wside_Mod snowpack THLB	Min. 15.5% >175 yrs
	OK_Wside_Mod snowpack CFLB	Min. 15.5% >120 yrs
	OK_Wside_Mod snowpack IDf mw	Min. 31.0% >175 yrs
	Trepanier_Mod snowpack THLB	Min. 12.2% >120 yrs
	Trepanier_Mod snowpack CFLB	Min. 14.7% >175 yrs
	Trepanier_Mod snowpack IDf mw	Min. 29.8% >175 yrs
	U_Salmon_Mod snowpack THLB	Min. 16.5% >175 yrs
	U_Salmon_Mod snowpack CFLB	Min. 16.5% >175 yrs
Deep snowpack CFLB by LU	Min. 60.0% >100 yrs	
Mountain Goat Winter Plateau	CFLB in Plateau Habitat by LU/BEC	Max. 33% of CFLB < 33 yrs and 150 yr rotation (100 yrs for PI)

² TFL 49 MP4 Timber Supply Analysis report. Version 3. Timberline Forest Inventory Consultants Ltd. September 2004.

Resource Issue	Portion of Landbase Applied To	Constraints Applied to Address Issue
Habitat		
Moose Winter Habitat	CFLB of Moose RMZ by LU/ BEC	Min. 33 % >16 yrs
Integrated Resource Mgmt	THLB by LU	33% < 2m

Growth and Yield Assumptions: Used to define the net volumes that will be realized when natural and managed stands are harvested. They also describe various tree/stand attributes over time (ie. height, diameter, presence of dead trees, etc). See MP4 data package for details. In general,

- Forest cover data was current to mid 2006 (depletions and projection)
- Analysis units were created using unique combinations of ecosystems (site series level), leading tree species, and site classes. There were:
 - 185 existing thrift natural stand AU's (AU 1-189)
 - 183 existing mature natural stand AU's (AU 201-389)
 - 53 existing managed stand AU's (AU 401-453) [less than 35 yrs old]
 - 50 future managed stands AU's (AU 501-550)
- VRI Phase 2 adjustments were applied to heights, ages, and volumes in natural stands >80 yrs old. This provided a 9.3% increase in existing volume.
- SIBEC site index values were used for all managed stand (TISPY) yield curves. This increased the average SI on the future managed landbase by 4m (26%).
- Predicted future volume gains from class A seed were used in future managed stands (PI-16%, Fd-22 to 26%, Lw-12%, Sx-15 to 19%)
- Utilization levels were assumed to be higher than standard giving a 1.9% volume increase on all yield curves.
- Because of detailed inventory mapping of NP areas, the OAF1 value used in TIPSYPY was reduced to 10% from the provincial average of 15%.

The variable density yield program (batchVDYP v6.6d) was used for the existing natural yield curves while TISPY (batchTIPSYPY v. 3.2k) was used for existing and future managed yield curves.

Natural Disturbance Assumptions: Used to define the extent and frequency of natural disturbances across the land base.

- On the THLB, a volume loss of 15,600 m³/yr was applied.
- On the Non THLB, succession was assumed to occur in PI stands at age 300 and at age 400 for all other species. Mountain pine beetle (MPB) assumptions did not let any PI stands reach 300 years of age in the analysis.
- MPB was assumed to kill 7 million m³ (90% of PI Vol) on the THLB (>60 yr old stands) and an additional 1107 ha of younger PI stands (20-60 yrs old). Mortality and a 2-3 yr shelf life were assumed make stands unavailable between 5 and 10 years into the planning horizon. All PI volume in MPB impacted stands was lost by the end of the 10th year in the planning horizon. Stands with >=60% PI had their age set to -20 (regen delay) but retained any non PI volume present at time of harvest. Stands <60% PI retained their age at time of MPB impact but had the PI volume removed. These impacted stands were eligible for harvest again once they had reached 100 m³ – depending on AU this meant it was immediately eligible or it had to wait for

5.3. Merchantability Analysis

This project included the completion of a stand level merchantability analysis. This was completed by assigning stand values and costs to each stand (polygon) based on forest cover attribute information

(i.e. species, stand age, volume, site index, and stand densities), terrain information, haul distances, and ecosystems types³. The methodology was developed by Oliver Thomae and has been calibrated to TFL 49 using the Okanagan TSA calibration values and the Interior Appraisal Manual (Effective December 1, 2006).

6. Base Case Analysis Results

6.1. MP4 Benchmark

In an effort to benchmark the modeling approach used in this analysis to the one used in MP4, a MP4 scenario was generated for benchmarking. Significant effort was invested in replicating the MP4 assumptions but small differences in yield curves still occurred (slightly higher) which in turn caused differences in MHAs (reduced by 10 years for several AU's). The resulting harvest flow for the Type 2 Benchmark Base Case is 5.9% higher in the short- and mid-term (385,900 m³/yr for the MP4 Base Case vs. 410,000 m³/yr for the Type 2 Benchmark Base Case) and 3.0% higher in the long-term (488,600 m³/yr for the MP4 Base Case vs. 503,500 m³/yr for the Type 2 Benchmark Base Case).

In addition to the yield curve differences, there were differences in the way the models were able to represent constraints and their solutions generation techniques (simulation vs goal seeking optimization). In a simulation model (used for the MP4 analysis), stands are queued for harvest using priorities such as 'oldest first' and a single solution is generated. Contrary to this, goal seeking optimization models (used for this analysis) do not queue stands but instead generate numerous solutions and keep solutions that better match user defined objectives for timber and non-timber values. In order to make a more direct comparison between the MP4 Base Case and the Type 2 Benchmark Base Case, a simulation model was created using Forest Planning Studio to compare input assumptions/datasets. The results showed a close correlation with the new Benchmark scenario indicating that the majority of the differences seen in Figure 8 are more likely a result of different data inputs than differences in model solution techniques.

When compared to MP4, growing stock forecasts are very similar. Initial growing stock for the Benchmark Base Case is within 2% of the initial growing stock of the MP4 Base Case.

³ Thomae, O. Timber Merchantability Analysis TFL 49 – Version 2.7. ArbourTech Forest Management Services. Cranbrook, B.C. November 2006.

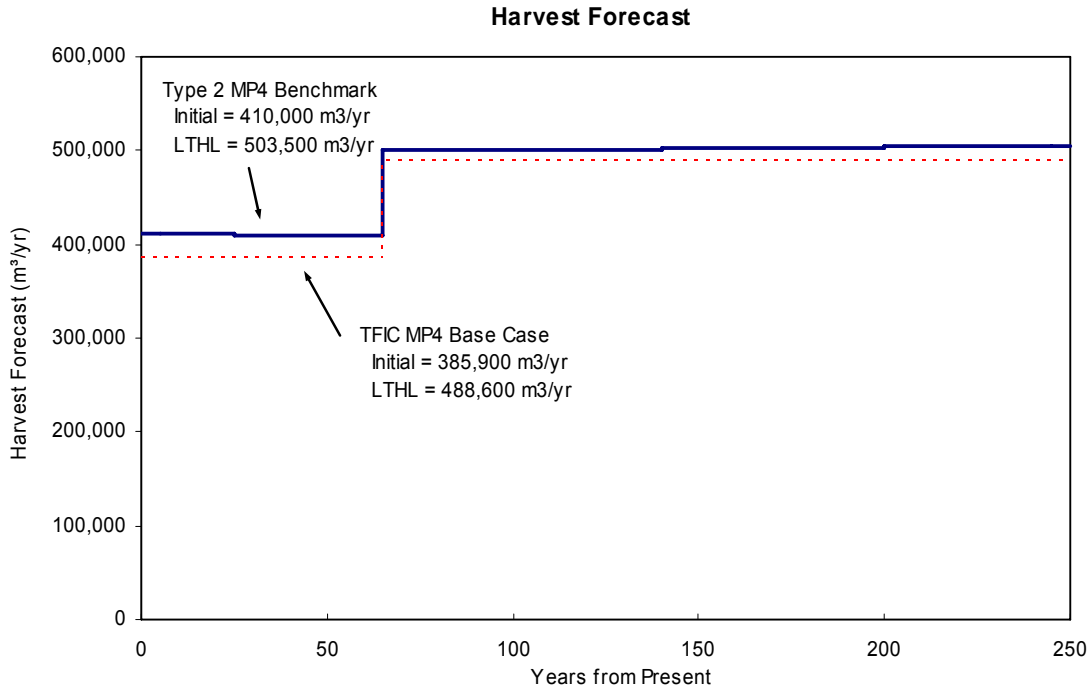


Figure 8. MP4 Benchmark Base Case projected harvest flow comparison.

The difference between the two benchmarks is not insignificant, but can essentially be ignored during the evaluation of results presented in this report as the results are all relative to the new benchmark. If comparisons are made to forecasts outside this report, the differences between the two benchmarks should be carefully considered.

6.2. Type 2 Revised Base Case

In order to fully understand the issues facing the TFL, a revised base case was created that reflects our best understanding of the current and future circumstance under which forest management will occur in the TFL. The following assumptions were updated in the modeling approach (details can be found in the data package):

- Anticipated impacts of the current MPB epidemic were incorporated,
- Disturbance was incorporated in the non timber harvesting land base,
- Spatially explicit Old Growth Management Areas (OGMAs) were implemented for 80 yrs,
- Long-term retention (from Tolko's retention plan) was implemented for 80 yrs,
- Current AAC uplift was implemented for 5 years.

6.2.1 MPB impacts

The MPB assumptions resulted in 30,800 ha being impacted, of which 19,900 ha are salvage harvested leaving approximately 10,870 ha unsalvaged (Figure 9). If unsalvaged in the second period (year 5-10) the PI volume was considered unsalvageable. In terms of volume, 7.0 million m³ of PI are impacted by the MPB, of which 4.1 million m³ are salvage harvested leaving 2.98 million m³ of PI unsalvaged.

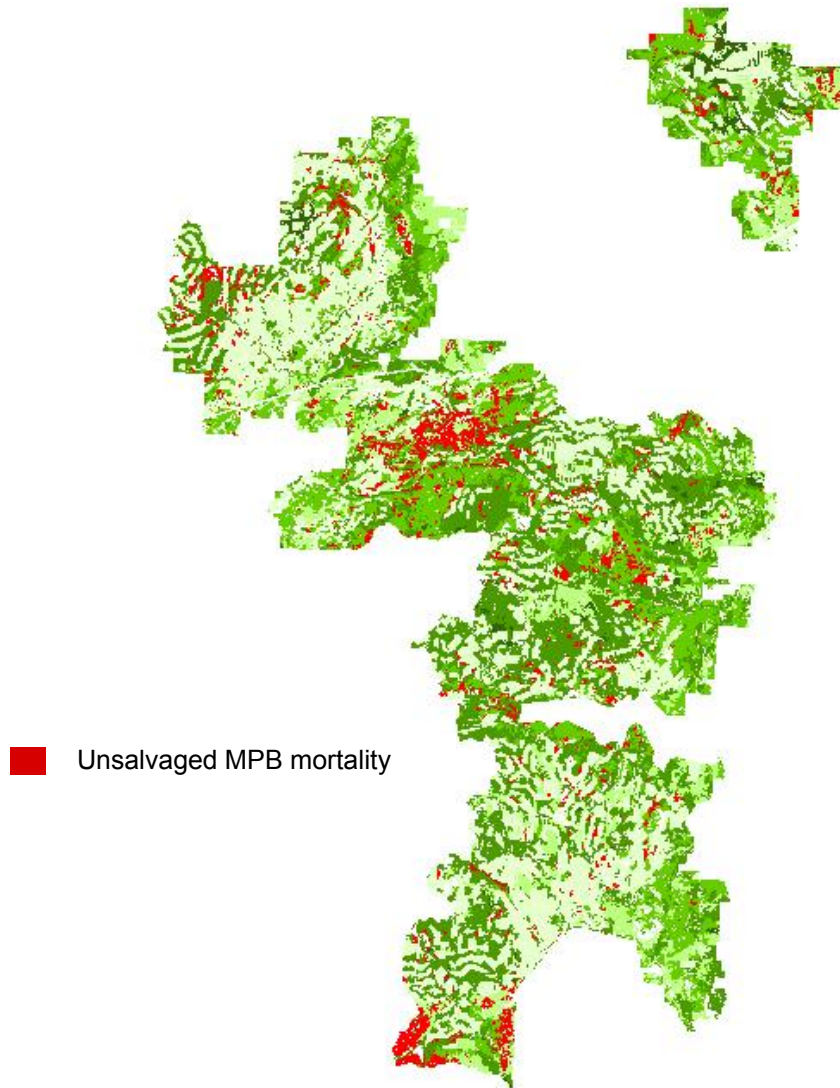


Figure 9. Map showing unsalvaged PI volume under the Revised Base Case scenario.

6.2.2 Timber Supply

The revised base case assumptions result in an initial harvest level consistent with the recent AAC uplift (580,000 m³/yr) plus an elevated harvest level in the second 5 year period (Figure 10). This second period harvest level is driven by the model attempting to capture as much PI volume as possible before it becomes unsalvageable. Once all salvage opportunities end at year 10, the mid-term timber supply trough begins with a harvest level 26% lower (106,600 m³/yr lower) than the Benchmark. This timber supply trough lasts for 60 years at which point, harvest levels rise dramatically and eventually come within 4.0 % of the LTHL for the Benchmark Base Case. The end of the midterm trough is defined by the timing of significant volumes of managed stands coming online and the corresponding increase in available volume / merchantable growing stock (see Figure 11). The long term harvest level does not reach the same level as in the benchmark scenario because disturbance in the inoperable forces a higher proportion of the non timber constraints to be met using THLB area.

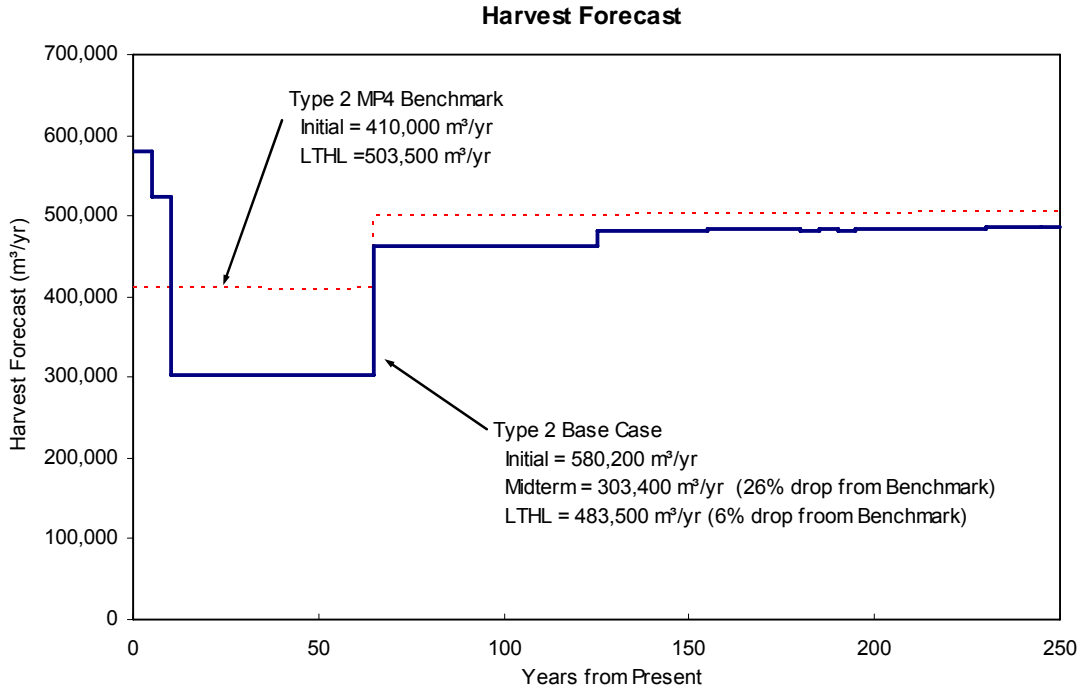


Figure 10. Type 2 Revised Base Case harvest flow comparison to Benchmark Base Case.

The total and merchantable growing stock is shown in Figure 11. The initial growing stock is approximately 18.3 million m³ and the merchantable growing stock is approximately 13.2 million m³.

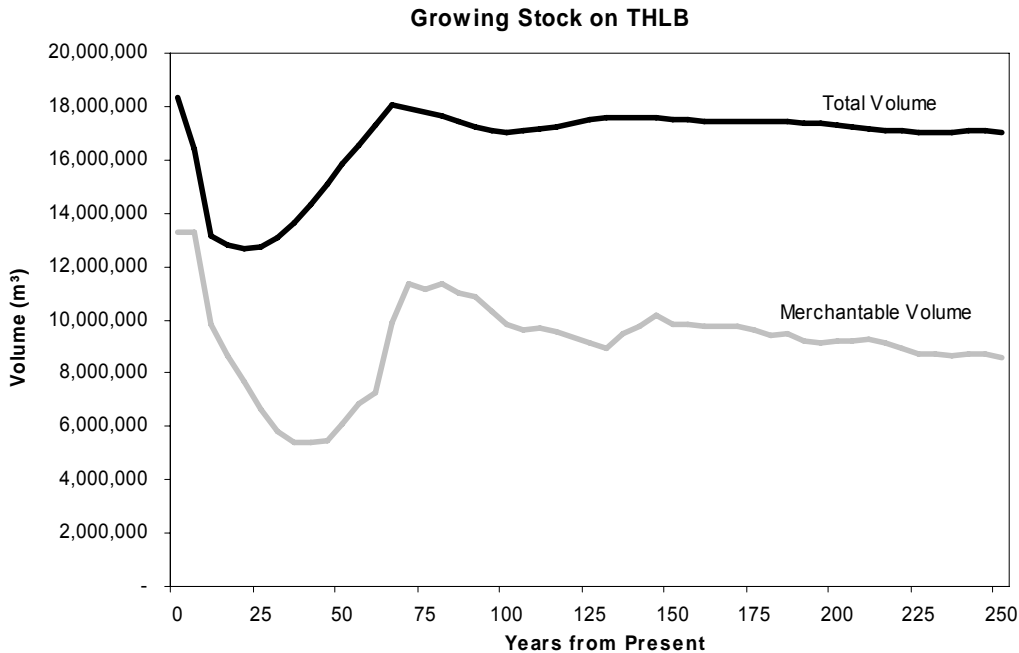


Figure 11. Type 2 Revised Base Case merchantable and total growing stock (THLB).

The rapid depletion of growing stock at the front end is due to the elevated harvest as well as unsalvaged losses related to the MPB. Growing stock recovers gradually through the mid-term timber supply trough and then peaks just after the point where the harvest level is increased 70 years into the

future. The lowest point of merchantable growing stock occurs in years 45-50. This period in the future is the pinch point for timber supply and is key to defining the depth and duration of the midterm trough. Silviculture strategies that can deliver additional volume into this period will help to reduce the midterm trough.

Figure 12 shows the annual area harvested, average harvest age of harvested stands, and average volume yield (m³/ha) of harvested stands over the planning horizon. The annual area harvested per period starts off high (~2,281 ha) because of elevated harvest levels and then drops quickly down to ~1250 ha/yr during the mid-term trough. The long-term average is approximately 1500ha/yr. The average harvest age near the beginning of the planning horizon is 130-155 years (initial lower because PI stands), which drops down to about 73 years on average in the long term. The spike in average age at 80 yrs comes from the release of spatial retention areas. The average volume yield (m³/ha) of harvested stands in the short term ranges from 230 to 300 m³/ha as the model targets captures PI stands before they become unsalvageable. In the long-term, the average volume yield of harvested stands is 325 m³/ha.

The general trend is that future managed stands are highly productive and will produce more volume/ha even on shorter rotation ages. Current stands produce an average of 275m³/ha at 160 yrs old, while future stands produce 325 m³/ha at 73 years.

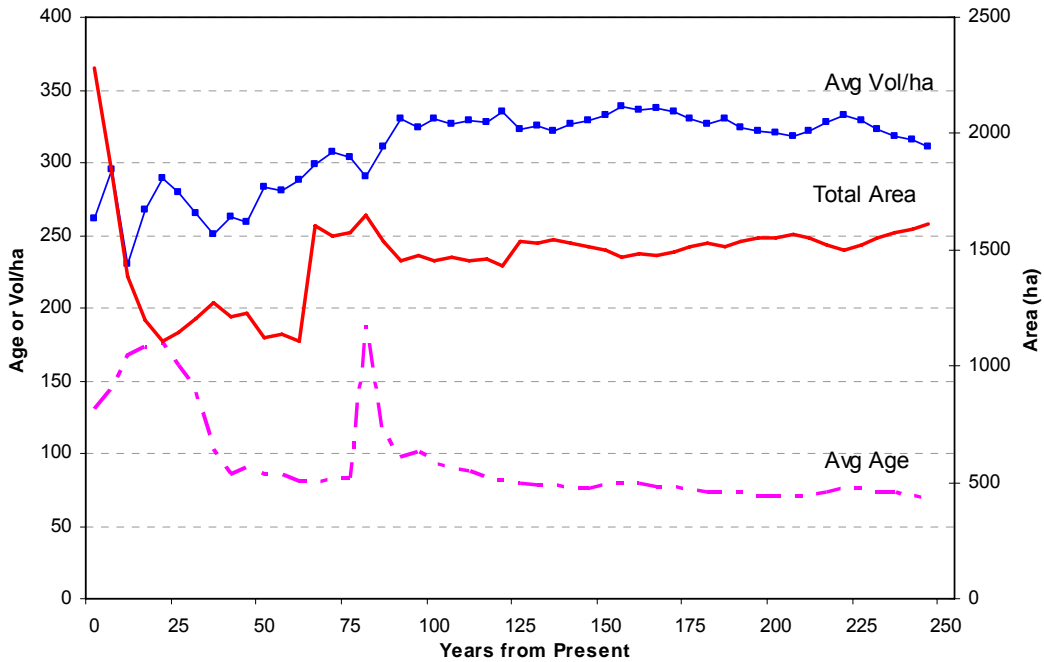


Figure 12. Type 2 Revised Base Case average harvest age / volume / areas.

The contribution from both natural and managed stands over time is shown in Figure 13. The transition from natural stands to managed stands starts 25 years into the future. These initial managed stands that are harvested are currently 30-35 years old on the land base. Significant harvest volumes are coming from managed stands by year 40, and by year 50 (back end of the midterm trough) harvest is almost entirely coming from managed stands. The notable exception is the spike of natural stands harvested 80 years from now when the spatial OGMA's and long term retention areas are released and redeployed on the land base.

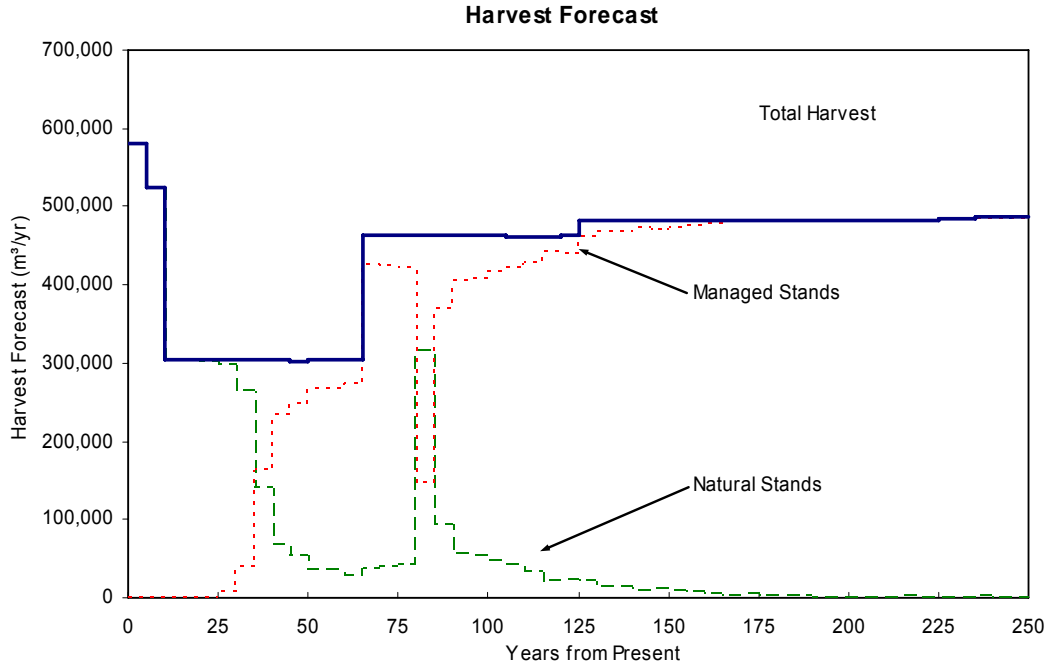


Figure 13. Type 2 Revised Base Case transition of natural stands to managed stands.

The projected tree species composition of the revised base case harvest is shown in Figure 14.

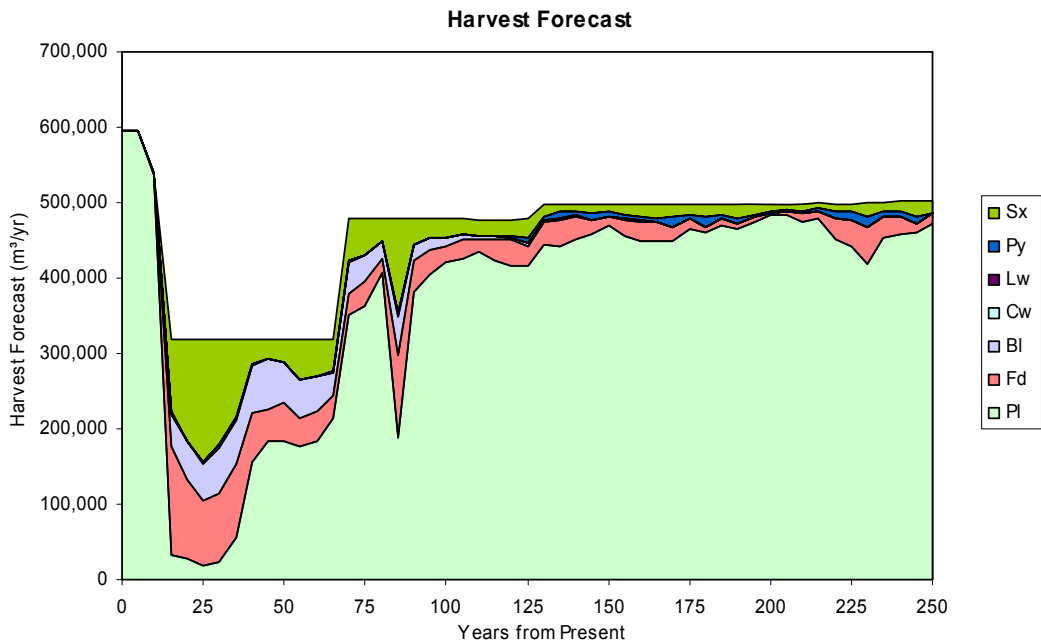


Figure 14. Type 2 Revised Base Case projected tree species contribution to harvest

Because of the focus on PI harvest and the predicted mortality due to MPB, harvest in the first 10 years is entirely focused on PI leading stands. During the front end of the mid-term trough, harvest relies largely on non-PI leading stands (mostly Sx, Fd, and BI). In the back end of the trough, PI starts contributing significantly to the harvest profile again. This PI volume comes from young PI stands currently existing on the land base and highly productive stands regenerated in the first 10-20 years of the planning horizon. In the long term, harvest is coming dominantly from PI leading stands because

most future managed stands are assumed to be PI leading (regeneration assumptions are heavy to PI). The spike of non pine volume at year 80 is associated with the release of the spatial OGMAs.

Figure 16 provides a time series showing the age class distribution of the TFL 0, 50, 100 and 200 years into the future. The present day stand ages are distributed over a wide range of age classes except for a lack of 50-60 year old stands. A large portion of area falling in younger (≤ 30 years) age classes. Plus a large portion falls in older (90 to 160 years) age classes. Fifty years into the future, the age class distribution is starting to get concentrated in the 0 to 90 year age classes with a large spike in the 50 year age class, caused by the elevated harvest and MPB mortality in the first 10 years of the projection. Year 100 shows this spike broken up and that the post midterm harvest level is creating more young stands per period than were created in the midterm. Year 200 shows a normalized forest with relatively even areas in age classes below 60 years old (avg harv age = 75).

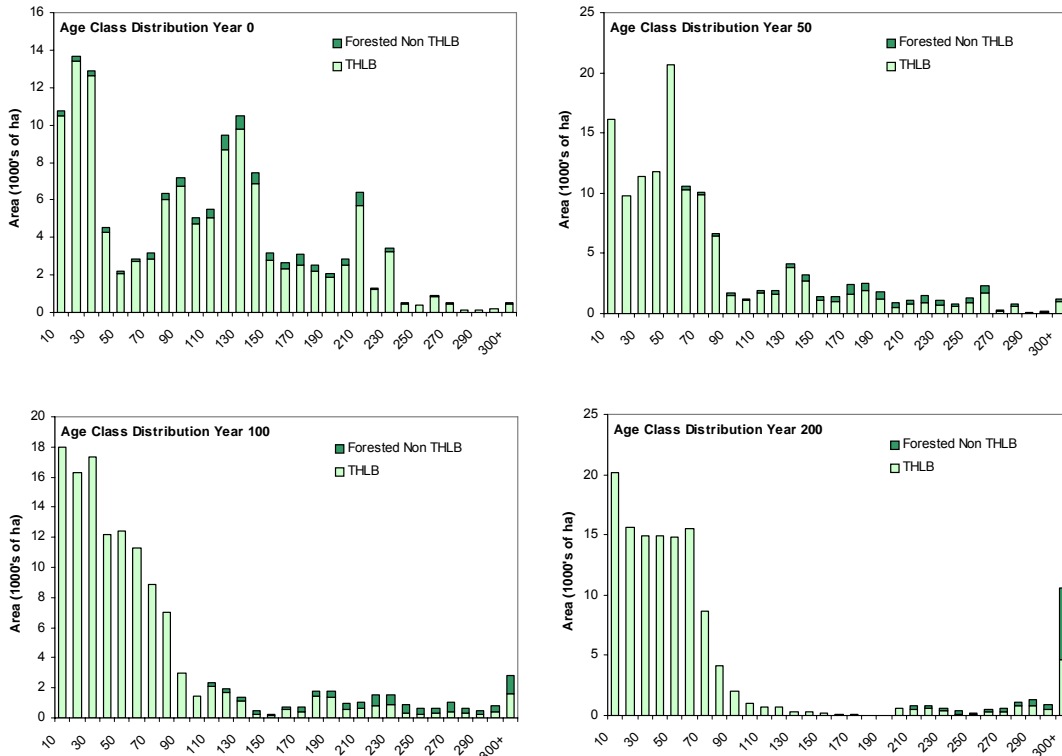


Figure 15. Type 2 Revised Base Case projected Age Class Distribution 0,50,100, and 200 years into the future.

Although natural disturbance was modeled in the revised base case, the age class distribution at first glance does not appear to reflect this. This is a function of the way succession is treated in the patchworks model. When succession is applied, the age remains the same, however all the stand attributes assume a starting age of zero. Figure 16 shows trends of volumes lost to succession over the planning horizon. Actual volumes lost are higher than shown here because these estimates were buffered by growth occurring between periods.

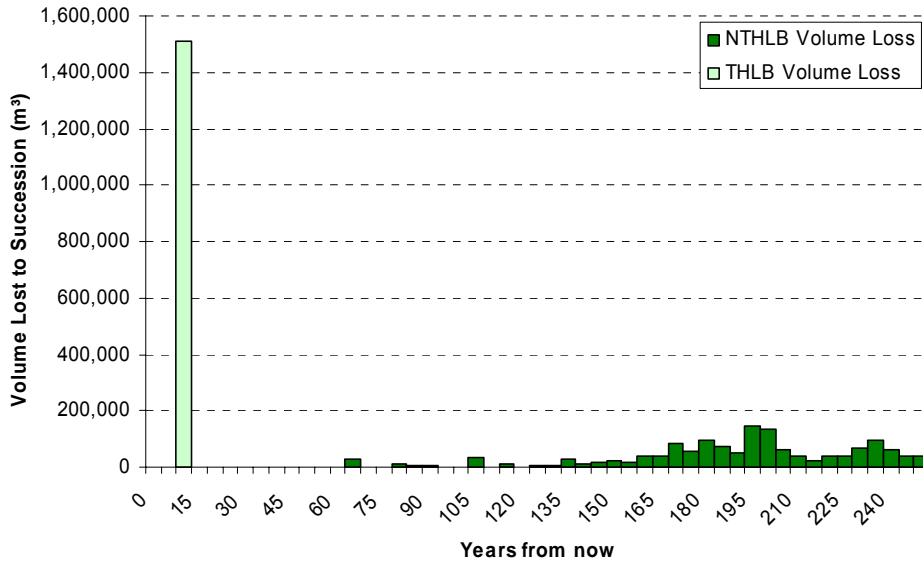


Figure 16. Type 2 Revised Base Case trends in volume lost to succession.

In general, the land base is becoming younger over time. The figures below show almost the entire THLB is mid seral or younger by year 200.

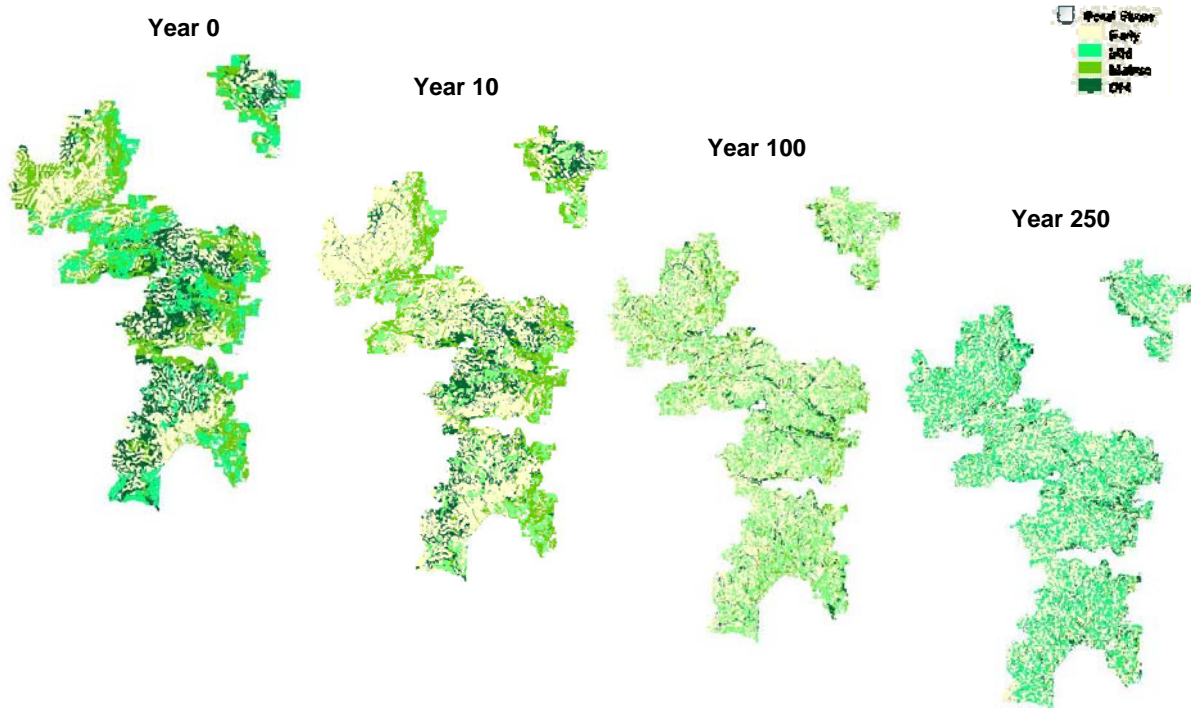


Figure 17. Maps of seral stage distribution over time

6.2.3 Economic Indicators

This section presents the ‘performance’ of the revised base case from an economic stand point. The three economic indicators are harvest by merchantability class, net revenue, and average diameter of harvest stands over the planning horizon.

Figure 18 shows harvest area by merchantability class as well as total net revenue of harvested stands by period.

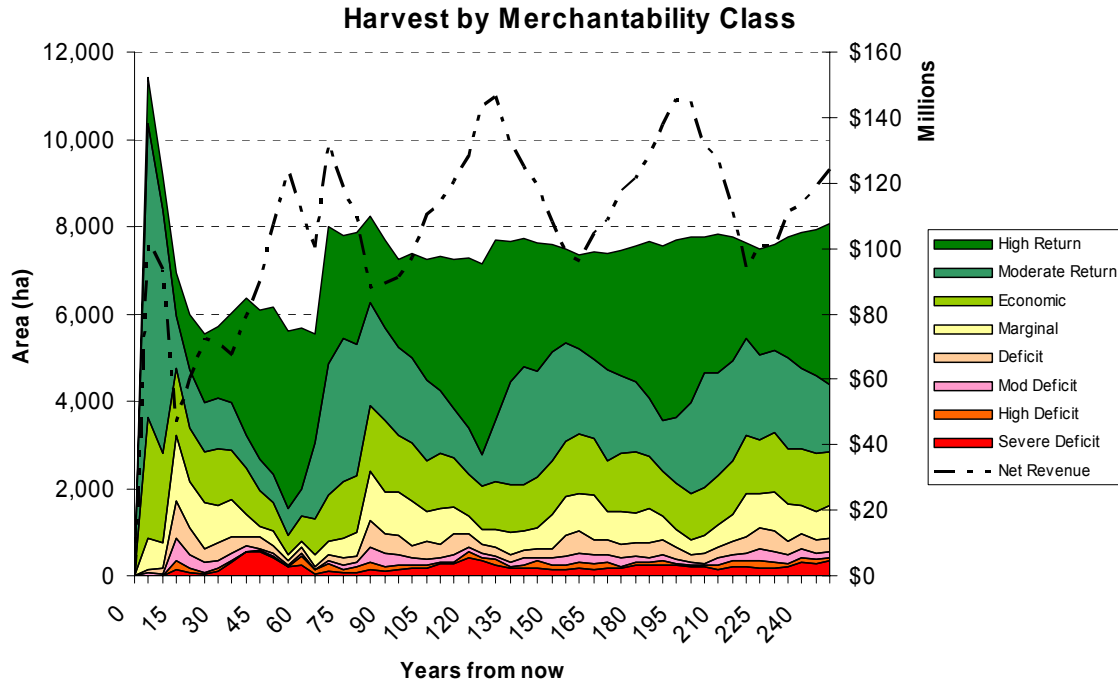


Figure 18. Type 2 Revised Base Case projection of Harvest by Merchantability class.

This figure shows that the majority of harvested stands in the first period fall in at least the moderate return category. The cyclical pattern of harvest in high return stands begins when the highly productive managed stands are harvested during the latter half the midterm timber supply trough (areas currently logged on TFL or most productive stands logged in period 1&2). The next time harvest occurs on these stands is largely determined by the minimum harvest age. The same cyclical pattern of high return harvest is what causes the total net revenue to fluctuate over time. Overall, the trend is for a steep drop in net revenue after the salvage period is over because lower volumes are harvested from generally lower value stands. From the back of the midterm on, the net revenue predictions recover as attractive managed stands come on line.

6.2.3.1. Diameter

Figure 19 shows the average diameter of harvested stands over the planning horizon. The average diameter of harvested stands near the beginning of the horizon is low because the model is harvesting PI leading stands that would otherwise be lost to MPB mortality. Once salvage ends, the diameter increases to reflect the harvest of older non PI stands. The long term trend is to harvest slightly smaller diameter stands than those currently on the land base (28cm vs 30-34cm).

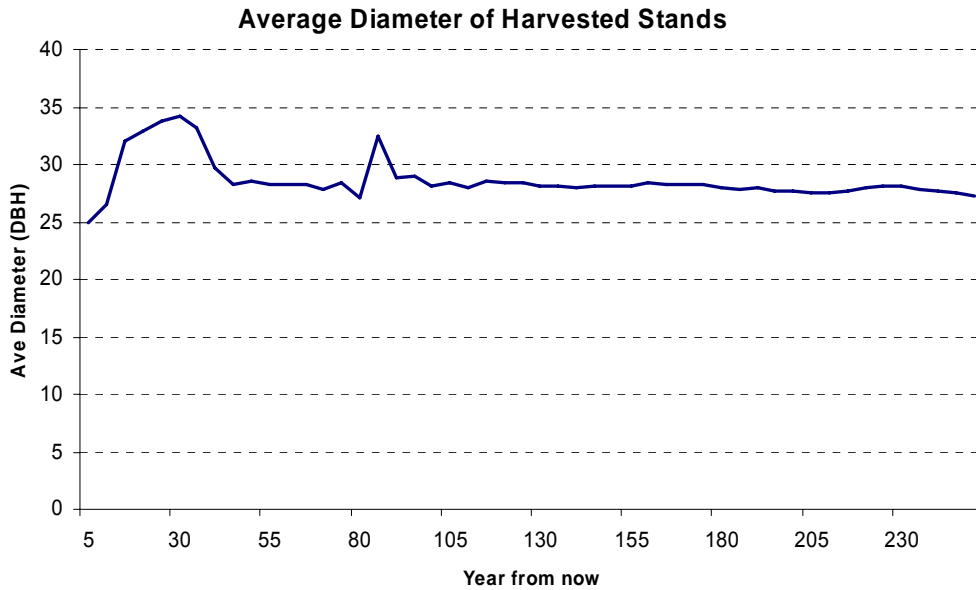


Figure 19. Type 2 Revised Base Case projection of average diameter of harvested stands.

6.2.4 Watershed, Ecosystem, and Habitat Indicators

The watershed, ecosystem and habitat indicators for the revised base case are presented below. These include seral stage distribution, disturbance in visual areas, disturbance in watersheds (ECA's), snags and CWD, deciduous area, OS-LRMP wildlife RMZ habitat requirements, and species specific habitat areas.

6.2.4.1. Seral Stage Distribution

The seral stage distribution for the CFLB in Natural Disturbance Type (NDT) 3 shows that approximately 46% of the landbase is currently considered mature or old (Figure 20). As the majority of the land base is converted to stands managed using shorter rotations, the proportion of mature and old seral stages falls to only ~6% in the long term and is dominantly Non THLB.

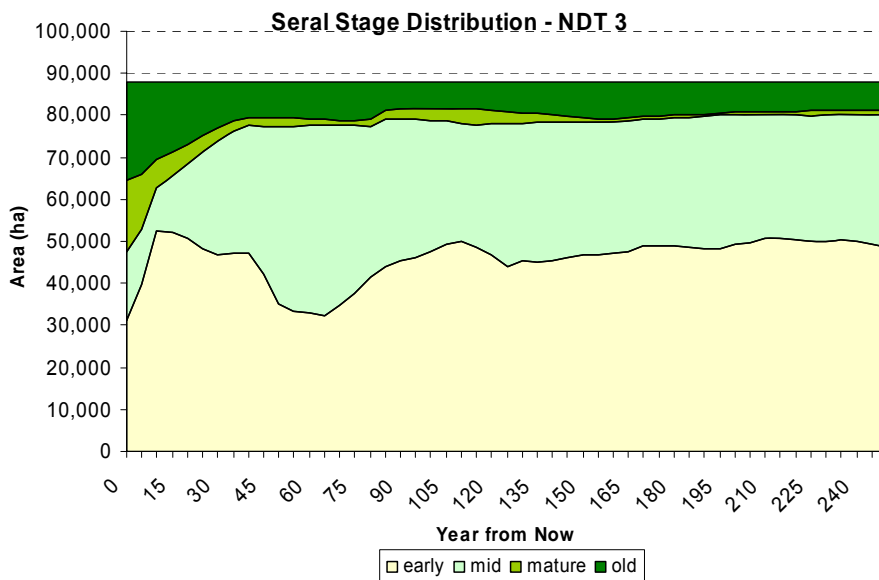


Figure 20. Type 2 Revised Base Case Projection of seral stage distribution for NDT 3.

The seral stage distribution for the CFLB in NDT 4 shows that approximately 60% of the landbase is currently considered mature and old (Figure 21). There is a net increase in old seral stands because there is currently almost no NDT 4 stands over 250 yrs old on the land base but the Non THLB portion of the land base is able to age into this 'old' definition over time. However, as with NDT3, harvesting stands at or near minimum harvest ages in the long-term reduces the combined relative abundance of mature and old seral stages to only 18.6% in the long term.

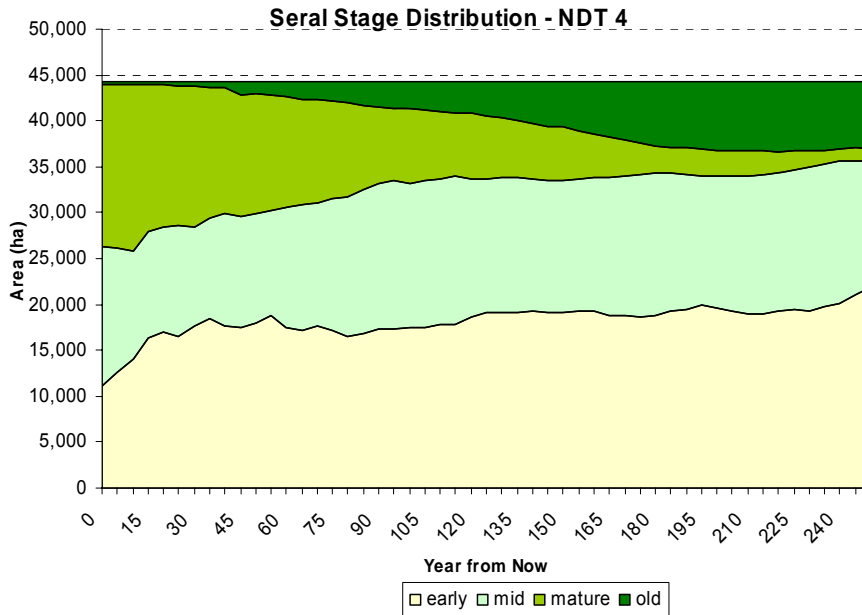


Figure 21. Type 2 Revised Base Case Projection of seral stage distribution for NDT 4.

The seral stage distribution for OGMAs is illustrated in Figure 22. At the beginning of the planning horizon, the majority of OGMA area is within mature or old seral stages while a minor component exists in Mid seral stages. Within 10 years, approximately 600 ha of OGMAs are impacted by the MPB and they appear as young seral stages. The spatial OGMAs start to get harvested immediately after they are made available in 80 years from now, which explains the large increase in early seral stages in 80 years. The model is replacing these spatial OGMAs with other suitable candidates because it better achieves the objectives set out in the model.

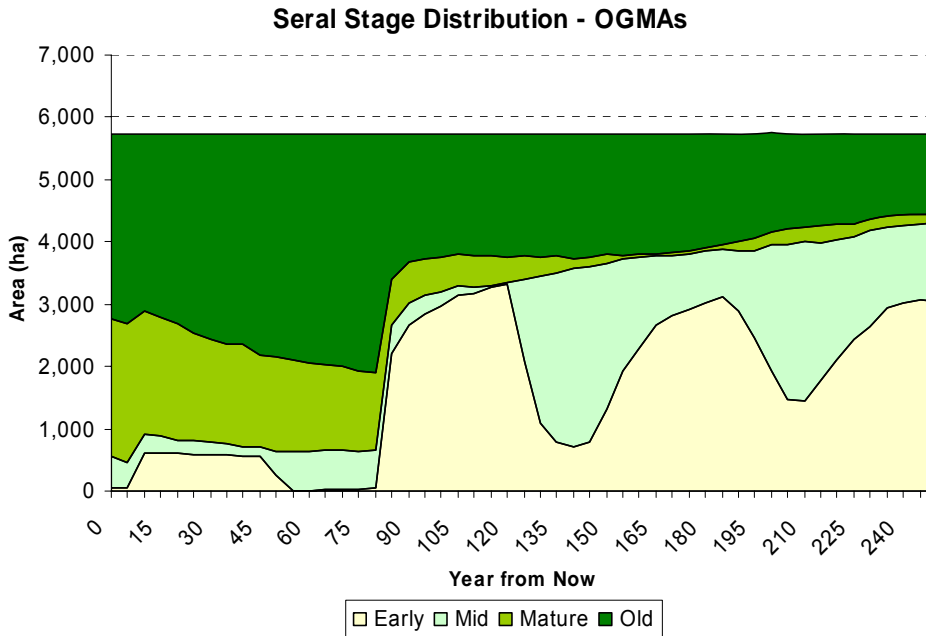


Figure 22. Type 2 Revised Base Case - serai stage distribution for spatially explicit OGMAs.

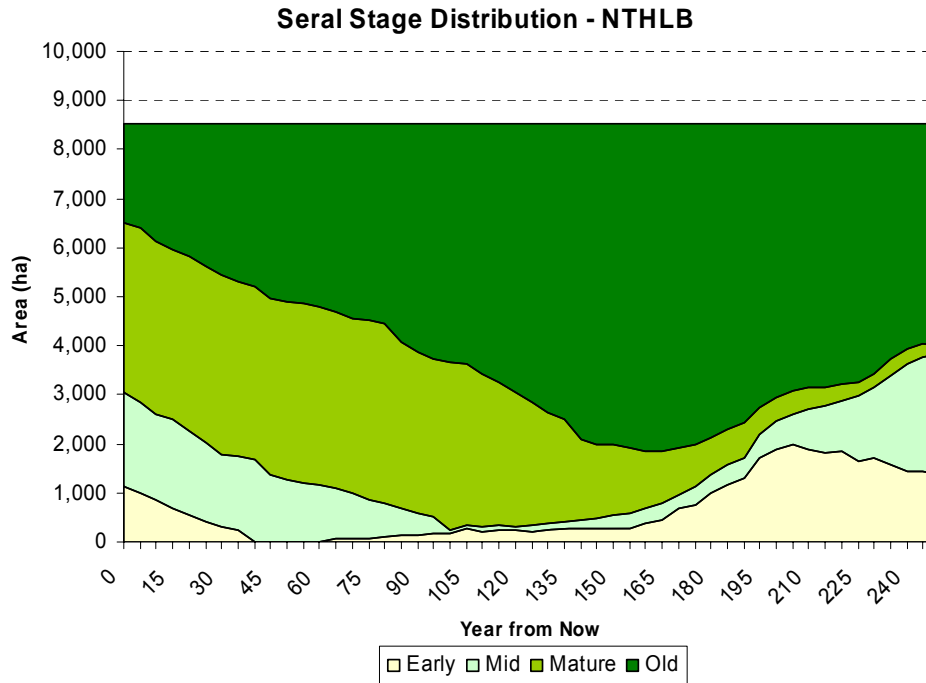


Figure 23. Type 2 Revised Base Case Projection of serai stage distribution for the NTHLB.

Figure 23 shows the serai stage distribution on the non-THLB over the planning horizon. During the first 60 years, there is an increase of old serai and mature serai stages and a corresponding decrease in young and mid serai stages. As older stands reach their respective disturbance interval age, they break-up naturally and once again are considered to be in an early serai state. Closer to the end of the planning horizon, young serai stages become mature and the corresponding increase is seen in the mature serai stages.

6.2.4.2. Disturbance in visuals

The total area considered visually disturbed over the planning horizon for the revised base case is shown in Figure 24. This is an aggregate measure of all individual accounts used to track visual disturbance levels and thus shows general trends. Individual accounts (ie VQO polygons) show different results depending on their size and the actual disturbance within them. Each VQO account is met throughout the planning horizon except for a few instances in the highly restrictive VQOs such as LMZ Class A VQOs (maximum 5% visual disturbance) where there is a few periods with small overachievements.

The periods with the highest disturbance levels occur 10 years from now and are associated with MPB impacts (salvage and stand mortality). As harvest is reduced down to mid-term levels, visual disturbance levels recover and stabilize around 2000-3000 ha. Overall, visual disturbance remains well below the maximum threshold for the remainder of the planning horizon, but there are individual VQO polygons that are always near their threshold values. This figure is somewhat simplified because it does not show the disturbance by VQO (and in turn the disturbance threshold values applied to those polygons).

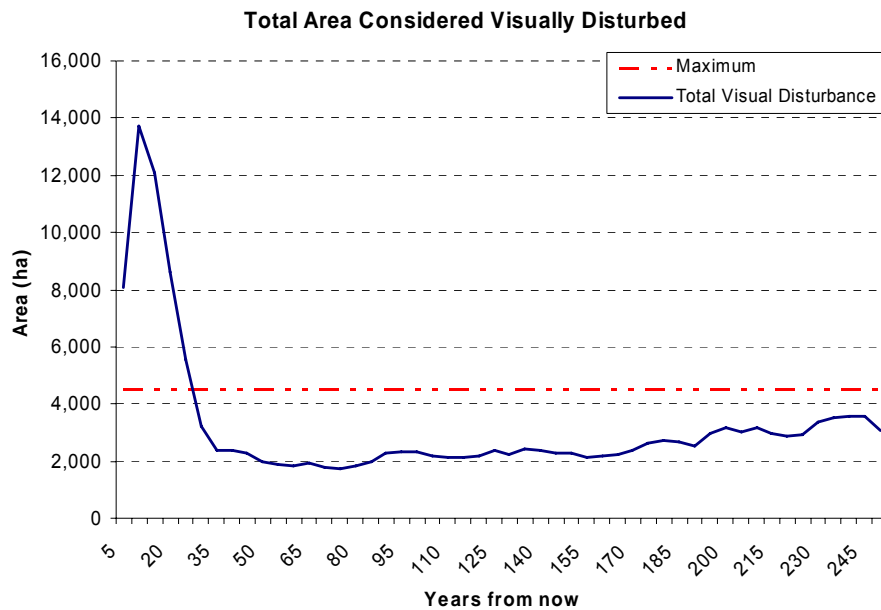


Figure 24. Type 2 Revised Base Case projection of total area considered Visually Disturbed.

6.2.4.3. Disturbance in Watersheds (ECA's above H40)

Equivalent Clearcut Areas (ECA's) were tracked for each watershed in the TFL over the planning horizon. Limits were placed on ECA's in the top 40% of these watersheds (H40 = Snow Sensitive Zone) based on guidance from the TFL's hydrological consultant (Don Dobson, PEng). ECA's for the snow sensitive portions of each watershed are shown for years 2006, 2011, and 2016 in Figure 25. It shows that the MPB related salvage and mortality drives ECA's up in almost every watershed and some exceed their maximum desired thresholds (i.e. Cain, Munro, Nash, Naswhite, Twig, Weyman, and Whiteman) and several watersheds are very close to their thresholds (i.e. Monte, Powers, Shorts, Silver, and Upper Bolean).

ECA's for Snow Sensitive Zones (H40): Years 2006, 2011, 2016

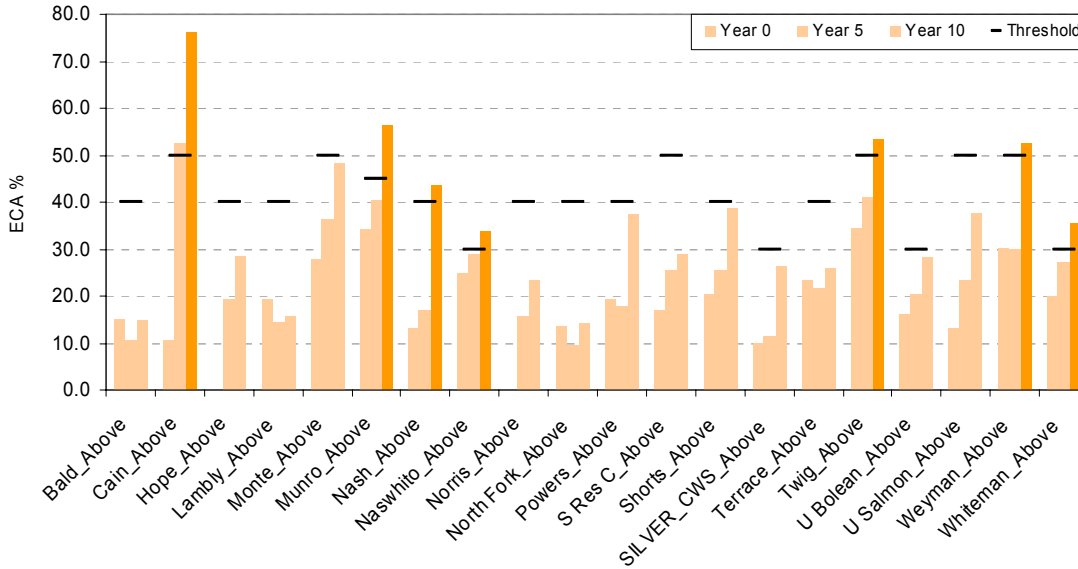


Figure 25. Type 2 Revised Base Case ECA's for watershed above H40 (yrs 2006, 2011, 2016).

To view longer term trends, a composite graph has been created to show the total ECA area in the TFL over time. As with the visuals aggregate, the detail for individual watersheds is lost but general trends across the land base become apparent. Overall, the amount of area considered hydrologically impacted peaks 10 years from now, recovers during the mid-term trough, and then rises to a long term level between 14,000 and 15,000 ha (Figure 26). This figure shows that cumulatively, ECA's never reach their combined maximum threshold value. However, as seen in Figure 25, individual watersheds do exceed thresholds in years 0-10.

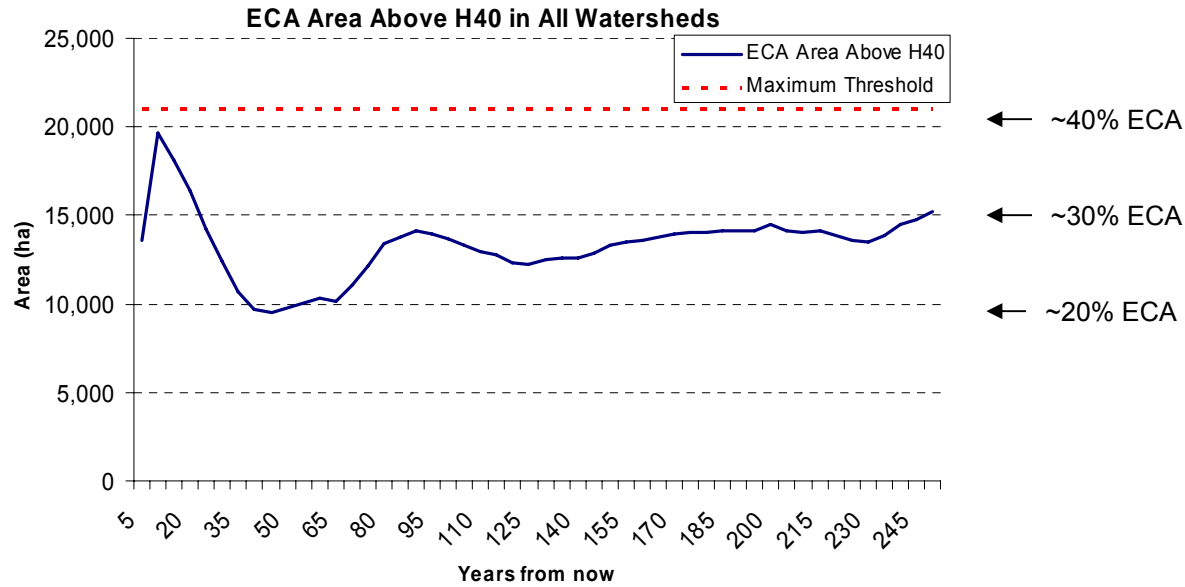


Figure 26. Type 2 Revised Base Case Total ECA from all watersheds above H40.

6.2.4.4. Snags and CWD

The average snags per hectare by Biogeoclimatic (BEC) zone over the planning horizon are shown in Figure 27. Snag densities are high at the beginning of the planning horizon and spike sharply 10 years from now. This spike is due to the succession of MPB killed stands, which were assumed to have a high proportion of snags if left unsalvaged. The MS zone has the largest spike because of the high incidence of pine stands in this BEC zone. Generally, as natural stands are harvested and are replaced by managed stands, snag densities across all BEC zones fall and achieve a steady state between 5 and 10 snags/ha.

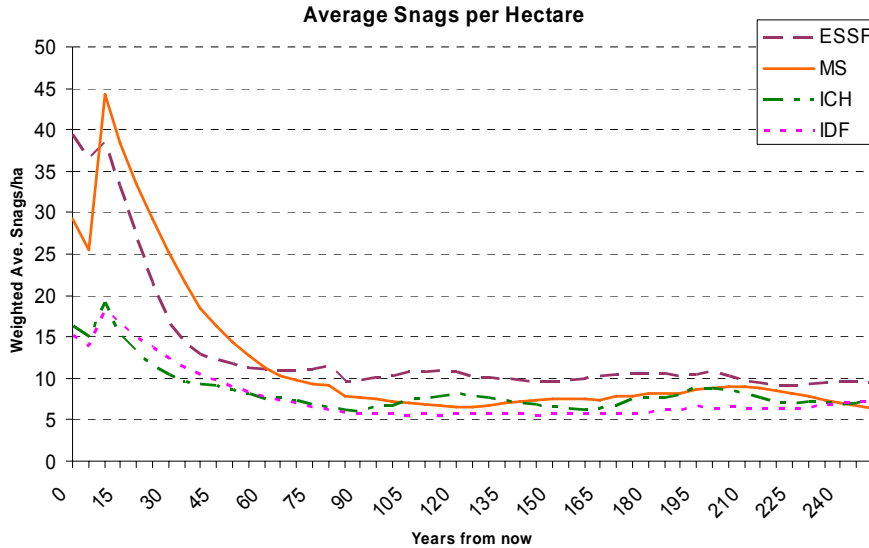


Figure 27. Type 2 Revised Base Case projection of Average Snags per Hectare by BEC Zone.

Figure 28 shows the average CWD volume per hectare (m³/ha) by BEC Zone over the planning horizon. As with snag densities, CWD spikes just after the MPB infestation, 10 years from now, and tapers gradually as natural stands are harvested and are replaced by managed stands.

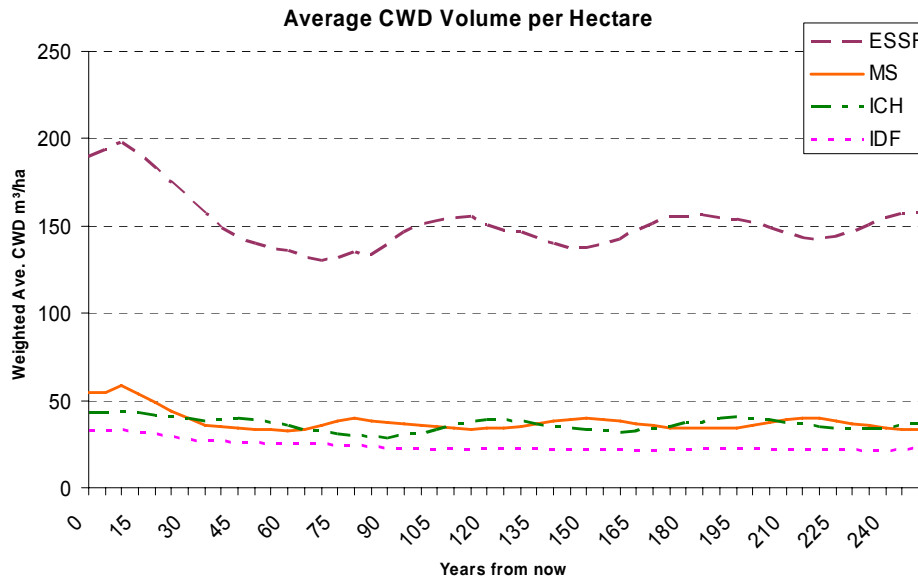


Figure 28. Type 2 Revised Base Case projection of average CWD volume per hectare

6.2.4.5. Deciduous Area

The amount of deciduous area projected for each BEC zone over the planning horizon for the revised base case is shown in Figure 29. Initially, there is ~2100 ha in the IDF, ~900 ha in the MS, 230 ha in the ICH, and almost no deciduous area in the ESSF. In all cases, the amount of deciduous area increases over the planning horizon as the average age of the land base decreases. Deciduous is most prevalent in mid seral stands and then typically falls out as they age into maturity.

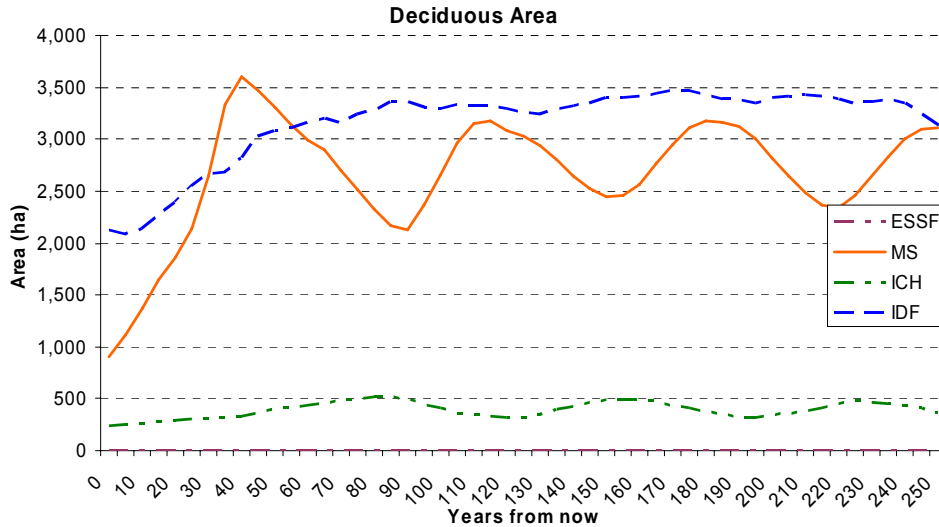


Figure 29. Type 2 Revised Base Case projection of Deciduous area.

6.2.4.6. OS-LRMP Wildlife

Mule Deer Winter Range (MDWR) Habitat for the Shallow, Moderate, and Deep snowpacks are shown in Figure 30, Figure 31, and Figure 32, respectively. These graphs are aggregates of the individual units where habitat cover constraints were applied and show general trends.

Shallow MWDR is not constraining the harvest flow at any time because it starts off well above the above minimum threshold, the salvage/MPB mortality results in a short term reduction but then the long long-term rises to exceed current levels. Overlap with VQO's are responsible for maintaining higher than required MDWR habitat in the shallow snowpack zone in the long term.

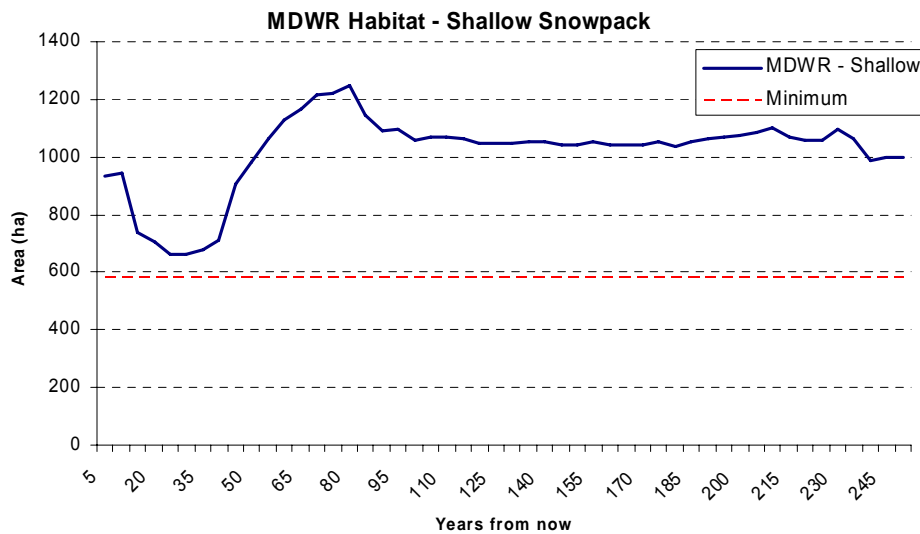


Figure 30. Type 2 Revised Base Case projection of MDWR Habitat in the shallow snowpack zone.

The moderate snowpack MDWR habitat requirements (Figure 31) also do not appear to restrict harvest flow at any time over the planning horizon, but when individual accounts are reviewed, many are limiting harvest – especially in the Trepanier and Upper Salmon landscape units. The aggregate graph shows surplus because some of the accounts have significant areas of non THLB within them and therefore have large surpluses over time. In all cases, the amount of habitat required by the LRMP is maintained over time for all accounts.

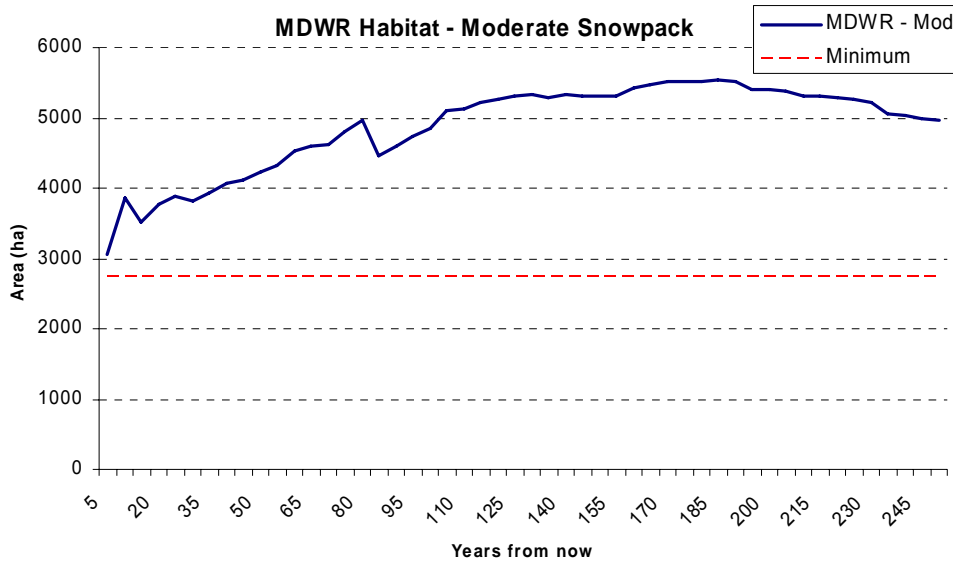


Figure 31. Type 2 Revised Base Case projection of Moderate Snowpack MDWR Habitat.

Deep Snowpack MDWR Habitat (Figure 32) starts off the planning horizon above the minimum threshold and is maintained at similar levels throughout the planning horizon.

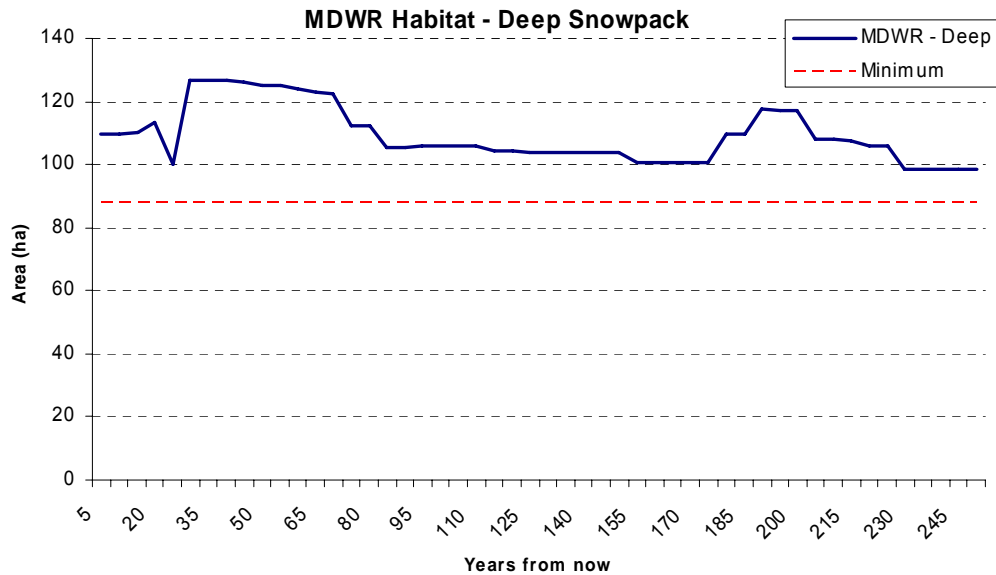


Figure 32. Type 2 Revised Base Case projection of Deep Snowpack MDWR Habitat.

Suitable moose habitat (>16m ht) over time in the revised base case is shown in Figure 33. At the beginning of the planning horizon, the moose habitat is well above minimum threshold values,

however, the amount of habitat is at or near minimum threshold levels for a majority of the planning horizon. Once again, this is due to the majority of stands in the future being harvested at or near their respective MHA's. There is also a strong association between mapped moose habitat and pine stands which are impacted early in the planning horizon and then managed on short 50-70 yr rotations later in the planning horizon.

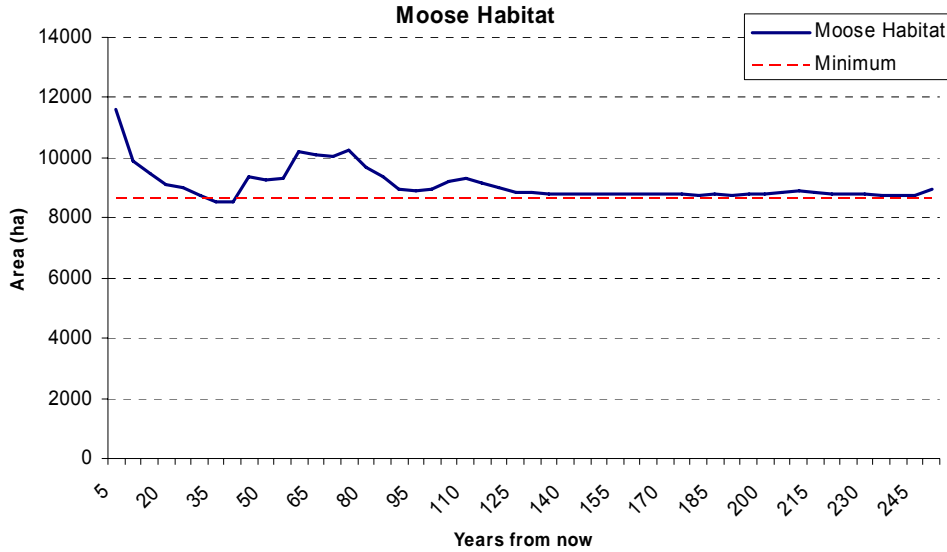


Figure 33. Type 2 Revised Base Case projection of moose habitat.

Aggregated bighorn sheep habitat (>16m ht) over time for the revised base case is shown in Figure 34. The amount of habitat decreases over time but is in excess of the minimum requirement for the duration of the planning horizon. When individual accounts are reviewed, there are several in the Trepanier LU that are held at minimum thresholds for much of the planning horizon.

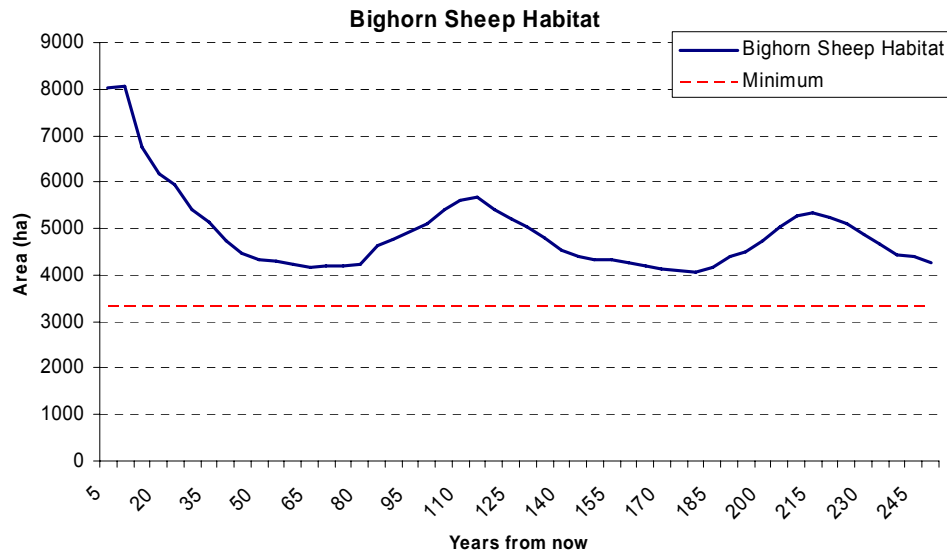


Figure 34. Type 2 Revised Base Case Bighorn Sheep Habitat.

Unlike the previous indicators, the Mountain Goat SMZ has a maximum threshold applied to it. No more than a third of the CFLB within the Mountain Goat SMZ can be less than 33 years old. This means that the less area showing in Figure 35, the better it is for the Mountain Goat. There is a significant increase in the amount of young stand area (<33 yrs) in the first several periods and then it

stabilizes into a long term state ~15% below the maximum allowed. When individual accounts are reviewed, most show the indicator reaching maximum values over much of the planning horizon.

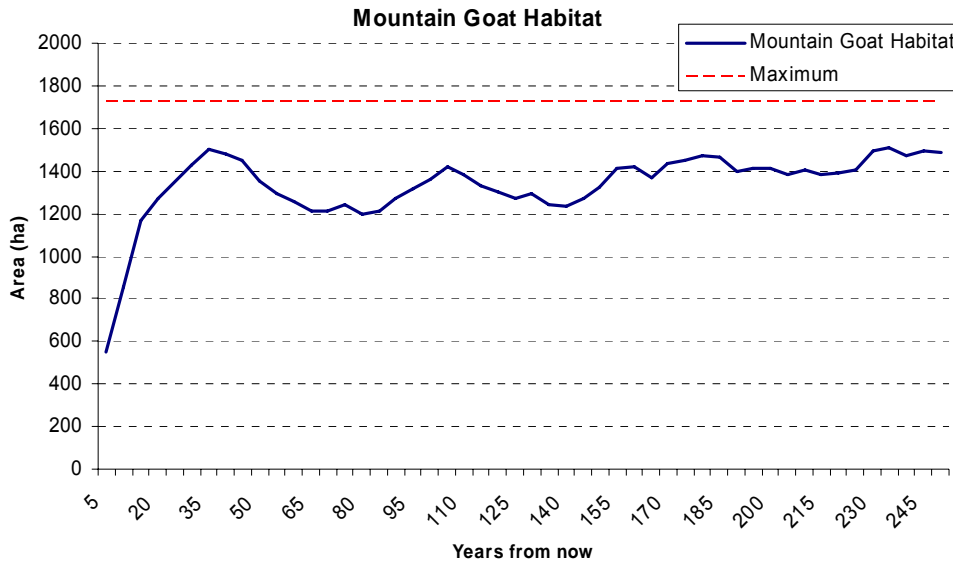


Figure 35. Type 2 Revised Base Case projection of Mountain Goat Habitat (area <33yrs old).

6.2.4.7. Species Specific Habitat – Flammulated Owl

The area considered suitable habitat for Flammulated Owl over time for the revised base case is shown in Figure 36. Initially, there is about ~18,800 ha that is considered suitable (≥ 10 ha patches) while in the long-term there is approximately 5,435 ha. This reduction in suitable habitat is function of managing for shorter rotations on the THLB and a reduction of Douglas-fir leading stands on the land base over time – a result of the regeneration assumptions. This estimate of habitat should be considered very coarse as it is extremely unlikely that there are currently 18,800 ha of suitable habitat currently on the TFL – however the trends shown here would likely be similar on whatever subset of the land base really is good habitat.

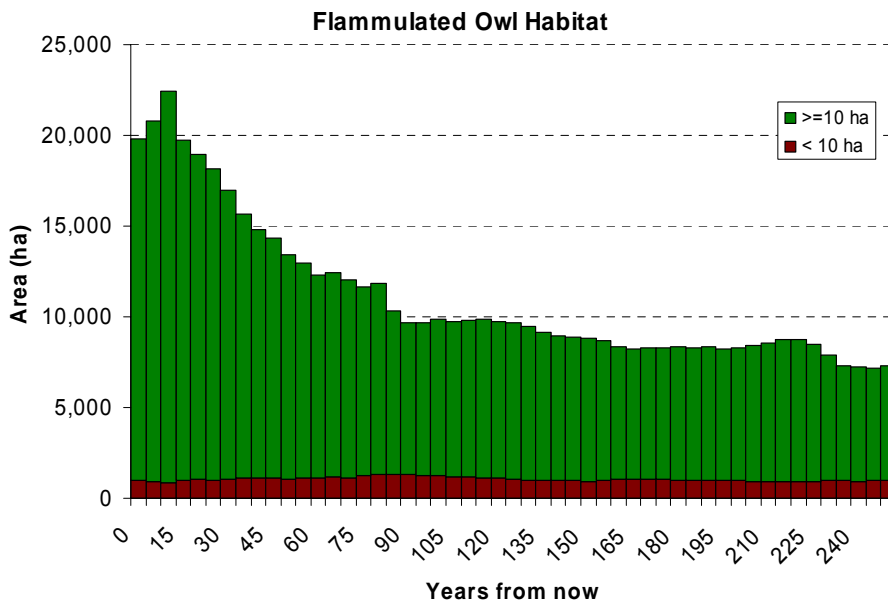


Figure 36. Type 2 Revised Base Case projection of Species Specific Habitat for the Flammulated Owl

6.2.4.8. Species Specific Habitat – Lewis’s Woodpecker

The area considered suitable habitat for the Lewis’s Woodpecker over the planning horizon for the revised base case is shown in Figure 37. Initially, there is about ~3,400 ha that is considered suitable (≥ 6 ha patches) while in the long-term there is approximately 2,100 ha. This reduction in suitable habitat a function of managing for shorter rotations as well as a reduction of Douglas-fir and ponderosa pine on the land base over time (result of regeneration assumptions). As before, the absolute estimate of habitat area should be considered very coarse (optimistic) but the trends over time are meaningful.

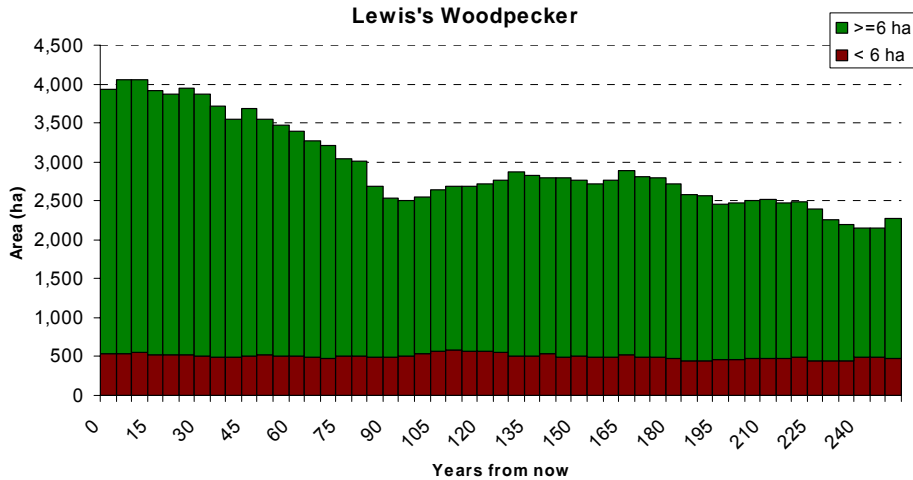


Figure 37. Type 2 Revised Base Case projection for the Lewis's Woodpecker habitat

6.2.4.9. Species Specific Habitat – Williamson’s Sapsucker

The area considered suitable habitat for the Williamson’s Sapsucker over the planning horizon for the revised base case is shown in Figure 37. Initially, there is about ~23,400 ha that is considered suitable (≥ 20 ha) while in the long-term there is approximately 6,800 ha. This reduction in suitable habitat a function of managing for shorter rotations as well as a reduction of aspen, Douglas-fir, and ponderosa pine on the land base over time (result of regeneration assumptions). There is a slight increase in smaller patch sizes (patches < 20 ha) over the planning horizon which also decreases Williamson’s Sapsucker Habitat.

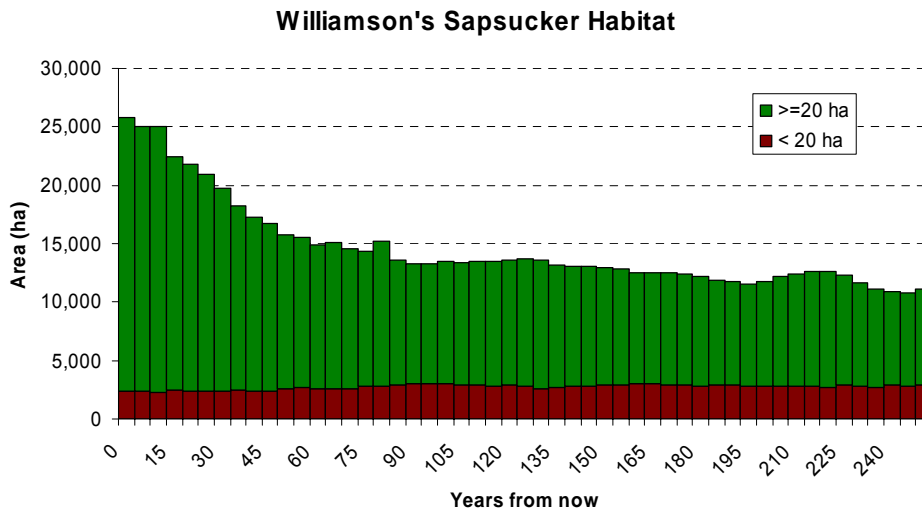


Figure 38. Type 2 Revised Base Case projection for the Williamson's Sapsucker Habitat

As with the previous 2 species, it has been recognized that the criteria used to define Williamson's Sapsucker Habitat is coarse. In reality, there likely isn't 23,400 ha of suitable Williamson's Sapsucker habitat on the TFL. However, it is likely that similar overall trends would be expected to occur if this definition was refined (i.e. significant overall reduction of Williamson's Sapsucker Habitat in the order of 40%). This occurs primarily because of the younger age class distribution on the THLB.

7. Basic Silviculture

7.1. No Incremental Silviculture

This section summarizes the modeling results when yield gains from Class A seed are removed. For this modeling option and all remaining others, only indicators that changed significantly or were at least expected to change from the revised base case will be highlighted and discussed. Refer to Appendix A for a complete suite of scenario indicator results.

7.1.1 Timber Supply Indicators

The lack of Class A seed volume gains caused a reduction in future managed yield curves. This causes a ~3.2% reduction in harvest flow in the mid-term, and a 14-17% reduction in the long-term. The mid-term decrease occurs because the end of the trough is being supported from a limited amount of future managed stands and these stands provide less volume and have older MHAs when no gains are recognized. The long-term reduction correlates directly with the removal of the volume gains attributed to class A seed in managed stands. Gains for individual species in the revised base case (12%-Lw, 16%-PI, 12%-Fd, and 15%-Sx) averaged ~16%. The use of class A seed is critical to achieving the revised base case harvest flow.

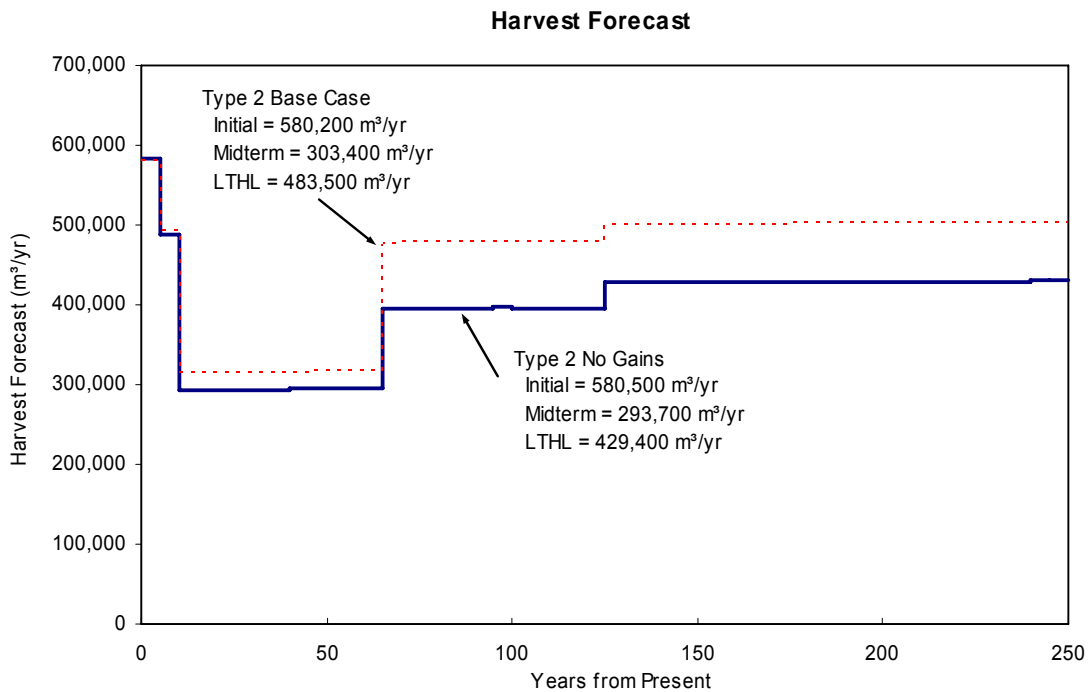


Figure 39. Type 2 No Gains harvest flow projection compared to Type 2 Revised Base Case.

In the mid and long term, this scenario results in less area harvested each period at older average harvest ages – yielding lower volumes per hectare.

From a non-timber perspective, the removal of class A seed gains is positive because it forces longer rotation ages which means less area harvested each period and a slightly older age class structure. This reduction in logged area over the midterm works to improve ECA levels. Figure 40 shows a faster and more full recovery post MPB – although there is likely little additional benefit to recovering to 17% ECA vs 21% ECA. In general, a reduction in the area logged in the midterm is more benefit to ECA levels than logging more area and planting it with faster growing stock (Class A seed).

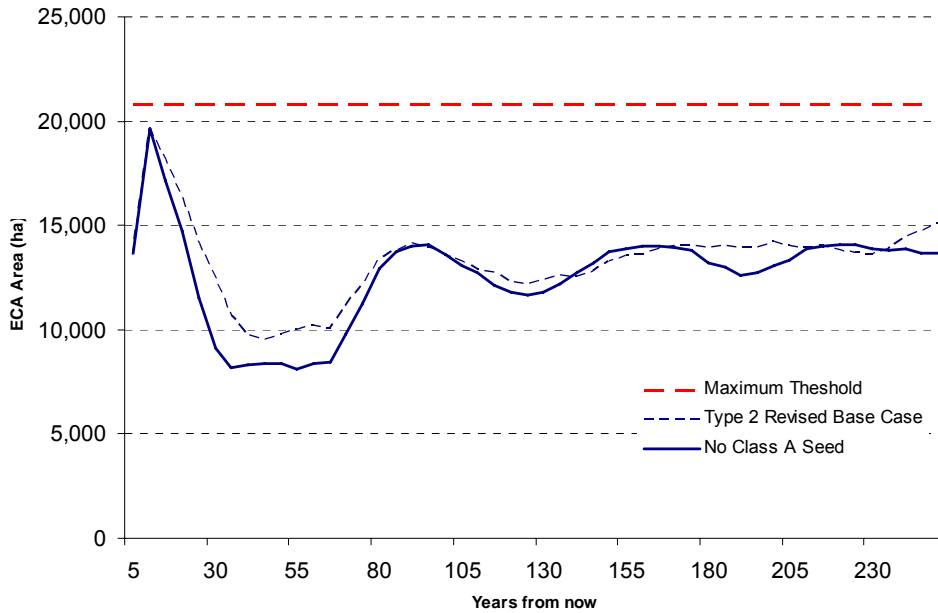


Figure 40. ECA comparison between No Incremental Silviculture and Revised Base Case.

A different situation can be seen for bighorn sheep habitat (Figure 41) in that reduced harvesting delays the decline in habitat and causes it to fall to slightly lower levels.

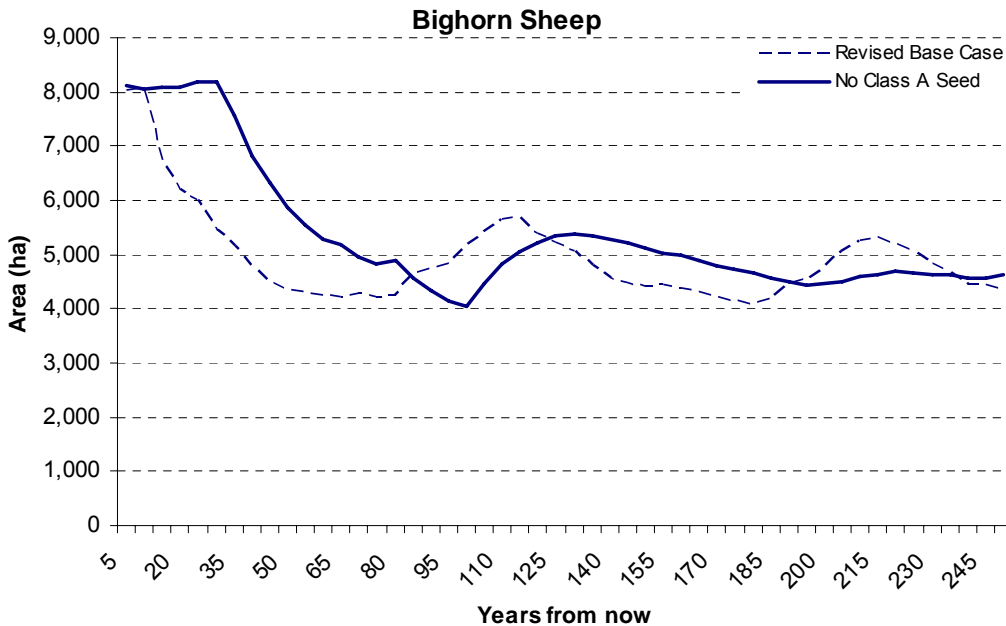


Figure 41. Comparison of bighorn sheep habitat for No Incremental Silviculture and the Revised Base Case.

7.2. Reduced Planting Densities

The timber supply analysis for MP4 used detailed, ecologically-based regeneration assumptions for future managed stands. Natural ingress is expected to occur for several of these stand types but only three AU's were assumed to have natural regeneration in MP4. Table 5 lists those additional AU's where natural ingress is expected to be significant. These AU's were modeled as planted stands with full gains from class A seed in MP4. This scenario presents the results of detailed stand level analysis based on field practices and results of modeling additional AU's as 100% natural regeneration.

7.2.1 Stand Level Analysis

To illustrate the impact of reducing planting densities where natural ingress is expected to occur, the regeneration assumptions were revised to include expected natural regeneration along with the original planting densities. New yields were then generated with TIPSy using reduced planting densities and the same contribution from natural ingress. Since TIPSy doesn't generate yields consisting of both natural and planted regen contribution, yields were generated at 100% natural and 100% planted and then a weighted average yield was generated. Any genetic gains for planted species were stripped when natural regen was used.

Table 5. Current (field based) and proposed regeneration assumptions for future managed yield curves for AU's where natural regeneration is expected to occur

AU	AU Description	Planted Species mix	Current					Proposed			
			Regen Delay (yrs)	Current Planting Density (sph)	Est. Current Planting Cost (\$/ha)	Proposed Natural Ingress Density (sph)	Current Total (sph)	Proposed reduced plant density (sph)	Est. Proposed Planting Cost (\$/ha)	Proposed Regen delay (yrs)	Proposed Total Density (sph)
518	IDFdk1-03/02-PIFd	PI(70) Fd(30)	2	1000	\$ 600	2000	3000	500	\$ 450	5	2500
519	IDFdk1-04-PIFd	PI(70) Fd(30)	2	1000	\$ 600	2500	3500	500	\$ 450	5	3000
524	IDFdk2-03-PIFd	PI(70) Fd(30)	2	1000	\$ 600	1500	2500	500	\$ 450	5	2000
528	IDFmw1-02-PyFd	Py(60) Fd(40)	2	600	\$ 500	800	1400	0	\$ -	5	800
529	IDFmw1-03-PyFd	Py(60) Fd(40)	2	600	\$ 500	1200	1800	0	\$ -	5	1200
530	IDFmw1-04-PIFd	PI(60) Fd(40)	2	1000	\$ 600	1500	2500	500	\$ 450	5	2000
544	MSdm2-01-PIsX	PI(90) Sx(10)	5	250	\$ 250	3500	3750	0	\$ -	5	3500
546	MSdm2-03-PIFd	PI(90) Fd(10)	5	500	\$ 450	1500	2000	0	\$ -	5	1500
547	MSdm2-04-PIsX	PI(90) Sx(10)	5	500	\$ 450	3000	3500	0	\$ -	5	3000

The largest of the analysis units shown above were chosen to illustrate the growth and yield and financial implications of reducing planting densities namely:

- the IDFdk1, site series 02/03, with PI/Fd species (AU 518 – 1,596 ha)
- the MSdm2, site series 01, with PI/Sx species (AU 544 – 34,106 ha)

IDFdk1 – site series 02/03

The proposal is to reduce planting density from 1000 to 500 sph – dropping total regen density from 3000 to 2500 sph.

Additional assumptions:

Planted stock genetic gain: PI = 13%. Fd = 21%

Regen delay = 2 yrs for planted and 5 yrs for natural regen

Site Index (as per MP4): 15.4

Average Sawlog price⁴: 55.82 \$/m³ for SPF sawlog.

Discount Rate: 2%

Figure 42 shows that a relatively small difference in volume is realized. This occurs because the planted portion of the stand represented only a small fraction (1/3) of the original stand so any regen

⁴ Revenue Branch, Ministry of Forests and Range. Report for the 3 month period August1, 2006 to October 31, 2006.

delay or volume reductions are watered down. There was little pure volume reduction because of the reduced density (still 2500 sph on site) but the loss of the class A seed gains was significant. Because of the relatively small difference in volume yield from reduced planting densities the reduced planting density for this AU is the financially superior approach (Figure 43).

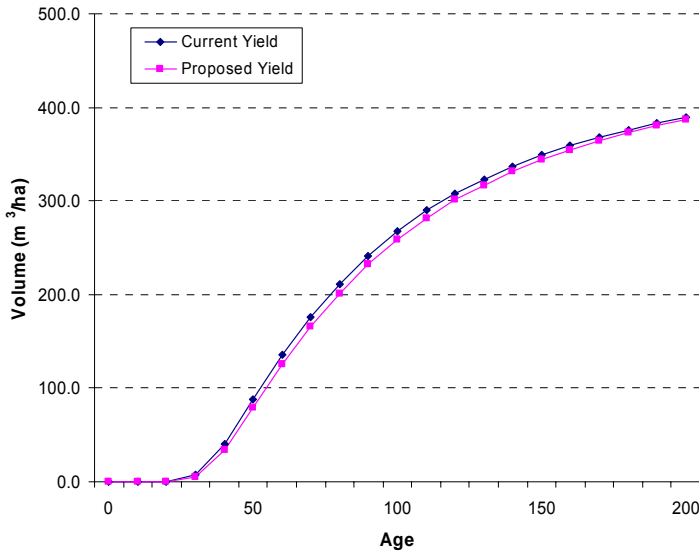


Figure 42. Volume (m³/ha) yield curves for current vs. proposed planting density regeneration assumptions for the IDFdk1 02/03.

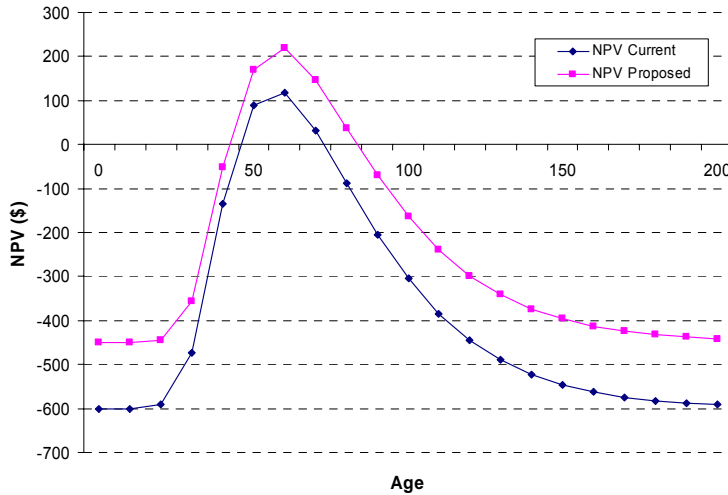


Figure 43. IDFdk1 02/03: NPV's for various rotation ages compared between current and reduced planting.

MSdm2 – site series 01

Proposal is to reduce planting density from 250 to 0 sph – dropping total regen density from 3750 to 3500 sph.

Additional assumptions:

- Planted stock genetic gain:* PI = 13%. Fd = 21%
- Regen delay = 2 yrs for planted and 5 yrs for natural regen
- Site Index (as per MP4):* 19.1
- Average Sawlog price:* 55.82 \$/m³ for SPF sawlog
- Discount Rate:* 2%

For this AU, a third scenario was investigated where planting density was increased from 250 to 944⁵. Results show similar trends to the previous AU expect that volume differences are even more watered down – the planted portion of the stand make up only 250/3750=7% of the original stand. Eliminating the faster regen delay and higher yields on this small portion of the stand had little impact. Figure 45 shows that the financially preferred approach would be to let the site regenerate naturally.

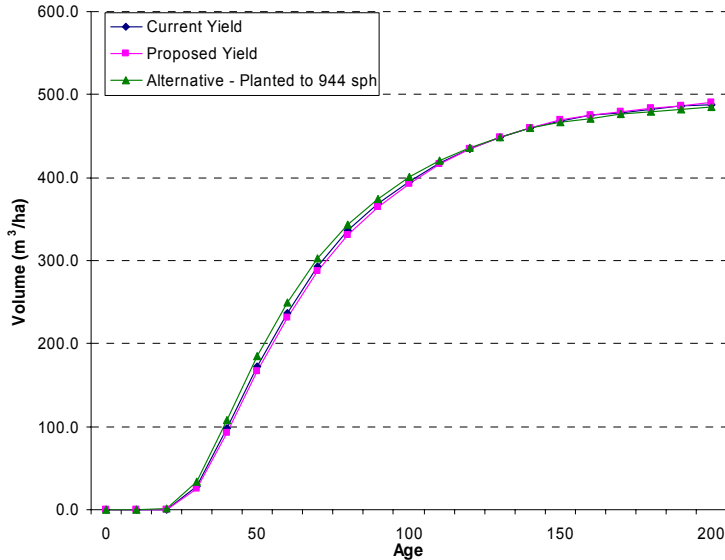


Figure 44. Volume (m3/ha) yield curves for current vs. proposed and alternative planting density regeneration assumptions for the MSdm2 01

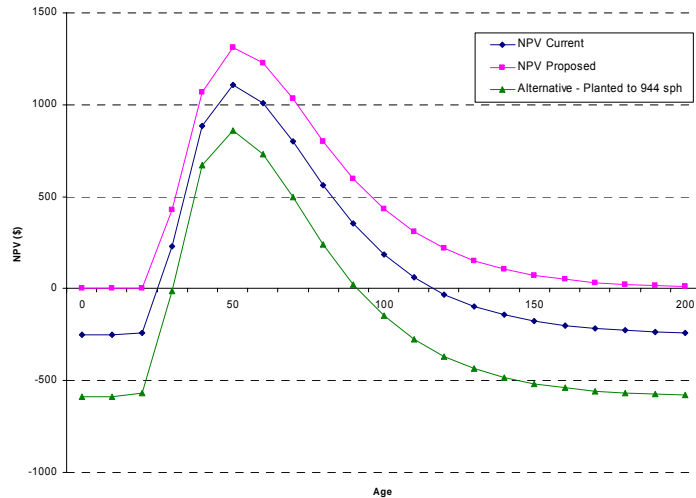


Figure 45. MSdm1-01: NPV's for various rotation ages compared between planting scenarios.

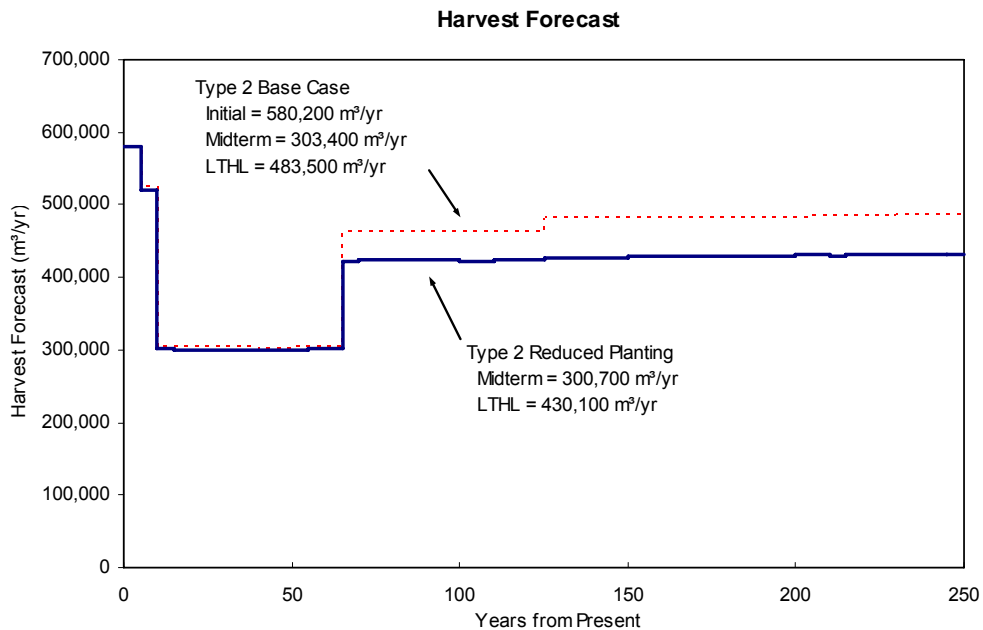
This stand level analysis indicates that significant savings could potentially be realized in terms of reforestation costs with no significant loss to timber supply (see landscape level section below for further discussion of this issue). Increased risks are incurred when regeneration is left for natural including reduced regeneration delay, increased likelihood of future brushing treatments, and increased risk of defaulting on regeneration obligations.

⁵ Initial intent was to increase to 1000 sph, however TIPSy caps the initial density to 3444 sph.

7.2.2 Reduced Planting Densities (Landscape Level)

In order to frame the full potential timber supply impact of reducing planting densities, all of the AU's shown in Table 5 were assumed to have 100% natural regeneration and no class A seed gains. The area associated with these AU's is 50,703 ha or 40% of the THLB. The revised base case assumes these AU's are 100% planted with full class A seed gains.

The change from planted to natural regeneration assumption for these AU's resulted in a small reduction in midterm harvest levels (-0.9%) and a significant reduction in long term harvest levels (-11%). Relative to the assumptions in the revised base case, the elimination of planting has significant implications on timber supply.



8. Enhanced Reserves Scenarios

8.1. Enhanced Reserves (Short-term)

This section summarizes the results of excluding the short-term reserves from Tolko's TFL 49 Retention Plan for 30 years. These reserves were designed to mitigate negative impacts to watersheds, ecosystems, and habitat in the wake of MPB salvage and mortality. Long term reserves from the Retention Plan are already excluded from harvest in the revised base case.

8.1.1 Timber Supply Indicators

When enhanced reserves are implemented, there is a ~70% reduction in harvest flow relative to the revised base case, starting in the second period and lasting for approximately 30 years (Figure 46). This occurs because the scenario excludes ~40,000 ha of mature stands from harvesting (total of 51,439 ha but 10,695 ha is under 60 years old and cannot be harvested anyways).

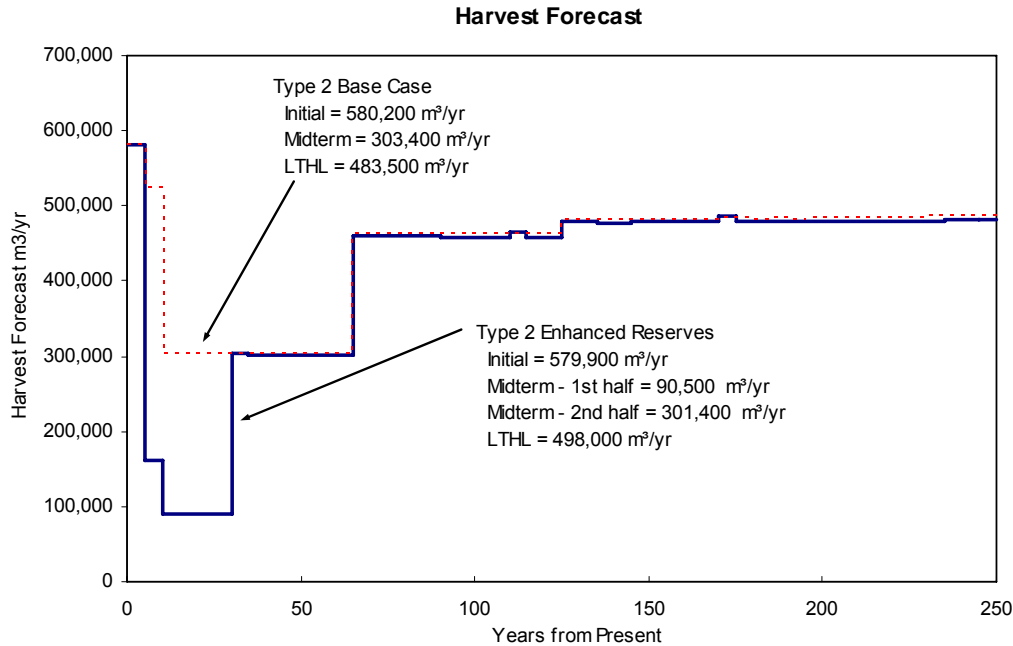


Figure 46. Type 2 Enhanced Reserves harvest flow comparison to Type 2 Revised Base Case.

The large drop in period 2 harvest (yrs 5-10) should also be noted because that is when significant salvage is occurring in the revised base case. This salvage volume disappears when the short term reserves are in place partly because they lock up PI volume and partly because they severely limit harvest options in non PI stands in the front end of the midterm.

8.1.2 Economic Indicators

The massive reduction in harvest flow during the front end of the mid-term trough causes a corresponding reduction in total revenue.

8.1.3 Watershed, Ecosystem, and Habitat Indicators

8.1.3.1 Disturbance in Watersheds (ECA's)

With the short term reserves in place, ECA's recover faster and more fully following MPB impacts. Aggregate ECA area falls to ~8000 ha (15%) instead of 10,000 ha (19%) during the midterm (Figure 47) and recovers to within first period levels by 22 yrs instead of 33 yrs. This occurs because the significantly reduced harvest levels at the front end of the midterm trough reduce the new area contributing to ECA while the MPB impacted stands recover.

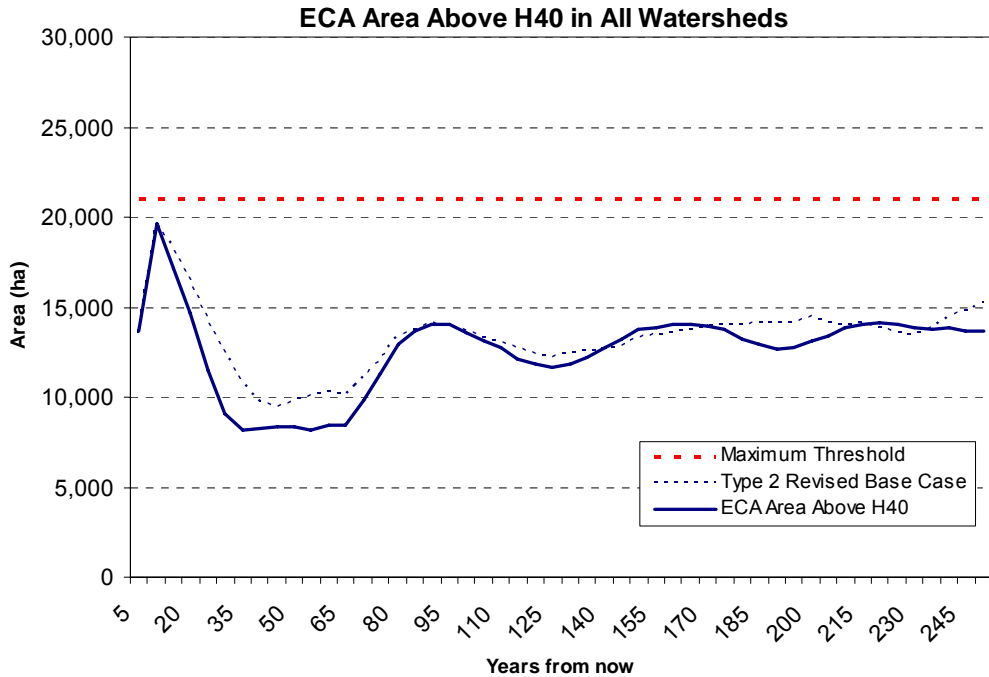


Figure 47. Type 2 Enhanced Reserves Total ECA (above H40) compared to the Revised Base Case.

8.1.3.2. Disturbance in visuals

Implementing enhanced reserves has little impact on aggregate visual disturbance levels while they are above the allowable disturbance levels. Once they have recovered, small differences can be seen between the scenarios but significant improvement does not occur because the reserves are released after 30 yrs (Figure 48).

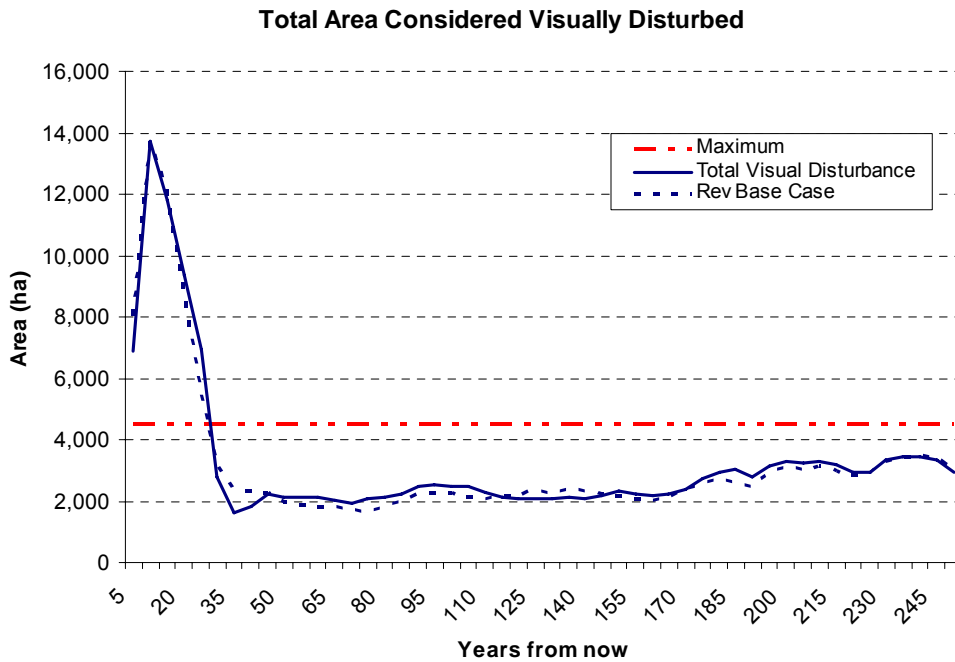


Figure 48. Type 2 Enhanced Reserves projection of total area considered Visually Disturbed compared to the Revised Base Case

8.1.3.3. Wildlife

Under this scenario, the performance of every wildlife habitat indicator is improved over the revised base case, at least in the short term (Figure 49). While there is improvement in habitat levels, all LRMP related wildlife habitat requirements are consistently met under both scenarios.

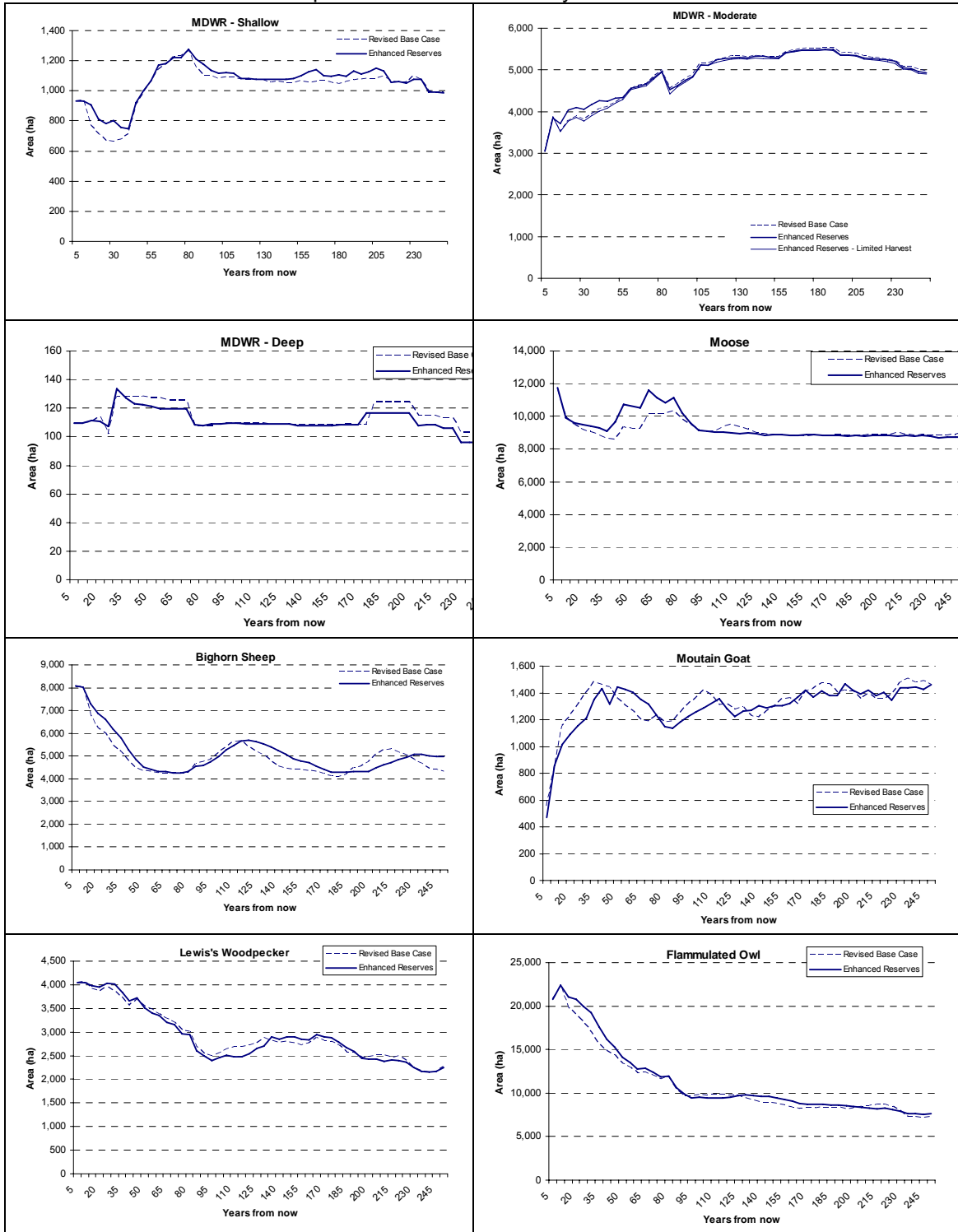


Figure 49. Wildlife indicators improved as a result of implementing Enhanced Reserves

8.2. Enhanced Reserves (Short-term) – Limited Harvesting

This section summarizes the results when short-term reserves designed to mitigate negative impacts to watershed, ecosystem and habitat are excluded from harvest for 30 years but limited harvesting is allowed. The model allowed 100,000 m³/yr to come from short term reserve areas without penalty, and additional volume under a penalty that ensured harvest only occurred where there was a significant improvement in timber supply with little or no tangible impacts to non-timber values.

When a portion of the short term reserves are eligible for harvest, and the model is able to decide on the value of further harvest in these reserve areas, the results is a dramatic improvement in timber supply (Figure 50) relative to the full reserve option. The harvest flow is now 26% below the base case instead of the 70% reduction see in the previous scenario.

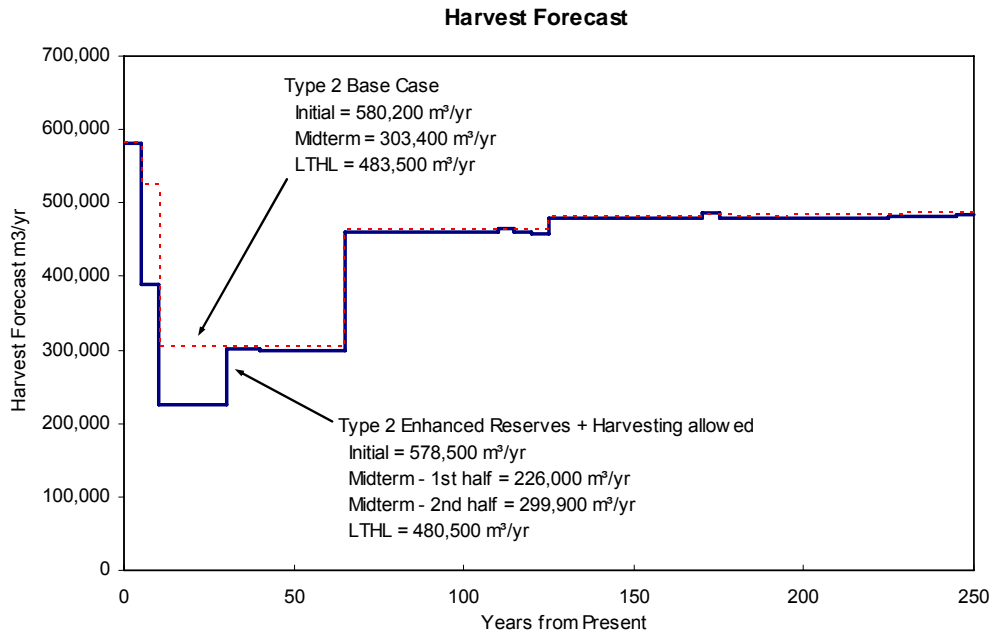


Figure 50. Type 2 Enhanced Reserves + Selection harvest flow comparison to Type 2 Revised Base Case.

Harvesting in a portion of the short-term reserves has a large timber supply benefit compared to removing the reserves from harvest eligibility, but it also maintains a portion of the gains seen in non-timber values. Figure 51 shows that the aggregate ECAs above H40 recover about half as fast as the Enhanced Reserve scenario and the recovery is almost as full.

From wildlife perspective, it should be noted that the revised base case has already optimized 'short-term' reserves by avoiding harvesting in areas that would result in negative impacts to non-timber values. In all scenarios, the minimum habitat values required by the LRMP are maintained so the enhanced reserve scenarios simply result in maintaining habitat levels above requirements. Figure 52 shows the benefits to MDWR (mod snowpack) from short term reserves is almost totally eroded by the limited harvest but all scenarios are showing improvement over time on this indicator.

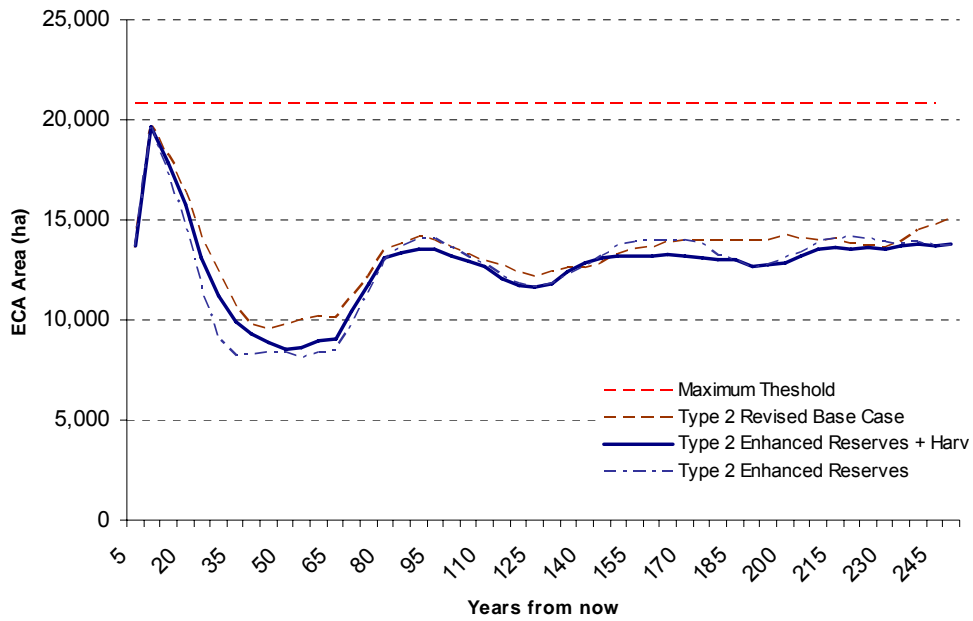


Figure 51. Aggregate ECA area above H40 comparison between revised base case and enhanced reserves with limited harvesting.

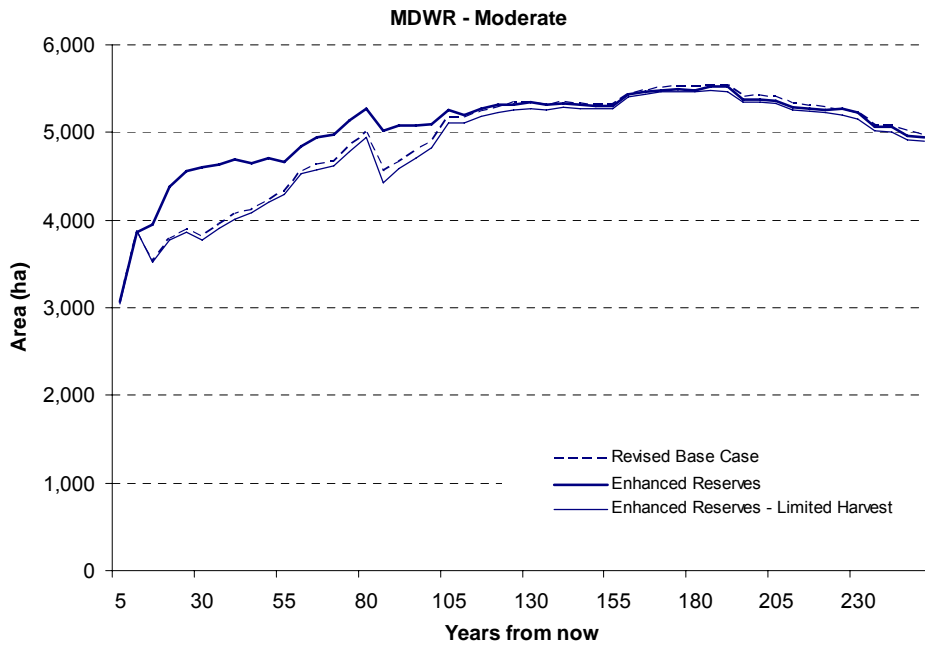


Figure 52. Moderate snowpack MDWR habitat comparison –revised base case vs enhanced reserve scenarios

9. PI Intermediate Harvest Scenario

The results of the scenario where the model is given options to clearcut, conduct intermediate harvest or leave mixed PI blocks during the MPB salvage period are summarized in this section. The objective is to harvest PI volume out of mixed PI stands (30-60% PI) and leave the green timber so that it can provide immediate benefits to non timber values and midterm benefits to timber supply.

When given the option to perform an intermediate harvest on PI stands (50% vol removal), the model chose to treat 1270 ha of mixed PI stands before their PI volume was lost to MPB in year 10.

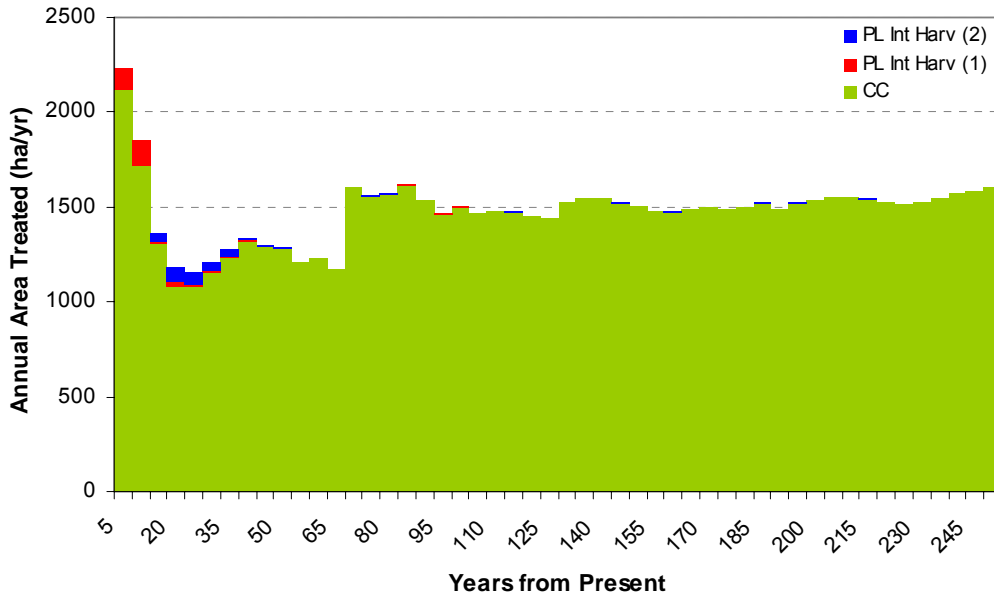


Figure 53. Treatment areas for the PI Intermediate Harvest scenario

Intermediate harvesting in mixed PI stands was successful at leaving green volume on the land base for harvest in the midterm. This simply strategy improves midterm harvest levels by 5.3% (Figure 54).

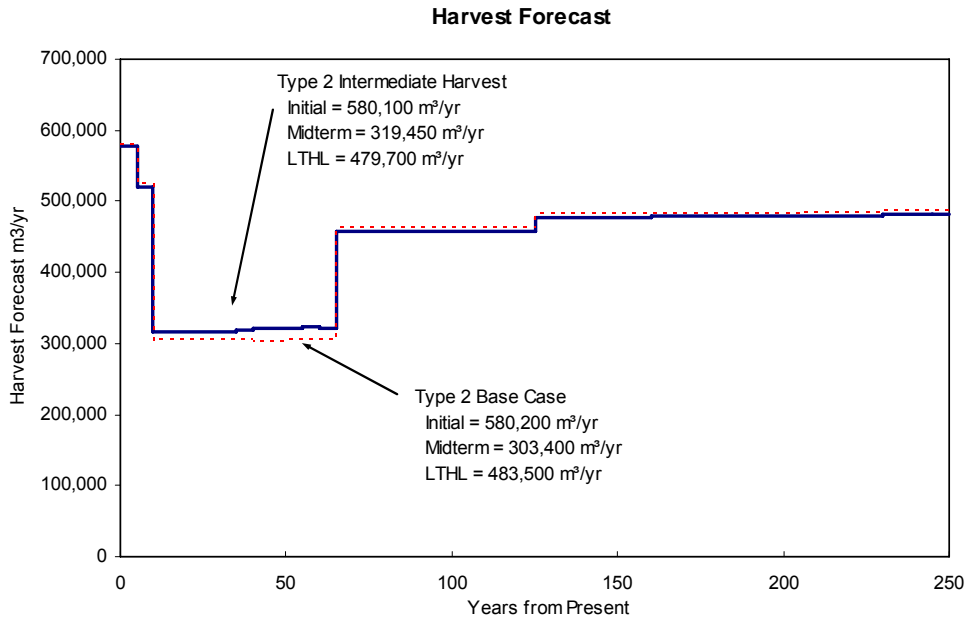


Figure 54. Type 2 PI Partial Harvest flow comparison to Type 2 Revised Base Case.

Intermediate harvesting also has the benefit of reducing ECA impacts relative to clear cutting in these mixed stands. Figure 55 shows the peak ECA that occurs in year 10 is reduced and this impact is shifted into the midterm (higher ECAs in years 40-90) when ECAs are much lower. This is the only strategy that was able to lower the peak ECA seen in year 10.

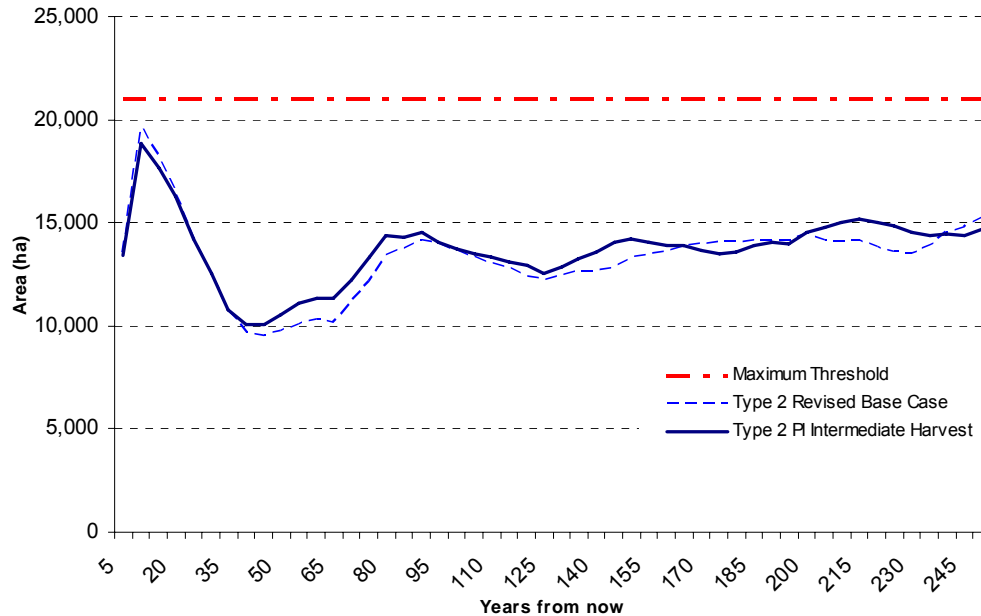


Figure 55. Type 2 PI Intermediate Harvest Total ECA (above H40) compared to the Revised Base Case.

10. Advanced Regeneration Scenario

This section summarizes the results of a scenario where PI stands expected to have advanced regeneration underneath are not salvage harvested in an attempt to enhance midterm harvest flows. The intent was for these stand to contribute earlier in the planning horizon because once the canopy was impacted by MPB, the advanced regeneration would release and the stand would be ready for harvest faster than if it was salvaged and then regenerated.

Specific to TFL 49, older PI leading stands in the ESSF were assumed to be candidates for this strategy. Based on forest cover and BEC data, it was determined that only 957 ha of these stands exist on the TFL, and Tolko's foresters felt that the advanced regen on these sites was spotty and heavy to balsam – a less desirable species. Based on these findings a run was completed where 957 ha were given the option of assuming a 30 year advanced age (avoid 20 yr delay + 10 yrs advanced growth) and a reduced yield curve if they were not salvaged.

Although, conceptually this strategy is a good idea, the limited amount of area meeting this advanced regeneration condition, combined with the low volume expectations, resulted in insignificant differences in all indicators. Further work on this strategy may be warranted as the MoF Southern Interior Region publishes research on the probability of advanced regeneration being present in various ecosystems.

11. Fertilization Scenarios

11.1. Impact of Young Stand Fertilization (x3) – Stand Level

This stand level analysis investigates the volume yield (m³/ha) and financial implications of applying a series of three fertilization treatments to Fd and Sx stands at ages 30, 40, and 50 years old. Two stand types were chosen for this analysis:

- An Fd stand in the ICH with a site index of 20; and
- An Sx stand in the ESSF with a site index of 20.

Since this fertilization is applied to stands that already exist, no reforestation costs were included. All costs and revenues were discounted to present for comparisons.

ICH – Fd – SI 20 (multiple fertilization)

Assumptions:

Fertilization Cost: \$400/ha

TIPSY Fertilization Response (adjusted for efficacy): 20%@age 30, 21%@age 40 and 50.

Stump to Dump Cost: \$45/m³

Sawlog Price: \$55.82/m³

Discount Rate: 2%

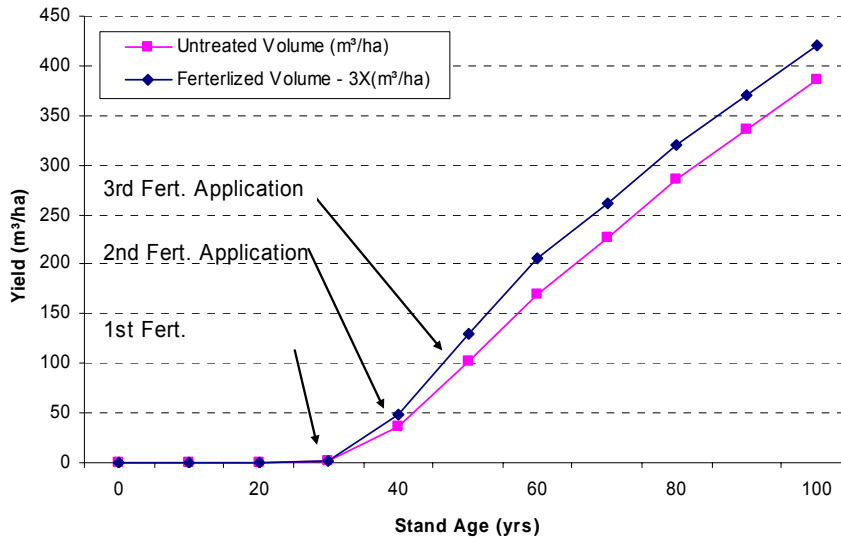


Figure 56. Volume response from fertilizing a 30 year old ICH, Fd stand today, 10, and 20 years from now.

Modeling shows the Fd stand volume can be increased from 170 m³/ha to 205 m³/ha at age 60 with three applications of fertilizer. This extra volume is then maintained as the stand resumes its normal growth increment.

Figure 57 below shows the 3x fertilization treatment having a positive net present value when harvest occurs between 60 and 110 years old (optimal at 80 yrs). However, it is far less financially attractive than the no treatment option.

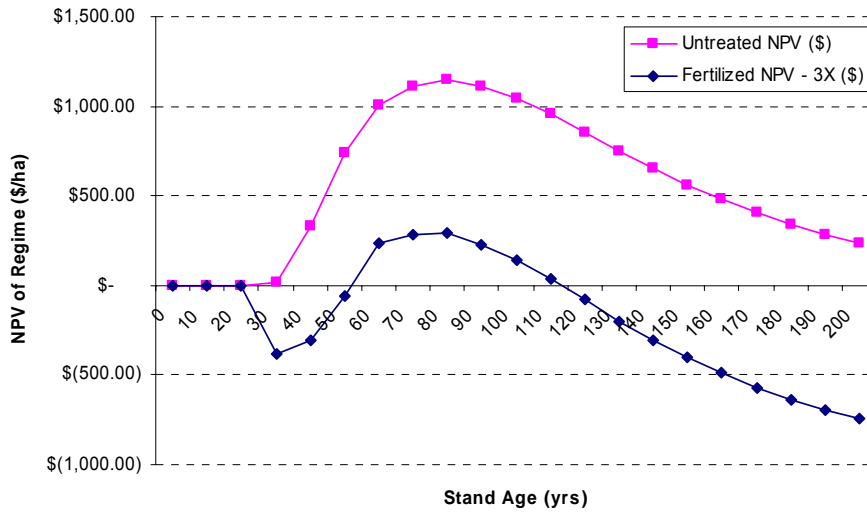


Figure 57. NPV of various harvest ages after fertilizing a 30 year old ICH, Fd stand today, 10, and 20 years from now vs. no treatment.

ESSF – Sx – SI 20 (multiple fertilization)

Assumptions:

Fertilization Cost: \$400/ha

TIPSY Fertilization Response (adjusted for efficacy): 8%@age 30, 9%@age 40 and 50.

Stump to Dump Cost: \$45/m³

Sawlog Price: \$55.82/m³

Discount Rate: 2%

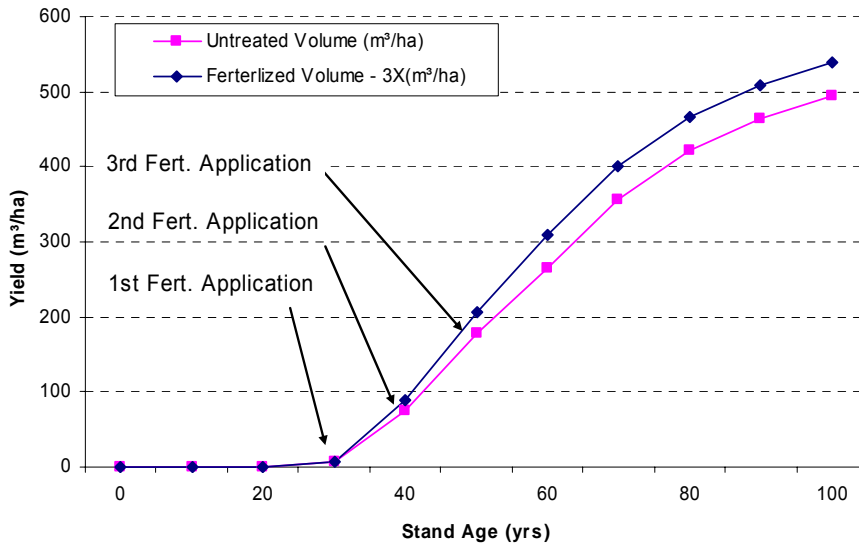


Figure 58. Volume response from fertilizing a 30 year old ESSF, Sx stand today, 10, and 20 years from now. Modeling shows the Sx stand volume can be increased from 280 m³/ha to 310 m³/ha at age 60 with three applications of fertilizer. This extra volume is then maintained as the stand resumes its normal growth increment.

Figure 59 below shows the 3x fertilization treatment having a positive net present value when harvest occurs between 40 and 120 years old (optimal at 70 yrs). However, it is far less financially attractive than the no treatment option.

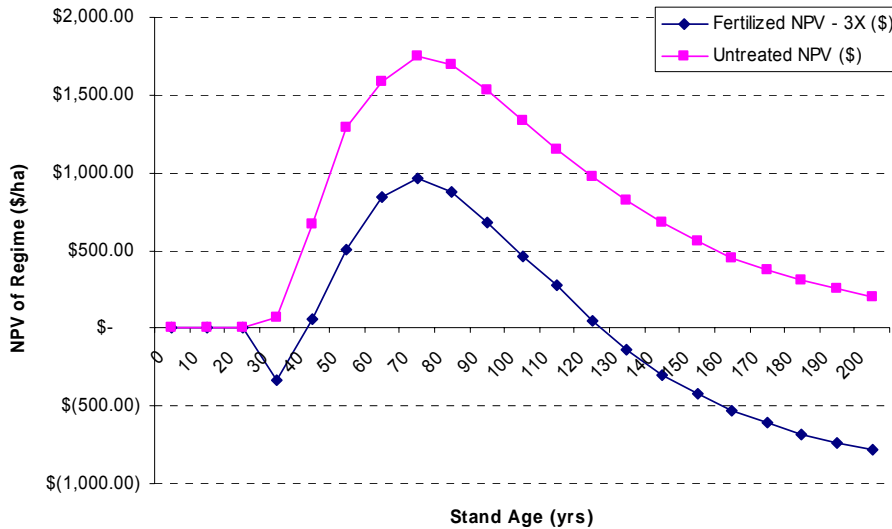


Figure 59. NPV of various harvest ages after fertilizing a 30 year old IDFdk-06 (AU 521) stand today, 10, and 20 years from now vs. no treatment.

Summary:

- The no treatment option was significantly more financially attractive than the 3x fertilization option.
- A 3x fertilization regime (yr 30, 40, 50) can yield positive net present values at a 2% discount rate if the stand is harvested within 40-50 yrs of the last treatment. Optimal economic rotation ages were 70 years for spruce and 80 years for Fd.
- Fd has a larger fertilization response (~20% of increment) than Sx (8-9% of increment) but spruce’s growth rate is significantly higher than Fd during the time of fertilizer application and this significantly reduces the differential. In addition, the higher initial growth rates in Sx stands mean that, in the same period of time, more volume is available and therefore the NPV calculations are far more attractive on the Sx stand.

11.2. Impact of Late Rotation Fertilization – Stand Level

This stand level analysis investigates the volume yield (m³/ha) and financial implications of applying a single fertilization treatment to an 80 year old Fd and an 80 year old Sx stand. All costs and revenues were discounted to present for comparison.

ICH – Fd – SI 20 (late fertilization)

Assumptions:

Fertilization Cost: \$400/ha

TISPY Fertilization Response (adjusted for efficacy): 21% @ age 80

Stump to Dump Cost: \$45/m³

Sawlog Price: \$55.82/m³

Discount Rate: 2%

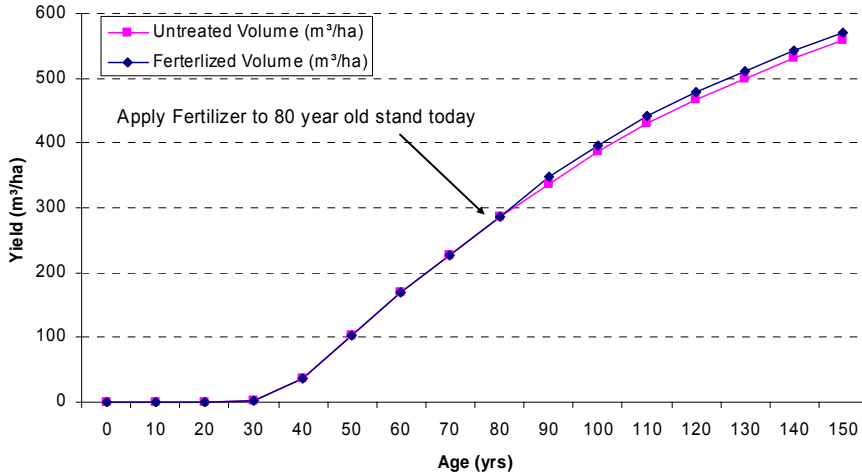


Figure 60. Volume response from a single fertilization treatment applied to an 80 year old Fd stand in the ICH.

A single application of fertilizer at 80 yrs is able to increase yield from 336 to 347 m³/ha. The graph below shows an immediate drop in NPV if the stand is harvested at 80 yrs (cost incurred but no vol gain yet). For older rotation ages, the narrowest margin between treated and untreated regime occurs immediately after treatment (year 90) because further aging of the stand doesn't result in enough volume gain to offset the additional years of revenue discounting. In general, the no treatment option is financially more attractive than the late rotation fertilization option proposed here.

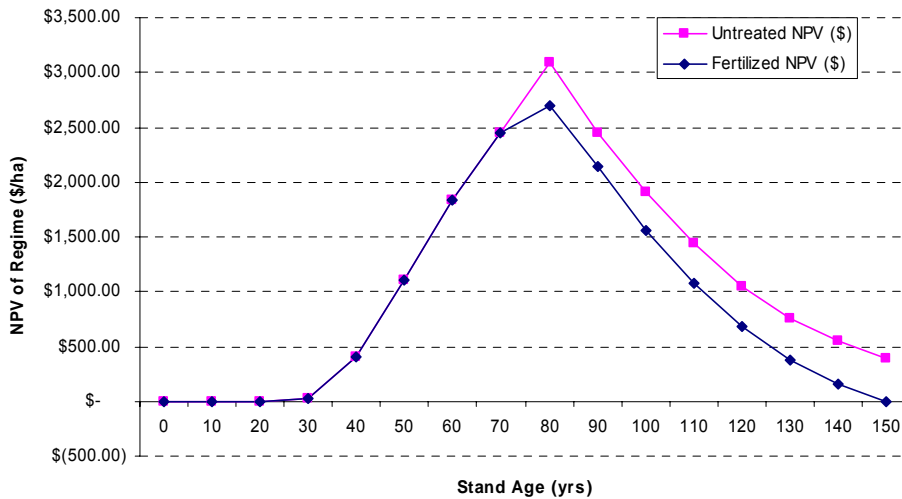


Figure 61. NPV of various harvest ages for a single fertilization treatment applied to an 80 year old Fd stand in the ICH vs. no treatment.

ESSF – Sx – SI 20 (multiple fertilization)

Assumptions:

Fertilization Cost: \$400/ha

TIPSY Fertilization Response (adjusted for efficacy): 14% @ age 80

Stump to Dump Cost: \$45/m³

Sawlog Price: \$55.82/m³

Discount Rate: 2%

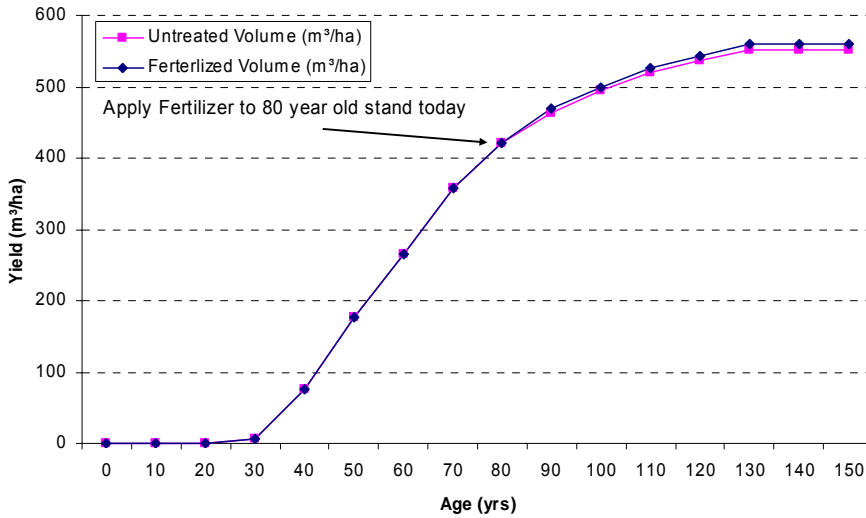


Figure 62. Volume response from a one time fertilization treatment applied to an 80 year old ESSF, Sx stand today.

A single application of fertilizer at 80 yrs only increased yield from 463 to 470 m³/ha because of the late stand age at application. The same NPV relationship as previous seen between treated and untreated regimes occur in this situation as well. It is financially more attractive to do nothing than apply the fertilization regime proposed here.



Figure 63. NPV of revenue realized from a one time fertilization treatment applied an 80 year old ESSF Sx stand today vs. no treatment.

In general, late rotation fertilization is more financially attractive than a series of 3 early rotation fertilizations, but the no treatment option is the most financially attractive option. This result is directly tied to the log profit assumptions in the example – see below for further discussion.

The most financially efficient fertilization regime (late rotation) typically results in 10-20 m³/ha of additional volume at a cost of \$400/ha made 10 years prior. Using a 15m³/ha gain and a 2% discount rate, this regime yields a negative NPV for the \$400 investment unless a \$33/m³ profit (after logging

costs) can be realised on the incremental volume. If a \$33/m³ profit can be made on the incremental volume at time of logging, fertilization is capable of providing a 2% rate of return. This profit margin is sensitive to the anticipated volume gain, the waiting period to achieve the gain, and the cost of the fertilizer application.

11.3. Fertilization – Landscape Level

This section summarizes the landscape level results associated with providing early and late fertilization treatment options to candidate stands in the model. These stands consist of existing and future Fd and Sx stands (15-80 yrs old) and future managed PI stands (15-80 yrs old). Currently existing PI stands were not eligible because of the uncertainty around MPB impacts to these stands. If fertilized, each treatment provided the following responses (Fd leading – 17m³/ha, Sx leading – 11 m³/ha, PI leading - 14m³/ha).

It is important to note that the nature in which fertilization yield gains were applied produced optimistic results. In reality, efficacy of fertilization treatments, fertilization of non-target species, local site issues, operational limitations, and species composition are all factors that act to limit the overall stand response to fertilization. This scenario was designed to show a maximum potential impact that could be achieved from fertilization.

Two different fertilization scenarios were run:

1. Late rotation fertilization only, and
2. Multiple fertilization (up to 3 applications possible between 15-80 years)

Given the option to fertilize stands and a maximum budget of \$400,000/yr to spend (1000 ha/yr), the model chose to apply the following treatments.

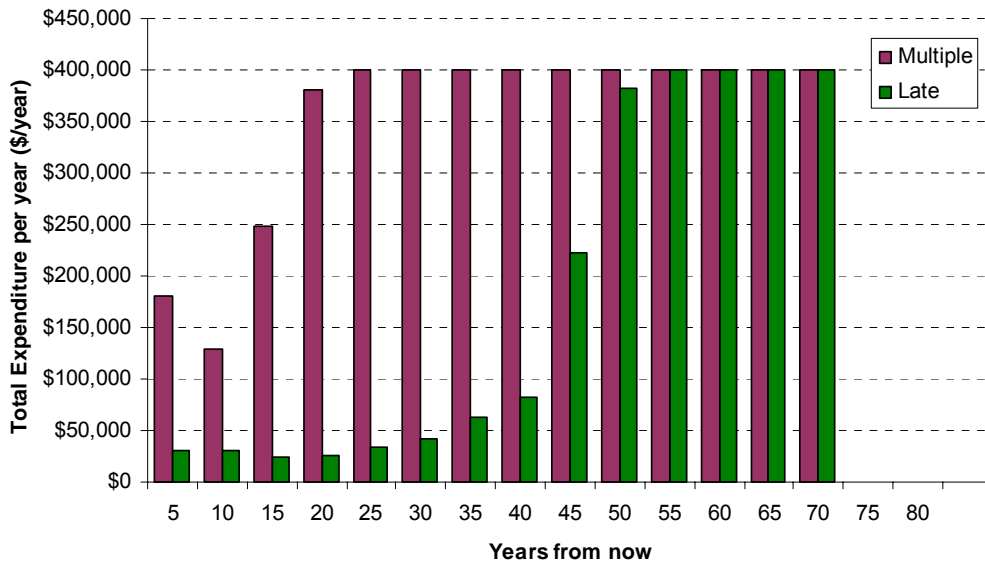


Figure 64. Fertilization treatment areas for late rotation and multiple fertilization scenarios.

It can be seen that late rotation fertilization occurred in a limited way in the first 40 years, and then was limited by the \$400,000/yr budget. This occurred because of a lack of suitable candidate stands being available prior to the arrival of managed PI stands later in the midterm trough. Treatments in the early periods are primarily on Fd and Sx stands. The late rotation scenario spent a total of \$12,684,000 on fertilization.

The multiple fertilization scenario was able to max out the \$400,000/yr budget much earlier in the planning horizon and spend more dollars overall. This occurred because it was able to treat young managed PI stands early in the midterm trough. The multiple fertilization scenario spent a total of \$24,704,000.

Timber Supply

The harvest flows resulting from the two fertilization scenarios are shown in Figure 65. A significant improvement in the mid-term harvest flow is realized under both regimes (~7.4% higher for the late and 8.0% higher for multiple). This improvement only lasts for the duration of the mid-term trough because the fertilization program was only implemented for the first 70 years.

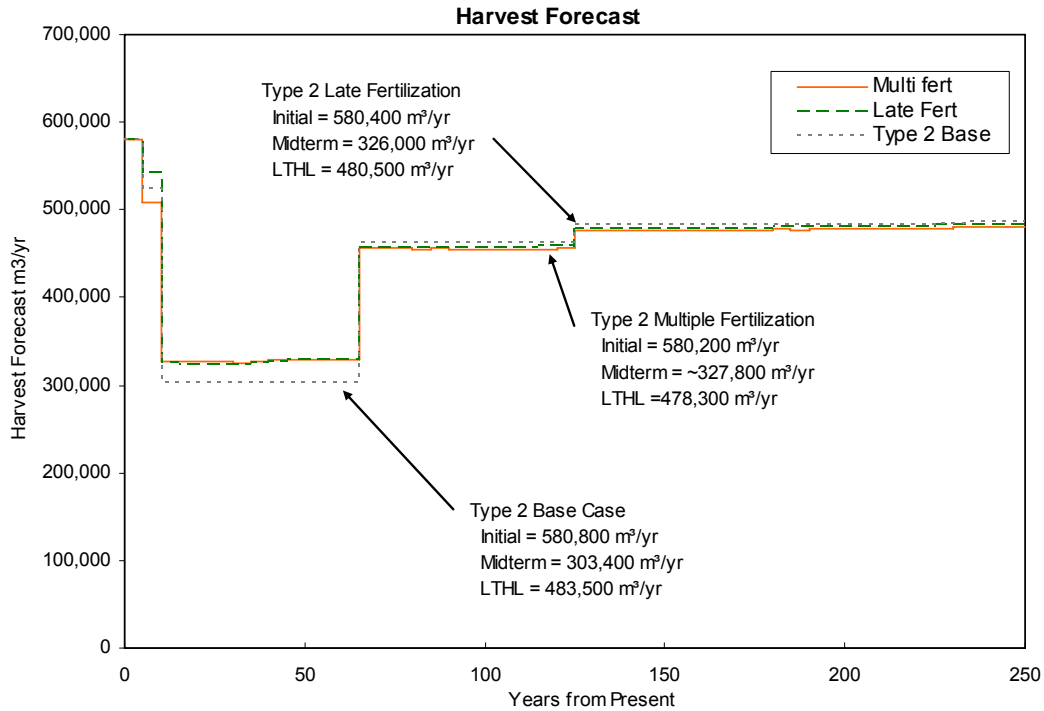


Figure 65. Comparison of harvest flow outcomes for late rotation and multiple fertilization regimes.

The comparison of species treated and timing of treatment for both late rotation and multiple fertilization regimes is shown in Figure 66. This shows that both treatment regimes favour PI leading stands. Though PI stands do not typically exhibit the best treatment response, they are the most abundantly available.

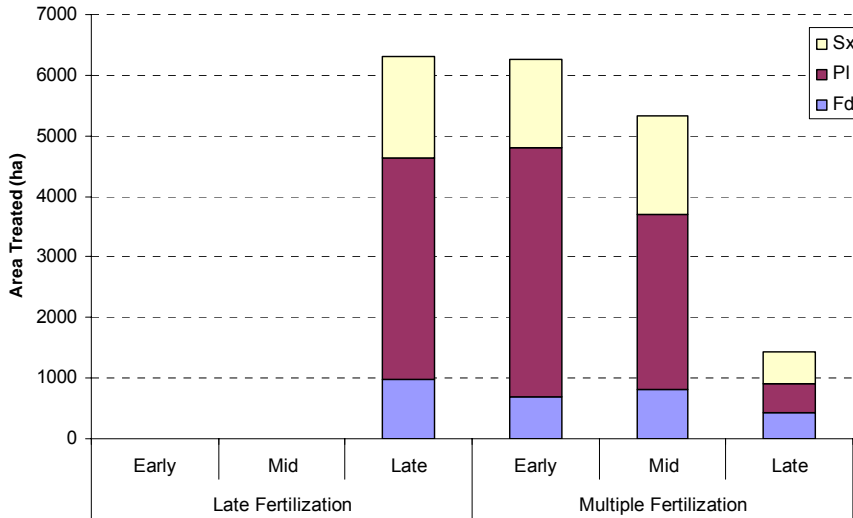


Figure 66. Comparison of area treated by species by timing of treatment for late and multiple fertilization Area fertilized by timing of fertilization and species for 'Early' fertilization

11.3.1 Economic Indicators

Though both fertilization regimes result in similar harvest flow improvements, the cost efficiency of the late rotation regime is far superior. Figure 64 shows the amount of area treated by period for the two regimes and the total. Almost double the area is treated under the multiple fertilization regime but the harvest volume gained over the revised base case is only 93,656 m³ (3.1m³/ha). Table 6 shows the comparison of total expenditures and total volume gained under both regimes.

Table 6. Landscape level financial comparison of late rotation and multiple fertilization regimes (Raw \$'s)

Fertilizer Regime	Area treated	Total of Fertilizer Expenditures	Total Volume gained (m ³)	Net Revenue Realized (\$10/m ³)	Net Revenue Including Fert. Costs	\$ / m ³ gained	m ³ gained / ha treated
Late	31,710	\$ 12,684,000	1,245,044	\$ 12,450,441	\$ (233,559)	10.2	39.3
Multiple	61,760	\$ 24,704,000	1,338,700	\$ 13,387,003	\$ (11,316,998)	18.5	21.7

Both of the fertilization regimes are able to provide more midterm volume than was placed on the land base through fertilization (39.3 and 21.7m³/ha achieved vs the 11 to 17 m³/ha applied). This occurs because fertilization is able to put volume into the pinch point occurring 45-50 years into the future and this allows the entire trough to rise. This timber supply dynamic makes fertilization significantly more cost effective.

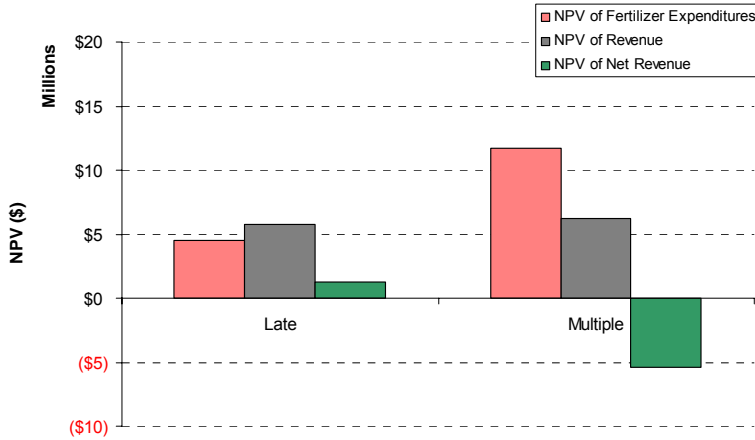
Late rotation is the most efficient at providing volume in the midterm (39m³/ha treated vs 21.7 m³/ha treated) because it is able to realize volume improvements more immediately and therefore provides direct benefits to more periods in the midterm trough. The early fertilization regimes focus more volume into the back end of the trough when the treated stands finally become eligible for harvest – and there is a limit to how much this extra volume can be pushed back into earlier periods of the midterm trough.

Table 7 below provides a net present value assessment of the two regimes. Even with only a \$10/m³ profit (log value – stump to dump cost) on the additional volume realized, the late rotation scenario had a positive net present value. This occurs because the bulk of the expenditure occurs in the back end of the midterm trough (see Figure 64) but volume gains are realized all the way through the trough for the reasons discussed above.

Table 7. Landscape level financial comparison of late rotation and multiple fertilization regimes (NPV \$'s)

Fertilizer Regime	NPV of Fertilizer Expenditures	NPV of Revenue	NPV of Net Revenue
Late	\$4,504,318	\$5,725,182	\$1,220,864
Multiple	\$11,677,731	\$6,260,602	(\$5,417,129)

* A 2% discount rate was used.



11.3.2 Watershed, Ecosystem, and Habitat Indicators

ECAs are higher during the midterm period under the fertilization scenarios because stands have shorter rotations and are being turned over faster and more frequently – thus a higher % of time is spent in ages that have an ECA impact. The fertilization scenarios also free up additional area/volume by addressing key pinch points and this additional logged area in the midterm also increases ECAs.

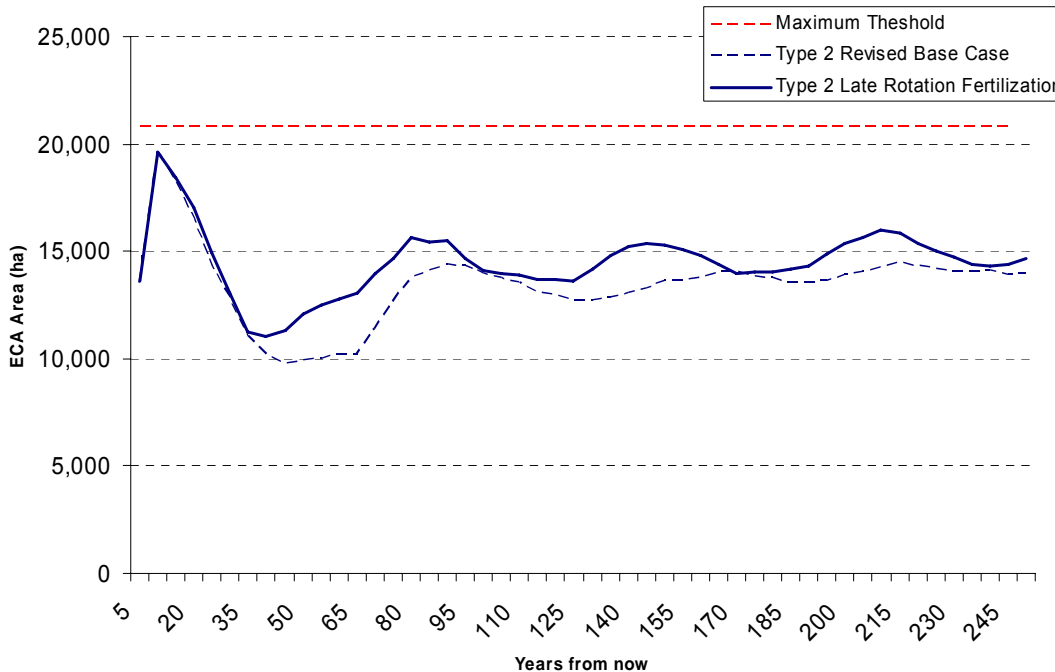


Figure 67. Late rotation aggregate ECA (above H40) compared to the Revised Base Case.

All LRMP wildlife objectives continue to remain within threshold values.

12. Impeded Stands

In 2005, the Forests for Tomorrow produced a list of openings considered to be “Impeded” in TFL 49. This list included 389 openings (approx. 10,832 ha). Impeded stands were defined as areas classified as “IMM”- immature stocking status that had not yet been declared free growing in RESULTS. In 2006, Forsite completed a manual review of these openings and recommended that 245 (approx. 7,013 ha) of these openings be acknowledged as Free Growing. Due to various reasons, 144 openings (approx. 3,819 ha) were still considered impeded (i.e. not recommended to be declared free growing) and field reviews and/or activities were recommended for these areas.

For this project, Forsite attempted to spatially map these areas so they could be incorporated into the strategic planning process. However, there were significant data gaps in the TFL forest cover that prevented the majority of openings identified in RESULTS as impeded from linking to the forest cover. Numerous linking approaches were attempted to no success:

- i. Mapsheet and Opening number
- ii. CP and block in Tolko’s historical logging data
- iii. RESULTS spatial data

These data deficiencies will need to be addressed manually through a visual / GIS exercise using the hardcopy maps of each opening and matching them to GIS forest cover polygons. Cleaning up this data was beyond the scope of this project and was therefore not completed.

13. Loss of Marginal Stands

The current THLB definition includes a population of currently marginal PI stand types that will be made even less economic if attacked by MPB. These stands are at or near maturity but have low volumes or small piece size because of young ages and/or low site productivity.

Two scenarios were explored to evaluate the impact of losing these stands from the THLB (worst case scenario). The first scenario assumed any PI stands >70 yrs old that did not currently have 100 m³/ha or a stand height of 19.5m or a stand quad mean diameter of 20cm (12.5+ cm stems) were excluded from harvest. The second scenario used the same criteria but increased the diameter cutoff to 25cm.

The first PI marginal stand scenario (20cm dbh) excluded 4,644 ha of THLB.
The second PI marginal stand scenario (25cm dbh) excluded 16,623 ha of THLB.

This second scenario is quite pessimistic because it includes many 70-80 yr old stands on decent site indexes. Completely excluding them from the THLB does not reflect the potential of these stands to recover from the MPB impacts and contribute in the future.

The timber supply projections associated with removing the PI marginal stands can be seen below. It is clear that a significant portion of the salvage volume logged in the first two periods is coming from marginal stands because under both scenarios, the 2nd period harvest is substantially below that of the revised base case. The removal of these poor quality PI stands from salvage harvesting also serves to push average harvested dbh and vol/ha up in the first and second periods.

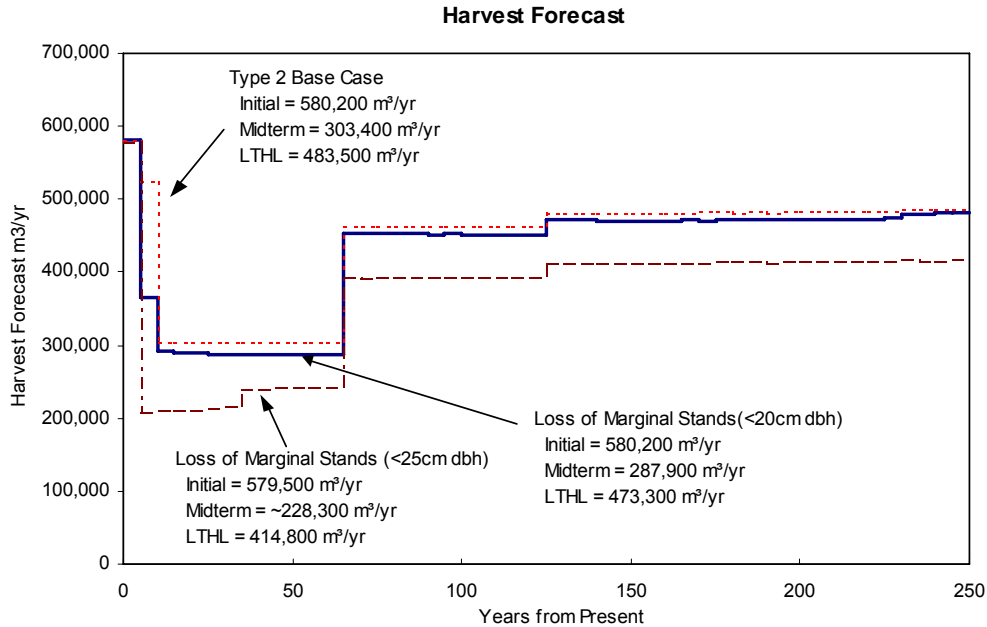
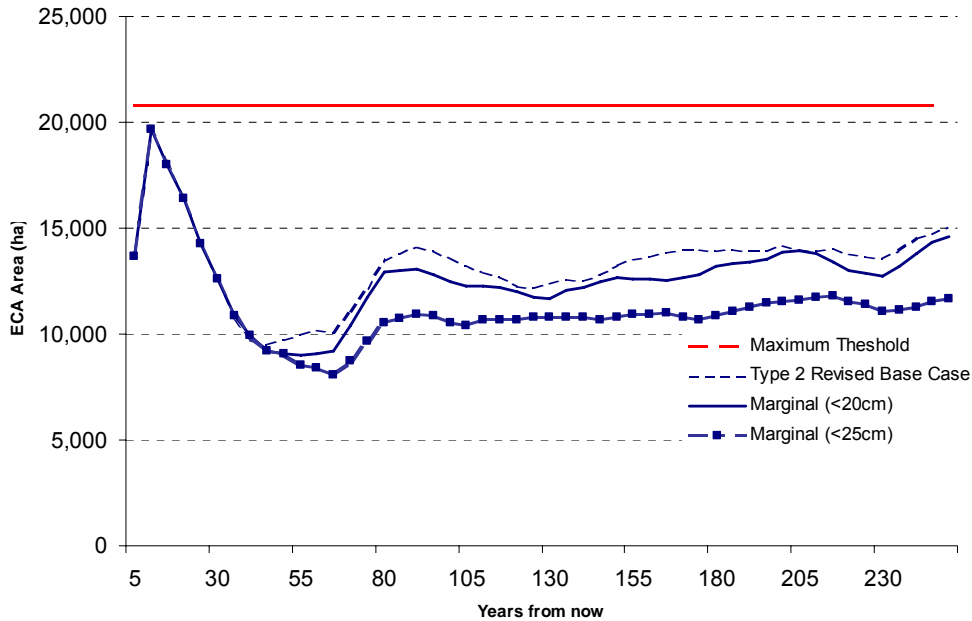


Figure 68. Harvest flow for marginal stand scenarios relative to revised base case.

The 20cm marginal stand scenario shows a midterm reduction of 5.1% and a long term reduction of 2.1%. This long term reduction is consistent with the THLB impact of removing ~4600 ha of lower productivity sites.

The 25cm marginal stand scenario shows a midterm reduction of 24.8% and a long term reduction of 14.3%. This midterm drop is exaggerated because of the severe shortage of mature timber in the midterm and its need to support both timber and non-timber objectives.

Eliminating harvest from marginal stands in the THLB has positive impacts on non timber values. Peak ECAs and recovery periods remain unchanged because the impact of MPB is assumed to be the same as salvage harvesting for the vast majority of these stands (>60% PI), however the recovery is fuller and the long term ECAs are lower as less of the land base is being harvested.



14. Rehab of Impacted/Unsalvaged THLB Stands

This section summarizes the results of applying rehabilitation treatments to unsalvaged MPB impacted stands on the THLB with over 80% PI (high % mortality required to a make rehab practical). A maximum budget of \$400,000 per year (~333 ha/yr) was implemented in the model. Instead of stands waiting out a 20 yr regeneration delay period and then growing on lower volume natural stand yield curves, rehabilitated stands are assumed to be treated (prep and plant) so they have a 2 year regeneration delay and grow on managed stand yield curves. Stands were only eligible for this treatment within 5 years of being impacted by MPB (years 5-15).

The model chose to treat 1535 ha in the first 15 years of the planning horizon. These areas consist of younger PI leading stands that were not salvaged because they were below minimum harvest ages. All other stands with 80+% PI were salvage harvested so there was not need for rehabilitation.

Timber supply results show a 4-5% increase in midterm harvest levels is possible as a result of rehabilitating MPB impacted stands (Figure 70). More of an impact could be realized if the definition of candidate stands was broadened to include sites with less than 80% PI (where pockets of mortality existed and allowed focused rehab efforts).

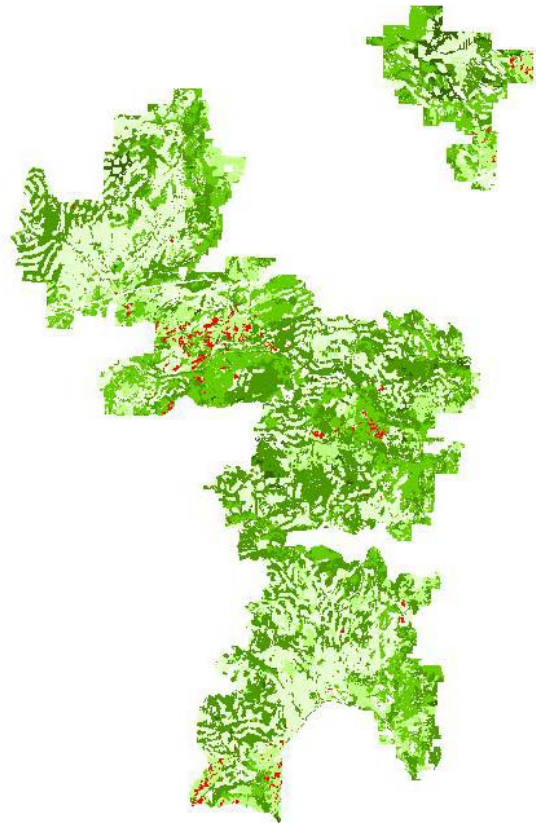


Figure 69. Areas receiving rehabilitation treatments in yrs 5-15.

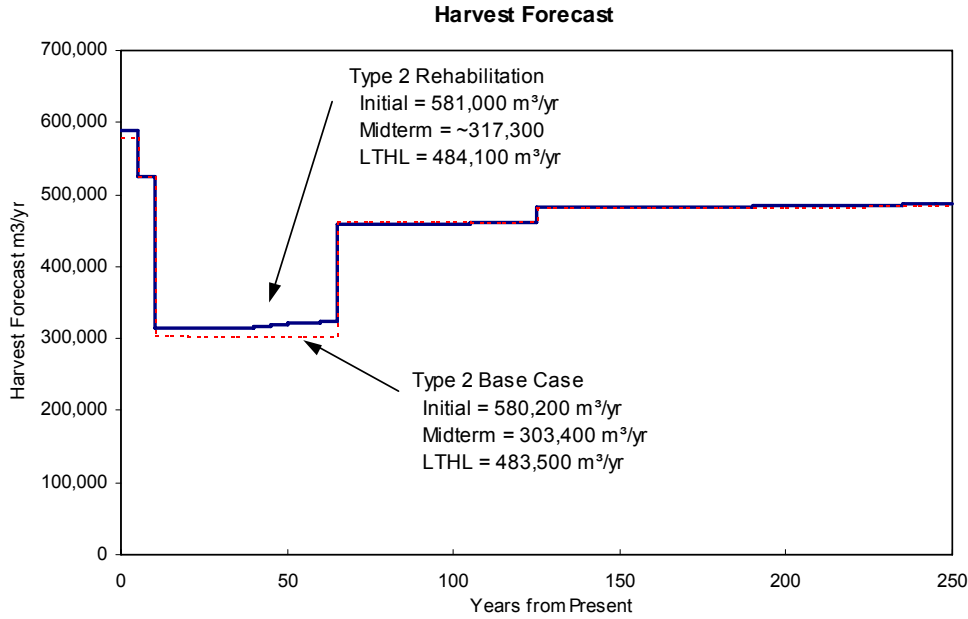


Figure 70. Rehabilitation harvest flow comparison to Type 2 Revised Base Case.

The treated areas provided additional volume in the late midterm and allow the entire midterm to be elevated. A total of \$1.84 million was spent and a total of 153,037 m³ was added to the midterm (\$12/m³). Only those stands that helped to improve the midterm flow were treated by the model.

This rehabilitation treatment is only required where stands >80% PI do not get salvage harvested. The same result could be obtained for 'free' if it was possible to salvage harvest these stands.

In terms of non timber values, little discernable difference was seen in the indicators. An example of changes that were observed can be seen below in the graph of ECA's above the H40 line. Rehabilitation ECA's are slightly higher in the back end of the midterm trough because the treated stands are allowing a higher harvest level during this time.

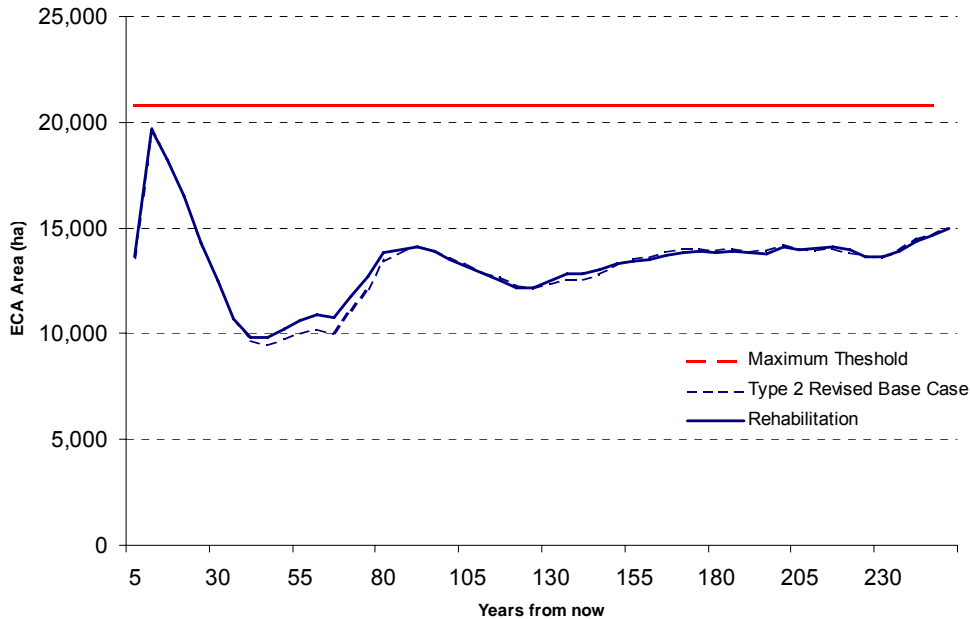


Figure 71. Aggregate ECA above H40 comparison between rehabilitation and revised base case scenarios

15. Enhanced Acceptance of Deciduous Species

This section summarizes the scenario results where an enhanced level of broadleaf species are accepted in the following ecosystems: ICH mk1-05, IDFmw1-01, IDFmw2-01/04, IDFdk1-06, IDFdk2-07, and IDFXh1-08/09. This increase in broadleaves is assumed to reduce managed stand yields by 5% within affected AU's (7289 ha or 5.8% of THLB).

The area impacted by these ecosystems was not large enough to cause a discernable difference in any of the indicators. Long term timber supply was reduced by 0.8% and deciduous area on the managed land base increased by <1%. Because the amount of deciduous on the land base is already predicted to increase above current levels as stands are managed on shorter rotations, this small change does not seem to offer much additional improvement for biodiversity.

16. Extended Uplift to Capture Mortality

Results associated with extending the current AAC uplift are presented below. The current uplift to 580,000 m³/yr is 200,000 m³ above the historical AAC for the TFL. The revised base case assumes a second period uplift (yrs 5-10) will be in place because it harvests 524,600 m³/yr during that period in an attempt to capture PI volume before it is lost. This scenario assumes that the current uplift level will be extended for years 5-10 so an increase in harvest of 55,400 m³/yr relative to the revised base case occurs.

This small increase in second period harvest is shown in Figure 72 below.

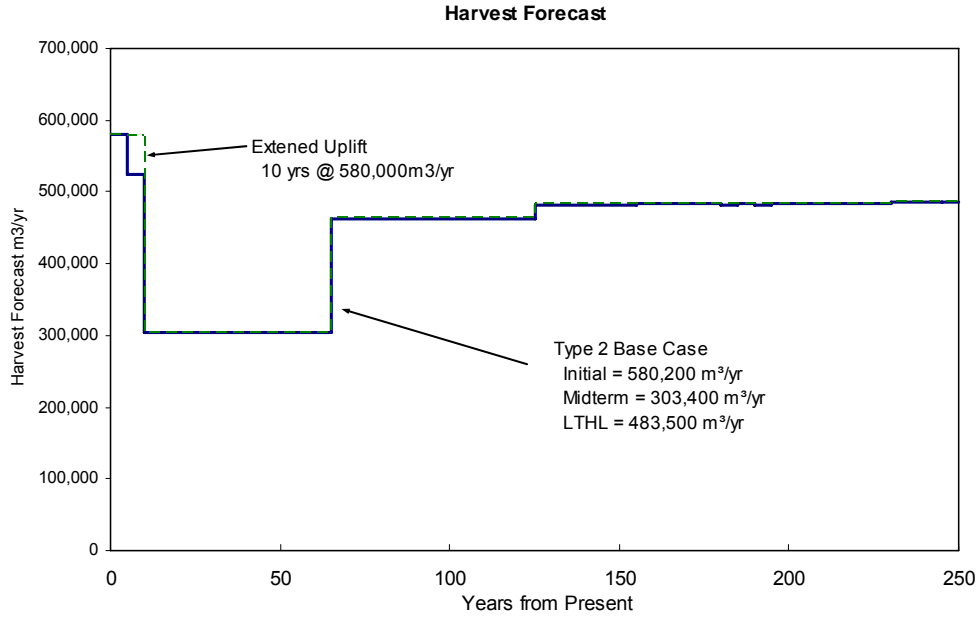


Figure 72. Additional Uplift harvest flow comparison to Type 2 Revised Base Case.

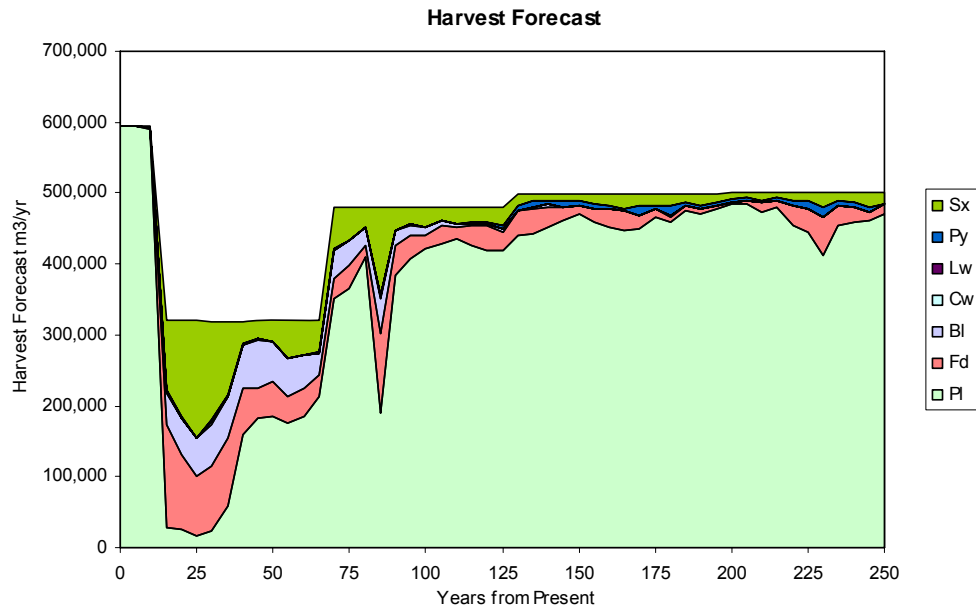


Figure 73. Extended uplift harvest volumes by leading species

The uplift occurring in the revised base case was considered passive in that no AAC uplift request was made of the model in period 2 but yet the model chose to increase harvest in this period. This occurred because it helped the midterm timber supply to regenerate these stands onto managed yield curves and avoid regeneration delays. The additional uplift implemented in this scenario forced the model to look at salvaging additional stands with lower PI volumes (mixed stands). Figure 73 shows that all of the volume harvested in the first two periods is still coming from PI leading stands.

The additional volume harvested in period 2 (relative to the revised base case) does not cause any mid or long term harvest flow differences from the revised base case. The additional harvest is primarily capturing volume that would have been otherwise lost to MPB. From a non timber perspective, there was no discernable difference in any of the indicators.

17. Summary and Recommendations

Each of the scenarios presented above were completed to explore a single issue or potential strategy. Table 8 provides a summary of the impacts to timber supply, timber quality, and habitat supply for each of the scenarios so they can be easily compared.

Table 8. Summary of impacts to indicator categories for each scenario.

Scenario	Timber Supply			Timber Quality	Habitat	Watershed H40 ECA's	Visuals
	Short	Mid	Long				
No Gains	-	↓3.2%	↓14-17%	-	↑	↑	↑
Reduced Planting	-	-	↓11.1%	↓	↑/↓	↑	↑
Enhanced Reserves	↓32.7%	↓70.0%*	-	-	↑	↑	↑
Enhanced Reserves with Limited Harvest	↓12.3%	↓26.0%	-	-	↑	↑	↑
PI Intermediate Harvest	-	↑5.0%	↓0.8%	-	↑	↑	↑
Leave Advanced Regen	-	-	-	-	-	-	-
Multiple Fertilization	-	↑7.4%	↓1.1%	-	-	↓	↑
Late Fertilization	-	↑6.9%	↓0.6%	-	-	↓	-
Loss of Marginal (<20cm)	↓14.4%	↓5.1%	↓2.1%	↑	-	-	-
Loss of Marginal (<25cm)	↓28.6%	↓24.6%	↓14.2%	↑	-(↑)	-	-
Rehab of Impacted/Unsalvaged	-	↑2.1%	↓0.74%	-	-(↓)	↑	↑
Acceptance of Deciduous	-	-	↓0.8%	-	↑	-	-
Extended Uplift	↑	-	-	-	-	-	-

*Only for the front end of the mid-term trough, remainder is more or less the same as the revised base case

Based on the findings of the workshops, project discussions, and analysis work the following summary points were defined:

Recommended Timber Supply Strategies:

1. Ensure volume gains associated with **class A seed** continue to be realized. The mid- and long-term harvest flows are highly dependant on these volume gains.
2. **Maximize planting** wherever class A seed is available and regeneration delays can be shortened. There is a financial incentive not to plant when natural regen is expected but there are mid- and long-term timber supply implications of delaying harvest and not realizing the volume gains provided by class A seed.
3. **Avoid using spatially fixed short term retention areas** for the next 30 years. Their impact on timber supply is very large and they provide only small improvements to non-timber values. All LRMP objectives are already being met in the revised base case without these reserves but they do speed hydrological/visual recovery by dramatically reducing harvest in the early midterm. It is likely possible to achieve a similar result more efficiently by minimizing harvest or partial harvesting in highly impacted watersheds in the short term (Cain, Munro, Nash, Naswhito, Twig, Weyman, and Whiteman).
4. **Intermediate harvest in mixed PI stands** (30-60% PI) to ensure green timber is retained for non-timber values in the short term and for timber supply in the midterm (potential to treat 1200-1300 ha in next 10 years).
5. Where MPB impacted stands area are found to have significant advanced regeneration, **protect the advanced regeneration** or make these stands low priority for salvage. There appears to be limited opportunity to implement this strategy in the TFL but where it is possible it will benefit timber supply in the future.
6. To optimize financial efficiency, implement only a small program of **late rotation fertilization** in candidate Fd or Lw or Sx stands in the short term (~75 ha/yr) while developing the required

infrastructure to deliver a much larger late fertilization program beginning in 45-50 years from now (1000 ha/yr). If FFT dollars are available for fertilization in the short-term, maximize their use as any form of fertilization will help timber supply in the midterm and there is no guarantee of funding 45-50 yrs from now. Fd or Lw are slightly preferred over Sx stands for treatment because of better volume response and less risk of losses to pests.

7. **Rehabilitate MPB impacted stands that do not get salvaged.** Rehabilitation is assumed to be practical if the impacted stands are almost completely killed or where treatment can target concentrations of mortality. These stands are typically younger stands that have little to no salvage value. There were 3,085 ha treated in the first 15 years for a total expenditure of \$3.7 million.
8. **Salvage in marginal stands** wherever possible. If these stands are not utilized there are significant timber supply implications and/or costs associated with rehabilitation. Marginal stands from 20-25cm dbh are important to any AAC extension beyond the current 5 years uplift.
9. Look to **extend the current AAC uplift** for an additional 5 years in order to capture more MPB impacted volume and regenerate these sites. Without the uplift, a significant increase in rehabilitation treatments (and costs) may be required to enter previously merchantable stands and assist the regeneration process. Harvest (or rehab) of highly productive PI stands is key to getting volume online in the back end of the midterm trough (50-70 years from now).

Recommended Timber Quality Strategies:

No specific timber quality strategies were evaluated but the following general recommendations can be made as a result of evaluating the modeling results:

1. Look to **diversify regenerated species** to reduce risks associated with changing markets and/or forest health concerns.
2. **Manage for longer rotations in constrained areas.** Purposefully managing for longer rotations once out of the midterm could provide a more diverse product base for the TFL in the future. Current expectations are for high volumes of small piece size PI.

Recommended Watershed/ Ecosystem and Habitat Strategies:

1. Continue to **maintain habitat related requirements from LRMP.**
2. **Minimize harvest in highly impacted watersheds** to speed hydrologic recovery (Cain, Munro, Nash, Naswhito, Twig, Weyman, and Whiteman). This may involve implementing portions of the Short Term Retention Plan for up to 20 years.
3. Any strategy that reduces the harvest during the midterm will help almost all non-timber related values. Any new harvesting in the midterm slows hydrological recovery.
4. Implement **intermediate harvests in mixed PI stands** instead of clearcutting. This is the only strategy that worked to reduce the ECA peak post-MPB.
5. Work to **maintain habitat for conservation listed species** such as Lewis's Woodpecker, Flammulated Owl, and Williamsons Sapsucker.
6. Similar to quality strategies, **diversifying managed stand species and ages** is important.

18. Preferred Silviculture Strategy Forecast

The results for each of the scenarios were presented to project participants at a final workshop and then a preferred strategy was defined. This preferred strategy includes many of the elements discussed previously:

- An extended uplift designed to minimize unsalvaged MPB losses and eliminate the need for expensive rehabilitation treatments. Amount dictated by optimization model balancing timber and non timber objectives.
- Marginal PI stands (<20cm DBH) are not eligible for harvest (but could be rehabilitated)
- Rehabilitation treatments are available to unsalvaged MPB impacted stands.
- Late rotation fertilization is implemented.
- Intermediate harvesting of PI stands is made available to capture PI volume while leaving green timber to fulfill short-term non-timber values and provide volume in the mid-term timber supply trough.

This section summarizes the results of implementing these incremental strategies within one comprehensive preferred scenario.

Dropping marginal stands (<20cm DBH) resulted in 4,644 ha becoming unavailable for harvesting. However, because rehabilitation was an eligible treatment for these stands, approximately 1880 ha were added back into the land base after year 10 and made available for future harvesting. In total, rehabilitation treatments were applied to 3,085 ha in the first 15 years for a total expenditure of \$3.7 million.

The area that received late rotation fertilization treatments over the first 70 years is shown in Figure 74. This treatment schedule is very similar to the stand alone late fertilization scenario in that the majority of the treatments are applied in the later half of the mid-term trough. Although not shown in this figure, the majority of the fertilization in the first 40 years occurs in Fd and Sx leading stand types while PI is primarily targeted in years 45 to 70. A total of \$14.38 million was spent on fertilization in the preferred scenario.

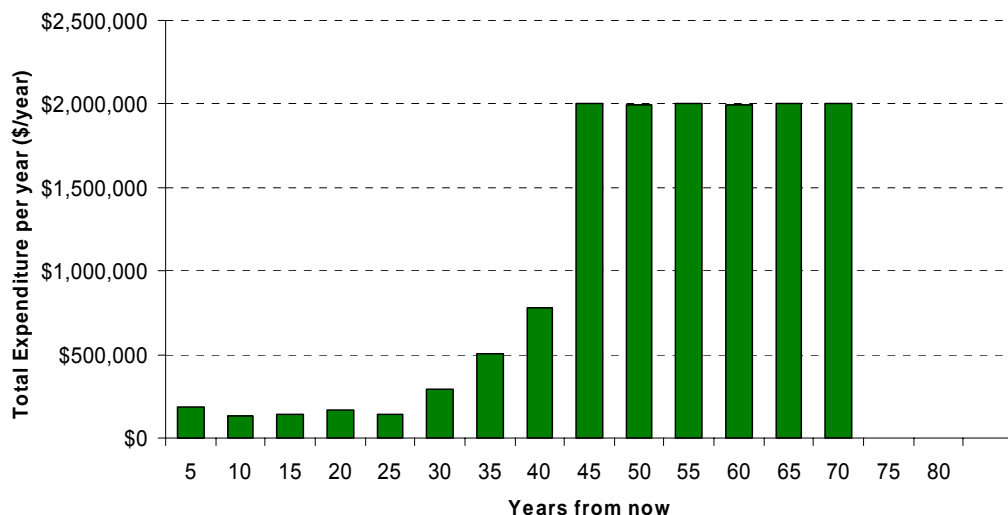


Figure 74. Total Expenditures of late rotation fertilization treatments under the Type 2 Preferred Strategy.

The area treated over time by treatment type is shown in Figure 75. The majority of intermediate PI harvesting (shown in red) occurs in the first ten years to capture PI mortality. Additional intermediate PI harvest occurs in the subsequent 10 years in order to access areas which are constrained by non

timber values. The second entry into these stands (shown in blue) occurs mainly in the front end of the mid-term trough when timber at the most scarce.

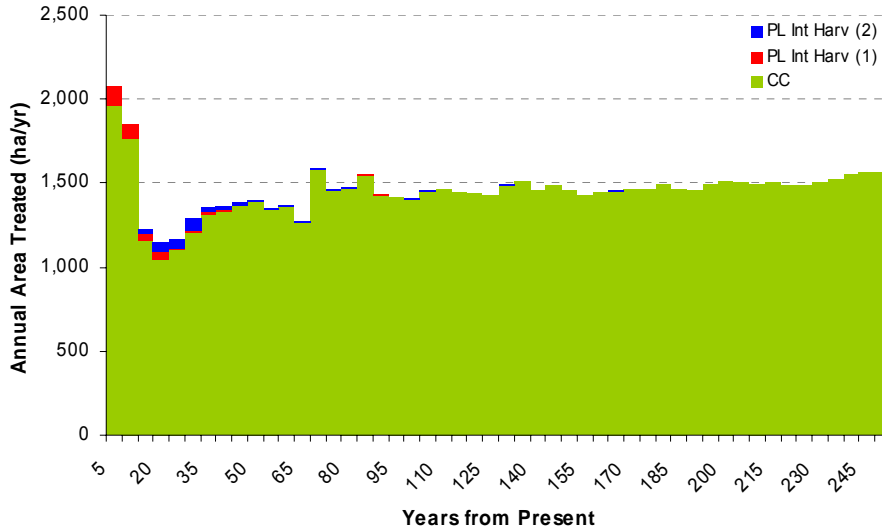


Figure 75. Type 2 Preferred Strategy - Area treated over time by treatment type.

18.1.1 Timber Supply Indicators

The harvest flow for the preferred scenario is consistent with the base case for the first two periods and then the front end of the mid-term trough is 5.7% higher and the back end of the trough is 13.1% higher. The improvements in the midterm trough are muted by the removal of the marginal PI stands (<20cm dbh) and causes a reduction in the long term harvest levels (-2.6%). Even though marginal PI stands were removed from short term harvest eligibility, the harvest level in the first two periods remains unchanged because a small amount of non PI leading stands (Figure 77) and lower % PI stands are now harvested. Some of these are intermediate harvests into areas that would have otherwise been unavailable due to non-timber objectives as discussed above.

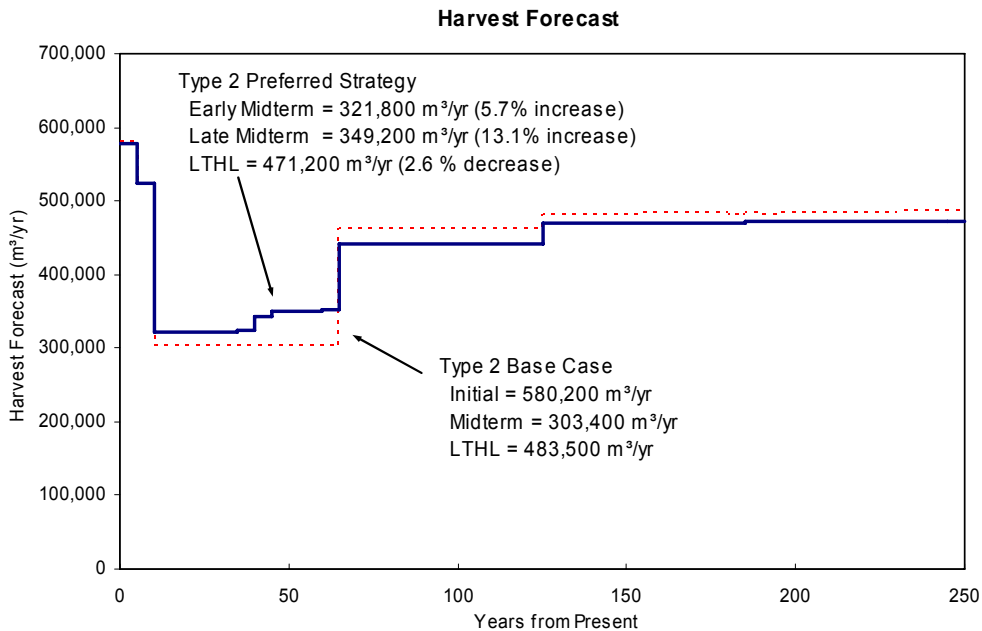


Figure 76. Type 2 Preferred Strategy Scenario harvest flow (m³/yr) compared to the Revised Base Case.

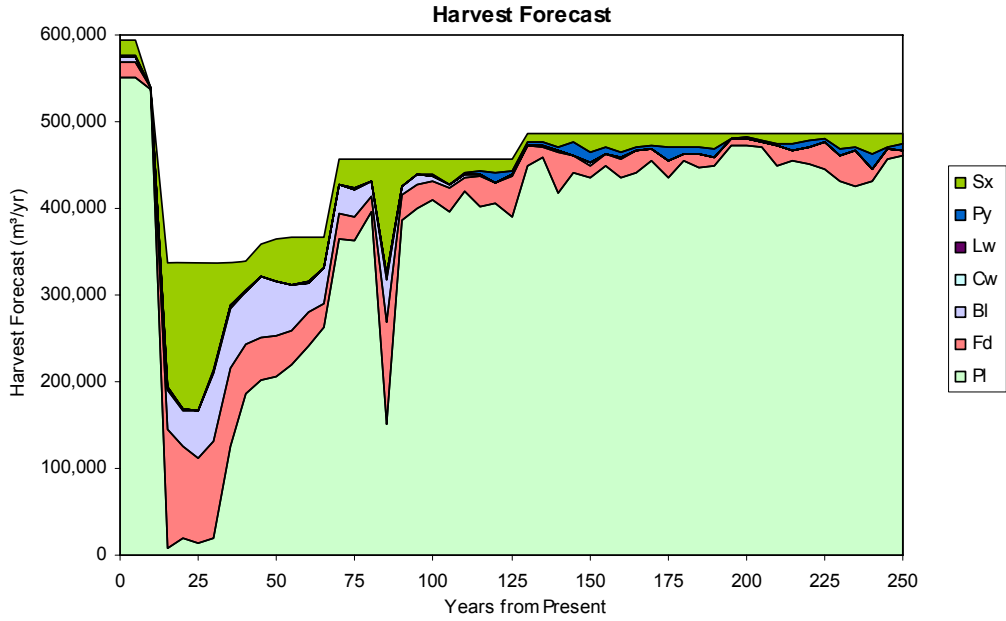


Figure 77. Type 2 Preferred Strategy Scenario harvest flow (m³/yr) by species

Under the preferred strategy, the loss of marginal stands (<20cm DBH) causes the first period average harvest age to be 29 years older and the average harvest volume to be 19m³ higher than the revised base case. This translates into less area harvested in the two periods.

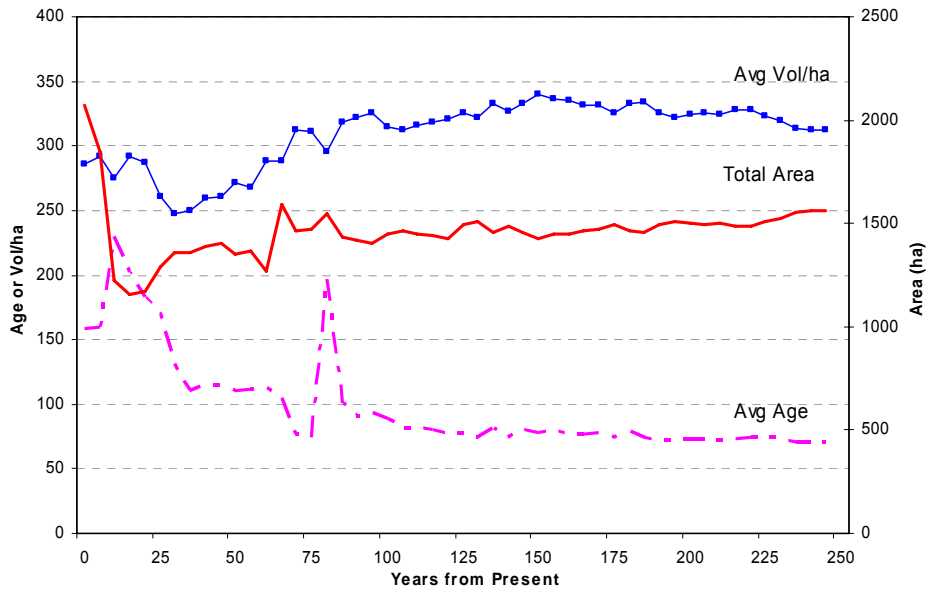


Figure 78. Type 2 Preferred Strategy average harvest age / volume / areas.

18.1.2 Watershed, Ecosystem, and Habitat Indicators

The preferred scenario shows that visual disturbance peaks slightly lower than in the revised base case (Figure 79). This occurs because of the reduced harvested area in the first two periods and the use of intermediate harvests for PI salvage instead of clearcutting.

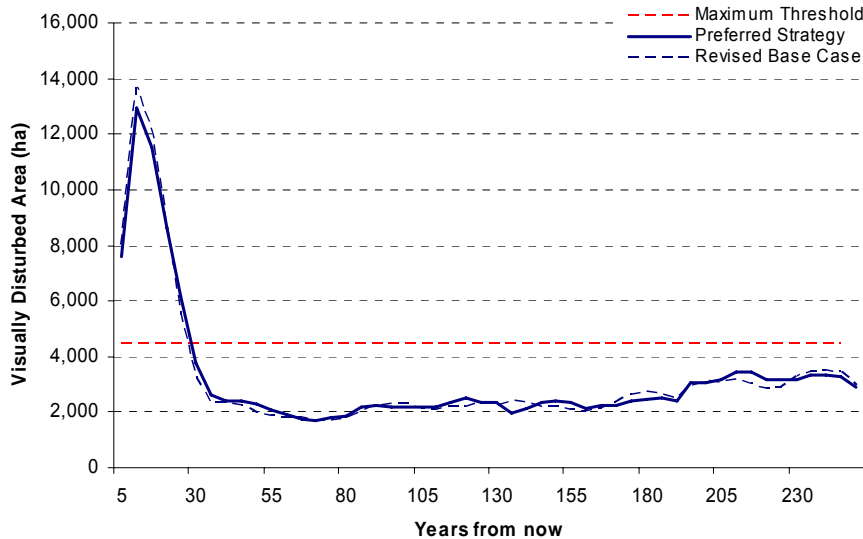


Figure 79. Type 2 Preferred Strategy Total Visual Disturbance Compared to the Revised Base Case.

As with visual disturbance, the ECA peak is lower in the second period because of the reduced harvest area and the use of intermediate harvesting in mixed PI stands (Figure 80). The intermediate harvesting shifts ECA impacts into the mid-term so they appear higher than the revised base case. This increase in mid-term ECA is also due to increased harvest levels.

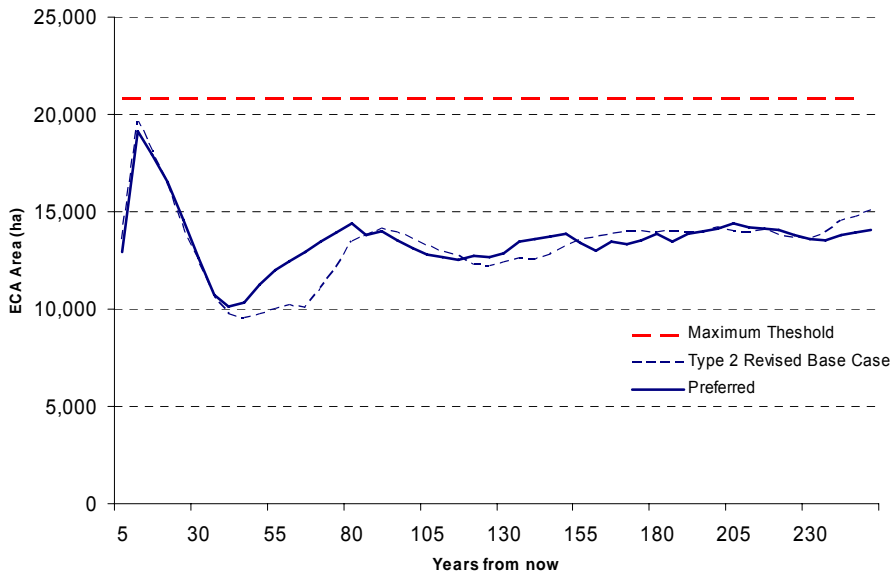


Figure 80. Type 2 Preferred Strategy Total ECA (above H40) compared to the Revised Base Case.

Most of the wildlife habitat indicators in the preferred scenario show slightly higher mid-term impacts than in the revised base case (Figure 81). The main reason for this is the higher harvest level during the mid-term trough. Some of these indicators recover to levels similar to the revised base case in the long-term (i.e. MDWR- Shallow, Moose, Bighorn Sheep, and Mountain Goat) though some remain depressed (i.e. MDWR – Deep snowpack, Lewis’s Woodpecker, and Flammulated Owl habitat).

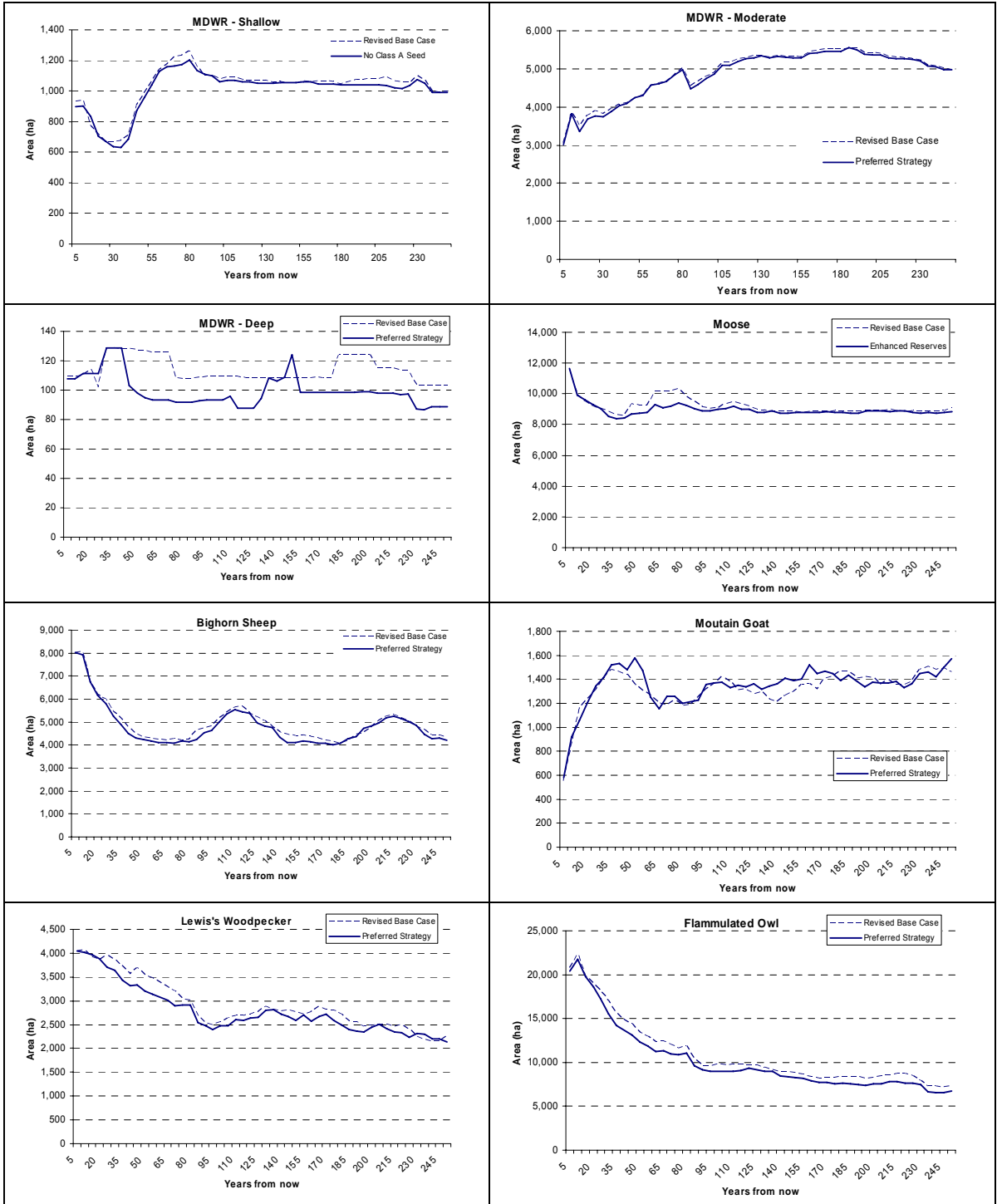


Figure 81. Wildlife habitat indicators under the preferred strategy.

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