TYPE 4 SILVICULTURE STRATEGY IN THE OKANAGAN TSA

SILVICULTURE STRATEGY USE REPORT

Prepared for:

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August 2013
Contract number: 1070-20/OT13FHQ175

STRATEGY AT A GLANCE

<table>
<tr><th colspan="3">Strategy at a Glance</th></tr>
<tr><td>Historical Context</td><td colspan="2">The annual allowable cut (AAC) in the Okanagan TSA has been set at 3.1million m^3/year in the 2012 TSR 4. Prior to the MPB epidemic the AAC was 2.6million m^3/year, which was increased to a high of 3.375million m^3/year in 2006 - 2011 for wildfire salvage and to address the MPB epidemic. Following TSR4 in 2012, the AAC was lowered to transition to the mid-term harvest levels. TSR4 forecasts that without mitigation, the mid-term timber supply will drop to 2.35million m^3/year for 5 decades.</td></tr>
<tr><td>Objective</td><td colspan="2">Using forest management and enhanced silviculture to mitigate the mid-term timber supply impacts of mountain pine beetle (MPB) and wildfires while considering a wide range of resource values.</td></tr>
<tr><td>General Strategy</td><td colspan="2">Continue to direct current harvesting into MPB affected stands and apply a variety of silviculture activities to mitigate mid-term timber supply and achieve the working targets below.</td></tr>
<tr><td rowspan="4">Working Targets</td><td>Timber Volume Flow Over Time:</td><td>Short-term (1-10yrs): Salvage as much pine as possible utilizing the current AAC of 3.1million m^3/year.
Mid-term (11 - 70yrs): Step down to a maximized mid-term harvest level.
Long-term (71-250yrs): Harvest level based on the productive capacity and resource values of the land base.</td></tr>
<tr><td>Timber Quality:</td><td>The overarching BC timber quality target is for at least 10% premium logs within a volume-focused approach. Carry out silviculture practices that will result in high quality and diverse stands.
Short-term (1-10yrs): Maximize utilization of MPB affected wood before deterioration.
Mid-term (11 - 70yrs): Maximize stand value and maintain at least 10% premium log volume.
Long-term (71-250yrs): Maximize stand value and maintain at least 10% premium log volume.</td></tr>
<tr><td>Habitat Supply:</td><td>Minimize the risk to a wide range of non-timber forest resources throughout the planning horizon (wildlife, water, forage etc). Risk categories are in relation to defined targets based on legal objectives and expert interpretation.</td></tr>
<tr><td>Range Supply:</td><td>Consider range values so that we can make resource management decisions that consider range values along with other forest values. At minimum reach the currently allotted AUM targets by pasture.</td></tr>
<tr><td rowspan="4">Major Silviculture Strategies</td><td>Timber Volume Flow Over Time:</td><td>The location of the 3 silviculture activities modeled: rehabilitation, fertilization and spacing, can be seen spatially in treatment maps (see Appendix A of this document).
Fertilization: Fertilize spruce-leading in the 30-50 year range in the wet-belt ecosystems in order to increase the timber volume in the short term (2020 onwards)
Rehabilitation: Plant MPB affected stands that will not be scheduled for harvest - largely located in the eastern part of the TSA with high mortality.
Spacing: Space over-dense stands to improve timber volume and timber quality.</td></tr>
<tr><td>Timber Quality:</td><td>Monitor harvest profile with interest on species composition, harvest methodology, piece size and minimum harvest criteria.
Monitor silviculture practices (basic and enhanced) and evaluate benefits and progress against targets.</td></tr>
<tr><td>Habitat Supply:</td><td>Consider the implications to non-timber resources and factors from all silviculture activities both short and long term.</td></tr>
<tr><td>Range Supply:</td><td>Implement approximately 1,000ha of range cut-blocks that vary from mild alterations such as increased mineral soil exposure with forage seeding and full tree stocking up to complete conversion to range. Range conversion was strongly favored in driest of the dry-belt IDF ecosystems.</td></tr>
<tr><td>Silviculture Program Scenarios</td><td>Potential Program</td><td>The following table summarizes the treatment areas and cost applied over 5 years in the 'Silviculture Scenario'. As the areas chosen were within a reasonable expenditure range, no upper limit on spending was imposed.
<table>
<tr><th>Priority</th><th>Treatment</th><th>Area (ha)</th><th>Av. Unit Cost ($/ha)</th><th>Target Funding ($M/yr for 5yrs)</th></tr>
<tr><td>1</td><td>Fertilization</td><td>16,274</td><td>450</td><td>1.46</td></tr>
<tr><td>1</td><td>Rehabilitation</td><td>3,538</td><td>2,682</td><td>1.90</td></tr>
<tr><td>2</td><td>Spacing</td><td>724</td><td>1,500</td><td>0.22</td></tr>
</table></td></tr>
</table>

Strategy at a Glance

Silviculture Program Outcomes	**Timber Volume Flow Over Time:**	**Short-term** (1-10yrs): AAC determines forecasted timber flow, therefore no change in modeled **Mid-term** (11 - 70yrs): Harvest level increase from 2.35 million m^3/year (modeled in TSR4) to 2.7 million m^3/year (a 15% increase).
	Timber Quality:	Through the short and mid-term 33% of the volume is sourced from premium stands defined as DBH > 32.5cm.
	Habitat Supply:	Traditional TSR resource management zones were met with relative ease overall, however specific areas with high salvage and mortality pressure are highly constrained and therefore at risk in the short and mid-term. Hydrological indicators were locally constrained.
	Range Supply:	Range AUM targets were achieved easily in the first modelling period through the implementation of range cut-blocks that utilize alternative silviculture practices.
Related Plans and Strategies	BC silviculture strategy Climate change and adaption strategy Ecosystem restoration Forest health strategy GAR and FRPA	Okanagan Shuswap Land & Resource Management Plan MPB salvage DOS forage strategy Resource inventories Wildfire management
Recommendations	**Implementing Strategies**	1. Implement fertilization projects in the areas (or similar areas) identified in the silviculture scenario; 2. Survey MPB affected stands not being salvaged to determine if stands need treatment – reforestation. Aggressively reforest those that are not naturally regenerating at 'managed' stand rates, considering hydrological values; 3. Work with forest practitioners to find over-dense stands for spacing; 4. Work with range experts to implement silviculture systems that, at minimum, meet the current range commitments; and 5. Review mule deer winter range with forest health experts and consider clear cutting areas with high forest health risk.
	Data Gaps and Information Needs	• The vegetation resource inventory used as the foundation for this project was designed to provide a reasonable average volume for the TSA. Improved stand level description of the forest cover would significantly improve the ability to make resource management decisions that maximize the economic, environmental, and social value derived from the land base. Improvements include: attributing Douglas-fir stands that capture multiple entries; improving stems per hectare estimates to capture spacing candidates; improve stand level estimates using feedback from cruise data; enable continual improvement of inventory using information collected from forest practitioners. • Ecosystem mapping for the TSA required considerable grouping to enable the product to pass the accuracy assessment. Improved ecosystem mapping would provide more spatial accuracy for many environmental values and improved estimates of managed stand yields. • Complete drought and frost risk mapping in the Okanagan TSA to identify spatially areas at risk of current and future mortality and provide direction for silviculture regimes through a climate change lense.
	Modelling Approaches	The Okanagan Type 4 has broken new ground on range supply modeling, forest health modeling, capturing hydrological values and wildfire hazard. These approaches should be heavily scrutinized and improved upon in subsequent analyses because in time this multi-value approach should become the norm for developing a natural resource management regime and implementing silviculture investment.
	Related Plans and Strategies	Continue to explore ways to align silviculture strategies with other related plans and strategies to maximize benefits to multiple forest users and values; including Wildfire Management Branch Strategic Plan and BCs Climate Change Adaptation Strategy
	Monitoring	Monitoring should be integral to the silviculture strategy. This includes monitoring of managed stand yields and monitoring the response to silviculture activity.
References	Okanagan TSA Type 4 Silviculture Strategy - Situational Analysis, September 2012 Okanagan TSA Type 4 Silviculture Strategy - Data Package, October 2012 Okanagan TSA Type 4 Silviculture Strategy - Modelling and Analysis Report, March 2013	

ACKNOWLEDGEMENTS

The authors would like to thank the following people for their participation and input into this process:

- Paul Rehsler, MFLNRO
- Ralph Winter, MFLNRO
- Ted McRae, MFLNRO
- Ashley Ladyman, Stella-Jones
- Bob Johnson, Terrafor
- Brian Drobe, Weyerhaeuser
- Bryce Bancroft, Symmetree
- Daniel Perrakis, MFLNRO
- Dave Gill, BCTS
- Dave Hails, MFLNRO
- Dave Myers, Ecora
- David Rusch, MFLNRO
- Doug Campbell, PIB
- Ed Collen, Weyerhaeuser
- Grant Thompson, WFN
- Harold Hetherington, MFLNRO
- Heather Rice, MFLNRO
- Katherine Ladyman, MFLNRO
- Kathy Danchuk, MFLNRO
- Kathie Swift, FORREX
- Kelly Osbourne, MFLNRO
- Ken Zielke, Symmetree
- Kerry Rouck, Gorman Bros
- Lorraine Maclauchlan, MFLNRO
- Pam Shumka, MFLNRO
- Pat McMechan, Stella-Jones
- Ray Crampton, MFLNRO
- Richard Toperczer, MFLNRO
- Rob Dinwoodie, MFLNRO
- Rob Kennett, Tolko
- Ted Swab, Tolko

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1.0 INTRODUCTION

In 2012/2013 the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) lead a Type 4 silviculture strategy for the Okanagan Timber Supply Area (TSA). The main goal was to provide tactical level direction for steering silviculture investment to help direct resource management decisions and silviculture investment to mitigate mid-term timber supply.

1.1 Project Objectives

The project aims to:

- Provide a realistic, forward-looking assessment of timber and habitat supply under a range of scenarios that will produce a preferred silviculture strategy;
- Provide products that will support operational implementation of the strategy (e.g., a tactical plan);
- Inform licensees and government on the alternative outcomes that could be achieved through different approaches to basic (mandatory) silviculture;
- Provide context information or indicators that would be useful to support future management decisions in the TSA; and
- Where appropriate, illustrate how the recommended treatments link with other landscape-level strategies while considering treatment risk.

1.2 Context

This ‘silviculture strategy’ document is the final of four documents that make up this Type 4 Silviculture Strategy for the Okanagan TSA:

1. **Situational analysis:** describes the general situation for the TSA;
2. **Data Package:** describes the input data, information and assumptions;
3. **Modelling and Analysis Report:** describes the modeling output and rationale; and
4. **Silviculture Strategy:** provides an overview of the project including treatment options, targets and benefits.

1.3 Land Base

The Okanagan TSA, located in southern interior BC, covers an area of 2.25 million ha of which just less than 1 million hectares classified as timber harvestable land base (THLB). The TSA supports a significant human population as well as a wide range of wildlife and diverse ecosystems and is currently supporting an allowable annual cut (AAC) of 3.1million m^3/year (including mountain pine beetle (MPB) uplift).

Table 1.1 shows the land base classification including the area classified as productive forest and THLB. For more detail, see the data package.

Table 1.1: Land base Area Summary Table

Land Classification	Area (ha)
Total Area	**2,251,590**
Non-crown land	430,595
Non-forest	294,401
Non-commercial brush	485
Existing roads, trails, landings	26,132
Productive Forest	**1,499,977**
Parks	142,123
Inoperable areas	172,453
Low productivity	42,875
Terrain Stability	17,031
Regeneration ESAs	38,905
Deciduous forest types	12,200
Problem forest type - hemlock	26,336
Riparian reserves	35,850
Enhanced riparian areas	8,907
CRAs	n/a
WHAs	3,163
OGMAs	58,571
No Harvest Caribou	14,979
Total reductions	**573,393**
Current Timber Harvesting Land base	**926,584**
Less future roads, trails landings	
Future Timber Harvesting Land base	926,584

1.3.1 Age Class Distribution

Figure 1.1 shows the initial area by age class on the THLB and non-THLB productive land base.

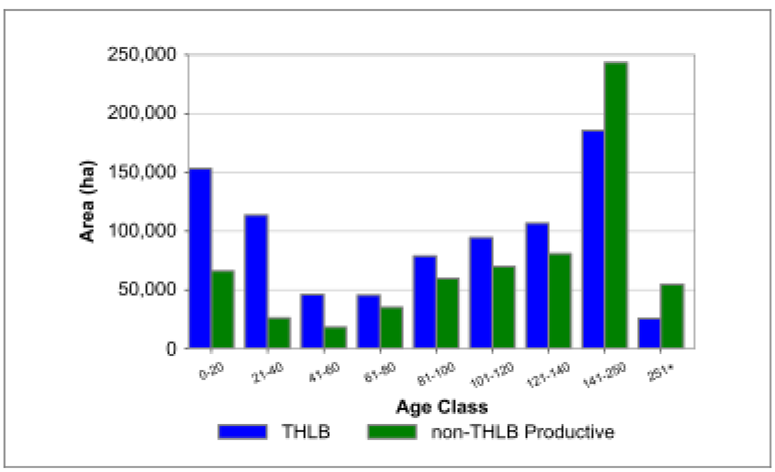


Figure 1.1: Initial Age Class Summary

1.3.2 Species Distribution

The TSA is very diverse, with the Douglas-fir, balsam and hemlock dominated wet-belt in the north and the lodgepole pine, ponderosa pine and IDF Douglas-fir forests of the dry-belt in the south.

Figure 1.2 shows the area by leading species on the productive land base. The TSA is 24% lodgepole pine leading and 23% dry-belt Douglas-fir leading.

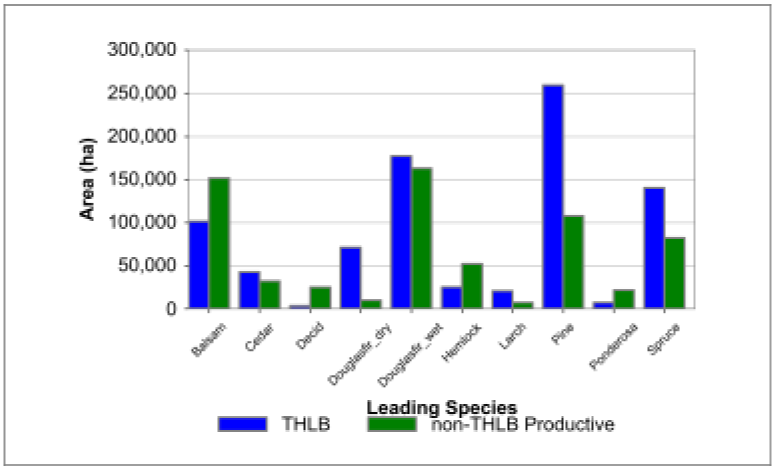


Figure 1.2: Leading Species Summary

1.3.3 Site Productivity

Figure 1.3 shows the THLB area by site index (height at age 50) for inventory site index and the provincial site index tile layer. Inventory site index is used to estimate the productivity of natural stands whereas the site index tile is used to estimate the site potential for managed stands. The THLB area-weighted average inventory site index is 15.3m and site index tile is 18.4m.

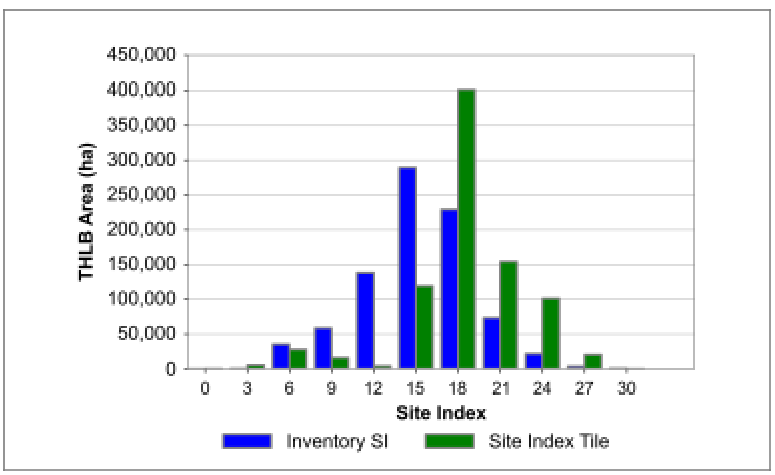


Figure 1.3: Site Index Summary

1.4 Key Issues and Considerations

1.4.1 Harvest Levels

Since 1980 the annual allowable cut (AAC) in the Okanagan TSA has ranged from just over 2.6million m^3/year to a high of 3.375million m^3/year in 2006 - 2011 to address wildfire salvage and the MPB epidemic.

The current AAC is set at 3.1million m^3/year for the Okanagan TSA. The most recent timber supply analyses forecast the harvest level to drop from this uplift level towards a sustainable mid-term harvest level in 10 to 20 years time. The actual transition will occur gradually over this timeframe as indicated by the recent step-down in AAC in the 2012 determination which was set to "begin the transition to the lower mid-term harvest levels while continuing to provide for the salvage of MPB-damaged timber" (Snetsinger, 2012).

Since 2004, the forest licensees and the Forest District have worked collaboratively and quite aggressively to identify stands susceptible to the MPB and prioritize them for harvest. This approach was taken after observing the results from the less aggressive approach used in the North at the time[1]. It is plausible that this aggressive approach has influenced the trajectory of the MPB epidemic in the Okanagan. Figure 1.4 shows the differences in projected pine volume killed in the Okanagan TSA for 2010 vs 2011 versions of the BCMPB model (Figure 5 from Walton 2011).

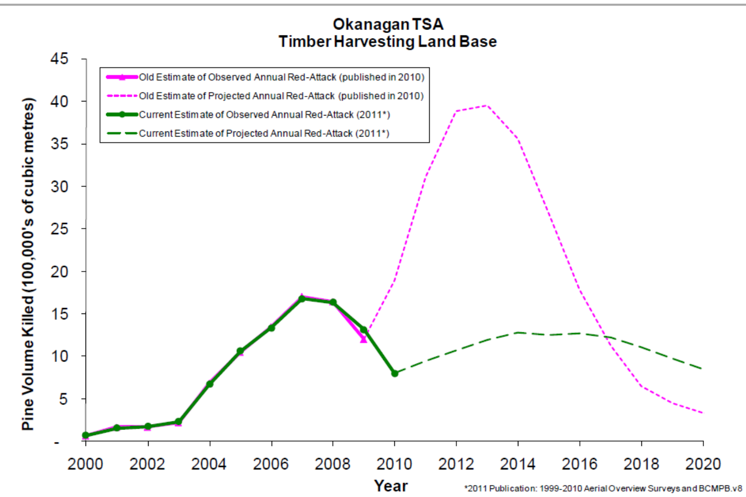


Figure 5. Observed and projected annual mature pine volume killed (red-attack) on the Timber Harvesting Land Base of the Okanagan Timber Supply Area. Also a comparison between results produced last year, which were based on the 1999 to 2009 aerial overviews, and current results, which include the 2010 aerial overview. With the addition of a new climate variable to BCMPB, pine units in the south east of the province are no longer projected to experience a large increase in red-attack pine. Although the current version of BCMPB does still project a minor/moderate increase in red-attack pine in these units, it is my opinion that BCMPB.v8 is still overestimating the epidemic levels in these units. Okanagan TSA is shown here as an example.

Figure 1.4: Differences in BCMPB Version Projections

[1] Prior to the MPB reaching unprecedented populations in the Northern BC, traditional approaches such as fall and burn, single tree removal, and patch removals were used in an attempt to control the spread.

Estimations of the mid-term harvest level range between:

- 2012 TSR 4: 2.35 million m^3/year;
- Type 2 silviculture strategy - simulation model: 1.87million m^3/year;
- Type 2 silviculture strategy - optimization model: 2.5million m^3/year; and
- 2013 Type 4 silviculture strategy – optimization model: 2.7million m^3/year.

1.4.2 Forest Inventory

The vegetation resource inventory (VRI) in the Okanagan TSA was carried out between 2000 and 2010 with the majority of the classification completed using 2001 and 2007 photography. The VRI includes stand level descriptions for natural forested stands that include tree species, age, height, crown closure and basal area. These attributes are used to group the stands into analysis units as well as provide inputs for the natural stand growth and yield program VDYP. The VRI has been updated to account for disturbances from wildfire, harvesting, MPB.

The VRI is the best available information; however there is still considerable uncertainty around the accuracy - especially at the stand-level when used for tactical and operational planning. The VRI is not designed for tactical or operational planning, but instead to get a reasonable volume estimate for the TSA as a whole. The planning needs, planning tools, and technology have advanced considerably over the past decade, however the VRI has remained a strategic volume based inventory.

1.4.3 Timber Supply

In the Okanagan TSA, an estimated 9.4 million m^3 has been affected by MPB (Walton, 2012). Key timber supply issues resulting from the MPB epidemic include:

- Although harvesting is heavily focused in pine-leading MPB affected stands, not all stands will be salvaged;
- This mortality and increased salvage will result in a significant drop in the standing timber stock and therefore mid-term timber supply;
- Shelf life (the period after MPB mortality during which a stand is assumed to be viable for harvesting) is variable and there is uncertainty around these estimates;
- Regeneration assumptions of managed stands are important to estimating the mid-term harvest level – if stands are harvestable earlier than assumed, then the mid-term will be shorter than expected. It is important to have monitoring programs in place to confirm managed stand growth and yield assumptions; and
- Regeneration assumptions of stands that are affected by the MPB are not well understood and can be very variable. In some areas there may be significant understory regeneration where others may have a complete lack of regeneration sources and material resulting in a longer than assumed period before trees regenerate with no intervention.

1.4.4 Timber Quality

The implications to timber quality that result from the MPB epidemic and the mid-term shortfall include:

- The standing dead timber is only salvageable for a short period of time, during which the quality degrades. Shelf life assumptions approximate this process;
- Near to the end of the mid-term, the timber supply is heavily constrained and the harvest is transitioning from natural stands to managed stands. This pushes harvesting into young, lower volume and lower quality stands; and
- In the analysis, assumptions around minimum harvest criteria have been made. Lowering these criteria will increase the volume available for harvest in the mid-term and consequently increase the harvest flow that is forecast. The opposite is also true, in that an increase to the minimum criteria will reduce flexibility and thereby reduce the harvest level in the mid-term.

1.4.5 Habitat Supply

The Okanagan TSA is home to many key wildlife species and non-timber values. This analysis considers TSR, GAR and OSLRMP requirements including caribou, community watersheds, elk, goat, grizzly bear, lakeshore management zones, marten, mule deer, moose, sheep and visually sensitive areas. Key habitat issues resulting from the MPB epidemic include:

- The mortality or reduction in habitat value of many protected areas, connectivity corridors and areas of important habitat (e.g OGMAs, WHA, fisheries);
- Watershed risk to peak flow events will be affected by MPB mortality, as well as the increased road densities and clear-cutting that goes with accelerated salvage; and
- Through the mid-term, when timber supply is heavily constrained there will be increased pressure on habitat supply.

1.4.6 Climate Change

The impacts of climate change are uncertain but may include increased damage from insect and disease, more severe wildfires and fire weather, species range shifting and ecosystem range shifting.

Through the process of completing the Okanagan Type 4 Silviculture Strategy there were two presentations to the stakeholders that provided background information about climate change. Data needs, such as drought and frost mapping, would be valuable and provide the spatial component to consider climate change in the analysis.

There are opportunities to adapt if we base today's forest management decisions on information of our future climate- viewing forest management through the 'climate change lens'. Long and mid-term strategies should consider the longer term implications of a changing climate.

In the Okanagan TSA, climate change can affect water supply and dry to very dry ecosystems that are common in the lower valleys are a major concern. One way identified to reduce the risk associated with an uncertain future climate is to increase diversity at the stand, ecosystem and TSA level.

1.5 Additional Resource Values Modeled

Traditionally timber supply analyses that support a TSR or a silviculture strategy have managed primarily for timber volume, which is one of many important values to consider when investing silviculture funds into the land base. In the Okanagan Type 4 there has been a concerted effort to capture many additional values in the decision support tool used to assess opportunities for investing in the land base. Some of the key additions that are included in this analysis are:

1. **Net-Revenue:** effort has been made to assign a monetary value and cost to all the activities being modeled and timber being harvested. This enables the model to consider net-revenue in the decision process, which has proven to significantly affect the management regime –note scenarios run without considering cost and value, such as TSR, show lower net-revenue;
2. **Range:** grazing agreements have been issued throughout the TSA, which are affected significantly by harvest activity. This analysis has a range supply analysis that shows the impact the silviculture strategy and management regime have on forage supply. Additionally it shows how the regime could be modified to enable the committed animal unit months (AUMs) to be available;
3. **Forest health**: the MPB epidemic has made it very clear that forest health hazard should be an essential consideration in our management strategy. This analysis dynamically assesses forest health hazard for 3 important insects, enabling the management regime to consider forest health hazard in the planning process;
4. **Wildfire hazard**: fire behavior prediction (FBP) system fuel types are dynamically assigned to each stand throughout the planning horizon. This enables the wildfire hazard to be considered in the management regime;
5. **Hydrology**: a concerted effort has been made to capture the hydrological impacts of harvesting including detailed modeling of the MPB affected stands. This enable the model to identify watersheds approaching their limits and provide direction where MPB affected stands should be left for their hydrological value.

Each of these values has been captured in the model through close collaboration with one or more subject matter experts, who provided input in at least two stages – initial model setup and evaluating the modeling results. These values are all in addition to the traditional TSR and silviculture strategies that consider factors such as visuals, wildlife, old growth *etc*.

1.6 Activities

The key output of the forest estate modelling is the schedule of activities. In the silviculture scenario, the activities being considered include: harvesting, rehabilitation (planting), fertilization and spacing. The main decisions being considered are around activities on the MPB affected stands – how much to harvest? Where to harvest? What stands to leave? Which non-harvested stands should be re-planted? Should we fertilize and if so where? How much non-MPB affected timber should be harvested?

In the modeling environment, potential treatment pathways are defined (Figure 1.5 shows an example for a MPB affected stand). Each activity has different effects on the modeled indicators.

The schedule of these activities is a key piece of the output as it provides direction to help resource managers implement a management regime and silviculture strategy that considers the wide range of values being captured. Although the data and modeling solution does not exist to provide a perfect answer, there are very real opportunities to improve our management decisions and silviculture investment.

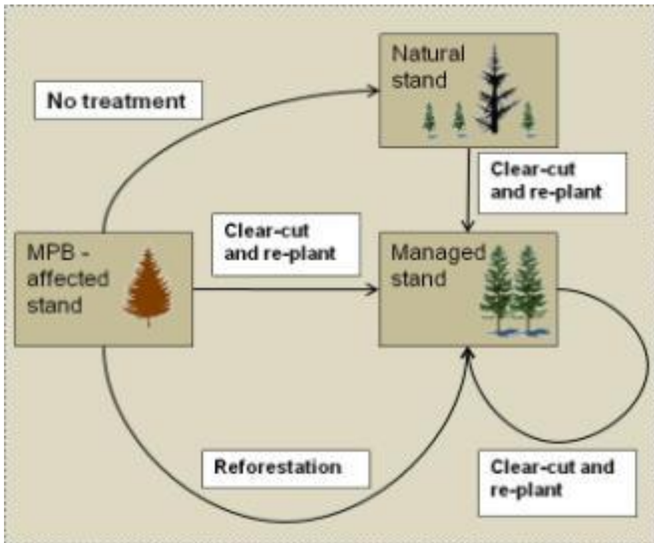
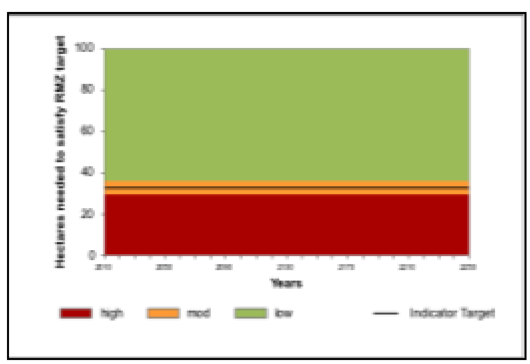


Figure 1.5: Activities Considered for MPB-Affected Stands

1.7 Measuring Success

One of the key elements of considering multiple values is to be able to define when any specific value is successfully achieved. To capture this concept; low, moderate and high risk classes have been established for each value (or indictor).

When results are shown they are generally presented with a risk-based backdrop in order to show how well the value is being achieved throughout the planning horizon. The risk classes have been defined using a variety of approaches and evaluated by subject matter experts wherever possible. For more detail around risk classes for individual indicators, see the 'Data Package' report.



Interestingly, this approach of defining success proves to be difficult because often a team of resource managers cannot clearly quantify a suitable goal. For this reason the process of defining risk classes is very important because "*if you don't know where you are going, any road will get you there*" (Lewis Carrol, born 1832).

2.0 SILVICULTURE STRATEGY

2.1 Working Targets

The Silviculture Scenario attempts to balance all land base objectives. In addition to capturing the multiple values listed above, the scenario allows for silviculture activity to be implemented, helping to achieve the stated objectives. Table 2.1 shows the targets and weightings for important indicators in the silviculture scenario.

Table 2.1: Indicators, Targets and Weightings for the Silviculture Scenario

Indicator	Target	Weighting
Harvest volume	Mid-term maximized	mod
Net-revenue	Maximum positive	mod
Wildlife RMZs	GAR targets	high
Visuals	TSR targets	high
IRM	TSR targets	high
Hydrology - EDA	25% above/below H40	high
Forest health hazard	Minimize hazard	tracked
Land base carbon	Maximize	tracked
Forage targets	Forage targets by pasture	tracked
Silviculture activities	Allowed for 10 years	allowed
Range cut-blocks	Across planning horizon	not allowed

2.2 Overview of Scenarios

Modelling scenarios included:

1. **TSR-equivalent**: This scenario implements the TSR harvest level and RMZs that are modeled in TSR. This is an important benchmarking scenario to ensure the model is consistent with TSR and to help understand any differences.
2. **Silviculture scenario:** This main scenario was developed considering the findings from the many scenarios that were run to understand the dynamics of the analysis. The scenario considers the TSR indicators as well as additional indicators that captured land base values such as EDA and economics. The silviculture scenario allows silviculture activities (planting, fertilization and spacing) to be implemented for 10 years. The model will only select silviculture activity where the cost and benefits make sense considering all the land base values.
3. **Economic scenario**: Selects a management regime and silviculture program that uses net present value(monetary value generated minus cost with discounting) as the dominant objective.
4. **Forage supply:** This scenario optimizes the harvest scheduling and silviculture activities to fulfill forage targets by pasture. Range cut-block types 1/2, 3 and 4 can be implemented throughout the planning horizon.
5. **No activities:** This scenario is a benchmark for comparison that has no harvesting or silviculture activities implemented. Over the 250 year planning horizon, natural disturbances are implemented based on the NROV on the entire productive land base.

Table 2.2 outlines the relative weightings of each indicator by scenario. Note that other indicators are tracked in the analysis, but this table outlines only those that are controlled in one or more scenarios (e.g. BPI is tracked in all scenarios, but never drives the model).

Table 2.2: Indicators, Targets and Weightings by Scenario

Indicator	TSR Equivalent	Silviculture scenario	Forage supply	Economic scenario
Harvest Volume	high	mod	tracked	tracked
Mid-term harvest level	high	high	tracked	tracked
Net-revenue	tracked	mod	tracked	high
Wildlife RMZs	high	high	high	mod
Visuals	high	high	high	mod
IRM	high	high	high	mod
EDA	tracked	high	tracked	tracked
Forest health hazard	tracked	tracked	tracked	tracked
Land base carbon	tracked	tracked	tracked	tracked
Forage/Range targets	tracked	tracked	high	tracked
Silv. activities	not allowed	allowed	allowed	allowed
Range cut-blocks	not allowed	not allowed	allowed	allowed

The following section outlines some of the key outcomes from these scenarios. For more detail, see the 'Modelling and Analysis' report.

1. The silviculture program selected by the model results in a silviculture expenditure of $3.6 million/year for 5 years. Most interesting is that this was the result of the 'optimized' solution that included no encouragement to implement silviculture activity[2];
2. The model was aggressive with the reforestation of MPB affected stands, which provides clear direction to make sure that stands are either reforested or are tracking to be naturally regenerated at rates similar to managed stands;
3. The fertilization program was reasonably aggressive and had a clear preference for fertilizing younger (~40 years old) spruce stands;
4. If allowed, the model would clear-cut harvest all partially harvested stands to capture benefits associated with forest health, wildfire hazard, volume, and regeneration growth rates. This suggests that stands currently identified for partial harvest that have forest health issues should be considered for clear-cut harvesting; and
5. Dry slower growing forests were immediately converted to range if allowed. The model found the range value/revenue far exceeded the timber value for these stands.

[2] Often silviculture budgets are implemented to force the model to implement silviculture activity. In this case the silviculture activity was selected entirely due to other land base objectives such as volume and value.

2.3 Preferred Silviculture Strategy

Figure 2.1 shows the harvest forecast of the Type 4 Silviculture Strategy and TSR 4. The Type 4 Silviculture Strategy can achieve a harvest level of 3.1million m^3/year for 10 years (current AAC) before dropping down to a non-declining mid-term harvest level of 2.7million m^3/year. The analysis supporting TSR 4 starts at 3.35million m^3/year before dropping to 2.35million m^3/year through the mid-term – the Type 4 uses 3.1million because it is the AAC determined in the TSR process.

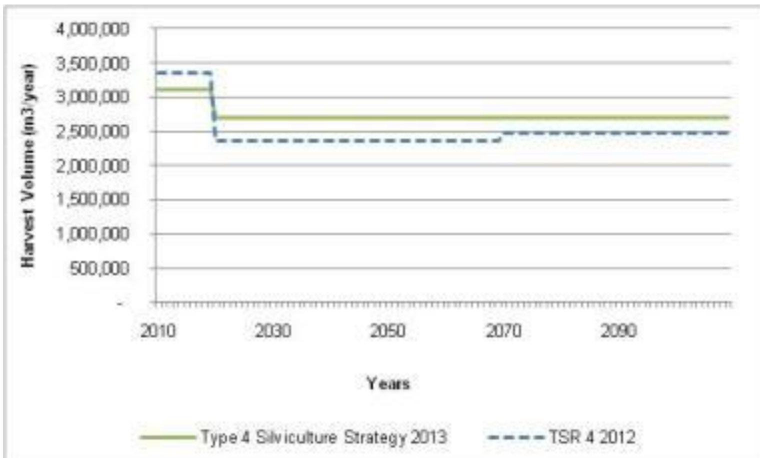


Figure 2.1: Harvest Volume: TSR 4 and Silviculture Scenario

2.4 Treatment Regime

Table 2.3 shows the proposed 5-year silviculture treatment regime that includes planting MPB affected stands, fertilization and spacing treatments. The strategy proposes spending an average of $3.8 million per year for 5 years, equating to an estimated additional 84 jobs per year for 5 years.

Table 2.3: Treatment Regime Table[3]

			2013	2014	2015	2016	2017
Current Reforestation	**Planting**	Ha	1,975	502	443	444	174
		$$	5,294,810	1,346,216	1,187,823	1,190,427	467,561
Subtotal ($$)			5,294,810	1,346,216	1,187,823	1,190,427	467,561
Timber Supply Mitigation	**Spacing**	Ha	173	88	157	143	162
		$$	259,532	132,380	235,148	215,088	243,519
	Fertilization	Ha	1,242	3,191	3,712	3,943	4,185
		$$	559,026	1,435,895	1,670,524	1,774,640	1,883,419
Subtotal ($$)			818,558	1,568,275	1,905,672	1,989,728	2,126,938
TOTAL			6,113,368	2,914,491	3,093,495	3,180,155	2,594,499

[3] Note: this table does not reflect all the activities carried out in the Okanagan TSA by the MFLNRO, only those modeled in this analysis.

On the outset of the Okanagan Type 4 Silviculture analysis there were two future points in time identified where the amount of timber available for harvest is most limited, specifically 2025 and 2060 (see the 'Situational Analysis' report). The silviculture activities scheduled in the analysis target these 'pinch points', by using fertilization to mitigate the shortage around 2025 and a series of activities to mitigate the mid-term shortage.

Figure 2.2 shows the timing and volume of harvest for the stands treated in the silviculture program. Interestingly, the fertilization program made additional volume available for the first pinch point (est. 2025) whereas all three program activities (fertilization, reforestation and spacing) made volume available in the mid-term pinch point (2060). Ensuring that these stands are available for harvest at these critical points is necessary to realize the increased midterm timber supply.

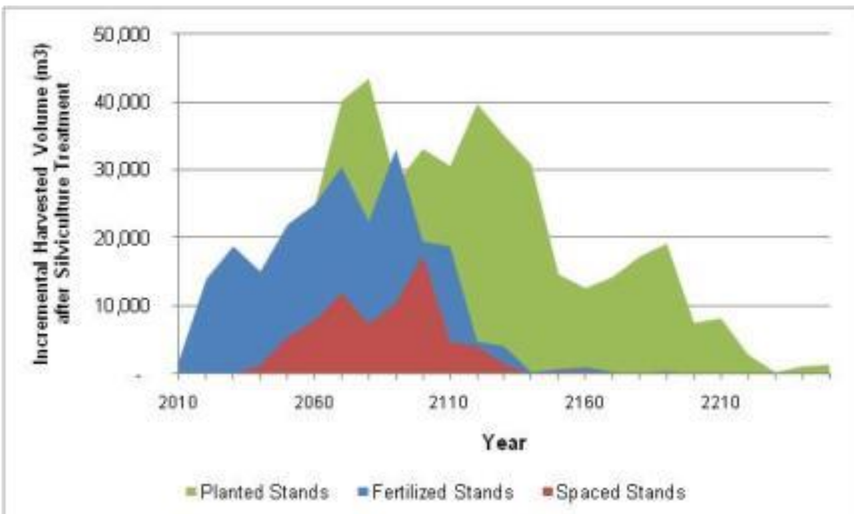


Figure 2.2: Utilization of Previously Treated Stands

2.5 Indicators

Reporting on the indicators modeled in this scenario includes traditional TSR resource management zones as well as:

- EDA considering the H40 line;
- Forage supply;
- Selected forest health factors;
- Economics;
- FBP fuel types;
- Road density; and
- Carbon.

These indicators are outlined in more detail in section 1.5 above. Selected indicators are shown in the section below, for more comprehensive reporting see the 'Modelling and Analysis' report.

Figure 2.3 shows the harvest volume from either in or out of visually sensitive areas. An average of 29% of the harvest volume is sourced from visually sensitive areas over the planning horizon.

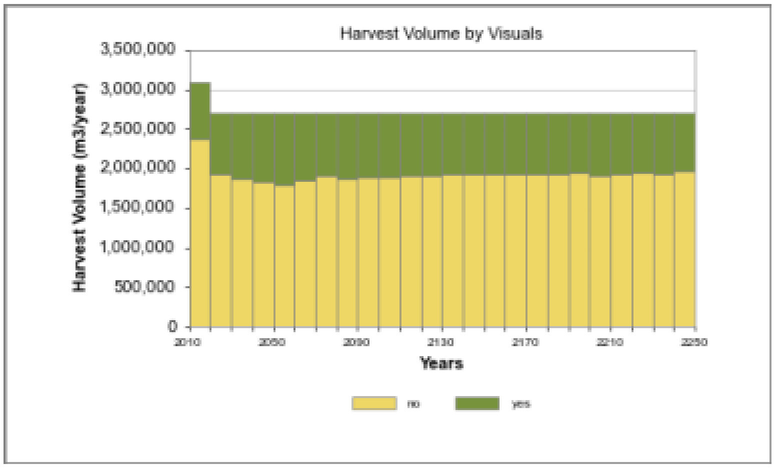


Figure 2.3: Harvest Volume in Visually Sensitive Areas

Figure 2.4 shows the harvest volume by harvest method. Over the 250year planning horizon, an average of 33% is sourced from cable harvested stands, ranging from 10% in the first decade and stepping up to a maximum of 49% in decade 4 before stabilizing around the average in the long term.

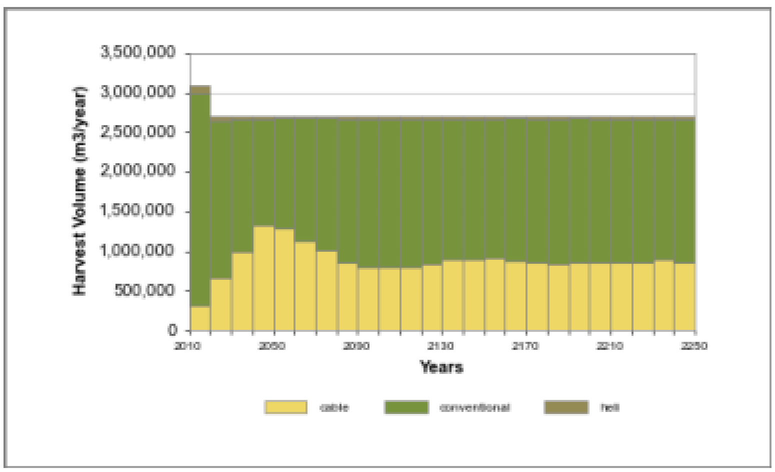
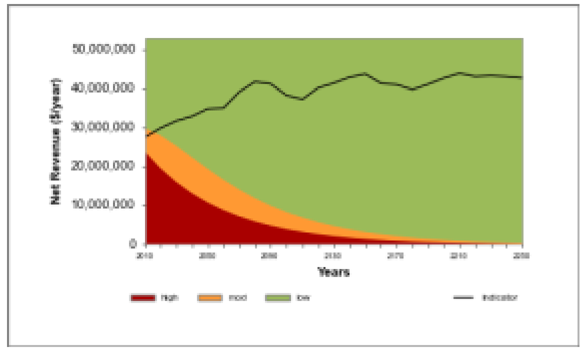


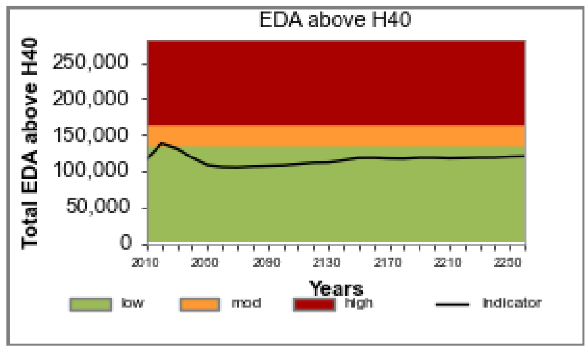
Figure 2.4: Harvest Volume by Harvest Method

The following figures show selected indicators from the silviculture scenario: net-revenue, EDA. forage/range supply, BPI, FBP fuel types, MPB hazard.

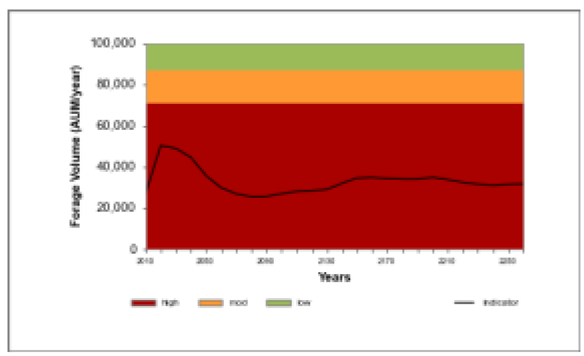
Net-revenue: Net-revenue is always positive, varying between an average of 9 \$/m3 in the first decade to 16 \$/m3 near the end of the planning horizon.



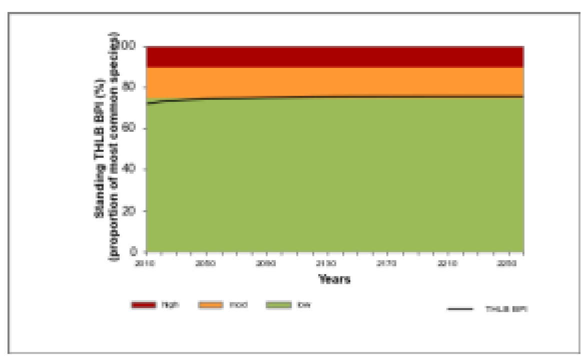
EDA: EDA above the H40 shows significant sensitivity to MPB mortality and harvesting patterns and is limiting in some areas in the short term.



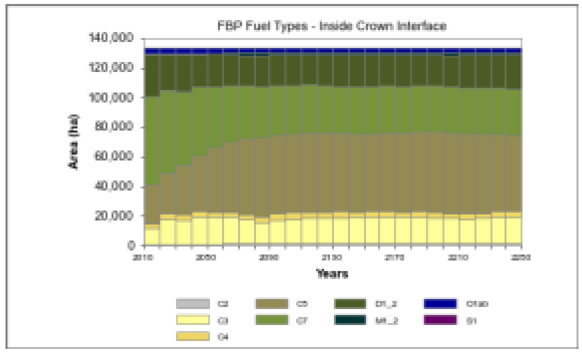
Forage supply: Forage production falls significantly short when no range-type cut-blocks are allowed. An alternative scenario that does allow range cut-blocks shows that with a small change in management, range targets can be met with relative ease.



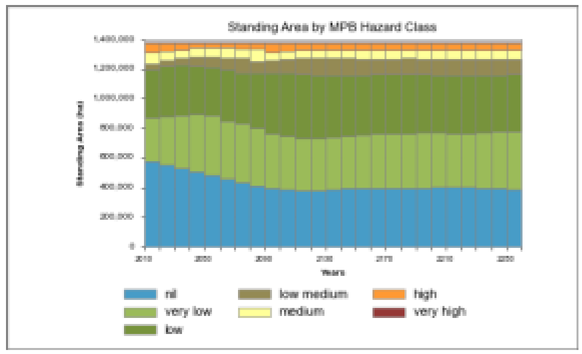
BPI: The BPI increases from 71% to 76% across the planning horizon- a higher BPI equates to lower diversity (i.e. a higher proportion in one species), so although this trend is not strong it is worth being mindful of.



FBP fuel types: FBP fuel types inside the crown interface show a change in the area of C5 and C7 types. The increase in hazard associated with this is not quantified in this analysis.



MPB hazard: MPB hazard class is shown as relatively static across the planning horizon

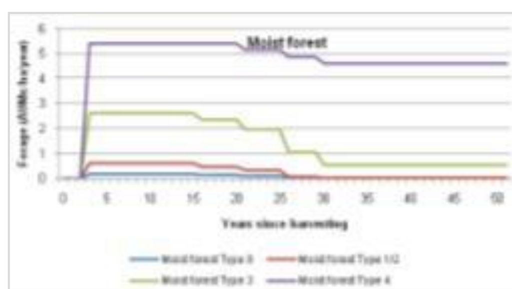


2.6 Range – Forage Supply

A forage supply analysis has been built into the analysis to enable range to be considered along with multiple other land base values in this project. For 'range' scenarios this allows full modeling of range cut blocks whereas for other scenarios this provides a means of reporting on the impact a management regime has on range.

The instrument through which changes in forage supply are assumed to be influenced is the implementation of what is termed 'range cut-blocks'. These cut-block types represent changes in silviculture practices at time of harvest and result in different levels of forage production (grass growth). The modeled range cut-block types are summarized as follows (for more detailed information, refer to the Data Package for this project):

- **Type 1/2:** Enhance and moderately increase forage opportunities with standard tree stocking;
- **Type 3:** Silvo-pasture cut-blocks. High forage production with 50% to 100% (assumed to be at an average of 75%) of timber volume at next rotation; and
- **Type 4**: Forage Pasture cut-blocks. Cut-blocks converted to permanent forage production.



Three scenarios are outlined in Figure 2.5, explaining the range of timber versus range focused scenarios. In both range scenarios, range cut-block types 1/2, 3 and 4 can be implemented throughout the planning horizon to fulfill forage targets by pasture.

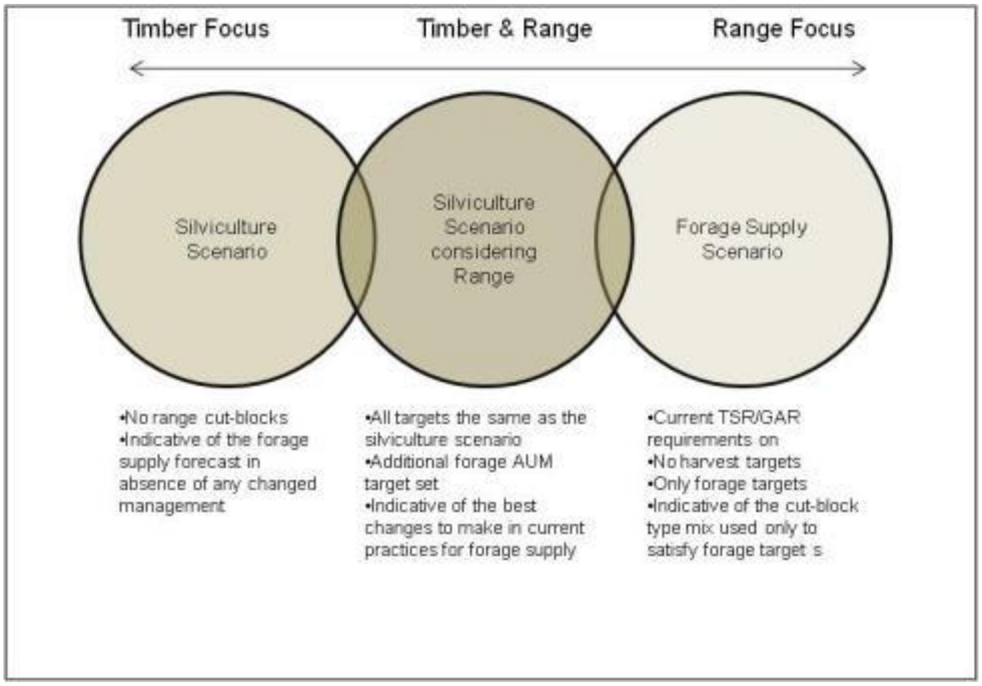


Figure 2.5: Range / Forage Scenarios

In scenarios where no range cut-blocks were allowed- e.g. TSR scenario and the silviculture scenario, forage production fell well below the AUM target. This indicates that with current harvesting practices occurring at the forecast harvest levels, it will be challenging to fulfill the allocated AUM forage targets.

Following on from these statements, the next question to be answered is, it is possible to achieve AUM forage targets across the land base and if so, what is the best way to implement this?

The sum of all AUM targets on the Okanagan TSA is ~88,000 AUM per year. This is easily achieved by both the silviculture considering range and forage supply scenarios as shown in Figure 2.6. This figure depicts a comparison of the forage supply achieved by each scenario against a risk-based backdrop (calculated as 10% on either side of the target i.e. low risk is defined 10% greater than the AUM target). Both scenarios increase from an initial value of 27,000 AUMs to the achievable AUM target in the first modeled period. In comparison, the silviculture scenario that does not implement range cut-blocks does not get near the 88,000 AUM target.

In addition, the “Economic scenario” found significant value derived from all the range cut-blocks and points towards the importance of considering the considerable value of range in management decisions.

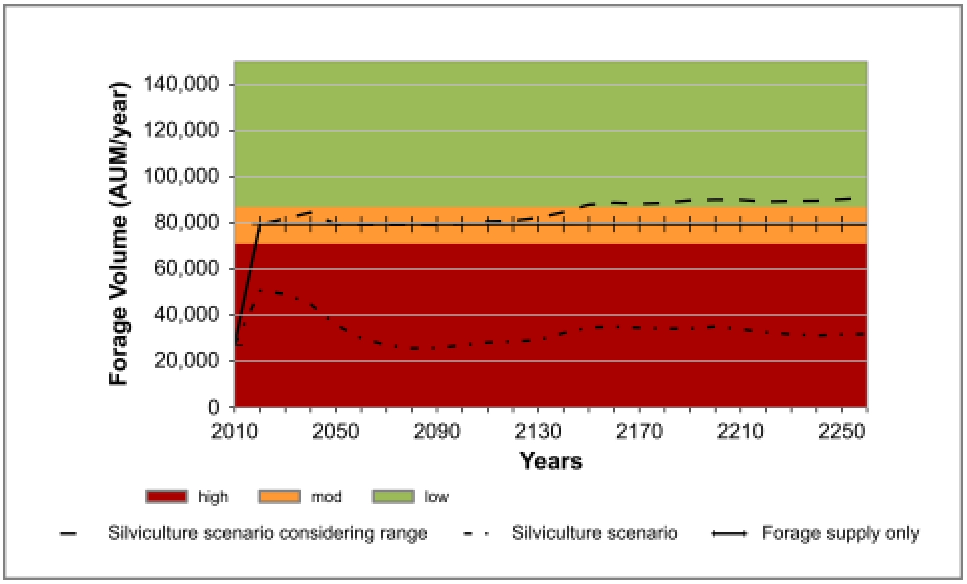


Figure 2.6: Forage Supply Comparison

Table 2.4 shows the area of range cut-blocks implemented in each scenario in order to achieve these levels of forage supply. As mentioned above, in the silviculture scenario, no range cut blocks were allowed to be implemented and forage targets did not influence activity in the scenario. In the 'silviculture considering range' scenario, only a small change in management (cut-block types) is needed to fulfill forage targets, i.e. 521 ha of type1/2 cut-blocks, 108ha of type 3 cut-blocks and 426ha of type 4 cut-blocks over the first 10 years. Note that the harvest volume from these cut-blocks counts towards term timber supply.

Table 2.4: Range Cut-block Area by Scenario in the First Decade

Scenario	Conventional Harvest (cc/pc) (ha.)	Range cut-block type 1/2 (ha)	Range cut-block type 3 (ha)	Range cut-block type 4 (ha)
Silviculture scenario	10,545	0	0	0
Silviculture considering range	9,298	521	108	426
Forage supply only	1,342	1,028	721	623

These cut-blocks were situated throughout all BGC, species and site index types- largely due to the localized spatial distribution of individual pastures. However, there was an important trend in type 3 and type 4 cut-blocks- where possible, these cut-blocks were placed in the IDF Douglas-fir stands- especially dry-belt. Conversion to range in some of these cases represents a win-win situation for overlapping values.

To maximize timber, forage and net revenue on the same piece of land, type 1/2 range cut-blocks are the best integrated option assuming there will be enough ongoing timber harvesting to maintain forage objectives over the timber rotation. This would require 2 to 4 times as much area to met forage targets compared to Type 3 and 4 range cut-blocks, but will maximize integration of timber and forage values and net revenue. However, Type 3 and 4 cut-blocks should be considered where forage targets cannot be achieved with Type1/2 cut-blocks and or where it makes sense for other overlapping values.

3.0 Tactical Plan

The tactical plan for this project is the process of giving direction to translate the preferred silviculture strategy into reality. It is made up largely of direction from the timber supply analysis and spatially explicit mapping layers.

3.1 Target Treatment Areas

Fertilization, reforestation and spacing treatments were considered in this analysis. The following sections outline the target treatment areas for each activity.

The spatial location of both eligible and priority stands is a key component of the tactical plan. These location maps and the spatial data behind them are provided to the MFLNRO as part of this project, however screen shots of these maps are shown for reference as 'Silviculture Treatment Maps' (provided as Appendix 1 of this document).

3.1.1 Fertilization

Eligible Stands

Eligible stands are the total pool that is available to choose from when implementing silviculture treatments. Stands that are candidates for fertilization must satisfy the following criteria (from the LBIS MFLNRO 2013/14 to 2017/18 LBIS Silviculture Funding Criteria for Forests for Tomorrow):

- THLB;
- Douglas-fir, spruce or lodgepole pine leading;
- Age between 15 – 80years;
- Inventory site index15 – 25;
- Minimal forest health hazard; and
- Not in the IDF.

Priority Stands

The preferred silviculture scenario chose to invest significantly in fertilization as shown in Table 3.1. 16,274ha were fertilized at an average of $450/ha, resulting in $1.46 million per year for 5 years spent on fertilization. These are the stands that are prioritized for treatment.

Table 3.1: Fertilization Silviculture Treatment

Fertilization	
Eligible Area (ha)	61,316
Treated Area (ha)	16,274
Treated %	27%
$million total (over 5 years)	7.32
$million per year for 5 years	1.46

Additional General Silviculture Trends

Summaries of the eligible vs priority treated stands can give insight into the types of stands prioritized for treatment and hence further direction. For fertilization, these general silviculture trends include:

- The model chose to fertilize a higher proportion of spruce and less Douglas-fir and pine;
- Although ages from 15 years through 80 years were eligible for fertilization, the model chose to fertilize heavily (73% of fertilization candidates) in the 30 to 50 year age range; and
- The model chose to fertilize proportionally more area in wet belt ecosystems.

Figure 3.1 shows an example fertilization treatment map. Stands eligible for fertilization are light green and stands that are a priority for fertilization are orange (i.e. treated in the timber supply model in the silviculture scenario).

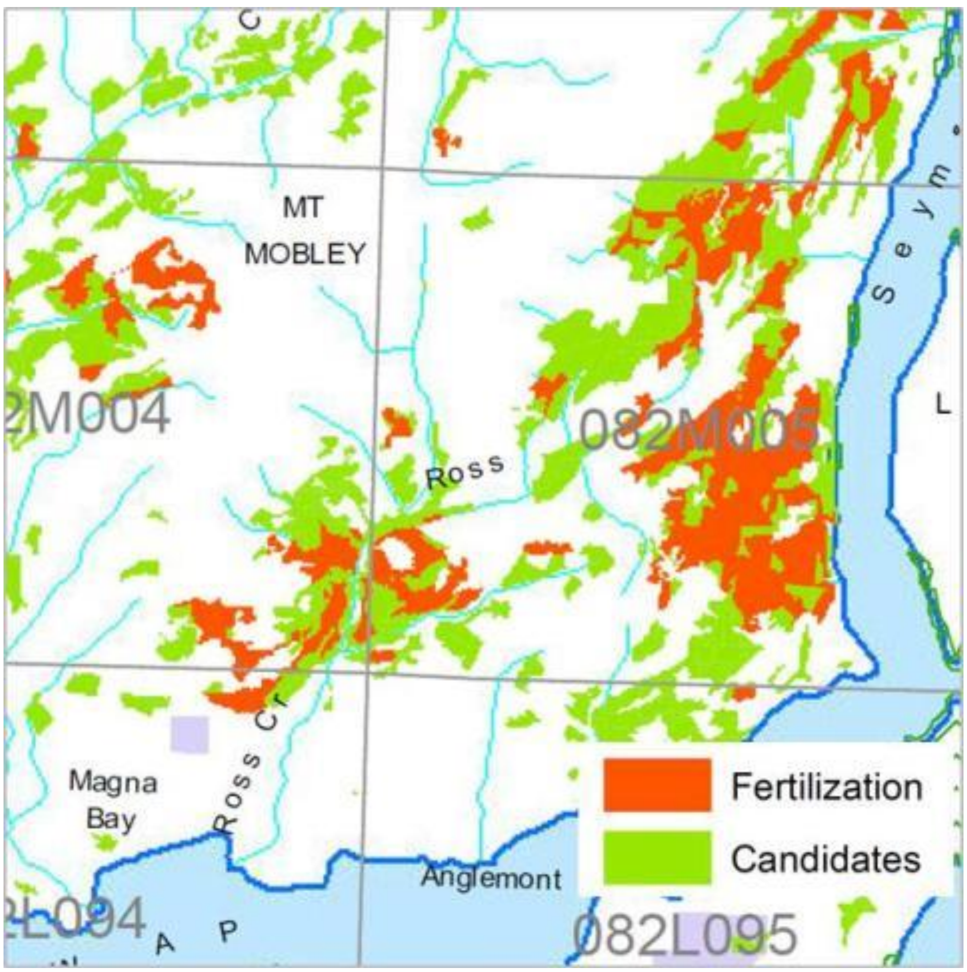


Figure 3.1: Example Spatial Fertilization Treatment Map

3.1.2 Reforestation

Eligible Stands

Candidates for reforestation[4] (i.e. the total pool of stands that are available to choose from when implementing reforestation) are:

- THLB;
- Heavily affected by MPB mortality; and
- Site index > 15.

Priority Stands

The preferred silviculture scenario chose to invest significantly in reforestation as shown in Table 3.2. 3,538ha were fertilized at an average of $2,681/ha, resulting in $1.90 million per year for 5 years spent on reforestation. These are the stands that are prioritized for treatment.

Table 3.2: Reforestation Silviculture Treatment

Reforestation	
Eligible Area (ha)	8,285
Treated Area (ha)	3,538
Treated %	43%
$million total (over 5 years)	9.49
$million per year for 5 years	1.90

Additional General Silviculture Trends

General silviculture trends for rehabilitation include:

- 43% of the eligible treatment area was chosen for treatment- which is the largest of any activity;
- Although harvesting and planting occurred in all types of affected stands, in general harvesting occurred in stands with lower levels of mortality i.e. those with mixed species, and planting occurred proportionally in those with higher mortality.

Figure 3.2 shows an example rehabilitation treatment map. Stands eligible for rehabilitation are light green and stands that are a priority for rehabilitation are orange (i.e. treated in the timber supply model in the silviculture scenario).

[4] from the LBIS MFLNRO 2013/14 to 2017/18 LBIS Silviculture Funding Criteria for Forests for Tomorrow

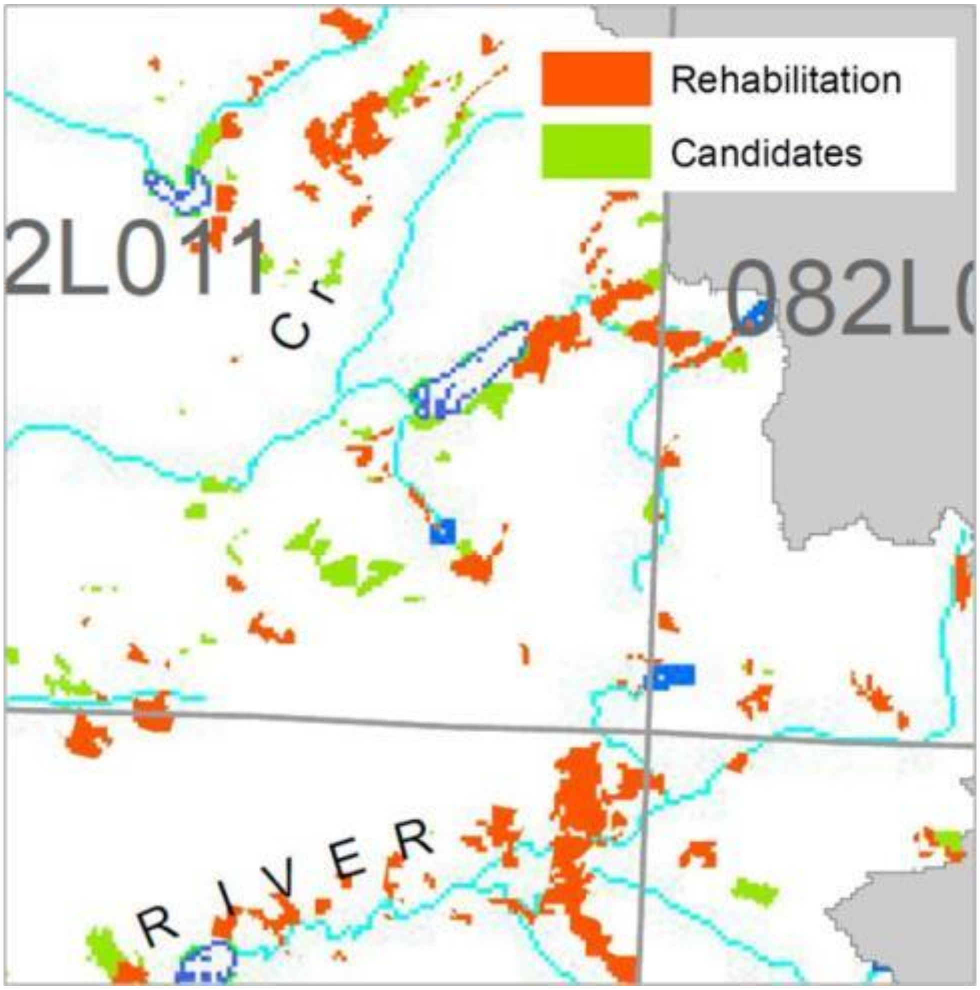


Figure 3.2: Example Spatial Rehabilitation Treatment Map

3.1.3 Spacing

Eligible Stands

Candidates for spacing must satisfy the following criteria:

- Height between 2 - 8m;
- Site index >=16;
- Stand density >=8,000 stems/ha for Douglas-fir and Spruce leading stands or >= 10,000 stems/ha for Pine leading stands; and
- Minimal forest health hazard.

Priority Stands

The preferred silviculture scenario chose to space stands 724ha as shown in Table 3.3. At an average of $1,502/ha, in $0.22 million per year for 5 years was spent on spacing. Of the three silviculture treatments, this is the lowest priority.

Table 3.3: Spacing Silviculture Treatment

Spacing	
Eligible Area (ha)	4,056
Treated Area (ha)	724
Treated %	18%
$million total (over 5 years)	1.10
$million per year for 5 years	0.22

Additional General Silviculture Trends

General silviculture trends for spacing include:

- Of the possible 4,056 ha considered for spacing only 724 ha was selected for treatment, which is the least of any activity.
- The areas selected for treatment tended to be in lower site indexes.

Figure 3.3 shows an example spacing treatment map. Stands eligible for spacing are light green and stands that are a priority for spacing are orange (i.e. treated in the timber supply model in the silviculture scenario).

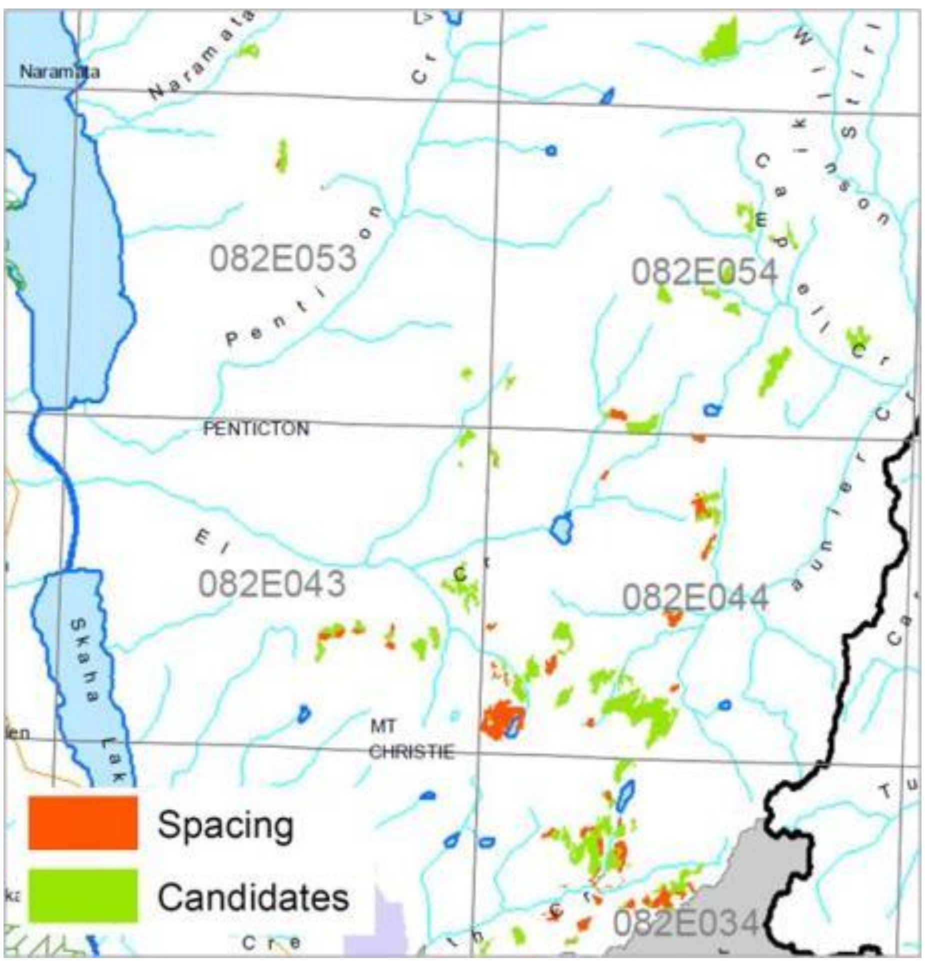


Figure 3.3: Example Spatial Spacing Treatment Map

3.2 Applying the Tactical Plan

The direction provided in the previous sections form the basis of tactical plan development in this project. The following chapters identify some additional considerations when translating this into an operational plan.

3.2.1 Treatment Risk

Consider the risk that the financial gain from the treatment will not be realized due to natural disturbance factors. This may include:

- Forest health hazard;
- Wildfire hazard; and
- Risk of harvesting for regeneration treatments in areas where salvaging is still viable.

3.2.2 Consider Related Plans and Strategies

Check how each treatment aligns with related plans and strategies (see section 4.0), especially including:

- Climate change,
- Forest health,
- Wildfire management;
- Ecosystem restoration; and
- Hydrological/watershed values.

3.2.3 Data Limitations

The accuracy of the information associated with key input data layers is variable and may change over time. For example ownership and OGMAs may change over time. Field verification of inventory attributes (e.g. species, age, site productivity) prior to treatment is a critical component of the planning and implementation process. The VRI that was used as the foundation for this project was designed to provide a reasonable average volume for the TSA and not the stand level accuracy that it is often being used at. Ecosystem mapping for the TSA required considerable grouping to enable the product to pass the accuracy assessment- a process that also reduced the spatial accuracy.

3.2.4 Utilize the Tactical Plan

Initially start with direction from the treatment maps to identify candidate and priority stands. Assess these areas in the field to verify data, treatment risk, relation to other plans/strategies and operational limitations that exist (e.g. road access). Areas will need to be of reasonable size for operational treatment. Access and operational feasibility of the areas will need to be assessed. A stand-level ROI analysis on silviculture investment can be utilized as part of stand-level treatment plans.

4.0 Related Plans and Strategies

When implementing the silviculture strategy, it is important to consider the multitude of other related plans and strategies that apply. While some of these factors were incorporated into the analysis and were considered when locating priority stands for treatment in the silviculture strategy, it is important to list and formalize the factors to consider.

4.1 Climate Change

Forest management opportunities currently exist to adapt to climate change if we view the decisions through a 'climate change lens'. Sources of information pertaining to climate change in BC are outlined in Table 4.1.

Table 4.1: Climate Change Information Sources

Source	Link
Kamloops Future Forest Strategy II	http://k2kamloopstsa.com/
MFLNRO's page on adapting to climate change	http://www.for.gov.bc.ca/het/climate/index.htm
Climate Map of BC	http://www.genetics.forestry.ubc.ca/cfcg/ClimateBC40/Default.aspx
BC CFA climate change information sources	https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=0CEYQFjAE&url=http%3A%2F%2Fwww.bccfa.ca%2Findex.php%2Fwhat-we-do%2Fconferences%2Fitem%2Fdownload%2F112_14e91a620a9e05dda0d75777e84af0b0&ei=ouELUoipLImkiQKMvIGQBw&usg=AFQjCNGXX2T_0WfcVbZ4pNrpOeSh3rkF9w&bvm=bv.50723672,d.cGE&cad=rja

4.2 Tree Species Deployment

As part of the Type 4 process, a workshop to provide landscape level guidance for strategic species deployment was undertaken. This direction is regarded as the first step in an iterative and ongoing process refining species deployment at the landscape level. Table 4.2 is a summary of the species deployment direction from this workshop where:

- The symbol "◊" = maintain the proportion planted to logged;
- The symbol "↓" = Decrease the current proportion planted to logged; and
- The symbol "↑" = Increase the current proportion planted to logged.

Table 4.2: Summary of Species Deployment Direction

BGC Zone	Desired Trend by Species								Comments
	Pl	Sx	Fd	Lw	Cw	Hw	Pw	Py	
ESSFdc	◊	◊	↑	n/a	n/a	n/a	n/a	n/a	Maintain the proportion of Pl and Sx to match the level harvested. Begin to bring in Fd where feasible e.g. low elevation south exposures.
ESSFwc	↓	◊	↑	n/a	n/a	n/a	n/a	n/a	Maintain the trend of lower reliance on Pl (maintain trend of lower planted vs harvest), maintain trend for Sx as the main species for reforestation, manage Bl with naturals. Promote use of Fd, Pw, Cw and Hw where feasible.
ICHmk	◊	◊	↑	◊	◊	◊	n/a	n/a	Maintain the trend for Pl – match to proportion cut. Maintain the trend for Sx and Fd – Fd is limited by root rot in this unit. Maintain the trend for Lw, used on root rot sites. Maintain the trend for Cw and Hw.
ICHmw	◊	◊	◊	◊	◊	n/a	n/a	n/a	Maintain the trends – promote Fd where suited.
ICHwk	◊	↓	◊	◊	◊	n/a	◊	n/a	Maintain the trends for Pl and Fd, may wish to limit Sx use - monitor. Maintain present trends, note the use of Pw and replacement of Cw.
IDFmw	↓	◊	↑	◊	◊	n/a	n/a	◊	Reduce level of Pl use below harvest proportion. Maintain trend for Sx, promote Fd. Maintain present trend of increased use of Lw and reduced use of Cw. Promote Py where suited.
MSdm	◊	◊	↑	n/a	n/a	n/a	n/a	n/a	Maintain trends for Pl and Sx, but do not increase Sx above the present proportion used. Promote use of Fd where suited. Use Lw where suited in a limited capacity.
IDFdk	↓	↓	↑	↓	n/a	n/a	n/a	↑	Reduce reliance on Pl except on sites unsuitable for other species. Avoid planting Sx on zonal sites due to increased drought potential. Promote the use of Fd. Decrease or do not increase use of Lw, promote Py where suited.
IDFxh	↓	↓	↑	↓	n/a	n/a	n/a	↑	Reduce reliance on Pl except on sites unsuitable for other species. Avoid planting Sx on zonal sites due to increased drought potential. Promote the use of Fd – either through natural regeneration or planting. Decrease or do not increase use of Lw, promote Py where suited.
MSxk	◊	◊	↑	n/a	n/a	n/a	n/a	n/a	Maintain use of Pl on Pl dominated sites, maintain use of Sx and promote Fd where suited. Begin to introduce Lw where suited.
ESSFxc	◊	◊	n/a	n/a	n/a	n/a	n/a	n/a	Maintain use of Pl on Pl dominated sites, maintain use of Sx.

4.3 Land Use Plans

The Okanagan Shuswap Land and Resource Management Plan (OSLRMP), Forest and Range Practices Act (FRPA) objectives, approved ungulate winter ranges (UWR) and associated orders and wildlife habitat areas (WHA) and associated general wildlife measures (GWM) form the framework for forest management and land use in the Okanagan TSA.

Many of these values are directly affected by MPB mortality and associated salvage harvesting, but have not been updated to specifically incorporate these affects. Table 4.3 lists sources of information regarding land use plans in the Okanagan TSA.

Table 4.3: Land Use Plan Information Sources

Source	Link
OSLRMP	http://archive.ilmb.gov.bc.ca/slrp/lrmp/kamloops/okanagan/plan/files/oslrmpfull.pdf
FRPA	http://www.for.gov.bc.ca/code/ http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/
Approved UWR	http://www.env.gov.bc.ca/wld/frpa/uwr/index.html
WHA	http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html

4.4 Forest Health

The 2012 Okanagan TSA forest health strategy outlines emerging and important forest health issues in the TSA and strategies to minimize losses. This document identifies Douglas-fir beetle, spruce budworm and hemlock looper as emerging forest health issues. In this analysis, forest health hazard for MPB, Douglas-fir beetle and spruce bark beetle was modeled at the landscape level. Table 4.4 lists sources of information regarding forest health strategies.

Table 4.4: Forest Health Information Sources

Source	Link
Okanagan Forest Health Strategy 2012	http://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest_Health/TSA_FH_Strategies/2012%20Okanagan%20TSA%20FH%20%20strategy.pdf
MFLNRO Forest Health Website	http://www.for.gov.bc.ca/hfp/health/index.htm

4.5 Wildfire Management

The BC Wildfire Management Strategy [5] aims to encourage healthier ecosystems, reduce the risk of loss to communities, recognize and plan for climate change, and enable more

[5] British Columbia Wildland Fire Management Strategy, September 2010, 21p.

cost-effective wildfire response. The five strategies that aim to achieve these goals are to:

- Reduce the hazards and risks associated with wildfire in and around communities and other high-value areas.
- Plan and implement careful use of controlled burning in appropriate ecosystems under suitable conditions to reduce hazards and risks and achieve healthy forests and grasslands.
- Allow wildfires to burn in areas where there is minimal risk to identified values. Monitor these wildfires and intervene only when necessary to reduce unwanted losses.
- Implement land, natural resource and community planning that incorporates management of wildland fire at all appropriate scales.
- Develop a high level of public awareness and understanding about wildfire and its management.

4.5.1 Planning Silviculture Activities to Address Wildfire Impacts

Silviculture activities should be planned to recognize and protect values that are at risk from wildfire. Ideally, projects should be located within areas of reduced wildfire risk and aligned in larger, more cohesive units that can be easily identified as a priority value for suppression. The process below describes the silviculture activities that can be deployed to address different wildfire risks and management objectives.

There are two key components to evaluating silviculture treatments from a wildfire management perspective:

1. Design treatments that reduce wildfire risk and consequences to life, property and other values, and
2. Locate treatments to minimize the likelihood of loss of the investment from wildfire.

At this time, it is recommended that the burn probability map (Burn-P3) be used in conjunction with local input on values and risk, to identify and prioritize candidate treatment areas based on wildfire hazard. As Fire Management Plans evolve they will include landscape level wildfire management objectives and strategies based on local input. Proposed treatments should be consistent with Fire Management Plan objectives and strategies (when they are available) and contribute to the development of a fire resilient landscape. Communities that have been identified as the highest risk should be targeted for amelioration treatments first. Other communities with lower risk, and other values outside of the wildland urban interface (WUI) (e.g., critical infrastructure, critical habitat, community watersheds) at high risk from wildfire, should be considered a high priority for amelioration treatments.

Table 4.5 illustrates the relationship between forest management activities and fire management. It is intended to assist prescribing foresters to consider wildfire risk when planning silviculture treatments. For example, a lower priority is assigned to proposed treatment areas where silviculture activities are likely to contribute to the fire hazard, or where there is a high probability of long term silviculture investments being lost to wildfire or fuel reduction treatments in the interface. Alternatively, a higher priority is assigned to proposed treatment areas where activities will likely mitigate the risk of losses from wildfires and have a higher likelihood of growing to a commercial harvest age. It is generally preferable to locate silviculture investments in low or moderate fire risk areas, however, under some circumstances, silviculture investments can be made in areas of higher fire risk, provided appropriate hazard mitigation is part of the investment and the resulting treated stand does not increase the hazard to communities and other values over time.

Although Table 4.5 does not specifically discuss prescribed burning, it can be an effective tool to reduce fuel loading and accomplish other objectives. Consideration should be given to how the planned treatment fits in with adjacent areas, and how it contributes to the creation of effective landscape level fuel breaks and a fire resilient landscape.

Table 4.5 Forest management priorities for wildfire management

Treatments		Treatment outcome (Fire perspective)	Lower priority where…	Higher priority where…
Harvesting	Clear-cut	Reduce fuel loading and eliminate crown fire risk (short term)		High values and high hazards exist; create fuel breaks
	Partial cut	Reduce crown bulk density which reduce crown fire risk (1). May increase surface fuel loading (2)		High risk interface area (3) identifies a need to treat fuels; mitigate risk
Silviculture	Enhanced Reforestation	May have surface fire potential. This is dependent on residual slash load and grass/ herbaceous fuel loading.	Burn probability is highest; avoid losing silviculture investments	
	Alternate Reforestation (4)	May have surface fire potential. This is dependent on residual slash load and grass/ herbaceous fuel loading.		Burn probability is highest; mitigate losses and protect values
	Prescribed Burn / Ecosystem Restoration	Maintains a natural fire return interval		High values exist with high hazard and risk; treat fuels and improve forest health/habitat

Treatments		Treatment outcome (Fire perspective)	Lower priority where…	Higher priority where…
	Spacing to normal stocking levels	Reduce fuel loading – lower intensity fires. May increase surface fuel loading	Burn probability is highest; avoid losing silviculture investments	
	Spacing to lower densities combined with/Fuel Reduction	Reduce fuel loading – lower intensity fires(5)		High values exist to protect community and Infrastructure High risk interface area (3) identifies a need to treat fuels; mitigate risk Burn probability and fire intensity criteria are the highest; mitigate fuel loading
	Fertilization	May increase crown bulk density and higher surface fuel loading	Burn probability is highest - avoid losing silviculture investments Burn probability is highest within interface; Areas in the interface have a high priority for treatment and silviculture investments may be lost.	Outside of interface areas, in areas of low to moderate burn probability.
	Pruning	Increase crown base height but will increase surface fuel loading.		High risk interface areas – increase height to live crown.
Rehabilitate	Knockdown and site preparation	Reduce fuel loading and eliminate crown fire risk (short term)		High risk interface area (3) identifies a need to treat fuels; mitigate risk
	Plant and brush	May have surface fire potential. This is dependent on residual slash load	Burn probability is highest; avoid losing silviculture investments	

(1) This treatment may also increase crown fire potential in certain areas due to increased air flow through the stand. Care needed with surface fuel load and crown base height

(2) Higher surface fuel loading can result in more intense surface fires. Higher intensity surface fires have the potential to increase crown fire potential.

(3) Identified through a Community Wildfire Protection Plan (CWPP) or Provincial Strategic Threat Analysis (PSTA) or Burn P3

(4) Encourage deciduous or other fire resistant species

(5) Intensity (I) is a function of the combustion (H), weight of fuel (W) and rate of spread of a fire (R) I=HWR

It is important to recognize that most of the treatments discussed in Table 4.5 have a limited amount of time where they will be effective from a fire management perspective.

As trees and other vegetation grow, ingress may occur, and fuels accumulate, the wildfire hazard will increase. It is important to design treatments to be effective over the long term, or plan for follow-up treatments to maintain effectiveness.

To illustrate how wildfire management might be considered to prioritize silviculture treatments, Figure 3.1 shows an example of two types of treatments: fertilization (green) and pre-commercial thinning (pink) in relation to areas within and outside of a community interface area. Applying the principles in Table 4.5 illustrates the relationship between forest management activities and fire management. It is intended to assist prescribing foresters to consider wildfire risk when planning silviculture treatments. For example, a lower priority is assigned to proposed treatment areas where silviculture activities are likely to contribute to the fire hazard, or where there is a high probability of long term silviculture investments being lost to wildfire or fuel reduction treatments in the interface. Alternatively, a higher priority is assigned to proposed treatment areas where activities will likely mitigate the risk of losses from wildfires and have a higher likelihood of growing to a commercial harvest age. It is generally preferable to locate silviculture investments in low or moderate fire risk areas, however, under some circumstances, silviculture investments can be made in areas of higher fire risk, provided appropriate hazard mitigation is part of the investment and the resulting treated stand does not increase the hazard to communities and other values over time.

Although Table 4.5 does not specifically discuss prescribed burning, it can be an effective tool to reduce fuel loading and accomplish other objectives. Consideration should be given to how the planned treatment fits in with adjacent areas, and how it contributes to the creation of effective landscape level fuel breaks and a fire resilient landscape.

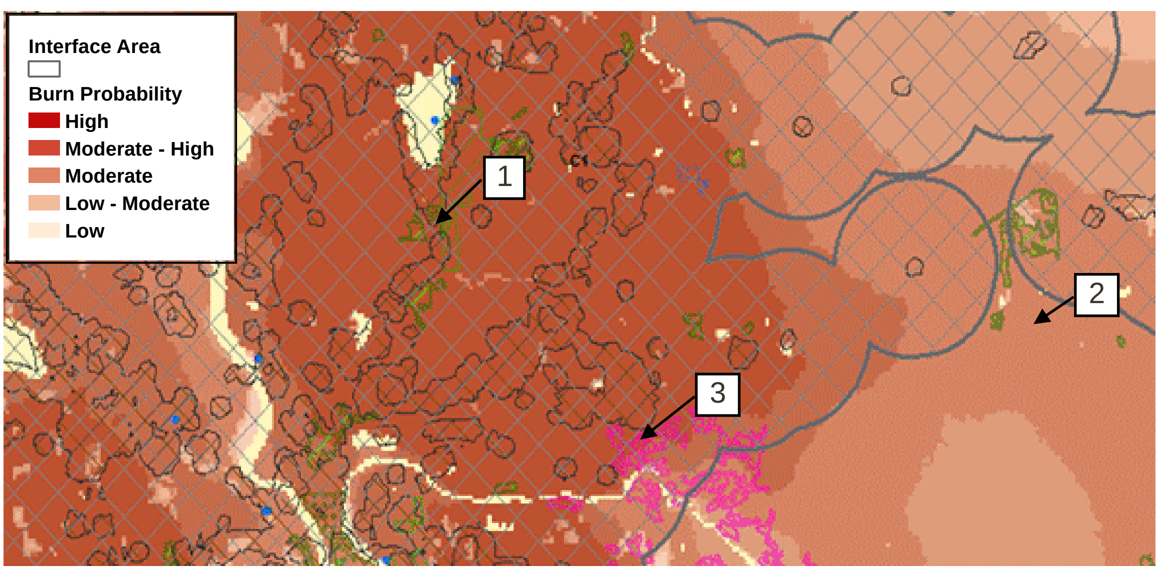


Figure 4.1: Map showing burn probability, interface areas and candidate treatments

Using Figure 4.1, silviculture treatments can be planned to maximize the protection of life, property and other values, while minimizing the risk of losing the silviculture investment to future wildfire as follows:

1. Fertilization of an area with high burn probability within the interface area is a low priority in untreated stands (i.e., high probability of losing the investment from future fuel reduction treatments).
2. Fertilization in an area with moderate burn probability and outside the interface area is a higher priority (i.e., high probability of the treated stand reaching maturity and being harvested). Outside of the interface areas traditional pre-commercial thinning may be acceptable; although this may not be acceptable immediately adjacent to the WUI (i.e., creating a large fuel load immediately adjacent to the WUI may not be consistent with risk mitigation).
3. Spacing to lower densities and fuel reduction in an area with high burn probability within the interface area is a high priority (i.e., reduced risk to life and property, with the potential for some future harvest volume). Within the interface areas: combine the pre-commercial thinning with concurrent fuel reduction treatments, selection for fire resistant species, and reduced stocking levels.

Table 4.6 list selected sources of information for wildfire management.

Table 4.6: Wildfire Management Information Sources

Source	Link
BC Wildland Fire Management Strategy	bcwildfire.ca/prevention/PrescribedFire/
Provincial Strategic Threat Analysis [ ] Fire Centre Fire Center Contact –[ ]@gov.bc.ca	[ ]
[ ]Regional District Community Wildfire Protection Plans Fire Center Contact –[ ]@gov.bc.ca	[ ]
[ ] Community Wildfire Protection Plan Fire Center Contact –[ ]@gov.bc.ca	[ ]
Burn-P3 Modelling Fire Management Specialist Contact – [ ]@gov.bc.ca	cfs.nrcan.gc.ca/pubwarehouse/pdfs/25627.pdf
Forest health and climate change: A BC perspective	bcwildfire.ca/ftp/HFP/external/!publish/ClimateChange/FRPA/Workshop/Forest_Health_CC.pdf
Innovative Timber Sale Licences (ITSL) – Stand Selection Policy	www.for.gov.bc.ca/hcp/fia/landbase/fft/ITSL-FLTC-Stand-Selection-Policy-20120920.docx.
Silvicultural Regimes for Fuel Management in the Wildland Urban Interface or Adjacent to High Landscape Values	www.for.gov.bc.ca/ftp/HFP/external/!publish/LBIS_web/Guidance/FFT%20guidance%20-Silvicultural%20Regimes%20for%20Fuel%20Management%20in%20the%20WildLand%20Urban%20Interface_V2.3.pdf

4.6 Ecosystem Restoration

Decades of fire suppression in the wildfire-maintained ecosystems have resulted in encroachment and ecosystem degradation. In the Okanagan TSA, these dry-belt IDF ecosystems are located in the valley bottoms that are also heavily used for range and recreation and are in close proximity to major population centres. The province's ecosystem restoration plan provides strategic direction to restore these areas to an ecologically appropriate and resilient condition.

Ecosystem restoration as an activity was not modelled in this silviculture strategy because it will not directly increase mid-term timber supply and has well defined potential treatment areas. Much of the treatment areas are outside of the THLB, but there may be an important indirect implication of reducing overall wildfire hazard through ecosystem restoration that will increase mid-term timber supply.

Table 4.7 list selected sources of information for ecosystem restoration.

Table 4.7: Ecosystem Restoration Information Sources

Source	Link
MFLNRO Ecosystem Restoration website	https://www.for.gov.bc.ca/hra/Restoration/index.htm
Provincial strategic plan	https://www.for.gov.bc.ca/hra/Restoration/Draft%20-%20Ecosystem%20Restoration%20Prov%20Strategic%20Plan.pdf
Rocky Mountain Trench blueprint for action	http://www.trenchsociety.com/setup/content/Blueprint_for_Action_2006.pdf

4.7 Watershed Management

The large areas of MPB mortality, as well as the increased road densities and clear-cutting associated with accelerated salvage harvests affects watershed risk to peak flow events.

In this analysis, the hydrological indicators EDA (equivalent disturbance area) above and below the H40[6] elevation and road densities were modeled to mimic hydrological operational considerations.

Harvest, salvage and silviculture activities need to be spatially located keeping these indicators in mind. Accelerated green-up will result from rehabilitating a MPB killed stand rather than letting it regenerate through natural regeneration. Watersheds that have high EDA values in the short term were identified in this analysis.

Table 4.8 list selected sources of information for watershed management.

Table 4. 8: Watershed Management Information Sources

Source	Link
Merritt/Southwestern Okanagan TSA Watershed Risk Analysis	ftp://ftp.geobc.gov.bc.ca/pub/outgoing/Merritt%20South%20Okanagan%20Watershed%20Risk%20Analysis%202012/Merritt_OkanaganTSA%20Watershed%20Report%20Final.pdf
MPB and watershed hydrology- a synthesis focused on the Okanagan basin	http://www.thompsonokanagansustainableforestry.ca/docs/mpb%20and%20watershed%20hydrology%20-%20a%20synthesis.pdf

[6] H40 refers to the elevation that 40% of the area is above (for a given watershed).

Okanagan Basin Water Board	http://www.obwb.ca/watershed/

4.8 Wildlife Habitat

The Okanagan TSA is home to many key wildlife species and non-timber values. This analysis considers TSR, GAR and OSLRMP requirements including caribou, community watersheds, elk, goat, grizzly bear, lakeshore management zones, marten, mule deer, moose, sheep and visually sensitive areas. When implementing the silviculture activities in this strategy, consider their impact on wider wildlife habitat objectives. Table 4.9 list selected sources of information for wildlife habitat.

Table 4.9: Wildlife Habitat Information Sources

Source	Link
OSLRMP	http://archive.ilmb.gov.bc.ca/slrp/lrmp/kamloops/okanagan/plan/files/oslrmpfull.pdf
Approved UWR	http://www.env.gov.bc.ca/wld/frpa/uwr/index.html
WHAs	http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html
Fisheries sensitive watersheds	http://www.env.gov.bc.ca/wld/frpa/fsw/index.html

4.9 Range Management

The BC range program allocates and supports grazing and hay-cutting agreements on crown land through licenses, permits and leases. Range agreements are broken down into pastures (areas for use during a particular season) that have a target forage requirement. Forage requirements are measured in animal unit months (AUMs) which is the amount of forage necessary for the sustenance of one cow or its equivalent for 1 month (450kg/AUM).

In the analysis, forage production was modeled and tracked throughout and analysis scenarios specific to range values were run. The instrument through which changes in forage supply are assumed to be influenced is the implementation of what is termed ‘range cut-blocks’. These cut-block types represent changes in silviculture practices at time of harvest and result in different levels of forage productions (grass growth).

These analyses indicated that while under current silviculture practices and management, existing forage allocations are not likely to be met, relatively small amounts of change in management is necessary to fulfill the forage targets. All silviculture activities should consider how they might affect or be affected by range activities.

Table 4.10 list selected sources of information for range management.

Table 4.10: Range Management Information Sources

Source	Link
BC Range program website	http://www.for.gov.bc.ca/hra/index.htm

BC Range factsheets and publications	http://www.agf.gov.bc.ca/range/factsheets.htm

5.0 RECOMMENDATIONS

Throughout this process, it was recognized that this planning process is meant to be iterative and continually improved upon. This section highlights possible process and data improvements that will enhance similar projects in the future.

5.1 Recommendations for Implementation of Strategies

Recommendations for the implementation of silviculture strategies modeled include:

1. Implement fertilization projects in the areas (or similar areas) identified in the silviculture scenario;

2. Survey MPB affected stands not being salvaged to determine if stands need treatment – reforestation. Aggressively reforest those that are not naturally regenerating at 'managed' stand rates, considering hydrological values;

3. Work with forest practitioners to find over-dense stands for spacing;

4. Work with range experts to implement silviculture systems that, at minimum, meet the current range commitments; and

5. Review MDWR with forest health experts and consider clear cutting areas with high forest health issues or hazard.

5.2 Data Gaps and Information Needs

Data gaps and future information needs that were identified through this process include:

- **VRI**: The vegetation resource inventory used as the foundation for this project was designed to provide a reasonable average volume for the TSA. Improved stand level description of the forest cover would significantly improve the ability to make resource management decisions that maximize the economic, environmental, and social value derived from the land base. Improvements include: attributing Douglas-fir stands that capture multiple entries; improving stems per hectare estimates to capture spacing candidates; improve stand level estimates using feedback from cruise data; enable continual improvement of inventory using information collected from forest practitioners.

- **Ecosystem mapping**: Ecosystem mapping for the TSA required considerable grouping to enable the product to pass the accuracy assessment. Improved ecosystem mapping would provide more spatial accuracy for many environmental values and improved estimates of managed stand yields.

- **Climate change**: Complete drought and frost risk mapping in the Okanagan TSA to identify spatially areas at risk of current and future mortality and provide direction for silviculture regimes through a 'climate change lens'.

5.3 Related Plans and Strategies

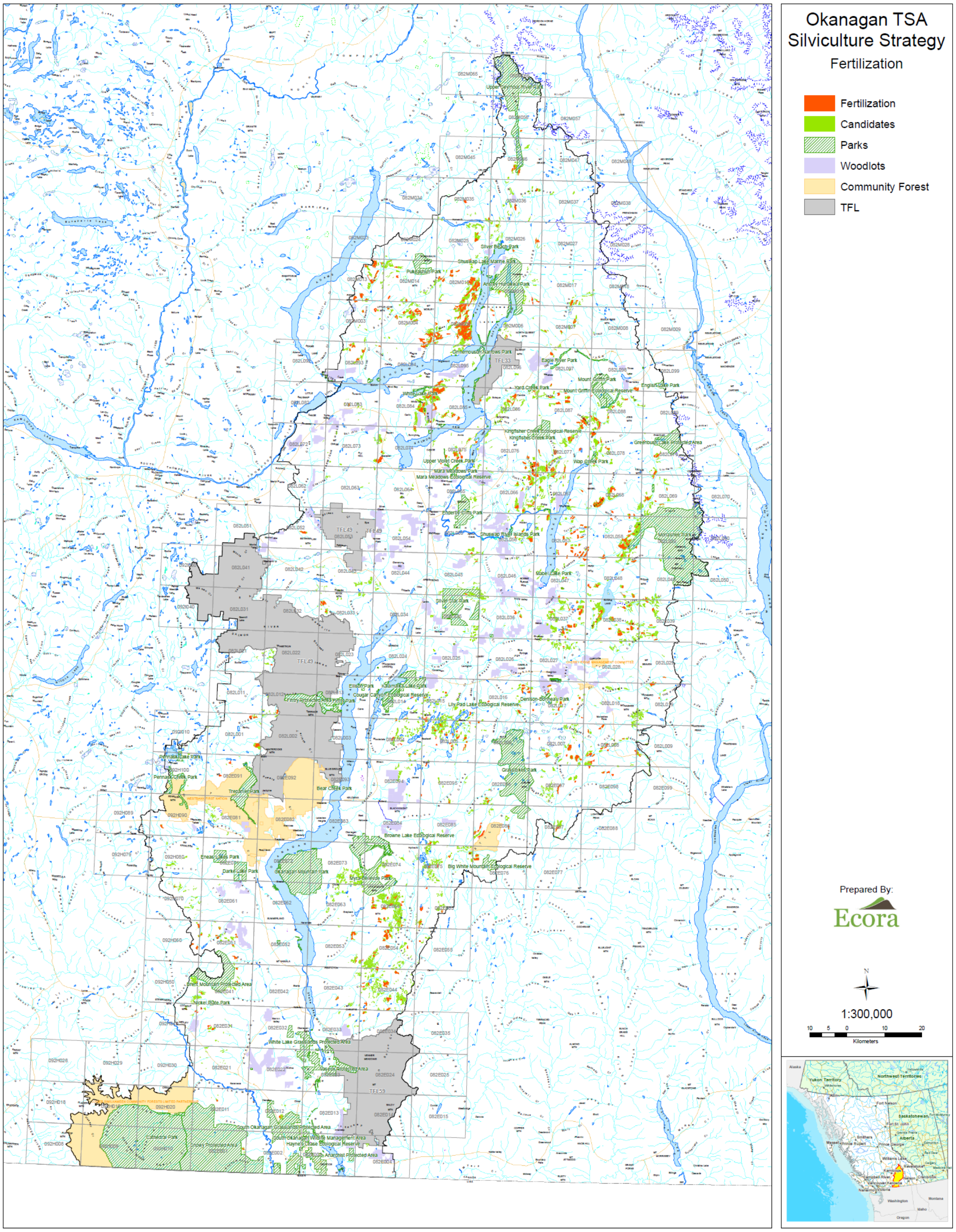
Continue to explore ways to align silviculture strategies with other related plans and strategies to maximize benefits to multiple forest users and values.

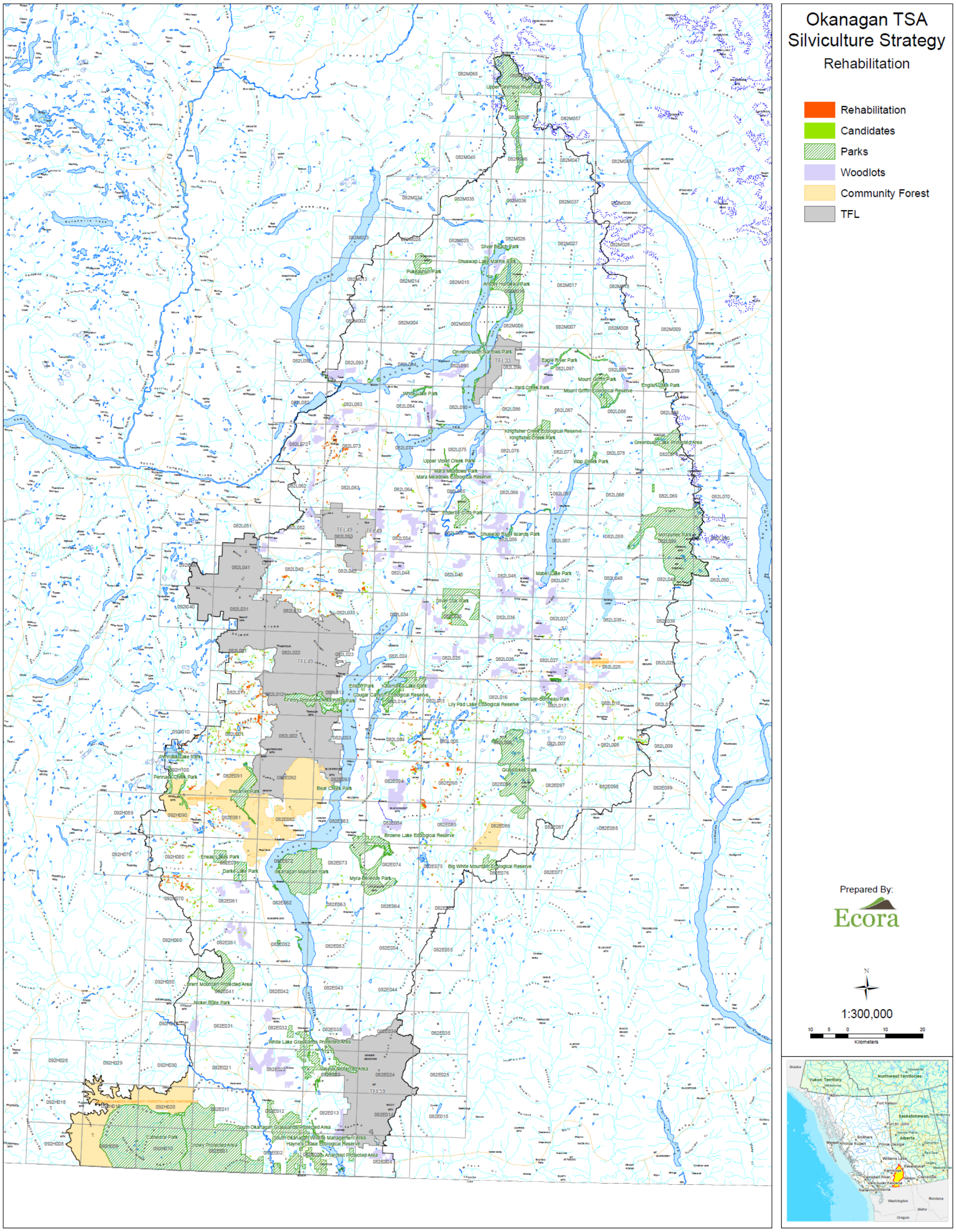
The analysis dataset and tools should be made available and encouraged for use in other planning processes in the TSA.

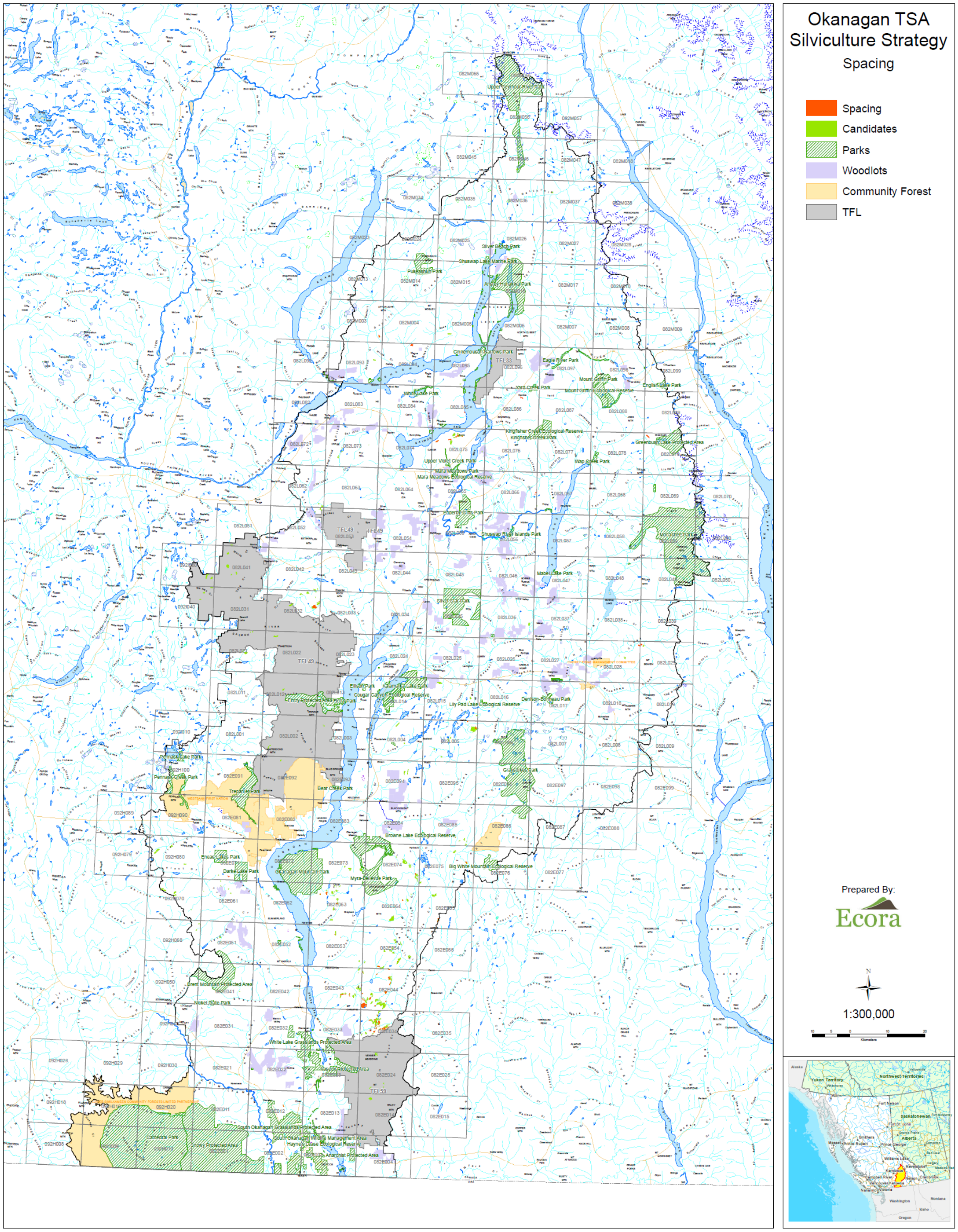
5.4 Monitoring

Monitoring should be integral to the silviculture strategy. This includes monitoring of managed stand yields and monitoring the response to silviculture activity.

Appendix 1: Silviculture Treatment Maps (fertilization, planting and spacing)


Okanagan TSA
Silviculture Strategy
Fertilization
Fertilization
Candidates
Parks
Woodlots
Community Forest
TFL
Prepared By:
Ecora
1:300,000
Kilometers


Okanagan TSA
Silviculture Strategy
Rehabilitation
Rehabilitation
Candidates
Parks
Woodlots
Community Forest
TFL
Prepared By:
Ecora
1:300,000
Kilometers


Okanagan TSA
Silviculture Strategy
Spacing
Spacing
Candidates
Parks
Woodlots
Community Forest
TFL
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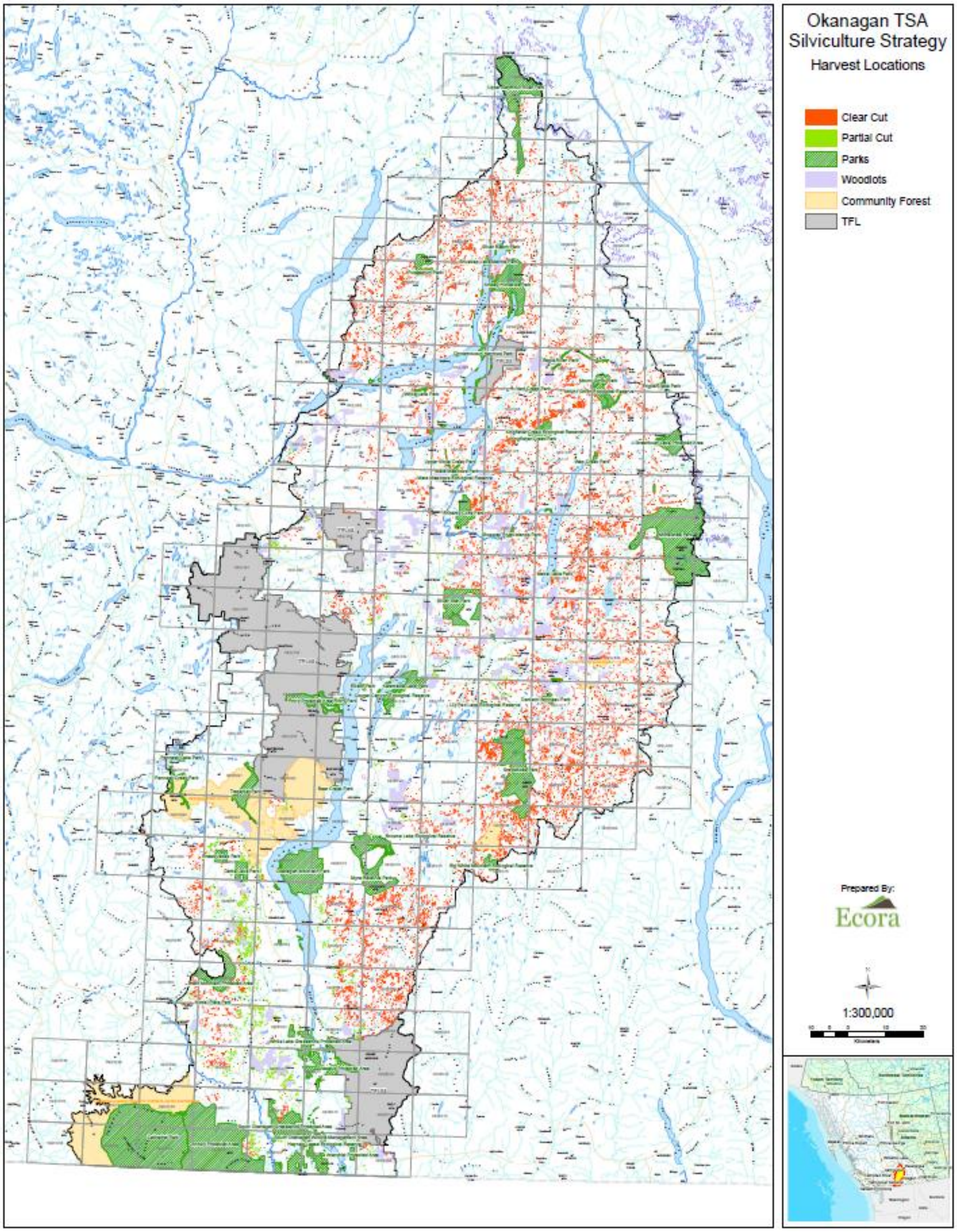
Ecora
1:300,000

Appendix 2: 10year Harvest Map for the Silviculture Scenario


Okanagan TSA
Silviculture Strategy
Harvest Locations
Clear Cut
Partial Cut
Parks
Woodlots
Community Forest
TFL
Prepared By:
Ecora
1:300,000