Lakes TSA – Type 4 Silviculture Strategy

Addendum 1 - Modelling and Analysis Report

Version 1.0

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Project 1023-2

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Prepared by:

Forsite Consultants Ltd.
330 – 42nd Street SW
PO Box 2079
Salmon Arm, BC, V1E 4R1

FORSITE
Forest Management Specialists

Prepared for:

BC Ministry of Forest, Lands and Natural Resource Operations
Nadina Forest District
PO Box 999 185 Yellowhead Highway
Burns Lake, BC V0J 1E0

BRITISH COLUMBIA

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1 Introduction

In November 2013, Nadina Forest District staff and Resource Practices Branch requested Forsite to undertake additional modelling/analysis for the Lakes TSA to explore different assumptions involving fertilization and rehabilitation treatments and to analyze the potential impacts of draft stocking standards intended to address concerns regarding forest health and climate change.

Following various discussions and correspondence, 4 additional modelling runs were proposed:

- Increased Stocking Assumptions
- Reduced Stocking Assumptions
- Updated Multiple-Fertilization Assumptions
- Updated Composite Mix of Strategies @ Budget of $3 M/year (only)

This addendum to the LT4 modelling and analysis report[1] briefly describes the approaches taken to undertake the additional modelling runs and summarizes results for each analysis.

2 Additional Modelling Runs

2.1 Increased Stocking Assumptions

This sensitivity examined impacts on the LT4 harvest flow (current practice) from incorporating the Draft Nadina stocking standards. Changes were only applied to future managed stands since existing managed stands currently reflect existing densities summarized from RESULTS.

Approach

Appendix 1 shows the adjustments made to the base case assumptions (highlighted in yellow) for relevant future managed stand analysis units. These changes involved:

- Increasing establishment densities of Pl-leading stands (Pl≥50%) within the SBS BEC zone (typically from 1500 to 1600 sph),
- Adding Fdi and Lw to species compositions of Sx- and Pl-leading stands on medium and good sites within the SBS BEC zone.

After the revised assumptions were confirmed with Nadina district staff, a new set of TIPSY yield curves were generated. It was also necessary to determine new minimum harvest ages (MHA) for the changed analysis units. The model was then set-up and run to produce the analysis results discussed below.

Results

Compared to the yields used in the Base Case, the changes described above – particularly species composition – generally resulted in lower yields at younger ages and higher yields at much older ages (Figure 1). As well, these new curves caused MHAs to increase by 1-3 years.

[1] Forsite Consultants Ltd. 2013. *Lakes TSA - Type 4 Silviculture Strategy, Modelling and Analysis Report.* Version 1.1. Technical Report.

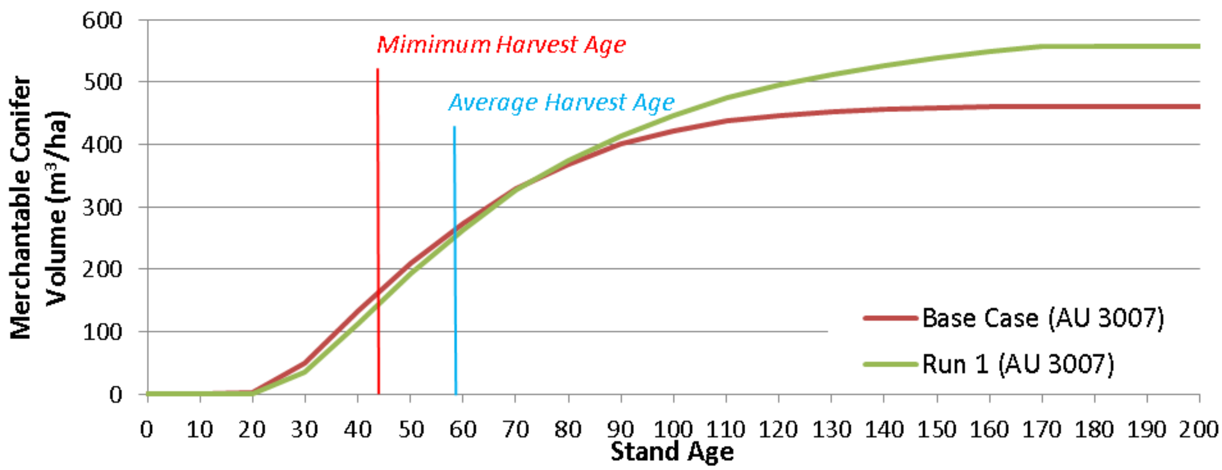


Figure 1 Yield curve comparison – example for future managed stand #3007

While the harvest forecast for Run 1 (Figure 2) was very similar to the Base Case, it produced a slightly lower (3%) mid- and long-term harvest level. While virtually no Douglas-fir or larch volumes were harvested in the Base Case, 12% and 6%, respectively, were harvested over the long-term in Run 1.

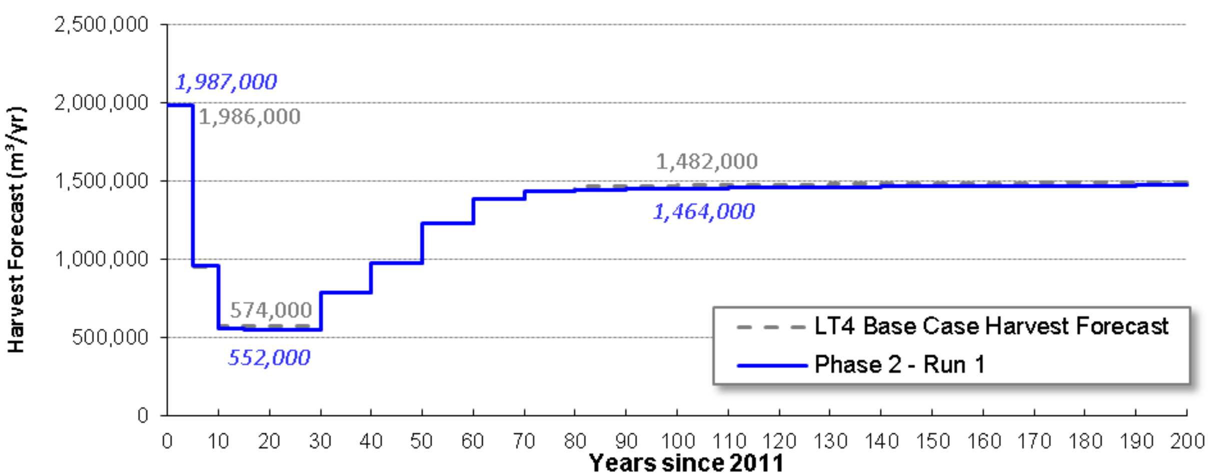


Figure 2 Harvest forecast comparison – Base Case and Run 1

Discussion

The changes to stand composition (more Fd/Lw) resulted in slower growth rates in the first ~70 years of the stand's life. This lengthened MHAs, made less wood available in the mid-term and caused a slight decrease in harvest volume.

It should be noted that the model only reflects the differences in growth rates of the two stand compositions and does not consider differences in the risk of loss/mortality associated with climate change, pests or disease between the two stand types.

Volumes are lower in the long-term because the extra volume produced late in the stand yields is not utilized because stands are harvested earlier. Using the example for AU 3007 (Figure 1), the model elected to harvest stands at 59 years (average), rather than waiting another 20-30 years for more volume. In this case, the harvest forecast is maximized by harvesting less volume more often.

2.2 Reduced Stocking Assumptions

This sensitivity examined impacts on the LT4 base case harvest flow from implementing reduced stocking assumptions in future managed stands to reflect, at least in part, significant levels of mortality observed in young stands due to pine stem rusts on lodgepole pine dominated stands.

Approach

Appendix 1 shows the adjustments to the base case assumptions (highlighted in blue) for relevant existing and future managed stand analysis units. These changes involved:

- Increasing the OAF1 from 15% to 30% on Pl-leading stands (Pl≥50%) within the SBS BEC zone. This will apply to both existing and future managed stands.
- Reducing establishment densities on Pl-leading future managed stands from 1500/ha to 1100/ha. This only applied to future managed stands since existing managed stands currently reflect densities summarized from RESULTS.

After the revised assumptions were confirmed with Nadina district staff, a new set of TIPSY yield curves were generated. It was also necessary to determine new MHAs for the changed analysis units. The model was then set-up and run to produce the analysis results discussed below.

Results

As expected, increasing OAF1 values by 15% resulted in yield reductions of 13-18% and led to increased MHAs. The reduced establishment densities in future stands contributed to the larger yield reductions.

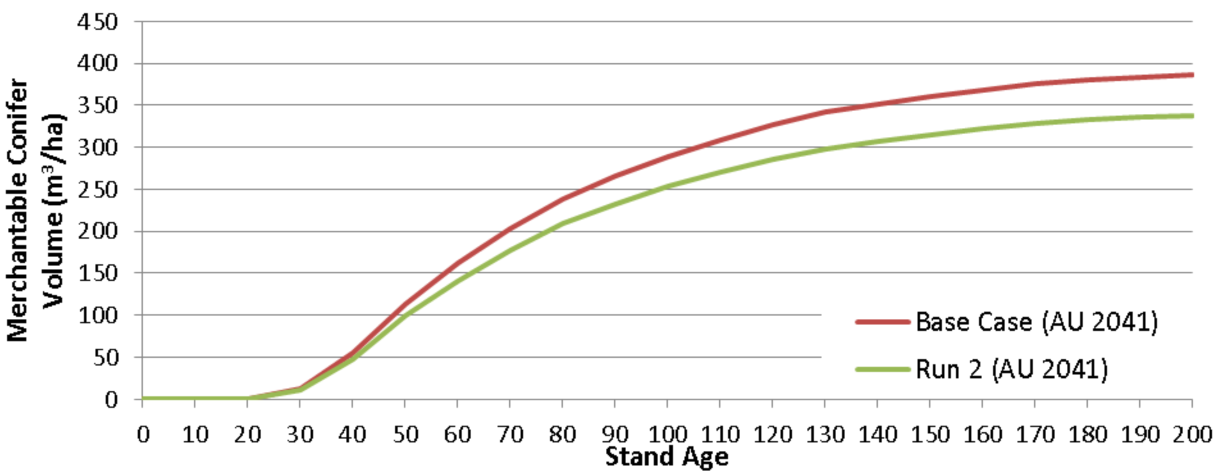


Figure 3 Yield curve comparison – example for existing managed stand #2041

Compared to the Base Case harvest forecast, the lower yields configured in Run 2 decreased harvest levels in the mid- and long-terms by 24K m^3/yr (13%) and 218K m^3/yr (15%) respectively.

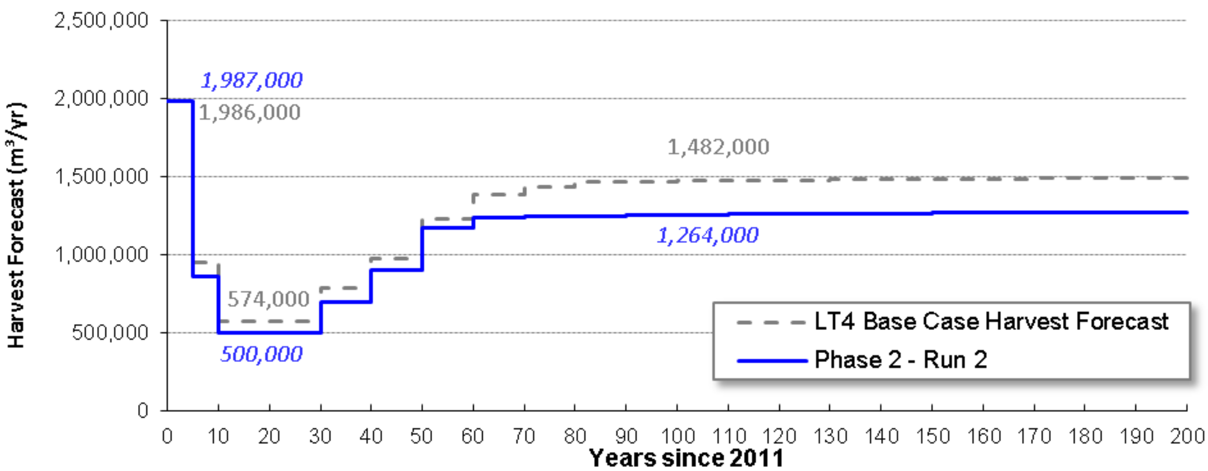


Figure 4 Harvest forecast comparison – Base Case and Run 2

Discussion

In this analysis, changing the volumes expected from existing and future managed stand yields (e.g., OAF1) has negative impact on the harvest forecast.

While our approaches for modeling these factors are intended to reflect real world examples, the yield estimates used for this analysis are simple representations of a range of silvicultural practices and biological factors. More work is required to accurately reflect forest health effects on stand dynamics.

2.3 Update Multiple Fertilization Assumptions

This sensitivity examined impacts on the LT4 base case harvest flow from updating the assumptions for multiple-fertilization treatments applied to existing stands. The intent was to increase the area of Pl-leading stands to be eligible for treatment.

Approach

Specific adjustments to the base case assumptions included:

- Lowering the site index cut-off for eligible pine-leading stands from SI 19m to SI 15m.

The model was then set-up and run to produce the analysis results discussed below.

Results

The stacked graph in Figure 5 shows that, including multiple applications, areas fertilized ranged between 2,200 ha and 6,000 ha annually. Approximately 400 ha/yr was treated with single fertilization treatments.

Treated areas vary from period to period as stands are: i) treated in a later period, ii) never available for harvesting and remain untreated, iii) harvested without treatment to overcome some other condition (e.g., better to harvest now than wait), or iv) retained and never treated for some non-timber value.

Including multiple applications, approximately 365,000 ha were treated under this fertilization strategy. Moreover, a total of 76,000 ha were treated within the first 20 years; averaging nearly 4,000 ha/yr. This average increased to 5,500 ha/yr between years 30 and 80.

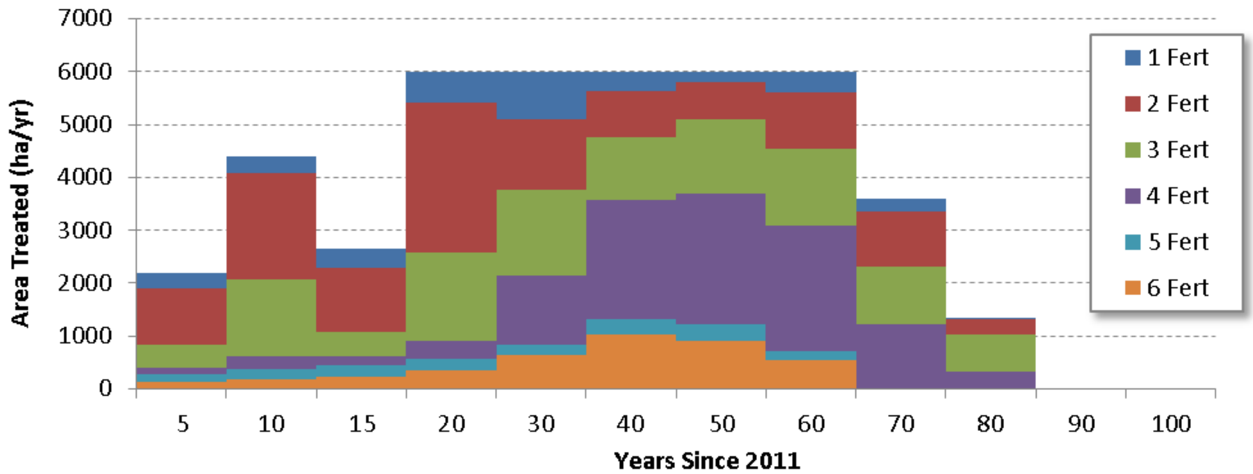


Figure 5 Area treated under each fertilization regime

Compared to the results presented in the previous Modelling and Analysis Report (Appendix 2; Slide 1), the revised assumptions in this run resulted in over 135,000 ha (59%) more area treated including 34,000 ha (81%) over the first 20 years.

Figure 6 shows that the budget for the fertilization is maximized between years 16 and 70. This declines sharply afterwards as few existing stands were left to treat (future managed stands were not eligible for treatment in the model).

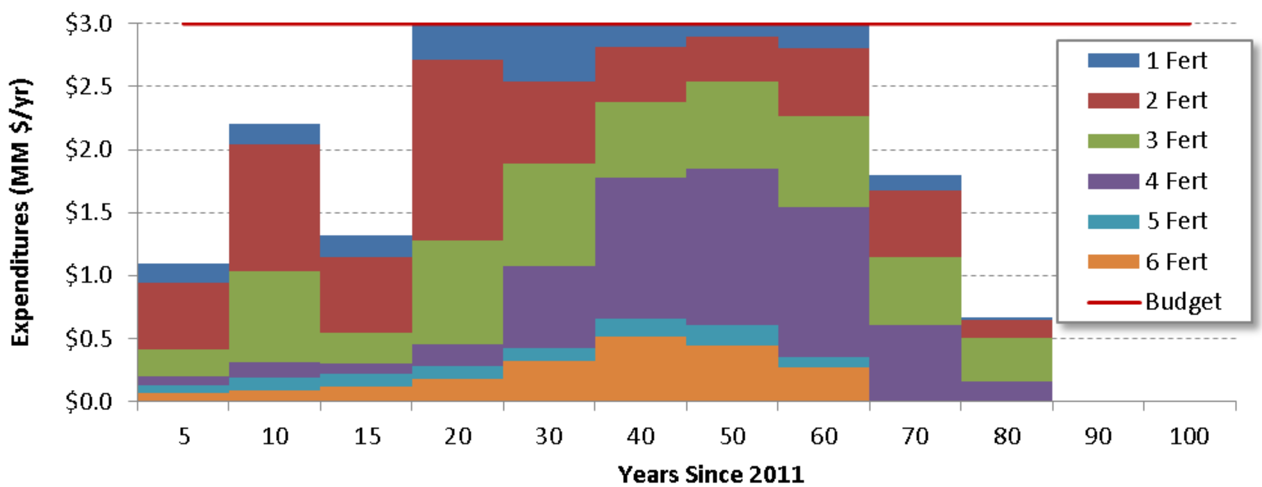


Figure 6 Expenditures over time for the multiple-fertilization strategy

Compared to the previous analysis (Appendix 2; Slide 2), this run spent over $8.4 M (62%) more on fertilization treatments including an additional $3.4 M (81%) over the first 20 years.

Figure 7 shows a very slight improvement to the harvest flow with multiple-fertilization. The harvest level increased by 17K m^3/yr (3%) in the mid-term, 53K m^3/yr (5%) in the rise to the long-term and 49K m^3/yr (3%) in the long-term.

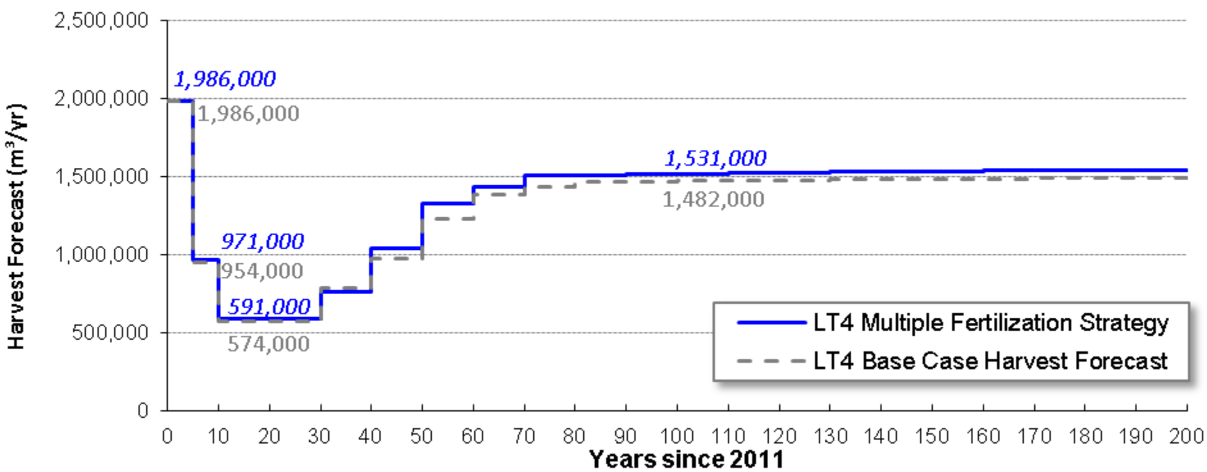


Figure 7 Harvest flow: Base Case compared to multiple-fertilization strategy

Compared to the previous analysis (Appendix 2; Slide 3), the revised fertilization assumptions produced very little change in the short- or early mid-term, but added 21K m^3/yr (1.4%) to the long-term.

Since most of the short- and mid-term harvest comes from natural stands, the incremental volume from fertilization was realized during the climb out of the mid-term trough (Figure 8), similar to the previous analysis. Only a few more stands eligible for treatment contributed to the mid-term harvest level. The incremental volume was not available in time to increase harvest in earlier periods (i.e. ACE[2] effect). The volume is added at a time when the model is almost exclusively harvesting managed stands as soon as they become available so adding more volume during this period does not support a volume shift into earlier periods.

[2] An immediate increase in timber supply resulting from expected future gains. This occurs because incremental volume in the future takes the place of existing stand volume that would otherwise be needed at that time. This effectively allows existing stand volumes to be harvested at a faster rate over the intervening time period.

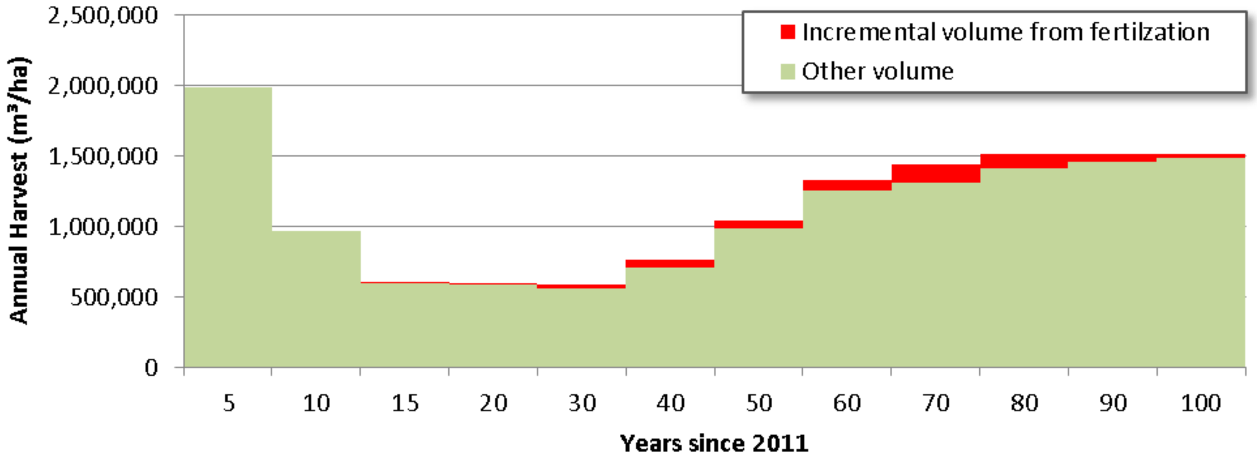


Figure 8 Harvest flow: Incremental volume harvested in the multiple-fertilization strategy

Compared to the previous analysis (Appendix 2; Slide 4), the revised assumptions for fertilization produced over 141K m^3 (38%) of incremental harvest volume over the next century - nearly 12K m^3 over the mid-term and 55K m^3 over the rise to the long-term. This reflects the significant increase in eligible stands available to the model.

Discussion

Relaxing treatment eligibility for multiple fertilization to include medium pine stands (SI ≥15 and <19) significantly increased the cumulative area treated (by 135,000 ha). Expenditures for the multiple fertilization treatments reached the maximum $3M/yr level from years 20 to 70.

This also produced an extra 141K m^3 of harvest volume from existing managed stands over the next century. Most of the additional volume was harvested after the mid-term for several reasons:

- Most fertilized stands do not meet the minimum harvest criteria for another 30 to 40 years (including the 10 year harvest delay after the last treatment);
- Nothing incents the model to harvest treated stands any sooner;
- The stepped rise in harvest flow between the mid- and long-term appears to dampen any potential ACE effect that might otherwise harvest other eligible stands sooner (stands are already harvested as soon as they are available).

For this analysis, the multiple fertilization treatment was not applied to future managed stands. If it had been, eligible future stands would become merchantable sooner and long-term harvest levels would increase. The magnitude of this increase would depend on the long-term funding level assumed for this particular treatment.

2.4 Update Composite Mix of Strategies @ Budget of $3 M/year (only)

This sensitivity examined impacts on the LT4 base case harvest flow from including the composite mix of silviculture treatments, including revised assumptions for fertilization and rehabilitation.

Approach

The model was updated to include the revised assumptions described for multiple fertilization (section 2.3), along with the following assumptions:

- Limiting rehabilitation to only stands with higher levels of merchantable green volume (i.e., 110-139 m³/ha - no rehabilitation option on stands in low or very low sawlog recovery classes).

The revised approach was first confirmed with Nadina district staff before the model was set-up and run. Ultimately, this scenario was expected to be used for preparing the LT4 tactical plan (separate project).

Results

Averaged over the first 15 years, the area of silviculture treatments selected under this scenario (Figure 9) is distributed fairly evenly between rehabilitation (Σ 22,000 ha) and fertilization (Σ 35,000 ha) plus some PCT (Σ 1,000 ha). For the next seventy years, treatments shift primarily to fertilization (Σ 288,000 ha) with a small amount of rehabilitation (Σ 24,000 ha).

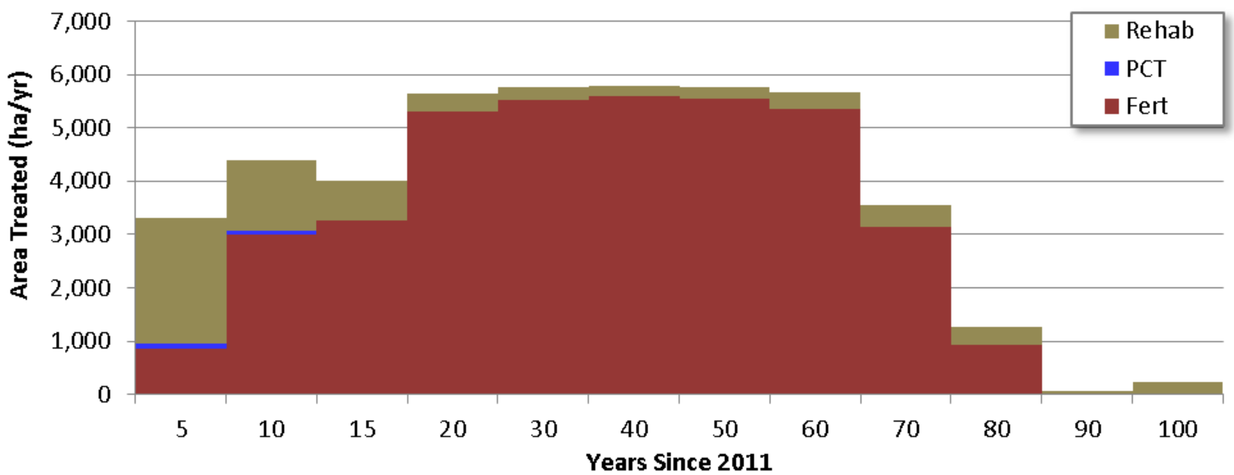


Figure 9 Area treated by silviculture treatment under the composite strategy at $3 M/yr

The revised assumptions generally involved additional area eligible for fertilization and more conservative volumes recovered through rehabilitation. Compared to the previous analysis (Appendix 2; Slide 1), these changes resulted in fertilizing nearly 3 times as much area while rehabilitating about half the area. The ability to access incremental green volume in the mid-term through rehabilitation was a key factor in the previous analysis – and reducing this mechanism made fertilization appear more attractive. To support future fertilization, the model applied five times more PCT but still less than 1,000 ha in total.

Figure 10 shows that besides the third period, the $3M/yr budget assigned to the composite scenario is maximized throughout the short- and mid-term then declines as the area of eligible stands for fertilization decreases. The drop in the third period corresponds with a 50% drop in rehabilitation from the previous period suggesting a lack of appropriate stands to treat over this period.

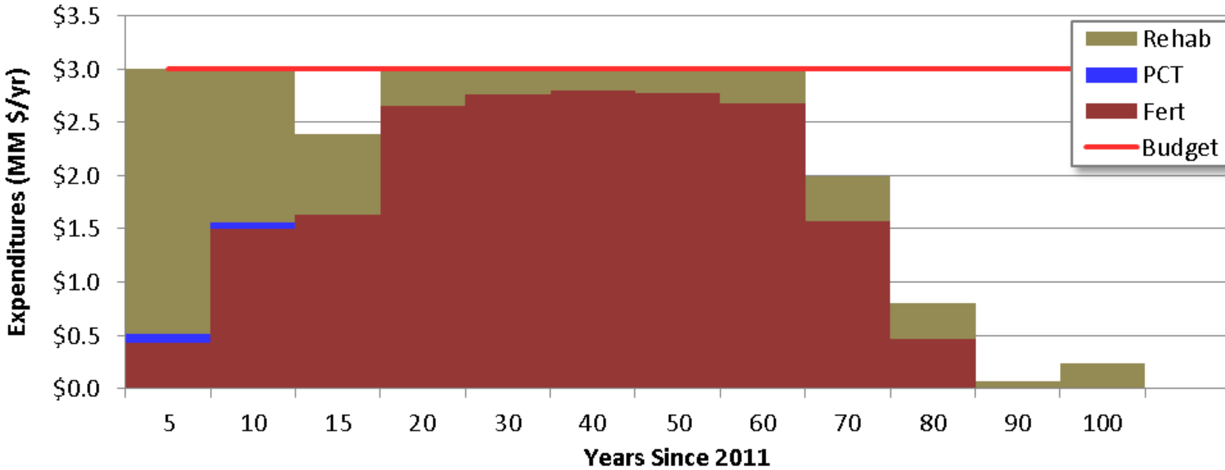


Figure 10 Expenditures over time by silviculture treatment for the composite strategy at $3 M/yr

As expected, a comparison to the previous analysis (Appendix 2; Slide 6) shows a much different distribution of expenditures. In fact, the budget in this analysis was maximized for an additional 3 periods before declining as areas eligible to treat diminished.

The new combination of silviculture strategies improved the harvest flow compared to the base case (Figure 11), particularly throughout the mid-term (+112K m³/yr or 20%) where additional green volume becomes available through the rehabilitation treatments. The rise out of the mid-term is also improved (102K m³/yr or +9%) by gains from fertilization and early rehabilitation of natural stands converted to high-producing managed stands. The increased long-term harvest level (+81K m³/yr or 5%) reflects the additional volume from rehabilitated stands that were otherwise unharvested (i.e., did not meet the minimum harvest criteria in the Base Case).

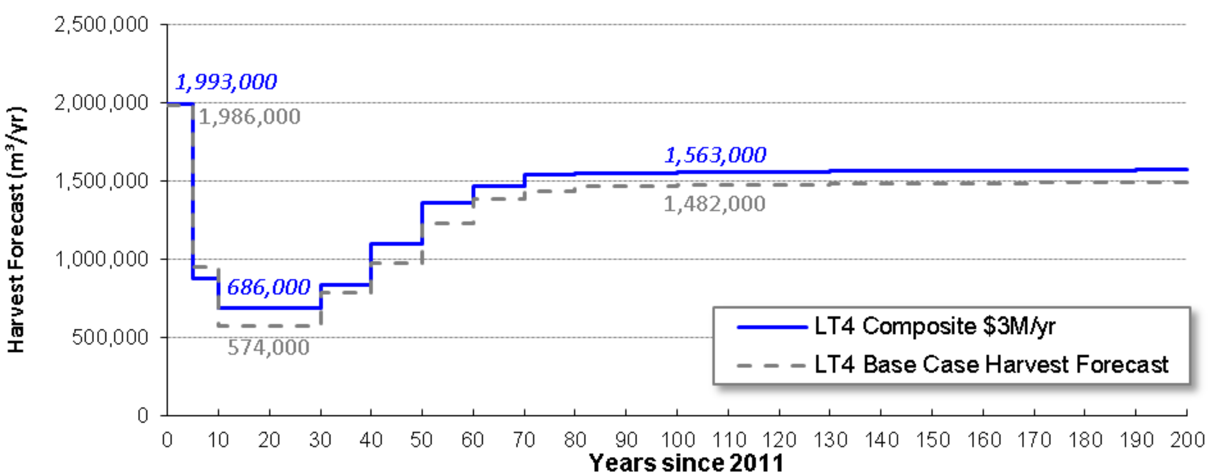
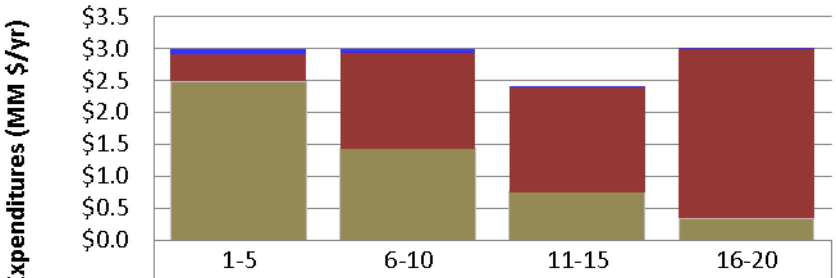


Figure 11 Harvest flow: Base Case compared to composite strategy at $3 M/yr

Compared to the previous analysis, (Appendix 2; Slide 7), new combination of silviculture strategies produced lower gains throughout the mid-term (-48K m³/yr; 6.5%), rise to the long-term (-10K m³/yr; 0.8%) and long-term (-14K m³/yr; 0.9%). This suggests that over the long run, gains added from fertilization are not as effective as the previous assumptions around recovery of sawlog volumes through rehabilitation (i.e., including low and very low sawlog recovery classes).

Figure 12 shows the unmodified expenditures by treatment activity for the next 20 years for the preferred silviculture strategy at $3 M/yr funding. Rehabilitating MPB-damaged stands continues to be the primary activity to fund over the first decade. Afterwards, expenditures switch favour fertilization as more stands become eligible for treatment closer to harvest. PCT remains a relatively minor funding component over the first decade only.



	1-5	6-10	11-15	16-20
PCT	79,000	60,000	6,000	1,000
Fert	429,000	1,500,000	1,628,000	2,658,000
Rehab	2,492,000	1,440,000	757,000	341,000

Figure 12 Expenditures by activity for the preferred silviculture strategy

Compared to the unmodified[3] expenditures in the previous analysis, (Appendix 2; Slide 8), this analysis showed a significant shift towards fertilization treatments over the first 20 years; from 2% to over half of the total funding. While rehabilitation was similar in the first decade, the new scenario significantly increased fertilization in the second decade in lieu of rehabilitation (Appendix 2; Slide 9).

<u>Discussion</u>

The revised assumptions for this scenario generally involved increasing the area eligible for fertilization and assuming less green volume can be recovered through rehabilitation. Not surprisingly, the composite mix of strategies shifted from a focus on rehabilitation, as in the previous analysis, to a focus on fertilization. These revised assumptions align better with the Nadina district staff's expectations.

The harvest flow was reduced, however, compared to the previous analysis. This occurred because the area rehabilitated dropped in half which, in turn, reduced the volume recovered during the mid-term. The reduction in rehabilitation also reduced relative gains over the long-term, since the untreated area was assumed to never reach the minimum merchantability criteria required to contribute to the harvest flow. Moreover, these non-rehabilitated stands never become future managed stands. This assumption likely underestimates the potential recovery of these stands over the long term.

Compared to the previous analysis, expenditures for the revised composite strategy maintained the maximum $3M/yr level from 2 more decades. Significantly more funds were allocated to multiple fertilization and PCT treatments while funds allocated rehabilitation treatments were reduced by half.

[3] The preferred strategy in the Lakes Silviculture Strategy was adjusted by adopting the modelling output from the $7 M/yr budget scenario and reducing the budget to $3 M/yr (more likely) by reducing the area treated under rehabilitation.

3 Summary

Increasing stocking standards to adapt to projected trends with forest health and climate change involved increasing establishment densities and/or adding Fdi and Lw for certain future managed stands. The assumptions applied resulted in a slight decrease in the mid- and long-term harvest level as the new regenerating stand volumes were lower at realized harvest ages.

Reducing regenerating stand growth to reflect additional forest health impacts over those assumed in the Base Case involved increasing OAFs and/or reducing establishment densities for certain existing and future managed stands. The assumptions applied decreased harvest levels in the mid- and long-terms by 12% and 14% respectively.

Compared to the previous analysis, increasing the number of eligible stands for fertilization, alone, did little to improve the short- or mid-term harvest levels but allowed for a faster rise out of the mid-term and a 1.4% increase over the long-term.

The revised composite strategy significantly increased the funding allocation for fertilization over rehabilitation treatments. Increasing the area eligible for fertilization and reducing the area eligible for rehabilitation resulted in reallocating approximately half of the funding towards fertilization treatments. However, the increase in fertilization does not completely make up for the opportunities previously assumed for rehabilitation. Compared to the previous analysis the reduced volume available from rehabilitation resulted in a lower (-6.5%) mid-term harvest level.

As a result of this study, Nadina district staff elected to utilize the revised composite strategy to develop the LT4 Tactical Plan (separate project).

Appendix 1. Revised TIPSY Inputs for Forest Health Runs

Changes to Existing Managed Stand Analysis Units and TIPSY Inputs (bold text; run 1 = yellow; run 2 = blue)

ANALYSIS UNIT DESCRIPTION									TIPSY INPUTS											
EM AU	FM AU	BEC	Species Group	Site Class	Stocking	THLB Area	BURN Area	THLB Pct	PHR Spc	PHR SI	Regen Method	Pct	Delay (yrs)	Establish Density	Spc1	Pct1	Spc2	Pct2	OAF1	OAF2
2010	3007	SBSdk	PLL	G	C	11,491	159	6.4%	PL	19.8	Natural	100	2	1500	Pl	60	Sx	40	0.85	0.95
2010	3007								PL	19.8	Natural	100	2	1500	Pl	60	Sx	40	**0.70**	0.95
2011	3007	SBSdk	PLL	G	D	9,554	92	5.3%	PL	19.8	Natural	100	2	3500	Pl	60	Sx	40	0.85	0.95
2011	3007								PL	19.8	Natural	100	2	3500	Pl	60	Sx	40	**0.70**	0.95
2012	3007	SBSdk	PLL	G	O	852		0.5%	PL	19.9	Natural	100	2	800	Pl	60	Sx	40	0.85	0.95
2012	3007								PL	19.9	Natural	100	2	800	Pl	60	Sx	40	**0.70**	0.95
2013	3007	SBSdk	PLL	G	T	3,218	47	1.8%	PL	19.8	Natural	100	2	5500	Pl	60	Sx	40	0.85	0.95
2013	3007								PL	19.8	Natural	100	2	5500	Pl	60	Sx	40	**0.70**	0.95
2014	3008	SBSdk	PLL	M	C	1,699	15	0.9%	PL	18.7	Natural	100	2	2500	Pl	60	Sx	40	0.85	0.95
2014	3008								PL	18.7	Natural	100	2	2500	Pl	60	Sx	40	**0.70**	0.95
2015	3008	SBSdk	PLL	M	T	139		0.1%	PL	18.5	Natural	100	2	6500	Pl	70	Sx	30	0.85	0.95
2015	3008								PL	18.5	Natural	100	2	6500	Pl	70	Sx	30	**0.70**	0.95
2016	3007	SBSdk	PLP	G	C	6,245	255	3.6%	PL	19.7	Natural	100	2	1500	Pl	90	Sx	10	0.80	0.95
2016	3007								PL	19.7	Natural	100	2	1500	Pl	90	Sx	10	**0.70**	0.95
2017	3007	SBSdk	PLP	G	D	5,190	129	2.9%	PL	19.8	Natural	100	2	3500	Pl	90	Sx	10	0.80	0.95
2017	3007								PL	19.8	Natural	100	2	3500	Pl	90	Sx	10	**0.70**	0.95
2018	3007	SBSdk	PLP	G	O	1,850	0	1.0%	PL	19.8	Natural	100	2	800	Pl	90	Sx	10	0.80	0.95
2018	3007								PL	19.8	Natural	100	2	800	Pl	90	Sx	10	**0.70**	0.95
2019	3007	SBSdk	PLP	G	T	5,929	19	3.3%	PL	19.8	Natural	100	2	6500	Pl	90	Sx	10	0.80	0.95
2019	3007								PL	19.8	Natural	100	2	6500	Pl	90	Sx	10	**0.70**	0.95
2020	3008	SBSdk	PLP	M	C	17,447	3,045	11.3%	PL	18.6	Natural	100	2	2500	Pl	100			0.80	0.95
2020	3008								PL	18.6	Natural	100	2	2500	Pl	100			**0.70**	0.95
2021	3008	SBSdk	PLP	M	D	201	1	0.1%	PL	18.6	Natural	100	2	3500	Pl	90	Sx	10	0.80	0.95
2021	3008								PL	18.6	Natural	100	2	3500	Pl	90	Sx	10	**0.70**	0.95
2022	3008	SBSdk	PLP	M	O	152	1	0.1%	PL	18.6	Natural	100	2	800	Pl	90	Sx	10	0.80	0.95
2022	3008								PL	18.6	Natural	100	2	800	Pl	90	Sx	10	**0.70**	0.95
2023	3008	SBSdk	PLP	M	T	382		0.2%	PL	18.7	Natural	100	2	6500	Pl	90	Sx	10	0.80	0.95
2023	3008								PL	18.7	Natural	100	2	6500	Pl	90	Sx	10	**0.70**	0.95
2029	3011	SBSmc	PLL	G	C	744	9	0.4%	PL	19.3	Natural	100	2	1500	Pl	60	Sx	40	0.85	0.95
2029	3011								PL	19.3	Natural	100	2	1500	Pl	60	Sx	40	**0.70**	0.95
2030	3011	SBSmc	PLL	G	D	764		0.4%	PL	19.3	Natural	100	2	3500	Pl	60	Sx	40	0.85	0.95
2030	3011								PL	19.3	Natural	100	2	3500	Pl	60	Sx	40	**0.70**	0.95
2031	3011	SBSmc	PLL	G	T	146	3	0.1%	PL	19.3	Natural	100	2	6500	Pl	60	Sx	40	0.85	0.95
2031	3011								PL	19.3	Natural	100	2	6500	Pl	60	Sx	40	**0.70**	0.95
2032	3012	SBSmc	PLL	M	C	17,227	258	9.6%	PL	18.2	Natural	100	2	1500	Pl	60	Sx	40	0.85	0.95
2032	3012								PL	18.2	Natural	100	2	1500	Pl	60	Sx	40	**0.70**	0.95

ANALYSIS UNIT DESCRIPTION									TIPSY INPUTS											
EM AU	FM AU	BEC	Species Group	Site Class	Stocking	THLB Area	BURN Area	THLB Pct	PHR Spc	PHR SI	Regen Method	Pct	Delay (yrs)	Establish Density	Spc1	Pct1	Spc2	Pct2	OAF1	OAF2
2033	3012	SBSmc	PLL	M	D	12,781	36	7.0%	PL	18.3	Natural	100	2	3500	Pl	60	Sx	40	0.85	0.95
2033	3012								PL	18.3	Natural	100	2	3500	Pl	60	Sx	40	**0.70**	0.95
2034	3012	SBSmc	PLL	M	O	1,000	19	0.6%	PL	18.3	Natural	100	2	800	Pl	60	Sx	40	0.85	0.95
2034	3012								PL	18.3	Natural	100	2	800	Pl	60	Sx	40	**0.70**	0.95
2035	3012	SBSmc	PLL	M	T	4,930		2.7%	PL	18.2	Natural	100	2	6500	Pl	60	Sx	40	0.85	0.95
2035	3012								PL	18.2	Natural	100	2	6500	Pl	60	Sx	40	**0.70**	0.95
2036	3013	SBSmc	PLL	P	A	172		0.1%	PL	13.7	Natural	100	2	2500	Pl	90	Sx	10	0.85	0.95
2036	3013								PL	13.7	Natural	100	2	2500	Pl	90	Sx	10	**0.70**	0.95
2037	3011	SBSmc	PLP	G	C	1,213	35	0.7%	PL	19.1	Natural	100	2	1500	Pl	90	Sx	10	0.80	0.95
2037	3011								PL	19.1	Natural	100	2	1500	Pl	90	Sx	10	**0.70**	0.95
2038	3011	SBSmc	PLP	G	D	434	2	0.2%	PL	19.2	Natural	100	2	3500	Pl	90	Sx	10	0.80	0.95
2038	3011								PL	19.2	Natural	100	2	3500	Pl	90	Sx	10	**0.70**	0.95
2039	3011	SBSmc	PLP	G	O	309		0.2%	PL	19.3	Natural	100	2	800	Pl	90	Sx	10	0.80	0.95
2039	3011								PL	19.3	Natural	100	2	800	Pl	90	Sx	10	**0.70**	0.95
2040	3011	SBSmc	PLP	G	T	137		0.1%	PL	19.3	Natural	100	2	7500	Pl	90	Sx	10	0.80	0.95
2040	3011								PL	19.3	Natural	100	2	7500	Pl	90	Sx	10	**0.70**	0.95
2041	3012	SBSmc	PLP	M	C	21,010	430	11.8%	PL	18.2	Natural	100	2	1500	Pl	100			0.80	0.95
2041	3012								PL	18.2	Natural	100	2	1500	Pl	100			**0.70**	0.95
2042	3012	SBSmc	PLP	M	D	10,701	50	5.9%	PL	18.2	Natural	100	2	3500	Pl	90	Sx	10	0.80	0.95
2042	3012								PL	18.2	Natural	100	2	3500	Pl	90	Sx	10	**0.70**	0.95
2043	3012	SBSmc	PLP	M	O	3,501	72	2.0%	PL	18.3	Natural	100	2	800	Pl	90	Sx	10	0.80	0.95
2043	3012								PL	18.3	Natural	100	2	800	Pl	90	Sx	10	**0.70**	0.95
2044	3012	SBSmc	PLP	M	T	5,713	40	3.2%	PL	18.2	Natural	100	2	6500	Pl	90	Sx	10	0.80	0.95
2044	3012								PL	18.2	Natural	100	2	6500	Pl	90	Sx	10	**0.70**	0.95

Notes:

- *BEC Groups: ESSFmc (ESSFmc/mv1/mv3/mvp/mcp/BAFAun); SBSdk (SBSdk/dw3/wk3); SBSmc (SBSmc2)*
- *Species Groups: PLP=Pure Pine (Pl, Pa ≥ 80%); PLP=Pine Leading (Pl, Pa ≥ 40% & <80%); SXL=Spruce Leading (Sb, Se, Sw, Sx, Ba, Bl ≥40%); DEL=Deciduous Leading (At, Ac, Dr, Ep ≥40%)*
- *Stocking Classes (Total Stems): A=All; O=Open (0 to <1000 sph), C=Closed (1,000 to <2,500 sph), D=Dense (2,500 to <4,500 sph), T=Thick (4,500 to <25,000 sph), R=Repressed (≥25,000 sph)*
- *Site Classes (PHR Site Index): A=All; G=Good (≥19m); M=Medium (≥15m & <19m); P=Poor (<15m)*
- *Natural regeneration methods were applied to reflect the spatial pattern of trees at establishment. Stands were actually regenerated using both artificial and natural methods.*
- *As existing managed stands were configured in TIPSY with only natural regeneration methods, genetic gains were not applied.*
- *The analysis units described here do not include criteria that divide units further (e.g., Age class for MPB attacked stands, MPB impact classes, Wildfire impacts)*

Changes to Future Managed Stand Analysis Units and TIPSY Inputs (bold text; run 1 = yellow; run 2 = blue)

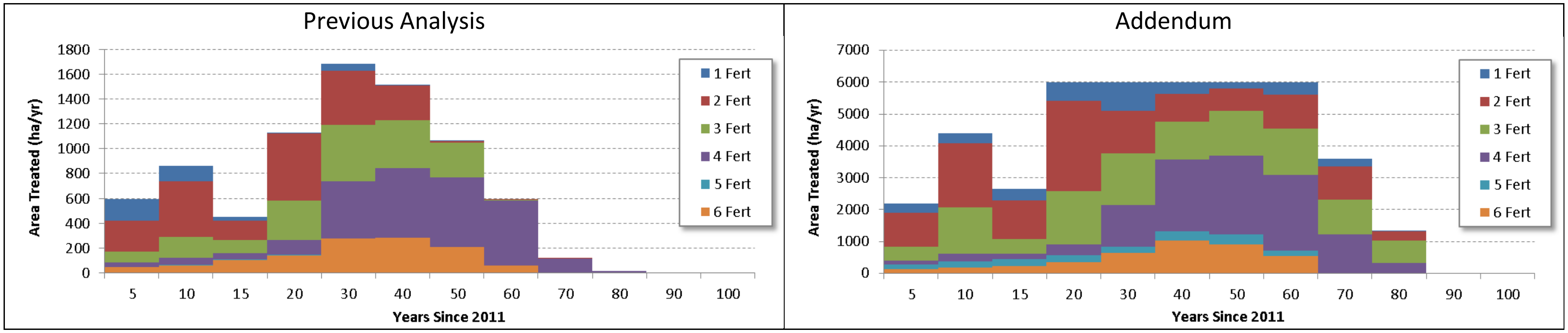
ANALYSIS UNIT DESCRIPTION						TIPSY INPUTS															
FM AU	BEC	Species Group	Site Class	THLB Area	THLB Pct	PHR Spc	PHR SI	Regen Method	Pct	Delay (yrs)	Establish Density	Spc1	Pct1	Spc2	Pct2	Spc3	Pct3	Spc4	Pct4	OAF1	OAF2
3007	SBSdk	PLL	G	119,117	22.3%	PL	20	Plant	100	2	1500	Pl	70	Sx	30					0.85	0.95
3007						PL	20	Plant	100	2	**1100**	Pl	70	Sx	30					**0.70**	0.95
3007						PL	20	Plant	100	2	**1600**	Pl	**40**	Sx	30	**Fd**	**20**	**Lw**	**10**	0.85	0.95
3008	SBSdk	PLL	M	29,771	5.6%	PL	19	Plant	100	2	1500	Pl	60	Sx	40					0.85	0.95
3008						PL	19	Plant	100	2	**1100**	Pl	60	Sx	40					**0.70**	0.95
3008						PL	19	Plant	100	2	**1600**	Pl	**30**	Sx	40	**Fd**	**20**	**Lw**	**10**	0.85	0.95
3009	SBSdk	SXL	G	3,472	0.7%	SX	19	Plant	100	2	1500	Sx	70	Pl	30					0.85	0.95
3009						SX	19	Plant	100	2	1500	Sx	**60**	Pl	**10**	**Fd**	**20**	**Lw**	**10**	0.85	0.95
3010	SBSdk	SXL	M	28,134	5.3%	SX	18	Plant	100	2	1500	Sx	70	Pl	30					0.85	0.95
3010						SX	18	Plant	100	2	1500	Sx	**60**	Pl	**10**	**Fd**	**20**	**Lw**	**10**	0.85	0.95
3011	SBSmc	PLL	G	10,316	1.9%	PL	19	Plant	100	2	1500	Pl	70	Sx	30					0.85	0.95
3011						PL	19	Plant	100	2	**1100**	Pl	70	Sx	30					**0.70**	0.95
3011						PL	19	Plant	100	2	**2000**	Pl	**55**	Sx	30	**Fd**	**10**	**Lw**	**5**	**0.80**	0.95
3012	SBSmc	PLL	M	185,385	34.8%	PL	18	Plant	100	2	1500	Pl	60	Sx	40					0.85	0.95
3012						PL	18	Plant	100	2	**1100**	Pl	60	Sx	40					**0.70**	0.95
3012						PL	18	Plant	100	2	**1600**	Pl	**45**	Sx	40	**Fd**	**10**	**Lw**	**5**	0.85	0.95
3013	SBSmc	PLL	P	226	0.0%	PL	14	Plant	100	2	1500	Pl	50	Sx	50					0.85	0.95
3013						PL	14	Plant	100	2	**1100**	Pl	50	Sx	50					**0.70**	0.95
3014	SBSmc	SXL	G	24,148	4.5%	SX	19	Plant	100	2	1500	Sx	60	Pl	40					0.85	0.95
3014						SX	19	Plant	100	2	1500	Sx	60	Pl	**25**	**Fd**	**10**	**Lw**	**5**	0.85	0.95
3015	SBSmc	SXL	M	33,056	6.2%	BL	16	Plant	100	2	1500	Sx	70	Pl	30					0.85	0.95
3015						BL	16	Plant	100	2	1500	Sx	70	Pl	**15**	**Fd**	**10**	**Lw**	**5**	0.85	0.95

Notes:

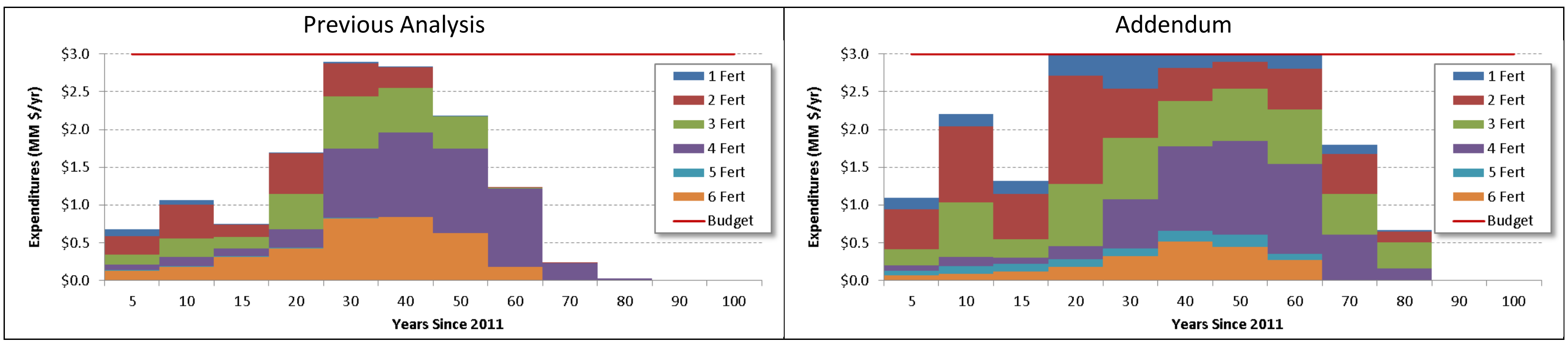
- *BEC Groups: ESSFmc (ESSFmc/mv1/mv3/mvp/mcp/BAFAun); SBSdk (SBSdk/dw3/wk3); SBSmc (SBSmc2)*
- *Species Groups: PLP=Pure Pine (Pl, Pa ≥ 80%); PLP=Pine Leading (Pl, Pa ≥ 40% & <80%); SXL=Spruce Leading (Sb, Se, Sw, Sx, Ba, Bl ≥40%); DEL=Deciduous Leading (At, Ac, Dr, Ep ≥40%)*
- *Site Classes (PHR Site Index): A=All; G=Good (≥19m); M=Medium (≥15m & <19m); P=Poor (<15m)*
- *Planting regeneration methods were applied to reflect the spatial pattern of trees at establishment. Stands were actually regenerated using both artificial and natural methods.*
- *Genetic Gains were applied accordingly: 7.7% to Pine (all BEC Groups) and 13.2% to Spruce (Only SBSdk & SBSmc BEC Groups)*
- *The analysis units described here do not include criteria that divide units further (e.g., Age class for MPB attacked stands, MPB impact classes, Wildfire impacts)*

Appendix 2. Results from previous analysis compared to results from this addendum

The following slides compare results from the previous analysis[4] to results from the analysis undertaken in this addendum.

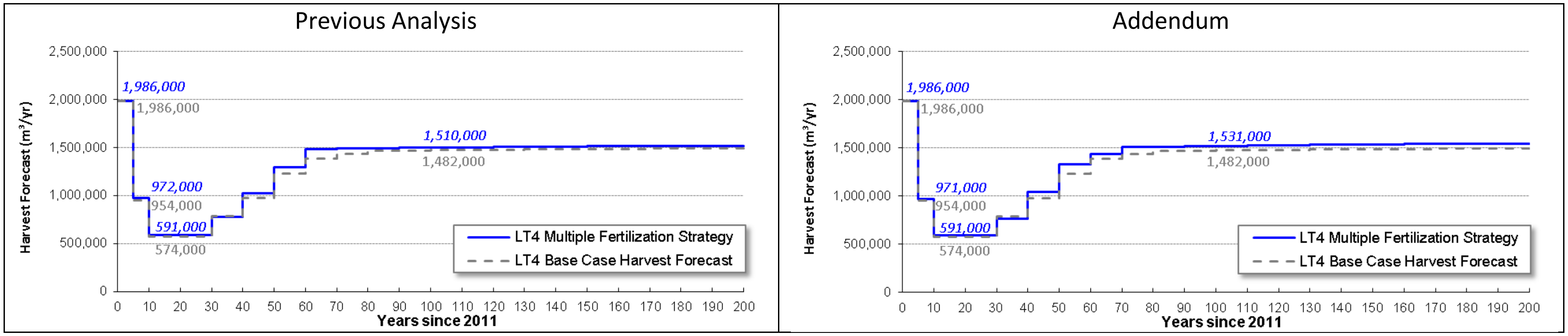


Slide 1 Comparison of area treated under each fertilization regime

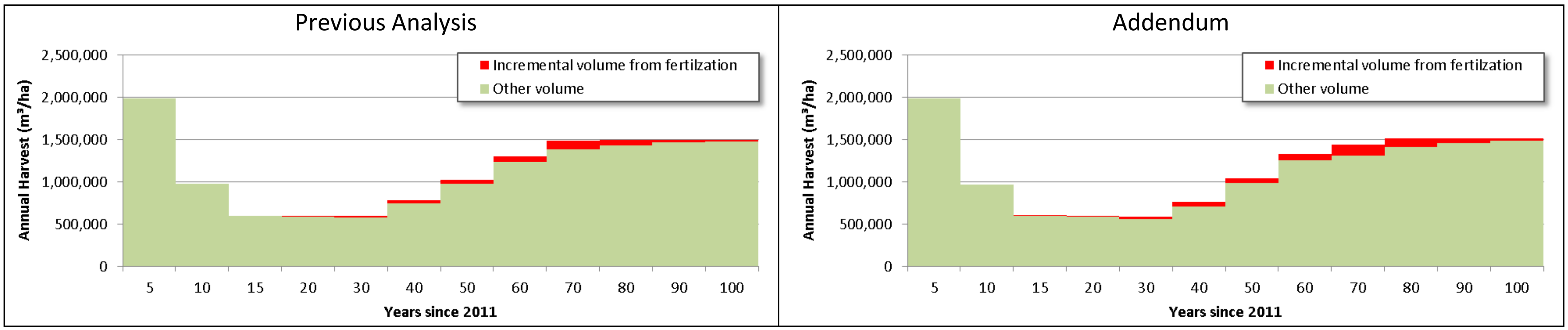


Slide 2 Comparison of expenditures over time for the multiple-fertilization strategy

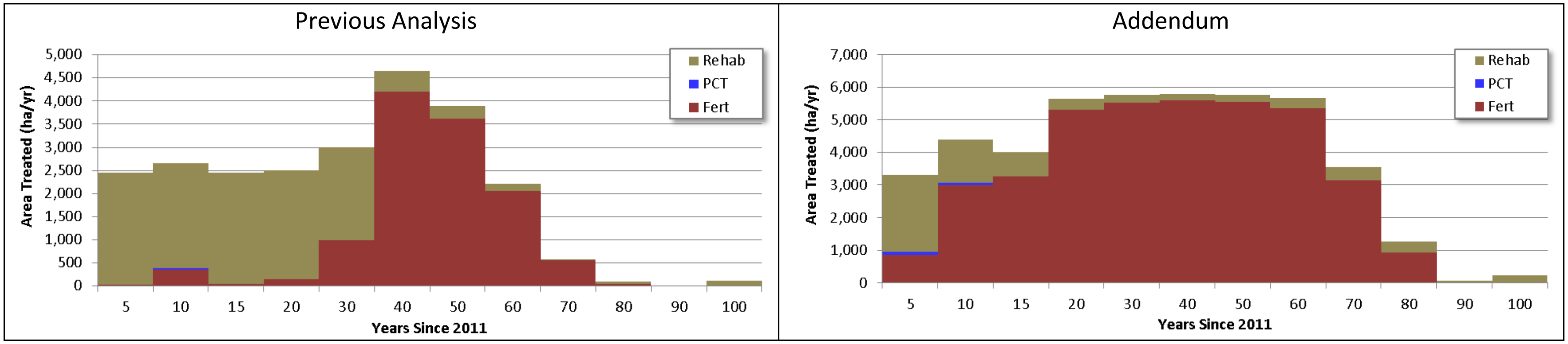
[4] Forsite Consultants Ltd. 2013. *Lakes TSA - Type 4 Silviculture Strategy, Modelling and Analysis Report.* Version 1.1. Technical Report.



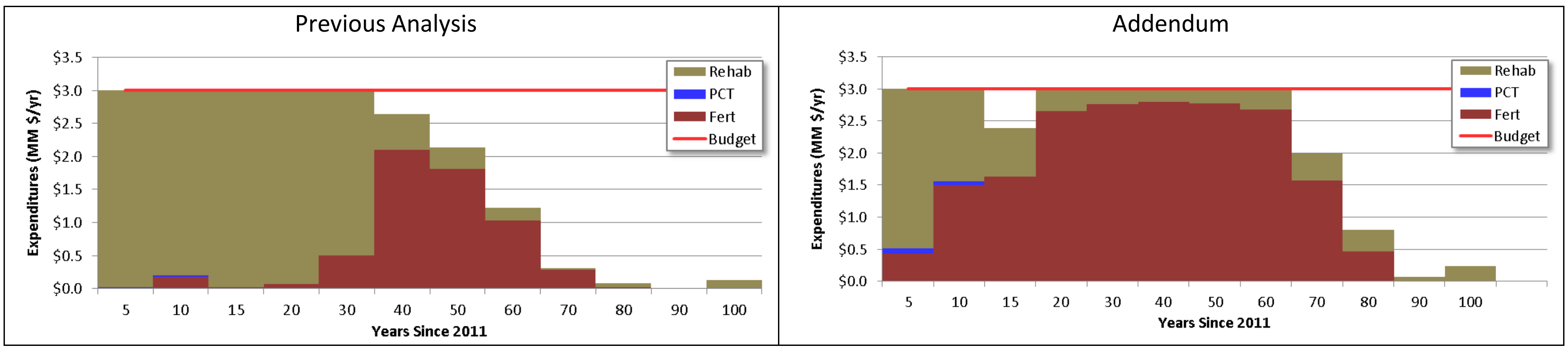
Slide 3 Comparison of harvest flows: Base Case compared to multiple-fertilization strategy



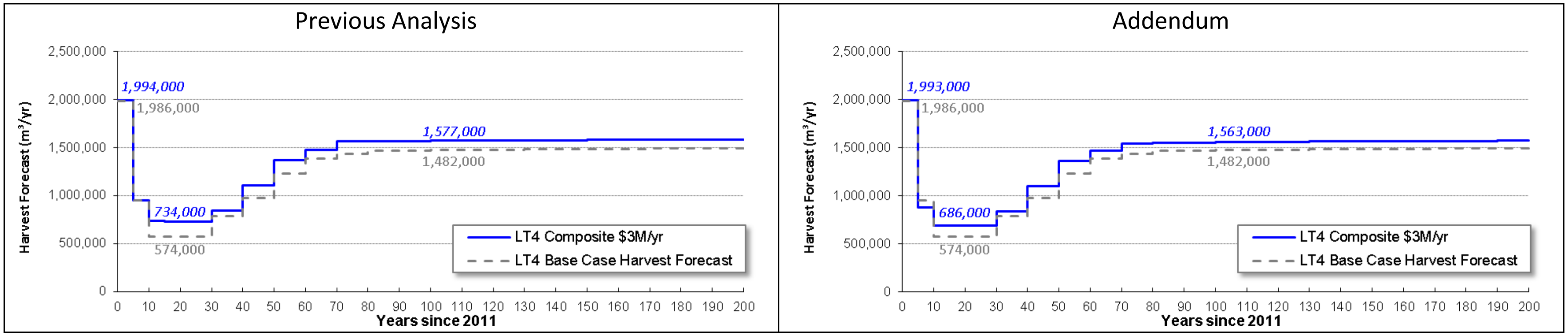
Slide 4 Comparison of harvest flows: Incremental volume harvested in the multiple-fertilization strategy



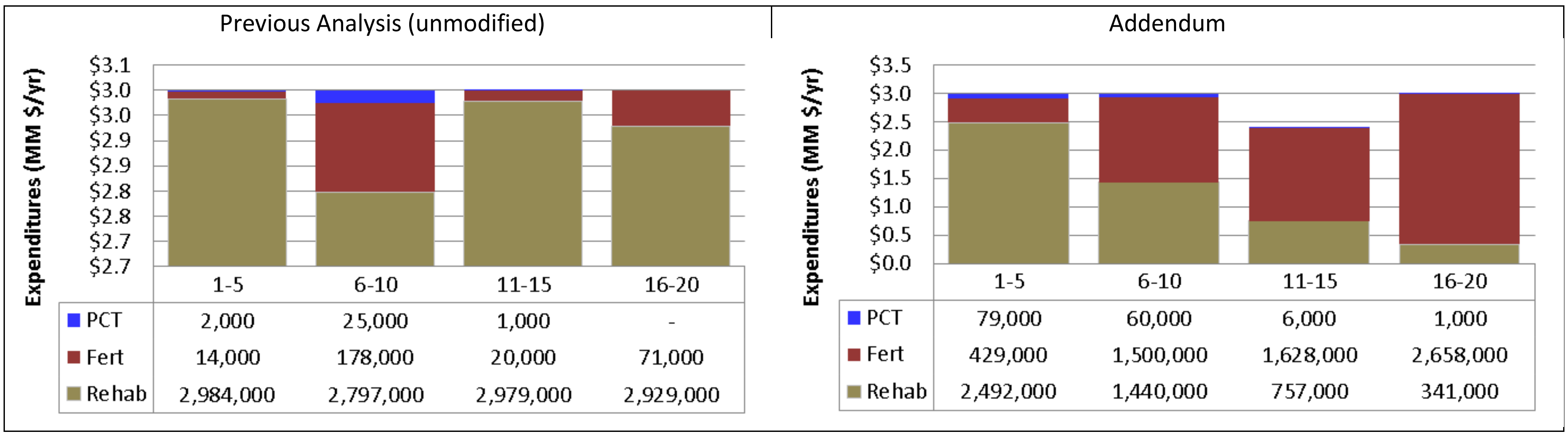
Slide 5 Comparison of area treated by silviculture treatment under the composite strategy at $3 M/yr



Slide 6 Comparison of expenditures over time by silviculture treatment for the composite strategy at $3 M/yr



Slide 7 Comparison of harvest flows: Base Case compared to composite strategy at $3 M/yr



Previous Analysis (unmodified)

	1-5	6-10	11-15	16-20
PCT	2,000	25,000	1,000	-
Fert	14,000	178,000	20,000	71,000
Rehab	2,984,000	2,797,000	2,979,000	2,929,000

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	1-5	6-10	11-15	16-20
PCT	79,000	60,000	6,000	1,000
Fert	429,000	1,500,000	1,628,000	2,658,000
Rehab	2,492,000	1,440,000	757,000	341,000

Slide 8 Comparison of expenditures by activity for the preferred silviculture strategy

Previous Analysis (unmodified)

Years 2011-2020

Priority	Treatment	Target Area (ha/yr)	Unit Cost ($/ha)	Target Funding ($M/yr)
1	Rehab	2,310	1,250	2.888
2	Fertilize	190	500	0.095
3	PCT	20	800	0.016

Years 2021-2030

Priority	Treatment	Target Area (ha/yr)	Unit Cost ($/ha)	Target Funding ($M/yr)
1	Rehab	2,360	1,250	2.950
2	Fertilize	90	500	0.045
3	PCT	0	800	-

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Years 2011-2020

Priority	Treatment	Target Area (ha/yr)	Unit Cost ($/ha)	Target Funding ($M/yr)
1	Rehab	1,570	1,250	1.963
2	Fertilize	1,930	500	0.965
3	PCT	90	800	0.072

Years 2021-2030

Priority	Treatment	Target Area (ha/yr)	Unit Cost ($/ha)	Target Funding ($M/yr)
1	Rehab	480	1,250	0.600
2	Fertilize	4,710	500	2.355
3	PCT	0	800	-

Slide 9 Comparison of target silviculture programs