Forest Research Partnership

Comparison of new FRP Yield Curves on Multiple Tembec Forests in NE Ontario

Project No: 130 - 010

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Executive Summary

This study undertook to measure the sole effect of using newly developed (FRP) yield curves in existing wood supply modeling scenarios on multiple forests that Tembec operates upon in Northeastern Ontario. The goal of the study was to determine whether the application of new yield information would alone affect (significantly or otherwise) the established SPF harvest levels, or contribute toward Tembec's 10/10 objective.

The combined results from this study demonstrate a positive short-term increase in potential SPF supply. Separate forests each demonstrate differing effects – some demonstrate little change at all. This study has also identified that the forecast SPF supply from two Tembec forests (Romeo Malette and Smooth Rock Falls) is very sensitive to "binding SPF volume limits" which have been applied to these forest in order to (a) regulate future landscape metrics, and (b) act as a surrogate regulator for wildlife habitat supply.

Tembec managers should exercise caution in interpreting what future SPF levels may be as a function of (strictly) this one study. Why? Because while some modeling inputs contribute toward a forecast increased SPF supply (ie. new FRP yield curves that suggest that there is a marginally increased SPF supply potential), other emerging planning guideline requirements (Natural Disturbance Pattern Emulation Guidelines, Old Growth Guidelines) will contribute toward a significantly decreased SPF supply forecast. This study captures what (positive) effects new FRP yield curves contribute toward the forecast SPF supply, but it does not capture the likely negative effects of the new guideline applications described above: the explicit guideline application requirements currently in 2003 are more restrictive than they were in 2000.

Methods

The selected management alternative SFMM scenarios used for the recent Forest Management Plans on each separate forest were used as a benchmark case for this study. All SFMM case files were supplied by Tembec.

Most of these forests used Forest Units (FU) which were, if not identical, reasonably similar to the 'Standard Forest Units' for which Margaret Penner developed new yield data. The one forest that had unique FU descriptions, the Gordon Cosens Forest, was dealt with somewhat separately. (Margaret Penner 'reversed-engineered' the process for this forest in order to develop FRP yield curves which related directly to the unique Gordon Cosens FUs – thereby eliminating risks that apple-to-oranges comparisons might obscure results)

For each forest studied, the FMPoriginal case, a Benchmark case, and a new FRPYield case were compared. On those forests where *no binding SPF volume limits* were mandated, the FMPoriginal case and the Benchmark case are identical. On those forests *where binding SPF volume limits were* mandated, the Benchmark case was altered to simply make these limits non-binding. SFMM would attempt to meet these specified volume targets, but would not be limited by them.

On each forest, a matrix was developed for each FU which described the expected species composition, stocking, and site class – for each renewal intensity (see NEBIE matrix below). Tembec supplied these matrixes - those used for the FMP original case. These renewal parameters were input into the new FRP yield curve templates for that FU, and new FRP yield curve estimates were developed. These new estimates were copied into a new FRPYield case replacing the other yield estimate, and the SFMM model was rerun. All other modeling assumptions (age operability limits, succession, habitat targets, reserve areas etc.) and constraints were unedited.

Management Unit			Timmins MU				Forest Unit			SP1				Avg Site class	1.4
Age to breast height (1.3m) =						10	for natural stands			(default = 6 years)					
		Species Composition													
	Code	stocking	Pw	Pj	Sb	Sw	Bf	Ce	La	He	Po	Bw	Mh	UH	LH	
Present		0.74		0.15	0.60	0.03	0.07	0.00	0.00	0.00	0.07	0.08				1.00
Extensive		0.70		0.05	0.57	0.03	0.07	0.00	0.00	0.00	0.20	0.08				1.00
Basic 1		0.75		0.15	0.60	0.03	0.07	0.00	0.00	0.00	0.07	0.08				1.00
Basic 2																0.00
Intensive1		0.80		0.15	0.70	0.00	0.00	0.00	0.00	0.00	0.07	0.08				1.00
Intensive2																0.00

Firstly, the SPF wood supplies between these three scenarios were reported graphically and in table format. Two specific elements were reported on for each forest:

(a) The overall SPF supply change over the next 50 years, and

(b) (b) the SPF Volume per hectare harvested, by FU, over the next 50 years. While the overall SPF supply change is obviously important as a result, the other results (SPF Volume per hectare harvested, by FU) are equally important too as they allow an understanding, by FU, of the source of the change in SPF supply.

Secondly, for each forest unit and Renewal intensity , the two yield curves for the Present Renewal intensity were graphed on the same axis to compare the trends of differences between the FRP yields and the FMPoriginal yields. Trends by FU were observed for all ten MUs studied. To the degree that the two 'Present' yield curves differ, the short /mid-term SPF supply would be expected to change as well.

Results

As stated in the executive summary above, the overall combined SPF supply change attributable solely to the use of new FRP yield curve data is both positive, and small. Detailed results, for each forest, can be reviewed in the attached Excel spreadsheets. Additionally, these results can be aggregated into a summary Table 2.

Clear trends in comparing graphically the two yield curves , by FU can be generalized as follows:

- new FRP **PJ1** yield estimates are significantly higher than old estimates AND the rate of volume loss beyond age 110 is much less in the FRP curves than in the FMPoriginal. Many Tembec foresters have confirmed this anonoly, and have suggested that this be examined more closely (it is felt that the Pj decline rate is faster than is suggested in the FRP curves).

- new FRP **PJ2** estimates (mixed pine) are similar if not marginally higher than FMPoriginal estimates, AND the rate of volume loss beyond age 110 is much less in the FRP curves than in the FMPoriginal – as per PJ1.

- new FRP **SB1** yield estimates (organic spruce) are similar if not marginally higher than FMPoriginal estimates.

- new FRP **SP1** estimates (mixed spruce upland) are similar if not marginally higher than FMPoriginal estimates.

- new FRP **SF1** estimates (mixed spruce fir) are VERY DISSIMILAR to FMPoriginal estimates. Margaret Penner has expressed concern about this and has advised Tembec to use these yield curves with caution (*see italics email note below). There are concerns with this SF1 FU because of the degree of heterogeneity of species within the FU, and the very limited PSP datasets from which the FRP curves were developed. This too is an area for further study.

Hi Colin,

There are a number of reasons to view results of the SF1 with caution.

First, the sample size. There are 32 PSPs with a total of 45 measurements in the Ontario dataset. The bulk of the data come from Quebec. That's not to say there is anything wrong with the Quebec data but this forest unit has less than 100 plots from Ontario.

Second, in the RMF, the site class drops from a site class of 1 around ages 65-75 to a site class of 1.5 by age 130 and continues to drop to about 1.9 by age 155. The yield curves assume a constant site index with age although this could be modified.

Third, this and the PJ2 forest unit show significant shifts in species composition over time in the RMF (again, there isn't much PSP data to work with). This has not been incorporated into the curves (although a custom species curves is available for the RMF because I have their inventory). This also indicates that correct forest unit assignment and succession rules are probably very important for this unit.

A note on the volumes. The SF1 data shows less recoverable volume than the SP1 and SB1 for the same BA and Top height. I attribute this to the Po, Bw, Ce, and Bf in the SF1. As well, the SF1 has more than double the cull, again, due to the presence of these other species. I would expect that, for a given stocking and site class, the SB would have the lowest yields, then the SF, then the SP. However, the SF has the lowest proportion of SPF species so I'm not surprised it shows up lower.

Margaret Penner Forest Analysis Ltd.

Discussion

The overall corporate SPF supply is complex, and cannot be understood simply. This study indicates the change in the ~year2000 SPF wood supply solely due to the use of new FRP yield curves only. A current evaluation of Tembec's overall corporate SPF supply must include the negative impacts (-20% < SPF > -5%) of emerging planning requirements (Natural Disturbance Pattern Emulation Guidelines, Old Growth Guidelines etc…) in order to be relevant to Tembec's current decision making.

Seven major elements that will affect the Tembec SPF supply forecast are as follows:

1. Which forests/FUs , on an area-weighted basis, are the most significant to SPF supply?
2. Which forests produce more PJ than SB than BF?
3. Which MUs are solely Tembec SFLs, versus SFLs managed by either Abitibi, TFA, Hearst, or as cooperatives?
4. What is the relative area distribution of organic SB, upland SB, and PJ on each forest?
5. Which forests have an accurate and current inventory of the hectares established as 'new forest' plantations?
6. Which forests are constrained by age-class gaps, landscape metrics requirements, or habitat supply requirements?
7. How each forest manager uses strategies to address the constraints described above?

Detailed graphical results for each Management Unit are supplied with this report to the FRP, but are not included in the text of this document. MU specific dynamics can be seen in these graphs.

The answer to Question#1 is found in the Table1 below : it indicates the Initial Available Areas, by MU, for select FUs. Those FUs depicted in red bold text are significant on an area weighted basis. Changes in yield curves for these specific FUs will alter the SPF supply forecast .

It can be seen that the relative area represented by the SF1 FU is very small (1% - 2%). This is fortunate given the questions about the yield curve accuracy as described above.

It can also be seen that although the significantly increased (FRP) PJ1 yields looks promising, the available PJ1 area is very small (0.5% - 1.5%) .
The only exception to this is found on the Timiskaming Forest where there is 110,000 ha of initially available PJ1 area.

Table 1. Relative Available Initial Areas by MU / FU

Initial Available Areas, by MU, for select FUs

MU	FU	Initial Available Area (ha)		Initial Available Area Percent
Gordon Cosens	LsF	335,305		**10.8%**
	LsW	90,275		2.9%
	Pn1	24,911	**MU Total**	0.8%
	UpC	270,837	721,328	**8.8%**
Iroquios Falls	Pjpur	20802		0.7%
IFF South & North	Pjmix	13529		0.4%
	Sbloc	165256		**5.3%**
	Sbloh	108057	**MU Total**	3.5%
	Spupl	175822	483,466	**5.7%**
Moose River	Sp1	28,960		0.9%
	Sbc	303,262		**9.8%**
	Sbh	13,849		0.4%
	Sf1	10,438		0.3%
	Pj1	11,018	**MU Total**	0.4%
	Pj2	5,742	373,269	0.2%
Nighthawk	PJ1	17,058		0.6%
	PJ2	4,955		0.2%
	SB1	104,461		3.4%
	SB3	24,468		0.8%
	SF1	34,776	**MU Total**	1.1%
	SP1	18,403	204,121	0.6%
Romeo Malette	PJ1	25,920		0.8%
	PJ2	14,044		0.5%
	SB1	98,810		3.2%
	SF1	25,776	**MU Total**	0.8%
	SP1	43,800	208,350	1.4%
Smooth Rock Falls	MixCo	15,036		0.5%
	SbINT	65,320		2.1%
	SbCLG	123,713		**4.0%**
	SbH	18,064	**MU Total**	0.6%
	SpUPL	8,750	230,883	0.3%
Timiskaming Forest	SbMixCon	57,377		1.9%
	SbLow	74,187		2.4%
	SbFirCedar	36,651		1.2%
	Jackpine	110,651	**MU Total**	**3.6%**
	PjMixCon	39,718	318,584	1.3%
Hearst	Jackpine	22,901		0.7%
	SbSC3	124,901		**4.0%**
	SbSlope	236,391		**7.6%**
	SbFlat	143,450	**MU Total**	**4.6%**
	SbSwamp	23,358	551,001	0.8%
		3,091,002	**3,091,002**	**100.0%**

Note :
Red Bold Text (left), highlights ten largest FU areas.

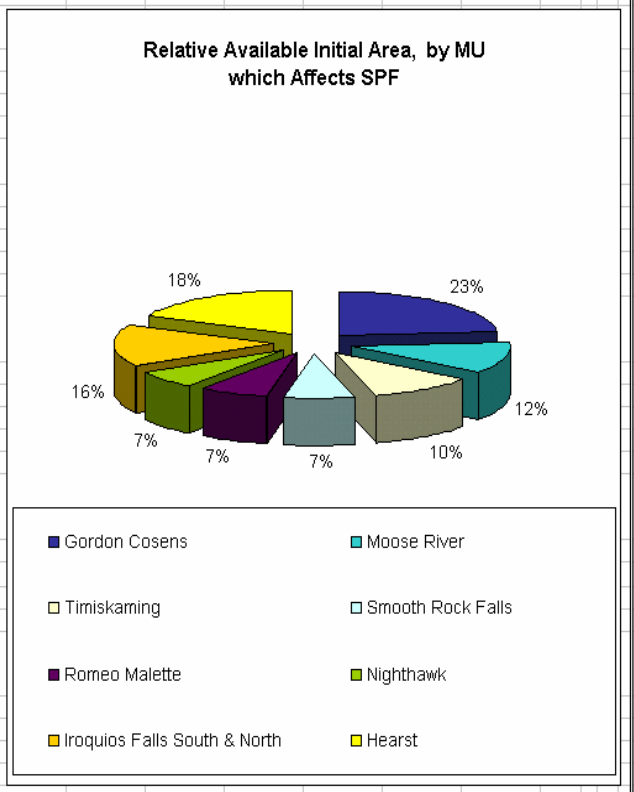


Table2. Multiple MU Summary of SPF Supply Forecast Change

Multiple Forest Summary of Annual SPF Volume Change

due to New FRP Yield Curve Inputs AND the Effect of NonBinding SPF Targets

SPF Volume targets NON BINDING FOR ALL SCENARIOS	term	SPF Vol Original FMP (000 m3)	SPF Vol Bench A (000 m3)	SPF Vol NewYields B (000 m3)	SPF Vol Difference B - A (000 m3)		Change per Term 10/10 Objective% of Yield curves ONLY
ALL FORESTS EXAMINED BELOW COMBINED	1	3,875	3,907	4,304	394		10.1%
	2	3,705	3,746	4,097	342		9.1%
	3	3,553	3,572	3,905	317		8.9%
	4	3,506	3,515	3,795	267		7.6%
	5	3,484	3,467	3,797	323		9.3%
MU							
Iroquois Falls Forest	1	553	553	660	107	NOTE 1	19%
	2	521	521	612	91		17%
	3	493	493	580	87		18%
	4	472	472	578	106		22%
	5	422	422	526	104		25%
Moose River and Cochrane CMU SubUnits	1	325	325	402	77	NOTE 2	24%
	2	315	315	341	26		8%
	3	315	315	315	0		0%
	4	315	315	318	3		1%
	5	315	315	350	35		11%
Nighthawk Forest Driftwood and Timmins SubUnits	1	215	215	235	20	NOTE 3	9%
	2	201	201	217	16		8%
	3	182	182	213	31		17%
	4	172	172	214	42		24%
	5	173	173	219	46		27%
Romeo Malette	1	306	304	306	2	NOTE 4	1%
	2	285	283	286	3		1%
Little change Terms 1 -4	3	270	268	290	22		8%
Deferral Areas specified 0 - 60 years	4	260	259	273	14		5%
	5	260	256	288	32		13%
Smooth Rock	1	266	300	343	43	NOTE 5	14%
	2	220	263	295	32		12%
Highly Sensitive to binding SPF targets	3	200	221	248	27		12%
SPF Targets used as Surrogate	4	175	185	211	26		14%
for Deferral Strategies	5	175	162	176	14		9%
Gordon Cosens	1	1,134	1,134	1,137	3	NOTE 6	0%
	2	1,110	1,110	1,119	9		1%
Little change Terms 1 & 2 & 3 &4	3	1,067	1,067	1,083	16		1%
	4	1,063	1,063	1,076	13		1%
	5	1,040	1,040	1,047	7		1%
Timiskaming	1	456	456	610	154	NOTE 7	34%
	2	433	433	607	174		40%
Signif. Increase in PJ1 Present Yield	3	406	406	561	155		38%
results in Change	4	439	439	520	81		18%
	5	490	490	594	104		21%
Hearst	1	620	620	611	-9	NOTE8	-1%
	2	620	620	620	0		0%
Little change Terms 1 - 5	3	620	620	615	-5		-1%
	4	610	610	605	-5		-1%
	5	609	609	597	-12		-2%

NOTE 1 Significant difference between FRP/FMP SbloC Present Yields, coupled with extensive area of this FU

NOTE 2 Marginal difference between FRP/FMP SbC Present Yields between ages A95-A175, coupled with extensive area in these specific age classes.

NOTE 3 Significant difference between FRP/FMP PJ1 Present Yields, coupled with large area of this FU

NOTE 4 Little change in Terms 1 & 2. Marginal change in medium term.

NOTE 5 Highly sensitive to binding SPF targets which were used as a surrogate for a deferral strategy.

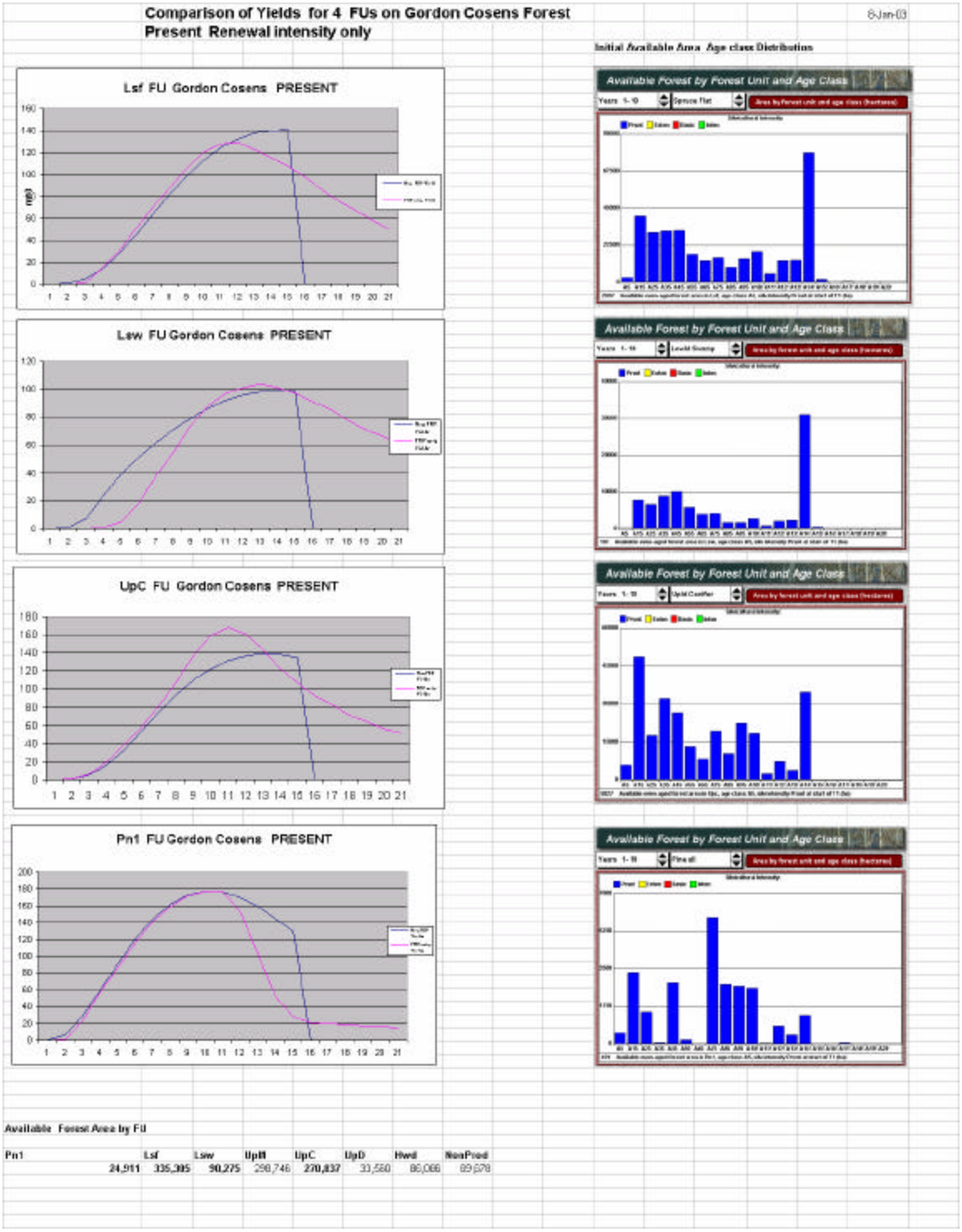
NOTE 6 Negligable change due to FRP yield curve substitution: ie. the two yield curve sets are very similar.

NOTE 7 Most all of the SPF gains are related to the PJ1 forest unit, and are in the jackpine species only.

NOTE 8 Little change in Terms 1 - 5.

Gordon Cosens Forest

The Gordon Cosens Forest is critical to SPF supply, as it contributes greatly toward the overall supply. The SPF supply change on the Gordon Cosens Forest (attributable solely to the use of new FRP yield curve data) is very small – ie. the old yield estimates and the new ones are quite similar.



Moose River MU (Moose River and Cochrane SubUnits)

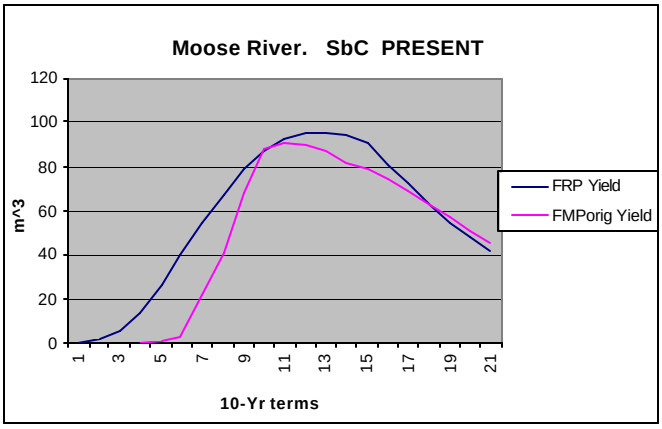
The Moose River MU also affects the SPF supply as it represents such a large area.

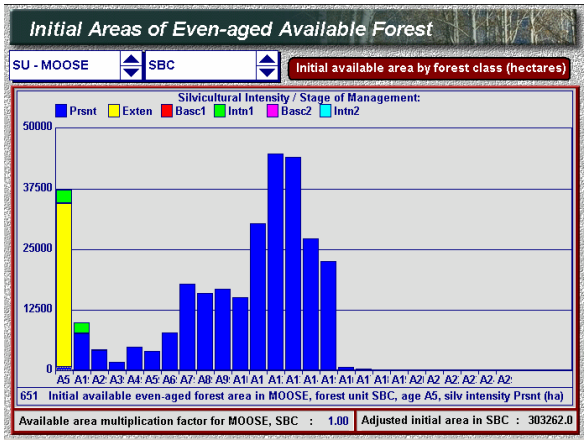
The **SbC** FU has 303,250 ha currently available. Despite that the comparison of the two yield curves shows similar SPF yield (using the FRP data) at age 95, it is significant that the FRP yields are higher between age95 – age175.

- The lower operability age limit is 110 years for SbC.
- There is approximately 184,000 ha of area on the Moose River MU within this age window.
- Succession doesn't begin until age 185.

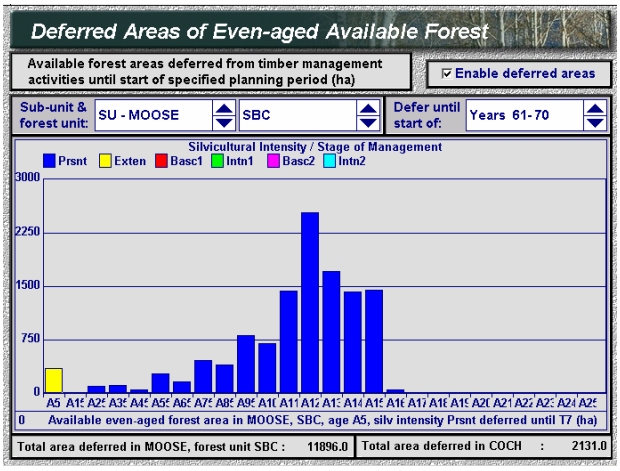
The coincidence of these three facts/assumptions results in a forecast of increased SPF availability on this MU for the next 20 years.

It should be noted that only 15,000 ha (approx.) of spruce is deferred on the Moose River MU - for the next 60 years. These deferral modeling inputs are supposed to include: retention of areas of core habitat, *and* ack of access to portions of the MU. This would appear to be a very small deferral area assumption, given the nature of the MU. Any revised increased deferral assumption set (scope, or timing) would reduce the SPF potential.





ageclass	intial area
A105	14,987
A115	30,178
A125	44,466
A135	43,791
A145	27,119
A155	22,330
A165	648
A175	307
A185	170
A195	27
	184,023



Smooth Rock Falls and Romeo Malette MUs

The Smooth Rock Falls MU and the Romeo Malette MU both are forests where the SPF supply is sensitive to “binding SPF volume limits” which have been applied to these forest in order to
(a) regulate future landscape metrics, and
(b) act as a surrogate regulator for wildlife habitat supply.

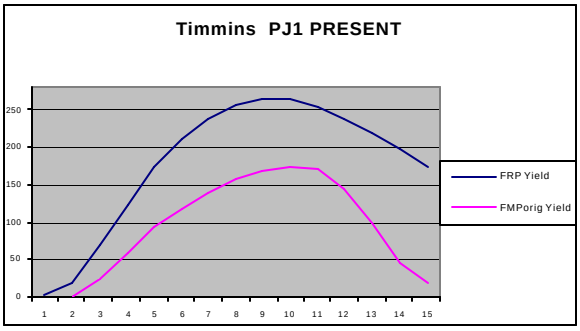
The Romeo Malette planning team took the modeling approach of identifying core habitat areas and then specifying a deferral from time 0 – 60 years for significant forest areas (see results), totaling 68,750 ha. Half of this deferral is comprised of SPF forest unit area. Additionally, upper and lower SPF volume limit targets were used to regulate the SPF wood flow so as to mitigate a forecast SPF supply gap (~Term5). The combined effects of these two alternative management strategies certainly affect the SPF supply.

The Smooth Rock Falls planning team took the modeling approach of NOT specifying habitat areas for deferral. They have however, also used upper and lower SPF volume limit targets to regulate the SPF wood flow so as to mitigate a forecast SPF supply gap (~Term7). This approach effectively stores SPF on the stump now in order to present a less dramatic SPF decline by Term6.

The management strategy of specifying binding upper and lower SPF volume limits on these two MUs accomplishes certain goals on these two forests, as described above. While it is debatable as to whether using these targets, as specified, are the *only* solution for Tembec, it must be recognized that possibly some binding upper and lower SPF volume limits would be appropriate – depending upon the management objectives. Therefore, the results presented for the RMF and SRF MUs (the scenarios were run assuming that the volume limits would not be binding) should be understood as such. Should Tembec revisit the question of modeling habitat supply using other tools (Patchworks) and using other modeling approaches, then it is possible that the current upper and lower SPF volume limits could be modified. To the degree that these limits are modified, the SPF supply forecast will change accordingly.

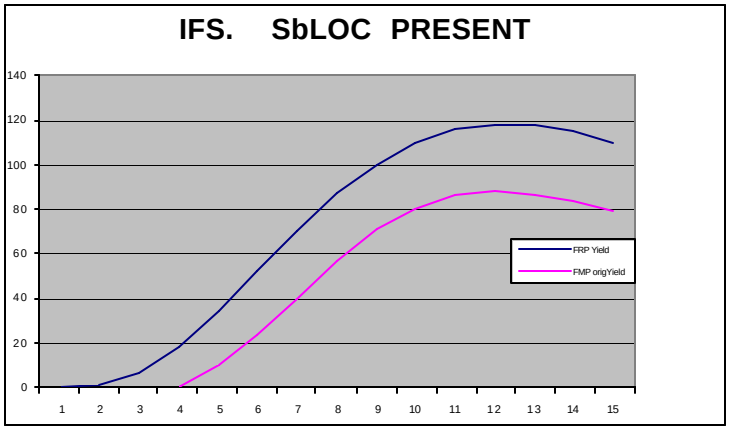
Nighthawk MU (Driftwood and Timmins SubUnits)

An increased SPF supply (of approximately 20K m^3) is forecast for the Nighthawk MU using the new FRP yield curves. This increase is almost completely in jackpine volume, and comes from the Timmins SubUnit exclusively. The forecast spruce volume is reasonably unchanged. The difference between the FRP and the FMPoriginal yield curves for PJ is significant.

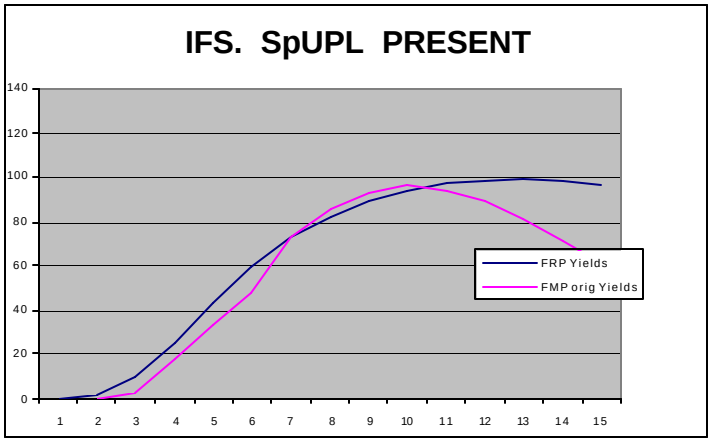


Iroquois Falls MU (IF North & IF South SubUnits)

Two spruce forest units contain large areas of initial available area: SbloC contains 165,256 ha, and SpUpl contains 175,822 ha. As highlighted previously (in red bold) in Table 1, these two FUs are significant in area.
The FRP:FMPoriginal yield curve differences for SbloC is significant, as shown in the graph below. This difference, coupled with the large area, accounts for most the forecast SPF supply increase.
Tembec may wish to further investigate this FRP:FMPoriginal yield curve difference, as it is clearly a sensitive input assumption.

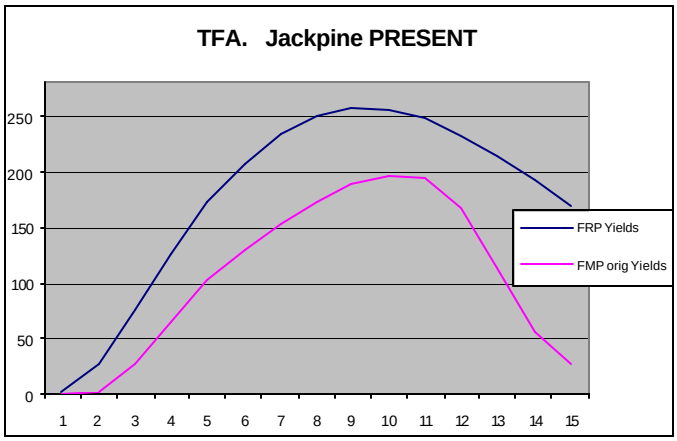


The FRP:FMPoriginal yield curve differences for SpUpl is not significant, as shown in the graph below. Despite the large area, this FU accounts for little of the forecast SPF supply increase.



Timiskaming MU

The Timiskaming MU contains the largest relative initial area of all the MUs of PJ1. This fact, coupled with the FRP:FMPoriginal yield curve differences for PJ1, results in a large change in the SPF forecast. Almost all of the forecast SPF supply change is in jackpine supply.



As stated earlier, there is an opinion that the FRP PJ1 yield curves may not reflect the observed rate of stand decline and volume loss. This will be a sensitive assumption in the case of the Timiskaming MU.

It should be noted that two specific deferral strategies are identified in the Timiskaming MU: ~9000ha is deferred for the next 20 years, and an additional ~44,000ha is deferred for the next 60 years. These two deferral strategies no doubt relate to wildlife planning /landscape metrics requirements. It should also be noted the NEBIE renewal intensity parameters for extensive, basic and intensive were not supplied by Tembec: estimates were used, as indicated in the detailed results for this MU.

Hearst MU

The Hearst MU represents a large area affecting SPF, second only in size to the Gorden Cosens MU. Like the the Gorden Cosens MU, the Hearst MU is comprised mainly of SB forest types. Also, the Hearst MU uses 'Non-Standard' FUs. In consultation with Margaret Penner, the (FRP) SB1 Yield template was used for following four Hearst FUs *: SbSlope, SbFlat, SbSC3,* and *SbSwamp*. . The difference between the new FRP yields and the FMPoriginal yields, for SB, are also very small. And so, despite the relatively large available area represented by the Hearst MU, the forecast SPF supply change due to new FRP yield curves is very small.

It should be noted that three specific deferral strategies are identified on the Hearst MU totaling over 112,000 ha. These deferral strategies no doubt relate to wildlife planning /landscape metrics requirements. It should also be noted the NEBIE renewal intensity parameters for extensive, basic and intensive were not supplied by Tembec: estimates were used, as indicated in the detailed results for this MU.

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Tembec managers should exercise caution in interpreting what future SPF levels may be as a function of (strictly) this one study. Why? Because while some modeling inputs contribute toward a forecast increased SPF supply (new yield curves), other emerging planning guideline requirements (Natural Disturbance Pattern Emulation Guidelines, Old Growth Guidelines) will contribute toward a significantly decreased SPF supply forecast. This study captures what (positive) effects new FRP yield curves contribute toward the forecast SPF supply only.