Weyerhaeuser Edson Sensitivity Analysis

Additional timber supply analysis was conducted to assess the sensitivity of the AAC to the following scenarios:

1) Spatial harvest sequence removed
2) First period carry over volume removed
3) Old forest constraints removed
4) Profile constraints removed
5) Harvest Design Area (HDA) access constraints removed
6) Surge cut removed (W6 only)

For this sensitivity analysis, the aspatial Woodstock model developed to generate the spatial harvest sequence and the PFMS was used as the base model. Scenarios one to five were assessed for all four FMUs. Scenario 6 was assessed for W6 only.

An additional series of sensitivity runs was conducted to assess the impact of changing the timing of harvesting blocks in periods one to four of the SHS. For this portion of the sensitivity analysis, the preferred forest management scenario that includes the LP schedule generated by Stanley was used as the base case.

Spatial Harvest Sequence

No additional runs were conducted to assess the impact of the spatial harvest sequence. The primary deciduous and primary coniferous AACs from the base models were compared with those for the spatial harvest sequence scenario. For the base case, the FMU AACs were considered to be the harvest level for periods two to 12, when there is strict even flow. W6 is an exception, as there is a coniferous surge cut for periods 1 to 4. In this case the sustainable AAC is taken as the harvest level for periods five to 12. The AACs are reported in this way for all the scenarios, except were noted otherwise.

The spatial harvest sequence is for the first 12 periods; there is considerable fluctuation in the harvest levels during these periods. To compare the harvest levels in the spatial harvest sequence to the even flow AAC, the average harvest levels for periods two to 12 were calculated (Table 1).

As was expected, the introduction of spatial constraints in the PFMS results in a reduction in AAC relative to the aspatial base runs (Table 1). The greatest impact is for FMU E1, where an 8.9% reduction is seen for the primary deciduous AAC.

Table 1. Comparison of AAC by FMU in periods two to 12 for the base case and the spatial harvest sequence

	E1 AAC (m^3)		E2 AAC (m^3)		W5 AAC (m^3)		W6 AAC (m^3)	
Description	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Primary conifer	75,885	75,138	43,853	43,020	24,738	23,593	164,414	163,004
Percent change		-1.0%		-1.9%		-4.6%		-0.9%
Primary deciduous	29,071	26,478	95,031	92,504	43,882	43,333	95,439	93,279
Percent change		-8.9%		-2.7%		-1.3%		-2.3%
Total primary	104,957	101,616	138,884	135,524	68,620	66,926	259,852	256,283
Percent change		-3.2%		-2.4%		-2.5%		-1.4%

To assess the longer term impacts of the spatial harvest sequence the harvest levels for periods 13 to 32 were also determined (Table 2). Implementation of the spatial harvest sequence for the first 12 periods has a greater long-term impact on the harvest than was seen for the term of the SHS.

Table 2. Comparison of AAC by FMU in periods 13 to 32 for the base case and the spatial harvest sequence

	E1 AAC (m^3)		E2 AAC (m^3)		W5 AAC (m^3)		W6 AAC (m^3)	
Description	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Primary conifer	75,885	73,181	43,853	41,739	24,738	23,848	164,414	156,670
Percent change		-3.6%		-4.8%		-3.6%		-4.7%
Primary deciduous	29,071	28,435	95,031	87,483	43,882	41,650	95,439	91,210
Percent change		-2.2%		-7.9%		-5.1%		-4.4%
Total primary	104,957	101,616	138,884	129,222	68,620	65,498	259,852	247,880
Percent change		-3.2%		-7.0%		-4.6%		-4.6%

First Period Carryover Volume

There is a first period carryover volume for primary deciduous and primary conifer harvest in all of the FMUs. In some cases it is negative and in others positive. In all cases, the carryover was modelled by constraining the first period volume to be equal to the second period volume plus (or minus) the carryover volume. To assess the impacts of including carry over volume, these constraints were turned off and new runs were conducted with strict even flow constraints for periods one to 12. For W6, strict even flow constraints were for periods one to four and five to 12. No other changes were made to the models.

Change relative to the base case was less than one percent for each FMU (Table 2).

Table 2. Comparison of AAC for the base case and for the scenario with first period carryover volume removed.

	E1 AAC (m^3)		E2 AAC (m^3)		W5 AAC (m^3)		W6 AAC (m^3)	
Description	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Primary conifer	75,885	75,947	43,853	43,689	24,738	24,767	164,414	165,668
Percent change		0.1%		-0.4%		0.1%		0.8%
Primary deciduous	29,071	29,095	95,031	94,923	43,882	43,849	95,439	95,909
Percent change		0.1%		-0.1%		-0.1%		0.5%
Total primary	104,957	105,043	138,884	138,612	68,620	68,616	259,852	261,577
Percent change		0.1%		-0.2%		0.0%		0.7%

Late Seral Stage Forest Constraints

Inventory constraints were used to control how much area of late and very late seral stage forest exists by natural subunit and covertype in the forest in each period. To assess the impact of these constraints, new runs were with the only change being that these constraints were turned off. It was expected this would lead to an increase in AAC, as the model would be less constrained. Although this did in most cases, the increases were very small (Table 3). The highest increases were for E2 with a 0.2% increase for conifer and a 0.4% increase for deciduous.

For E1, there is a 0.1% decrease when only the sustainable harvest levels for periods two to 12 are considered. In subsequent periods when the even flow constraint is relaxed, the harvest levels are increased. This leads to a higher total cut over the planning horizon than in the base case.

Table 3. Comparison of AAC for the base case and for the scenario with late seral stage forest constraints removed

	E1 AAC (m^3)		E2 AAC (m^3)		W5 AAC (m^3)		W6 AAC (m^3)	
Description	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Primary conifer	75,885	75,886	43,853	43,925	24,738	24,738	164,414	164,420
Percent change		0.0%		0.2%		0.0%		0.0%
Primary deciduous	29,071	29,040	95,031	95,382	43,882	43,944	95,439	95,607
Percent change		-0.1%		0.4%		0.1%		0.2%
Total primary	104,957	104,926	138,884	139,307	68,620	68,683	259,852	260,027
Percent change		0.0%		0.3%		0.1%		0.1%

Profile Constraints

To ensure that harvesting occurs in a representative cross section of the profile of standing timber, constraints were placed on the amount of harvest from stands of different crown closure and site conditions. These constraints were removed to assess their impact on AAC. New runs were done with no other changes.

For all FMUs there is a slight increase in AAC when the profile constraints are removed (Table 4). This is consistent with expectations

Table 4. Comparison of AACs for the base case and for the scenario with profile constraints removed

	E1 AAC (m^3)		E2 AAC (m^3)		W5 AAC (m^3)		W6 AAC (m^3)	
Description	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Primary conifer	75,885	76,349	43,853	44,014	24,738	24,834	164,414	164,691
Percent change		0.6%		0.4%		0.4%		0.2%
Primary deciduous	29,071	29,339	95,031	95,034	43,882	43,945	95,439	95,579
Percent change		0.9%		0.0%		0.1%		0.1%
Total primary	104,957	105,689	138,884	139,047	68,620	68,779	259,852	260,270
Percent change		0.7%		0.1%		0.2%		0.2%

HDA Access Constraints

In the base model, Harvest Design Area constraints were created by using the Woodstock system variable _CP in the ACTIONS section. The _CP system variable allows the periods in which an area is available for harvesting to be specified. These references were removed from the ACTIONS section in Woodstock, there by allowing harvest to occur in all HDAs in every period. New runs were done to assess the impact of HDA access constraints.

Changes in AAC are small positive increases, except for deciduous in E1 (Table 5). As described for the late seral stage sensitivity analysis, the slight decrease in AAC of 0.2% is actually a product of relaxed even flow constraints from period 13 to 32 and does not result in a lower total harvest over the planning horizon.
Table 5. Comparison of AACs for the base case and for the scenario with HDA access constraints removed

	E1 AAC (m^3)		E2 AAC (m^3)		W5 AAC (m^3)		W6 AAC (m^3)	
Description	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Primary conifer	75,885	76,026	43,853	43,859	24,738	24,738	164,414	164,414
Percent change		0.2%		0.0%		0.0%		0.0%
Primary deciduous	29,071	29,023	95,031	98,418	43,882	43,947	95,439	95,439
Percent change		-0.2%		3.6%		0.1%		0.0%
Total primary	104,957	105,050	138,884	142,277	68,620	68,686	259,852	259,852
Percent change		0.1%		2.4%		0.1%		0.0%

W6 Surge Cut

A surge cut was used in W6 for primary conifer, and the sensitivity analysis examines the impacts of the surge on the AAC. The scenario was only run for W6, as there was no surge for the other FMUs, however, W6 results are presented with base results from the other FMUs to allow an assessment of the impact of the surge cut at the FMA level.

When the surge cut was removed, the conifer AAC increased by 0.8% (Table 6).

Table 6. Comparison of AACs for the base case and for the scenario with the W6 surge cut removed

	E1 AAC (m^3)		E2 AAC (m^3)		W5 AAC (m^3)		W6 AAC (m^3)	
Description	Base	Scenario	Base	Scenario	Base	Scenario	Base	Scenario
Primary conifer	75,885	75,885	43,853	43,853	24,738	24,738	164,414	165,763
Percent change		0.0%		0.0%		0.0%		0.8%
Primary deciduous	29,071	29,071	95,031	95,031	43,882	43,882	95,439	95,439
Percent change		0.0%		0.0%		0.0%		0.0%
Total primary	104,957	104,957	138,884	138,884	68,620	68,620	259,852	261,202
Percent change		0.0%		0.0%		0.0%		0.5%

Harvest Timing for blocks in Periods One to Four of the SHS

Weyerhaeuser expects to treat period one and two blocks as a pool of blocks to be harvested in the first 10 years, and period three and four blocks as a pool of blocks to be harvested in the second ten years. The LP schedule generated by Stanley was modified to assess the potential impact of this practise. Strata scheduled for period one harvest were assigned to period two, and ages were adjusted upward by one period. Period two strata were assigned to period one and age was adjusted down by one period. The same swap was done for periods three and four.

For all of the FMUs, some adjustments had to be made to the model constraints to allow a feasible solution to be found. Even flow constraints were adjusted to apply to periods five to 32. Some of the profile constraints were also relaxed for periods one to four. None of the old forest constraints had to be modified, except in w6, where the large change in harvest levels between periods one and two (because of the surge and carry over) resulted in a shift in the age class structure and the inventory constraint for upper foothills late seral stage CD stands couldn't be met. The constraint was for a small amount of area (UF_O1CD >= 49). When the constraint is turned off, the area in this type reaches a low of 32 ha in periods 13 and 14, increases to 39 ha in period 15 and is only below 49 ha in those three periods.

AACs presented in Table 7 are the average harvest levels for periods 13 to 32. Only these periods were assessed, as earlier periods are controlled by the LP schedule and the intent of the scenario is to assess the impact on long-term sustainability.

Table 7. AAC impact of changing timing of harvest for blocks in the first four periods of the spatial harvest sequence

Scenario	FMU Primary AAC (m^3)								Total FMA	
	E1		E2		W5		W6			
	Conifer	Deciduous	Conifer	Deciduous	Conifer	Deciduous	Conifer	Deciduous		
PFMS	73,181	28,435	41,739	87,483	23,848	41,650	156,670	91,210	295,439	248,777
Switched periods	73,180	28,367	41,798	87,732	23,849	41,668	156,477	91,076	295,303	248,843
Difference	2	67	-58	-249	-1	-19	193	135	136	-66
% difference	0.0%	0.2%	-0.1%	-0.3%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%

FMA Summary

The Edson FMA AAC is most sensitive to the introduction of spatial constraints, as seen in the scenario examining the impact of the spatial harvest sequence. The AAC is relatively insensitive to all the scenarios examined. Removing the HDA access constraints made the greatest impact on AAC; it resulted in a 1.3% increase for deciduous AAC.

Table 8. Summary of FMA level impacts on AAC of sensitivity analysis runs

Scenario	Primary Conifer (m3)	% Change	Primary Deciduous (m3)	% Change	Total AAC (m3)	% Change
Base	308,890	0.0%	263,423	0.0%	572,313	0.0%
Impact of spatial sequence	304,755	-1.3%	255,594	-3.0%	560,349	-2.1%
Remove carry over volume	310,072	0.4%	263,775	0.1%	573,847	0.3%
Remove profile constraints	309,888	0.3%	263,897	0.2%	573,785	0.3%
Remove old growth constraints	308,970	0.0%	263,972	0.2%	572,942	0.1%
Remove HDA access constraints	309,038	0.0%	266,827	1.3%	575,864	0.6%
Remove surge cut[1]	310,239	0.4%	263,423	0.0%	573,662	0.2%