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Modelling of timber yield implications of Variable Retention

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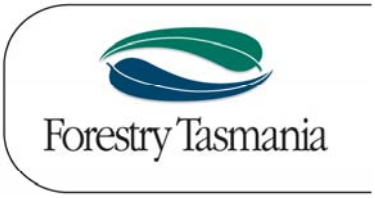

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Modelling of timber yield implications of Variable Retention

A report to the TCFA Implementation Committee

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Abstract

The 2005 Tasmanian Community Forest Agreement (TCFA) requires Forestry Tasmania to achieve non-clearfell silviculture over a minimum 80% of the annual harvest area of oldgrowth forest on public land by 2010.

Modelling of timber yield undertaken for the Final Advice to Government (Forestry Tasmania 2005) assumed that the impact of Variable Retention (VR), when compared to the prevailing clearfell system, would be a 20% reduction in *area* (modelled as a 20% reduction in *yield per hectare*) at initial harvest due to the additional retention, and a 10% reduction in subsequent silvicultural regeneration *growth* due to suppression and lower stocking. In addition, the impact of VR on high quality eucalypt sawlog woodflow over a 30-year time horizon was described in terms of the reduced supply from oldgrowth forest, and increased supply from plantations, to ensure an ongoing legislated total supply of 300 000 m^3 per year.

This project aimed to:

1. Conduct sensitivity analyses of a range of retention levels and regeneration productivity levels to determine the implications for the supply of high quality eucalypt sawlogs at the public native forest estate level; and

2. Investigate sampling operational VR coupes to determine if retained aggregates contain a different volume per hectare compared to their forest class average. If possible, a statistical comparison of forest class plot average volumes, and their related aggregate plot average volumes, would be undertaken to clarify the potential bias in the use of forest class average values for specific areas.

Results from the two components of this project were:

1. The ongoing legislated total supply of high quality eucalypt sawlogs of 300 000 m^3 per year is achievable at a VR retention level of 30%; and

2. The assumptions made regarding the volume reduction associated with increased retention are reasonable.

Key Words
Forest estate modelling, timber yield, oldgrowth forest, variable retention, sensitivity analyses, sampling, bias.

Introduction

The 2005 Tasmanian Community Forest Agreement (TCFA) requires Forestry Tasmania to achieve non-clearfell silviculture over a minimum 80% of the annual harvest area of oldgrowth forest on public land by 2010. As a result, State forest was classified as at 30 June 2007, whereby some 41 000 ha of coupes containing oldgrowth are designated for partial harvest silviculture, 30 000 ha for variable retention silviculture and 26 000 ha are designated for clearfell silviculture (Table 1). Coupes containing at least 25% oldgrowth, referred to as coupes containing oldgrowth, form about 16% of the area designated primarily for eucalypt sawlog production on State forests.

Table 1: State forest classification as at 30 June 2007

	Area (ha)
Reserves and non-harvest areas	760 000
STMUs	69 000
Softwood plantation coupes	54 000
Eucalypt coupes	
non-oldgrowth/plantations	509 000
coupes containing oldgrowth	
- partial harvest	41 000
- clearfell, burn and sow	26 000
- variable retention	30 000
Total State forest	1 489 000

Variable retention (VR) has been recommended as the main silvicultural alternative to clearfelling for tall wet oldgrowth forest (Forestry Tasmania 2005). Variable retention systems as defined in parts of Canada and the Pacific Northwest of the USA typically leave more than half the total area of a coupe within one tree height of old trees or forest patches for at least one rotation (Mitchell and Beese 2002). Forestry Tasmania's goals and guidelines for implementing variable retention in tall oldgrowth forests are outlined in its Draft Variable Retention Manual (Forestry Tasmania 2007a). For biodiversity, safety and fire management reasons the majority of VR silviculture in Tasmania's tall oldgrowth forests will be by aggregated retention.

Modelling of timber yield undertaken for the Final Advice to Government (Forestry Tasmania 2005) assumed that the impact of VR, when compared to the prevailing clearfell system, would be a 20% reduction in *area* (modelled as a 20% reduction in *yield per hectare*) at initial harvest due to the additional retention, and a 10% reduction in subsequent silvicultural regeneration *growth* due to suppression and lower stocking. In addition, the impact of VR on high quality eucalypt sawlog woodflow over a 30-year time horizon was described in terms of the reduced supply from oldgrowth forest, and increased supply from plantations, to ensure an ongoing legislated total supply of 300 000 m^3 per year.

An independent audit of the modelling work (Brack 2005) suggested the implicit assumption, that a reduction of 20% in area due to aggregate retention equates to a 20% volume reduction, may be biased if there is a preference for retention of aggregates near riparian areas or including large habitat trees (ie, the aggregates are not the average of the forest class). At the time this issue was dealt with using a single sensitivity analysis scenario model.

Since the implementation of the TCFA, nearly 20 VR coupes have been harvested in tall oldgrowth forest in Tasmania (Scott 2007) and it is now possible to further examine some of the assumptions used to underpin the modelling undertaken in 2005. This project on timber yield modelling was funded under the TCFA Program of Research into Alternatives to Clearfelling in old growth forests (Australian Government 2005) and aimed to:

1. Conduct sensitivity analyses of a range of retention levels and regeneration productivity levels to determine the implications for the supply of high quality eucalypt sawlogs at the public native forest estate level; and

2. Investigate sampling operational VR coupes to determine if retained aggregates contain a different volume per hectare compared to their forest class average. If possible, a statistical comparison of forest class plot average volumes, and their related aggregate plot average volumes, would be undertaken to clarify the potential bias in the use of forest class average values for specific areas.

This report describes the project and explores the feasibility of meeting legislated sawlog supply levels given the TCFA commitment to a mixed silviculture strategy for oldgrowth forests in areas designated for wood production.

Methods

1. Sensitivity Analyses

A range of retention levels, above the normal provisional coupe area discounts that result from clearfell coupes, were chosen. Retention levels included those assumed in Forestry Tasmania (2005) and those actually achieved (Scott 2007). In addition, a range of regeneration productivity levels were applied to growth curves for silvicultural regeneration to test implications of future reduced growth on sustainable yield.

Levels for sensitivity analyses, from which a 6x6 matrix of model scenarios were built, are:

Retention level %	Regeneration productivity level %
5	-5
10	-10
20	-20
30	-30
50	-40
75	-50

The base forest estate model for undertaking sensitivity analyses was the latest five-yearly Wood Review (Forestry Tasmania 2007b). The model was run to identify at what level of retention and regeneration productivity the supply of 300 000 m^3 per year of high quality eucalypt sawlogs became infeasible.

2. Aggregate measurement

Before undertaking any measurement in the forest, an assessment of the number of aggregates available for measuring by forest class was made, to see if enough sampling points would exist to reach any meaningful conclusions.

As a result, a single forest class was chosen for this study – forest class 4 (tall mature forest, of moderate density) in inventory area 21 (Smithton, northwest Tasmania). Inventory area 21 includes about 50 000 ha of State forest potentially available for wood production, including about 4 000 ha of forest class 4.

There were 36 recently measured (post-2002) sample points available, and these were used to characterise undisturbed forest of this type. These sampling points were bounded circular plots with an area of 0.0167 ha each. All measurements not relating to total standing volume were discarded for the purpose of the study.

Two VR coupes have been harvested in inventory area 21 and have resulted in the creation of some 16 aggregates, most of which are in forest class 4. The aggregate sample points (again bounded circular plots with an area of 0.0167 ha each) were located in mapped aggregates in recently harvested coupes, buffering the mapped edges by 15 metres to avoid the disturbed aggregate edge - the intent being to sample forest that was still in its original condition. Plots were established using a variation on Forestry Tasmania's temporary inventory procedures for Native Forests (Mannes 2003). Measurements not related to total standing volume were not taken, but plot size and tree assessment were kept standard to those taken in the non-aggregate population.

A total of 24 sample points were taken from within 9 aggregates.

A statistical comparison of forest class 4's plot average total standing volumes, and their related aggregate plot average total standing volumes, was undertaken to clarify the potential bias in the use of forest class average values for specific areas. Data was analysed using "R" open-source statistical software. A Welch two sample t-test was performed, which takes into account unequal sized samples and unequal variances between populations.

Results

1. Sensitivity Analyses

Table 1 shows the results of the sensitivity analyses.

Green ticks represent achievement of the target 300 000 m^3 per year of high quality eucalypt sawlogs, and conversely, red crosses represent the inability to achieve this same target.

The red cell represents harvesting before alternatives to clearfelling in oldgrowth forests (ie, no retention level above the normal provisional coupe area discounts that result from clearfell coupes, and subsequently no impact on silvicultural regeneration productivity). The green cell represents our assumptions as modelled for the TCFA (ie, 20% retention and 10% reduction in regeneration growth). Other cells with no retention, or no regeneration productivity reduction, rule themselves out for further consideration.

Results were sensitive to retention level (Table 2). At 30% retention in oldgrowth coupes designated for variable retention, Forestry Tasmania can supply the 300 000 m^3 per year of high quality eucalypt sawlogs, but not at 50% retention. This is because of the importance of oldgrowth in the short to medium term to the high quality eucalypt sawlog supply. Oldgrowth makes up about a quarter of sawlog supply until 2030. By 2025, half of the high quality sawlog supply will be met by plantations (Forestry Tasmania 2007b).

In contrast, results were insensitive to regeneration productivity level (again Table 2). In this model, with a planning horizon of 90 years, it does not matter what the future regeneration productivity level is, because coupes with retained aggregates are such a small component, about 5% by area, of the total wood supply. This result was confirmed by running a 200-year model which assumed that coupes containing oldgrowth that were first harvested using aggregated retention had VR applied in subsequent rotations.The 200-year model was also unaffected by regeneration productivity level in aggregated retention coupes.

Table 2: Sensitivity Analyses Matrix

		Regeneration productivity level %						
		0	-5	-10	-20	-30	-40	-50
Retention level %	0	✓						
	5		✓	✓	✓	✓	✓	✓
	10		✓	✓	✓	✓	✓	✓
	20		✓		✓	✓	✓	✓
	30		✓	✓	✓	✓	✓	✓
	50		✗	✗	✗	✗	✗	✗
	75		✗	✗	✗	✗	✗	✗

2. Aggregate measurement

Results of the Welch two sample t-test are summarised below:

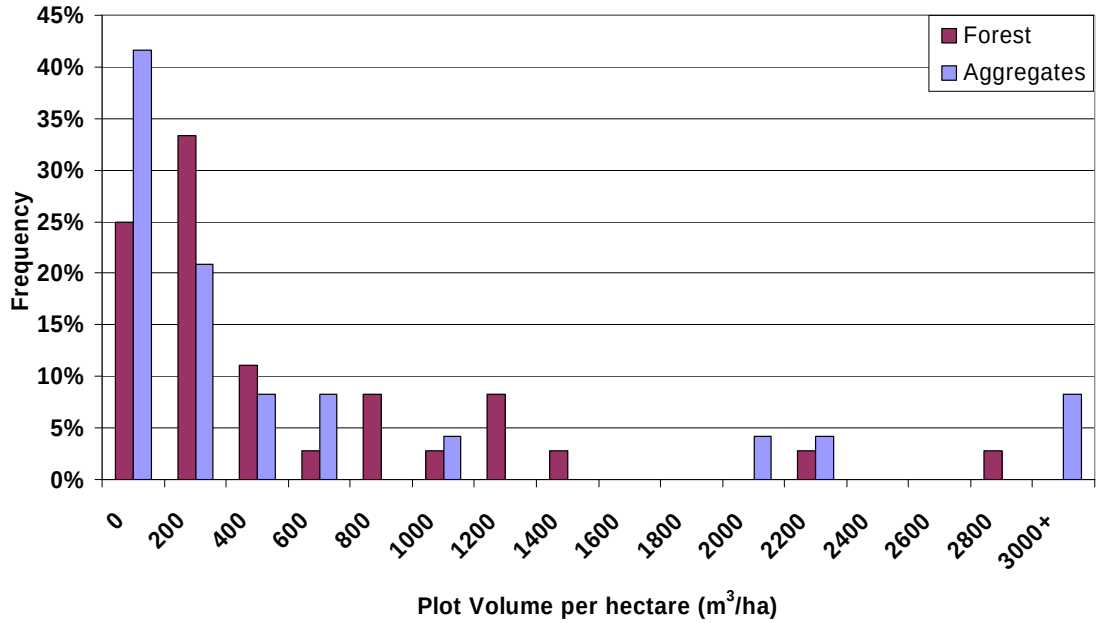
<u>Sample estimates of total standing volume</u>
Mean of forest/not aggregates = 595 m^3/ha
Mean of aggregates = 785 m^3/ha

t-value = 0.6721
df = 30.807
p-value = 0.5065

The high p-value leads to confirmation of the null hypothesis, that there is no true difference in means, and hence the two sampled populations are not significantly different.

Although the aggregates' average was greater than the forest average, the variance in the sample distributions mean that there is no statistically significant difference in the two populations (at a 95% confidence level). Note that the aggregates had both the most plots with lowest and highest volumes (Figure 1), suggesting no "high-grading" bias at harvest time, and equally that not all retained areas had large volumes.

Figure 1: Plot Total Standing Volume Estimates in Mature Forest Class 4



Discussion

Sensitivity analyses around the assumptions made regarding retention level and regeneration productivity level, for modelling alternatives to clearfelling in oldgrowth forests in the TCFA, have identified that Forestry Tasmania can achieve the legislated 300 000 m^3 per year of high quality eucalypt sawlog requirement at a retention level of 30% above the normal provisional coupe discount of around 25%.

This 30% retention level is similar to what has been achieved in the first 11 aggregated retention harvest coupes, and about 10% more than the assumed retention level used for modelling in 2005 (Forestry Tasmania 2005). However, based on these sensitivity analyses, it is not possible to make available the required sawlog if the retention level increases to 50%. In other words, the boundary between feasibility and infeasibility falls somewhere between the 30% and 50% retention levels.

In contrast, but again based on these sensitivity analyses, it does not matter what level of regeneration productivity is assumed, as the achievement of the required sawlog is insensitive to future growth in these aggregated retention coupes. These oldgrowth coupes are important in ensuring the sawlog supply in the short to medium term, but not in the long term. This is because there are insufficient alternative coupes available now, but after 2030 native forest regeneration after clearfell, and eucalypt plantations, will dominate sawlog supply (Forestry Tasmania 2007b).

Modelling of the effect of variable retention implementation beyond the 30 000 ha of oldgrowth coupes currently designated is beyond the scope of this project. The area of coupes designated for VR currently forms about 5% of the productive eucalypt forest estate. Obviously if VR silviculture was to be applied more broadly, for example to all native forest coupes or even to all oldgrowth coupes, then the effect of varying retention levels or regeneration productivity, would be expected to be more significant.

Measurement of aggregates in mature forest class 4 in the northwest of the State has confirmed that assumptions in our forest estate model, regarding the volume reduction associated with increased retention, are reasonable. For example a 20% retention level, above the normal provisional coupe area discounts that result from clearfell coupes, will equate to a 20% volume reduction. What this suggests is that, for a given forest class, the volume per hectare retained in aggregates is on average the same as the volume per hectare harvested.

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