REPORT

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Logging Residue Distribution

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Figure 1 - Logging residue on different sites, hauler cutover on left and mechanised ground-based cutover on right

Abstract

Intensive line intersect sampling of cutover logging residue was carried out in areas harvested by three different logging systems (hauler, mechanised and conventional ground-based).

The results were analysed to determine residue volumes, composition and distribution patterns.

Average residue volumes were approximately 30m³/ha to 50 m³/ha. Most of the residue comprised of unmerchantable stem wood and large branches. Hauler residue tended to be concentrated in gullies and the ground-based systems tended to have slightly higher volumes as distance from the landing increased.

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Introduction

The objective of this study was to determine the effect of three different harvesting systems on the volume and distribution of logging residue. The systems studied were:

- hauler (mechanised processing at landing)
- ground-based mechanised whole stem
- ground-based motor-manual

Cutover logging residue is that material which is left at, or near, the stump when forest harvesting occurs. This material is made up of needles, branches and small sections of stem wood. The stem wood is that which is unmerchantable due to its quality or uneconomic to extract due to its small size. This material is assumed to have long term benefits for the nutrient status of the site as nutrients will be released during the decay process.

On some sites, the volume of logging residue is such that it requires treatment to facilitate re-establishment of the next crop. However, the distribution and volume of slash will vary with harvesting system, extraction pattern and crop type (Figure 1).

The data in this report provides information on logging residue volumes and distribution.

Acknowledgments

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Methods

Data were collected from six cutover sites, with two sites for each of the three different harvesting systems:

- hauler motor-manual felling with mechanised processing at landing
- ground-based mechanised (whole stem)
- ground-based motor-manual

Residue volumes on the cutover were collected using line intersect sampling (Van Wagner 1968, Warren and Olsen 1964).

The sampling pattern used is shown in Figure 2 below. The plot lines were put in a zig-zag pattern (Hall, 1996). Approximately 300 plots were used at each site, covering an area of approximately four hectares, giving a sampling density of 75 plots per hectare.

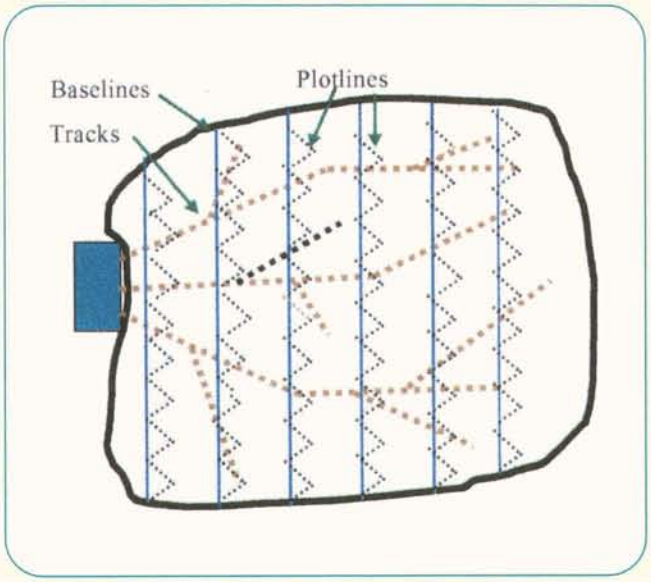

Figure 2 - Sampling pattern used to gather data (not to scale)

Residue was classified and measured in the following categories:

- Merchantable stem (greater than 10 cm sed and greater than 1 m length)
- Unmerchantable stem
- Large branches (50 mm +)
- Medium branches = 25 to 50 mm
- Small branches = < 25 mm
- Needles (subplot of 1 m) count needles

The following were analysed for each site:

- Volume of residue calculated per plot
- Distribution presented as two-dimensional surface charts
- Volume vs distance from landing

Results

Total residue volumes varied from plot to plot, ranging from 1 m^3/ha to 280 m^3/ha. Average volumes were:

- 61 m^3/ha for the hauler settings
- 37 m^3/ha for the mechanised whole stem settings
- 49 m^3/ha for the conventional ground-based settings

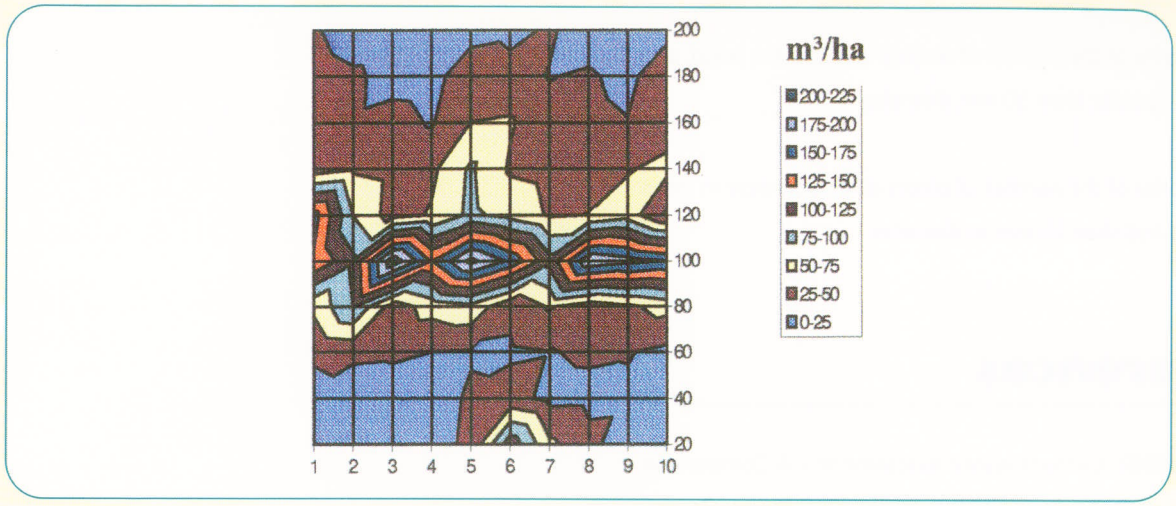

Figure 3 - Two-dimensional area plot of residue distribution for hauler settings

Note: For all area plots, the vertical axis is the distance from the road or landing edge, the horizontal axis is distance along the landing or road edge (each grid line represents 20 m).

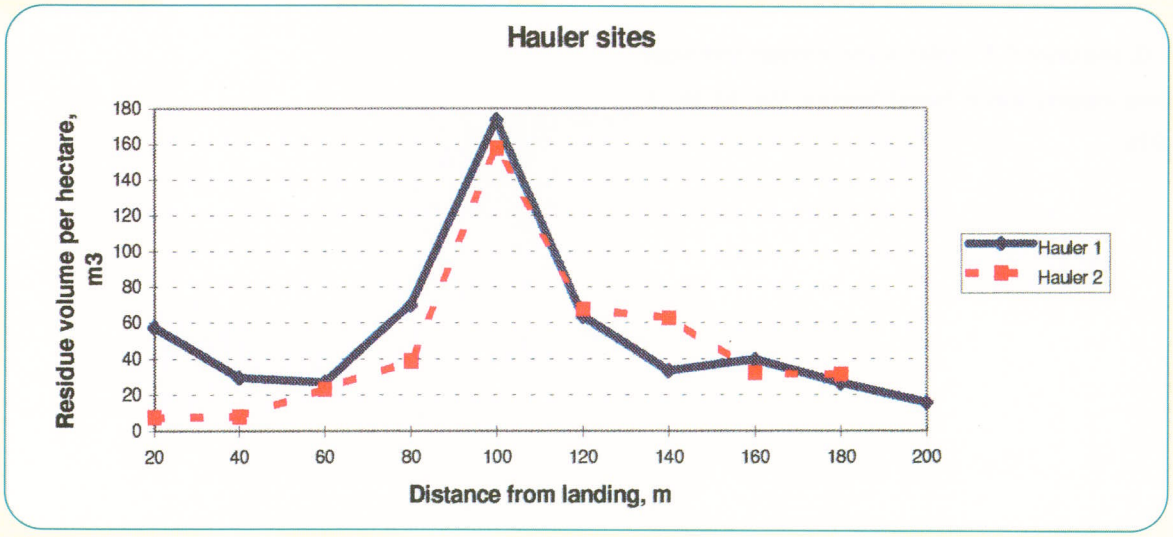

Figure 4 - Residue volumes by distance from landing, for two hauler sites

The distribution of residue in the hauler settings had a very distinct pattern. The area with the most dense residue coincided with the lowest point in the gully. There was also a dense patch of residue near the landing edge (Figures 3 and 4). There was substantial variation between average line and plot volumes for the hauler sites (Table 1).

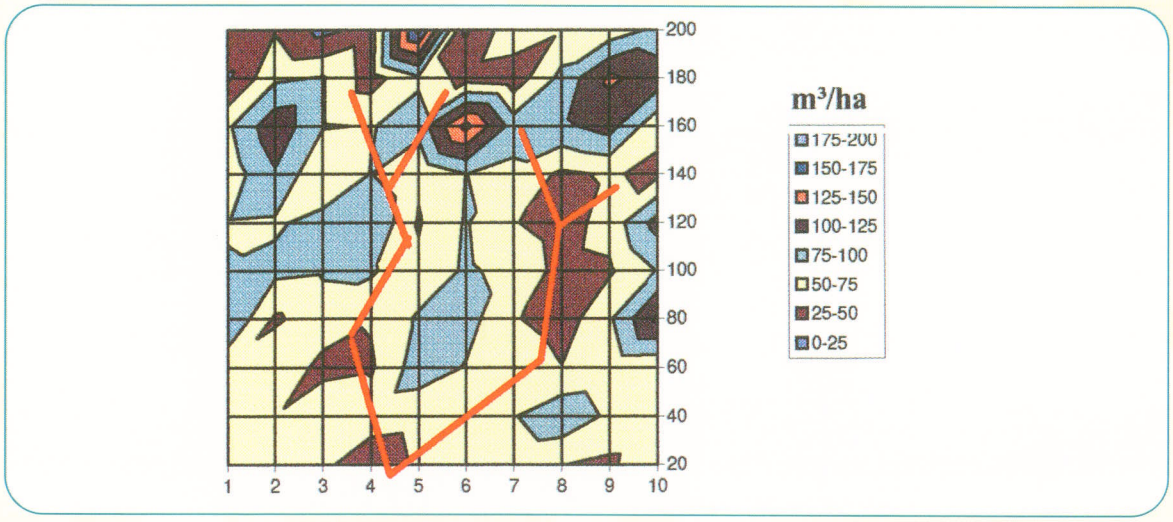

Figure 5 - Two-dimensional area plot of residue distribution mechanised whole stem harvesting operations

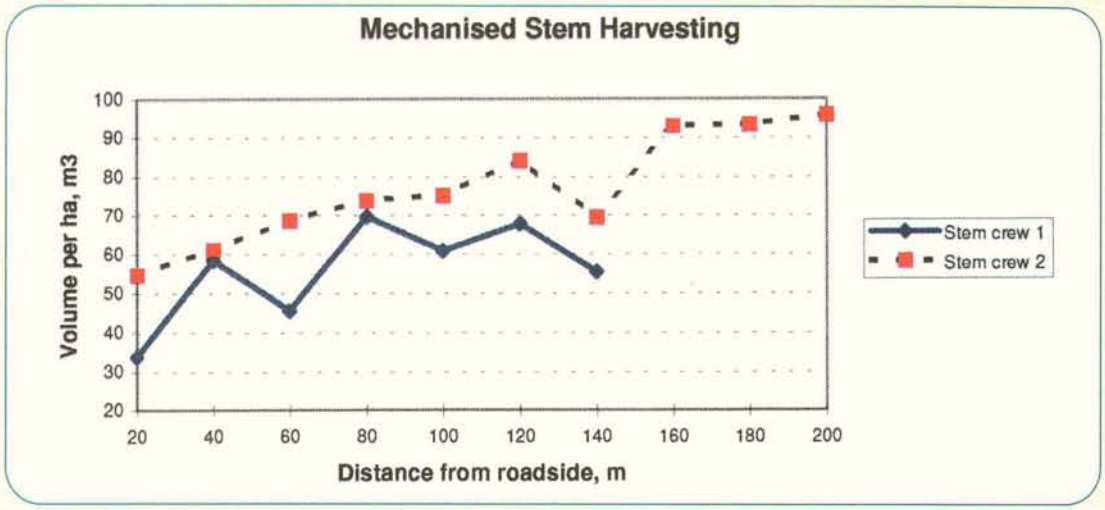

Figure 6 - Residue volumes by distance from landing, for two mechanised whole stem harvesting sites

The residue distribution in the mechanised whole stem settings was more even than in the hauler sites, with some evidence of extraction tracks (marked in red) with lower volumes of residue (Figure 5). In the mechanised whole stem harvesting area, there was considerable variation in the volume between rows of plots. Overall, there was a trend for there to be more residue the further the plot was from the landing or road edge (Figure 6).

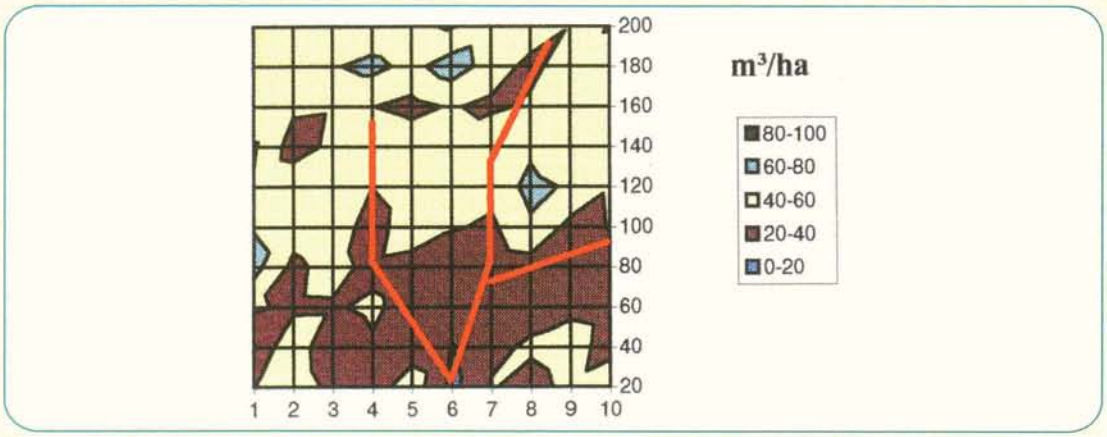

Figure 7 - Two-dimensional area plot of residue distribution in ground-based motor-manual harvesting operations

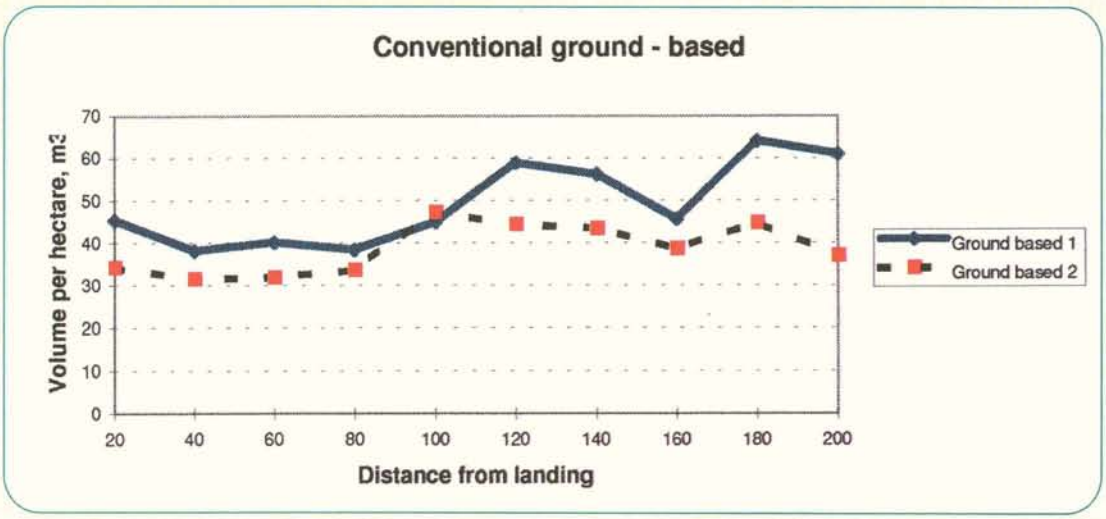

Figure 8 - Residue volumes by distance from landing, for two ground-based motor-manual harvesting operations

For the ground-based motor-manual sites, there was a trend for the residue to be of lower volume at the front of the block (close to the landing) except for the skid surround. Residue volume rose slightly towards the rear of the block (Figures 7 and 8). Extraction tracks were apparent only at the front of the block (red lines). There was an increase in the volume residue when plots were beyond 120 metres from the landing in the conventional ground-based settings.

System	Average density	Standard deviation Plots	Standard Deviation Lines (30 plots/line)
Hauler	61 m^3/ha	53.4	44.1
Mechanised	37 m^3/ha	27.7	10.3
Conventional	49 m^3/ha	15.5	7.9

Table 1 - Residue density variation from plots and lines (group of 30 plots)

The residue was extremely variable in its density (Table 1).

	Total	Merch stem	Unmerch stem	Large Branch	Medium Branch	Small Branch	Needles	Bark
Hauler	60.65	1.5	35.5	11.5	4.5	3	0.15	4.5
		0.04	*1.3*	*2.8*	*6.1*	*89.8*	-	-
Mechanised	37.3	0.6	14.0	8.0	6.5	4.5	0.1	3.6
		0.02	*0.7*	*2.4*	*8.0*	*89.0*	-	-
Ground-based	49.0	0.25	21.0	12.5	7.0	4.5	0.15	3.6
		0.01	*0.8*	*2.0*	*7.2*	*90.0*	-	-

Table 2 - Residue volume, m^3 per ha and % of pieces, by component for hauler system, mechanised system, conventional ground-based system

At the hauler site, 48.5% of the volume of residue was in large branches and stem wood; these comprised only 4.1% of the number of pieces (Table 2). For the mechanised sites, these figures were 22.6% and 3.3% respectively and at the ground-based sites the equivalent proportions were 33.7% and 2.9%. A substantial proportion of the residue on all sites was contained in very few pieces.

Conclusions

The residue distribution in the hauler settings had high concentrations of residue in gullies and around landings.

In mechanised and conventional ground-based harvesting operations, distribution was less clearly defined, but tended to rise with increasing distance from the landing.

Total residue volumes varied from plot to plot from 1 m^3 per hectare to 280 m^3 per hectare, mean volumes were:

- 61 m^3/ha for the hauler settings
- 37 m3/ha for the mechanised whole stem settings
- 49 m^3/ha for the conventional ground-based settings,

with substantial variation around the means.

The majority of the volume of residue was in stem wood, and branches greater than 50 mm diameter.

The majority of the number of pieces of residue were in small branches less than 25 mm in diameter.

References

Hall P (1996): Cutover waste assessment - A Comparison of Sampling Techniques and Intensities. LIRO Project Report, P. R. - 60.

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