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BELL LOGGER EXTRACTION IN THINNINGS

A.P. Gleason

Figure 1 - Bell Logger extracting tree length logs

INTRODUCTION

The Bell Logger has proven to be an extremely versatile logging machine, capable of bunching, extracting, sorting, and loading. When used as an extraction machine, the Bell has several limitations, including; the small load size limited by the grapple capacity, the necessity to travel backwards when loaded, and the machine's inability to operate effectively on steep slopes. As with any grapple machine, the Bell cannot drop and winch in its load to get around obstacles.

This Report describes a study designed to determine the machine's potential productivity and cost when extracting in thinnings.

ACKNOWLEDGEMENTS

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THE TRIAL

The study was carried out in a 12 year old radiata pine stand on flat terrain. The stand was being thinned from 1300 sph down to 350 sph. The site had been V-bladed and trees were planted on either side of the mound formed. The Bell's extraction path was along the top of a mound.

A 330 metre strip, containing two rows of selected and marked trees, was felled away from the skids for butt pull extraction. After felling and delimbing, each tree was numbered for later identification, measured for volume, and its distance from the skid recorded. A fixed-boom Bell Logger (Series 20 grapple) then travelled into the bush, assembled a load of 1 to 6 trees, and extracted and fleeted the tree length logs on the skids. Work study was conducted to record the time per element, the distance travelled, and the trees extracted for each cycle.

RESULTS

There were 160 merchantable trees in the 330 metre strip, with an average log size of .23 tonne. The trees were extracted over 4.35 productive machine hours (PMH), comprising 39 cycles. The total weight of the logs extracted was 37 tonne, which was later confirmed by weighbridge figures. The average cycle breakdown is shown below :

Table 1 - Bell Logger extraction cycle breakdown

	Time per cycle (min)	Percent
Travel empty	1.48	22 %
Clear slash	.55	8 %
Acquire load *	1.41	21 %
Travel loaded **	2.57	39 %
Fleet	.46	7 %
Delay	.22	3 %
Total	6.69	100 %
Range	(.93 - 13.77 min)	
95% confidence interval	(5.53 - 7.86 min)	

* Average number of trees was 4.1 (.95 tonne)
** Average skidding distance was 170 metres

With an average cycle time of 6.69 min. and a load size of .95 tonne, average productivity was 8.5 tonne/PMH. The expected range of average productivity would be between 7 and 10 tonne/PMH. Under the circumstances in which the machine was studied, the potential productivity would be 55 tonne (48-68 tonne) for a $6\frac{1}{2}$ PMH day.

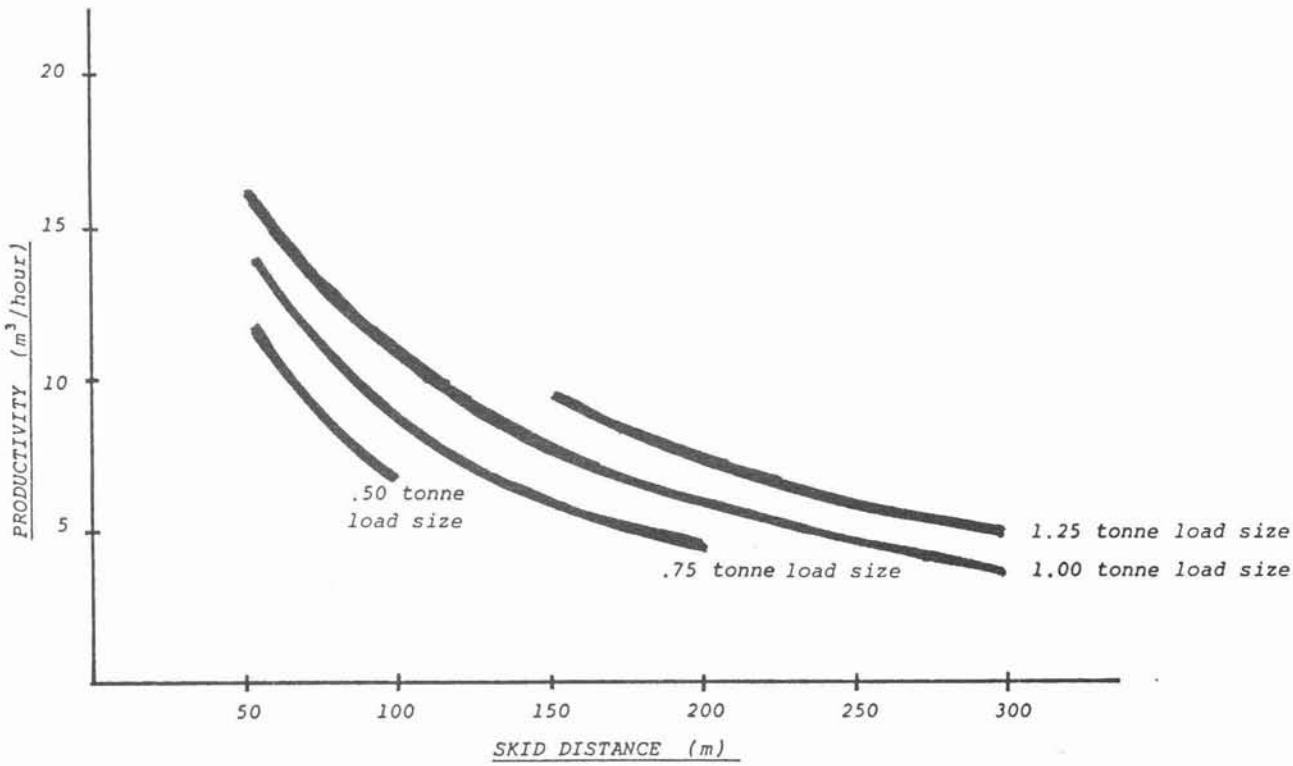
Further analysis of the cycle times showed strong relationships between travel time and distance, and between acquire time and volume per cycle. A multiple regression analysis between total time per cycle versus skid distance and load size, resulted in the following equation :

Total time = -.71 + .029 x (skid distance in metres) + 2.48 x (Load size in tonnes)

where r^2 = .84 (equation explains 84% of the relationship)

The graph below shows the potential hourly productivity, using the prediction equation over a range of load sizes and skid distance.

Figure 2 - Tonnes per productive machine hour over various skid distances and load sizes



Unloaded travel speeds on the skid trail, driving forward, averaged 7.4 km/hour. Travel speeds loaded, driving backwards, averaged 4.5 km/hour with a load of 0.95 tonne. The maximum load extracted was 1.57 tonne, made up of five trees, 7 - 14.5 metres long.

Due to backwards travel when loaded, one would expect a high occurrence of bark damage. Of the 65 final crop trees in the strip, 8 trees or 12% were damaged (5 above 30 cm from ground level). All of the damaged trees occurred between 100 - 200 m along the track. This was attributed to operator fatigue from turning around to check the machine direction and losing orientation in the middle of a long haul. On short hauls (less than 100 m), no trees were damaged - which could be attributed to the operator being familiar with the correct path as a result of frequent passes through the area.

COSTS

Using the LIRA Costing Handbook, the estimated cost of a Bell Logger would be $125/day and $95/day for the operator. Over a 6.5 productive machine hour day, cost per productive hour would be $34. Using the predicted productivity shown in the graph, the cost per m^3 to extract using a Bell over various skidding distances and load sizes is shown in Table 2.

Table 2 - Estimated cost of Bell extraction in $/tonne for various load sizes and skid distances

Load size (tonnes)	Skid Distance (m)					
	50	100	150	200	250	300
.5	2.85	5.05				
.75	2.40	3.75	5.65	6.80		
1.0	2.10	3.40	4.25	5.65	6.80	8.50
1.25			3.75	4.85	5.65	6.80

DISCUSSION

The results in this Report represent a one-day study conducted in a stand on flat terrain, using an experienced operator. Rolling terrain would limit machine access and reduce productivity. Even on flat terrain, the machine tipped forward under heavy load conditions. Although not tested, uphill pulling would restrict load sizes, reduce productivity, and shorten economic haul distances. With small or short trees, the grapple capacity limits load size. Fitting the larger Series 33 grapple would overcome this problem.

In this study, there was no interference from felling or skid operations. Extraction was carried out on a single, straight skid trail. In a productive situation, interference with other operations and the use of multiple skid trails would reduce expected productivity.

Driving the machine backwards can lead to neck problems for the operator. When extraction paths are not straight, the problem would increase. Long skid distances required repeated turning around by the operator during extraction. This problem would be minimised with skid distances less than 150 m. The addition of rear view mirrors, although highly vulnerable to damage, would help.

CONCLUSIONS

The machine was able to quickly assemble a payload and extract logs to the landing. The average productivity of 8.5 tonne per productive machine hour (0.23 tonne/log) with an average skidding distance of 170 m was high considering the small payload. Its quick cycle time offsets the low payload and results in high productivity. However, it is not recommended that the Bell Logger be considered as a primary means of extracting logs. It is more suited as a support machine, to extract only part time and over short distances.

Ref. 1 Wells, G.C. "The Bell Logger", LIRA Machinery Evaluation, Vol. 5 No. 3 1980

Ref. 2 Wells, G.C. "Costing Handbook for Logging Contractors", LIRA, 1981

The costs stated in this Report have been derived using the procedure shown in the LIRA Costing Handbook. They are only an indicative estimate and do not necessarily represent the actual costs for this operation.

For Further Information Contact: N.Z. LOGGING INDUSTRY RESEARCH ASSOC. INC.
P.O.Box 147,
ROTORUA, NEW ZEALAND. Phone 87-168