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FACTORS INFLUENCING LANDING SIZE

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Figure 1 - Hydraulic knuckleboom loader sorting multiple log sorts

INTRODUCTION

Traditionally log landings in New Zealand have been tailored to meet the space requirements of the operation. Generally the area involved and the cost of construction have not been restricting factors. However, as the volume of wood harvested from steeper terrain increases, the need to minimise landing size and reduce construction costs will become more important.

This Report discusses the results of a survey of log landing operations over a range of various harvesting systems throughout New Zealand.

Some important factors influencing landing size and layout have been identified. Regression equations to determine landing size from these influencing variables were also calculated.

Previous work in the area of landing operations has been reviewed by Hart (1980). The Forest Research Institute's work in the area of loading operations (Twaddle, 1979) and in landing size variation (Twaddle, 1984) is also relevant to this study.

Figure 2 - Small landing at Whitford Forest

DATA COLLECTION

A survey of clearfelling operations representing the full range of current New Zealand practise was undertaken over the period February/June, 1986. Operations were surveyed in terms of the following :

- crop factors - species, piece size, extracted length
- location factors - topography, climate, soil type
- landing area - shape, surface, drainage and access requirements
- extraction system - machinery used, daily production
- functions performed - manning levels, log sorts produced, effect of interfacing extraction and transport operations (truck scheduling, turnaround, delays, etc)
- loading operations - loader type, daily number of trucks loaded, organisation of stockpiles, layout
- identification of problems - delays, bottlenecks, safety hazards.

The survey covered as many measurable parameters of the log landing phase as practicable in an attempt to establish common patterns of operation.

A total of fifty clearfelling operations throughout New Zealand were surveyed.

The sample included operations in small forests, those on restricted landings, and covered a wide range of production levels and machine types. Table 1 summarises machine types sampled. The proportion of the industry that this sample represents is also given (based on 1985 logging industry survey figures, Liley 1985).

SURVEY RESULTS

Analysis of Data

Due to the range of landings sampled, the variation in the data was very wide. Figure 3 shows the landing size distribution.

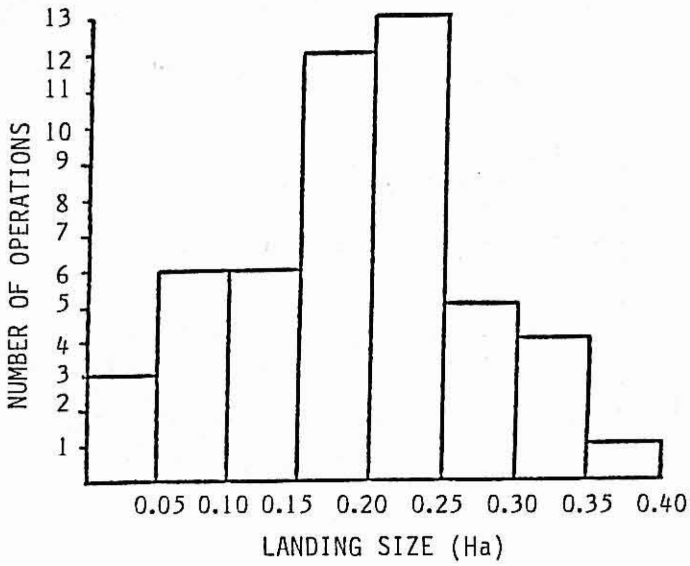

Figure 3 - Landing Size Data

Table 1 - Operations by Logging Type (Number Sampled)

Extraction Type	Loader Type: Wheeled Front-End	Rope Crane	Knuckle-boom	Tracked Front-End	Total	Proportion of Industry Sampled
Hauler	12	1	3	1	17	21 %
Skidder	13	2	7	-	22	7 %
Tractor	8	2	1	-	11	4 %
Total	33	5	11	1	50	

Regional Differences in Landing Size

The major regions of operation surveyed were Auckland/Coromandel, Bay of Plenty, Nelson and Otago/Southland. Figure 4 gives the mean and range in landing size for each of these regions.

A statistical test on landing size for each region showed significant differences at the 95% confidence level between Auckland and Bay of Plenty landings and between Otago/ Southland and all other regions. No differences between Auckland and Nelson, or between Bay of Plenty and Nelson operations were found.

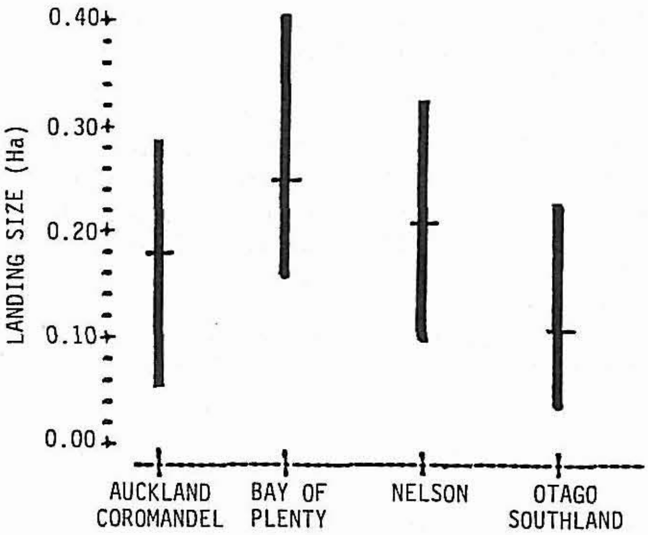

Figure 4 - Location vs Landing Size

Soil types were analysed for their influence on landing size. Significant differences were found between clay/loam types (typical of North Auckland and Otago/Southland) and pumice/sand types. Clay type soils are more difficult to work and require more metalling for surface consolidation. This generally results in higher construction costs and hence pressure to restrict landing size. Pumice/sand landings, on the other hand, are easily constructed, stable and free draining, resulting in a tendency towards larger landing sizes.

Differences in landing size between Otago/ Southland and other regions may be attributable to both the type of loader operated and the number of log sorts produced. Hydraulic knucklebooms are the predominant loader type, accounting for over 60% of the operations sampled in this region. Tests on all data showed that the difference in landing size between operations using knuckleboom loaders and other loader types is large (see Figure 5).

Operations using knuckleboom loaders tend to be lower volume restricted landing operations sorting fewer log sorts. The effect of the number of log sorts on the landing size is discussed in a later section. There was no significant difference in landing size between operations using rope crane loaders and wheeled front end loaders.

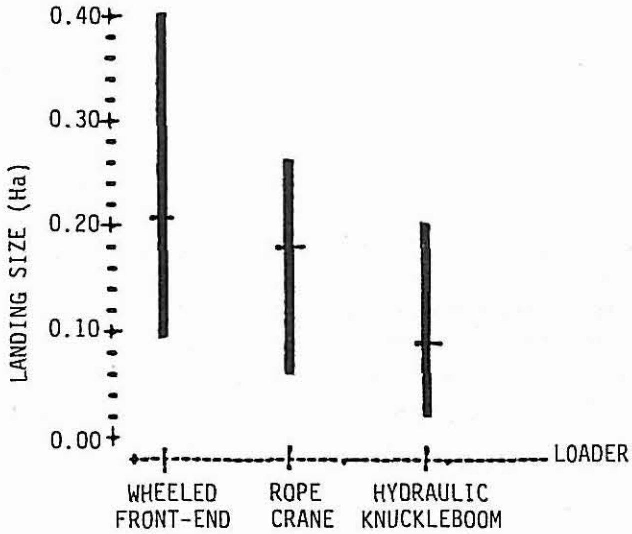

Figure 5 - Landing Size vs Loader Type

Regional differences in log sorting are represented in Figure 6.

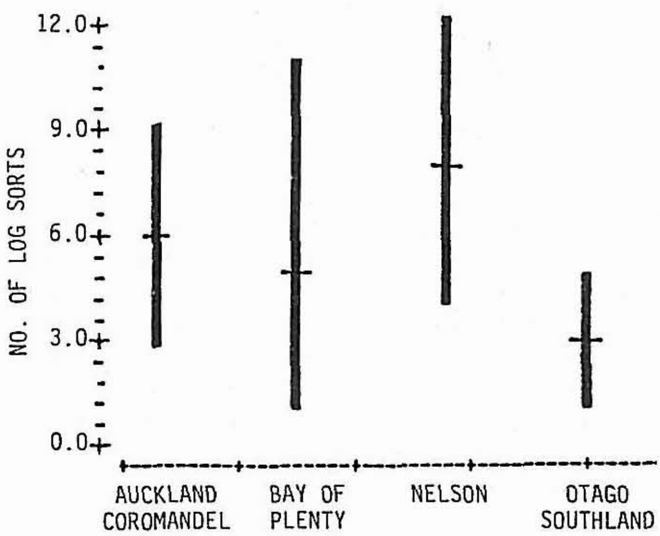

Figure 6 - Landing Size vs Log Sorts

Analysis of regional log sorting practices showed significant differences at the 95% level between the mean number of log sorts produced in Auckland (6) and Otago/ Southland (3). The Bay of Plenty region showed such a wide range in log sorting (from 1 to 11 sorts) that no significant difference from other regions was evident.

Effect of Extraction Type on Landing Size

Figure 7 shows the range in landing size for each type of extraction method (hauler, skidder, tractor).

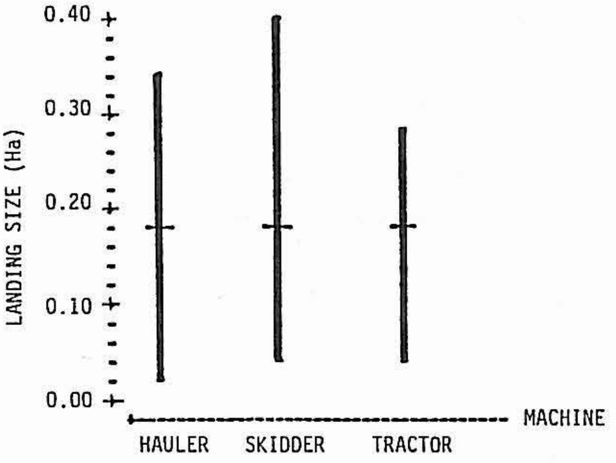

Figure 7 - Landing Size vs Machine Type

Despite their differing requirements for landing space (between extraction types) the mean landing size was the same. Due to the wide range in operations surveyed within each system type, no significant difference in landing size was found. For example, production levels for haulers surveyed ranged from 45 tonnes per day in small roadside operations (0.02 ha landing), to over 200 tonnes per day in large scale operations (0.34 ha landing).

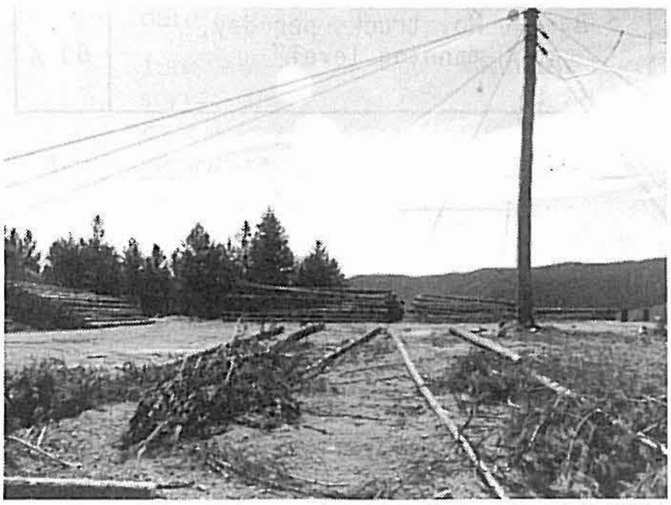

Figure 8 - Hauler landing showing multiple log sorts

From the collected data, the major variables influencing landing size were determined. Six major operational variables were recorded for each operation.

- extracted piece volume (m^3)
- extracted piece length (m)
- average daily production (tonnes per day)
- number of trucks loaded per day
- number of skid workers and operators on the landing (landing manning level)
- number of log sorts produced

Regression analysis was used to determine which variables influence landing size for each extraction type (Table 2).

For all operation types, landing manning level was found to be an important variable influencing landing size. It was found that this variable was not highly correlated with other variables such as daily production or the number of log sorts produced. Hence, it was considered valid to include in the analysis. Since tree length wood is often extracted to the landing from more than one direction, the square of the extracted tree length was analysed as a possible variable influencing landing size. It was found that this variable was an important predictor of landing size in hauler operations, although this was not evident in either skidder or tractor operations. In these operations, measures of production (the number of trucks loaded per day) was found to be a more important variable.

EXTRACTION TYPE

TYPE	PREDICTOR OF LANDING SIZE	R^2
HAULER	Extracted length^2, manning level	59 %
SKIDDER	No. trucks per day, manning level, No. log sorts produced	61 %
TRACTOR	No. trucks per day manning level, No. log sorts produced	74 %

Table 2 - Variables influencing landing size by operation

The Effect of Production Rate on Landing Size

The production level data for all operations was analysed to find the level at which differences in landing size became significant. These production levels were determined as being less than 80 tonnes per day, between 81 and 200 tpd, and greater than 200 tpd. The differences in landing size for these three groups are significant at the 95% level. Figure 9 shows the mean and range in landing size for each level of production.

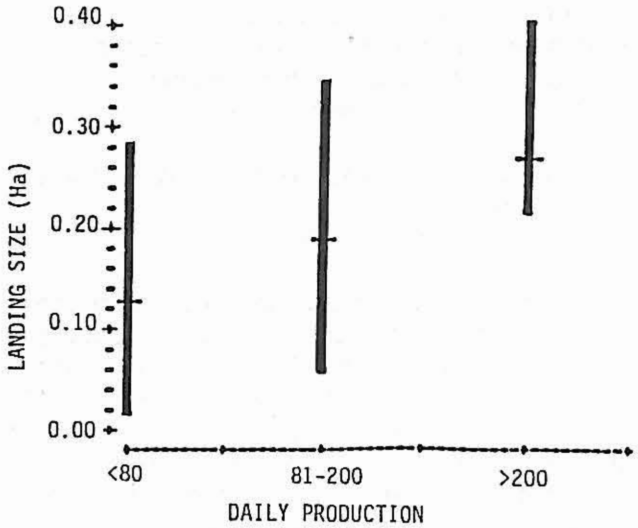

Figure 9 - Landing Size vs Daily Production

The important operational variables influencing landing size for each production level were determined through multiple regression. Results are given in Table 3.

PRODUCTION RATE		
TONNES PER DAY	PREDICTORS OF LANDING SIZE	R^2
< 80	No. log sorts produced, manning level	65 %
81-200	Extracted piece length, manning level	50 %
> 200	No. log sorts produced, No. trucks loaded per day	88 %

Table 3 - Variables influencing landing size by production level

The mean landing size for each number of log sorts was calculated and plotted against the number of log sorts produced (see Figure 10). This Figure shows the effect on mean landing size of producing progressively larger numbers of log sorts.

Regression equations were developed for operations with 1-3 log sorts and for those with greater than 8 log sorts. Due to the wide variation in the data for operations producing between four and seven log sorts, no satisfactory predictors of landing size were found. The important variables influencing landing size are given in Table 4.

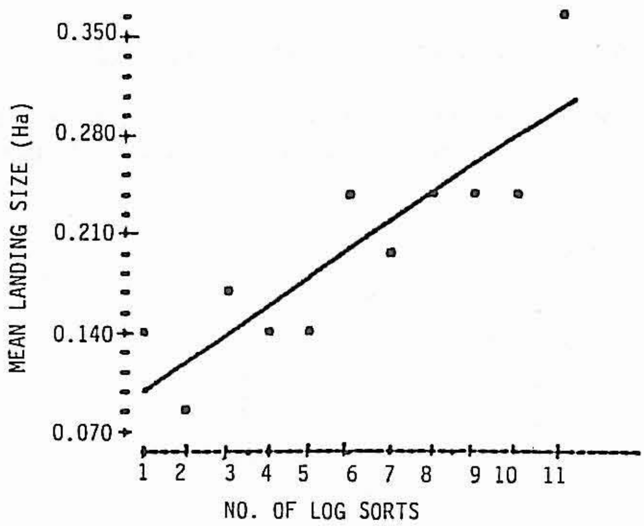

Figure 10 - Mean Landing Size vs Number of Log Sorts

In operations where few log sorts are cut, the square of the extracted tree length is the important variable. Production level in truck loads per day is the important variable determining landing size where many log sorts are cut.

LOG ASSORTMENTS		
NO.OF LOG SORTS	PREDICTORS OF LANDING SIZE	R^2
1-3	Extracted length^2, Manning level	69 %
4-7	-	-
> 8	No. trucks per day, manning level	60 %

Table 4 - Variables influencing landing size by number of log sorts

Figure 11 - Roadside Processing

SOURCES OF VARIATION IN LANDING SIZE

As can be seen from the preceding data, the relationship between landing size and operational variables such as; daily production, average piece length extracted and the number of log sorts produced is widely variable. There is obviously a large amount of variation in landing size that is not explained through regression analysis.

Possible sources of this variation are :

Management Prescription

As discussed by Twaddle (1984), an important influence on landing size is the specification prescribed by management. Most logging organisations have prescribed log landing dimensions, which vary for different regions depending on construction difficulty, tree size factors and to varying degrees "local practice". This is verified in the section on regional differences in landing size.

Operator Preference

Landings are often enlarged from their original constructed size during logging. This is related to various factors, including adverse terrain features, delays in truck scheduling or availability of a suitable machine to enlarge the landing. Enlargement occurs either through the use of secondary landing areas and roadside bays, or by simply extending the existing landing area.

Logging Planning

Some variation in landing size can be attributed to the size and shape of the individual logging settings. Hauler landings are often larger to accommodate the logging of several settings from the one landing. Haulers can also operate on very small landings and narrow roadsides. Hence logging planning, taking into account the configuration of each operation, is a source of variation in landing size.

Influence of Other Features

In addition to the factors already discussed, there are features of logging operations which may give significant relationships with landing size. These include truck scheduling, the length of log types segregated and the proportion of volume output in long lengths.

Irregularities in truck scheduling will result in larger log storage facilities and more bottlenecks in the sorting and stacking phases of the operation.

Longer log types and higher proportions of volume in long lengths require additional manoeuvring and storage space, resulting in pressure for larger log landings.

CONCLUSION

In the future, logging conditions will change with the onset of new crop radiata pine. Logging from steep ridge top roads and on unstable soils may mean that smaller log landings will be necessary.

The results of this survey of current landing practices show that smaller landings are possible with lower production operations, shorter log lengths and fewer log sorts segregated.

The alternatives of log length processing at the stump or processing at centralised log sort yards need to be further investigated.

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