



## Landing Size and Characteristics

### Summary

Landings are an integral part of harvesting operations in New Zealand. A representative sample of 142 landings was measured using GPS; twelve recently constructed and unused, 38 live landings and the remainder (92) older and closed out landings. The average landing size was 3900 m<sup>2</sup>, with a range from 1370 to 12540 m<sup>2</sup>. On average 11 log sorts were cut, the landings were in use for 4 weeks, and estimated daily production was 287 m<sup>3</sup>/day. Log processing was mechanised on 53% of the landings and 47% used manual processing. Most of the operations (79%) used tracked knuckle boom loaders and 21% used wheeled front-end loaders. A regression equation to model landing size indicated that the number of log sorts and production levels are the two main factors that determine landing size. Landing size tended to increase over time, with used landings on average being 900m<sup>2</sup> larger than newly constructed (unused) landings. Most recently constructed landings were much larger than the company design specifications; whereby either 40x60 m or 40x80 m were common specifications. A comparable study in 1987 showed the average landing area to be just over 1900 m<sup>2</sup>, indicating that landing size has nearly doubled in the last 20 years. Landings serviced by front-end loaders were on average 1100 m<sup>2</sup> larger than those serviced by tracked knuckle boom loaders, but this result is partially explained by the fact that front-end loaders were more commonly used in high-production systems.

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### Introduction

A forest landing or skid is a term used to describe a designated area in the forest constructed prior to harvest specifically for the purpose of landing full tree stems for further processing to logs, sorting into different log sorts and loading out to customers. This designated area is constructed by clearing the area of obstacles such as trees and stumps to create a flat even surface which can vary in size and shape and cost depending on the terrain and the processing, storage and loading out requirements of the harvesting operation.

Harvest system productivity for New Zealand operations ranges from 80 to over 450 tonnes per day (Visser 2009). Costs associated with landing construction range typically from \$4000 to \$7000 per landing. Many forest companies have prescriptions depending on the type of operation or location (Twaddle 1984), but these designs are rarely definitive or benchmarked against industry practice.

For the purpose of this project four different types of landings were distinguished: 'Pad'; 'Skid'; 'Super-skid'; and Central Processing Yard or 'CPY'.



*Figure 1: A typical (cable yarder) skid that incorporates the extraction, processing and loading phases of the operation.*

A 'pad' is a small landing used in a two-stage harvesting operation, where the pad serves as the site for transferring the extracted tree stems from the primary extraction machine to a secondary extraction machine. A common example is a hauler pad in steep terrain where a cable yarder is positioned on the pad to extract the trees, from which they are transferred to a ground-based machine for further extraction to a larger processing landing. Where appropriate,



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contractors may attempt to integrate a mechanised processor onto the pad to delimb and top the trees. This aids subsequent extraction and also leaves the slash at the pad to avoid accumulation at the processing landing.

A 'Skid' is by far the most common type of landing. It will typically service one harvesting crew and accommodate all the log processing, storage and loading functions (Figure 1).

A 'Super-skid' is a processing area that services a number of smaller landings (or 'pads') to concentrate the log-making (processing), sorting, storage and loading activities. Multiple crews, over a larger forest area, will provide stems or logs which are often forwarded to the super-skid off-road by a two-stage type machine, such as a grapple skidder or forwarder.

A 'CPY' is the largest landing type, to which stems are transported by either off-road, or on-road log or stem trucks. In the USA they may be referred to as Sort Yards (Dramm *et al.* 2004). CPYs are normally located close to a mill, port or rail head, and are also characterised by more automated, or sophisticated, processing capability. CPYs are still relatively uncommon in New Zealand, with just a few in use.



*Figure 2: A CPY, showing the scale of the operation and the proximity to the mill.*

## Methods of Study

Six regions in New Zealand were visited in 2009 and 2010. where a range of 'typical' landings from different forest companies were studied. During the study of each landing the perimeter was mapped with a Garmin GPSmap 60 CSx hand-held GPS receiver. The landing was defined as any area that had been 'built', with criteria that included the removal of topsoil, or being compacted, flat and contiguous. If a road clearly went through the landing it was included in the landing area. If the road ran along the landing edge then it was excluded. Areas prepared for vehicle parking were included if they met the above criteria.

The GPS was also used to collect position points inside the landing to separate the following functional areas: extraction, processing, fleeting, stacking and loading. Position points were then downloaded into a laptop computer and used to calculate the perimeter, the surface area, the length and width of the landings and the functional areas.

The use of a simple hand-held GPS receiver entailed a certain error in the positioning, normally indicated by the device itself. Given the favourable conditions encountered when mapping landings (i.e., the absence of a forest canopy), the positioning error was normally contained within 2-4 metres. A small number of landings were tested using different number of GPS points and it was found that when using more than 30 points to define the landing the area accuracy was less than 2% error.

For each of the sampled landings, forest managers were asked to provide the following data: type of operation (ground based or hauler), type of processing (manual or mechanised), type of log loader used (front-end or knuckle boom), number of log sorts, daily productivity, and duration of harvesting operation in weeks.

During the survey of active landings, the type, number and tasks of all machines were noted, as well as the number of crew members and their tasks. At the same time, sketches were



produced, describing the wood flow through the landing.

Using the GPS coordinates for each landing, where possible they were located on GIS digital terrain models. Average slopes were calculated for circular areas from the centre point of the landing for analyses of landing size with average slope.

Data was analysed using the statistical program R, and differences reported were significant at the  $p < 0.05$  level.

## Results

In total, 142 landings were measured, with 131 landings captured in 2009, the remainder in 2010. Twelve were new (unused), 38 were in operation and 92 were recently completed. Table 1 shows the mean, 5th and 95th percentile values for each of the parameters.

*Table 1: Mean, 5th and 95th percentile values for each of the parameters.*

Parameter	Mean	5 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile
Landing size (m <sup>2</sup> )	3868	1944	7476
Weeks in Operation	4.3	1	10.5
Production (t/day)	287	150	450
Log Sorts (#)	10.2	1	15
Perimeter (m)	271	187	396
Length/Width ratio	2.1	1.1	4.0

When the data was analysed it was possible to determine some interesting characteristics:

### **Landing Age:**

Used landings were 900 m<sup>2</sup> larger than new, suggesting that during harvesting the crews enlarge the operating area of the landing. They may do this to make additional space for log stacks, but it will also occur as residue is pushed over the side and the landing surface is "graded" clear during the operation.

### **Ground-based versus Cable Yarding:**

Of the total, 63 % of the landings were ground-based, 27% were in cable settings. On average a ground based crew extracted 320 tonnes/day, cut 10 logs sorts and was on the landing 3 weeks. A cable yarding crew extracted 232 tonnes/day, cut 11 log sorts and operated for 6 weeks. On average a ground-based landing was 430 m<sup>2</sup> larger than a cable landing. Yarder landings tended to be slightly more elongated (2.4 length to width ratio) than ground-based (length to width ratio = 2.0).

### **Manual vs Mechanised Processing:**

Of the total, 53% of the landings used mechanised processing and 47% used manual processing. On average the manual processing crews operated just under one week longer at a single landing and cut 13 log sorts. Their productivity was 26 tonnes per day less than the average mechanised processing crew. The landing shape was the same.

### **Front-end Loaders versus Knuckle boom:**

Of the total, 79% of the landings used knuckle boom loaders for loading out, and 21% used front-end loaders. The landings surveyed that were operated by front-end loaders handled an average of 15 log sorts, were on average 1100 m<sup>2</sup> larger, and produced 35 t/day more than landings using knuckle boom loaders.

### **Regression analyses:**

The best regression equation for predicting landing size was:

$$\text{Landing Size (m}^2\text{)} = 390 + 560 \times \text{Landing Age} + 173 \times \text{No. Log Sort} + 3.5 \times \text{Daily Prod.}$$

Whereby Landing Age =0 when new; =1 when in use; and =2 when harvesting completed.



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## Discussion

### **Comparison with previous data**

In 1986 a similar study was carried out surveying size and other factors of 50 landings in four different regions in New Zealand (Raymond, 1987). The average landing size was 1900 m<sup>2</sup>, which is 2000 m<sup>2</sup> less than in 2010. The upper range of landing size in the 1986 study was 4000 m<sup>2</sup>, similar to the average landing size in 2010.

In 1986 there were three times as many landings using front-end loaders as there were knuckle boom loaders. Landings using front-end loaders were also approximately 1000 m<sup>2</sup> larger than those using knuckle boom loaders. This trend has completely reversed, with knuckle boom type loaders dominating (79%) operations now, but the absolute difference in size is still about the same (1100 m<sup>2</sup> in 2010). In 1986 there was no discernible difference in landing size between ground-based and cable yarder.

Number of log sorts and production were two parameters that were the same in the landing size regression analyses for both studies. In 1986 the coefficients were 160 and 5 for number of log sorts and daily production respectively, and they remain very similar (the 2010 data showing them to be 173 and 3.5). This indicated that a lot of the increase in landing size can be explained by both the increase in average productivity and the number of log sorts being cut.

The 1986 study measured only landings in operation, so it did not record a change in landing size over time. That study also measured stem length at the landing, which was a significant factor for yarder landing size.

### **Evaluation of schematic diagrams**

The diagrams depicting the layout of the active operations were difficult to interpret. Attempting to differentiate between zones on the landing was inconsistent as most areas served multiple purposes. Landing layout analyses of the

schematic drawings for the live landings indicated that as landing size increased, there was a preference for using multiple rows to manage log inventory on the landing. Operators of smaller landings typically preferred to stack around the edge of the landing.

The production through cable landings was typically more 'linear' with the cable yarder at the 'far end' and clearly separated from the landing processing and loading activities (Figure 3).



*Figure 3: Arrow overlaid on cable landing photo showing linear flow of production.*

Landings with motor-manual processing operated with clearly defined processing decks with deck placement aligned with skidder access to the landing. Many ground-based landings with mechanized processing attempted to centralise the processor to minimize subsequent fleeting distances (Figure 4).



*Figure 4: Mechanised processor located more centrally on the landing to minimise fleeting distance.*



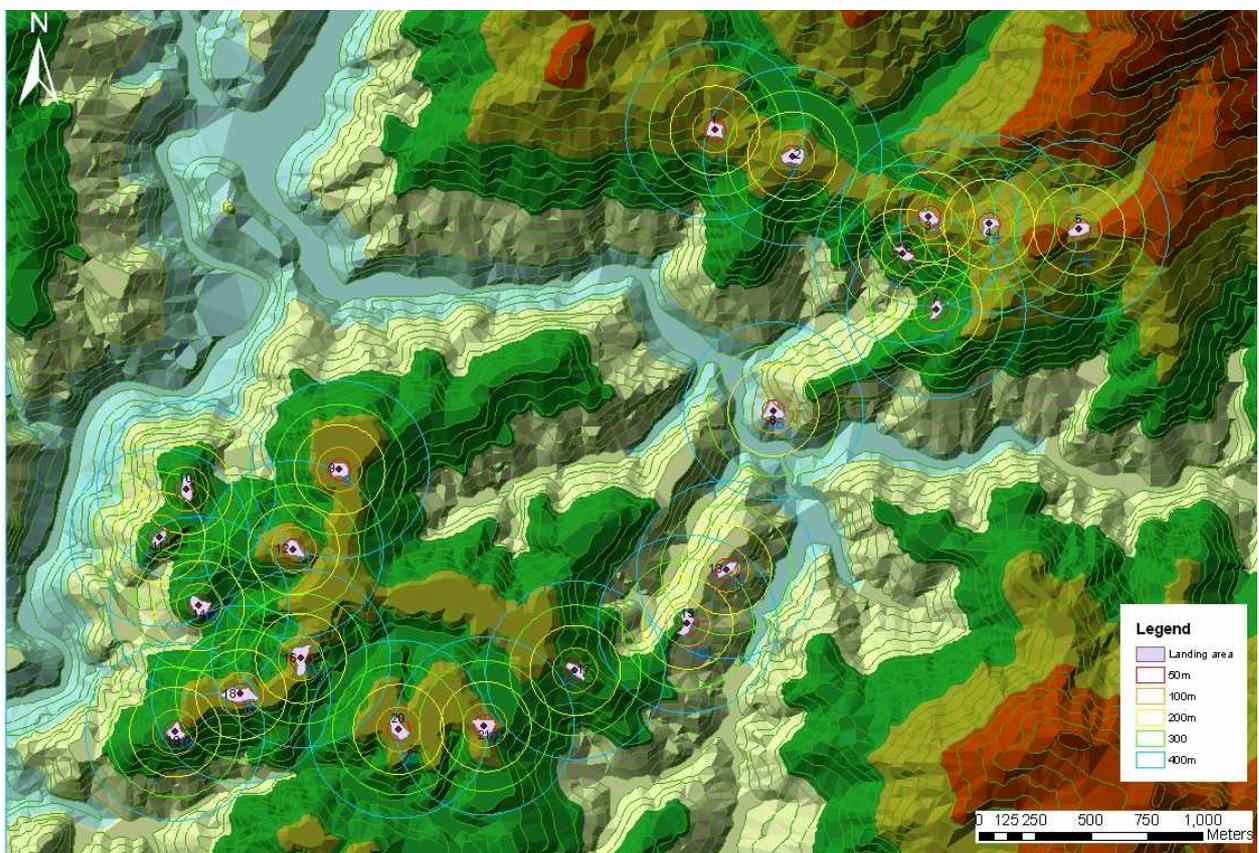
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## ***Evaluation of surrounding slope.***

In general the steeper the surrounding slope the smaller the landing, and using 50 or 100 metre circles gave the best correlation between landing size and slope, but no statistically significant relationship was found. Surrounding slope was compounded by a 'location' factor (Figure 5). The largest landings were typically

found on the lowest elevations and had the lowest surrounding slope. However large landings were also easily constructed at the top of ridges, but were characterised by quite steep slopes leading up to them. The smallest landings were found at mid-slope, on steep slopes.



*Figure 5: GIS map showing landing locations. The circles shown around the landings were used to determine average surrounding slope at different radii. Note that landings on top of ridges were generally larger than those on mid-slopes (Figure prepared by Hamish Berkett).*

## **Conclusions**

Landings are (and always have always been) an integral part of large scale harvesting operations. They are expensive to build and their location and size is important to an efficient and safe operation. Mean landing size has doubled since an earlier LIRO study in 1986 (Raymond 1987). This study effectively validates

the 1986 study in terms of the parameters of production and number of log sorts as driving landing size, but has also added to the knowledge base by including landing use as a significant factor. A number of changes in equipment preferences, such as the trend towards mechanised processing and the current prevalence of knuckle boom grapple loaders, have also been established.



## References

Dramm, J. R., Govett, R., Bilek, E., and Jackson, G.L. (2004): Log sort yard economics, planning, and feasibility. Gen. Tech. Rep. FPL.GTR.146. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. Madison, WI: 31 p.

Raymond K. A. (1987): Factors influencing landing size. Report Vol.12 No. 1 1987. Logging Industry Research Association Rotorua, New Zealand 6 p.

Twaddle, A.A. (1984): Variation in skid site area amongst some exotic forests. NZ Forest Research Institute Bulletin No. 64.

Visser, R. (2009): Benchmarking Harvesting Cost and Productivity. Technical Note Vol 2, No. 6 2009. Future Forests Research (FFR), Rotorua, New Zealand.

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