ISSN 0111-6711

LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND

REPORT

Vol. 12 No. 11 1987

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A CABLE HAULING TRIAL WITH THE MADILL 071 — USING THREE DIFFERENT RIGGING SYSTEMS

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ABSTRACT

A cable hauling trial was conducted where a Madill 071 used three different systems (North Bend, Mechanical Slack-pulling Carriage (MSP) and Shotgun) to log a 5.5 hectare setting. Each system was matched to the limiting terrain constraints. The shotgun system showed faster outhaul and inhaul cycle times, and line shifting was simpler, than the other two systems. The MSP system involved a lower proportion of the total operating time being spent in line shifts than the North Bend system. The trial showed the importance of landing location and the relatively small area needed for a mobile hauler system.

INTRODUCTION

More of the future new crop forests are growing on different terrain than most of the current harvest operations and present a new set of constraints (e.g. topography, soils and environmental impacts). Many of these areas will require some new thinking for planning and for logging and transportation techniques, for successful management. Cable logging will have a greater application in these areas.

Timber harvesting in the Pacific Northwest region of the United States (PNW) has dealt with similar operating conditions and issues to those beginning to occur in New Zealand. Two concepts that have contributed to success in the PNW are :

- Planning the logging and transportation system together within the framework of the "best whole system" and "minimum total cost". This means, for example, that the forest roads are not just laid out for a transportation network; rather they are also laid out for productive logging (e.g. considerations for landing location, hauling distance and ground profile, hauler capabilities, etc.). In some cases this involves high road construction cost to achieve low logging cost and minimise the total cost.
- the use of a range of cable systems best suited to terrain and operating conditions. Of course, specific equipment availability for each area of operation is a limiting constraint. However, there are usually several alternative cable systems that can be rigged with each machine. It is this versatility in using different systems to log a setting that can improve logging productivity.

These concepts have potential applications for New Zealand and they were recently demonstrated in a cable hauling trial on a steep portion of Kaingaroa Forest.

The main purpose of the LIRA study was to evaluate the feasibility of operating a cable system and hydraulic knuckleboom loader on relatively small landings. Results of the landing study are reported in Kellogg (1987). In addition, the study provided an opportunity to evaluate a variety of cable systems with one hauler and relate these experiences to harvest planning of the area. The aim of this Report is to discuss the two concepts listed above (planning and versatile cable system selection) in the perspective of results from an actual operation.

The hauler used in this study has the capability to use many different systems. However, the versatility concept can be applied to other hauler operations in New Zealand as well. The harvest planning information reported here is limited to landing location and ground profiles in relation to equipment capabilities. This information is a component of the whole logging/transportation planning concept.

ACKNOWLEDGEMENT

LIRA wishes to acknowledge the co-operation from J. Dudson and the crew of Skyline Logging Limited, and the assistance from the Forest Research Institute Harvest Planning Group.

TRIAL AREA

The trial was mainly conducted in Compartment 1128 of Kaingaroa Forest; a small part also occurred in Compartment 1123. Douglas fir trees were clearfelled on both areas. In Compartment 1128, the mean merchantable tree volume was 3.4 m^3, with a mean dbh of 58 cm. There were 217 stems/ha with a merchantable volume of 741 m^3/ha.

Two log preparation options were undertaken and their effect on landing operations was studied. The two treatments reflected a relative difference in the amount of log preparation completed in the bush (one or two long logs cut off the butt section of the tree).

LOGGING EQUIPMENT AND PROCEDURE

The hauler studied was a Madill 071. This machine is highly mobile with a tank track carrier, three guylines and 15 metre tower. There are five operating drums with the following line capacities :

	Diameter (*mm*)	*Line Length* (*m*)
Skyline	*26*	*580*
Mainrope	*19*	*665*
Tailrope	*16*	*1,340*
Slackpulling rope	*10*	*1,010*
Strawline	*10*	*1,010*

It is anticipated that mobile haulers, such as the Madill 071, will have increasing application on much of the future steep country.

The trail was limited to working with the existing layout where large landings were previously used with old skyline haulers for production thinning. The terrain was highly variable with a range of ground slopes. Ground clearance and skyline deflection was generally not a problem. A key factor was locating the hauler close to the edge of the landing. Slope hauling distance was approximately 230 metres maximum, with an average distance of 135 metres.

A 30 tonne Sumitomo Link Belt hydraulic knuckleboom loader was used for sorting and loading. The hauler and loader worked from a central location and log sorts were stacked in a radial pattern around the equipment.

There were eight men in the logging gang plus the contract owner. Their work responsibilities varied depending on the hauling situation and other operating logistics. Two fallers adequately stayed ahead of the hauling. Only one skiddy was needed in the complete log preparation option. There were two to three breakerouts. The extra skiddy switched over to breaking out when hauling in the complete log preparation area.

ALTERNATIVE CABLE SYSTEMS

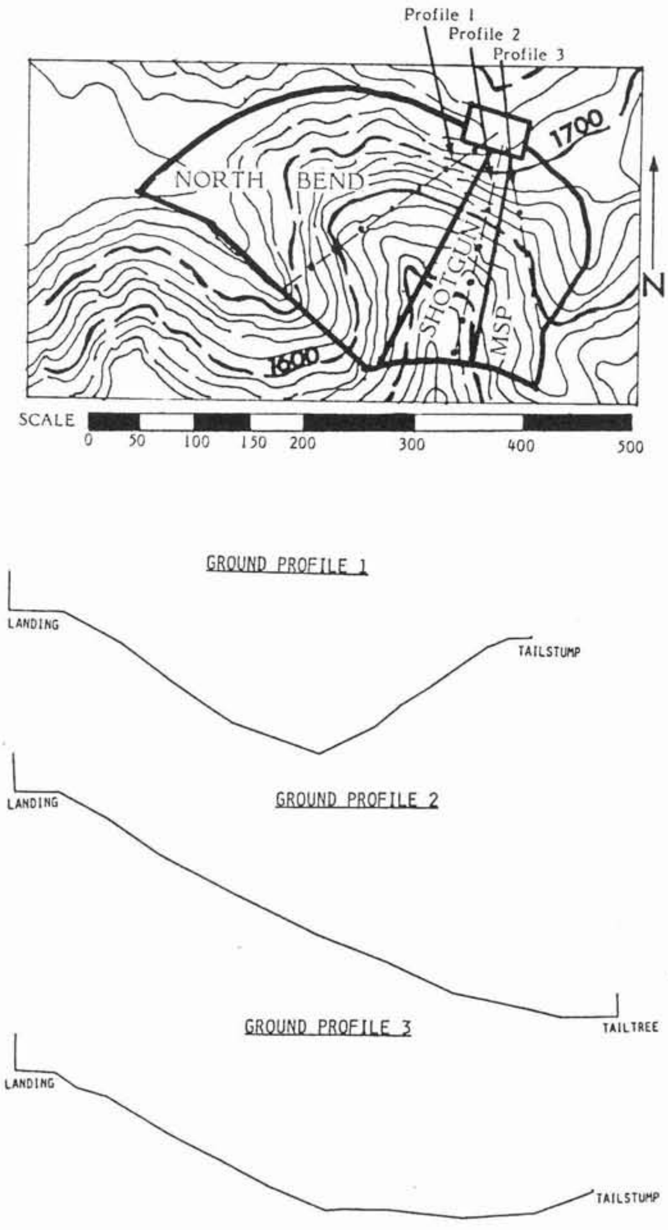

Figure 1 - Cable hauling trial area terrain

A topography map of the cable setting with three representative ground profiles is shown in Figure 1. Three different systems were used for logging; North Bend, mechanical slackpulling (MSP) and shotgun (Figure 2). The North Bend system requires three operating lines and works as a standing skyline. Four strops were attached behind the fallblock. The mechanical slackpulling system requires four operating lines and also generally works as a standing skyline.

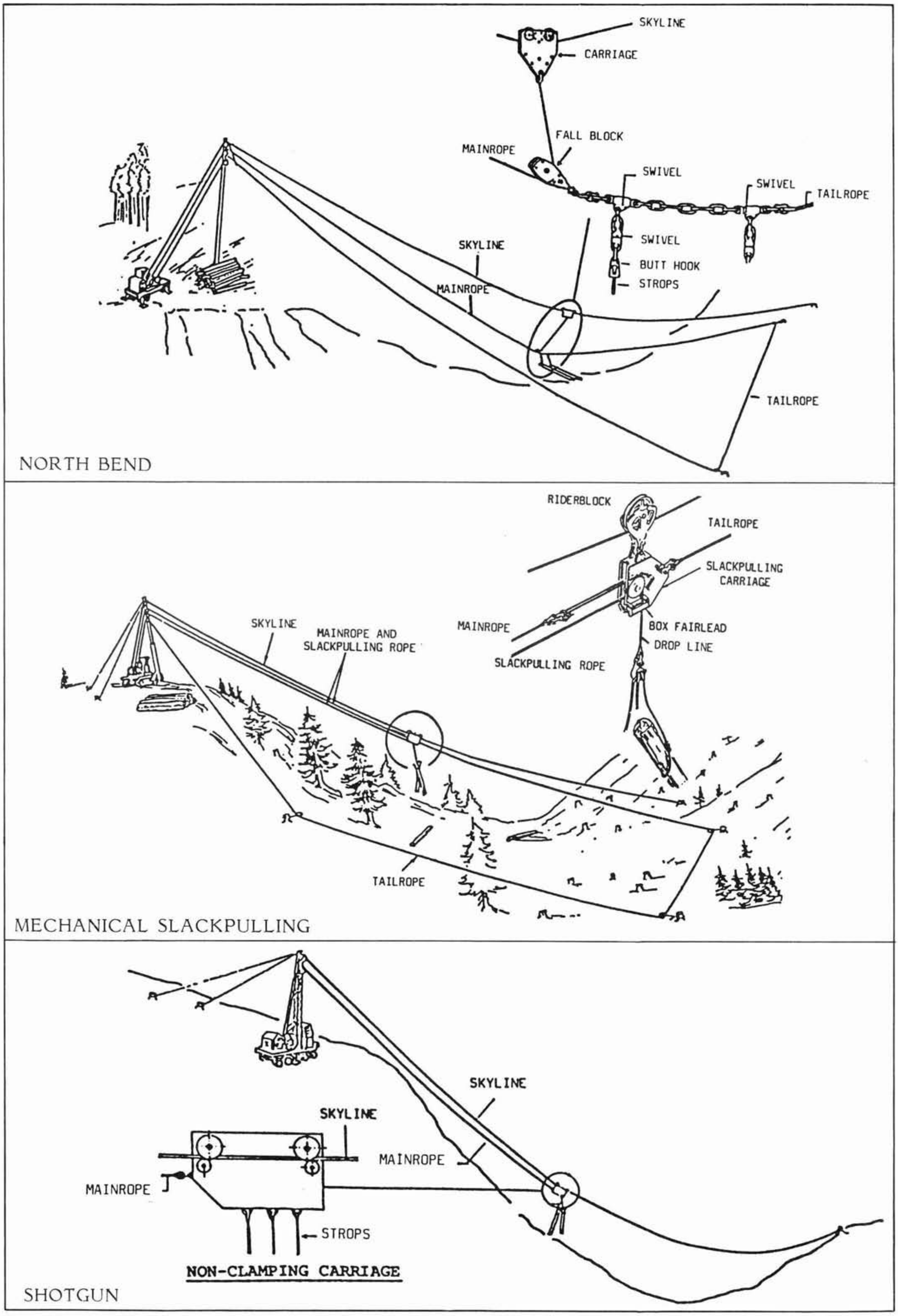

Figure 2 - Cable Systems (from Studier and Binkley, 1974)

Figure 3 - Gravity carriage designed by LIRA

The mechanical slackpulling system requires four operating lines and also generally works as a standing skyline. The mechanical slackpulling carriage extends the lateral reach to approximately twenty metres on each side of the skyline. Four strops were used; one attached to the end of the dropline and the other three on sliding hooks along the dropline. The shotgun system only requires two operating lines; the carriage travels out by gravity. The system works as a live skyline, requiring the skyline to be raised and lowered during the hauling operation. Carriage designs vary but are usually kept simple. For this study, LIRA built a non-slackpulling carriage that weighed slightly less than 0.5 tonne and had five lugs at the base to attach strops (spaced 450 mm apart). Tailrope blocks were shackled on top of the carriage thus serving as skyline carriage sheave (Figure 3). Further descriptions of skyline systems and carriages can be found in the LIRA Cable Logging Handbook (Liley, 1983) and Skyline Carriage Survey (Hemphill, 1985).

North Bend System (Figure 4)

This system was most effective when logging terrain characterised by Profile 1. The fallblock was readily dropped into the gully for hooking logs. Disadvantages of the system that influenced production were :

Figure 4 - North Bend system used when hauling across gully

- slow outhaul and inhaul times (Table 1). The North Bend system was limited by the speed of the tailrope drum for outhaul travel time. By contrast, the shotgun system was faster.

Table 1 - Hauling Cycle Comparison between cable systems

Cycle Component (mean value) [1]	*Skyline Systems* Shotgun	MSP	North Bend
Outhaul (min)	*0.51*	*0.88*	*0.79*
Inhaul (min)	*1.54*	*1.72*	*1.89*
Drag volume (m^3)	*3.7*	*4.2*	*3.6*

[1] *Times are for all systems at a 200 metre drag distance. Outhaul is the unloaded travel time from the landing to the log hooking point. Inhaul is the loaded travel time from the log hooking point to the landing.*

- slow unhook times, often with delays. When the tailblock was at a lower elevation than the landing, the carriage and fallblock had a natural tendency to slide away from the landing when releasing mainrope tension to unhook logs, making it difficult to get slack in the strops. Work sampling data showed that a significantly higher proportion of time was spent unhooking logs with the North Bend system than the MSP system (Kellogg, 1987).
- no lateral reach (beyond the strop length), thus more frequent line shifts. The bridling technique can be used for obtaining lateral hauling capacity toward the rear of a setting.

  The proportion of operating time spent in line shifts was :

  North Bend 24% (measured over 8 line shifts)

  MSP 16% (measured over 7.3 line shifts, landing work sampling occurred for 7 complete line shifts plus a portion of 1 shift)

  (Comparative data for the shotgun system was not available.)

  The time per line shift averaged approximately 42 minutes for both systems.

The North Bend system was used for logging the west portion of the setting. Hauling then shifted to the eastern boundary and progressed down to the gully (refer to Figure 1). The hauling terrain there was well suited to the mechanical slackpulling system. Little time was lost when changing systems. The carriage changeover was made on the landing while other line shift activities occurred.

Mechanical Slackpulling System (Figure 5)

Figure 5 - MSP carriage with lateral hauling capability

The main advantage of this system was the additional lateral reach over the North Bend and shotgun systems. This reduced the proportion of operating time spent in line shifts. It also extended the length of reach for hooking logs thus providing more opportunities for achieving optimum drag loads. Disadvantages of the system were :

- slow outhaul and inhaul times, similar to the North Bend system. The MSP system was also limited by the tailrope speed for outhaul and requires tailrope tension when dragging the logs to the landing (the MSP carriage used in this study was a non-clamping design; there are MSP clamping carriages available that would eliminate this problem).
- difficulty in holding logs up to the carriage (tailrope tension required as noted above). The system was best used on ground slopes as shown in Profiles 2 and 3 and was not as effective on the deep-concave Profile 1, sidehill or downhill hauling.

Figure 6 - Shotgun system used when hauling over a constant ground slope

Shotgun System (Figure 6)

As logging progressed toward the gully, away from the eastern boundary, the ground profile became a more constant slope (ideal for the shotgun system). The shotgun system would not work well on Profiles 1 and 2 because when lowering the skyline for hooking at the back of the setting, the carriage would drift back to the low point in the profile.

The main advantage of this system was the relatively fast outhaul and inhaul times (refer to Table 1). Also logs were suspended below the carriage; a tailrope was not used thus the resisting tailrope tension, required in the North Bend and MSP systems, was eliminated. There is less drum brake wear in the shotgun system compared with other systems where tailrope tension is required. In addition, other studies have reported approximately a 30% fuel saving with the shotgun system over highlead (Dubowits, 1980).

A disadvantage of the shotgun system used in the trial was no lateral reach beyond the length of the strops. Longer strops were used with the shotgun system (5.7metres) compared with the North Bend and MSP systems (3.7 metres). Lateral reach can be achieved with a shotgun system by using a hand slackpulling carriage (e.g. Christy carriage).

Line shift times were reduced by making use of a tractor as a mobile tailhold. It was also used in approximately half of the line shifts with the North Bend system; it was not used during the MSP line shifts because of the terrain. In the shotgun system, only the skyline required shifting - there was no tailrope to re-position. In other situations with the shotgun system, where a mobile tailhold is not feasible, there are rigging practices and equipment to speed up line shifts (Conway, 1982).

In summary, the versatility of the Madill 071 was used by logging the setting with three different systems. One system, such as the North Bend, would have worked for the whole setting. However, it was not the most productive system to use in all cases. The MSP and shotgun systems were more effective in the terrain types where they were used. The use of other systems than those tried in this study could also be feasible. The main concept is a versatile use of systems to harvest a setting. Changing systems is not time consuming when the logging supervisor plans and organises the gang for the work involved.

PLANNING

Harvesting planning (roads and logging) should be done with considerations for the capabilities of the available equipment. For the Madill 071, unique characteristics are :

- mobility
- relatively short tower height
- five drums, thus a wide range of cable systems

Landing location and organisation is especially important in every operation. The landing should be located for logging over "good ground profiles" where there is adequate ground clearance and deflection. There are a variety of "hand-calculation" techniques and computer programs available for evaluating ground profiles and deflection (LIRA Cable Logging Handbook (Liley, 1985)). The profiles also influence the kind of systems that can be used. The advantages and disadvantages of each system should be considered and the setting laid out to utilise the most productive system.

With a relatively short tower height, the hauler often needs to be positioned close to the landing edge (within 13 to 20 metres) for adequate ground clearance over the slope below the landing. The mobility advantage of the Madill 071 makes it feasible to move quickly between several landings or along a road.

There were two main problems with the available large landing used in the trial. Firstly, the large area was not needed by using a mobile hauler and hydraulic loader and completing some of the log preparation in the bush. The landing layout and organisation was designed to work effectively in a relatively small area (0.07 hectares, 25 metres by 28 metres). The size of the previously constructed landing was 0.26 hectares (73 metres by 36 metres). Using the large landing caused non-productive time with machine moves around the landing for adequate positioning of the hauler to log various parts of the setting. The second problem with the one landing was that the less productive North Bend system was needed for hauling across the gully shown in Profile 1. Also there was a substantial portion of sidehill hauling.

An alternative plan for the trial area would utilise two small landings rather than one large area (Figure 7). The size and cost of constructing two small landings would be less than one large landing. There was a large landing previously constructed on the western boundary as well as the one used on the eastern boundary.

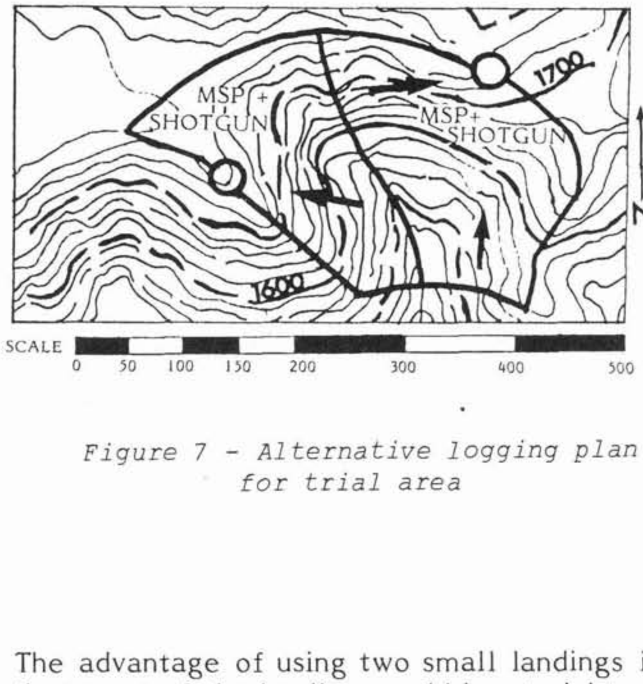

Figure 7 - Alternative logging plan for trial area

The advantage of using two small landings is that most of the hauling would be straight up the slope with ideal terrain for the more productive MSP and shotgun systems. Tailholds outside the hauling boundary, on the opposite side of the gully would improve deflection.

The disadvantage of the alternate plan is that an additional machine move is required between landings and more line shifts are needed. However, the Madill 071 is highly mobile, thus short distance landing moves can be quickly completed. As earlier noted, it is often just as time consuming to move the machine around a large landing.

CONCLUSIONS

The experience from this trial highlighted two important points that should be considered in future steep country harvesting operations :

- the use of a variety of cable systems within the capabilities of each hauler.

  In this trial, three different systems were used for logging a small setting. Each system was matched to the limiting terrain constraints.

  The Madill 071 hauler design allows for a high degree of versatility. However, this concept can be applied to other haulers. For instance, in the Pacific Northwest, it is common practice to modify existing highlead machines, such as the Madill 009 for shotgun skyline logging. The highlead mainrope is used as the skyline and the tailrope becomes the mainrope in the shotgun system. Further details of these changes can be found in the LIRA Skyline Carriage Survey (Hemphill, 1985). Murphy and McConchie (1984) have reported on using a Madill 009 as a shotgun system. Companies and contractors in the Pacific Northwest have generally increased production and improved safety over the more conventional highlead. With the two drum hauler, there is thus versatility between highlead, scab skyline and the shotgun system.

- operational success starts with efficient planning. The amount of planning needs to increase in future steep country areas where new challenges will be faced.

  Experiences in the Pacific Northwest have shown that steep slope planning requires a higher technical level of knowledge in areas such as cable systems, slope stability and site impacts. Harvest planning should integrate both the transportation and logging components within a whole system concept.

  This trial has shown the importance of knowing the capabilities of the available logging equipment when determining landing locations and size. The road system should be laid out to connect landings that are in the best position for logging.

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RP13570/9/87