LOGGING INDUSTRY RESEARCH ASSOCIATION

NEW ZEALAND

PROJECT REPORT

TACTICAL PLANNING SEMINAR

PROCEEDINGS

The Proceedings of a Seminar
held in Rotorua
June 1981

P.R. 16 1981

N.Z. LOGGING INDUSTRY RESEARCH ASSOCIATION (INC.)

P.O. Box 147 Rotorua New Zealand

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PREPARED BY:

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Research Assoc. Inc.

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* Editors Note

For the purpose of these proceedings, Session 5 & 7 have been combined.

- INTRODUCTION -

Tactical Planning of logging operations is one step in a chain of planning decisions required to ensure that the economic,evnironment, production and safety factors are compatible.

A large proportion of the forests established in New Zealand since the late 1950's has been on steep erosion prone sites and unsuitable or reverted agricultural land. In many instances stabilisation of the land has been an important criteria for establishing the forest. These forests and others will make an important contribution to the boom in forest harvesting which the industry will undertake over the next 20 years. A wide range of planning decisions need to be made to ensure that soil and water and other on or off site values are not foregone. The more critical the site, the more careful the planning must be.

What are the tactical planning requirements for the future? What is the known state of the art? Who should be doing the planning, and how far ahead?

The answers to these questions were the basis for the 1981 LIRA seminar on planning held in Rotorua over three days in mid-June. The seminar, attended by 120 people, did not attempt to teach participants how to plan but to think more carefully of the planning needs. Five broad areas were covered :

1. Planning constraints - the land, the crop and management.

2. Roading and landing construction and design.

3. Environmental quidelines - are they working?

4. Planning principles for newly developed systems.

5. Case studies of three sensitive areas in New Zealand.

These proceedings record the main papers presented and the discussion which took place during the seminar.

- KEYNOTE ADDRESS -

Chairman: Jim Spiers, LIRA

LIRA PLANNING SEMINAR 1981

"AN OVERVIEW OF PLANNING NEEDS"
by A.W. Grayburn,
Manager, Forestry Division,
N.Z. Forest Products Limited.

"OBJECTIVES AND AIMS OF SEMINAR"
by Viv Donovan, LIRA

AN OVERVIEW OF PLANNING NEEDS

A.W. GRAYBURN

Introduction

It is a pleasure, as Chairman of the LIRA Board, to open this seminar. Planning is a vital part of any operation, particularly as seen from a General Manager's point of view.

I persuaded Jim Spiers to have this Seminar well before he retires. He helped develop logging planning in New Zealand in the 1950's. It has gone on well since then, but needs reviewing and updating. LIRA, under Jim Spiers, is the best organisation to do that and to lead the way for the next 25 years, during which time the New Zealand forest industry is expected to grow enormously, especially on the utilisation side. See the papers and findings of the 1981 Forestry Conference, to see the extent and location of that growth. Loggers will need to understand what the future of the forest industry means to them because of their inevitable involvement in it.

History in New Zealand

Logging planning as we know it today, commenced after the Second World War.

That doesn't mean to say no planning was done in the great boom days of Kauri and other indigenous logging. Think of the planning for Kauri dams, log booms and barging, steam donkey cable logging, extensive trams with often very sophisticated layout and construction, early roadways, and so on. Planning was included in the early demonstration logging units at Minginui, Whaka Forest, Pureora and Tapanui, set up by the Forest Service before, during and immediately after, the War.

It was seen that more sophisticated planning techniques would be absolutely essential for the concentrated, large log volumes needed from the Kaingaroa and Kinleith Forests beginning in the 1950s for the pulp and paper industry. We looked to the Pacific Northwest for example and guidance.

Names immediately come to mind :- Jim Foresman
Max McKee
Tom Simpson
Don McColl (Canada)
Ed Stamme (U.S.A.)
Chook Chambers
Pat Crequer

And of course, Jim Spiers, to mention some of those who were involved.

Most of the methods we use today were introduced and developed by these men and those who worked under them, based on their various training and experience.

The Present Situation

Naturally, emphasis is in the exotic forests - increased to over 90% of total log production in New Zealand and the bulk of this in the large forests of the central North Island.

It has concentrated on the following factors :-

1. Log demand, simple log segregation and flow demands. Included seasonal variances in some cases.

2. Road layout by density per acre and topography of the forest area.

3. Equipment choice by log size, topography and availability of machines.

4. Productivity based on stand measurements, log sizes and work study.

5. Attempting to smooth out variations in costs to give an acceptance overall annual average unit cost to the "customer".

The Future

By today's standards, there are some omissions from that list. That doesn't mean to say that some of the following points haven't already been considered, they have, but they need increasing and continuing emphasis. That, I hope, will be the job of this Seminar. Hence, I will only touch on them and not in any order of importance - in many cases only posing the question. It is not intended as an extensive check list.

1. The Log Market

Who is going to use the logs, for what, and for how long? The investment in equipment, its type, the log cutting pattern, the form of extraction, loading and caring, will all depend on this. Perhaps the best recent example of this has been the plannning for the log supply to the new ANM Ltd mill at Albury, New South Wales. Compare that with the situation at Kaingaroa with multitudinious log sorts to a wide variety of dispersed mills using all sizes of gear. That is, what has to be done for one "customer" as against a large number.

To plan the log input for a new mill gives the forester and logger a great opportunity to plan fully in advance and to influence the log processing equipment at the mill. But remember, mill equipment lasts 15-20 years or longer, is very expensive to change, trees grow in size or are replaced by smaller ones, so either your forecasting must be very good, or you should build in room for flexibility. How often is the logger asked why he is doing something a certain way, when the answer is "That's the way the mill must have the logs", or "They can't handle it any other way", because of log processing equipment designed and installed years ago.

2. <u>The Forest Constraints</u>

Most of these are well known but silvicultural regimes are changing and over the next ten years in particular, log supply could be short. This will require better log salvage, different cutting patterns, and supplies to the one mill from a wider source and ownership. Allocations and log transport may have to be rationalised. A greater proportion of our log supply may come from thinnings - compare the current situation in Australia. There the bulk of the pine supply is from thinnings. For a while at least, rotation ages will shorten to maintain mill supplies - what does that do to logging planning, and particularly the effect on cost?

The forester is managing his forest better and is spending considerable sums on improving log quality, at least in part of his crop. To see that these specific logs get to the right market will require better log cutting and grading, better sorting, and better control of delivery. It might even need a change in truck design. I do not see a wholesale trend to log merchandising yards as has been the trend in the Pacific Northwest, it will continue to be done somewhere in the bush by the logger, in part at least.

3. <u>Environmental Considerations</u>

Over the last ten years, these have assumed increasing importance and certainly will not lessen. They will be extended in the future and involve :

- protection of soil and water values;
- maintenance of soil fertility and productivity;
- protection of patches of indigenous bush in the forest, or areas of other species to be left;
- coupes or settings are likely to become smaller;
- recreational areas and tracks may need to be avoided;

- landscape values, as yet little understood, may need a new approach;
- better cutover cleanup and generally a tidier job;
- protection of wildlife habitats that are of significance;
- avoiding areas of historical interest (refer to Historic Places Trust);
- protecting the forest owners' other property, e.g. paddocks and stock in the case of farm foresters.

4. Logging Equipment

Think back on what has happened over the last 50-60 years. The disappearance of the bush tram, the almost universal use of the internal combustion engine compared with steam earlier, the advent of the oil crisis, the place of aircraft in our lives, and so on. What will happen in the future with technology the way it develops so rapidly? Fortunately, most logging equipment only has a 5-10 year life so you can keep up with the changes to some extent.

Our logging planning must allow for these changes to remain efficient and cost competitive. They allow changes in techniques but beware of the mill constraints which can't change so readily, so that the whole system or flow is compatible.

There are many pitfalls in choosing equipment for your logging system :

- is the equipment readily available;
- are replacements and spares held locally;
- can maintenance staff be trained and retained, often in isolated locations;
- is the equipment compatible with local supply and demand;
- what operator skills are required;
- what are the weak links in the total mechanical systems being offered, and either plan for them or avoid them;

and, of course, most important of all, will it suit your operational conditions at the cheapest price? All parties have to make a "profit" of one sort or another. Total or varying degrees of mechanisation do not necessarily give you the cheapest wood. In addition, beware of the glamorous methods such as balloons and helicopters, and the view that cable logging will solve all your environmental problems. They will solve some, but at enormous cost. Beware of advice from the inexperienced but see that it is countered by the best experience and practice well presented in the debate.

5. Continuity of Work

It is under this heading I want to deal with the human side of our operation. Both the equipment and the people need to be employed continuously if resources, (men, machines, materials and capital), are not to be wasted or used inefficiently. Let us consider some planning questions. The aspirations of people must be taken into account :

- where do you set up your logging base;
- where do people live and what travelling is involved;
- how do you recruit and train;
- what is the balance of crew numbers and sizes, but don't overlook the inevitable fluctuations in demand;
- "absenteeism" is more common today, plan for it;
- what is the place of contractors;
- what facilities do the men want on the job;
- because of greater leave entitlements, it may have to be scheduled in future. Not an easy planning exercise when people want freedom of choice for taking leave;
- during strikes, maintenance periods and sudden breakdowns, how are the loggers kept employed?

Some logging crews and their equipment will have to be pretty mobile to cope with the cuts from small forests and woodlots. Periodic cuts from these sources will be important inputs to the industries and they will have to be carefully scheduled into the overall supply, but recognising local constraints. The small woodlot owner will expect a well planned and executed job to be done.

In spite of all these problems, people are looking for continuous employment, the contractor as much as anyone.

6. <u>The Computer and Other Planning Aids</u>

I know little about these, but I know they are available. They are based on the computer, both large and small, using mathematical models. Not a great deal of use has been made of them in New Zealand until recently. Perhaps they are like total mechanisation, they are not the complete answer. But if they help planning, we should use them.

We should be aware of the various techniques developed, largely in North America, and at least evaluate them. They vary from designing cable log settings, to total logging systems planning, to optimum log inventory planning and to optimum log cutting patterns for stands and trees (FRI have one), to mention but a few.

No matter how good such methods might be, they do not remove the need for you to know your forest and the conditions under which you will work. Good information has to be gathered first for any planning system to work.

Aerial photography has been in use for planning for a long time but here too, new developments and techniques are cropping up all the time. Keep abreast of research results and publications to improve your planning. LIRA has been set up to help you.

Conclusion

I have attempted to review the logging planning scene in New Zealand from the indigenous operations to the large exotic forest logging of the central North Island. Planning to date has been very adequate. It needs reviewing, shortcomings identified, changes forecast and techniques improved for what wil be both a shortage and then a growth period, during the next 25 years. I hope I have identified some of the problems which may have to be faced. You, no doubt, will cover them during this Seminar.

I wish you well in your discussions and workshop sessions.

DISCUSSION

Mr Grayburn was asked that in the light of the problems he had outlined in scheduling wood flow to the mill if any overseas experience was useful. He replied that in general it was not as stockpiles in New Zealand had a limited life because of our species and climate and usually less than one week's supply can be stored at any one time, therefore stockpiles cannot be used as a buffer. This is peculiar to New Zealand and perhaps also Australia and Chile.

OBJECTIVES AND AIMS OF SEMINAR

V.F. DONOVAN

The purpose of this seminar is to provide information and provoke discussion on logging planning and the requirements for the future especially in areas where either soils or other constraints are critical. It is not a course on planning and LIRA had some considerable difficulty devising a programme which would stimulate thought on the needs for planning rather than give information on existing planning technology.

The seminar is aimed at people who "do things" or "make things happen". We are not here to question policy, politics or regional resources. Our question is <u>how</u>?

How to do a better job of planning?

How to plan to get the wood off the hill in a way which is satisfactory to all requirements.

How to make a dollar.

How to, in some cases, survive.

We have deliberately put the emphasis on critical or sensitive areas. The case studies have been included which incorporate these - Mangatu, Marlborough Sounds and the small woodlot on the "dirty back acre".

More of these areas in the future will be logged. Many of you involved with planning will not be dealing with such critical areas but I'm sure that the lessons learnt will be valuable for any planning exercise.

We will be loking at what has happened in the past and why. Not to point the finger at any individual or specific company but purely as an example. As an industry we must learn from previous judgments after all mistakes are written on the landscape.

DISCUSSION

Dick Everts of the F.R.I. asked if the seminar could keep in mind the need to re-establish the next crop after logging and therefore logging and crop establishment should be considered together at the planning phase, for example, stump height, slash concentration and skid tracks all affect re-establishment. Viv Donovan responded that yes it should be part of planning and that we would keep it in mind during the seminar. In addition, at the end of the seminar there would be time to look at areas which needed more consideration.

- SESSION 1 -

PLANNING CONSTRAINTS

Chairman : Jim Spiers, LIRA

"THE LAND"
Andrew Pearce, Scientist, Forest Research Institute, Ilam.

"THE CROP"
Bill Liley, Forest consultant, J.G. Groome & Associates, Taupo.

"MANAGEMENT"
G.R. (Sandy) Hampton, Forest Manager, Carter Holt Central Limited, Napier.

Session 1
Paper (a)

EARTH SCIENCE INFORMATION FOR LOGGING PLANNING - WHAT, WHERE, WHO?

ANDREW J. PEARCE
Scientist
Forest Research Institute
Ilam

INTRODUCTION

Earth science data that are potentially useful in the planning of logging operations are gathered, collated, or mapped by several organisations in New Zealand that are concerned with geology, geomorphology, soils and hydrology. Often the available data are not presented in a form or at a scale suitable for direct use by logging planners, and these data must be interpreted by trained earth scientists who can also speak the logging planner's language and who understand at least some of the planner's needs. Regrettably, such intermediaries seem few and far between, and the earth science profession in New Zealand has not been to the forefront in training people for this important applied science role. In this paper I attempt to give an outline of the types of earth science data that are available, how they might be interpreted to make them useful to planners, their limitations, and where suitable interpretation might be obtainable.

At the outset, however, I want to make a distinction between two aspects of land-use planning. One of these I will call indicative planning. This is concerned with medium and long time scales, is usually done at rather small scales of mapping and principally identifies sets of constraints and sets of options to produce a coherent and optimum pattern of land use for an area. Most regional planning and some aspects of district scheme planning are of this type. The second aspect I will call operational planning, which is concerned with decisions, rather than sets of options. The operational planner has to bite the bullet and decide whether or not, for example, a road will follow a particular route, or whether a particular compartment will be tractor logged. These decisions apply to the immediate future, and operations are planned on a detailed (large) scale. These two types of planning are at the ends of a spectrum of planning processes and the boundary between them is neither clear nor very important; logging planning, however, is definitely at the operational end of the spectrum and is concerned with hard decisions, short time scales and fine subdivisions in space. These characteristics in themselves place some constraints on earth science involvement in logging planning, since only data that are readily available and which can quickly be interpreted can be used. Professional earth scientists are too often not prepared to commit themselves to advice when data are few and time is short, thus by default, they may force planners to make decisions that are less soundly-based than they could be.

WHAT SHOULD THE LOGGING PLANNER HAVE?

Ideally, the logging planner should have access to a terrain zoning map of the area to be logged. Such a map should be on a topographic base of about 1:10 000 to 1:15 000 with a contour interval of about 10 m; it should identify specific erosion hazards such as old landslides, zones of particular instability because of slope steepness, soil water conditions, or rock type; it should identify routes, at least for major roads, that avoid or minimise contact with such hazards; it should specify the need for streamside protection zones on particular rivers and/or streams; and it should subdivide the total area into zones that are suitable for particular types of management, e.g. clearfelling, summer-only logging, selection logging, protection zones, etc. The basis of the zoning system should be made explicit as far as possible in a legend of supporting information, e.g. rock formation X zoned for no logging because of extreme landslide hazard; streams draining >100 ha have perennial flow and support trout populations, thus streamside protection is required.

Engineering geologists or geomorphologists using stereoscopic viewing of large-scale aerial photographs can characterise particular landscape types which may have differing erosion hazards, can identify particular rock and or soil types with specific problems, and can identify specific hazard areas. This interpretation should be undertaken jointly with the logging planner, who can specify options for road and track layout, logging system, coup size, seasonal logging patterns, etc. Local field staff's road construction experience, if available, should be drawn on while field checking of the photo interpretation is being done. Rainfall intensity/ frequency data should be reviewed to assess the probability of large storm damage during various seasons, and the areal extent of very intense storms may be important in determining coup sizes in some regions. Hydrologic data on floods and low flows should be reviewed to assess the need for streamside protection zones for various catchment sizes. The finished terrain zoning should be presented on a large scale topographic map or orthophoto map. The role of the earth scientist should be to interpret the raw data into a zoning map for the planner, and to help the planner to assess the likely consequences of his various options for roading, logging system, logging pattern and timing etc., so that a suitable compromise can be achieved between undesirable effects of the logging on slope stability, streams etc., and the efficiency of the logging operation.

WHERE ARE THE DATA?

The data needed to produce a terrain zoning map are widely scattered across organisations. Topographic maps at a suitable scale will be available for many State Forest areas, but may have to be prepared from large-scale aerial photographs where maps are not already available. Map scales smaller than about 1:20 000 will not be very useful in most areas, because of the probable need to identify and separate out areas as small as a few hectares. Geological data for the whole country are mapped at a scale of 1:250 000 but for various reasons the data presented are often not useful for the sort of zoning map that logging planners need. Many areas are mapped at scales of 1:63 360 or larger but, except for specific engineering geology maps, are unlikely to be directly useful to the logging planner without additional interpretation by an engineering geologist or geomorphologist. Even where no large-scale geological map is available, aerial photograph interpretation and some field work can produce suitable maps in a short time, provided trained staff are available. Topographic maps, and aerial photographs and photogrammetry are largely the responsibility of Lands and Survey (although the Forest Service does some photogrammetric work, and MWD has a research group in photo interpretation at the Palmerston North Science Centre). Large-scale orthophoto maps, which are ideal for presenting the terrain zoning, are beginning to be produced for some State Forest areas. Geological mapping, especially engineering geology and special-purpose mapping, is mainly done by Geological Survey (although FRI does some geological mapping for terrain zoning). Hydrologic data for determining the need for riparian protection, and rainfall data for storm rainfall intensities and frequencies are variously held by Water and Soil Division of MWD, the Meteorological Service, and by Catchment Authorities. Storm rainfall intensity-frequency data are probably best obtained from the maps of Tomlinson (1979). Data on the areal extent of intense storms are probably most important in the Northland, Coromandel and Bay of Plenty areas, which can receive intense subtropical storms that affect only small areas in any one storm. Such data are probably available from Catchment Authorities and the Meteorological Service.

The National Land Resource Inventory Worksheets and the derivative single-factor maps (e.g. erosion) produced by NWASCO will in general not be useful for the detailed planning of logging operations, simply because they are at too small a scale. The Worksheets were not intended for such purposes but were to "... provide land resource information ..... at a scale detailed enough for use at regional and district levels (1:63 360)." (Hawley and Leamy, 1980, p.20). An additional complicating factor with the worksheets for the North Island is the lack of a single coordinated legend for all the sheets.

I believe that the wide variety of sources of earth science data, the range of scales and styles of mapping and presentation of data, and the general need for digestion and interpretation of the raw data into special purpose maps for the logging planner, make it imperative that earth science skills be incorporated into the workforce that plans logging operations of any consequence.

WHO CAN INTERPRET THE DATA FOR PLANNERS?

At present there are few applied earth scientists in New Zealand who are involved in interpreting data for land use planners at the operational level. The Palmerston North Science Centre of MWD has developed considerable expertise at smaller mapping scales suitable for what I have called indicative planning. The Engineering Geology section of Geological Survey has considerable expertise in assessing slope stability and road construction problems and has produced some special purpose engineering geology maps. The skills resident in the staff of these and similar organisations could be used in logging planning, but a period of familiarisation with logging practices and needs would be needed for most staff before they would become really useful to logging planners. The Geohydrology Section of FRI has a small group of earth scientists who have developed some methods of mapping and zoning for forest management, including logging, but this group is far too small to tackle the whole of the forest estate of New Zealand. Indeed I imagine that the resources of the Water and Soil Division of MWD, the Geological Survey, FRI and the Catchment Authorities would be taxed to keep up with producing terrain zoning maps of all areas to be logged within the next decade.

In my view, if terrain zoning is to become a routine part of forest management planning in general and logging planning in particular, there are two possible routes to obtaining the necessary earth science inputs to planning. The first is for all Forest Service Conservancies (and probably all large districts) and for large private forestry concerns to recruit their own earth scientists. There is no shortage of graduates with the necessary background training, but most recent graduates will need some training and familiarisation with forest management practices and needs. Such a development within the Forest Service alone would enable the small FRI earth science group to concentrate more on developing zoning and assessment techniques for particular problems, and to spend less time on what is essentially a servicing task (but a very important one). The second alternative is to make use of private consulting organisations to prepare zoning maps from available data to a standard specification of scale, etc. The actual zoning scheme could not be too tightly specified as it will be very much area- and operation-specific. A small number of engineering consulting firms have geotechnical and engineering geology groups who could undertake such a task. This alternative has a number of attractions to both large and small forestry organisations since it avoids difficulties of recruiting and training staff to develop and use a consistent zoning system, and it permits small organisations to have the same quality of earth science input to their planning as larger organisations have. Inevitably, some combination of these two alternatives will have to be used if terrain zoning maps are to be prepared to any large extent in the near future. Even if consulting firms are used to carry out the bulk of the routine map preparation, some earth science staff will be needed by forestry organisations to set specifications, maintain some quality checking on the consultant's products, and to refine the zoning systems used. If we are serious about using terrain zoning to help logging planning there is an urgent need for recruitment and training of staff by both forestry and consultant organisations so that a start can be made on terrain zoning of the vast areas planted since 1960, which will be coming due for logging in the next and following decades.

SOME EXAMPLES

Two examples of terrain zoning carried out by FRI earth scientists will give some idea of the range of approaches and outcomesthat are possible. In 1977 Westland Conservancy requested a zoning of the production forests of Central and Northern Districts of the conservancy to aid in preparation of Regional Management Plans. Their request stemmed partly from some earlier work done in relation to the West Coast Beech Forest Utilisation Proposals, which had recognised high erosion hazards on particular rock types, and lower hazards on similar terrain underlain by other rock types (O'Loughlin and Gage, 1975; O'Loughlin and Pearce, 1976). Discussions with Conservancy staff indicated that they would be happy with a three-class system of zoning for their immediate purposes:

- a class where there were no erosion or water and soil conservation constraints on clearfelling, if that was desirable,
- a class where selection logging would be acceptable, but where clearfelling was likely to cause erosion problems,
- a protection zone class, where logging should not be permitted.

Geological and soil maps were obtained at the largest available scale, topographic maps at 1:10 000 and 10 m contours had already been prepared and a recent uniform 1:15 000 aerial photograph coverage was available. The geological data were briefly checked in the field where possible and by photo interpretation, then photo-interpretation of slope steepness and existing erosion was combined with the geology data, with Soil Bureau erosion hazard ratings for the soils as mapped by them, and with data on the behaviour of recently-logged areas on particular rock types and soils, to place particular areas into one of the three classes. Zoning into the three classes was presented on 1:10 000 topographic maps. The zoning was briefly checked in the field again, with particular attention to slope steepness and existing erosion. This reconnaissance-level zoning exercise enabled mapping of Nemona, Hohonu, Waimea and Kaniere Forests to be completed, in conjunction with other work, in one year (Pearce, 1978 a,b,c). O'Loughlin and Gage (1975) had previously zoned much of Mawhera, Omoto and Hochstetter Forests in about 1 year, and Pierson (1980) has since zoned Granville Forest using the same system.

The Westland zoning example is one where the geology was reasonably well known and relatively simple; certain rock units were known from past logging experience to have high erosion hazards on steeper slopes, and other rock and soil combinations that have similar erosion hazards were relatively easy to recognise. In practice, the zoning exercise tended to identify those areas where clearfelling was acceptable and those areas where no logging should be permitted, with the residual area being zoned as where partial or selective logging would be acceptable. Those involved in the zoning probably tended to err slightly on the safe side, especially in decisions whether to place areas in the protection category or in the selection logging category.

The second example is the terrain stability classification developed at Mangatu State Forest (Gage and Black, 1979), an extended form of which is currently being developed for the other state forests of the Gisborne District. The geology of Mangatu Forest was not well known and is rather complex, and the same is true for most of the other areas of afforestation in which the extended classification is being mapped. The first requirement in all these areas is to produce geological maps at scales of about 1:10 000 to 1:25 000. At Mangatu Forest a classification of eight terrain types was developed based on the rock type, the type of erosion processes that were active now and had been active in the past, and the age, or duration since the last active erosion period, of the present land surface. The age or duration of stability for various areas could be determined by the presence or absence of various well-dated volcanic ash layers in the soil profile. A clear scale of decreasing relative stability was established for six of the eight types of terrain. This system could not be applied in an unmodified form to other State Forests because of differences in the rock units present, in the geological structures, and the lack of the crucial volcanic ash layers in some areas. By working gradually away from the Mangatu area, through regions that are closely similar in geology towards those that are less similar, we have tried to redefine each of the stability types to include terrain of similar relative stability. The development and extension of this terrain stability system is still underway, and we may yet have to abandon the ideal of having the same classification system for the whole region, and have a set of classifications each of which applies to a smaller area. From the viewpoint of the forest manager and logging planner, having several different schemes would be much less desirable than the one system covering the whole region. The great strength of the system developed at Mangatu is that it is based largely on objective criteria; unfortunately the further it is extended into other areas where some of the criteria can not be used, the more the zoning of a particular piece of terrain depends on subjective geological interpretation.

The system developed at Mangatu Forest certainly cannot be applied to most areas outside the East Cape region because of differences in rock units, geological structures, erosion processes and topography. Systems based on the same principles could, however, be developed for much of the northern half of the North Island, where volcanic ash layers can be used to date the land surface. Elsewhere, systems like that used in Westland but with more objective criteria, where possible, can undoubtedly be developed. Collating the information on the response of various rock and soil units to past logging would be the most important and time consuming part of developing such a system in any region.

SUMMARY

Applied earth scientists can greatly aid logging planners by preparing terrain zoning maps that will help planners to identify hazards and constraints, and by helping planners to assess the consequences of various options for roading, logging system, etc. Many of the basic data needed to prepare such maps are already in existence, but they require compilation and interpretation into a form that is useful to planners. The existing pool of earth science skills within state and private forestry organisations is far too small to undertake such a task. If terrain zoning is to become a routine part of the logging planning process for the large areas that will be harvested in the 1980s and 1990s, both state and private forestry organisations, and private consulting organisations will have to recruit and train a substantial number of applied earth scientists from the ample supply of earth science graduates being produced within New Zealand.

Terrain zoning systems will have to vary from one region to another because of differences in geology, topography, erosion processes, the forest resource, and the logging planner's needs. Objective criteria for assigning pieces of terrain to categories of the zoning system need to be developed where possible, to minimise the degree of subjective geological interpretation used in the mapping of areas. It will not be possible to eliminate subjective interpretation entirely, but by developing systems that are based on sound earth science principles and objective criteria, it will be possible to assess the responses of clearly-defined terrain types to logging and other disturbances of various kinds. These

responses can then be used as input to modify and continuously improve the basis for terrain zoning.

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DISCUSSION

Ron O'Riley from the University of Canterbury said that roads were claimed to be the cause of erosion, not tree felling as such. Therefore, good logging planning must start when the first access tracks are put in. Generally very little is known about soil types and most operational planning is done by those planning the roads. The speaker agreed with this but said that the vast areas which had been planted in the last couple of decades on steep country had not been assessed for erodability. It was also true that there was a low correlation between erosion hazard rating and actual erosion following logging. Generally when an area is given a high hazard rating, loggers modify their methods to reduce erosion. In further discussion it was said that the east coast of the North Island is getting a lot of attention now although areas such as Marlborough, Otago coast and North Auckland which would soon be logged, needed consideration. The principle developed on the east coast will be applicable in other areas of a similar type but the criteria used for hazard zoning cannot be transferred too far from the original soil and rock types. For this reason personal experience gained in one area on erosion hazard rating usually cannot be transferred to another area with guaranteed success. The question was then asked whether Catchment authorities used erosion hazard classification for other purposes, for example, land clearing for agriculture. A Catchment authority representative replied that it could be done but was not probably because of staff shortages. One area where it had been done was for the Maui pipeline which shows that Catchment authorities can carry out this work.

SESSION 1

Paper (b)

PLANNING CONSTRAINTS - THE CROP

B.A. Liley

J.G. Groome
& Associates

Insofar as it affects planning constraints the crop can be examined from the following aspects :

(i) The tree and stand characteristics
(ii) The forests capacity for sustained yield production
(iii) The topographic types represented within the forest
(iv) Distance from markets.

In this paper it is the first of these that is considered, the <u>tree and stand characteristics</u> :

The potential productivity of both machines and labour can be calculated before logging commences through study of the work content aspects of the stand to be logged. Such aspects are the stems per hectare, the average piece size, limb density, degree of malformation, etc.

Having mentioned these stand parameters it is appropriate to review project work currently being co-ordinated by the Radiata Task Force. They are involved with relining a combination of measurement techniques and operation simulation models which deal with aspects of the forest stand pertinent to logging planning, e.g. :

- Projects MARVL and PROD. Both of these are simulation models concerned with the standing forest and its utilisation. MARVL assessss the forest immediately prior to logging whereas PROD effectively "grows" the forest as well. For this purpose it incorporates other models such as KGM1, the Kaingaroa Growth Model.

- Project HARSIM, as its name indicates, is a harvesting simulation model. In fact the development of HARSIM is effectively in abeyance at present. Ideally the log mix produced by MARVL or PROD could be assigned a cost recognizing both the growing cost of the wood and the harvesting costs. In determining the latter, harvesting simulation, if practicable, would be invaluable. Unfortunately the amount of unpredictable variability within the logging industry makes identification of various cost elements difficult to the point of impracticability. This at least has been the experience overseas, and it is an interesting reflection on the task facing New Zealand's tactical planners that such is the case.

- SIMSAW, MATSAW, OUTBOARD, etc. By comparison with harvesting, simulation of the processing operations for model construction is relatively straightforward as the number of simulations attests.

The MARVL Method

In the context of this seminar MARVL, the Method for the Assessment of Recoverable Volume by Log types, is worthy of further consideration. It supercedes earlier assessment techniques by gathering all raw data in a form which can be immediately processed by computer. The approach used is to observe and record stem quality and size as a sample of standing trees and then to predict the results of crosscutting these trees under the influence of a variety of log specifications and requirements. Sample trees are assessed for 'features' which are basically any variations from a single headered, non-malformed tree. The features recognised are 'Fork', 'Merchantable Branch', 'Short leader', 'Dead Tree' and 'Regions Affected by Sudden Taper'. The whereabouts of 'features' on the tree is recorded and the diameter at a point immediately above.

The optimum cutting strategy is calculated by a computer program which will mimic the activities of the cross-cutter and predict the yield of the various logs from a tree of given size and quality. In order to do this it is necessary to know the preferences given to each log type. The program user indicates such preferences by specifying a list of log dimensions, a list of codes indicating types of stem qualities that may be incorporated in logs of that type and value per cubic metre for the log type.

The actual cross-cutting of each piece is performed by an optimisation routine so as to maximise the total value of the resultant logs for each piece. The relative values of the log types are used to determine which logs to cut, when to downgrade portions, or when to waste otherwise merchantable portions in order to obtain a more valuable log elsewhere. These are exactly the decisions that must be made by cross-cutters working on the skids, ideally by following guidelines laid down by forest management. The following information can be identified from the MARVL program :

The live stocking is stems per hectare
The dead stocking per hectare
The % of live trees malformed per hectare
The total live volume per hectare
The value above breakage points
The merchantable volume which can be extracted
The mean tree diameter
The mean top diameter
The expected production by log type
The expected cutting pattern waste.

The output illustrated refers to stand parameters. However the program can also provide details of the individual trees assessed which include :

The individual piece length (assuming certain breakage factors)
The piece volume
The logs produced by size and quality assuming the optimum cutting pattern.

Recognition of the Tree and Stand Characteristics in Planning

All of the above is eminently useful information and represents crop constraints that the planner must recognise. Of most importance is the individual piece size. This determines machine sizes and power ratings, particularly where the logs are big and must be handled by a machine individually. With small piece sizes there is some capacity to vary load characteristics by varying the number of pieces in the drag.

Studies invariably show that there is a high correlation between piece size and productivity and hence logging cost.

The total live volume per hectare is a critical constraint in that it determines the rate at which areas must be logged if set rates of production are to be achieved. This in turn determines the rate at which new roads and landings must be constructed and the frequency of change in hauler settings or rope shifts.

The mean tree diameter affects chainsaw sizes, choker sizes and felling times. In 'mechanised' operations it is important to know diameters to determine such considerations as whether a felling head has sufficient jaw opening or whether delimbing knives can accept the full stem width.

The tree length may also be important in mechanised operations. Does, for instance, the delimbing boom have the capacity to reach the full utilisable length of the stem? In conjunction with piece size, tree length may be an important consideration in skyline operations - does the slung length of the tree beneath the skyline allow sufficient ground clearance?

The average values for the stand parameters cannot be considered without also recognising the levels of variation associated with them. A logging system may function cheaply and efficiently at mean piece sizes, or lengths, or diameters, but be inefficient or inoperable at extremes in the range. A wide variation in crop characteristics may require a single very flexible system, or perhaps a combination of systems such as seen where a small skidder based wood salvage crew follows a larger feller buncher operation.

The Effect of Log Out-turn on Logging Planning

The characteristics of the crop discussed so far do not necessarily rely on MARVL for their elucidation. A variety of assessment techniques have been used successfully for decades now in determining important crop parameters prior to harvesting.

Where MARVL and its associated developments will become invaluable is in the assessment of log production by quality class. As earlier explained, the MARVL program can predict the optimum log segregation, provided that the preferences for each log type are adequately specified.

Further work by the Radiata Task Force is indicating just how different the various products of the wide spacing regimes are going to be. Being given most priority in the regime design is the rapid accumulation of clearwood on the butt log. Higher logs in the tree will also grow rapidly but are expected to be more coarsely branched than corresponding logs in the older close-grown regimes. Despite the coarsely branched upper logs the tree as a whole will be more valuable; in the first place because the clearwood component should command a considerable premium, and second because all logs should be of greater average size and therefore more efficiently processed.

We can be assured that forest owners do not allocate finance to sometimes very expensive forest tending operations without having confidence that such investment will be adequately rewarded by increased value in the final crop. The forest managers accept the responsibility of recommending and implementing the most suitable silvicultural regimes to meet the forest owners concept of greatest value. The tactical logging planner bears a similar responsibility. Besides ensuring that the logging system produces wood at least cost while recognising a variety of constraints, he must also ensure that the logging system is geared to produce a product assortment to the required specifications. This in turn ensures that investment in tending of the forests has been worthwhile.

Not only is there an unprecedented opportunity, through the application of MARVL, to predict an assortment of products but for profitability reasons there will be an unprecedented requirement to ensure that the optimal segregation is in fact realised, particularly in the tight supply situation predicted for this decade.

Recognitioin of Log Assortment Characteristics in Planning

Of what practical consequence will be the log assortment data produced by MARVL? Given a logging operation in, say, a 25 year old stand of Radiata grown under the board regime the MARVL data can be used in resolving such considerations as :

- What area will the landings have to be insofar as this is related to the amount of product segregation carried out?

- What area of forest will have to be logged to produce, say, 1000 tonnes of peeler logs, or 1000 tonnes of sawlogs?

- What will be the truck scheduling necessary to ensure that the various log types are delivered to their respective destinations, e.g.

  Peelers to the plywood plant,
  Export sawlogs to the port,
  Domestic sawlogs to the mill,
  Pulpwood to the chipper.

  Needless to say, the destinations may be in opposite directions and different rig configurations may be necessary for each type.

- What extra personnel will be required on the skids to ensure the optimal cutting pattern can be carried out.

- What extra training and supervision of the logging gang will be necessary.

- Should the segregation be carried out at the bush landing at all or would economics of scale make it more worthwhile to carry it out at a central transfer yard.

Monitoring and Review of Logging Planning

The tactical logging planner determines the means by which the various wood products will be transformed from standing trees to logs on the skids. Thus he may find himself, with the logging manager, among the first made answerable in the event of a discrepancy between predicted out-turn and actual out-turn. What will be the tactical planner's defence?

In the first place, MARVL is a computer based sytem, and as we are so frequently reminded the computer's output is only as good as the data supplied.

The tactical planner may enquire whether the MARVL assessment crew has performed its sampling and measurement properly (it has been found that the field work requires a certain degree of skill, and this may be lacking). Have the preferences which determine the optimum cutting pattern been correctly specified?

Second, the logging crews may not be performing their operations correctly. The skiddy's, for instance, may be consigning too much wood to the pulp stack and selecting too little as sawlogs. Such a deficiency is the responsibility of the logging manager to correct.

A third possibility is that the tactical logging plan does require some fine tuning to ensure that the logging systems implemented are adequate in producing the optimum log assortment from the forest. By providing a standard, MARVL improves the tactical planners capacity to critically monitor the performance of his logging planning, and make revisions where necessary.

Conclusion

In presenting the tree and stand characteristics as they affect planning the opportunity has been taken to discuss MARVL, a new development in standing tree assessment techniques. The sample printout from the program which has been included shows numerous stand parameters which have also been adequately measured by earlier cruising methods. The constraints that these tree and stand characteristics present in logging planning have been discussed.

Where MARVL offers an unprecedented advantage is in its ability to quickly calculate the optimum log yield from the forest by log quality class and dimensions. In providing this information MARVL improves the tactical logging planners capacity to select logging systems which will adequately recover the products that the forest has been grown for. The responsibility remains with the planner for monitoring and reviewing the logging plan to ensure that this aim is realised.

DISCUSSION

The discussion following this paper centred on the use of the MARVL program for optimising the value of logs cut from trees in a stand. The input to the program requires structural codes to determine things such as length and diameter for different log classes and quality codes to give a value to different kinds of product. As yet branch characteristics have not been used although the Radiata Task Force is working on incorporating it. One difficulty noted for loggers in particular is that some cutting instructions result in waste being produced in order to gain the best value from a log. As contractors are paid by weight loaded out, this needs to be compensated for in some way. The program can now be modified to exclude any waste although this requires using random log lengths. There was some variation amongst commentators on whether the program had been useful or not. At this stage the hardest factor is getting the correct instructions for the program on quality and structural codes. It provides a good target for loggers and supervisors although in some cases the checking of predictions with out-turn has not been followed through. It was emphasised that the quality codes put into the program must reflect the market requirements. A major constraint on the MARVL program is that it requires a large computer facility.

SESSION 1
Paper (c)

PLANNING CONSTRAINTS

THE MANAGEMENT

G.R.Hampton
Carter Holt
Central Limited

At the moment New Zealands exotic wood resource appears at least fully committed to existing processing plants, with additional pressure on standing timber being sporadically applied by log export spot marketeers. Privately owned old crop of easy access, non-demanding of specific logging equipment has long gone, leaving the stands of difficult access and extraction to be fought over. Many more recent plantings, jointly comprising significant areas, are in this category.

So it is the future logger required to handle the many varied terrain and soil types, product types and access conditions, which the main thrust of this seminar focuses.

While many constraints encountered in logging are common to major large scale operators and the smaller logger, this discussion will investigate the realm of the latter - the small operator. Most of the logging operations beyond the confines of the Volcanic Plateau are undertaken by those who fall into the category of "small operators". Their function has been most important in the past, during the phasing - in of exotics at the expense of indigenous, to maintain many and varied local industries based on exotics. Until recently adequate supplies of relatively accessible logs were readily available, such logs being harvested using simple and cheap equipment. This situation no longer exists. The present day logger, and those of the future are facing most complex circumstances, a reflection of advanced social and economic change.

For many of us, harvesting small lots of a non-recurring nature, will comprise the source of wood on which many processors will rely heavily in future.

The Small Lot:-

For the purpose of this exercise a small lot comprises any volume that is insufficient to occupy or justify the type of equipment most suited to its extraction, for a period in excess of nine months, or any other area where constraints may necessitate periodic production breaks. Many Forest Service Sale Areas fall into this category, together with company, local body, and farmer owned plantations.

Planning For The Future:-

The future logger will be engulfed by the aftermath of presently evolving sophistication. The weight of increasingly burdensome constraint effects, must be shared, the costs of which apportioned to all parties on whom the logger depends. He is frequently a small man (in financial terms only) yet has a major cost-benefit impact on his domineering partners between whom he will likely be constrained (the grower and the purchaser).

Preservation of the future of this small scale logger implies understanding of the total spectrum of constraints within which he is required to operate, by the forest owner and the log purchaser. Tactical planning of his operation therefore embraces at least two parties (logger and purchaser) but more likely the logger, purchaser, and forest owner.

The planning considerations are numerous, and the expertise necessary to ensure adequacy of planning is very varied. Our present understanding of 'logging planning' i.e. the matching of field conditions to equipment, in order to supply logs as and when required at a price acceptable to the purchaser, comprises only part of the planning component of the future. Even this element of planning has been found inadequate particularly where one party alone has assumed responsibility for its compilation.

The Constraints:-

The constraints well known to loggers that can and should be anticipated are:-

1. (a) Weather:-
   - extraction
   - loading
   - transport, forest roads, County road closures during Winter.

   (b) Resource Size:-
   - inadequate to justify the type of machinery most suited to extraction, loading & cartage.

   (c) Production Requirement:-
   - Processor or purchaser unwilling or unable to accept sufficient regular supplies to justify the operation of equipment most suited to the field conditions.

   Other constraints that are not predictable and cannot as a rule be anticipated are those which may have serious financial consequences to one or more parties along the harvesting chain. Despite being termed 'unpredictable', the industry has a long record of such eventualities.

2. (a) Market Collapse:-
   - export log, roundwood, sawn timber.

   (b) Major Financial Collapse:-
   - any one or more parties between forest and market.

   (c) Invasion of Working Circle:-
   - new competitor seeking to secure the logging by price cutting; a new competitor for the logs; processor being attracted to the purchase of cheap logs from an outside source, dumping of cheap sawn timber on a (or roundwood) "foreign" market necessitating production cuts.

Forest management and environmental constraints are those which will likely emerge as major considerations in the near future. An awareness by forest owners, catchment authorities and county councils that logging may be undertaken without severe site damage, will likely force the hand of industry to employ equipment and techniques to take account of these emerging values. The limitations county councils may place on logging in future, or in fact have already enforced in some counties, may prove to be particularly onerous. Forest owners may require cable systems to be employed as an aid to re-establishment of weed infested sites. These and numerous other in - forest constraints will either load costs of logs landed at the market, or constitute a reducation in value to the grower. Either way the logger in the centre will surely carry a share of the burden.

Assuming the above constraints are taken account of, the small logger proceeds in accordance with his interpretation of the options available. The constraints personal to any logger are those centred on his business risk, the most crucial constraints to the sole trader. It is these aspects of logging the forest owner and log purchaser desire to be shielded from, in most cases anyway.

1. Equipment:
   (a) Type - hauling, loading, trucking.
   (b) Utilisation - adaptability, flexibility.
   (c) Risks to capital employed - value in event of forced sale.

2. Labour:-

(a) Degree of permanence - stability.
(b) Cost - special skills.
(c) Training, safety.
(d) Redundancy or alternative work.

3. Produce Disposal:-

(a) Security of produce outlet over range of product types.
(b) Capacity of purchaser to carry stocks.
(c) Ability and willingness of purchaser to agree to and accept a monthly volume for a sustained period.

4. Job Security:-

(a) Wood procurement.
(b) Price reviews.

Discussion:

In general a contractor enjoys support of either a forest owner, or the log buyer, providing this employer is satisfied the operator is 'efficient'. Efficiency is generally measured in terms of amount of royalty received (in the case of the forest owner being the employer) or the cost to put logs on a truck (when the log buyer is the employer). The indirect costs incurred in achieving this "efficiency" may not be taken account of, therefore the total efficiency is questionable. Operators required to work small lots will surely avoid specific equipment. The resultant compromise will result in skidder areas and hauler areas being respectively trodden to death or quarried by the old D7. Constraints on production and the effects of insecurity allow the operator no alternative.

While some operators will never enjoy the luxury of owning a soundly based logging business with an assured future, enlightened tactical planning could vastly improve the status of logging in some regions at least.

The basic requirement of any logger is that he is efficient. Efficiency cannot be gauged any longer by direct cost comparison, as most employers tend to believe. For effeciency to be achieved in real terms, the forest owner, log purchaser and logger must be committed to tactical planning, the means by which account can be taken of the entire spectrum of constraints, enabling costs and benefits to be accurately established. Each party must therefore be technically equipped to participate in such planning, an exercise essentially in the recognition and assessment of basic principles.

If it is considered desirable that the small logger continues to play a major role in the harvesting scene it will be most important that work duration and volume is adequate to justify the provision of specific equipment. It is likely log purchasing agreements will be conditional upon the provision of specific gear, such gear being mandatory to meet requirements as defined in a meaningful logging plan.

A step toward the achievement of logging efficiency has been taken by two competing sawmillers whose individual annual requirements could not attract the type of equipment most suited to efficient extraction. A successful joint tender for a State Forest Sale Area produced a simple solution to what had been a major logging problem for two sawmillers over many years. A case where commonsense prevailed and several D7's were retired in favour of a hauler. Grouping of small lots (particularly cable hauler areas) must surely be forced upon the owners to enable such areas to be marketed in future. In some way loggers must be attracted to these stands otherwise many will remain standing.

Those involved in marketing of wood from areas that necessitate specific equipment (hauler) must appreciate the planning constraints that demand full recognition. Of equal importance, the log buyer must play his part. It therefore follows, the logging planning exercise must be undertaken ensuring total involvement of the woodlot owners (or forest owner) the processor or log buyer and most importantly the logger. Each must make a commitment in the interests of the other parties. Where such co-operation is not possible the logical solution will be for the forest owner or the log purchaser to shoulder the burden of equipment ownership and labour management. This may be his first opportunity to understand fully what logging is all about.

DISCUSSION

The discussion following this paper centred round the fact that the speaker had claimed that small organisations could not pay for quality based on expectations of good pruning in the past. Although it was agreed that the buyer must be concerned with the quality of the material as it affects his products and price. History has at times proved assumptions on quality incorrect and in any case other factors such as location, size of resource, etc, may be more important than assumed quality. If there is any doubt, the buyer will go for a low price. It should be possible for a larger resource to saw some samples of logs. This may not be feasible for hauler areas. There was some discussion on when a resource became so small, that it affected the cost of production. It was thought that two or three years production would be needed for equipment pay-off. It was commented that with low capital value equipment more flexibility in the size of the resource was possible.

- SESSION 2 -

PART 1 - ROADING

Chairman : Lionel Ellis, Henderson & Pollard Limited

QUESTION AND ANSWER PANEL
Panel Members :
Colin Cornelius, Logging and Roading Engineering Division, N.Z. Forest Products Limited.
Peter Farley, Engineering Division, N.Z. Forest Service, Wellington.
Jim Riley, Logging Manager, Fletcher Forests Limited, Thames.

PART 2 - ROADING AND ENVIRONMENTAL PROTECTION

Chairman : Ron O'Reilly, School of Forestry, University of Canterbury.

"SOIL AND WATER VALUES WITH PARTICULAR REFERENCE TO LOGGING AND ROADING - The Guidelines - are they working?"
Kevin Steele, Water and Soil Officer,
R.M. (Bob) Priest, Resources Manager, Waikato Valley Authority

ROADING PANEL : QUESTION AND ANSWER

Panel Chairman : Lionel Ellis (Henderson & Pollard)

Panel Members : Colin Cornelius (N.Z. Forest Products Limited)
Peter Farley (N.Z. Forest Service)
Jim Riley (Fletcher Forests Ltd)

Editors Comment: Replies by panel members have been editted to make them more readible. Other irrelevant comments have been deleted.

Chairman's Introduction

Ellis : Roads can generally be regarded as a basic link in our transport system and of course roads as well as the transport of logs are integral parts of the harvesting system. In large scale forest development well designed and well planned roads systems are absolutely essential. The total roading system required for any particular forest area and the quality of roading system has to be matched to the logging method to be used and the volume of material to be removed. Roading standards from various traffic loadings have been determined for state forests and the large private sector holdings. Provided these are used wisely it is possible to match the roading system to the requirements of the forest and to ensure that roading costs are kept to a minimum consistant with acceptable standards of construction.

I hope you will note these comments in opening this question and answer panel session.

SECTION (A) WHEN SHOULD ROADS BE CONSTRUCTED

Ellis : If a high standard road is constructed at the time of establishment, compounded costs mean that this becomes very expensive. How can you reduce the initial costs of roading if you decide to construct logging roads at time of establishment?

Farley : Roading costs must be kept in perspective with the total cost. They are not dominant costs. Being involved in the NZFS where logs are sold at ½ the export price I wonder if we should be bothering about roads at all.

Construction of a high standard road or a logging standard road at time of establishment will not reduce initial cost. It is not a sensible thing to do. The initial roads should be the minimum necessary to meet all the requirements, not just the initial construction but also maintenance cost on the road as well and to serve the planting and silviculture of the forest. There is no reason for making them any more grandeous.

Ellis : Do you consider it cheaper and better to plan and build a road when the land is bare?

Riley : Most definitely.
Taking the two phases separately.

Firstly Planning : There is no substitute for physically being able to see where you want to go with the road. At Tairua, contour maps define the contours of the canopy, not the ground beneath, with deficient soils and a tremendous variation in tree growth this causes mapping problems. Contour maps made from aerial photographs taken when the land was bare would be a step in the right direction.

Secondly construction : Where alignment is covered by mature forest, you first have to log the alignment and stump it, before you can build the road. There is a cost in tracking for logging in steep country and in stumping. The greatest cost is in time. In clay soils with persistent summer rain it has taken years to form a relatively short road through mature forest that would have been completed in one summer had the land been bare.

Ellis : If constructing at the time of establishment, can you be sure the road is located correctly for :

(a) eventual egress of produce from the forest in the shortest direction to the eventual mill, or

(b) for the specific logging equipment that might be available at the time?

Cornelius : If the new forest is adjacent to an existing mature or semi-mature forest there is no problem - the mills have been set up and the transportation direction and system is in place. With a new isolated forest (particularly a smallish forest) there may be more than one option as to the direction of the produce. It is important to keep these options open, reduce the road standard, watch the road gradients (adverse/favourable), leave major culverts or brdiges until closer to harvesting. In both cases the road location will be as required for clearfelling.

The roads put in at establishment time are or will be the arterial and secondary roads - the establishment road density used at NZFP is about 0.015 km/ha. The spur roads that actually feed the logging equipment are not built until harvesting - and account for about 50% of the total roading. There is plenty of flexibility to accommodate future developments. The planner has to decide whether the timber is going to be extracted down slope if less than 1:3 (18°) by tractor, skidder, or by a hauler system pulling up or down the slope. The methods have not changed greatly in the past but the machinery certainly has - I see a similar situation with the next rotation.

Ellis : If you establish roading at the beginning, how detailed should it be - only arterial roads or right down to small spurs and landings?

Riley : In difficult soil types with high rainfall - it would be ideal to go right to forming landings. However, definitely arterial roads and wherever spur roads to assist in access for establishment and tending, even if they are not metalled. Landings are not logically formed across or at the end of spur roads. Landings will probably have to grow trees for the first rotation. But definitely not the second rotation.

Ellis : Are establishment roads over engineered which then prohibit subsequent logging road selection. Should establishment roads be no more than 4 x 4 tracks?

Farley : There is a tendency to use the judgment 'over engineered' purely on a visual assessment of the road rather than what its intended to do at the establishment phases. If 4 x 4 tracks are adequate for the circumstances, certainly. The factors that must be kept in mind when deciding on establishment roads, are the type of vehicle to move through the forest (supervision vehicles and the transport of men) plus other forest management activities, fire control, animal control, silviculture etc. These requirements should be met with the minimum expenditure on the roads. It maybe to meet all those requirements efficiently as possible in terms of the total cost, not just road building cost, a fairly high standard road in some part of the forest will result. In this case it is not over engineered. Does this prescribe your logging options? When comparing costs of completely new road construction at time of logging roading costs are not dominant. It maybe an easy excuse to say the road is there and therefore it must be used and to fit the logging system around it. I would question very closely whether such advocates had done adequate preparation on the logging system.

Ellis : Should landing sites be selected at time of establishment, put in and then planted up?

Cornelius : No practical purpose is served by constructing the landings at establishment. It would constitute a large expense because it is so early in the forest cycle. However, with a tree length logging system sufficient landing sites must be identified to ensure that a ridge-top or valley bottom road system is required to harvest the area. Length of road should be kept down and as much of the land in trees as possible.

Ellis : Should the decision to construct roads at the beginning be influenced by soils and topography?

Farley : It should not influence it at all.

Ellis : Is it more important for logging planners and roading engineers to allow longer lead time on soils which are sensitive to roading and require greater preparation?

Cornelius : Yes, roads must be built and be available at the scheduled harvest time. The more difficult the roading the longer the lead period. On average NZFP allow a lead time of 2 years. This position includes roads available for logging, roads formed but not metalled, and roads only partly formed. Add up work context of that and this amounts to 2 years ahead.

DISCUSSION ON BRACKET (A)

Ellis : The panel of experts have given their views on question.
Questions from the floor.

Sharp : Riley mentioned that it is alright to plant up landings on first rotation but not 2nd rotation. Does this not reduce the area on which to grow trees?

Riley : This was qualified by saying that high rainfall areas with clay soils required ripped landings. In 2nd rotation this could be up to 1 m of metal to rip. This is a waste of money to rip consolidated landings and I don't know what trees consolidated landings in clay will grow. They may need a lot of ripping and a lot of fertilizer.

Sharp : You don't think that logging methods are going to change which might mean different landings.

Riley : When we conquer gravity we might see a change, but not before.

Hampton : Riley is slightly at variance with Cornelius on landings. It is a very sensitive thing, firstly the availability of metal and cost and secondly the type of hauling equipment to be used on the landing. More money can be spent than the stumpage value of those trees off the landings in downtime by replacing strops and chains caused by pulling logs into the buried stumps that have been pushed over the edge of the landing at the time of construction. The alternative is to dig a hole and bury the stumps. I suggest we should look very critically at planting any landing even if they are established at time of planting.

Cornelius : I do not agree.

Farley : Landings are a capital asset on the forest. They give an option during the second rotation to do economic production thinning which would not otherwise be available. An edge effect around landings and open spaces will make up some volume increased with the option of pruning. In areas that are skidder logged the skid tracks constitute a capital asset on the forest. They are available for silviculture in 2nd rotation, salvage work in event of storm or fire damage. In most situations alot of money would be thrown away if these were ripped and replanted.

Douglas : The rapid encroachment of tracks into the forest area is not a problem at NZFP with good soils but on clay and compacted soils the loss of land means that skid trails must be planted up.

Ellis : Thank you, your comment is noted.

O'Reilly : There is no consensus on what should be done at time of establishment.

Landings have been discussed but what other factor. Is road location, alignment, grade, width - taken into account at time of establishemnt. Which of those are made suitable for the logging phase for sometime in the future, or are they totally ignored and merely a track put in at time of establishment.

Farley : It is difficult to clarify this from the NZFS viewpoint. It is too simplistic to think that a set of roading guidelines can apply throughout NZ. In many cases it is being limited by financial constraints at the time and the most economic thing in the long term cannot be done. The department does not have money to buy 4 x 4 vehicles for servicing and transport, so roads must be of a standard for conventional vehicles. It is not unreasonable to consider the ultimate logging scheme but in the interim do the most economic access taking into account capital cost of the road, maintenance cost, and other forest management and protection costs.

Ellis : Does the panel differ violently from that?

Cornelius : Slightly, in the establishment phase the standard roads are built is dependent on the area served and the topography. If direction is set roads can be built to a higher standard. If all year around access is needed it means a metalled road and to get this axle loadings the same as a logging truck are required. Ultimately you end up with something very close to a logging standard road. In NZFP we go for the one shot. If it is known where to go build it once. This includes design, location and final standard but skimp on the metal because it is not needed.

SECTION (B) WHAT GEOMETRIC STANDARDS FOR ROADS

Ellis : There appears to be a general intention to keep grades below 1:10 favourable or even 1:15 adverse, but as we get into steeper country this becomes more difficult. It is noted that in the U.S. West Coast, trucks work very steep roads - what are the practical safe limits? Do the new trucks available mean that some of the old standards should be revised? Better braking systems, retarders, etc, have improved truck performance.

Riley : Wherever possible gradients aimed for are 1:8 favourable and 1:10 adverse. Unfortunately in steep country there is often only one way to go. As a result favourable grades sometimes are steeper than 1:8. To get up empty is often the greatest problem. Generally where a loaded metal truck can get up, a loaded logging truck will get safely down.

Ellis : Most trucks these days are traction limiting and not power limiting. Should roads be built to steeper gradients with higher quality surfacing on steep portions?

Cornelius : No, as a general rule road gradients should be kept down to maintain truck speeds and reduce road maintenance. The best grade for a logging truck is 2% favourable grade and the speeds will be the highest. As grade increases favourable or adverse the speed will drop. Higher quality road surfaces (sealed surfaces) can only be justified on the arterial routes due to costs.

Ellis : Should there be different standard roads and roading systems for different types of trucks? Obviously single-axle trailers and shorter trucks can cope with different requirements to the large trailer train units.

Farley : It is conceivable but I do not know of places where it can apply. As mentioned earlier, metal trucks became a constraint on what is required on the road. This point does not not seem like a practical thing to investigate.

Ellis : Can sight distance mean that only a single lane road is required, provided that passing bays are available?

Riley : Good sight distance is certainly a help and some passing bays a necessity. These days, nearly all trucks have radio telephones. Single lane roads are constructed with the reliance on drivers using R.T's for safety.

Ellis : Are N.Z. logging roads over planned or oversized?

Cornelius : Logging roads are not overplanned considering the money spent on the logging and roading systems. With increasing constraints being placed on forestry operations this is amply repaid.

Systems are planned on contour maps with a 5 m contour interval. The logging systems and the roading systems are considered as one. There is a definite design split between arterial roads (9.5 m) and secondary 8.0 m) and spur roads (6.5 m), taken water table to water table.

Arterials have a lane width of truck width plus 1 metre (2.75 m + 1.0 = 3.75 m) slightly less than that recommended by some overseas authorities.

Arterial roads are where the money is spent because they carry approximately 80% of the loaded tonne-km but only 10% of the total road length. Secondary and spur roads together carry the balance - 80% of the length but only 10% of the volume.

Ellis : Do you consider good roads pay for themselves through being safer, more reliable, and reduce wear on vehicles?

Riley : Required are reliable all weather, winter access. Roads are expensive and have a limited life. Spur roads are constructed to the minimum standards that complies with the NZFS requirements. There is no financial advantage in improving the current standards. The roads are reasonably well surfaced safe roads.

DISCUSSION ON BRACKET (B)

Ellis : Any questions on that section.

Gaunt : I've been involved in the planning for the off highway road from Murupara to Kawerau. The design restrictions over a 1:20 adverse grade with a speed limit on curves of about 70 kph, off-highway loading and 2.5 m wide bolster. After the surveys were completed in conjunction with KLC, the Pacific Truck Company took all the survey plans and are in the process of designing a truck to suit the grade. The point was made earlier to design the grade to suit the truck but in this instance it is in reverse.

Spiers : The panel are defenders of the status quo. A lot of the new forest is on particularly steep country with constraints from people who say we must think smaller. An analysis of trucking cycles done by LIRA has shown that the % spent travelling with load is fairly low in the total cycle. Many delays occur in loading and unloading. The Hira forest near Nelson is very steep but is only 25 km or less from the port. Is a high standard road desirable in a forest such as this? Shouldn't the road geometry be more in keeping with small trucking units?

Farley : It is possible but I doubt if people are going to bring in special small logging trucks for a forest which at its maximum is going to produce 12 truck loads a day. The idea shouldn't be scrubbed but maybe requires a better example.

Spiers : Is not the situation in Hira quite different from say the situation in Kinleith where circumstances are very different! Should you not change ideas on road geometry according to the regional circumstances.

Farley : I am not convinced. There is not much difference in cost by changing the road geometry. The road has to be metalled so metal trucks are required. It is equally possible that because the road is scaled down the roading cost is higher and the effect in the overall cost is small. Each situation must be adjudged on its own merits taking all factors into account.

Pivac : Riley spoke of metal and log trucks coming downhill - what grade is reached for log trucks going uphill and are attempts made to ease that grade if they have to turn.

Riley : Definitely, I specifically did not mention loaded logging trucks on adverse grades. The aim is for 1:10 if trucks are turning on a sharp corner then the corner must be eased as trucks will baulk at a 1:10 grade on a corner.

SECTION (C) ARTERIAL ROAD LOCATION

Ellis : It is better to have a bad road in a good location than have a good road in a bad location. A bad road can be fixed - a bad location cannot. Can the investment in a bad road (poor construction) be recovered compared with a bad road location?

Cornelius : It is better to have a bad road (i.e. poor construction) in a good location because the initial investment is less. Also, the poor construction can be probably fixed on a once only basis. The badly located road even though well built will probably have an unstable foundation or be too close to a waterway, therefore will need excessive maintenance over the life of the road. Generally the investment in neither can be recovered. Once the road is built you are stuck with it.

Ellis : Should arterial roads in major forests be primarily engineered roads from (a) to (b), regardless of stands adjacent to the roads? How important is landing location in laying out roads, particularly arterial roads. On the other hand, are landing locations possibly obligatory points for secondary or spur road location? What steps do you take to layout the preferred road for an arterial route as compared with a secondary or spur road?

Farley : Arterial roads are only a small percent of the roading network but carry 80% of the traffic so that the economics of transport become the dominant feature not the adjacent stands.
Landing location in relation to arterial roads do not have much relevance. Obligatory points for landings are the main things to determine secondary or spur roads. With arterial roads there is seldom a choice of route and the same will probably be true in many of the newer forests. In a few cases it might be the best choice of a number of bad options.

Ellis : Is roading and logging planning done concurrently in your area, and do you require specific objectives and a broad transportation network before deciding on individual alternatives?

Cornelius : Roading and logging planning are planned concurrently. The planner has to use the best information available and base his decisions on that information.

DISCUSSION BRACKET (C)

Spiers : In the forests of NZFP being established in North Auckland - are both roading and logging planning being done concurrently?

Cornelius : Yes, the only concession made is a lower standard road about 4.5 m wide. A decision on a uphill or downhill system is needed. Adverse grades might become the favourable.

SECTION (D) ROADING PATTERNS

Ellis : Should there be different requirements for thinning and clearfeling road patterns? If one or other comes first, what compromise or principles should be considered so that both are catered for?

Riley : Thinning must fit in with clearfelling road patterns especially in high rainfall areas with clay soils. It is pointless half doing the job for the smaller piece size handled in thinnings. Money is to be spent so don't waste it by later burying or scraping off consolidated metal already on roads and landings to bring them up to clearfelling standards. From the roads and landings to a clearfelling standard, then only metal them to the standard required when thinning.

Ellis : Do you plan your logging roads on easy terrain on a systematic layout or on a random layout?

Cornelius : We use a systematic layout developed from consideration of the maximum haul distance, topography, and other constraints for the particular logging operation. I have not worked with country so easy that optimum road spacing could be calculated and put in place - topography has always dictated the roading pattern. Random layout is someone designing the logging system from a seat on the bulldozer?

Ellis : Should minor spur roads be planted up after use to assist with maintenance?

Farley : Definitely not, unless someone has a very persuasive case to the contrary.

DISCUSSION BRACKET (D)

Wells : It is surprising engineers haven't been able to modify their calculations enough to determine the optimum roading pattern and it is based on topography alone. Surely there is some choice as to the density of roads which you must be able to determine as being optimum for particular logging systems. For example, if one reads the text books from overseas they offer formulae which can be used. Can you not do something of similar sort in N.Z.

Cornelius : Most of those have a big 'C' factor in the front. They say 'if its easy country plug this in and if it's difficult plug a different 'C' factor in. They just modify what they do on flat country. With a good contour plan you are going to come up with the best system not something based on a formula. It has to be really flat before using the formulaes. People should understand them but the contour plan and the constraints of the logging machinery are going to set the pattern. Topography still dictates the road pattern.

Farley : I support this very strongly. The logging operation cost is the dominant cost, not the roading cost. Fiddling about with the roads is little benefit compared with putting real effort into planning, supervising and management of the logging operation. Thats where the money is, plus where the forest is in relation to plant and port etc.

Cornelius : While we have a long tree length system of logging, topography plays an even bigger part than overseas where logs are cut to length and they have a little skid on the side of the road. The long length is probably here to stay to keep piece size up and a reasonable area is required to land logs. Landings are therefore important so it gets back to topography.

O'Reilly : Is volume per hectare considered when planning roading spacing or road density. It is one thing a lot of people overseas do. Large volume roads are close together but small volumes less dense spacing. Is that ever taken into account.

Farley : It would depend if you are on flat sites. I am not aware of areas where it would be a factor.

Riley : It depends on soil type. On pumice country roads and landings can be close together because they are cheap to construct but on clay soils where costs are high one cannot afford too many roads and landings, you are trying to get every cent you put into the roads.

Tustin : Do the panel advocate landing sites first and then building roads and linking them up on roads first and landing sites on the road alignment. Could we have clarification?

Farley : Pick the logging system first and then put the road around it.

Cornelius : The arterials go (A) to (B) and do not worry about adjacent landings and the way it is to be logged. But the long length system the landing sites dictate where to go. To build a road and put a skid on the side of it like they do in the States is not possible.

Reutebuch : Cornelius mentioned determining harvesting systems where secondary roads are put in. What detail is looked at in that part of the work element of the harvesting system concerned. Are profiles on the ground looked at or is it mostly past experience and how far do you go into doing that planning.

Cornelius : One must decide if it is going to be tractor country, or skyline or highlead country. Areas of doubt at harvesting stage must have detailed plan of the whole area. At establishment stage you must know enough to catagorise tractor or hauler and whether it is going uphill or downhill. The grades are plotted on the contour plan, profiles are run over the contours to check deflections of the hauler systems. The basic tool is the contour plan with 5 m contour intervals.

SECTION (E) STEEP TERRAIN

Ellis : What modifications to roading method or layout are necessary to cope with very steep terrain? How practical is it to reduce geometric standards in such terrain without affecting either safety or stability?

Farley : This seems to be a vague suggestion that does not have a great deal of practical effect. Economics dictate that we should be aiming to get the best value for money from the whole system and roading is one part of the system. You put in the road that is appropriate to that system in that particular area.

There is little scope for reducing the geometric standard merely on account of being in difficult country. It is not realistic to reduce road standard when country gets over x degrees in slope.

Ellis : There are probably five principle factors which determine erosion from road surfaces: soil type, road grade; road location or topographic position; aspects; and side slope. Which of these are the more important on steep terrain?

Cornelius : This can vary, and they tend to be interrelated.

1. Soil type. If it is an erodable soil it can affect both the stability of the road structure and its surface can be quickly eroded. The consequences are that water control and maintenance must be to a higher standard and more often than normal.

2.& 3. Slide slope and road gradient. The steeper the slope the greater the erosion. Both will compound problems due to the soil type.

4. Road Location or Topographical Position. Generally there are fewer options in steep terrain than easier country. The final location will have taken into account the factors already mentioned and will provide the required transportation function. It may be a ridge top road, a mid slope road, or a gully bottom road, with varying degrees of erosion potential. Road location is very important but the other 3 must go ahead of it because of their variable nature.

5. Aspect. Put the road on the sunny side of the hill, all other things being equal.

Ellis : Should there be a classification of soil stability which would help roading engineers to decide on where a road should be constructed and to what standard?

Riley : In steep country there can be very limited choice for road alignment. Any classification of soil stability must be on a very broad basis. In the Coromandel for example, soil types change in extremely small distances. The intensity required to provide an accurate assessment of soil stability on a particular route would possibly be too expensive to be practical. The 1:10000 maps discussed by Pearce gives a very broad classification. To get down to a particular road alignment would require a very intensive study and may be impractical in cost terms.

Ellis : Do you consider soil strength and cohesion to develop cut and fill slope ratios for specifying culvert placement, or do you determine the latter by some other formula.

Farley : In forest roads you are not concerned about the soil parameters for working out stable batters on a strength basis. It is not justified to do soil testing because the cost per meter of road is very low. It is done on the basis of past experience in the same country and if wrong so what. Just clean up the slip or fill in the hole. Although that may sound crude in actual fact it is a very practical way of doing it. On very high standard roads it would be justified going into some of that work. On difficult country where you might have cut batters 10 m or higher it could be justified to put in some technical effort. The MOW Tech Memo 63 is used for designing the flood discharges and designing the culverts. General experience is usually used for judging culverts up to about 1 m size.

SECTION (F) CONSTRUCTION

Ellis : What are the comparative advantages of bulldozers, tractor/scraper combinations, and shovels? Where should each be used? Will our requirements for roading in steep terrain, given the environmental considerations, force changes in road construction methods.

Riley : It is difficult to visualise attempting a roading job without a bulldozer especially when stumping and ripping rock. There are obvious places where a scraper or hydraulic digger would do the job better than a dozer but after a dozer has opened it up. I do not see environmental considerations forcing too great a change on traditional methods of road construction.

Ellis : Road construction in steep country involves excavation of large volumes of rock and fill that are traditionally side-cast. Do you see any viable alternative to this method of roading in N.Z.?

Cornelius : If we cannot sidecast some other more expensive method must be used, motor scrapers or shovel and dump trucks. The alternative at NZFP is to operate a balanced fleet with approximately one-third of the heavy earthmoving machinery being motor scrapers. We build our road fills and sub-bases and end-haul the road excavation material in sensitive areas with motor scrapers. Shovel and truck excavations are between 3 to 5 times more expensive than sidecasting if materials are clay and rotten rock and up to 7 times where the rock is so hard that it has to be shot. In steep country it is often very difficult to find a safe tiphead close to the road excavation. Sometimes the situation is compounded by doing it with shovel and truck.

Ellis : Is it correct to assume that most roads in N.Z. can be built by bulldozer methods? Do you specify the exact type of equipment required when planning a road?

Farley : Most roads can be built best with bulldozers but it is certainly not the most economic way of doing it. The bulldozer comes into its own when excavating material and moving it relatively short distances - less than 100 m but more than a couple of metres. Beyond that it is better to use some other machine for moving it. In the Nelson area there is good experience with hydraulic excavators. In terms of output in good conditions they can produce the same as a bulldozer of about the same size but immediately it gets wet and sticky the excavator goes far ahead. They use about ½ the fuel as a bulldozer to produce the same amount of work. Their limitation is that they cannot move material a great distance. They can put it onto a truck or side cast it but if you are in big cuts then you need the bulldozer for the shorter distance and the trucks or motor scrapers for the longer distances. Excavators are a machine we will see a lot of in N.Z.

Ellis : Our company has had experience in roading on waterlogging clay in North Auckland. The UH07 has been the only machine to handle the road building. They can do the job very efficiently.

DISCUSSION BRACKET (F)

Grayburn : Cornelius rejected shovel and dump truck out of hand. We have heard from Farley how excavators can be used. In very steep country you did not compare like with when talking about shovel and truck. That country is going to need blowing and that cost cannot be put against shovel and dump truck and not against the tractor as well. In very sensitive environmental areas isn't it going to be better to use shovel and truck or excavator and truck?

Cornelius : At NZFP we haven't had country steep enough to build with shovel and truck. It has always been done with dozer and motor scraper I have not seen any country that the shovel has been used on.

Cornelius : In the U.S. if the USFS specified no side casting then the end haul was done with shovel and truck. That is where costs increase particularly if it is wet. Cost is dependent on how far it has to be carried by truck. We may have to get into it but in the meantime scrapers would be the pick until forced into it.

Farley : If in country where a scraper can be used then that is a cheaper way of doing the road but in some steeper situations then there will be a place for the hydraulic excavator on a straight out cost basis.

Pivac : Our company has used a hydraulic excavator for loading logs and alternatively for roading as well as bulldozers. The excavator on wet land you can drain it, cordroy the road, and put in culverts. If it has trouble with stumps these can be blown out.

Farley : An excavator can break out rock easier than a bulldozer of equal size.

Anstey : Environmentally one of the big objections is side casting and that results from the deepness of the cut. It is economical or sensible to have two one lane roads, one on top of the other rather than 1 two lane road.

Cornelius : Water control is going to be a problem and there would be more dirt to shift. Water off the top would be doubled up as it goes across the bottom one. It is better to plug for 1 road.

SECTION (G) <u>ROADING RESEARCH AND TRAINING NEEDS</u>

Ellis : (a) How well trained in roading construction should the logging planners be?

(b) Should roading design be left to the roading engineer or should it be a multi-disciplinary planning decision including soil scientists, hydrologists, landscape designers, logging planners, and loggers.

Cornelius : (a) Well trained. The operations from roading to logging have a lot of money tied up. It is an Engineering function and he should have that background.

(b) I do not go for the "committee approach" as it is an engineering type function. The roading engineer; is close to the action and will normally consult with experts in associated fields. At NZFP the Catchment Authority is consulted in the first instance, and detailed logging plans are vetted by the Logging Department.

Ellis : Will computers help in selecting road design and road survey alternatives?

Cornelius : I cannot see computers being used to any great extent within the forest. The effort expended in putting all the input information onto the computer and then considering the alternatives is probably greater than doing the job. NZFP also have good contour plans, a high percentage of tractor country, excavate on waste material at will, use a tree length operation (piece size - road design), and we are not chiselling our roads out of just hard rock. These points cut down some of the options that you are trying to get from a computer. Planning starts at establishment with method only, not specific machines. Computers could be useful in analysing transportation needs in, say, Northland where there are several possible modes of transport and the forest resource is spread far and wide.

Ellis : Cornelius has said that he does not think computers will play their part inside the forest. Where you have more complex transportation systems involving whole regions such as Northland and maybe the East Coast then maybe these systems may help unravel objectively some of the options that exist.

Ellis : Do planners need better techniques to help them identify potential slope stability problems and to determine how specific slope conditions might react to logging and roading disturbance?

Riley : It is obvious the Forest Service is already developing such techniques, in the most sensitive areas. Pearce has illustrated that progress is being made in this field.

Ellis : Is there a need for greater research into the technical feasibility and economics of log transport with multiple cable systems or other means, to reduce roading in critical site areas?

Farley : Roading is a minor part of the overall system. If it is possible to modify the system, without changing their unit cost then you could then look at changing the roading layout - not the other way round.

Ellis : Are environmental guidelines restricting roading design or construction and should they be for regional areas rather than N.Z. wide?

Farley : The guidelines are not unncessarily effecting roading design, in fact they have a beneficial result because they tend to make people plan roads better which is improving the cost and quality of roads. Any guidelines definitely need to be localised. There are no formula that can be plugged in for forest roading in N.Z. People must do their homework for the particular situation.

DISCUSSION BRACKET (G)

Skudder : A comment rather than a question because some people might be confused. There are certain areas that have 100's of landings and roads planted up for very good reason. People say there will not be much change in logging methods. Logging methods have changed. We have had whole aerodromes cut out of Kaingaroa. Skagits operated on wide strips of land and they have been all planted up and are now being thinned on the 2nd rotation. Certain circumstances require different things being done. Up North Auckland Northern Pulp might wish to clearfell at age 14. After clearfelling the first time they might to into a different regime and they might be looking for a 35 year old crop next time. Of course they will plant up the roads and landings. It depends on what is suitable and this must be appreciated. The situation at Lake Taupo forest where a firm started thinning at age 9 is different than other areas, where roads for heavy loads might not be needed until age 30. We have to accept all these different constraints on all the different forests.

Ellis : Landings and tracks account for about 15% of the productive area so we have to think of the loss of land incurred.

Robilliard : Cornelius stated that the roading engineer does not require a lot of assistance for roading although he might need to go to the Catchment Authority. It seems that we are now getting more and more constraints and it is probably important to use as many professionals or alternative people with expertise as possible, to ensure the roads are in the right place. One must assume that a roading engineer knows something about forestry although the two do not go hand in hand. The inputs from other people tell you what is acceptable not only for your company but for N.Z. as a whole.

Cornelius : The roading engineer must go wherever he needs to for this information. So far NZFP have found the Catchment Authority quite good. Engineers have a certain type of training and discipline as part of that training. They are the ones building the road and making the decisions. If they think they need to call in a geologist then they should do so. So far in NZFP we have not had a need but we would not discount using one in the future. The way the original question was phrased it appeared we would be planning and constructing roads by committee. With this I do not agree. One person needs to be responsible and he will be judged on his performance and on the results.

Wallis : Riley stated earlier that he would prefer to plan and construct roads while the land is bare. Before we can lay the land bare roads have to be planned and constructed.

Riley : The question asked is it cheaper to plan and construct roads when the land is bare. I assumed that the forest is to be planted and a logging road is to be constructed before planting. This would be a new afforestation area.

Wells : A question relating to planning. My training in roading is limited but what I recall are such things as calculations for cuts and fills and calculations of critical batter slopes. Is my training completely irrelevant because the panel seems to be saying that all that is needed is to choose a couple of landing sites and get the bulldozer driver to put the road between them. Is this a logical conclusion? Is training aiming at the wrong sort of things?

Cornelius : Firstly, the logging planner is going to put his plan on a contour map so he views the overall situation, not just a couple of landings. The plan is then vetted by logging and forestry people. Next it goes to someone with a NZCE or a certificate in engineering who considers it and marks the planned road on the ground. The construction people form up the road under the control of a construction supervisor who could have 15-20 years experience and is under the guidance of a roading superintendant who might have a BE in Civil Engineering. There are a lot of controls in the roading system. I do not think it is just the tractor drive going between two landings.

Wells : I was referring to the training required to supervise them. Do you consider experience is more important than training.

Cornelius : No, but people are getting trained in the job as they proceed. The person laying out the plan in the field has usually a certificate of engineering and this is the level he should be at. The various supervisory levels are under people with Civil Engineering degrees. There is training going on at all levels.

Ellis : We will now close the panel discussion. Any points requiring discussion can be taken up with the panel members during the seminar.

Thank you panel members.

SOIL & WATER VALUES WITH PARTICULAR REFERENCE TO LOGGING & ROADING

K.W.Steel
R.M.Priest

LOGGING AND SOIL AND WATER VALUES

Regardless of the primary objective of growing wood production forest lands have undoubted secondary objectives in water production and in watershed protection. The importance of these secondary products is of course dependant on many factors including geological stability, soil type, topography and location. The forest operations that fall under the umbrella of logging inevitably result in soil disturbance to a greater or lesser degree which may effect soil and water values implicit in these secondary products.

The degree to which logging effects soil and water values is dependant upon the physical characteristics of the site along with the type and standard of operation undertaken. The effects of logging operations on soil and water values can be expressed in terms of suspended sediment load down stream of the site of operation. Megahan (1971) notes that this effect differs markedly, varying from no detectable change in suspended sediment load in some cases to extremely large increases in others. One particular study reported by the U.S. Department of the Interior in it's Industiral Waste Guide (1976) recorded suspended sediment levels 7,000 times greater than those occuring upstream of the operation.

Roading and Tracking

Road and track formation involves soil distrubance but it is when soil and other associated debris move off site that soil and water values are threatened. Numerous studies including those of Megahan (1971), Slaney, Chamberlin and Halsey (1973), Haupt (1959), Fredricksen (1965) and Packer (1967) identify roading and tracking operations as being the chief contributor of sediment. While these studies originate in North America the results are undoubtedly pertinent to the New Zealand situation as confirmed in Pearce and O'Loughlin (1978).

Mechanisms operating in suspended sediment contribution from roading and tracking include:-

1. movement of soil and debris directly into watercourses during construction and maintenance;
2. movement of soil and debris placed near watercourses, or in ephemeral watercourses, during periods of peak flow or overland flow;
3. surface erosion of carriageway and watertables;
4. surface erosion of fill and sidecast materials;
5. mass movement of sidecast material from the failure of oversteepend sideslopes;
6. mass movement of upslope materials from reactivation of old erosion features;
7. failure due to slope toe removal.

The studies referred to above have also noted that the suspended sediment load associated with roading is greatest in the first year or two after construction while earthworks settle and revegetate. Fredricksen (1965) found that the runoff from the first rainstorm following the completion of the road under study carried 250 times the concentration of sediment measured from an adjacent undistrubed catchment. Two months after construction the observed sediment concentrations had diminished to levels slighly above those from the undisturbed catchment. Megahan (1971) found that 93% of the total sediment production during a six year study period occured by the end of the second year after construction.

Slash Deposition

The deposition of logging slash and associated organic debris in watercourses or in a position such that it may enter the watercourse, and damage to the banks and beds of watercourses are the other major effect that logging operations can have on soil and water values.

LOGGING AND WATER QUALITY

Water quality is adversly effected by the addition of suspended sediment and organic materials.

Suspended Sediment

The adverse effect of high suspended sediment loads includes:

1. increased costs of treatment for water supply purposes;
2. excessive wear on turbine blades, pumps, irrigation gear etc;
3. reduction of channel storage by deposition which may lead to increased flood risk;
4. inhibited recreational use, both aesthetic and physical;
5. damage to the aquatic ecosystem by:
   i) acting directly on fish living in the water and either killing them or reducing their growth rate and resistance to disease;
   ii) reducing the abundance of fish food where settleable materials blanket the bottom of water bodies damaging invertebrate populations and disrupting plant life. Sediment concentrations of 80 mg/l have been shown to reduce invertebrate populations by up to 60%;
   iii) silting of spawning grounds and smothering of fish eggs.

Nutrient Enrichment

Logging slash and organic debris in contact with water go through the process of decomposition resulting in an increase of dissolved plant nurtients, particularly the wood sugar products released by leaching. Evidence of this decline in water quality is seen in the growth of bacterial slimes and algae bloomswhich thrive in these conditions.

Dissolved Oxygen

The decomposition of this material is carried out by microorganisms which utilise dissolved oxygen in the process. As dissolved oxygen is a vital part of the aquatic environment any depletion by way of the decomposition of organix materials is detrimental to water quality. Where there is insufficent dissolved oxygen in the water column anaerobic processes function producing materials such as hydrogen sulphide and methane which are generally regarded to be undesirable.

Light Penetration and Temperature Changes

The combined effects of suspended sediments and algal growth reduce the penetration of light into the water body so reducing the photic zone and limiting primary production in the food chain. A further effect is the heating of the surface water due to the greater heat absorbancy of this particulate matter. This heating stabilises the water column and prevents vertical mixing which in turn decreases the dispersion of dissolved oxygen to the lower levels so promoting anaerobic processes.

Where previously shaded streams are exposed to full sunlight after logging has removed cover from the banks water tempreature rises with an accompanying decrease in dissolved oxygen content (the saturation level of dissolved oxygen is temperature dependant). The decrease of dissolved oxygen levels can be sufficient to limit aquatic life.

FOREST OPERATIONS GUIDELINES

The realisation that forest operations can have significant impacts on soil and water values for considerable distances downstream, coupled with the fact that many forests are located in upper catchments above areas of more intensive land use and occupation with associated demands on the water resource, saw the introduction of the Forest Operations Guideline (1978).

This guideline was prepared by a Technical Committee established by the National Water and Soil Conservation Organisation with representatives from the New Zealand Forest Owners Association, the New Zealand Loggers Association, the New Zealand Forest Service, Catchment Authorities and NWASCO. It has the objective of assisting forest managers in the development of practices that will safeguard the country's soil and water resources.

The Guideline is designed to give individuals involved in forest operations an indication of the requirements or considerations necessary to protect soil and water values when undertaking individual phases of forest management. It was intended that the Guideline should form a broad basis upon which local interpretation would build specific requirements for specific sites. It would be neither practical nor desirable to attempt to formulate a rigid National Guideline that was site specific due to the immense variations in soil type, topography, vegetation cover, climate and operational objectives. Forestry concerns may wish to produce their own Guidelines specific to their situation in consultation with the Catchment Authorities e.g. the NZ Forest Service Kaingaroa Forest Guideline.

LOGGING AND THE FOREST OPERATION GUIDELINE

The introduction of the Guideline saw some concern within the forest industry that it would, or could, be used by the Catchment Authorities in a heavy handed manner that would unduly restrict normal operations or add to costs unreasonably. There was also some concern that the conservation and environment lobby could attempt to use the Guideline for purposes outside its intent.

Experience to date has shown that the Guideline has been largely successful and has been used as intended by both the Catchment Authorities and the Forest Industry. Overall there has been a definite improvement in operations, in terms of soil and water values, with some exceptions. The most notable exceptions is in the area of the smaller private contractor, particularly the two or three man indigenous logging contactor, where soil and water values are either not recognised or are not considered as being important or are consciously ignored.

Roading: Planning

The adverse effects of roading and tracking described earlier can be eliminated or brought to within acceptable limits with sound and careful planning and the application of existing knowledge. The roading section of the Forest Operations Guideline outlines measures that should be viewed as good roading practice regardless of the Guideline. High standards of roading planning should not be regarded as a concession to the water and soil movement or to the environmental movement but should be regarded as an integral part of responsible land management.

By specifying high standards of design it is not inferred that all forest roads and tracks should be designed as four lane highways, it is implying that all roads should be designed with regard to the level of use intended, to the terrain to be covered and to sensitive water and soil matters encountered on route. For example the criteria used to determine the satisfactory location, design and construction or a roadline through terrain of moderate slope may fail to cope with steepland conditions and lead to intolerable levels of disturbance. On the other hand identical criteria should not be applied to two different roadlines that traverse similar sloped terrain with widely varying geological stability.

Hence future road planning must continue to strive for road lines that:

1. are planned and implemented well ahead of logging and with regard to catchment topography and general drainage conditions;
2. minimise the risk of debris and spoil entering watercourse;
3. avoid the unnecessary crossing of watercourses and erosion prone areas;
4. stabilise cut and fill slopes be appropriate measures such as seeding, compacting, benching etc;
5. avoid earthworks on unstable slopes when climatic or soil moisture conditions would aggravate soil erosion and sediment transport;
6. have adequate culverting and cutoffs to provide for the safe disposal of runoff water and prevent concentrations of flow and the scour of water tables and fills;
7. have stream crossings designed with due regard to flow characteristics;
8. minimises interference with natural drainage.

Roading: Construction and Supervision

It is considered that the planning phase of roading in logging generally causes few problems to soil and water values. There is however some concern that supervision of road construction and ongoing maintenance are not always up to the required standards.

No matter how good the technical knowledge and capability of the planning staff it is performance in the field that is critical during the construction phase. Many machine operators cause irrepairable damage by failing to follow instructions or being unaware of the consequences of their actions. A high level of competent supervision is not a luxury but a necessity. In a similar vein all the good work put into building a road of good standard is negated by the failure to ensure that ongoing maintenance is carried out:- a blocked culvert is useless when it comes to safely disposing of runoff water.

Temporary Tracking

The location and construction of temporary tracking utilised in logging must be treated in a similar manner to the planning and construction of permanent roads as discussed previously, but obviously to design standards suited to their temporary nature.

While it is considered that few threats to soil and water values exist in permanent roading today, the area of temporary tracking is viewed with some concern. There would appear at times to be a lack of proper planning with machine operators taking the easiest line, sometimes with a total disregard to soil and water values, resulting in spectacular and damaging results.

With the completion of use temporary tracks should be left in a state providing for adequate drainage and soil stability without the need for ongoing maintenance. All too often these tracks are abandoned with little or no provision for drainage and stability which results in scour of their surfaces by way of uncontrolled runoff. It would appear that there is often the thought that perhaps the track may be needed just once more, with the result that the necessary work is overlooked. The logging supervisor should be held responsible for ensuring that all necessary drainage and runoff control works are completed before his machinery leaves the area.

Similarly temporary crossings must be removed when no longer required.

Riparian Strips

The Guideline provision for riparian strips, or protection areas, along watercourses was initially viewed with concern by the Forest Industry. It was felt that the over zealous use of this section of the Guideline would unreasonably restrict forest planning and operations with considerable cost effects. In practice the provision of riparian strips where local conditions or the significance of the watercourse warrant has proved to be a useful measure in protecting the watercourse and it's water quality by:

1. ensuring that machinery is kept out of the watercourse;
2. ensuring that logging slash and debris is not deposited in the watercourse;
3. acting as a filter for suspended sediments being carried in runoff waters entering the watercourse;
4. maintaining water temperature by keeping the bank cover vegetation intact.

Involvement of Catchment Authorities

Regular inspection of field operations by Catchment Authority staff is a useful means of ensuring that soil and water values are protected. The presence of Catchment Authority staff in the field has the psycological effect of keeping field supervisors and machine operators aware of these values as well as allowing problems that do arise to be remedied quickly.

The level of contact between the Forest Industry and the Catchment Authorities varies from Authority to Authority, ranging from frequent contacts with good understanding to few contacts with possibly a corresponding poorer level of understanding.

CONCLUSION

The protection of soil and water values during forestry operations, particularly those operations falling under the logging umbrella, is an essential and integral phase of forest management. Consequently the costs of keeping soil resources on site and protecting water quality for downstream users must be regarded as a legitimate cost of responsible land management.

Following the introduction of the Forest Operations Guideline the standard of operations, particularly in the area of roading, have shown a general improvement to the extent that in general few soil and water problems are expected from this area provided that routine maintenance is carried out.

Temporary tracking and the exclusion of logging slash and debris from watercourses are seen as being areas that require a further improvement in standards. All too often the principles of good roading practice employed in the primary roading system are not carried into temporary tracking operations with the result that soil and water values are threatened.

Many problems occuring through machine operator error or ignorance will be avoided with adequate supervision and more importantly proper training and education. The education of equipment operators and lower echelon supervisors is an important factor in determining the field performance of operations. Contact with Catchment Authority staff is seen as a valuable tool in this process.

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DISCUSSION - ENVIRONMENTAL PROTECTION

Initial discussion was on the credibility of Catchment Boards when stipulating strict environmental controls for forest interests yet allowing unimpeded land clearing by agricultural interests in the same locality. It was pointed out that the 1941 River Control Act does not bind the Crown although the 1967 Water and Soils Act does bind the Crown. However, it is difficult to use this Act as an enforcement measure. It was also pointed out that the Land Development Encouragement Loan is a paradoxical piece of work in that it pays farmers to clear land without giving compensatory funding to other organisations to protect the land. Section 34 and 35 of the Soil and Water Act came under some discussion as there apeared to be some anomilies in the way the Sections were being applied. In the Marlborough Sounds it was stated that over recent times logging had been stopped on three occasions because of impacts on the Marlborough Sounds water system. Logging operations had commenced in the area prior to the Catchment Board becoming involved. Most of the problems had now been overcome. Some Catchment Boards were applying Section 34 on a voluntary basis and this appears to work satisfactorily although others appear to prefer to have a Section 34 notice served rather than voluntary procedures as they then know quite clearly what can or cannot be done.

The question of compensation for damage to down stream users was raised. It was pointed out that this is a common law situation which the affected party could take an action, but it usually results in the people responsible acknowledging it and fixing it up on a one to one basis. Compensation claims for soil and water violations have been settled out of court recently in the Coromandel area.

The effectiveness of riparian strips was discussed as it was pointed out there is now considerable experience regarding this form of protection. The Catchment authorities appreciate that each area must be looked at on its own merits and that riparian strips are not a universal problem solver. It was stated that riparian strips although good at filtering out sediment in a lot of areas, must extend far enough up-stream into the headwaters of a Catchment to be fully effective. Generally, most suspended sediment occurs from roads but this is only true if loggers do not cause other catastrophes to happen. Hundreds times more sediment can occur from land slides than ever gets into streams from roads.

There was brief discussion on whether it was necessary to change the guidelines. It was generally felt that they are satisfactory and are working. One of the main problems is that of communication, particularly in getting the message through to the small operator who is under considerable financial pressure therefore cannot spend time or money on extra protection. It was felt that the guidelines have brought the forest industry and Catchment authorities into a closer understanding of each others problems. The majority agreed that the guidelines be non-binding legally, but site specific.

- SESSION 3 -

FILM AND SLIDE DISCUSSION EVENING

Hosted by Pumicelands Section N.Z. Loggers Association

Chairman : Cam Sycamore, President N.Z.L.A. Pumicelands.

FILMS:

"The Trees Came Back"*
Produced by Forest Research Institute, Rotorua.

A documentary on the removal of native forets in the Mangatu and Waipoua River Catchments on the east coast of the North Island, the resultant agricultural development and subsequent severe erosion. Stabilisation of many of the worst areas has resulted from exotic forest establishment at Mangatu Forest.

F.I.M.E. 1980 *
Produced by C.S.I.R.O., Australia.

A resume of some of the new equipment and technology exhibited at Myrtleford during F.I.M.E. 1980.

"Planning Problems in New Zealand".
A slide/discussion presentation delivered by Jim Spiers, LIRA, on a wide range of difficult planning and logging problem areas throughout N.Z.

* LIRA Acknowledges the F.R.I. and C.S.I.R.O. for lending these two films for showing at the Seminar.

- SESSION 4 -

Chairman : Geoff Wells, LIRA

(a) "PRINCIPLES OF SELECTION AND DESIGN OF HARVESTING SYSTEMS", Viv Donovan, Research Officer, LIRA

"PLANNING PRINCIPLES FOR NEWLY DEVELOPED SYSTEMS" Chairman : Viv Donovan, LIRA

(b) "PLANNING FOR LOG EXTRACTION USING HELICOPTERS" John Gaskin, Logging Development Officer, LIRA

(c) "PLANNING FOR STEEP COUNTRY THINNING" Dave Lamberton, Logging Department N.Z. Forest Products Limited.

(d) "PLANNING PRINCIPLES FOR FMC SKIDDERS" Simon Vari, Planning Superintendent, Kaingaroa Logging Company.

(e) "PLANNING FOR MECHANISED OPERATIONS" Geoff Wells, Research Forester, LIRA

(f) "NEW TECHNOLOGY IN FOREST HARVEST PLANNING" (Paper and Demonstration) Steve Reutebuch, Forest Research Institute.

PAPERS TABLED

"SKIDDERS AND TRACTORS ON STEEP COUNTRY - A PLANNING OPTION " Bob Gordon, Research Engineer, LIRA

"PLANNING FOR TRACTOR, SKIDDER AND SIMPLE CABLE SYSTEMS" Viv Donovan, Research Officer, LIRA

SESSION 4

Paper (a)

PRINCIPLES OF SELECTION AND DESIGN OF HARVESTING SYSTEMS

Matching machine to plan or plan to machine

V.F. Donovan

Research Officer
LIRA

INTRODUCTION

A logging system defined as an assemblage of logging machines arranged in a particular logical sequence is influenced by a wide variety of things which affect decisions made by the logging planner. Some of the key ones such as the terrain, the soil, the volume to be logged over a certain time span, and the tree size, are factors that cannot be changed by the planner although have a very real significance on the system selected. Decisions on the logging method and technique are open to the planner. He needs to be aware of these factors which can be influenced or modified to overcome logging constraints and to make the logging plan a workable and economic proposition.

This paper discusses the principles for the selection and design of systems when producing a plan. It is aimed at what could be termed critical site situations rather than the more common logging situation where the restrictions are not so dominant. The paper is in three sections, firstly the machine selection options, secondly the system selection options and thirdly the landing design options.

General Principles of Design for Critical Areas

Safety, production and environmental protection are compatible and trees can be logged without degrading other land values. However, three key points must be applied appropriately to prevent or defuse productive and environmental conflicts :

1. Communication,

2. Planning,

3. Co-operation.

Communication is probably the most easily dealt with yet is frequently overlooked. Planners must keep a generally poorly informed public abreast of developments in an area and also other agencies which can offer some input when compiling a plan. It is very easy for environmentalists to be destructive with their comments (and sometime in the past they have had good cause) but they are adept at slanting their presentations. Logging planners can and must counter much of this comment by letting people know what they are planning to do, why that course of action is being taken and why alternatives are not feasible.

Planning of critical sites must have a system and equipment designed to fit the site, not modify the site to fit the system. A range of options need to be available to the planner and he must be prepared to adopt a system that is less than conventional. In critical sites planners need to be receptive and innovative.

Co-operation between a whole range of people and agencies is essential when producing a logging plan. The forest manager, the sawmiller or buyer, the forester, the soil and water authorities, other off-site interests, the roading engineer, the logging supervisor and of course the logger and perhaps the unions. Roading has been discussed in previous sessions at the seminar as being a major problem for any logging operation. Roads and landings take on an awesome dimension when applied to critical or sensitive sites. They must be kept to a minimum to reduce damage. Given therefore that quality and quantity of roading and landing size are the key to overcoming site degrade, what system options are available to the planner.

SYSTEM OPTIONS

Highlead

Detail on the highlead system can be read in the paper "Planning for Tractor Skidder and Simple Cable Systems" tabled at this seminar. Highlead or ground hauling is not a good system for critical sites, particularly convex slopes, as the logs are mostly dragged along the ground with the only lift achieved close to the landing. The stationary highlead spars have disadvantages in that large landings are required to site the hauler back from the spar to get good fleet angles onto the hauler drums, and to site the spar back from the edge of the landing to land the last log on the butt rigging. Usually therefore a high spar is required to get some effective lift over the edge of the landing. Rigging up time is relatively slow therefore costly. No lateral hauling is possible unless long chokers are used and these subsequently reduce effective lift.

Highlead mobile integral steel spars overcome the requirement of fleet angles and the slow setting up and shifting time. The landing of logs and the spar height problem are not overcome. Mobile integral tower highlead machines or the smaller highlead mobile yarders have operating advantages which are discussed in the machine options on page 5, of this paper. The machines are usually big and relatively expensive. Planners must look at the ability to get them onto logging sites, given their overall length and weight.

Scab Skyline

This rigging technique is a type of running skyline which can be used with the newer highlead steel spar haulers. A riderblock is run on the tailrope with the butt rigging attached to the block. Lift to the rigging is achieved by tensioning the tailrope while at the same time bringing in the drag. Obstacles such as rock outcrops, intermediate ridges or logging downhill over bluffs, can be achieved because of the good log control but machines using this system need very high power and extremely efficient braking as one drum is being played off against the other (For further information see LIRA Report Vol.3 No.10, 1978). At N.Z.F.P. Kinleith forest the scab skyline system is being used on difficult terrain where traditional skyline systems would normally have been used.

Live Skyline with Gravity Return

A two drum hauler can be used for a gravity return skyline. The main rope becomes the skyline and must be free to be raised and lowered. The tailrope is used for inhaul. Provided a hauler has good free wheeling drums and reasonable brakes, and the lead blocks at the top of the tower can be changed so the mainrope is on the top, the gravity return is a very efficient system. Hauling distance is only limited by rope capacity of the skyline (mainrope drum) and a minimum 20% slope is required to get the carriage to return by gravity. Adequate clearance is needed all the way to the back of the setting. If a shotgun carriage is used, chokers are fixed directly to the carriage. No lateral pulling ability is available unless long chokers are used. The system is limited to uphill extraction and care must be taken not to overload the gear.

Gravity return with a lock-in carriage is an efficient technique because a two drum machine can be used as a skyline and lateral pulling can be achieved. It can be used in thinning and clear felling provided sufficient chord slope and deflection is available. The advantages of this type of carriage over the shotgun carriage are that the skyline doesn't need to be lowered to attach the logs. The load is locked into the carriage during inhaul thereby reducing the strain on the machine. (For further information on this hauler system see LIRA Report Vol.3 No.11, 1978.)

Standing Skylines (Single Span)

Unless a specifically designed three or four drum hauler is used (a slack-line yarder) with matching tower, these systems must operate with an independent spar and hauler and require relatively large landings.

North Bend is the most common rigging configuration used with standing skylines and is also discussed in the paper "Planning for Tractor Skidder and Simple Cable Systems". To re-emphasise the key points, the system requires a three drum hauler with big line capacity, power, and line speed to operate efficiently. Planning must be such to obtain good deflection over the total hauling distance. Bridling to the side is possible.

South Bend (also known as modified North Bend) differs from North Bend only by the rigging of the mainrope. Machine requirements are similar but a three sheave carriage is necessary. The South Bend is most suited to downhill or steep gully applications where lift is essential. Because of the extra purchase in the mainrope which achieves the lift, the system can be easily overloaded. Careful calculation of maximum allowable tensions and loadings on the skylines are needed.

Slackline

This option is a live skyline system but is included here because a three drum hauler is required with heavy rigging. The system is not commonly used in N.Z. because skyline haulers available do not have the skyline drum as a working drum so that the line can be raised and lowered readily. All lift is tensioned on the skyline and the forces imposed on the tower or spar are greater than the North Bend. There is limited ability to lateral haul from underneath the skyline.

Multi-Span Skyline

The multi-span is any skyline system which uses an intermediate support between the spar and back anchor to provide additional lift to the skyline. In N.Z. multi-spans have been used with the Wyssen hauler operated in the 1950-60's and are currently used with the small thinning haulers in radiata thinnings. Intermediate supports allow uniform or slightly convex country to be logged where deflection would otherwise not be available. Long convex slopes may require too many supports to be economical. Intermediate supports also allow the use of a short spar to achieve lift off the edge of the landing. The main disadvantages are the extra rigging time (although this depends on the complexity of the system) and the need for an open sided carriage. The lower the percent deflection the less difficulty the carriage has to pass the support. The change in the span of the chord slope at the support must be kept under 35%. Sensitive sites can be logged with intermediate supports and must be considered a strong option when logs would otherwise be dragged along the ground or deflection is not available. (For further information see LIRA Report Vol.4 No.4 1979.)

Running Skyline

The running skyline is where two or more suspended moving lines that, when properly tensioned will provide lift and travel to the carriage. Uphill and downhill logging is possible. The main system requirements are a specifically designed machine. A normal three drum slackline hauler is not suitable as the drums are not synchronized to wind in and out in the same direction and at the same speed. Good deflection is required throughout the haul line and distances up to 650 metres can be logged although maximums of 400 metres are more common.

Endless Line Systems

This option has limitations because of the high rigging time involved. The endless system is usually associated with a large number of intermediate supports to achieve lift. Rope wear is higher than other systems as ropes are in constant motion and tensioning the system can be difficult. The system requires a hauler with a Capstan drive and often two conventional drums.

MACHINE SELECTION OPTIONS

Mobile Spar Haulers

This type of equipment was developed as an improvement on the wooden spar hauler system. Mobile haulers have received wide acceptance due to their increased mobility and faster set up and derigging time. Recently small mobile haulers have been developed to log on steep country with tree sizes under 1 m^3.

Mobile haulers can be categorized into three groups, lightweight, medium and large, with each group having as variation of the main components, the tower, the winch and the carrier. Also there are certain differences between these three classifications as regards design and application of this equipment.

Small Mobile Haulers : Design Characteristics

Typical examples in N.Z., Timbermaster, Wilhaul, Lotus Skyline Series 1, Skagit SJ4.

The spar and hauler usually come as one unit.

The spar is laid down over the carrier for easy transport and sometimes hinged to shorten its length.

The spar is normally stabilised by two or three guylines. The hauler usually has three operating drums plus a strawline drum which is normally only used for laying out and changing operating lines.

When the carrier is a trailer, the power for the hauler may be included with the trailer unit or maybe provided by the machine which tows the unit, i.e. an agricultural tractor. When the carrier is a truck, the power for the hauler is sometimes provided by the truck.

Medium sized Mobile Haulers : Design Characteristics

Typical examples in N.Z., Skagit SJ7, Lotus Skyline Series 3, Madill 071, Ecologger.

The spar and hauler usually come as one unit.

The spar can be laid down over the carrier for easy transport.

The spar is normally stabilised with three to six guylines, depending on tower height, tower design and the forces exerted on the tower.

The hauler usually has two to four operating drums, plus a strawline drum. The strawline is normally only used for laying out and changing operating lines.
The self-propelled carrier can be a skidder, truck, crawler or tank unit.

The carrier and the hauler are usually powered by the same engine.

Large Mobile Haulers : Design Characteristics

Typical examples in N.Z., Madill 009, Washington 127T, Berger Portatower, Skagit Skyline Tower.

The three main components can be ordered individually so that the resulting combination best suits the users needs.

The steel spar can be telescopic or non-telescopic.

Spar is normally stabilised with three to eight guylines although some spars can use up to twelve guylines. The number of guylines is dependent on spar heights, spar design and the forces exerted upon them.

The hauler is available with two to four operating drums plus a strawline drum.

A carrier is available as a trailer unit or self-propelled rubber tyred or track unit.

The carrier and the hauler are powered by the same engine except in when the carrier is a trailer.

The small machines are designed for single or multi-span skyline use with the carriage often for lateral hauling. These systems are commonly used in thinnings with haul distances up to 400 metres. Small haulers are designed for temporary location with landings normally on road edges. In such situations the wood can be hauled and bunched for subsequent transportation to other roads by ground skidding equipment. In this way truck road transport can be reduced. The machines operate efficiently both uphill and downhill.

The medium sized haulers are basically designed for highlead or skyline use. In this country they are being used for gravity return systems. Their fast set up times and mobility allows them to be used in a similar manner as described for small mobile haulers.

Large mobile haulers being manufactured today are basically designed for clear felling of large timber in steep terrain. A variety of different cable configurations can be used which dictate the haul distance and operating conditions. Although these machines are designed for temporary location, they are in a somewhat fixed position and have no swing capabilities. The incoming logs are all placed in the same location on the landing therefore it is important to consider the difference in productivity between the hauler and the loading machine in order to keep operations as efficient as possible. The size of the machine and the need for an effective guyline set is one factor that restricts landing size and location.

Running Skyline Swing Yarders

This cable logging machine received rapid acceptance in North America since the late 1960's. The machines have the advantage of being mobile, have a swinging boom, and normally use a slack-pulling carriage with chokers. Running skyline swing yarders have the following design characteristics :

The three main components, tower, yarder and carrier come as a complete unit.

The leaning steel tower is normally of lattice construction.

The leaning steel tower is normally stabilised by two or three guylines. Walking guylines allow quicker shifts.

The yarder has three operating drums, two mainline drums (or a mainline and a slack pulling drum) and an interlocked tension haulback drum. In addition, the yarder has a strawline drum which is normally used for laying out and changing operating lines.

The yarder and leaning tower are mounted on a swinging assembly on the carrier and the entire unit is self-propelled.

The self-propelled carrier is either rubber-tyred or tracked.

The carrier and yarder are powered by the same engine.

To take advantage of the mobility of the running skyline machines, the harvesting operations can be planned so that the running skyline swing yarder can move along the road and stockpile the hauled logs on the road behind it. This eliminates the need for large landings. Also the loading machine can work independently compared with the mobile spar machines. Although a running skyline system need only consist of an interlocked mainline and haulback, in practice it consists of two mainlines (mainline and slack pulling line) and a haulback line. The haulback is tensioned to provide lift. By employing two mainlines it is possible to control the slack pulling operations from the yarder. The load is supported by the haul back and the mainlines. As this is equivalent to two lines these lines can be lighter to support a load. The best and more efficient means of maintaining the tension between the mainlines and the haulback is through the use of interlock. This tension device allows the deflection of the lines to increase with an increased load, rather than increasing the tension of the lines. As with all skyline systems, running skylines require good deflection. Haul distances of 600 metres are possible although common practice limits distance to about 400 metres.

Carriages

Cariages are available in many different designs but must be compatible with the harvesting situation and the logging system being used. It is possible to have a relatively simple hauler and a complicated carriage. Alternatively a simple carriage and a complicated hauler. Some important factors which determine type and application for a carriage are :

Whether or not the carriage can pass over intermediate skyline supports.

Whether the carriage is held in position on the skyline with a carriage stop, carriage clamp or by the operating lines.

Whether or not the carriage is dependent upon gravity to carry it in one direction along the skyline.

Whether or not the carrige has slack pulling capabilities.

The cable logging system with which the carriage can be used.

Since most carriages have a combination of operating features, the same carriage can often be used in different ways or modified for different applications. It is difficult to classify each carriage into a single category.

LANDING DESIGN OPTIONS

From the system options and the machine options already outlined, it should be obvious that these factors influence to a large degree the landing option. With critical sites the question must be asked, why have landings? Logging planners dealing with critical sites should address this question closely. If landings are to be constructed they should be part of the transport system and designed as such, not as an afterthought. Specifications that apply to roading should also apply to landings. If the locations are known in advance (as a result of good planning) they should be built as part of the road construction. Landing size should be pre-determined for each situation. Not a rigid standard for all landings. A survey and design should be made to determine the quantity of excavation required. The size of landings depends on many factors. Generally the larger the landing the more economical the log handling. However, this may well be in conflict with other forest management criteria. Landings must be located so logs can be handled with safety and efficiency. All weather landings are essential. It is little use having the best hauler or system available if logs cannot be loaded out because of landing conditions. Loader options must be looked into closely to see if hauler and loading work is compatible.

Excavations can be reduced by minimising the activity on the landing. Two stage landings can be used so logs can be processed at the second landing. In parts of Australia, the U.S.A. and Europe, logs are stockpiled parallel to the road by leaving high stumps below the road edge. Loading out is done with a swinging boom hydraulic or rope crane or a self-loading truck.

On steep side slopes between 20 and 30 degrees, split level or two tier landings require approximately half the excavation of a single level landing for the same effective width. On side slopes greater than 30 degrees access to the upper level becomes a problem. The amount of soil excavated for the access road may be more than the amount excavated if a single level landing is used.

Roads with steep gradients are not likely to limit hauler access provided the grades are not in excess of 11 degrees (20%). Most self propelled haulers can travel grades of this degree. Trailer mounted units are mostly pulled by a log truck and can negotiate grades similar to a loaded log truck (sometimes with a bit of help from a friend). A problem with steep grades is the difficulty of establishing landings on them. Large mobile spar haulers and swing haulers need to be level to operate. Swing loaders also need a near level surface to operate efficiently.

Most swing boom yarders are limited to boom height of 15 to 18 metres. A swinging boom will provide more deflection for uphill hauling than is available to a fixed tower of the same height if the fixed tower machine has to sit back on the landing to land logs in front of it. When proposing downhill hauling to narrow landings along a road it is essential to check the effect of the cut bank on deflection and the safety of the machine and the people on the landing.

CONCLUSIONS

Critical site logging is feasible and a range of options are available to the logging planner. It is essential that logging planners or forest engineers know in detail the various limitations of both equipment and systems. Critical areas to be logged must have machines and equipment to fit the site, not the design of the site to fit whatever is available. Logging planners in N.Z. have historically had planning and operational problems caused by limitations of equipment. They have had no choice in the way in which an area could be logged. Large landings have been necessary for example because of the wooden spar and independent haulers, whereas an integral spar machine with its mobility could possibly improve the situation. The economics of scale have also influenced decisions as to the type and size of equipment. The initial cost of machine should not be the sole criteria that should be used to decide if a hauler or not should be purchased and used.

Recent studies in North America looking at the theoretical cost comparison of highlead versus long reach alternatives (over 300 metres) found that although highlead had the cheapest hauling cost, the total cost picture indicated that better overall costs were possible for all the longer reach alternatives except balloon. Hauling costs represent the highest cost component of the systems investigated, and the average hauling cost for the long reach systems were all higher than highlead (this is probably the case in N.Z. at the moment where N.Z.F.P. are using Scab skylines where traditional skylines have been used).

The key to deciding the best environmentally acceptable plan with the best logging economics can only be solved by detailed costing of roads and landing construction and an understanding of production rates of the system based on sound planning by people with a full knowledge of all the requirements. The technology for achieving this is available as will be discussed in a later paper. The urgent need facing the industry is to train the people to use it so the decisions can be based on these results. Planning in critical site areas therefore needs sufficient lead time (three to five years) so that the design options available can be fully evaluated.

DISCUSSION

The problem involved in converting old rope cranes to haulers was raised and given as a reason for bringing in secondhand reconditioned haulers from North America. The speaker said that it was a viable option to import proven technology at reasonable prices, however, converting cranes was still one option which could be investigated further. It was pointed out that for example, a reconditioned Skagit GT3 yarder would cost around $300,000. The wisdom of always importing secondhand used equipment was questioned. Perhaps the New Zealand industry needed modern technology, which meant new gear even if the cost was high. The problem was, who would meet the cost? It was apparent that the logging sector needed their slice of the investment in the forest industry in the future to harvest the larger resource. New equipment with new technologies could be used in the new areas where the resource was large and a long term cutting plan could be implemented. The big problem was that sales were often organised on a short term basis. Some change was needed so that planning could consider a five year period into the future and look for appropriate equipment. The cost of equipment was not a major consideration and with higher utilisation this problem could be overcome.

SESSION 4
Paper (b)

PLANNING FOR LOG EXTRACTION USING HELICOPTERS

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INTRODUCTION

The first reported trials using a helicopter to extract logs were conducted as early as 1956 in Scotland. These first trials were made without incident, however, at a cost six times the economic rate. Further trials were carried out in the late 50's and early 60's by the Russians, Canadians, Norwegians and others. These initial attempts proved uneconomic due to limited load carrying capacities. An attempt was even made to drag loads two times the free lift capacity on even ground. This operation was potentially too dangerous.

With increased lift capacity in the early 70's there was renewed interest which resulted in the first exclusive helicopter extraction sale being let by the U.S. Forest Service in April 1971. Since then, helicopters have been recognised as an optional extraction machine. It is important to recognise that helicopter operations are designed to harvest timber from sites not suitable for conventional logging.

Helicopters have only recently been used for logging in New Zealand. The first reported trial was carried out in August 1978 at Waimahia subdivision of Kaingaroa, using a Hughes 500. This proved however to be uneconomical. A more recent successful exercise has been the extraction of Kauri thinnings at Russell. This proved to be economically sound as well as being environmentally acceptable. Helicopters have also been used to extract posts in difficult situations, although these trials have only been of short duration.

Helicopter logging is expensive. The hourly operating costs can be as much as five times that of a conventional system. This dictates the need for a rigorous operations design and effective economic analysis before making a decision. Any environmental protection requirements should be confirmed from facts not accepted from supposition. The merits of application of other systems should be thoroughly examined prior to selection of helicopters.

APPLICATION

The attempts to date in New Zealand have shown that helicopters do have a future in logging. Below are listed areas where helicopters could have the most potential :

(a) Widely spaced or scattered pockets of high value timber where it would not be worth roading, i.e. Kauri pole stands, scattered or remote blocks of rimu, totara, etc. A small block of radiata which would yield predominantly peeler or export quality wood.

(b) Areas where road building is either environmentally or economically unsound, e.g. City Water Catchment areas or unstable soils. It is important to remember that logging roads are often of assistance in later silvicultural programmes and this should be taken into consideration.

(c) Areas which cannot be harvested by conventional systems because of remoteness, lack of appropriate equipment or labour. Helicopters are extremely mobile, e.g. from Taupo to Russell is about 2½ hours flying, it would probably take all day and half the next one to get a hauler the same distance.

ADMINISTRATION

This is possibly the most important aspect of a good helicopter logging operation. If the administration is done correctly things flow very smoothly and there are no hitches. Only one person can be in charge and all people involved must recognise this. There are three main areas to a helicopter operation which this person is in charge of:

(a) Bush - he should dictate who does what and ensure that his radio operators are well versed in what is expected of them.

(b) The skids.

(c) The Helicopter - Any decision re flying and maintenance servicing of the machine is the pilots, but factors affecting the operation, such as two short a tagline, not stripping down the machine, parking the fuel tanker, etc, are the controllers.

Decisions to stop the operation due to poor flying conditions must be made between the controller and the helicopter pilot.

Other areas he must control or designate to someone else to control are, pre-operation briefing of all personnel involved, safety consideration, ensuring people are adequately attired for the work they are to be doing, starting the operation in conjunction with the helicopter pilot, crowd control, possibly the most important and difficult, de-briefing after the operation is completed. Other functions that should come under his control are fringe activities such as time studies, forest checks for damage for whatever, photography and publicity, etc. It is preferable that this person is not involved in any other job such as radio operator on skids, as he may be required to sort something out in the bush or be talking to groups etc.

OPERATION DESCRIPTION

Costing from $600 to $3,500 per hour, it is essential that planning for a helicopter operation is kept to a high standard. In conventional logging systems a delay of 15 minutes can be tolerated, however, such a delay in helicopter operation can be very expensive.

There are two essential factors in planning helicopter operations: maximising drag efficiency by having load weights as close as practical to carrying capacity; and minimising cycle times. To achieve these requires careful planning in the felling and crosscutting phase. Logs should be cut to optimum weight whilst remaining within market specifications. Strops should, wherever possible, be pre-set.

(a) Maximising Lift

Payload capacity. This is the most important aspect as far as logging is concerned. It is essential that all unnecessary equipment is removed prior to the commencement of extraction, e.g. passenger seats, non structural panels etc. Manufacturers lift capacities are for sea level operations at standard temperature conditions. The weight which can be lifted decreases with increase in temperature and/or altitude, see Fig.1. Only 30 minutes fuel is carried to maximise load capacity. 4.5 litres = 3.17 kg therefore, 182 litres is 127 kg which cannot be carried underneath the machine.

HELIPCOPTER LIFT CAPACITY

.icopter Model	Approximate Payload Capabilities									
	Sea Level		610 metre		1220 metre		1830 metre		2440 metre	
	15 °c	30°c	15°c	30°c	15°c	30°c	15°c	30°c	15°c	30°c
:orsky 58T	2290	2290	2290	2279	2290	1838	1858	1383	1383	930
.otsky 64E	9412	9412	9276	8845	8459	8164	7643	7507	6872	6232

Figure 1. Helicopter Lift Capacity

(b) <u>Minimising Cycle Times</u>

A typical cycle consists of fly-out, hook-on, fly-in, un-hook. The shortest flight path is often not the quickest. As Fig.2 illustrates this shows the affect a flight path can have on cycle times and that actual horizontal distance is not the most important factor.

(a) The machine must spiral down to a close landing,

(b) The machine flys further but due to more gradual descent cycle time is reduced.

(c) By minimising descent and straightening the flight path the quickest cycles are achieved.

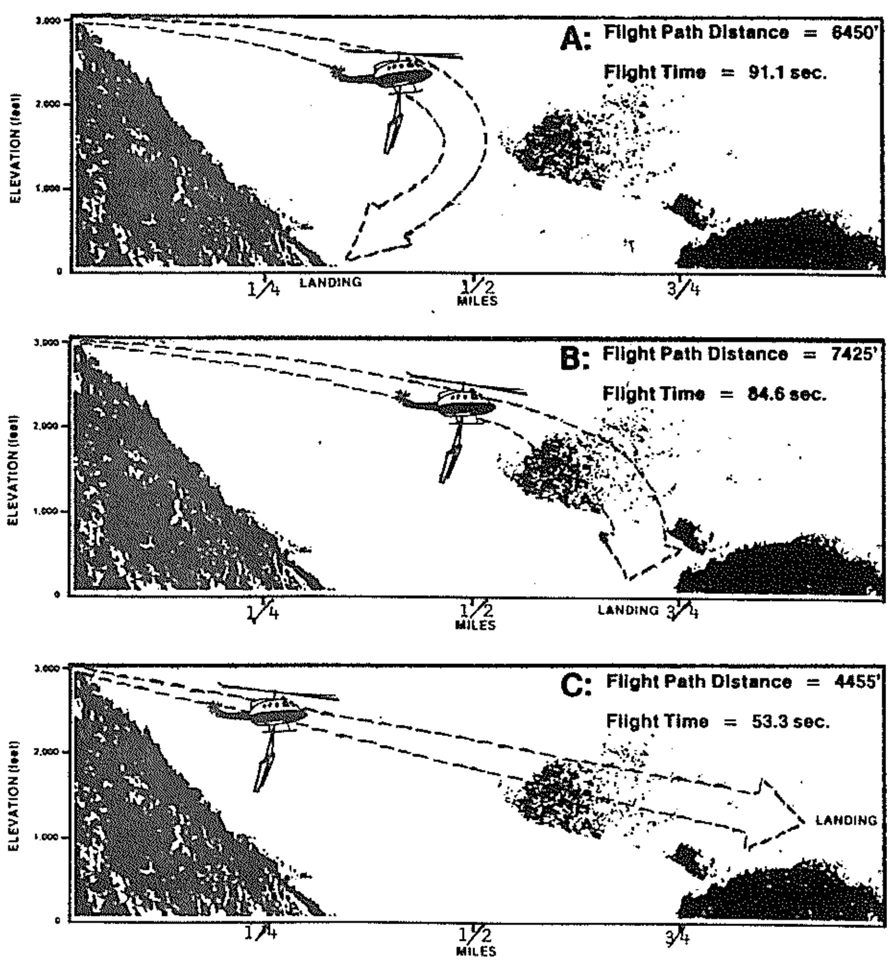

Figure 2. The Affect of Flight Path on Cycle Times

Other factors which affect flight path are wind direction and speed. Better lift is achieved if the machine can lift into the wind, lift is further increased if the machine can fly down rather than having to lift up over a ridge.

OPERATIONAL PLANNING REQUIREMENTS

1. Helicopter

To maximise utilisation it is essential that the machine is correctly prepared for the operation. All the non-essential gear should be removed prior to the commencement of extraction.

1.1 Refueling

The machine commonly used in N.Z., the Lama, uses 4.5 litres of fuel per minute. The machine normally carries only sufficient fuel for 30 minutes flying, plus 10 minutes spare, i.e. 127 kg of fuel. Therefore it is essential that provision is made for re-fueling to take place as easily as possible, i.e. tanker parked on or near skids with sufficient hose reach to refuel without either it or the helicopter having to go out of its way.

1.2 Tag line

This should be long enough to allow the machine to be well clear of the tallest tree plus an allowance for slope on steep country. The tag line should be made of non-rotating wire rope, attached to an electronically operated hook beneath the machine with a hook for attaching strops at the bottom. Electronically and manually operated hooks are best. This facilitates easiest hooking on and unhooking. Time for positioning of helicopter increases with length of tag line so it is essential to keep this as short as practical, allowing for maximum safety.

1.3 Strops

Sufficient strops should be available to pre-set approximately 45 minutes extraction. Therefore the number of strops required is quite considerable, up to 30. These have to be returned to the bush at regular intervals, say after 10 cycles, so they must be able to be retrieved at the skid and bundled and rehooked on to the tag line. The longer the strop the quicker the hook-on. If the hooker can hook on and the pilot lift without him having to get clear this can speed the cycles by up to 15 seconds. Polypropylene are probably the best for helicopter extraction as they often have to be carried some distance through the bush and are easy to work with than wire rope. An eye spliced at each end or a continuous strop is adequate. If larger lift capacity machines are used then wire strops are better because of their higher breaking strenght to diameter ratio.

2. Felling and Cross-Cutting

This should be done prior to extraction or well ahead and clear of any helicopter logging activity. It is important that when felling is done consideration should be given to ease of extraction and ease of breaker-outs getting clear, i.e. it may be necessary to cut up heads of trees to form a path away from the log. Logs must be crosscut as close to the maximum lift as possible. This requires a crew of two men to scale each log and mark it for cutting, plus the crosscutters to cut it. Ripping of large logs can be carried out, however it is time consuming and on steep country very difficult.

3. Personnel Requirements

3.1 Bush-end

Five people are required for maximum efficiency. One radio operator to direct the machine into the breaker-outs and to keep contact with the skids, to keep the supply of strops constant. Two breaker-outs, one catching the hook and one hooking-on, and one or two pre-stropping, depending on how far apart the logs or bundles are. The radio operator would also be responsible for indicating to the breaker-outs which drag should be hooked on when. With regard to the amount of fuel the machine is carrying and the weight of each individual drag. It is best if drags can be pre-cruised to get the exact rates and the breaker-out has a list of these weights with corresponding numbers attached to the logs.

3.2 Skids

One or two people are required to retrieve strops and prepare them for return to the bush. One radio operator to direct when strops are to be sent back to bush, he is in contact with the bush and pilot.

3.3 Helicopter Service Personnel

This is normally provided by the firm operating the machine and consists of two or three people for refueling and servicing, etc.

4. Radio Communication

It is essential that good radio communication is maintained between the three parts of this operation and that those responsible are aware of their particular duties. The bush radio is possibly the most important as he directs the machine to the breaker-outs and tells the pilot when to lift.

5. Landing

5.1 Location

Landings should be located to service as much of the area as possible. They should be located to yield the shortest possible average haul distance. This should not exceed 1.6 k with a maximum return distance, i.e. skids to bush of 2.5 k. The difference in elevation between landing and bush should not exceed 14 to 20^{o}, preferably landings should be situated downhill of the pick up point. Service areas should be located as close to the landing as possible to minimise servicing times. Wherever possible the landing should be situated so that the helicopter will be flying into the wind when approaching, loaded.

5.2 Size

The landing should be large enough to handle the longest log to be extracted and provide a safety margin for, sliding logs, early releases and pilot error. A minimum size would be 2½ times the longest log. Any support equipment should be kept at least 15 metres from the outside extremity of the drop zone. If a front-end loader is to be used a safe parking area must be made available for it while the machine is unhooking. An area should be set aside well clear of the drop zone for vehicle parking and spectators. Provision must be made for the machine to land for refueling and service. This should be a minimum of 1½ times the sweep of the main rotor.

6. Safety

Due to the speed at which helicopters extract timber and the fact that they are carrying a suspended load, safety plays an important part in planning the helicopter operation. The following points should be considered.

6.1 Flight path

This should be arranged so as not to cross the access track to the bush.

6.2 All persons involved in the operation should be familiar with the procedures for working around helicopter, i.e. when and how to approach a helicopter, etc.

6.3 Key persons working in the bush, like breaker-outs and radio oeprator, should wear distinctive coloured capes or jackets as should those on the skids.

6.4 Down-wash. The air velocity at ground level from a Lama in hover is approximately 37 miles per hour. This can be hazardous to the people working in the bush and on the skids. Loose branches and other hang-ups can be blown out of standing trees. There is also, in dry conditions, a lot of dust blown up from the ground.

6.5 It is essential that lift doesn't commence until breaker-outs are clear. This is the radio operators responsibility to indicate to the pilot. The breaker-outs should always move uphill as the machine will fly either across or down slope.

6.6 Signs should be erected along roads, blocking them to unauthorised people. Also, unauthorised people should not be allowed within the confines of the operation unless under strict supervision.

CONCLUSIONS

It cannot be overstressed that using helicopters is possibly the most expensive form of extracting timber. However, if the cost of roading is placed alongside the cost of conventional logging it would look less attractive. In areas of unstable soils, where roads for establishement and silviculture operations have been formed and can be used as extraction roads for logging, then provided they are in the right place, timber can be flown out with much less soil disturbance and cost than conventional logging. Using an helicopter for extracting means that a contractor isn't faced with having to invest in a machine costing $100,000, he could employ people to cut for him for a week and then once enough timber is on the ground he could hire a helicopter to extract it. Although still in its infancy in New Zealand, helicopter logging has its role to play as an extraction unit in the future.

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DISCUSSION

More information on the availability of helicopters was requested. It was stated that there was no maximum daily flying time for pilots as yet in New Zealand. While mist stops helicopters, rain will just decrease the load (by about 10%) and winds do not stop flying unless they are over around 50 knots. Heat and altitude are not too important in New Zealand. Helicopters would only be used on an intermittent basis in New Zealand in logging operations so that it was unlikely that any logging organisation would purchase their own. The bush phase of operations had to start well in advance with helicopters of a load size available in New Zealand now. When bigger helicopters become available then the bush work would have to start even earlier. It was said that for the Russell trial it required five weeks to fell and rip the logs and considerable problems were experienced in this area. It seemed that the preparation in the bush may be more critical than the organisation of the helicopter flying.

SESSION 4
Paper (c)

PLANNING FOR STEEP COUNTRY THINNING

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N.Z.Forest Products Limited

The policy of my Company, N.Z.Forest Products Limited, is to production thin the whole forest, or as much of it as is physically and economically possible.

Four years ago the first small hauler commenced thinning. Today six hauler, one tractor and three chute crews are thinning steep country. These are all owned and operated by independant contractors.

The cost of this wood is twice that of normal thinning on flat country. The species is *Pinus radiata* and the age set for this thinning is 14 years. This reduces the stand to a final stocking of 280-350 s.p.h.

All the wood produced is classed as pulpwood although some of the more suitable of this is processed as roundwood for posts and poles.

Experience has shown that thinnings younger than 14 years make the cost of steep country thinning unacceptable to my Company. Chuting can work in a wider range of age class, e.g., 11 year old to 17 year old stands.

75% of the wood thinned from steep country at the present time is with small haulers. In the past these small haulers were used exclusively so other means of extracting this wood at a lesser cost were examined. Chutes and small tractors have now established a place for themselves although they are restricted in their application.

Criteria used in determining areas:

Chutes - a. slopes over 18° and not steeper than 35°

b. slopes not longer than 120 m

c. slopes that lead onto roading.

Tractors - areas so far allocated for this operation have been the easier of the steep country allocation with generally shorter slopes.

Haulers - do the remainder.

(A) <u>Haulers</u>

There are three makes used.

Wilhaul 130 H.P.

Timbermaster 70-90 H.P.

Lotus 90 H.P.

They all use 9 mm rope for main and tail ropes with a 16 mm skyline. They are truck mounted and have a maximum haul distance of 350 metres.

The basic crew is 6 men. Each gang also has a tractor (D4 size) or skidder (Clark 664 size). This machine is used to haul the logs away from the hauler to a load-out site. A cranab type crane can be mounted to the hauler and in some situations can be used instead of the secondary machine.

Preparing Logging Plan

1. Areas scheduled for steep country thinning are inspected to ensure that this can be achieved, considerations being access, stocking and topography.

Access: NZFP Co. planning policy is to permanent road only for clearfell so this means that some areas e.g., skyline blocks, may have some pockets that cannot be reached because of lack of access.

Stocking: Usually need to be over 800 s.p.h.

Topography: Large areas with rock faces and bluffs, generally excluded. (Above and below can be thinned where this is possible). Difficult broken country is looked at closely. This inspection needs to be far enough in advance so roading and site preparation can be organised before thinning commences.

2. Roading. Attempt to be 12 months ahead of the thinning crews. Previously logged areas need very little preparation as the majority of these have been previously clearfelled with large highlead or skyline machines. Existing roads and dumps are opened up and reused. Newly planted areas with little permanent roading, require at least 12 months prior notice to prepare.

3. Production data. Before work commences a target or standard is set for each area. A wide difference in height, diameter and stocking can mean a difference in production of between 28 tonne daily to 40 tonne daily for haulers. An assessment is run through each area which determines:

a. Piece size (range .15 m^3 - .23 m^3)

b. Volume to be removed (range 90 m^3 - 200 m^3 per ha)

This together with the average length of haul determines the daily production standard. The rates are set accordingly.

4. Hauling. Uphill or downhill hauling is possible with preference to downhill as it produces more wood easier than uphill.

There are three types of conditions:

a. Working from clearfell skyline or hauler sites. These are generally good winter areas as the roads are well stabilized and many of the loading sites metalled.

b. Working onto roads.

c. Working from tracks. There are times when haulers are required to work on tracks sometimes up to 300 metres from the load-out area. Most operators prefer to form these tracks themselves just prior to logging as most have a crawler tractor.

5. Planning options. Small thinning haulers can be fitted into varying condition to suit their individual characteristics. Haulers with a crane are well suited to working along roads where the wood can be stockpiled ready for load-out without using a secondary hauling tractor. Also working along the lip of a steep slope the crane can hold the logs, to stop them slipping back down the slope until they are unstropped and then position them for further processing. They can also load direct into cradles when the multilift transportation system is used. The choice of a skidder or tractor also allows for optional placing of these machines to the best advantage.

Winter and summer areas usually relate directly to road and dump conditions which can effect the load-out.

6. Load-out. This must be regular. Most crews produce between 1-2 loads daily and for these reasons the Company use self-loading trucks to ensure each crewgets a daily load-out.

7. Marking. Some marking for selection of crop trees is done from time to time but the majority of the areas are selectively thinned by the individual crews to a defined pattern.

8. Quality control. Weekly checks with attention to

a. tree damage

b. tree selection

c. safety procedures

d. log presentation.

Problem Areas

There are several of these where conditions are such that either the area is not thinned at all or the thinning is accomplished at a reduced production.

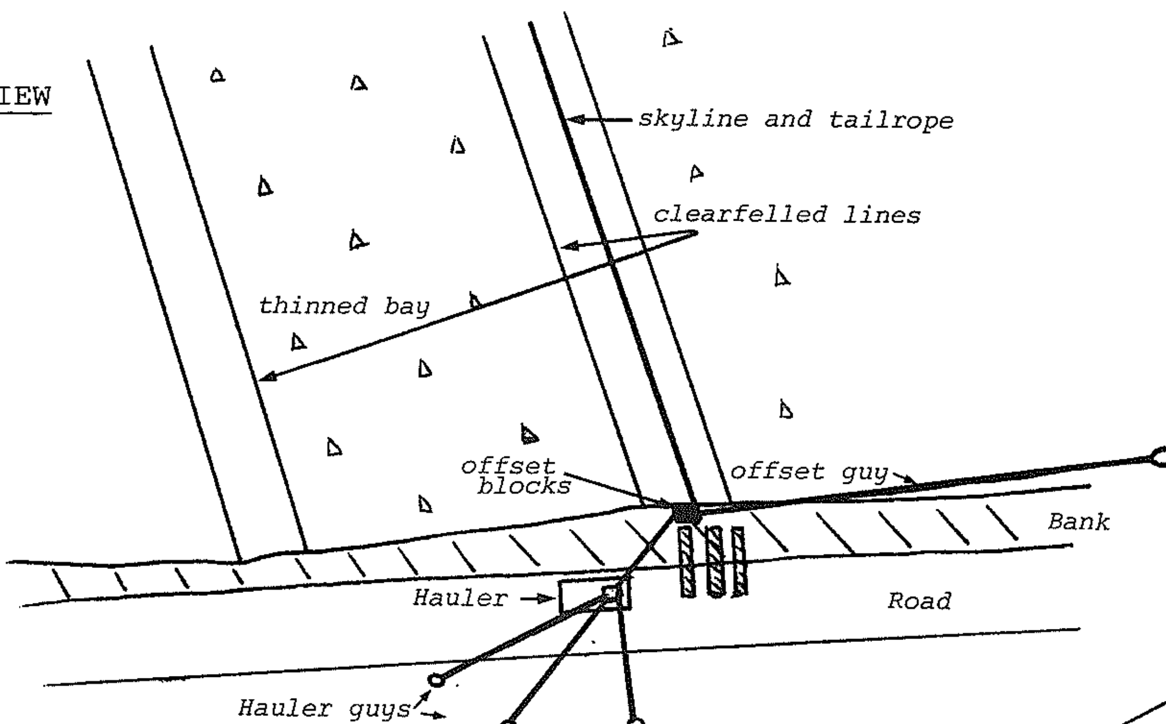
1. Hauling across rock outcrops. Uphill hauling can be achieved but at a reduced production because where rock faces are found the slopes are very steep so the average haul size is reduced.

Downhill hauling causes trouble because of the difficulty in controlling the logs coming over these rock faces. The usual result is a great deal of broken wood requiring double handling and generally high tree damage.

Because of the danger to both fellers and breaker out, many of these very steep areas are not thinned.

2. Hauling downhill over a steep bank with the hauler in line with the incoming logs and not enough space to land the wood safely without hitting the hauler. Some areas can be thinned by positioning the hauler off the line by several metres and offsetting the skyline and mainrope. This offsetting is usually achieved with the aid of a long strop, one end with a block attached, pulling both skyline and main rope over into the haul line and the other end attached to a large tree or stump.

)P VIEW



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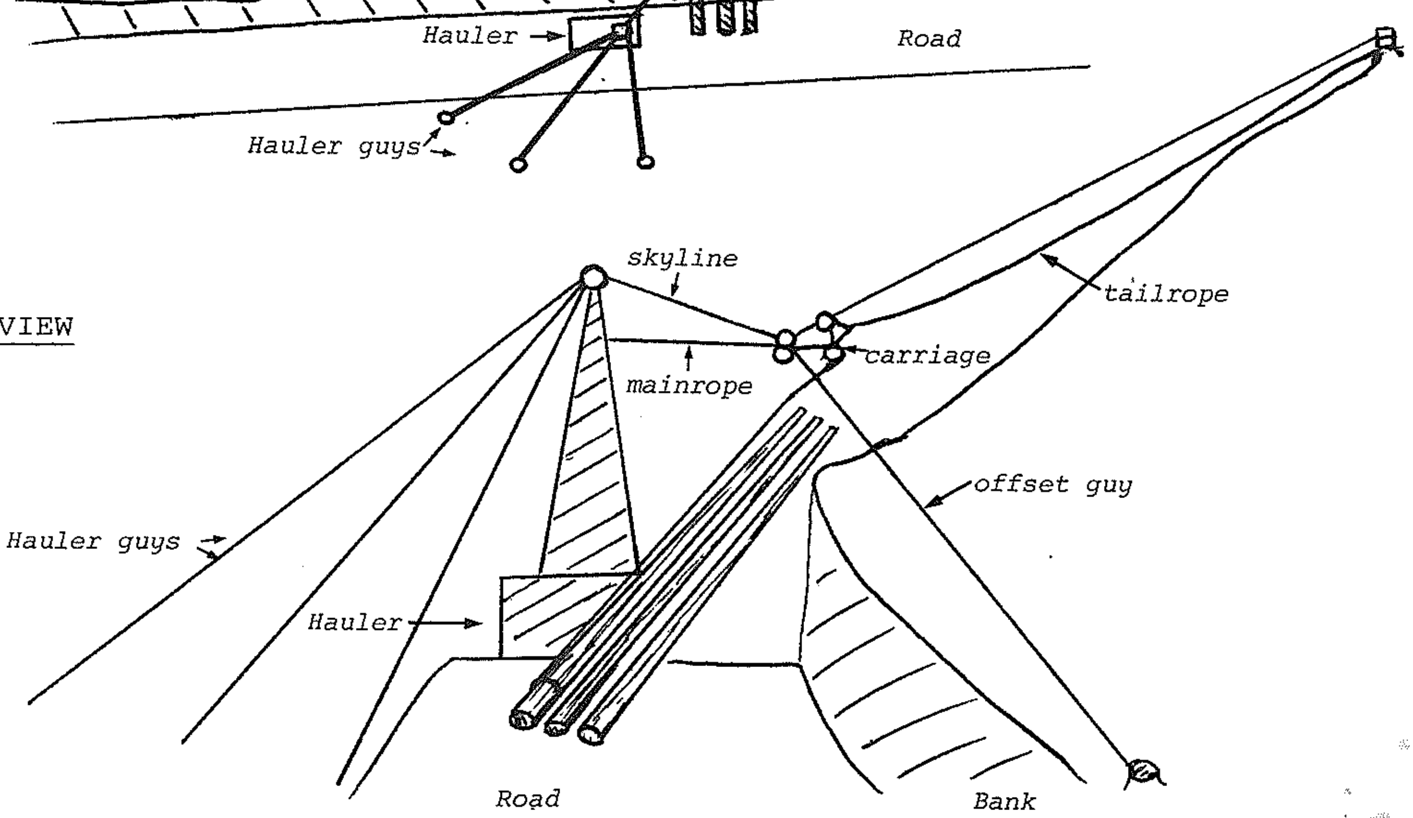

There must be sufficient lift to maintain the skyline well clear of the ground, as this offsetting reduces the effective hauler tower height.

3. Across gully hauling, i.e., hauling downhill then uphill, or fully suspended. Where the wood is hauled fully suspended the haul size is reduced and the tree damage high due to lack of lateral control.

Where the logs are hauled one end up much breakage and logs diving into the ground occurs.

Rigging time is also slower so altogether production is low. Where possible these situations are avoided.

4. Convex slopes. These usually restrict the length of haul. The use of an intermediate support extends this length and is an important attachment to thinning haulers.

5. Downhill hauling into a basin. This requires the haul lines to be cut in a fan pattern. This causes the lines to be too close together at the foot of the slope and wide at the top. Difficulties in getting the haul rope into this wide area means that several things can happen.

a. two men may be required to pull the rope

b. cut and trimmed logs may be left if they cannot be reached.

Normal downhill pulling is preferred as better production can be achieved. i.e.parallel lines with 20 m line centres.

(B) Chute Thinning

The use of chutes for extracting wood from steep slopes is not new. The new element in the current operation is the material the chutes are made of, instead of wood, polyethylene or alkathene is used.

Lengths of 6 m of 455 mm diameter pipe with a wall thickness of 12 mm are split length wise into three pieces or chutes. These chutes are overlapped and joined together with two bolts with wing nuts with handle attachement welded onto them. When installed on the slope the chute line is tied down to trees and stumps usually to the handle on the wing nuts. This is necessary to stop the whole chute line working its way down the slope.

Gang size is usually 2 or 3 men. A two man gang is the most efficient but the disadvantage being any absenteeism puts the crew out of action.

Pulpwood will not slide easily on slopes less than 18° and on slopes over 35° it is very difficult to get men to cut and carry pulpwood billets. These chutes can handle wood up to 300 mm (12 inches) in diameter.

On long slopes which are reasonably steep there is a problem with the speed of the pulpwood travelling down the chute line and at present no method has been found for successfully slowing them down.

The need for chuting onto roading is soley economic as the wood is then stacked into heaps along the road side ready for uplifting by self-loading trucks.

Production Standards

Undergrowth conditions vary and this is one factor regulating production the other one being stocking, and high stocking (over 1100 s.p.h.) invariably make underfoot conditions good. Production (and cost of wood) relate directly to these factors. Present standards are set by eyeball evaluation by the supervisor.

(C) Tractor Thinning

One tractor, a Komatsu D45A, has been in use for several months thinning 14 year old *Pinus radiata* on steep country. The crew size is four men and may be increased to five. A small trailing arch was used but it was found unsatisfactory mainly because of its poor manoverability. Tractor is fitted with a bull blade.

Hauling: The tractor first attempts to get as much wood as possible from either the top or bottom of the slope. The remainder requires tracking. Each area has differnt characteristics but tracks formed on a grade of 15°-18° and spaced 40 metres apart are working well. The trackwidth is just wide enough to take the tractor. At present tracks are marked in by the supervisor.

Production standards are based on the same information as for the haulers but the production range is normally between 30-45 tonne daily. Cost is lower than the haulers by about 25%.

Observations: The D45 Komatsu is ideal for the tracking but is probably overpower for this size wood. An intergral arch would probably be an advantage. To date soil disturbance caused by tracking has caused no apparent erosion damage. Cutoffs are placed at regular intervals on the completed pulling tracks. The soil type mostly encountered is clay/pumice.

Conclusions

The current haulers appear to be the optimum size and horsepower for the pulling of 14 year old thinnings. Although they produce expensive wood, they still thin 75% of our programme. There are still many problem areas, but with well organised and detailed planning and execution, many of these situations can successfully be thinned.

Chute thinning is a low capital cost operation and as such must be favoured for suitable areas. The availability of men who will work constantly on steep slopes is a question yet to be answered.

Tractor thinning. There is a great deal more information yet to be learned on what size and types of machines will be best suited for varying types of ground conditions. In NZFP setup there is a place for this operation as it allows the easier of the hauler slopes to be thinned at a lower cost.

DISCUSSION

It was said that chute operations required no other servicing than loading out after stacking. The chute cost was 25% greater than producing short pulp on flat terrain. Some interest was expressed in contour tracking on steeper slopes and the use of skidders rather than tractors on these contour tracks. The only organisation thinning on steeper country in the Bay of Plenty, N.Z. Forest Products Limited had only just got into this sort of operation and had not yet had time to try all options. For hauler operations it had been found that the haul or strip roads did not really use much land, if the strip size was kept down to the prescribed level. This was an area where supervision needed to be strict. 5 to 20% bark damage occurred in hauler operations and it occurred both high and low on the stem.

Contracts for thinning contractors need to be a minimum of two years but preferably longer. At todays costs for a thinning hauler and other expenditure about $100,000 is required to set up.

Session 4
Paper (d)

PLANNING PRINCIPLES FOR F.M.C. SKIDDERS

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MURUPARA.

INTRODUCTION

As Planners in an increasingly sensitive and high-cost industry it is, I suggest, our duty to evaluate those options which this seminar have highlighted; - not only during these three days, but as a continuous process in carrying out our jobs.

Let me remind you of these options, and there is no better way to do this than to quote Viv Donovans definition of tactical Planning:

> "What is tactical Planning?
> Given an existing forest the ways and means of logging it so that production, safety and environmental protection are compatible at least cost and that logging practices do not degrade other land values.
> Two options exist:
> Choice of the best system and equipment for the new situation;
> Planning to make best use of current equipment where limited options exist".

Planners should be addressing themselves to these options constantly. The process or techniques used will vary according to particular situations, and the degree of flexibility they present.

Planning, like economics, is concerned with the best use of scarce resources, - These could be finance, equipment, Labour or in some cases good Planners.

THE F.M.C. 2200 C.A. LOG SKIDDER

The F.M.C. Skidder is a special breed of logging equipment which the Planner can use when options are limited.

Before discussing some of the Planning sequence used, it may be just as well to say something about the machine itself.

F.M.C. skidders were developed from the military vehicle originally designed as a personnel carrier. Some of the design features such as speed, light weight and smooth-riding suspension were useful in converting the carrier to a logging machine.

The present 220 series is a third generation model incorporating improvements over the earlier 200 and 210 series. Low ground pressure, about 39kPa (5.6ps.i) is an important feature when planning for environmentally sensitive areas. It has a maximum speed of 24 km/h (15 mph) and the smooth ride is attributed to its flexible "soft" track. The track is composed of forged steel pads or segments joined by pins with rubber bushings.

This track is supported by a front drive sprocket, a rear idler, and five road wheels on each side. The road wheels are suspended independently by torsion bars. This arrangement allows the track to conform to the contours of the ground, rolling over obstacles like a snake, instead of having to climb over them and lose ground contact over portions of the track.

The result is a comparatively smooth ride and minimal ground disturbance.

The drive train includes a 149 kw (200 hp) G.M. 6V 53N diesel engine supplying power to a front-mounted differential via a torque converter and 4-speed power shift transmission. The differential delivers power separately to each track via planetary final drives, and steering is controlled by steering brakes within the differential. This ability to keep power in both tracks during a turn is especially useful when climbing or under heavy load.

Basic specifications of the F.M.C. 220 CA

Engine - G.M. 6V53N Detroit diesel
Transmission - Clark - powershift 4 speed forward and reverse
Horsepower - (200) 149 kw.
Suspension - Roadwheels, torsion bar sprung
Unladen operating weight - 12.7 tonnes
Area of track on ground - 3.208 sq.metres
Overall height - 3.15m
Overall width - 2.62m
Ground clearance - 48.3 cm
Winch capacity - 65.8m of 19mm dia. rope
Max line pull - 18148 kg (bare drum)
Max line speed - 103.6 m/ sec (full drum)

KEY POINTS ABOUT THE F.M.C.

The previous brief description shows that the F.M.C. possesses certain specialcharacteristics which are important for a Planner to be aware of when weighing out the options open to him.

These are:-

'Soft' tracks, low ground pressure
- allows mobility in soft ground and minimize disturbance in environmentally sensitive areas.

Fast travel speeds
- enables longer average hauls

Weight: Power Ratio
- Its low weight gives a better weight to Power ratio resulting in a comparatively higher pulling capacity.
Note: In horsepower it is equivalent to a D7, but is 8 tonnes lighter.

Controlled differential steering
- Having power applied in the tracks for steering enables the machine to overcome adverse slopes and improves its turning ability.

Flexibility
- It fits into existing logging systems with no special requirements for falling or loading

Disadvantages
- The F.M.C. has three major disadvantages.
It is a high cost machine
It is a high maintenance machine
It is highly susceptible to self-destruct
- by this, I mean, that its speed, power and traction combined with its light construction makes it extremely operator sensitive.

Now you know some of the key advantages and disadvantages of the F.M.C.
- lets talk about specifics.

TACTICAL PLANNING AS APPLIED AT K.L.C.

a) General Procedure

Plans are usually done on a compartment basis. A compartment is taken from the annual program issued by the Forest Service, and a logging strategy based on that compartments feature, e.g. terrain, ground conditions, piece size etc., is derived.

From a preliminary survey of the compartment's features, applicable logging systems are chosen by planning staff. The initial survey usually involves, an assessment of tree and log parameters by a field crew, and measurement of other field data such as slopes, undergrowth, and other features capable of affecting operations in the compartment. Aerial photographs and maps, featuring topography and timber boundaries, are added to the survey information, so that a comprehensive picture of the compartment is built up.

Planning staff then locate potential road and landing configurations on 1:5000 scale maps, using accumulated compartment information. Landings are laid out as symetrically as practical, with the necessary roading paths to facilitate trucking access, linking them. The symetrical landing layout is desirable because, for a given setting area, the more regular the shape, and more central the landing, the shorter the average hauling distance.

For each of the potential road and skid configurations the least cost, practical hauling systems combination is calculated. From this a total hauling cost for each road and skid configuration is determined. Then the roads and skids are costed so that each configuration has a total logging cost.

The cheapest total cost, and appropriate combination of roads, skids and hauling systems, is then chosen to log the compartment.

b) Selecting the optimum combination

The general equation for determining the cost of combinations of roads, skids and hauling systems is:-

$$HC + SC + RC = TLC$$

where:- HC is hauling cost, dependant on the combination of hauling systems, piece size, hauling conditions and haul distance

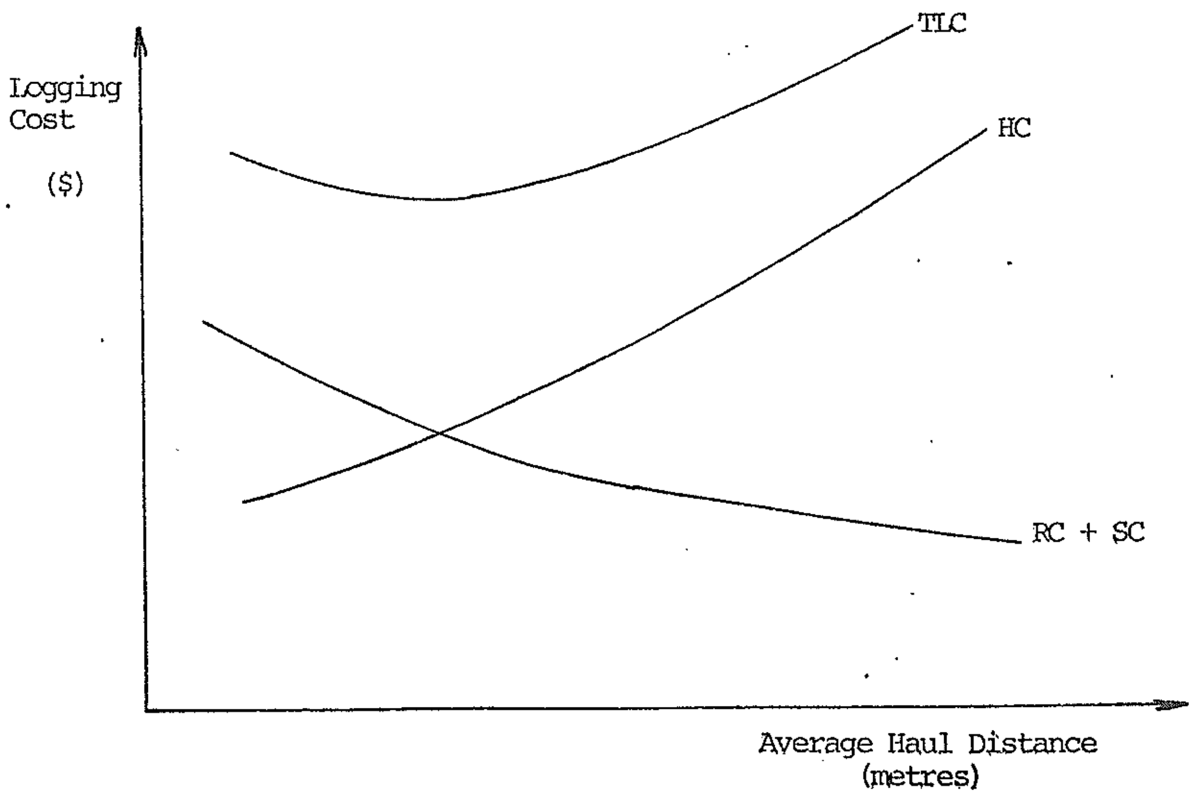
SC is landing cost, dependant on the type and number

RC is roading construction cost, dependant on the adversity and length of roading

and:- TLC is total logging cost.

The optimum combination for a compartment is the minimum TLC. Generally, the effect of increasing the cost of road and skids is to reduce the average haul distance and subsequently decrease the hauling cost. Thus the minimum TLC will usually occur when the marginal cost of additional roading and skids is equivalent to the marginal saving in hauling cost, produced by the reduced haul distance. This can be illustrated graphically.

Figure 1. Logging Cost on Average Haul Distance



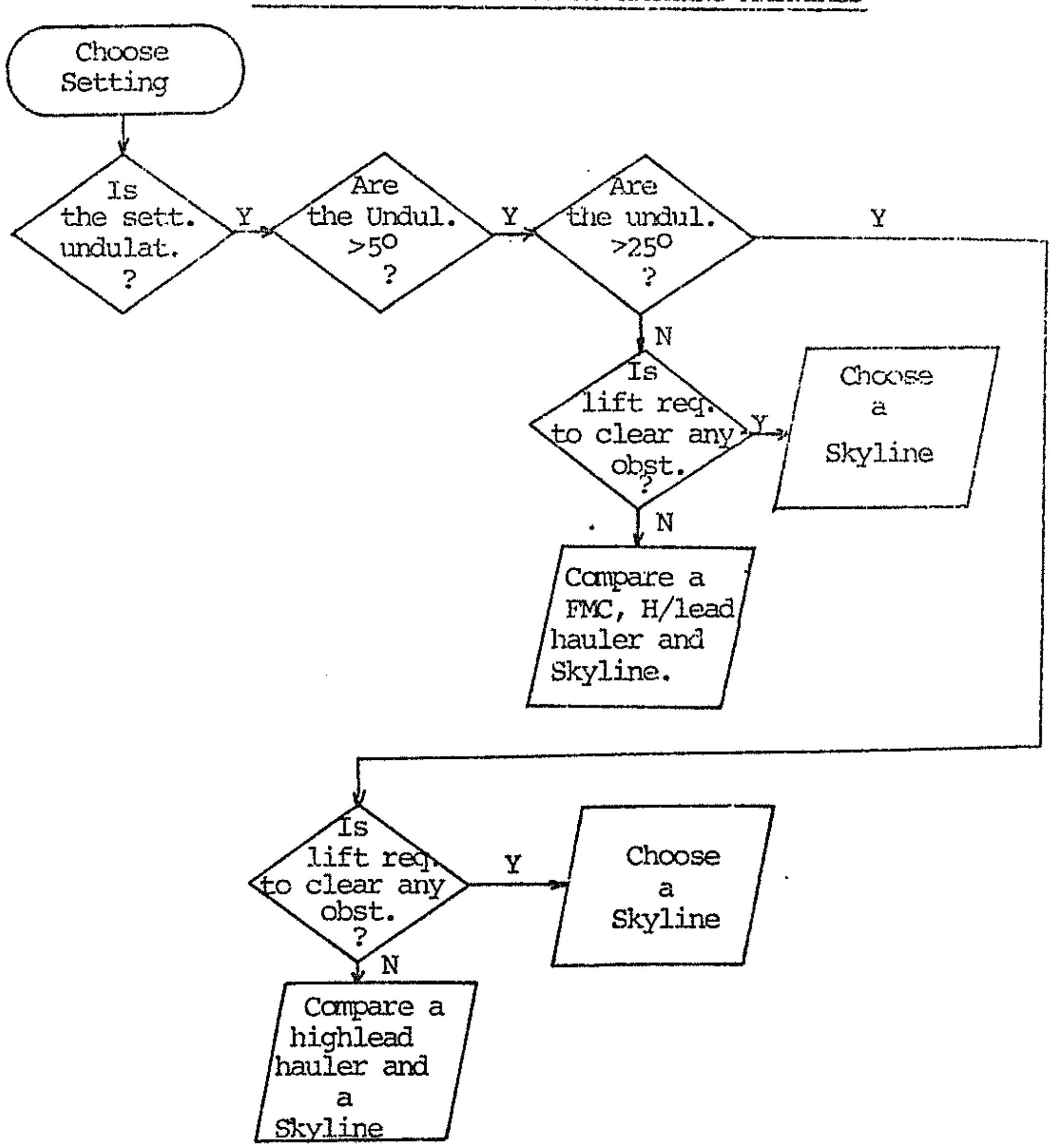
c) Evaluating the Cost of roads and Landings

Roads and skid location is obviously constrained by a compartment's physical features. Consistant with maximum allowable road grades and a desire to minimise grades, a number of potential road and skid configurations are planned. The cost of each configuration is usually based on cost information from recently logged compartments with similar operating conditions. These costs are simply pro-rata on the length of road and number of skids. If the roading is complicated by adverse grades, cuts or haul material, costs are estimated from the expected machine time necessary to complete specific pieces of road. Thus, road and landing costs for each configuration are derived.

d) Choosing applicable hauling systems

For each configuration of roads and skids a compartment can be broken into a series of similar hauling settings. These settings are mainly separated by topography and any adversity. The applicable hauling systems (hauling machines) are initially broadly selected by a process of elimination. The flowchart set out below is indicative of how potential hauling machines are chosen.

FLOWCHART FOR SELECTING HAULING MACHINES



Once the options are known, the next step is to evaluate them based on historical Work Study and cost information . The analysis can be a very tedious affair unless you happen to own a computer or have access to one.

SPECIFIC PLANNING REQUIREMENTS FOR THE F.M.C.

In planning for the F.M.C. you can afford to be a little more innovative.

K.L.C.'s experience has shown that in typical tractor or skidder country the limiting factors are the capability of the skiddy's and loader to handle production that F.M.C. will haul.

PLANNING SEQUENCE:

(1) Establish the economic unit cost for the wood.

(2) Using Work Study standards, derive the average haul distance and manning level to give the required production rate.

(3) Check that topography and other limiting features of the stand allows for that haul distance and production rate to be achieved.

(4) Vary the options to give the best unit cost.

As mentioned above in typical tractor/skidder country the F.M.C. will haul up to 700m^3 per 7½ shift in a stand of old crop P. Radiata 3.5 m^3 average stem volume.

The unit cost though cheaper by up to 15% than a skidder or tractor, the F.M.C. is best used in marginal or critical sites if it is shown that the unit cost difference is better than this or where there simply is no other choice.

Key Specific points - F.M.C. Planning for marginal sites

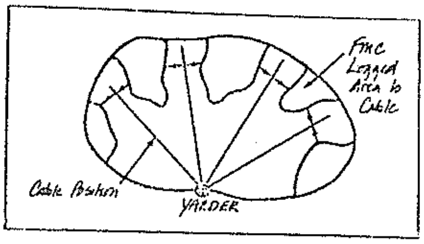
(1) Pre-track if allowed
(2) Fell to suit butt hauling
(3) Keep the drag sizes to a level to avoid winching .
(4) Track to minimise side pulling.

TYPICAL MARGINAL SITES USE

(1) With Cable Systems

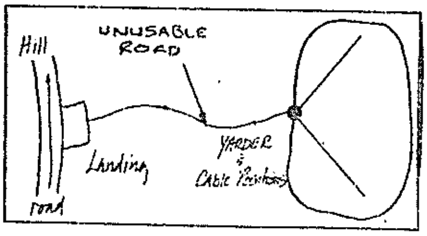
(a) Cleaning corners

Haul long or blind corners



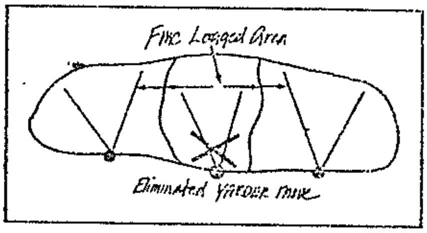
(b) Haul as Forwarder

Haul from yarder to a landing where tracks or other forms of transport can reach.

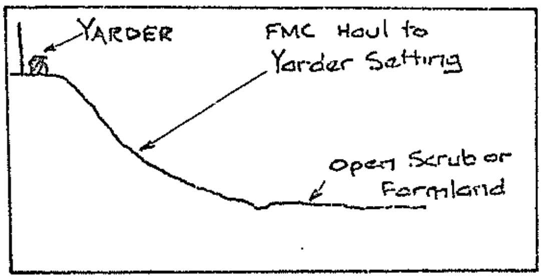


(c) Reduce Yarder setting

May be economical to use and cut costs in cable re-setting.



(d) Assist where suitable Anchors are not available



(2) With Skidders or Crawler

Scout haul out of sensitive areas or do long hauls of pre-bunched logs.

(3) Use with helicopters

(4) Haul out of Wet, Swampy ground

(5) Use in areas where debris and other ground obstacles are a problem.

(6) Use on Farm/Forestry woodlots.

FUTURE APPLICATIONS

As the demand and competition for land between farming and forestry get more acute in the next decade or so, I have no doubt that F.M.C.'s or machines of a similar nature will become increasing popular.

It is obvious that except for farm woodlots, our best use land policy will only allow extensive forestry on marginal land, that farming does not want.

I can see that in places like Mangatu, Hikurangi and the other potential forest areas in the Poverty Bay - East Cape area, F.M.C. type equipment will be the most like choice for logging except for the very steep country.

My guess then, is that in the year 2000, High speed track skidders with even lower ground pressures than 39 kPa will be as common as Watties pea harvestors in the Gisborne District.

DISCUSSION

The influence of the capital cost of the FMC compared to other skidders is taken into account in the calculation of a daily hire rate when a planning exercise is being done. This is then compared with other options of equipment that could be used for the same job.

When questioned on ground pressure of the FMC, it was pointed out that this machine had 5.6 psi compared to about 10 psi for a tractor. This was in an unladen state. The difference when the machines were laden was not known.

SESSION 4
Paper (e)

PLANNING FOR MECHANISED OPERATIONS

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LIRA

1. Introduction

A successful mechanised harvesting operation requires efficient planning, effective management and operational competence at all levels. The management of mechanised operations is extremely complex. The factors which cause this complexity include :

1. The work environment of the harvesting operation which is inevitably variable in comparison with the factory environment in which many machines operate.

2. The many choices available for machines, but once a system has been chosen there is a relatively low level of flexibility in terms of methods, suitable tree dimensions and product specifications.

3. The high capital cost of the equipment which is subject to frequent mechanical breakdown. The more complex the equipment, the greater is the chance of individual component failure.

4. The operating and maintenance personnel who need to adapt to new methods, new equipment and a new environment, and therefore require adequate training.

Some of these factors are common to all logging operations. This paper deals with the planning required to overcome those factors which are unique or especially important to mechanised operations.

2. What is Planning?

Intensive planning is essential if management is to be successful. Planning means fitting together the variable factors such as machinery, operators, and supervisors with the fixed factors such as the trees, the stand and the terrain so that management objectives can be achieved. The Logging Manager is presented with an area of forest which he is required to harvest according to his organisation's objectives. The forest and the terrain on which it stands are fixed and he cannot alter them. The equipment, the men and the methods with which he harvests the area of forest are to a varying degree within his control. Planning for a good match between the forest which he has been given to harvest and a mechanised system which he chooses to introduce, is particularly important because of :

1. The high capital cost of the equipment, meaning tht productive machine time must be maximised to reduce the fixed costs per unit of wood produced.

2. The lack of flexibility once the equipment has been chosen, meaning that the correct choice is vital.

Unless these factors are carefully considered during the planning stage, management objectives are unlikely to be met.

3. What is Mechanised Logging?

The most labour intensive (or least mechanised) logging method employed in New Zealand is the motor manual shortwood system. In this sytem the following breakdown of time is commonly found for the processing components of harvesting :

(a) Felling : 15%
(b) Delimbing : 55%
(c) Cutting to length : 15%
(d) Stacking : 15%.

Extraction is considered mechanised in all but a very few operations. Cable skidder systems require men in the bush who are not needed in grapple skidder or forwarder systems, and therefore represent a lower level of mechanisation. However, only the processing components are considered here.

If this shortwood system is taken as a non-mechanised system as a yardstick to assess other options, there is a range of systems with varying degrees of mechanisation, up to fully mechanised. The extent to which they are mechanised depends on the proportion of the time involved in the shortwood method which has been replaced by mechanised methods. The following table gives some examples. Note that in many systems such as producing long pulp, cutting to length may be mechanised at the mill site, and stacking may not be required.

System	Mechanised Phase				% mechanised
	fell	delimb	cut to length	stack	
Shortwood	0	0	0	0	0
Tree length	0	0	15	15	30
feller buncher, tree length	15	0	15	15	45
delimber feller buncher, shortwood	15	55	0	0	70
feller buncher, processor, shortwood	15	55	15	15	100

In some highly mechanised systems extra delimbing is required for example at the landing. In this case there will be less than 100% mechanisation.

For the purposes of planning, mechanised harvesting has here been taken as any system where the felling or the whole or part of delimbing is carried out by a machine.

4. Planning Requirements

The following notes cover in some detail specific planning requirements for mechanised operations.

4.1 Management Objectives

Management objectives will usually be stated in terms of the quantity and quality of wood required at a certain point over a period of time, with the operation to be conducted at minimum cost. Various constraints may be given, for example acceptable limits of stand damage, maximum production capacity required and minimum piece size to be harvested.

Mechanised systems frequently have production rates five times greater than motor-manual systems. Care must be taken to choose systems which can achieve the required rate at optimum daily utilisation. There will obviously be less flexibility with fewer production units. It is unwise to rely on just one, or even two units for the entire input to a mill. Often a mixture of mechanised and motor-manual systems will be the best choice.

Delimbing quality and accuracy of log making vary in different mechanised systems, and end user requirements must be clearly understood. Delimbing quality can be improved by additional manual work, but this must be planned in advance.

4.2 Terrain

Slope and surface obstacles are important limitations to mechanised logging systems. As a generalisation, machines mounted on rubber-tyred carriers have more or less constant production on slopes up to 10^{o} in wet weather and up to 15^{o} in dry weather. This is if the machine can work as closely as possible at right angles to the contour. Side slopes over $5\text{-}7^{o}$ cause operators to lose confidence and in thinnings operations stand damage will become unacceptably high. Machines mounted on tracks may be able to move more readily on steeper slopes. However, positioning a felling head or controlling the movement of trees on steep slopes is difficult and these machines are limited to the same extent as those mounted on rubber-tyred carriers.

Prototype feller bunchers which will work on steep slopes are under test in the U.S.A. In Europe, whole trees may be extracted from steep slopes with a cable hauler, and processed on the landing by a machine.

Surface obstacles include gullying on relatively flat terrain, old logging rubbish, boulders, etc. In New Zealand gullying or surface uneveness is likely to be the most important factor. Mechanised system production is considerably reduced where operators have to cope with surface obstacles.

In some instances it may prove worthwhile having a backup logging system such as a rubber-tyred skidder to cope with areas such as gullys or short steep slopes where the productivity of a mechanised system would be significantly reduced.

4.3 The Forest or Stand

The first requirement is sufficient quantity of wood on suitable terrain to keep the system operating for the life of the mechanised equipment. Mechanised systems require a large volume of wood and area of forest per year compared with a motor-manual system. Unlike a motor-manual system, they cannot be shifted to less favourable terrain when the forest is finished.

An important consideration is the size of the area of forest which is to be harvested before the logging equipment must be moved to a different site. The greater the capital cost of the equipment the more expensive it is to move. This is partly related to transport costs and partly to the lost production while moving. The cost of moving from one site to another must be spread over the volume to be logged from the new area of forest. If this volume is large then the extra cost per cubic metre will be small. Ideally, a highly mechanised logging system should operate for the life of the machinery in the one stand.

Stand stocking has a very limited affect on productivity of mechanised systems within the normal ranges found in New Zealand plantations. A more important factor is the residual stocking in a thinnings operation. Where many trees are to be left, highly mechanised systems will be limited in their productivity because of the need to search out the next tree and to avoid damaging remaining trees during the moving phase.

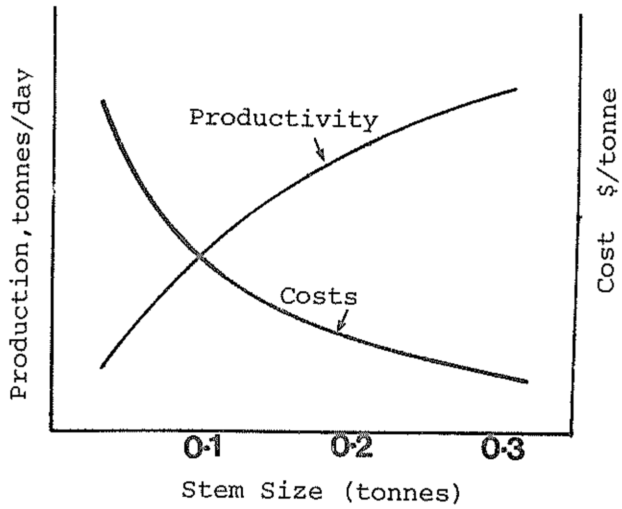

Figure 1

Productivity and Costs Related to Stem Size for a Highly Mechanised System.

4.4 The Trees

Knowledge of tree dimensions and wood characteristics is fundamental to matching equipment with the forest. Mechanised equipment for harvesting small trees costs less than that for handling large trees. However, the effect of tree size on productivity for any equipment has a much greater influence on final wood cost than does the cost of the capital equipment. For example, to harvest a tonne of 10 cm dbh trees in a fully mechanised single tree system will be approximately 5 times the cost of harvesting 20 cm trees. In a motor-manual system, the cost difference will be only a factor of two or three. The relatively higher cost of small trees can be overcome to some extent where the mechanised system can handle several trees at once, such as in flail delimbing or accumulating felling heads. These multiple stem handling systems are more suited to clear felling than to thinning operations.

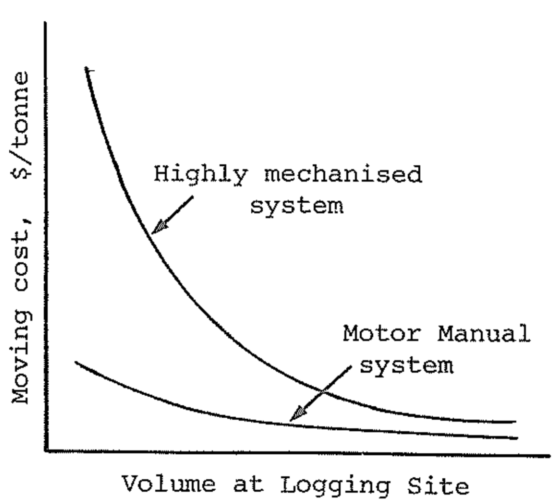

Figure 2.

Moving Cost - $/Tonne. Different Move Distances give Different Parallel Curves.

While the average tree size in a stand will have considerable influence on the productivity of a mechanised system, the maximum tree size is also important. The maximum capacity in terms of diameter for felling head and delimbing knives must be closely related to the maximum butt diameter of the stand trees. The more uniform the tree size the better, as one chosen mechanised system will not work efficiently over a wide range of tree sizes. In some cases it will be more efficient to manually fell and delimb a small percentage of large trees either before or after the mechanised operation rather than plan the mechanised equipment to handle the greatest stem dimension which exists. No more than five percent of trees should be bigger than the machine's capacity. A small number of machines, for example the New Zealand developed delimber-feller-buncher head are limited by the stem length over which they can effectively operate.

The fast growth of some plantation species may cause problems where planning takes place a year or more before harvesting. When harvesting does occur the trees may have grown beyond the capacity of the machines which were originally planned for that stand. Therefore, planners will have to bear in mind the growth rate of the stands for which they intend to use mechanised systems.

The need for an accurate inventory of tree dimensions and the proper timing of operations for mechanised systems follows from the lack of flexibility of these systems. Once the machines have been chosen there is a narrow range of tree sizes over which lowest costs can be expected. It is difficult to change their capacity. With motor-manual systems the chainsaw cutter bar size, or the chainsaw itself can be increased at little extra cost if trees are found to be larger than expected.

Branch and wood characteristics are likely to be fairly uniform in New Zealand as mechanised systems are likely to be restricted to only a few species. For these species, branches can only be completely removed by cutting. Flails will partially delimb, while gate systems have not been shown to be successful.

4.5 Operators

Good bushmen, i.e. skidder drivers or fallers, do not necessarily make good operators for highly mechanised machines. Experience has shown that many fallers find working on highly mechanised systems relatively less exciting and often move on after a short period. Most mechanised systems involve using feet and hands to control the felling and delimbing functions at a remote distance. Formal training facilities for this kind of work are non-existent in New Zealand. When planning a mechanised operation it is important to bear in mind the learning period of operators. Results indicate a six-week learning period is required in clearfelling operations, and longer then this in thinning operations.

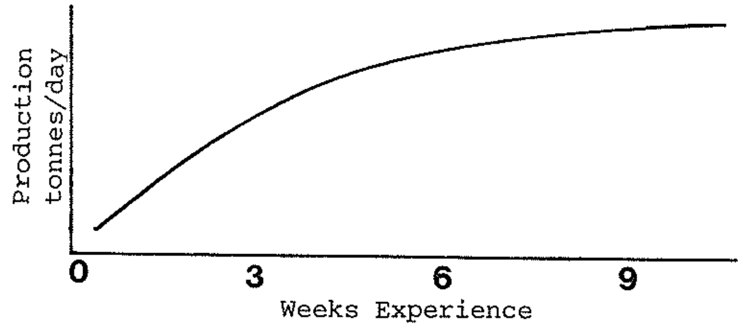

Figure 3.

Learning Curve for Sophisticated Logging Machines.

4.6 Maintenance

Because of the high capital cost of mechanised systems, it is vital that machine downtime for maintenance and repairs be kept to a minimum. Mechanised logging systems usually involve fairly sophisticated hydraulic components and these are commonly the cause of downtime. If machine operators are to undertake basic maintenance and repairs they will need specific training for the kind of equipment which they are working. More complex repairs and servicing will mean calling in experts, usually from a considerable distance. It is essential to plan for a very efficient, rapid repair service if highly mechanised systems are to be kept operating in the forest. Regular planned maintenance is a must. Although it rarely happens in New Zealand, the ideal situation is where enough highly sophisticated machines are working close together so that a repair mechanic can be available full time.

4.7 Roading

Road location is a critical factor to consider in planning for logging operations on steep terrain. However, mechanised operations are generally restricted to easy country and roading is less of a problem. The main decisions concern the roading pattern and road spacing.

Parallel roads with occasional link roads, are preferred. Where thinning is to be undertaken, roads should be parallel to row direction. Road and landing spacing depend on a trade-off between road building cost, forest area lost to roads and extraction cost. To achieve a mean haul distance of 100 m, roads need to be 400 m apart.

Where the extraction machine has a large load capacity (e.g. a 15 tonne payload forwarder) road spacing can be wider than where a lower load capacity machine (e.g. a 2 tonne payload grapple skidder) is to be used. Thus planning for road spacing must consider the extraction machine to be used.

5. Planning the Operation

Once machines have been chosen, roading pattern established, and decisions made on operating amd maintenance personnel, attention can turn to the actual operation. The following points should be borne in mind.

5.1 Reduce Unproductive Time

Because of the high capital cost involved with complex logging machinery, the fixed cost per hour regardless of whether the machine is operating or not is high. The greater the hours in a day and days in a year when a machine is operating the lower this fixed cost will be per cubic metre of wood produced.

Avoid dead moving as a result of shifting between rows, between stands to be harvested and from operating to maintenance positions. If at all possible, work long days or double shift the prime machine in a mechanised system. In addition to reducing the fixed cost per volume of wood produced, this also ensures that the total life span of the machine will be as short as possible. This would enable new technology to be taken advantage of as soon as they are introduced.

If silviculturally compatible, thinning operations should be conducted on an outrow system as the amount of dead moving between trees will be less than with a selection thinning system.

If a situation arises where log supplies must be reduced, for example because of mill shutdown, that part of the supply from mechanised systems should be maintained as long as possible. Because of the high capital investment, the cost of not working is higher in these systems than in motor-manual systems.

5.2 Work Perpendicular to the Slope

The pattern of movement of the machine should be planned in advance and should always be perpendicular to the slope. This will enable greater slopes to be negotiated and reduce residual stand damage in thinnings operations to a minimum.

5.3 Match Equipment Capacities

Mechanised harvesting systems generally have a large hourly or daily volume output. This reduces the flexibility when matching one machine to another, compared with, for example, a motor manual system where the output of an individual man is relatively low. Once again, because of the high capital cost of the equipment involved, it is important that machines are not kept waiting for each other. It is sometimes difficult to get advance estimates of the productive capacity of the various pieces of equipment which might be employed. It is therefore a good idea to allow some flexibility in the working hours of the machines so that they are matched. It is general experience that sophisticated logging machines are only used on productive work for about 70% of the time during which they are scheduled for work. Where a processing machine and an extraction machine are working in the same forest, the processing machine should keep at least one day ahead of the extraction machine. This means that short periods of downtime experienced by the processing machine will not affect the extraction machine.

5.4 Consider the Next Operation

To gain greatest advantage from mechanised logging systems, it is important that each operation leaves the trees or logs handled in the best situation for the next machine. For example, a processor or harvester should leave trees in the best situation for the extraction machine and the extraction machine must leave logs suitably placed for loading. The pattern of operation of a felling and/or delimbing machine should be such that the extraction machine has the shortest possible route to the landing. Product length is important for trucking, especially where tree length logs are extracted. Planning should ensure that truck layouts are suited to log length.

6. Conclusions

The most important factors to bear in mind when planning for mechanised logging operations are :

6.1 The forest and the terrain on which it grows are fixed. Make sure the the machine introduced to harvest in this environment are suited to it.

6.2 Once a system has been introduced, choice of working methods is reduced and flexibility is relatively low. Plan patterns of operation to best suit the machines and plan machine capacities to suit each other.

6.3 Because of the high capital cost of equipment employed it is essential to keep it operating for as long as possible, each day and each year.

DISCUSSION

It was stressed that the planning detail required for mechanised systems also applied for less mechanised systems. Many people had not realised the significance of this until studies had been done. To increase productivity people should look at changing a work method, but to increase production then a longer number of hours need to be worked. It was pointed out that mechanised systems are limiting in flexibility compared to a simple system using perhaps a skidder. For this reason planning must be well thought out otherwise small problems can become large problems.

SESSION 4

Paper (f)

NEW TECHNOLOGY IN FOREST HARVEST PLANNING

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Development in Forest Harvest Planning

Over the past decade, many significant advances in the analytical tools for the forest harvest planner have become available. These tools have been developed as small scale computing technology, in the form of pocket calculators and small micro-computers, have become widely available on the market at relatively low cost. Using these harvest planning tools can greatly reduce the burden of time consuming, repetitious calculations which are common to harvest layout and forest road design.

A partial list of harvest planning topics in which new computational aids have become available includes problems in cable logging equipment layout, forest road layout and design, perspective plotting of harvest areas, forest transportation network analysis, land surveying and mapping, and logging equipment production and cost estimation.

One of the first timber harvesting applications developed for small computing installations was a series of programmes written by Carson (1975) for analysing the load carrying capacity of several cable logging configurations common to western North America. These analytical tools were developed on a small desktop computer used in conjunction with a graphics plotter and a digitizing tablet. This combination of computing equipment was also used by Burke (1974) to develop a forest road design package and by Twito (1978) and Nickerson (1977) to develop routines for producing perspective plots of proposed harvest areas. As computer technology has advanced, more sophisticated harvest planning packages which model the entire surface of the harvest area have been developed and are now being used by several large companies in North America. The first of these "digital terrain models" for harvest planning was developed by Lemkow (1977). The U.S. Forest Service is currently working on a harvest planning package which expands and builds on the early work of Lemkow. Fjone (1979) reported that this same combination of a desktop computer, plotter and digitizer has been used by Carson and Skramo to develop a system for cable logging equipment layout directly from aerial photographs. In New Zealand, a similar computing set-up is being used by the Water and Soil Division, Ministry of Works and Development (1979) in an automated national land resource survey system and in the measurement and mapping of river gravel movement and slope mass movement from aerial photographs.

A requirement common to many harvest planning applications is the need to use information from maps or photographs. Traditional manual methods for measuring, recording, and reproducing information from maps are often very time consuming, repetitious and error prone. The amount of time needed to extract and process data from maps and photos can be the limiting factor on the number of alternatives a harvest planner can consider. The analytical tools available on desktop computer systems provide the harvest planner with tools which allow him to more quickly and efficiently extract, process, and display information from maps and aerial photos. By using the desktop computer system, the planner can take a much more indepth look at the planning of a harvest area than could possibly be done in the same time using only manual methods. Use of the desktop system helps the planner to quickly pin-point potential problem areas and concentrate his field time more effectively on these problem areas. Certainly, use of the map-based harvest planning tools does not replace all of the field work in the harvest planning process. On the contrary, use of analytical planning tools requires that field checking of the harvest area be carried out so that factors not apparent on maps and photos are not overlooked. This is particularly important when the accuracy of available maps is suspect. Use of computer assisted harvest planning tools, which utilise map or photo data, allows the planner to much more efficiently use the data available to him on existing maps and photos.

Forest Harvest Tools in New Zealand

Harvesting activities account for a large portion of the cost incurred in the production of a timber crop. This is particularly true in steep country where the magnitude of harvest costs can be greatly influenced by not only the harvest system employed, but also by how well the harvest system is fitted to local topography. Drawing on earlier harvest planning tools developed in North America, a computer assisted package for looking at the suitability of various cable logging systems has been developed by the N.Z. Forest Service. With the package, the feasibility of harvesting an area with a variety of cable logging systems can be tested. The local topography can be examined, either from topographic maps or field surveys, to produce ground profiles. The load or turn size capacity over a ground profile can be rapidly computed for different cable logging equipment and configurations.

After a number of possible harvest alternatives are identified, the computer package contains a routine which allows the planner to rapidly perform an economic comparison of the alternatives to determine which is likely to result in the least overall extraction cost. This economic comparison routine uses production equations which were developed from detailed time studies of harvest systems. The production equations can be quickly modified or replaced to reflect local conditions.

The Logging Engineering Planning Package contains the following routines :

INPUT	A routine to digitize the entire surface of a harvest area to produce a digital terrain model of the area for later use in the skyline analysis programme.
SKYMOD	A routine to analyse the feasibility of cable logging equipment in an area by constructing ground profiles from a digital terrain model produced by INPUT.
ONESKY	A routine to analyse the feasibility of cable logging equipment in an area by constructing ground profiles from either single corridors digitized from topographic maps or from field surveyed ground lines.
PIAHD	A routine to calculate the average hauling distance and area within a harvest unit.
COSTS	A routine to estimate extraction production rates and costs for comparing harvest alternatives for a setting.

All of the routines in the package are written in FORTRAN, a common computer language. The package was developed on a small desktop computer used in conjunction with a digitizer. The package, which is currently in the testing stage, will be put into use in the upcoming year on a trial area. It is expected that many useful modifications and possible expansions to the package will surface during this trial period.

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DISCUSSION

As well as the work being done with computers for planning, other developments include optimisation programmes, transport networks and such things as simulating wood flows from forests. The package on planning shows the best way to do something and gives a range of options but it does not make a decision. The cost of the computer and package ranges between \$20,000-\$25,000. This cost is not significant when looking at the overall investment in logging and could be purchased by Consultants to do work for a number of clients. It would not be suitable for small infrequent operations.

SESSION 4
Reference Paper
(Tabled)

SKIDDERS AND TRACTORS ON STEEP COUNTRY - A PLANNING OPTION

(A Literature Review)

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INTRODUCTION

The use of skidders or tractors on steep country has commonly been critised. This is mainly because of the problems of machine and operator safety, and erosion of soil and water values.

As an alternative system for logging hill country though, skidder and tractor operations have some attractive features. The equipment required is simpler, lower cost and more versatile. Personnel required in all aspects of the operation do not need to be as highly skilled. As well, a suitable tracking system, if created, can improve forest access for many other in-forest operations from silvicultural work to fire fighting and wood recovery.

It is no wonder then that over the past decade considerable development work has been carried out world-wide in an effort to overcome the problems of using skidding equipment on steep slopes. Better equipment has become available, improved operating techniques have been developed, and much more is now known about the possibilities and limitations of such operations.

This paper reviews the literature available in LIRA's library on the topic, and attempts to identify some of the more important factors to consider for this planning option.

EQUIPMENT OPTIONS AND HISTORY

The range of skidding machinery available has developed over the past years to now include the crawler-tractor-dozer, the wheeled fixed-frame type agricultural tractor, the articulated rubber-tyred log skidder, and the tracked log skidder. The sizes currently available in each of these options is shown in Table 1.

Of this range only the rubber-tyred and tracked skidders are purpose built or designed for logging, and the crawler tractor is the only machine designed for dozing or tracking work. The tracked skidder is the newest development and to date is not available in a full range of sizes or in a wide range of brands.

The various machine types have different operational limitations, performance abilities and system planning needs, that need to be understood for effective application on hill country.

Machine type	Up to 75 h.p.	75 h.p. to 150 h.p.	Over 150 h.p.
Crawler tractor	wide range	wide range	wide range
Wheeled agric. tractors	wide range	wide range	limited range
Artic.Rubber-tyred skidders	very limited range	wide range	wide range
Tracked Skidders	none available	very limited range	very limited range

Table 1 : Range of Machinery Available by Type and Size

The historical trends in using such machinery on steep country as covered in the literature shows the following :

In 1971 an international symposium on forest operations in mountainous regions (Ref.1) summarised the trends up to 1970. It found that skidding systems using medium-sized machines were proving feasible and justified, versus cable systems on steeper country. Also that the four-wheel drive articulated rubber-tyred skidder was out-performing the crawler tractors on steep country and that the non-articulated wheeled agricultural type tractor had very limited ability on slopes

Emphasis thus went on to the application of aritulated rubber-tyred skidders and medium-sized crawler tractors on steep country, and by 1975 much was known about their respective abilities and limitations. Wellburn in considering alternatives for steep country logging in Canada (Ref.2) indicated that generally, tracking was required for these machines once slopes exceeded 30%.

A new machine type that could work on untracked slopes to 50% then arrived on the scene. It was the tracked skidder with examples being the American FMC 200, the Canadian Bombardier B15, and the Russian Belarus TD (Ref.3). The application of these machines in steep country has continued to develop since their introductions.

More recently though, since 1979/80, for very steep slope logging (70%-80% slopes) and where tracking is required for skidding extraction, both Australia and Canada have used small sized crawler tractors (Refs. 4 and 5) in an effort to minimise ground disturbance.

Such then are the equipment options developed to date, but what are their capabilities.

FACTORS AFFECTING SKIDDING PRODUCTIVITY AND COSTS

Before summarising the literature on the operational limitations and systems of application for skidding on steep slopes, it is pertinent to touch briefly on just what are the important factors affecting productivity and costs.

A number of reports give good coverage of the factors affecting productivity and only specific ones are noted here.

In one of the earlier reports Parker (Ref.22) illustrates the productivity differences between the crawler tractor and the rubber-tyred skidder, as shown in the figure below (provided the terrain permits operation). This is due to the different speed and pull capabilities of the two machine types.

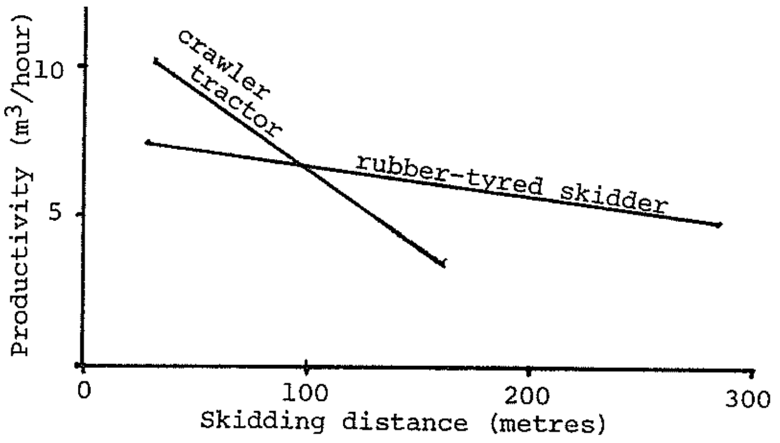


Figure 1.
Difference between crawler tractor and rubber-tyred skidder.

Following on from this, Silversides (Ref.6, 1967) notes the factors having greatest effect on productivity as including :

Tree size,
Load size,
Distance travelled.

The typical relationship for a particular machine in a particular forest he illustrates as follows :

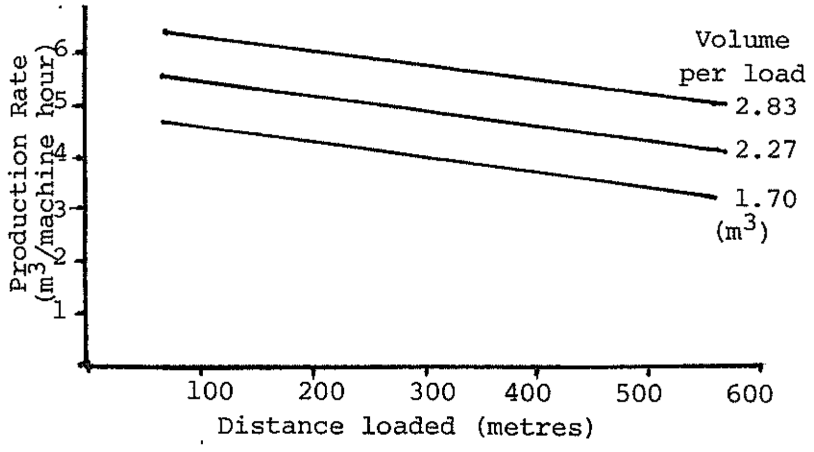


Figure 2.
Effect of volume per load and distance loaded on productivity.

McIntosh and Johnson (Ref.7, 1974) extended this by noting that the major factors affecting productivity between different forest types were :

Average tree size and log size,
Stand and terrain characteristics,

and between operations within a forest type were :

Degree of difficulty of logging the area,
Skidder operators skill and motivaton.

Koger (Ref.8, 1976) touched on costs as well as productivity and from a detailed study of different sized skidders under a variety of conditions, found the following :

1. *An increase in horsepower increased production but does not necessarily reduce logging costs. Minimum costs occur for each skidder when it is fully utilised.*

2. *When volume per cycle is low (small logs, insufficient chokers, etc) in relation to the skidder, potential smaller skidders have lower costs per unit volume production.*

3. *When skidding short distances and small volumes per cycle, load positioning (skidding butt first versus top first) does not significantly reduce logging costs.*

4. *Logging costs can be reduced by locating skid roads that are as straight as terrain and stand characteristics permit. Crooked skid roads with frequent sharp turns increase logging costs.*

Finally, a report that provides a good all round summary of the factors affecting productivity and costs is by Sampson and Donnelly (Ref.9, 1977). They summarise that productivity is affected by :

- *the machine (pulling power, speed capability, tractive characteristic)*
- *the forest (piece size, stocking, residual stand requirement)*
- *the terrain (slopes, skid distance, surface characteristics)*
- *the operator (skill, motivation).*

They report that the main opportunities available to increase productivity lie with maximising volume skidded per turn and minimising delay time. They also confirm findings from other studies that 30%-40% of production variation can result from operator differences.

Notably slope, although a factor affecting productivity, is not the major factor, provided the machine can operate. What then are the operational limitations for skidding machinery on steep slopes?

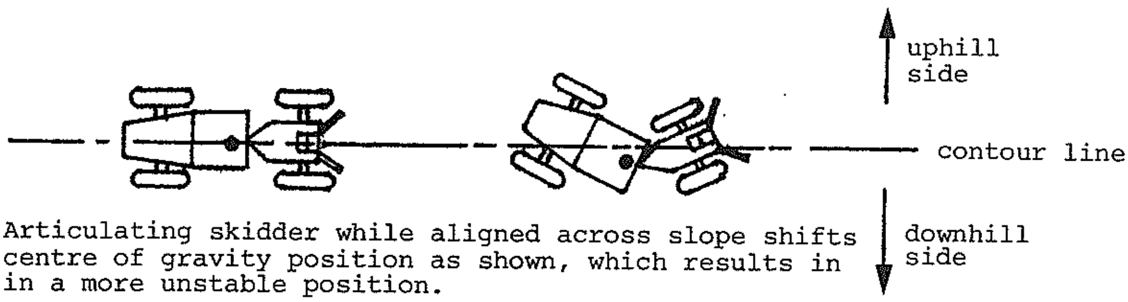
OPERATIONAL LIMITATIONS FOR SKIDDING MACHINERY ON STEEP SLOPES

The major concern for any machinery on sloping ground is that of stability. Different machine types can operate to different limits of slope, and to operate beyond this limit a tracking system can be used. Also of importance is traction and like with stability, different machine types have different tractive capabilities for pulling loads. The literature shows the following :

A 1967 report by Park, Gibson and Phillips (Ref.10) finds that only a few of the early rubber-tyred articulated skidders on the market then, could operate on slopes of 40-45%. One of the major reasons for this was arch and fairlead design.

By 1971 however an international symposium (Ref.1) put the climbing limits for rubber-tyred skidders at 58-72% slope, depending on soil, and the climbing limits for crawler tractors at 87-100% slope, also depending on soil conditions.

A detailed analysis of the articulated rubber-tyred skidder side slope stability by Gibson and Biller was published in 1974 (Ref.11). This indicated that the unloaded stationary skidder would tip at a 55% slope if aligned across the slope, however, more importantly it could tip at 47% slope if fully articulated while aligned across the slope. From this work important guidelines resulted on the operating technique for articulated skidding machinery on slopes. These minimise the danger of over-turning due to shifting the machine centre of gravity outwards by articulation.



Articulating skidder while aligned across slope shifts centre of gravity position as shown, which results in in a more unstable position.

Figure 3. Articulated rubber-tyred skidder side slope stability

Wellburn in 1975 (Ref.2) in considering alternative methods for steep slope logging, notes that wheeled skidders can operate without skid roads on slopes (with firm ground) to 30%, but are restricted to downhill skidding. He reports that early trials with a tracked skidder puts its limitations at 40% plus. Also he notes that crawler tractors can operate on slopes over 30% (depending on soil and moisture content) provided skid roads are bulldozed.

Traction is obviously one of the limiting features of rubber-tyred skidders and Anderson quantified this in 1976 (Ref.12) by advising that if uphill skidding with rubber-tyred skidders is necessary then gradients should be restricted to less than 12-14%.

In a 1975 N.Z. study (Ref.23) of skidder logging on hill country gravels, an uphill track gradient of up to 35% became impassible by the unloaded skidder in wet weather due to loss of traction.

By 1976 the stability and traction capabilities of the various skidding machines were obviously beginning to be well known, and FERIC (Forest Engineering Research Institute of Canada) published an excellent Handbook (Ref.13) for planning skidding operations on steep country, without skid roads. It indicates the limits as shown in figure 4.

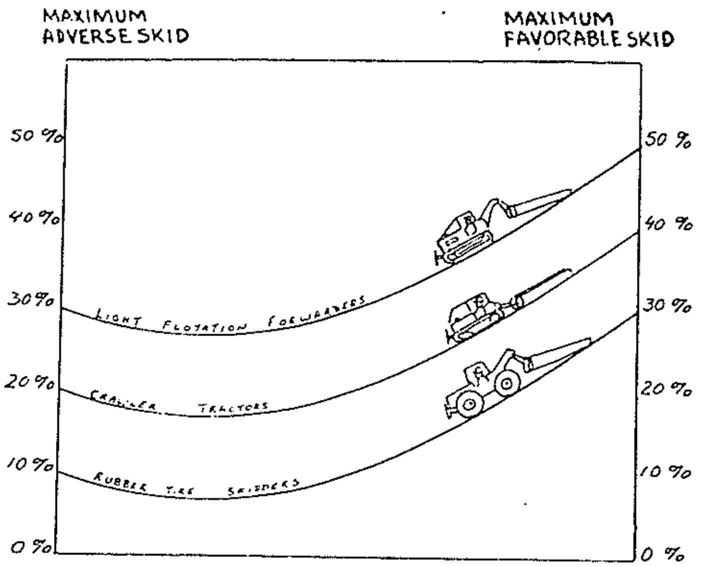


Figure 4.

Skidding Machine Limitations

NOTE: Left and right hand side of the graph represents traction under the best conditions but gradeability may be reduced with soil and weather conditions.

Kochenderfer in 1977 (Ref.14) also confirmed that a 30% slope was the limit for safe wheeled-skidder operation over land (no tracking). He also notes that wheeled skidders are not as suited to winching logs uphill as an equivalent weight crawler tractor, presumably because of traction differences.

Better information on the capabilities of tracked skidders starts to appear in 1977 with one report (Ref.3) noting that one model (Bombardier B15) would handle grades up to 60% adverse and 40% side slope.

Following this in 1978 Powell concludes (Ref.15) from a FERIC study that the FMC 200 tracked skidder could operate effectively on untracked slopes to 50% while still meeting production and environmental requirements.

About the same time a comparison of the tracked skidder and rubber-tyred skidder capabilities was put out by the U.S.D.A. (Ref.16) and this is indicated in the following figure.

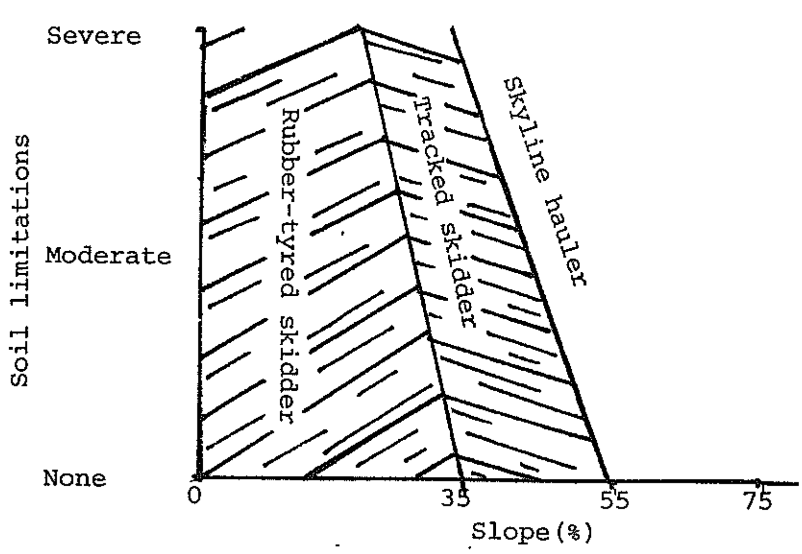


Figure 5.
Machine Limitations

A good summary of the above slope limitations of various skidding machines is thus given by the above figure 4, from the FERIC handbook (Ref.13).

Once tracking or skid trail systems are introduced, steeper slopes can of course be worked, although the trail grade limitations will be as covered in the proceeding section. Formed trail systems on steep slopes however cost extra money, dictate the operating pattern and can result in significant environmental damage if not carefully controlled.

<u>TRACKING PATTERNS AND CONTROLLING ENVIRONMENTAL DAMAGE</u>

As skidding distance is one of the major factors affecting productivity, initial methods of logging very steep slopes with tracking patterns concentrated on minimising the skidding distance.

The literature indicates that prior to 1970 skidding roads were commonly formed diagonally across the slopes within gradients on which the machines could safely operate. The overall pattern was to radiate tracks out from the landings, and slopes up to 80% were logged in this manner (Ref.1).

Robinson (Ref.17) of New Zealand notes that skid tracks for 130 hp rubber-tyred skidders were generally kept within grades of 7% to 17%, or in dry weather up to 50%, provided traction on the intermixed gravel and sand soils was adequate. He states that skidding distances were preferably kept within 400 metres maximum. Similarly Bills (Ref.18) of Australia describes tracks for a 100 hp skidder with a consistent grade between 21% and 29% used on slopes of 30% to 70%.

It was soon found however with increasing environmental awareness that such skid trail patterns were a major contributor to erosion. Kochenderfer (Ref.19) in 1970 notes that they remove the litter cover to expose soil, and the skidding machinery compacts the soils to reduce soakage. Water therefore tends to collect on the skid roads, which once running on the bared soils cause erosion. The steeper the water channel (skid trail) the faster the flow and erodibility. Also, some soil types are more erodible than others. He advises that a tracking system using one climbing road and several contour spur roads works well in reducing erosion. To control erosion the road and trail system mustbe properly planned well in advance of logging. His report (Ref.19) also goes into drainage requirements (e.g. suggesting 3% outsloping roads, road drainage dips at planned intervals, etc) and subsequent trail maintenance needs.

With skidding trails there is not only an erosion concern. Such operations also compact the soil and this affects growth rates. In 1970 Hatchell Rolston and Foil (Ref.20) reported significantly retarded growth rates of loblolly pine growing on skid trails and they estimated that the compacted and disturbed soil would take 20-40 years to recover.

In 1976 following considerable development work in interior British Columbia, FERIC published a handbook (Ref.13) that was aimed at *establishing good ground skidding and roading practices, to skid efficiently and minimise soil disturbance and erosion.*

The preferred method outlined was to use skidding machinery that did not require formed trails as far as practicable. Where trails were required they tabled guidelines on the pattern requirements which were dependent on moisture, soil and slope characteristics as shown in the following table:

TABLE 2 : Trail Patterns and Machine Types for Different Conditions of Soil Moisture and Slope.

Slope	Moisture and Soil	Machine type	Trail Pattern
Gentle (0-25%)	Dry-stable	All types	Random depending upon desirability of soil disturbance
	Variable	Skidders & Crawlers	Systematic taking advantage of dry or elevated areas
		Light Flotation Tracked Skidders	Random
	Wet-unstable	All types	Random on frozen ground
		Light Flotation Tracked Skidders	Systematic taking advantage of dry or elevated area
Moderately (26-49%)	Dry-stable	All types	Systematic taking advantage of most favourable soil and slopes
	Variable	All types	Systematic on frozen ground or during dry weather
	Wet-unstable	All types	Systematic on frozen ground
		Light Flotation Tracked Skidders	Systematic in dry weather

Cont/...

Slope	Moisture and Soil	Machine type	Trail Pattern
Steep (50-69%)	Dry-stable	All types	Systematic taking advantage of most favourable soil and slopes pre-located if necessary
	Variable	All types	Systematic with adequate snow cover
	Wet-unstable	None	No ground skidding permitted
Very Steep (70%+)			On site inspection required

Slope and skid trail definitions:

(a) Gentle slope - ground skidding areas where skid trails are not necessary and may be undesirable. Fully mechanised systems may be used on these slopes, provided Workers Compensaton Board regulations are followed.

(b) Moderate slope - ground skidding areas requiring some skid trail construction. These slopes must be considered the most critical because trails tend to be constructed on a hit and miss basis.

(c) Steep slope - ground skidding areas where skid trails must be side cut. Construction of these trails must be held to an absolute minimum.

(d) Random trail pattern - machines operate freely on the area and avoid soil disturbance by spreading the traffic over the whole area.

(e) Systematic trail pattern - planned trails.

Notably, on slopes over 50% they were very careful about the use of ground skidding trails.

Further work by Köchenderfer on tracking systems in eastern U.S.A. was reported in 1977 (Ref.14). He notes that for wheeled skidders, the skid trails need to be wider and straighter than those needed for crawler tractors. Also, wheeled skidders are not as suited to winching logs uphill as an equivalent weight crawler tractor with arch. For rubber-tyred skidders a closely spaced skid trail network (45 metres maximum spacing on slopes over 30%) results because of this, as well as the difficulty of pulling rope. As such, roads and landings accounted for 10.3% of a skidder logged area compared to 7.8% for a similar *jammer cable logged area. For comparison he also cites west coast U.S.A. figures for soil disturbance as :*

tractor logging - 9%
skyline logigng - 2%
helicopter logging - 1%.

By 1979 rubber-tyred skidder operations on steep slopes in Nelson, New Zealand, had developed considerably with contour tracks (put in by a D6 sized crawler tractor) at 30 metre spacing being used (Ref.21). Down tracks following the ridges were used leading onto landings located either on the ridge or just off the ridge as in the sketch below :

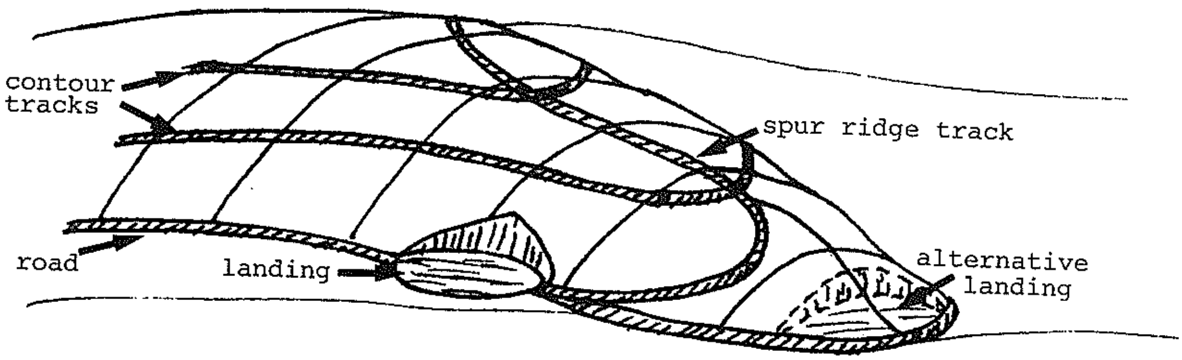


Figure 6. Tracking Patterns and Landing Placement

As such this trail system did not accumulate large water flows, and to control flow on the down-tracks cutoffs are put in at 40 metre spacing. The limit to maximum slopes on which this system is applied is determined by the ability of the skidder to climb back up the ridge track. Generally haul distrances planned were within a 400 metre maximum.

In 1979/80 developments in British Columbia took an interesting turn. They considered that road and trail related soil disturbance could be reduced in a system using very small crawler tractors instead of the medium sized rubber-tyred skidders or crawlers. McMorland reports (Ref.5) that on slopes up to 80% contour tracking at 30 metre spacing for small crawlers (70 hp) caused one-third less site disturbance than tracking with a large crawler for rubber-tyred skidders. Also the logging costs with these smaller crawlers were :

9% lower than with rubber-tyred skidder,
17% lower than with tracked bunk grapple skidder,
61% lower than with cable hauler.

The small crawlers were used on skid distances up to 330 metres.

A similar operation using small crawlers and contoured tracking on slopes to 70% was also reported in Australia by Lembke during 1979 (Ref.4). Both uphill and downhill logging were performed with skid distances uphill being restricted to 60-80 metres and downhill being extended to 250-300 metres. This report adds, however, that the economics are just not there when the going gets worse, as on steeper and rocky slopes.

The literature thus indicates that where tracking patterns are necessary to enable ground skidding to be carried out, then considerable attention needs to be paid to using a tracking system that minimises environmental disturbance. Important factors influencing the suitability of an area to tracking include :

- nature of topography, evenness of slope, angle of slope and slope length
- soil structure, ease of dozing, erodibility
- rainfall, moisture characteristics of region.

CONCLUSIONS

An increasing portion of New Zealand's logging is to be carried out on steep country or on slopes traditionally considered only suited to cable logging. Literature indicates that developments world-wide over the last ten years have resulted in skidding machinery and operating techniques that offer a possible alternative to cable systems for steep country logging. This alternative is economically competitive and involves equipment with greater versatility (than cable systems) which must be important to a relatively small industry like New Zealand's. Skid trail tracking systems have been developed that are suited to specific categories of steep country and which meet environmental requirements. With the fast growing forest crops predominant in New Zealand, the value of such an integral tracking system that allows improved forest access is increased.

Skidders and tractors on steep country (whether with or without formed tracking systems) must therefore be a planning option to be considered seriously in New Zealand. Currently some use is being made of this alternative, however, more extensive trials are required to establish the areas in which it is suited.

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SESSION 4

Reference Paper
(Tabled)

PLANNING FOR TRACTOR SKIDDER AND SIMPLE CABLE SYSTEMS

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INTRODUCTION

One of the aims of this Seminar is to look at tactical planning for new systems and for specific sensitive areas in New Zealand and to identify future requirements. These aspects will be important in the years to come but a great deal of the current logging and even the future logging will be done with equipment that people have come to accept as part and parcel of the every day scene and often the principles of sound planning are overlooked because of their commonplace or simplicity. What are the tactical planning needs when using a skidder or tractor on flat ground? What are the limits of skidders on steep country? Where and when should a cable system be introduced and what determines the design of the setting or area? These are a few of the questions this paper will attempt to answer.

GENERAL REQUIREMENTS

A formal logging plan needs to be prepared for all logging operations regardless of terrain or the size of area. The logging plan enables the planner to identify any constraints that may be present (i.e. requirements for adjacent boundaries, etc) and stipulate the layout to ensure that unnecessary and expensive difficulties are avoided.

The logging plan should achieve the following.

1. Identify the constraints of the area to be logged, i.e. soil and water.

2. Prescribe the way the area will be logged and look at all alternatives. Planning to log at least cost must be strived for, within the constraints imposed.

3. Present detail on the roading and landing requirements.

4. Establish a time scale for the work to be done.

5. Ensure that the production commitments by the logger can be met from the plan that is produced, i.e. length of haul, landing size, adverse skidding, etc.

Before a logging plan can be prepared there is a large amount of information that must be gathered. This includes stand data, tree characteristics and terrain details, including soil types. These requirements have been covered in other sessions. The limitations of the machines to be used need to be known and clearly specified. There is little sense preparing a plan for a hauler with an external haul distance of 500 metres if the machine has only 300 metres of rope. Similarly, the size of wood to be extracted, the average haul distance, the influence of adverse hauling, must be considered when specifying a particular machine to meet a particular production target. Any logging plan must however be flexible as it is to cover a long time period and must allow revision for equipment or method changes. No plan should be started before the planner has done a thorough reconnaissance of the area involved.

TACTICAL PLANNING FOR TRACTOR AND SKIDDER

Topographic and soil constraints are the main limitations for ground based skidding systems. Generally these systems can be more flexible as the machine travels to the tree but it is here the problems can arise within settings for tractor and skidders.

If the area to be logged is predominantly clay soil and winter logging is proposed, the planner must allow for contingencies or have an alternative locality as it is inevitable that production will be affected by the conditions.

Skid trails for skidders should be marked in prior to logging so as to avoid undesirable and unnecessary tracking and to ensure grades, corners and their general location meets the accepted standards.

Tractors and skidder systems ideally operate downhill. Slope is one key variable which will affect their productivity. If skidding uphill the haul size should be lightened rather than constantly winching heavy loads. A general rule for grade resistance on adverse grades for skidders is a 10 kg loss of pull for every 1000 kg weight (skidder and load) for each 1% of adverse grade. Tractors can work slopes up to 26-30° but skidders should be restricted on slopes over 10° without tracks. Tracks on steeper country should only be considered if the soils are appropriate to allow stable tracking patterns to be established. A general guide for skidder-tractor operating ability on slopes is:

Ability to Operate	Tractor Slope	Skidder Slope
Good	Up to 18°	Up to 10°
Poor	Up to 26°	Up to 18°
Impractical	26°+	18°+

Although slopes in excess of 30° can be negotiated by tractors, it is not desirable because of likely environmental damage.

Optimum skidding distances vary with terrain and other physical conditions. Where topography isn't a factor, the roading spacing should be determined on skidding costs versus roading costs. Total cost is minimised when variable skidding costs and road construction costs are equal. Because roads are essential for forest management, restricting the landing densities is more important than restricting the roading density. Increased landing density on rough terrain is hard to dispute. Because logging costs are higher, shorter hauls become more desirable. It is difficult for the planner to mechanically calculate an ideal landing spacing and it usually ends up as a choice between say two 120 metre average hauls or one 240 metre average haul. In a situation where logging cost is particularly sensitive to distance, the shorter distance should be chosen. Combination tractor-skidder or double skidder operations allow flexibility when logging a setting so that close logs and distant logs can be hauled together. The average haul can be extended and the log loader still kept at its maximum production.

Individual landings within a tractor or skidder layout should be located to achieve maximum downhill extraction provided unsuitable soils, drainage and obvious wet localities are avoided. Similarly, side slopes where excessive cuts and fills are required, should also be avoided if possible. When working a contour tracking pattern the main track to the landing should be down a ridge, the climb off the landing onto this track can be the steepest adverse grade the skidder may have to climb and can in fact limit operations if the skidder is unable to obtain sufficient traction to negotiate the steep return track. Tree lean must be considered as butt hauling is more desirable than head pulling when using tractors or skidders.

Setting size can affect the unit cost of wood. Spur road and landing construction are fixed costs and must be absorbed regardless of the volume available. Large settings are preferable for this reason but how large or how small is not a matter of definition, but of economics.

TACTICAL PLANNING FOR COMMON CABLE SYSTEMS

Logging organisations in New Zealand have tended to adopt a conservative approach to cable systems and generally for very valid reasons. Because of the equipment used, the range of system options that could be adopted are foregone. Some reason for this approach has been :

Lack of knowledge and expertise by management and loggers;

Restricted quotas and volumes available;

High initial cost of suitable new machines;

Wood values not conducive to high cost cable systems;

Because of production commitments a cable logging operator is prevented from phasing in a new development.

These features will still apply as newer steep areas come on stream and loggers undertake cable logging for the first time.

HIGHLEAD

With tractors and skidder systems, haul distance, tree size and volume per hectare are the three important variables which influenced productivity. These apply equally to a high-lead system with the haul distance constrained by the height of the spar, the size of the hauler and the slope shape. Low volumes will mean a greater number of rope shifts thus lower production and higher unit costs. The haulers daily operating costs will not change regardless of volume per hectare or small volumes per tree. Slope shape can influence haul volume and to a lesser degree inhaul time. The direction of slope in relation to landing location is critical in highlead, particularly if no lift is available. Ideally, the highlead system works best uphill because of better log control and because soil disturbance or channelling caused by logs is in a radial pattern away from the landing rather than all converging on the landing as in downhill hauling. Side slopes should be avoided, particularly if no lift is available, because considerable times can be spent fighting hang-ups.

Maximum haul distance for highlead depends on the hauler selected. In N.Z. the older type haulers using wooden spars are in fact ground hauling until the drag is close (5 x height of spar) to the landing. These machines do not have the power or brakes to tightline thus achieve effective lift. Ideally, highlead distances should not exceed 300 metres, although commonly in this country they do. The optimum and recommended maximum hauling distance is often exceeded by necessity but it is important for planners to weigh up the alternatives before arriving at a decision.

Highlead landings must be located to complement the extraction and be large enough to safely carry out all processing and loading. Landing size is dependent on the following: tree size; type and size of hauler and loader; the lead; type of processing and number of log sorts; volume to be extracted; hauling direction in relation to trucking direction; the need for through traffic; the need to park caravan and other vehicles, and the need to have trucks turn around. Often good landing sites are available but the landing is formed in the wrong place because of a lack of understanding by planners. If excavation is expensive or the site unsuitable for one landing to be adequate to meet all requirements, a secondary processing landing may need to be formed, and a tractor or skidder used to pull to the secondary landing.

Landings need to be well drained and large enough to safely land the last log or tree length on the butt rigging in front of the spar or pole. There needs to be adequate guyline anchor stump which are located to allow the ideal angle for guylines. If logging is downhill there must be adequate area between the slope and the hauler so that loose logs or other debris do not create a safety hazard on the landing. The landings need to be located to avoid blind leads which not only cause slower extraction but result in excessive rope wear.

SKYLINE

The common standing skyline system used in N.Z. at this time is the North Bend. This rigging configuration usually requires a minimum three drum hauler with good power and tailrope brakes to achieve lift. The system works best in uphill logging. The "lift" to the skyline is achieved when the logs are under restraint, i.e. tailrope breaking force or incoming logs meeting some obstruction. The North Bend system also allows bridling (or lateral hauling to the skyline). In bridling the rigging and chokers are pulled to the side, depending on where and how the tailrope blocks are set. Bridling should be avoided if possible if a choice of landing site is possible. Excessive bridling limits productivity of the hauler. It cannot be carried out where the slope rolls away from the skyline and ideally there must be a clear pull and plenty of lift to the skyline when bridling. Machine power and rope capacity dictate maximum haul distance but the shorter the average haul, the better the machine production will be. Long distances when most of the rope has run off the drum, reduces line speeds. Skyline haulers using wooden spars have high set up time and require skilled people to operate them efficiently. They therefore tend to be used where a high volume is available to any one landing, or the absolute maximum area is logged before shifting to another landing. This does not always lead to sound environmental practice (landing size) or create a situation where the hauler is producing at its most economic level. The alternatives must be carefully weighed up during planning.

In most current skyline logging in N.Z. the planner does not have a choice of equipment available to him. Therefore he must plan areas to best suit both the terrain and economic constraints. With any skyline system, the deflection determines the maximum load that can be carried during inhaul. Planners must ensure there is adequate deflection available between the spar and backline. If the skyline is tightened to increase the clearance thereby reducing the deflection, then the load imposed on the system must also be reduced. Planners must be aware of critical locations in a setting by running profiles during planning and alterations made or allowed for accordingly by altering landing location, etc.

Landings for skyline logging have similar general requirements as highlead logging, although they must be sited to give adequate deflection and if possible to avoid bridling. Safety requirements and the means of handling logs from in front of the hauler are essential. Interference between the hauler, loader, processing and stockpiling logs and load-out on trucks, must be avoided. Planning the skyline landing must also take into account guyline anchor stumps and skyline anchors stumps for both strength and position.

No setting for skyline logging should be looked at in isolation. Adjacent areas must also be considered. Changes made to a plan must recognise possible effects on other areas.

CONCLUSION

This paper has covered very briefly some of the key requirements planners must consider when preparing a logging plan for common systems. Planning for logging is a complex requirement. The logging plan is the blueprint for a logging operation and must look at all constraints and alternatives, with the chosen proposal being the most practical, economic solution. Each setting must be judged specifically and decisions made based on conditions which apply to that area. Communication between planner, manager and logger are essential. Logging planners must also communicate with the public and environmental concerns. Often criticism aimed at the logger, or planner, is because people are not informed on what is proposed or why courses of action have been taken.

- SESSION 5 -
*- SESSION 7 -

CASE STUDY PRESENTATIONS
CASE STUDY DISCUSSION GROUPS REPORTS

Chairman : Geoff Wells, LIRA

(a) MARLBOROUGH SOUNDS

Lindsay Vaughan, Forester, N.Z. Forest Service, Blenheim

Discussion Group Reports :
Lindsay Vaughan, N.Z.F.S., Blenheim
Ron Sutherland, Marlborough Catchment Board, Blenheim
George Bonner, N.Z.F.S., Golden Downs
Ross MacArthur, Marlborough Catchment Board, Blenheim.

(b) MANGATU FOREST

Robin Black, Geologist, Hawkes Bay Catchment Board, Napier

Discussion Group Reports:
John Ruru, N.Z.F.S., Te Kuiti
Chris Phillips, N.Z.F.S., Gisborne
Bruce Willis, N.Z.F.S., Gisborne
Ian Glennie, N.Z.F.S., Gisborne

(c) SMALL WOODLOTS

Peter Wallis, Forester, P.F. Olsen & Co. Ltd, Rotorua

Discussion Group Reports:
Andy Pearce, F.R.I., Ilam
Peter Wallis P.F. Olsen, Rotorua.

* Editors Note
For the purpose of these proceedings, Session 5 & 7 have been combined.

SESSION 5
Paper (a)

MARLBOROUGH SOUNDS

L.Vaughan
N.Z.F.S.
Blenheim

1. Existing resource - Marlborough District

(i) 23,000 hectares of exotic production forest, of which 18,000 hectares (78%) have been planted since 1970. Only 760 hectares (3%) are older than 30 years and these are mostly farm shelter belts.

(ii) 16,000 hectares lies within Inland North Marlborough
6,000 hectares lies within the Marlborough Sounds
1,000 hectares lies within South Marlborough

(iii) 10,000 hectares are managed by N.Z. Forest Service
13,000 hectares are privately owned, mostly by small companies, local bodies, farmers and businessmen.

(iv) 21,000 hectares (91%) is radiata pine
2,000 hectares (9%) is mostly Douglas fir, Eucalypts and Corsican pine, and state-owned.

2. Future Resource - Marlborough District

(i) 60,000 hectares of exotic production forest by the year 2000, based on planting 1850ha/year (a total of 37,000ha) for the next two decades.

(ii) A total of 70,000 hectares of reverting and reverted farmland is available in the Sounds and inland North Marlborough to establish this 37,000 hectares. This excludes grazed farmland indigenous forest and substantially regenerated areas of "native bush", and is considered to provide a generous margin for reserves, riparian strips, residential buffer zones, visual amenity, unproductive areas and ownership wishes. Most of this will be established on steep hill country (25° - 35°) of land use capability class VI and VII.

(iii) This resource will sustain an annual cut of around 1 millon m^3/year of sawlog quality roundwood. 0.25 millon m^3/year of pulplog-quality roundwood from the year 2000 onwards. Domestic requirements of 50,000 m^3/year of sawlogs leave the vast majority of the resource (95%) potentially available for export, either as roundwood or as processed products.

3. Future Constraints

Coordination in harvesting, transportation, processing and marketing overseas face several constraints.

(a) A large number of small owners, with a small and scattered resource. (60% of the owners have stands under 50ha in size).

(b) A very limited roading network particularly in the Sounds, with the local roading authoity (Marlborough County Council) opposed to the large-scale trucking of logs in the Sounds. Barging is the preferred mode of water-based transportation of roundwood and heavy machinery, but there are four distinct "Sounds" - Q. Charlotte, Pelorus, Port Underwood and the Croiselles - in which forest development is occurring. A canal at Linkwater would link Pelorus Souhd to Queen Charlotte Sound, but the high costs of construction ($12 million +) are likely to preclude its development if the forest resource has to carry the total cost.

Open-sea barging is another option, but could involve union problems and the Cook Strait storms could severly restrict the number of operating days.

Multiple handling involving a combination of barging and trucking appear to offer the greatest flexibility, unless helicopters, airships, or "cycla-cranes" are used.

(c) An export port to handle forest produce is planned for Shakespeare Bay, by Port Picton, a superb sheltered deep-water harbour with adequate land for port-related industries and close to existing services and to a stable labour supply.

(d) The recent involvement of a large national forest company and a Nelson-based wood-processing company in the purchase of land and forests in the Marlborough ~~District~~ indicate that some of the local resource may be processed outside Marlborough.

(e) A total lack of skilled local logging contractors with experience in hauler operations on steep hill-country.

(f) The presence of a Maritime Park in the Sounds highlights the importance of the area for recreation and amenity, particularly water-based activities like boating and fishing. The park occupies a total of 45,000 hectares (31%), mostly indigenous forest, made up of former scenic reserves and State Forests. Most of the 750 km of shoreline in the Sounds has a 20m (1 chain) wide foreshore reserve which must be crossed to load roundwood into barges or place logs in the water.

(g) The rapid development of marine farming in nearshore waters near **exotic forests** will place additional pressure on logging planners to minimise the levels of sediment and to prevent logs and branches entering the seawater. It may preclude the possibility of harvesting directly into the sea.

(h) Residential development has occurred sporadically through out the Sounds. Many small bays adjoining hillcountry that was once farmed have been subdivided for holiday baches. Many forest owners find that they have small baches below their properties who depend on streams draining the adjoining exotic forest for drinking water and this could significantly affect the location of roads and choice of logging methods.

(i) Telephone and power lines have been reticulated across hillcountry farmland.With a change in land use from pastoral farming to exotic forestry there are situations where mid-slope powerlines divide a single hauler setting into two units. It is possible to install a temporary ground line at time of harvesting but it is difficult and expensive to place underground. Telephone Lines can be more readily shifted.

(j) Approval is required from the Marlborough Catchment and Regional Water Board for activities incolving roading, tracking and harvesting, under Section 34 of the 1959 Amendment of the 1941 Soil Conservation and Rivers Control Act.

SOME STANDARD ASSUMPTIONS

1. External (off-forest) travel distances to Shakespeare Bay export port

(i) 23km by water from log marshalling areas
(ii) 31km by road from forest epi centre

2. Internal Travel Distances

(i) 5km to log marshalling area from logging study area
(ii) 15km to log marshalling area from adjoining forests (outside logging study area)

3. Capital Outlay

(a) Powered Barges

(i) $1 million for 480 tonne lead, dimensions 42 x 13 x 2.5m, cruising speed 11km/hr, 4 man crew, twin 230kw (310HP) motors.

(ii) $600,000 for 190 tonnes load, dimensions 29 x 8.5 x 1.8m, cruising speed 13km/hr, 3 man crew, twin 175kw (230 HP) motors.

(b) Towed Barges

(i) $680,000 for 540 tonnes load - dimensions 42 x 13 x 2.5m.

(ii) $440,000 for 220 tonnes - dimensions 29 x 8.5 x 1.8m

(c) Logging Truck and Jinker

$120,000; assume a cruising speed of 25km/hr.

(d) Road upgrading

$100,000/km for a sealed tow-lane highway with Class I loading.
$ 50,000/km for an unsealed road with Class I loading.

Study group members can draw on the expertise within the groups for other information viz coats for logging equipment, production rates, etc.

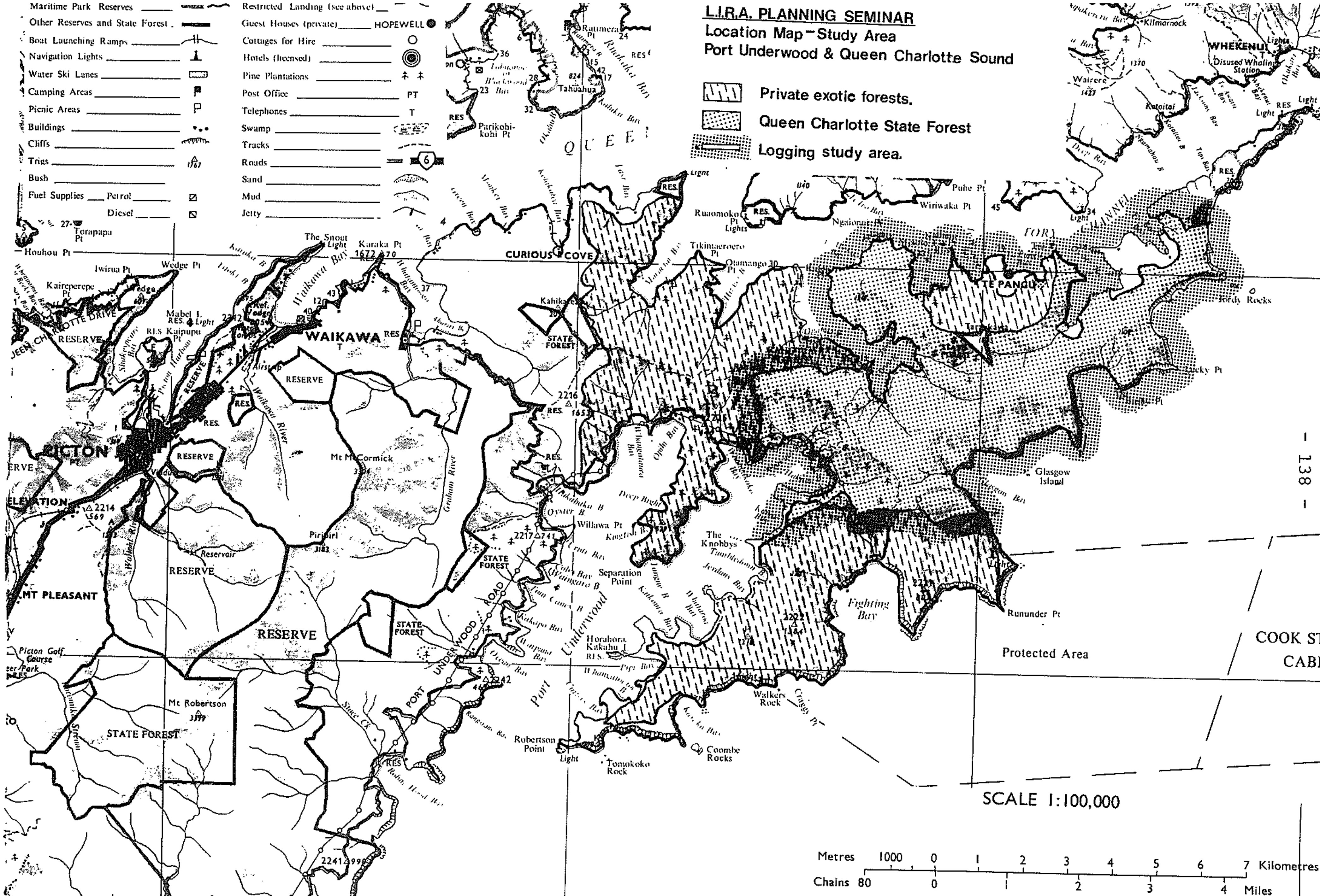
Appendix I : - LOGGING CASE STUDY.AREA - AGE CLASS DISTRIBUTION

.. Charlotte S. F.	PLANTING YEAR	AREA (HA) IN RADIATA PINE CT 300	CT 500	AREA (HA) IN DOUGLAS FIR CT 500
Cpt 1	1944	164		
2	1951	167		18
3	1951	204		
4	1952		198	
5	1952		237	
6	1953		200	
7	1955	180		
8	1956	56		
9	1954	150	44	
10	1053	72		
11	1941		214	
12	1942		208	
13	1959		80	145
Private Exotic Forest				
Fisher	1952	66		
Williamson	1952		110	
Jones	1960		200	
	TOTAL	1059	1447	207

Total P. radiata 2506ha
Total P. radiata & D. fir 2713ha

Appendix II:- PHYSICAL CHARACTERISTICS OF CROP TYPES

AGE (YRS)	STOCKING (S/HA)		DBH (CM)	HT (M)	TOTAL UTILISABLE VOLUME (m^3/ha)	SAWLOG VOLUME (m^3/ha)	AV. PIECE SIZE (m^3)
Radiata Pine CT 300							
25	300		45	32	391	361	1.3
30	298		49	36	538	504	1.8
35	295		53	40	685	651	2.3
40	290		57	44	832	803	2.9
Radiata Pine CT 500							
25	490		37	32	423	363	0.9
30	474		41	36	574	515.	1.2
35	455		44	40	719	663	1.6
40	432		46	44	860	808	2.0
Douglas Fir CT 500 (Production Thinning at 10 year intervals							
	THINNED STOCKING BEFORE (S/HA)	THINNED STOCKING AFTER (S/HA)					
30	500	300			127	108	0.6
40	300	200			173	156	1.7
50	200	136			203	191	3.2


L.I.R.A. PLANNING SEMINAR
Location Map - Study Area
Port Underwood & Queen Charlotte Sound
Private exotic forests.
Queen Charlotte State Forest
Logging study area.
Maritime Park Reserves
Other Reserves and State Forest
Boat Launching Ramps
Navigation Lights
Water Ski Lanes
Camping Areas
Picnic Areas
Buildings
Cliffs
Trigs
Bush
Fuel Supplies
Petrol
Diesel
Restricted Landing (see above)
Guest Houses (private)
HOPEWELL
Cottages for Hire
Hotels (licensed)
Pine Plantations
Post Office
PT
Telephones
T
Swamp
Tracks
Roads
Sand
Mud
Jetty
PICTON
WAIKAWA
CURIOUS COVE
TE PANGU
WHEKENUI
Disused Whaling Station
Kilmarnock
Mt McCormick
Piripiri
Mt Robertson
RESERVE
STATE FOREST
MT PLEASANT
UNDERWOOD ROAD
PORT
Port Underwood
Robertson Point
Horahora Kakahu I
Separation Point
Fighting Bay
Rununder Pt
Glasgow Island
Protected Area
COOK STI
CABLI
Walkers Rock
Craggy Pt
Coombe Rocks
Tomokoko Rock
Jordy Rocks
Wedge Pt
Iwirua Pt
Kaireperepe Pt
Mabel I.
Kaipupu Pt
Picton Harbour
Waikawa Bay
Waikawa River
Graham River
Karaka Pt
The Snout
Tikimaeroero Pt
Otamango Pt
Ruaomoko Pt
Wiriwaka Pt
Puhe Pt
Parikohi-kohi Pt
Torapapa Pt
Houhou Pt
Ratimera Pt
Tahuahua
The Knobbys
Willawa Pt
Oyster B
Deep Bight
Whangatawa Bay
Opihi Bay
Picton Golf Course
Reservoir
SCALE 1:100,000
Metres
1000
0
1
2
3
4
5
6
7
Kilometres
Chains
80
Miles

MARLBOROUGH SOUNDS DISCUSSION GROUPS

Vaughan

To summarise requirements of case study area;to plan harvesting to cope with sustained yield of 50,000 m^3 per annum;a transportation system to get 100,000 m^3 from the area to Picton;to maintain domestic water supplies suitable for drinking; to ensure that the near shore water quality was preserved; that the visual area from Torrie Channel were harvested in staggered settings.

Firstly, transportation, three different costings were arrived at. Road unsealed, \$9.50 per m^3; roads sealed, \$11.50 per m^3; and barging \$10.50 per m^3. Roading was preferred because of flexibility, less union problems, and the potential for other users. The 20 logging truck loads per day were not considered likely to upset local residents.

Harvesting options, preferred uphill, using skyline, because of the ability to work over longer distances with less disturbance. Two medium sized machines capable of producing 100 m^3 per day would be used, some mid-slope tracking to break up long slopes would be required. The logs would be moved along the tracks to the ridge tops where they would be prepared and sorted, rather than have large landings in the middle of steep slopes. There could be an application for haulers with slack-pulling carriage potential and that aerial systems should not be discounted. It was not envisaged that problems would arise with domestic water supplies provided small coupes were adhered to. Small coupes and minimising side casting would reduce the visual impact. Formation of landings would be required some two years in advance of logging to allow for consolidation and revegetation. In areas where public use was high, two options were discussed. One was to screen the areas behind mixed species, the other was to educate the public so they understood what was going on. It was also mentioned there is a need for further work on the effects of sediment on mussel farming.

Sutherland

Trucking option for transport preferred over barges because it was more flexible, costs competitive, and because of the amount of handling required with barging. Wood flows would be important, particularly if looking at areas other than Picton. There was some discussion on value cutting to maximise log value, thereby reducing transport costs. Ridge roading would be needed for stability and to reduce the impact by roads at lower altitudes. It was seen as a problem to take wood from the Port Underwood side up the hill and over the other side for barging, whereas with a roading option this could be taken straight out.

It would be necessary to work through the area because of the various age classes. Staggered settings would only be required on high visual impact areas. Two haulers working together would be preferred, these being four drum machines. With regard to screening, it was felt by the group that the Douglas fir should be left as is along the shore edge although the two species mix because of logging problems should be taken out together. Helicopters were not considered a viable option at this time because of the economics and because of the training problems they present. However they should not be ruled out and further work is required to identify areas where they could be used. The group emphasised the need to monitor their management practices and to make changes as deemed necessary. There were problems with trying to harvest small amounts of wood whereas it may be more desirable to remove larger volumes at one time.

Buffer strips would not be desirable for water quality and this could be achieved by careful management of operations. Screening is also not desirable because once off-shore, any screen would be ineffective. In conclusion the group preferred to follow known systems and attitudes for logging and transport with flexibility being designed within the systems, to prevent environmental damage.

Bonner

Transport options, barging was not considered a viable option as only six km of new road needed to link up with County road which would cost about $300,000 or 45¢ per m^3. This assumed the County would upgrade their road to class 1.

Harvesting would be by conventional skyline although the convex country would limit clearance. The machine selected would need to handle ground hauling. Roading would be for uphill hauling although mid-slope roads would be required due to the length of slope. The roading density for the area came to 30 m per hectare at a roading cost of approx $1.00 per m^3, with road maintenance included an all-up roading costs came to approximately $1.70 per m^3. The extraction systems would operate off formed landings. Two haulers would be required although 50,000 m^3 per year would be on the low side. It would be preferable to clearfell at an age later than 28 years. The Tory channel side was recognised as being environmentally sensitive and it was considered best to treat this area by keeping coupe size down to 20% of the Catchment size in any one year. Because of high winds logging would be best in an orderly fashion rather than a staggered setting basis. Felling techniques with a cross slope felling pattern would be important to protect streams and reduce breakage. The Douglas fir area could be thinned with a Christy carriage set up.

MacArthur

With regard to data requirements and an approach to planning the group envisaged two main areas. Firstly, maximum consultation and dialogue with relevant local agencies and authorities at the beginning, particularly the Marlborough County, the Maritime Park Board, the Maritime Planning Authority and the Catchment and Regional Water Board. Also included would be keeping the local public fully informed. Secondly a multi-disciplinary approach to the basic soil and water resource in the area with special emphasis on soil erosion potential and land stability. Also, a comprehensive ecological study on marine life. Another point considered important was the collection of market requirement data as well as that of the timber resource parameters. Water supply areas to dwellings would also require special study.

The group did not envisage the need for any special trials or experimentation other than the ecological impact study. Some of these studies might take up to one to two years to complete.

Harvesting systems would be an FMC skidder for easier slopes and a Madill 071 hauler, uphill hauling over the rest of the area. It was envisaged that some areas could be left due to environmental constraints or potential soil erosion problems. Extraction of these areas by other means such as helicopters was not considered to be economic.

Transportation. Due to the obvious roading difficulties all log lengths would be shorter than 9 metres to permit negotiation of tight corners, otherwise conventional trucks and trailers could be used. Landing sizes would be restricted to 20 x 30 metres with track type loaders used. Landings would be ripped and replanted on completion. The visual sensitive areas would be logged in the same manner although on a staggered setting basis.

Barging was a viable option with barge loading points to be developed, but the type of barge would be related to other operations in the Sounds. On its own the area could only support a towed barge system. It was felt that this aspect would be covered by a specialist marine consultant, in conjunction with the Harbour Board requirements.

SESSION 5
Paper (b)

MANGATU FOREST, CASE STUDY

R.D. BLACK
Land Resources Conservator
Hawke's Bay Catchment Board

INTRODUCTION:

Mangatu Forest is 65km by road northwest of Gisborne, the last 20km of road are narrow, winding and unsealed. The forest covers approximately 11,000ha of the Mangatu and Waipaoa catchments, on the eastern flank of the Raukumara Ranges. The elevation varies from 200m a.s.l. at the forest headquarters up to 1,000m a.s.l. on the Tarndale Road, the watershed boundary between the Waipaoa and Motu Rivers. This range in elevation has a marked effect on climate; August is the wettest month with 284mm average rainfall at Tarndale Station and a minimum of 147mm rainfall recorded at Waipaoa Station. Snow can also lie on the ground for up to a week at a time on the ridge areas. Although August is usually the wettest month, flash floods are likely in almost any other month.

The hillcountry on which Mangatu Forest is planted is the southernmost section of what has been called the "Critical Headwaters" of the East Coast. This zone of highly erodible rock extends from Mangatu, northeastward along the foothills of the Raukumara Range to Te Araroa. The reason for this severe erosion potential is the normal strength of the bedrock has been destroyed by the actions of folding, overturning, faulting and crushing, grouped together and labelled as "tectonic activity". Under normal forest cover the landform developed by the activity of normal erosion and at Mangatu this was earthflow (mass wasting), gullying and slumping. Following the pastoral development phase of 1890 - 1910 that rate of erosion changed dramatically and it was apparent within 20 years of clearence that erosion was serious. Reports in 1910 and 1920 indicated that reafforestation was the best landuse in the area but it was not until 1960 that large scale afforestation started.

LANDFORM:

The landform of the Mangatu and Waipaoa valleys is typical of many tectonically disturbed valley systems throughout the East Coast region. Mangatu Forest can be divided into four distinct landform units, each of which indicates the difference in the underlying geology. The landform zones and major erosion features are:

(1) Tikehore - Waimatau; bedding plane earthflow.
(2) Eastern Waipaoa; shallow slipping and slumping.
(3) Te Weraroa; gullying and slumping.
(4) Crush zones; large scale earthflow.

THE TIKEHORE - WAIMATAU CATCHMENT is an area of approximately 3,400ha on the western side of the Waipaoa River. It is an area of moderately high rainfall but there are few incised creeks, run-off is spread across the surface in many superficial channels. The bedrock is composed of an alternating sequence of sandstone and carbonaceous mudstone; the dip of the bedrock produces the characteristic assymetric valley landform of a long, dip-slope and a steep back-slope. The earthflow movement in these catchments is therefore structurally controlled with preferential movement down the bedding plane. A modification of this earthflow surface is the deposit of volcanic ash; on the upper slopes there are Waiohau ash deposits and on the lower slope there is only a thin deposit of Taupo Pumice. The difference in age and characteristic of the ash and pumice have been used to produce a stability map.

THE EASTERN WAIPAOA area extends eastward from the Waipaoa Fault. It comprises all the Miocene mudstone and sandstone sequence that forms the distinctive Tutamoe Plateau. This area is geologically, undeformed and its erosion is primarily caused by the collapse of the weaker underlying argillites. Normal erosion is surface slipping and minor slumping but at the crush zone contact with the argillite, earthflow movement is common.

TE WERAROA CATCHMENT lies immediately south of the Tikehore catchment on the western side of the Waipaoa River. The bedrock is composed of well bedded marls and siltstones, commonly called the Mangatu argillite. It is in this rock unit that the most well known erosion features of the Mangatu area occur in; these are the two large erosion scars of "Tarndale and Mangatu Slips". Both features have existed for thousands of years as eroding gullies with slumped headwalls but removal of forest cover has accelerated them to such an extent that planting trees has had no effect on reducing the rate of erosion. Within Te Weraroa catchment the usual landforms are steep V-shaped gullies with well defined ridges and a pronounced dendritic drainage pattern. As seen in Tikehore-Waimatau catchment there is similarly a range of volcanic deposits on the hillslopes, from a complete Waiohau sequences on the ridge to no Taupo pumice at the river edge. This range in type and thickness gives an indication of the length of time a soil has existed on any slope and conversely it indicates the rate of erosion or degree of stability of a slope.

CRUSH ZONE The most pronounced crush zone occurs along the eastern side of the Waipaoa River. The bentonitic crush-zone associated with the Waipaoa Fault varies from 500 - 1,000m wide and this is an area of severe earthflow and gully erosion at the contact with the overlying mudstone units. The crush zone of the Wheturau Fault in the catchment of Homestead Creek was the area first planted in Mangatu Forest. A major access road from the headquaters to the Tarndale Road passes through the bentonitic section of the crush zone and there is still evidence of slope movement along the margins of Homestead Creek even after 20 years growth of trees. The other fault system is the Te Weraroa-Te Waka Fault system that extends across the forest in a north-west direction. This is not a bentonitic zone but the crushed argillite and sandstone have a consistency of porridge and this means that very active earthflows and gully erosion are common.

THE EFFECT OF LANDFORM ON LOGGING:

TIKEHORE-WAIMATAU

The broad open catchment is best suited for skidder operations because the shallow earthflow is most effectively controlled by trees. It has been stated that disruption of the Waiohau Ash is not allowed but practically this will occur but it must be minimised. The drainage of roads and the maintenance of full vegetation cover in the small streams is essential because of the higher rainfall in this catchment. The steep back-slopes can be hauled effectively or additional roads may be necessary; the geology will allow additional roads.

EFFECTS OF AFFORESTATION:

Because of the advanced stage of erosion existing when afforestation commenced in 1960, the results have been slow in appearing. Homestead Creek is usually shown to visitors as the best example of what afforestation can achieve. The former area of raw, grey argillite debris fan now has a channel, which was entrenched 5m deep prior to the placing of an Armco culvert in the bed. The natural degrade back to bedrock situation has produced an armoured, bouldery creek bed which is now on-grade. This channel has therefore removed most of the stored sediment from the channel and there are only minor amounts now removed from the few active earthflows. In Matakonekone Stream similar channel degrade of 3m in four years has resulted in large volumes of material removed from the stream bed and deposited in the main Waipaoa channel. This means that within a few more years stabilised crossings and installation of culverts will be possible. Other tributaries of Te Weraroa Stream have also undergone this aggradation-degradation cycle and there are examples of large debris fans, now planted in trees and drained by an incised, single-thread channel. The stabilisation effect has been to reduce debris movement on the slopes and to remove stored sediment and discharge it into the main channel. In time this process will occur throughout the larger channels but this is a much longer-term process.

Associated with the improvement of the channels is the increased slope-stability such that roads can now be maintained where previously it was thought impossible due to the activity of the wet, moving ground. The overall result is to reduce the rate of erosion back to the natural state such that any sediment removed from the slope can be accomodated within the normal sediment transport system.

There are however areas that have not responded to afforestation, Mangatu and Tarndale Slips, Gully 117, Island Creek and Matau Creek. These areas are apparently producing as much debris as they did 20 years ago in-spite of all efforts to control them. At present it would appear that these large individual features will have to undergo their natural cycle and reach a stage at which man's efforts will be most effective.

CONSTRAINTS ON LOGGING:

The major constraint is the distribution and number of logging roads and landings. Present formation costs of $10,000/km without metal and the cost of $23/m^3 for high quality greywacke make the roading costs very high both within the forest and on County roads. The only alternative source of moderate quality rock is from Mt. Arowhana, near the northwest boundary of the forest, but this area because of environmental and historical reasons is unavailable at the moment. The highly dissected Te Weraroa catchment suggests numerous ridge roads and small mobile hauling rigs whereas the rolling terrain of the Tikehore-Waimatau catchment suggests wheeled or tracked ground hauling methods. The slope of the ground however is not always the best indicator for deciding logging method, the steeper slopes are usually solid bedrock, the rolling areas are active, moving crush-zone earthflows. The geological nature of the hillcountry and the broad expanses of riverbed indicates that the riverbeds have to be main roads. This will mean there has to be summer and winter logging plans, working the lower slopes, down into the stream beds during the period of low stream-flow (November - May) and working uphill to the ridge roads in the "wet" months. At present the Waipaoa River bed is negotiable from the headquarters up to at least the mouth of Tikehore Stream. Assuming a continuing improvement in channel stability, all of the large branches such as Matakonekore, Tikehore, Te Weraroa, Matau and Island Stream will be important roadways.

The lack of suitable, stable road metal may be overcome by the use of lime stabilisation of the sub-grade. Experimental work on No. 15 Road has shown that these crush-zone situations can be stabilised by the lime method.

The landform will also govern the size and distribution of the areas to be logged, this will be further modified by the condition of the actual stream channel of the catchment or sub-catchment being logged. For example, in Homestead Creek there are areas of bedrock and areas of earthflow. Where-ever possible existing tracks must be used and the area must not be logged such that several active earthflows are cleared in the one operation. The argillite areas are very susceptible to gullying and full protection of these channels must be maintained. Where-ver possible the deep volcanic ash deposits must not be removed by skid tracks or haulage ways because this will allow the percolation of groundwater and cause further instability.

An unknown factor is the quality of timber from the first rotation. Because of the period of ground movement over much of the trees life (10-15 years) the apparently straight trees may only be of pulp grade. For this reason it may be better to fell the trees earlier than planned and start the second rotation for a better quality crop. This problem does not occur in all parts of the forest however and normal rotation length can be expected. The removal of this timber from the forest to Gisborne may be achieved by way of the County road or possibly downriver to Whatatutu. The river-road is at present a short-term alternative depending on the rate of upgrading of the County Road and the rate of degrade in the main channel required to produce stable terraces.

CONCLUSIONS:

Mangatu Forest will be a difficult forest to log; public pressure to see that the present "stable" situation is maintained and the practical need to remove the trees to ensure a better quality second crop will make the logging fraternity think hard about the economics of this type of logging venture. To maintain the present conditions existing in the forest the following are the basic requirements.

(1) Where-ever possible existing roads and tracks should be used but if new construction is essential it must be done well in advance of being used. Lime-stabilisation and use of river-run material must be investigated as road construction materials, both to minimise cost but also to aid the degrade of the main channel.

(2) Some small-scale logging operation is required before the major contract work to determine the quality and size of material in the first rotation. This exercise may indicate that the rotation-length can be increased or decreased on certain sites if quality is not improved by time.

(3) To satisfy the water and soil conservation requirements, a two-tier logging plan for winter and summer logging is required to make best use of the riverbeds as roadways and to reduce the damage caused by vehicles moving across wet, erodable slopes. This type of planning approach would neccessitate several logging methods within one logging area and this may also be a reason for having a small scale logging operation to try the various methods available.

Finally it is hoped that the ideas put forward by the participants in this planning seminar will enable the formulation of logging plans that combine the best elements of soil conservation and practical logging.

MANGATU DISCUSSION GROUPS

Ruru

The Groups primary consideration was the existing values of protection and to maintain them. To achieve this it was decided that all class 6 zones should not be logged but monitored during the initial five years of logging. The second consideration for planning was the initial sale of 30,000 to 50,000 m^3 per annum for the first five years covering 50-60 hectares.

Some of the constraints discussed were:
Silvicultural practices, where areas have not been fully treated, such as thinned to waste, thus causing a variation of tree size;
Re-establishment and the need to leave some slash on the ground for soil protection from rain, and to restock before root holding capacity is weakened;
Soil and downstream values, in terms of water and soil quality and the effects caused through flooding. Floods in the Gisborne Plains in 1948 & 1952 are still being compared to those in 1976 & 1980.

Criteria requirements considered were :
small landings,
mobile haulers,
self loading transport, and the
establishment of sound roading standards with the emphasis on the placement of extra culverts and the emphasis on drainage.

The group considered logging should be stratefied for hauler skidder and FMC operations. However, it was considered that in the initial areas it would be hauler logged from the ridge tops using something like a Washington narrow track mobile hauler or Madill. This would be supported by a machine like an FMC because of its low ground pressure, to fleet logs to roadside or to a marshalling point. Wet weather was considered a restraint and no logging would be carried out in the wet during the months of July, August, September, or other occasions while soils were saturated. Clearing of Catchments should be critically examined in terms of rotational operations to minimise the area to be cleared. It was considered important that the size of the Catchments should be known and supported with good contour maps, aerial photographs and earth soil data. With the proposed cutting rate of up to 50,000 m^3 per annum for five years, it was likely that by the 10th year, tree age class could be up to 35 years which would have an enormous effect on logging machinery. The group considered also that trimming and cutting of trees should be done prior to extraction to reduce machine size. To minimise ground disturbance logs needed to be lifted off the ground although this conflicts with the earlier hauler systems mentioned, such as the Madills. Consideration should be given to machines that are mobile, not too heavy, but capable of being set up so logs are kept off the ground during hauling. Coupe sizes should be small, particularly on class 5 zones and staggered over the Catchment to minimise and break the flow of water run-off. The Waipaoa river could be used as a marshalling point for stockpiling logs. Low flotation forwarders could be used to carry logs to the marshalling point. Logs would be then loaded on trucks of the sheep truck size for transport down river.

The upper slopes can be logged on a reverse basis with logs transported over the County road. The group considered the possibility of using the Waipaoa river to Whatatutu be investigated. If the County was to receive assistance from Central Government to upgrade the existing road then this would be the most desirable route.

The existing arterial roads cannot be improved on in terms of location and grade and will serve as the main logging roads. The condition of the roads, i.e. surface, batters, downhill slopes, culverts and drainage, are important factors, particularly where these roads cross known class 6 zones. After considering the possible high cost of bringing in metal, the limited wearing use of crushed or flaky limestone in the adjacent area and a likely environmental impact of quarrying the base of Mount Arowhana, it was decided that the metal in the Waipaoa river should be seriously considered for use and perhaps reinforced with some form of lime treatment however it should be mentioned that the wearing strength of the river metal is reduced considerably during wet weather by normal forest traffic.

The recommendations by the group were :

1. The approach to planning is to consider further the practical use of mobile haulers and keeping logs off the ground to reduce ground disturbance, supported by low ground pressure type vehicles for fleeting logs to marshalling points. The availability of good contour maps, aerial photographs and data on soils with the areas zoned as they are shown but in much more detail for specific catchments.

2. That the initial sale of five years be carried out by N.Z. Forest Service to sort out all the possible options and problems before the major big areas are reached. The group did not think a contractor would be keen, nor was it fair, to expect him to go into something that we have little knowledge about in terms of logging.

3. Harvesting systems have to be mobile haulers to have a resonable degree of flexibility and capable of keeping logs off the ground. Low flotation vehicles to fleet logs to the marshalling point. Provided the County upgrade the road, logging trucks of the size known around the Bay of Plenty, could be used.

The group's general approach was to look at the entire forest first in terms of its stability rating and existing arterial roads. The major zone for consideration was class 5. The primary areas for protection were class 6 zones. Class 5 zones in the upper reaches of the Waipaoa and Waimatau, Tikihore and Weraroa catchments where the country has extremely long slopes, a system to log these should be designed during the initial five years. Good effecient road maintenance with emphasis on drainage should be a primary consideration within the logging areas. During all phases of logging operations monitoring systems must be instituted prior to an area being logged to gauge and record all the changes that take place during logging and after canopy closure of the re-stocked area. Restocking should be immediate with no burning. The public should be informed of the important considerations being undertaken. Earth scientists, loggers, engineers and people with an indepth knowledge of Mangatu are available and must get together to sort out the problems.

Phillips

Any approach to harvest planning must take into account that Mangatu was originally set up as a protection forest and hence the major consideration in any plan, either constraints or factors relating to protection of soil conservation values. Secondly planning must also take into account the characteristics of the stand, its age structure, wood quality and the amounts of material to be extracted. Thirdly, roading, protection of soil values places constraints on roading as does the volume of timber likely to be removed and the type of timber, i.e. long versus short logs. The approach to planning therefore must involve these three factors, remembering that the prime objective always is to protect the soil values. The approach felt most suitable for Mangatu involves the use of sieve planning technique whereby various factors or constraints such as soil and terrain type, summer and winter areas, are superimposed upon one another to obtain a pattern of logging movement within the forest.

To approach a method of planning information has first to be collected then examined and finally formulated into a working plan. General information such as topographical maps and aerial photographs exist for Mangatu as does geological and terrain maps. The effect of existing logging techniques in this type of country are little known and the logger has no real data base or experience to fall back on. The question of logging trials was posed and it was generally felt that traditional trials where not viable, due to the long data collection period required. The discussion group recommended instead that operational trials should be conducted during the actual operation phases of the harvest. The main area requiring further information was on the suitability of the river bed as an access transport route. Inherent in this is a need to know whether existing equipment can be used or whether new systems of transport will have to be developed.

The logging technique chosen will be based upon the terrain type. It will inevitably involve :

long haul systems, possibly over 400 metres,
low roading densities,
small landings,
some suspension logging although anchors may be a problem,
dual haul systems.

It was felt type 1 terrain could be logged by skidders or FMC type machines providing care was taken not to greatly disturb the ash horizons. Type 5 terrain, most sensitive in terms of logging, may be logged by a combination of low ground pressure systems and cable hauling. Tracking should be absolutely avoided in the crush zones, if possible, and hauler systems used. The use of narrow wheel base systems was recommended.

Transport. It was felt that where possible long log systems should be used to reduce handling. However, the short log system may be the more viable method. The group felt that a two stage system of log transport was inevitable regardless of the final method of delivery to the market. Until more research is carried out, particularly on the river based system, no decision is possible.

In summary, the techniques used will be primarily constrained by the need to protect soil values. Experience can be gained by adopting initially a conservative approach but that once a given operation begins, future operations should be reviewed with an open mind, in light of the then existing knowledge.

Willis

In sorting out a recommended approach to planning, and planning procedures, it was interpreted as what action should be initiated now, to get logging started at Mangatu in a reasonably well planned manner. One thing that was quickly apparent was that there were large gaps in the existing knowledge and a considerable amount of investigatory work would need to start immediately to make the commencement of logging easier. It was quickly apparent that there was not going to be a concensus view from the group on some basic points, such as should logging trials commence with various machines in advance of an operational sale, as opposed to starting to log at an operational scale without preliminary trials. A personal view was that logging should start at an operational scale as soon as was feasible to sustain 50-70,000 m^3 per year from 25 year old stands.

The group agreed that initial logging would be by a cable system although the exact system was not agreed on. A small Madill was suggested as a possibility. Once logging was started it was suggested that it be monitored closely to obtain data on the affects on slope stability, optimum landing size and siting, full tree hauling, or short logs, timber quality and re-establishment. It was also decided that a zoning exercise should be done now to identify winter logging areas and hauler only logging areas. More information is also required on growth rates, volume and piece size. This would lead to the preparation of a detailed logging plan by 1984 for logging to start in 1985/86.

The Group had a cursory discussion on roads and transport. The river was suggested as an alternative route from the forest to Whatatutu and it was agreed that this should be investigated. However, as the Tarndale road already exists, this can be upgraded for log transport and this is regarded as being the most likely egress from the forest. Internal forest roads were barely discussed as it is not seen possible to establish further roads. Some upgrading could take place with greater metalling densities required. The source of metal was discussed and it was agreed that there is a need to look at using Waipaoa deposits by improving their quality with lime or some other chemical,. Alternative sources of metal are at some distance and are expensive.

The group did not consider logging more than the first five years. During this time some of the most unstable sites at Mangatu will be logged and the information gained should help plan the second lustrum. It was generally agreed that because the second five years involved different topography and cut, other logging systems such as the FMC could be used. Finally, in view of the large increase in volume, coming on stream at Mangatu, production should be built up as fast as possible from the start. This will avoid getting into progressively older aged classes and subsequently large old crop type trees.

Glennie

The group adopted a slightly different approach to planning, firstly seeking the significant factors relevant to a planning exercise. Firstly, the knowns, the resource of 8,000 hectares, the species being 65% radiata and 35% minor species (P.nigra. D.fir, Eucalypts and Cupp.species). The forest will be logged over 40 years with an estimated annual volume of 160,000 m^3 average with an increasing m^3/ha and with increasing rotation. Piece size and rotation increases will be significant. Seasonal logging will be required due to sensitive sites. Maybe a 160 day maximum between October and May. Over this period of logging a high volume output could be sustained, up to 51-68 loads per day. This volume suggests a log transfer yard with the ability to hold stock to maintain a constant output (surge chamber). Trucking will be confined to the valley bottoms and a graded river systems and roading on sound stable ridge systems. County roading will be limited to class 2 loading and the Tarndale road cannot be counted on. Alternative access via Oil Springs and Airstrip Road, within the forest, could be maintained by the Forest Service or taken over by the County. The Mangatu supply while a major one is only part of a total East Coast supply situation. Other forests will have volume input into any sales. The primary objective of the forest is protection. Production as a secondary objective. Therefore the group agrees that maximising stumpage is not an objective in itself.

The requirements for indicative planning were discussed and identified as being a sound investor base with MARVL product type projections. Mill studies currently being undertaken should indicate grade returns. Topographic and geology and soil maps are required and essential for planning. Potential markets need to be defined from early advertisements calling for proposals for use of the resource. Public Relations involve discussions with County, District Catchment Boards, City Council, Harbour Boards, etc. It may be necessary to condition attitudes. Capital and operating costs are to be determined as no infrastructure exists on the Coast at this stage. Labour supply and skills on the East Coast are very much lower than traditional industry areas. A small scale start is very necessary to develop skills and an industry infrastructure. Planning and managerial skills also need to be developed. A log sale is essential because of the intrinsic value. No private company is likely to accept the responsibility and the Forest Service has the skills to maintain the protection values of the forest.

Logging systems are restricted due to basic roading patterns such as river beds and existing ridge top roads. Options discussed were, easy country such as earth flows, forwarder systems being used to the valley bottoms where conventional trucks could pick up. High logging costs here suggest total utilisation. Low ground pressure feeder systems and forwarders to trucks do not tie into a landings situation. On steeper country integral steel spar haulers would be required with minimum hauler landing size and self loading transfer of forwarder to trucking points. Some mid-slope roading is required because of the length of slope, in some areas up to 3,000 metres. An option for easier country is helicopter to exclude the low ground pressure forwarding units. Further options were not considered, however, all available options must be assumed to determine feasibility of those options which have application to the special circumstances of Mangatu.

Operations must be based on staggered settings. There is no basis at this stage to suggest the number of gangs. Experience with the Mangatu situation will be needed to establish this. Roading standards must be of a high class where they can be supported.

Standards will, in reality, be variable because of the geology, soil types and lack of suitable alternatives, particularly on spur roading and secondary roads. A further option for transport beyond assembly points is rail, from Whatatutu to Gisborne. This must be considered to cope with the expanding volume expected from adjoining forests such as Fletchers. Research other than logging research already mentioned should be undertaken. It should be noted that experience within New Zealand industry to date cannot be translated to the East Coast. Early logging from a 1985 start, on a small scale, is required to evaluate systems prior to the forests coming on stream with large volumes from 1990 to 1995. Early trials must also incorporate evaluation of road construction techniques, permanent constructions and water control systems to ensure the country stability.

SESSION 5
Paper (c)

SMALL WOODLOT PLANNING

F.P. Wallis
P.F.Olsen & Co.Ltd.

The brief for preparing a background paper to a group study approach on planning the logging of small woodlots has required examination of the following two main features:

a) The future main characteristics of the resource in the context of the total forest industry.

b) The various factors that must be taken into account that may be regarded as specific to planning the small woodlot operation.

It can be fairly established that beyond the period 1990 the woodlot resource established under loan and grant schemes will make a meaningful contribution to the forest industry potential in New Zealand from a national viewpoint. This has been primarily due to incentives to afforestation in the 1960's and 1970's and Figure I shows the broad age class distribution of the resource established since 1960 under grants and loans. There is an additional area of small woodlots which have also been established outside the loan/grant scheme by companies and individuals that is yet undefined in area, but currently being surveyed by the NZ Forest Service.

In examining this national age class distribution in resource size in more detail, apart from showing the significant increase in private woodlot plantings since 1971, with only limited potential logging capability development for the resource established before this time, problems arise in quantifying the nature of the small woodlot resource distribution since some quite large forest projects had been implemented under the government incentives. In defining the size of a small woodlot, it has been assumed to be a forest or a five year age class, that due to soil conditions, contour and location is unlikely to support more than 4 months continuous logging by a single tractor crew and will therefore be unlikely to exceed 20 hectares in size.

When one tries to determine the number of small woodlots within this size constraint and the significance of their total area in relation to national or regional resources, problems are encountered. Although the NZ Forest Service has commenced collection of data on woodlot sizes, growth rates, soil types, logging methods (tractor/hauler) and access, the analysis is far from complete. Data has been obtained for the Auckland and Rotorua planning districts being the only information available at present and an attempt has been made to summarise some of the main patterns that emerge if we can assume the data represent a very crude sample of the national situation. The patterns that appear to be present are:

a) There is a similar number of small woodlots or woodlot age classes being established as larger ones, contrary to the sometimes popular view that small woodlots would predominate in numbers (See Figure 2).

b) The collective area of small woodlots established under the grant/loan schemes appear to be significantly less than the larger grant/loan projects even though they are similar in number (Figure 3), as shown in the case of Rotorua planning district in particular.

However, this picture needs to be examined further and checked for the overall country situation as it raises the question of whether the small woodlot by size definition, will have any role of significance at all in forest industry planning and markets, due to the very small nature of the resource relative to larger grant, company and State projects.

c) The type of logging (hauler/tractor) will vary from one region to another as the Auckland and Rotorua data indicate (Figures 4 and 5). The easier, free draining Rotorua soil types permit a much higher use of tractors than Auckland for example, with the latter's pattern of woodlot size, age class distribution, soils and logging methods being more likely to be repeated elsewhere in the country.

Moving onto the various factors that must be taken into account in planning woodlot logging the list is lengthy and can no doubt be added to substantially by seminar participants. Each must be carefully considered, no matter how minor, at the onset of planning each block, as they can have a very significant impact on the productivity and costs of production, due, in last analysis, to the small scale of each operation. For example, a recent log export operation requiring harvesting of 7500 cubic metres from a series of 2-6 hectare woodlots over a 2 month period generated a log/load cost of $17 per cubic metre without any allowance for pre-assessment, sale negotiation and planning costs. The types of factors we are concerned with are numerous but the following are some of the more common:

1. Measurement and analysis of stand area and volume.
2. Planning and negotiation of timing of harvesting and the terms and conditions under which the operation be carried out.

   Excessive legal costs in settling contracts that may be incurred through local authority statutory requirements or difficult forest owners who are not members of a marketing co-operative who would be expected to have a standard agreement format.
3. Obtaining clearances from local authorities to harvest and transport, e.g. Catchment Boards for any restrictions under Water and Soil legislation and District Councils who may have set restrictions on load sizes for transport or close roads in wet conditions to avoid pavement damage.
4. Public road access may require some realignment prior to harvesting to permit a reasonable log length to be carted and this should be done at least six months in advance at the latest to permit pavement consolidation for high loadings
5. Access through, and even landings in, a neighbours property may have to be negotiated with protective covenants as the most viable approach to logging a block.
6. Fences must be stripped and temporary ones may need to be erected for stock control and new fences erected after logging.
7. Equipment shifting costs and times for tractors and loaders and rigging times for haulers are very significant.
8. The formation and preparation of landings and primary extraction leads in many parts of New Zealand must be carried out well in advance of harvesting to allow adequate consolidation particularly where soils are heavy and greasy.
9. The requirement for an availability of metal for landings and access to them must be carefully checked as in many parts of New Zealand metal is both expensive and scarce.

10. The need for local accommodation for a highly mobile operation demanding highly skilled personnel with reasonable needs for living standards, must also be checked as this is often expensive.

11. Given correct equipment selection and availability for the stand size and characteristics, it is important that a reasonable and experienced estimate be made of average daily productivity after allowance for downtime due to the seasonal weather conditions under which the operation is to be carried out. The maintenance of a viable continuous logging operation concentrated on small woodlots will create the need for classifying them into summer and winter logging categories if reasonable levels of productivity are to be obtained.

12. Continuous review and inventory by the logging operator of capital, operating and labour cost inputs and changes as he will be operating at the extreme end of the scale for his industry in terms of his sensitivity to energy cost movements and market fluctuations relative to larger scale main forest operations within a region. The level of risk potential profit is exposed to in this type of operation will involve a high degree of sensitivity to pricing structures.

As a brief summary to this introduction to logging of small woodlots it is fair to say that for the operation to proceed profitably to all parties towards the turn of the century in the context of local and overseas markets, and jointly in competition with the harvesting and utilisation of other regional suppliers, the following will be demanded:

a) A relatively small and strongly localised deployment of equipment with a workforce that requires a high level of versatility and skills.

b) A high regional input into a joint co-operative effort by small forest owners in harvesting and market strategy planning that is carried out in strong liaison with skilled logging industry planning personnel.

FIGURE 1

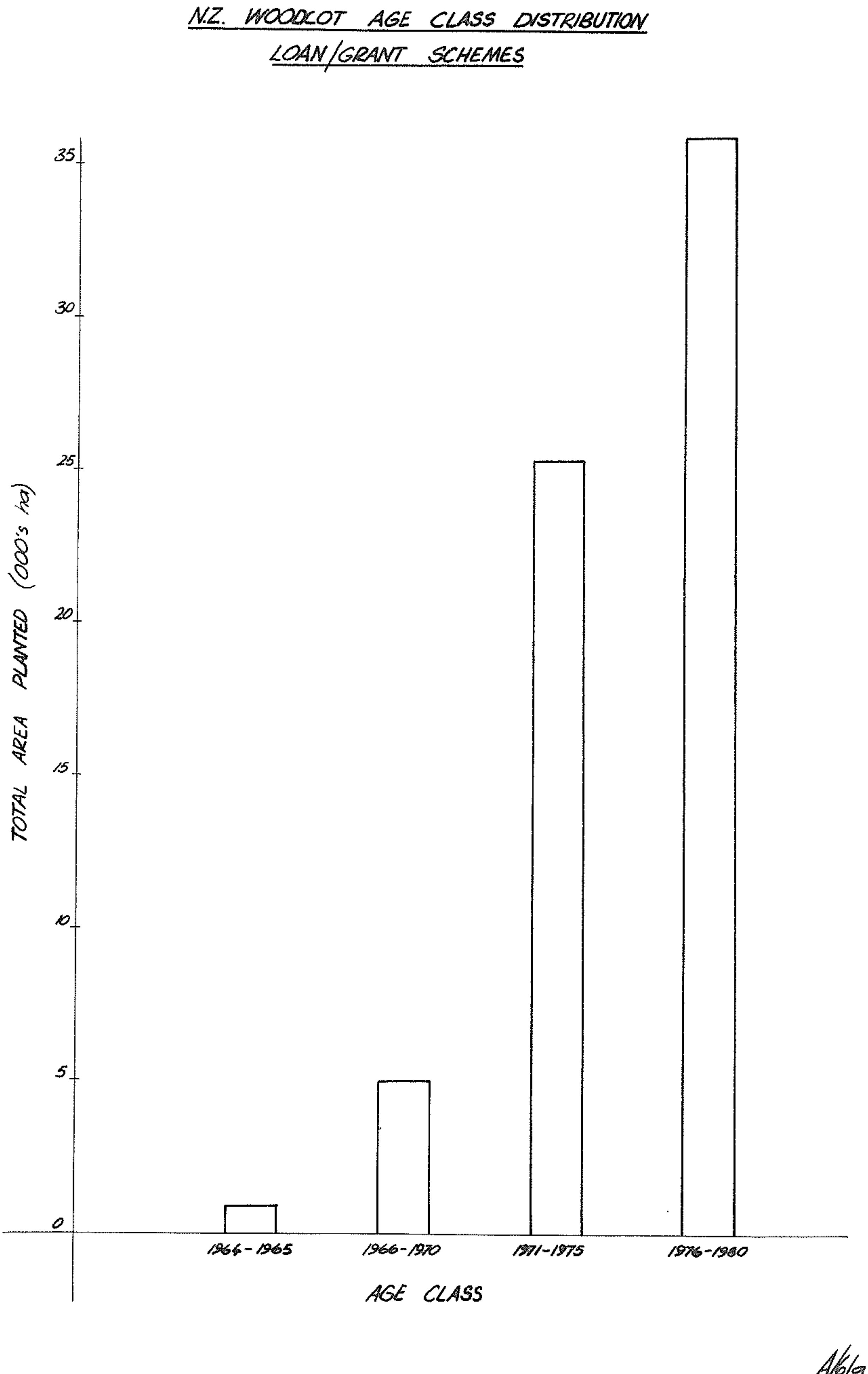
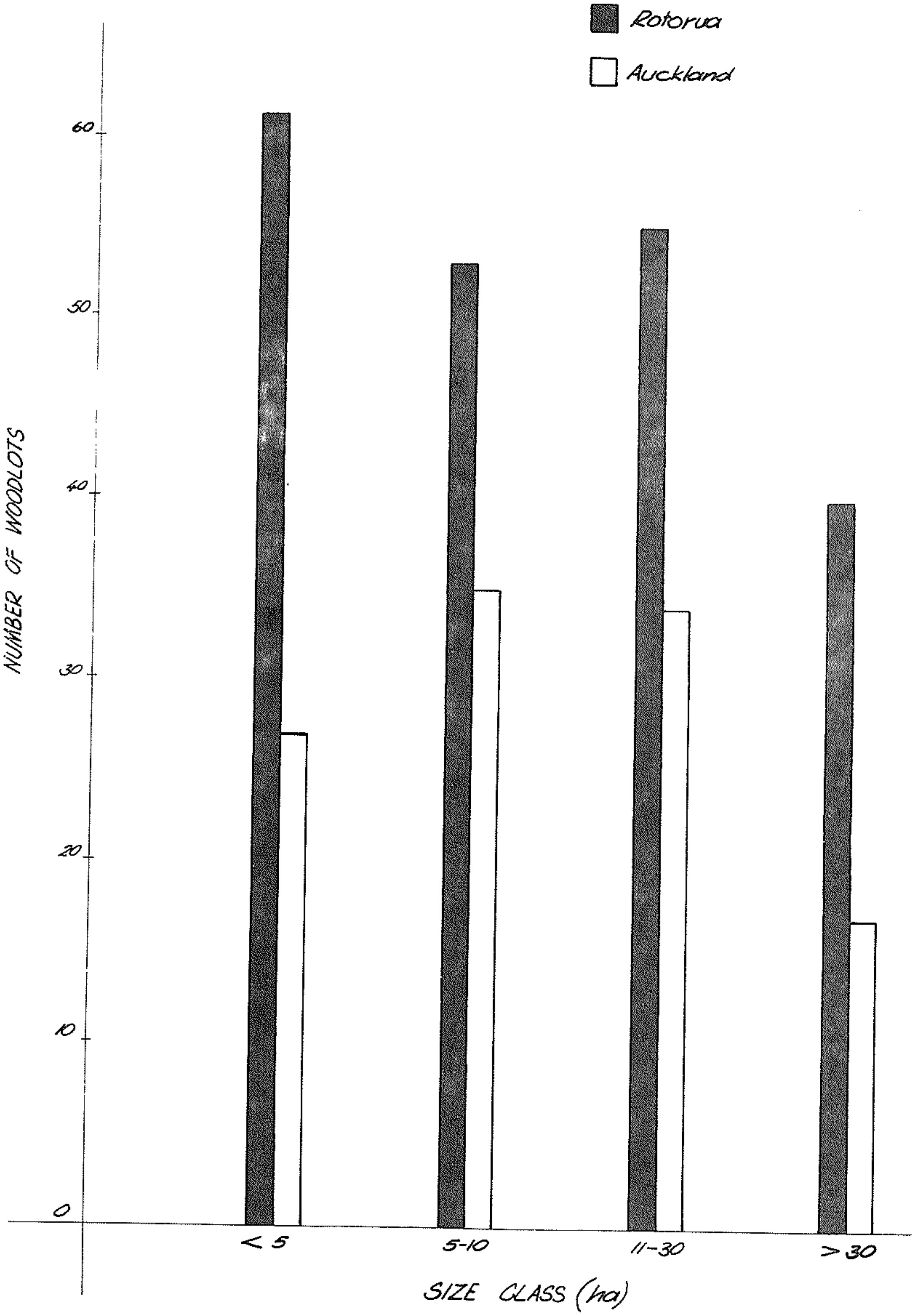

N.Z. WOODLOT AGE CLASS DISTRIBUTION
LOAN/GRANT SCHEMES
TOTAL AREA PLANTED (000's ha)
35
30
25
20
15
10
5
0
1964-1965
1966-1970
1971-1975
1976-1980
AGE CLASS

FIGURE 2

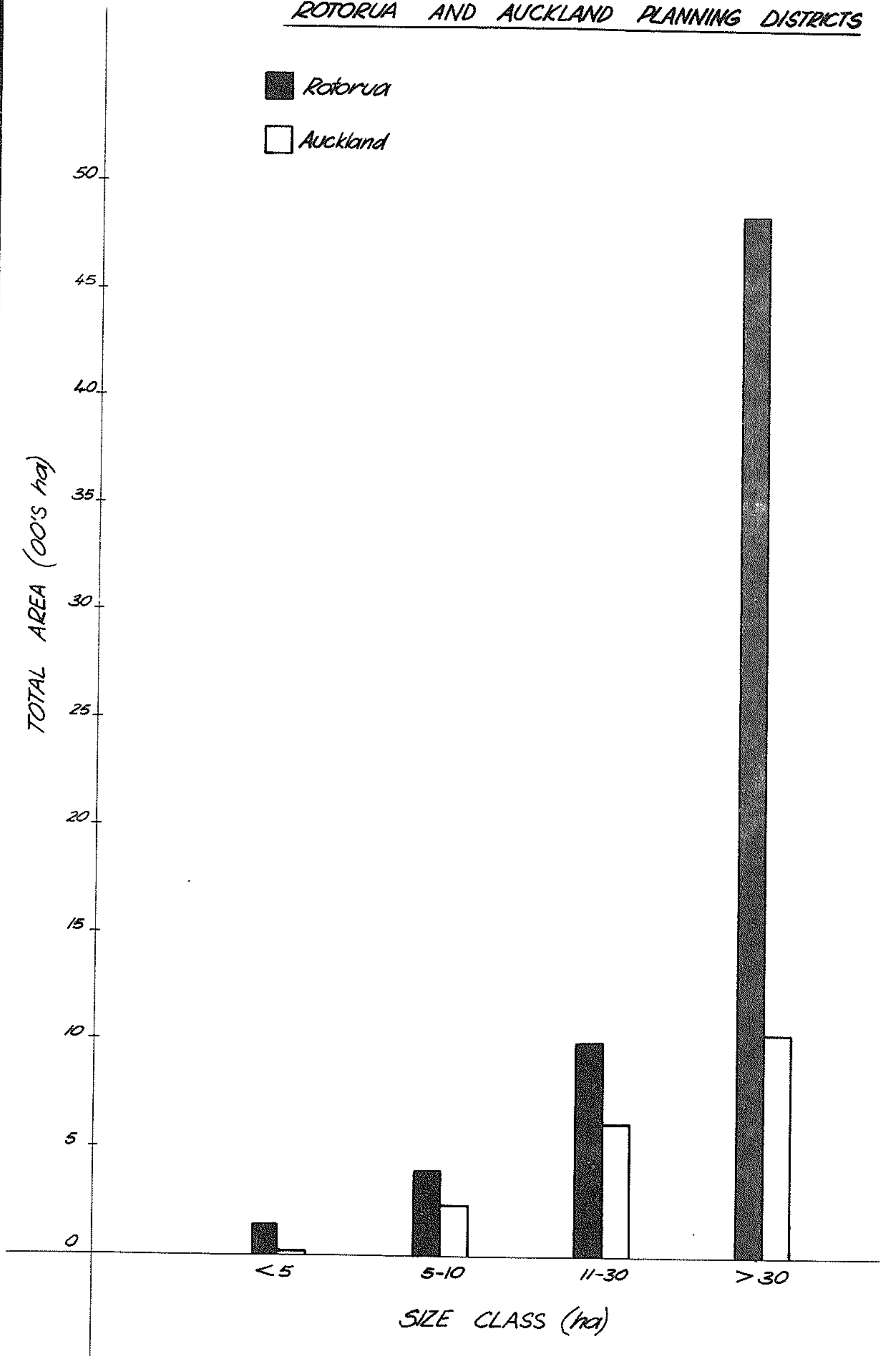
WOODLOT SIZE CLASS DISTRIBUTION ROTORUA AND AUCKLAND PLANNING DISTRICTS



A/616

FIGURE 3

TOTAL AREA BY WOODLOT SIZE CLASS
ROTORUA AND AUCKLAND PLANNING DISTRICTS



A/6lc

FIGURE 4

LOGGING METHOD AND SOIL TYPE BY AGE CLASS
ROTORUA PLANNING DISTRICT

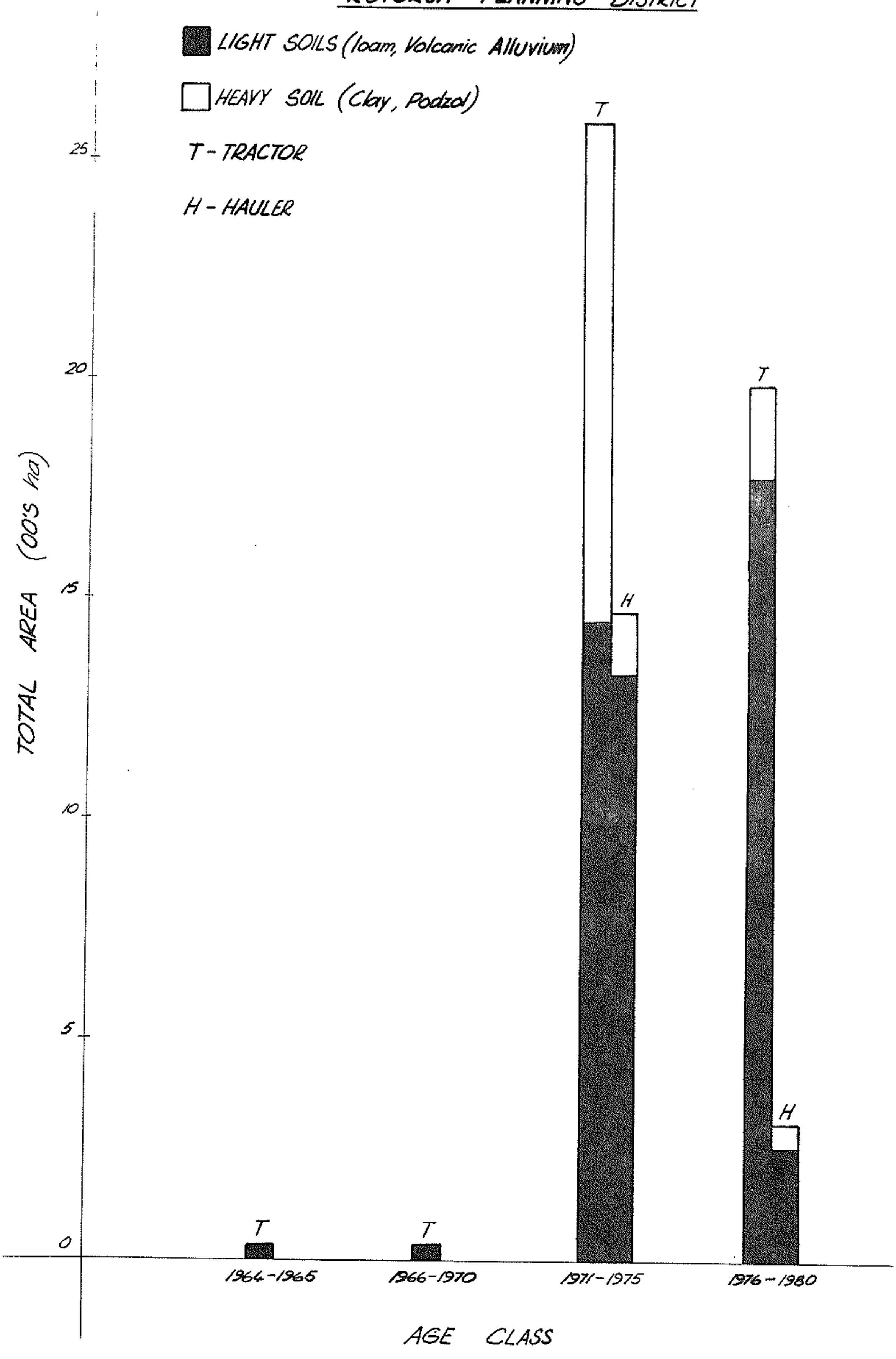


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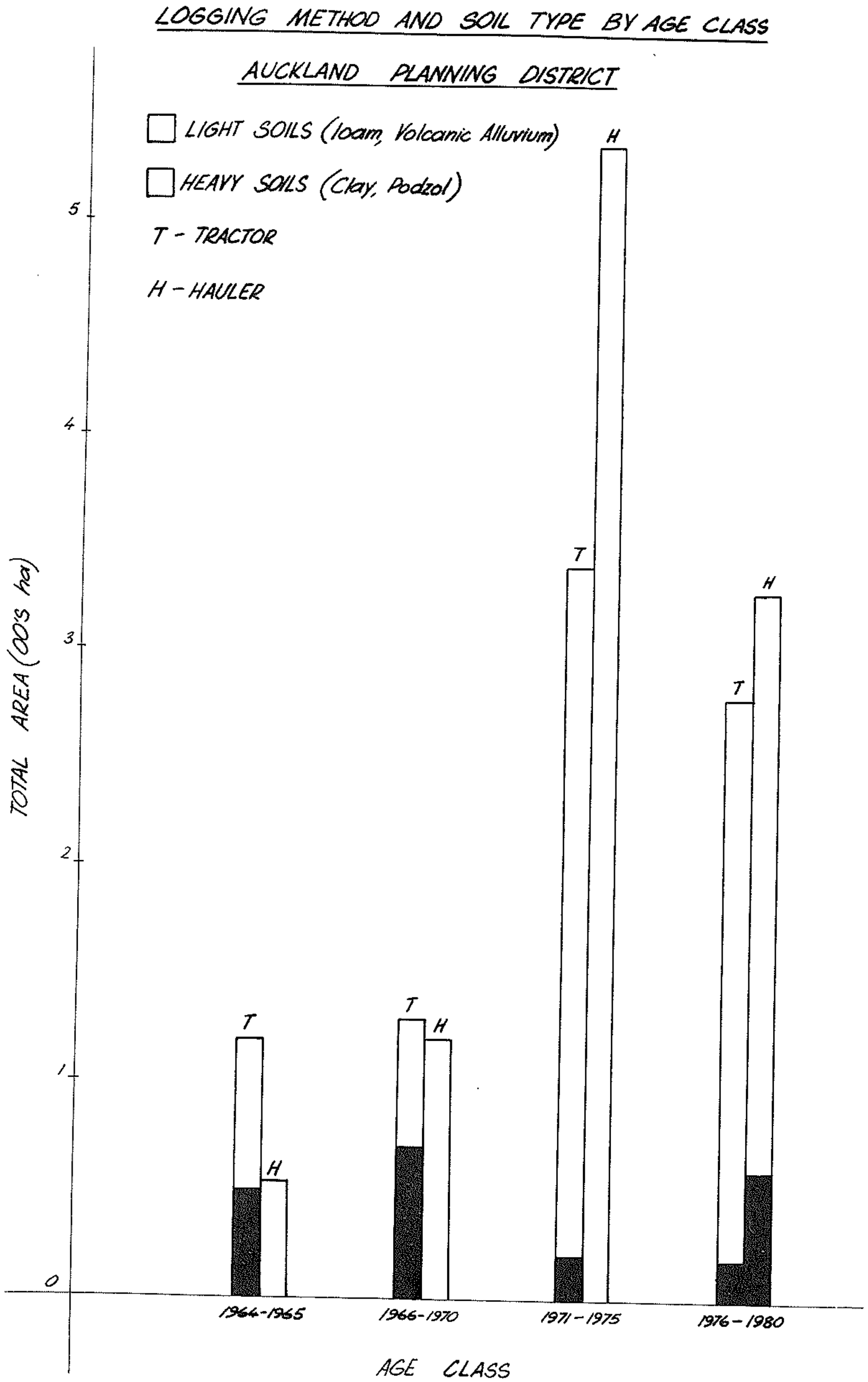
FIGURE 5



A/61e

SMALL WOODLOT DISCUSSION GROUPS

Pearce

Information and basic data was lacking on which to make sound decisions for small woodlots. There was one overall constraint recognised that affects small woodlots and this would pre-condition other judgements or decisions. This was continuity of work within a district. Reasonable continuity of work would allow large companies or co-operatives to be set up with a range of equipment to thus tackle a range of sites and different conditions. They could then compete with small operators who may have only a limited range of equipment. However, when looking at the figures as presented it did not appear that continuity would occur until about 1995. This left therefore the option of using small operators. It was decided that ideally roading and landing construction should be done one year ahead by local contractors under the supervisions of the logging contractor. Local contractors could work through consultants to either find them work and do their planning for them.

The area of data and information was discussed at some length. A key point was in identifying the major constraints of a small woodlot. Some of these were, volume required to a sawmill, time to do the operation, i.e. in the summner months, a cost constraint, market requirements or acceptability of the poor quality that could occur from some woodlots. Also required was climate and rainfall data to determine when logging should ideally be done. Access restrictions, topographic data, to determine the logging system, yield and volume data for species other than radiata and the market potential for material other than sawlogs. A further restriction could be imposed by the farmer, particularly if he has adjacent crops. County roading restrictions and bridge weight limitations need to be determined. The supply of metal and labour also are required. An extra cost is the taking down and replacement of fences, accommodation for the logging crew, which could conflict with summer tourists, and shearers. The group decided that no trials would be possible because each area was different. Experience from a region could be built up as logging contractors became more proficient. For the Manguahine area the group decided that a medium sized three drum hauler, plus tractor, could produce 150 m^3 per day and log the total area in four months at a cost of \$12.00 per m^3. Other constraints for this area identified were, good communication with local authorities, the possibility of a Section 34 permit, the advice of Catchment authorities and an escalation cost overrun clause in the contract. Sales of produce for export would be a factor in determining when logging could be carried out.

Wallis

This discussion group also found it difficult with limited data on which to base decisions. Firstly, the planning approach required. This usually starts with a dialogue between the buyer and the seller, although it is not significant who runs the logging. The first task is to identify the crop characteristics and what variation may be in it. This is needed so markets for the various wood products can be identified. The second point needed is slope and soil types so access and logging system can be identified and thirdly the constraint imposed by the term of the sale, noting that it would probably have to be logged over a summer period to meet buyer demand and also because once logging starts the farmers are then pleased to see the end of them. Logging would therefore need to start in October and be completed in March. This would equate to about 160 m^3 per day over the 80 day period, with allowances made for wet weather and Christmas shutdown.

The next step would be development of the logging plan. A large range of options were discussed and highlighted was the degree for flexibility in equipment assuming a continuity of work in the region. It was decided that the best option for the area under study would be a D6 size machine using a contour tracking pattern on the easier country. A 7 man crew could be used and a tracked knuckle boom loader required to prevent landing degrade. Also used would be a medium sized 130 hp secondhand hauler which would cover 75% of the area and produce about 110 tonnes perday. The easier slopes would be logged by tractor producing about 40 tonnes per day. Planning for such areas should be 9 to 12 months in advance and having done this, then advise the Catchment Board who could vet the plan and make any changes deemed necessary. The County would also be advised of the intent to carry logs over the road. The next step would be to get a settlement on the sale and purchase agreement with the appropriate cost price and escalation clauses. The costing exercise for the case study area calculated out to equipment costs of $300,000, and an allowance in the yearly operating cost of $50,000 for accommodation and transport of crew. This worked out to an on-truck cost of $13.30 per tonne.

The Group saw a big need for good maps and detailed stand information to help with the planning process. Also required was information to help make decisions on the on-going logging in a region, to ensure an operator can cover his high capital expenditure.

CASE STUDY SUMMATION

The following are a summing up by the case study presenters on the findings from the various discussion groups:

(a) MARLBOROUGH SOUNDS - Lindsay Vaughan

The summary from the four discussion groups came up with an approach to logging the case study area. This summation will cover the wider issues of logging in Marlborough Sounds. The Marlborough Sounds resource is some 6,000 hectares scattered throughout the Sounds, in four quite distinct areas, Port Underwood, Queen Charlotte Sound, Pelorus Sound which is isolated from Picton and the Croisilles on the northern side. It is very important to know what is likely to happen in the next ten years. There is about a 15 year lead-in time before something is likely to happen. There are some areas without any road transport at present and are unlikely to have road transport in the future. It is essential therefore that some water based transport will be needed. At this stage barging seems to be the most likely option and acceptable from an environmental point of view. The option of some form of aerial transportation however cannot be ruled out. An improvement in roading came through as the best option in the case study area which is close to Picton, although there was not much difference in terms of cost between roading and barging. Most people recognised that roads offer an important asset on a forest. The real problem in the Marlborough Sounds is one of legal ownership. The best place for roads is on the stable ridges where there is the least weathering, least impact on soil and water values. However, much of this land is privately owned and there are problems of linking up these roads. The alternative of winding around the foreshore leads to massive problems. The emotive issues of logging trucks roaring through the sounds, crushing tourist traffic, have been used as examples to hinder future development. The need for dialogue with local bodies was mentioned and this needs elaborating. Firstly, local bodies and other groups of interest - who are they.

The Maritime Parks Board, controlled by the Lands & Survey Department are responsible for the foreshore reserve which wanders throughout the sounds. They exercise control over its use and modification. They are a very powerful voice for recreation and amenity.

The Maritime Planning Committee which is a new organisation with the responsibility of planning the use of the water up to high-water mark.

The Marlborough County Council who are responsible for the planning of the land and the local roading authority.

The United Council, above the County Council, they are responsible for outlying regional resources and the direction of regional development.

The Ministry of Agriculture and Fisheries who are responsible for the mussel farming which is quite separate from the Maritime Planning Council.

The Ministry of Works & Development who exercise an over-view for the planning of the land and the water.

Ministry of Transport, Marine Division, who are interested in transportation on the water.

The Marlborough Catchment and Regional Water Board, who are responsible for the land and its effect on water quality.
The Marlborough Harbour Board who will be responsible for transportation and exporting of logs.
The Marlborough Mussel Farmers Association who are monitoring their members interests.
Conservation Groups such as NFAC, Royal Forest & Bird Protection Society who have very strong environmental protection lobbies,
The Recreational interests such as the Yachting and Cruising clubs.

When talking of a dialogue there is no formal mechanism existing which brings together these various groups. When discussing this important PR role and education role it is important to get to all these groups, not just half of them.

The discussion on harvesting emphasised the need for a regional skills build up, particularly for use with hauler logging. Most of all, the groups emphasised the need for early planning. Most people based decisions on their own local knowledge and so it is important in areas such as Marlborough where new skills and new developments are required that the experience of people from other regions are tapped. Also, it is important that planners have some input as far as species, siting, etc, at time of establishment.

In summary, it would seem that the techniques are available, the experience is available, and all that is needed is the confidence to put these into practice and maintain a good dialogue with the appropriate authorities.

(b) MANGATU FOREST - Robin Black

Mangatu was set up primarily as a protection forest and most groups emphasised that it would be very difficult to expect a contractor to make a viable logging proposition. The area was set up by the State and the State must therefore sort out the initial problems and find out the constraints which can then be imposed for the future. As was pointed out, the first five years are the crucial ones because they are on some of the worst country. If this is sorted out the State could then put the constraints they require on other logging areas in Mangatu forest. The various terrain types is one of the difficult problems. The difference in age classes counters the possibility of setting up experiments on different terrain types. The operation trial process is probably the most sensible to pursue. To cover the Homestead Creek area over a five year period would require restricting logging in one sub-catchment in summer and the bottom of another sub-catchment in winter. Haulers and FMC seemed to be the most logical equipment to handle the country. Any additional tracking in this earth flow country is not on. Most groups recognised that the Tarndale road would no longer exist by the time the bulk of the forest is available for logging. This County road then could only be used from the Mangatu slip south. Further Catchments to the north and other private plantings would have to come down through the forest. This is the only choice available. The riverbed has possibilities but also problems. Flash floods can occur in any month of the year. Logging equipment if not moved rapidly could be rendered useless. To use the river for the total volumes to be removed per annum certainly would require a surge chamber if logging could only be done over 6-8 months of the year.

The transport of logs down the riverbed would need rigs with low ground pressure tyres. The expense of sorting out the County road is one of the major problems. If this cannot be sorted out then the river will have to become the main highway. It would appear that in the initial five year period with smaller volumes being removed, the existing Tarndale road would be suffice but subsequent logging would require a more permanent road set up. The sieve planning procedure is a good one and should work well in Mangatu. It could tie in with computer planning techniques with basic scientific input and inputs from the existing unknowns which could be sorted out after the initial five year period. One of the unknowns is how the class 5 country will react to logging. At this stage it is unkown if the earth flows will be reactivated. It must be the responsibility of the state to find out these things and not left in the hands of logging contractors. Overall it appeared that logging in Mangatu would be far from economic but Mangatu wood flows must be looked at as part of a total overall regional resource.

(c) SMALL WOODLOTS - Peter Wallis

In presenting the constraints of the small woodlot it was emphasised that there would be considerable difficulty in producing cost competitive wood from woodlots compared to other major forests. Over half the woodlots being established in New Zealand are under 20 hectares and represent less than 1% of the total forest estate. The picture painted was not bright but the discussion groups do not consider all is doomed for the small woodlot owner. The groups showed that on a co-operative effort the small woodlots, given a sound planning approach, and a co-operative effort, can be harvested within a reasonable cost range. To allow this wood to be marketed either locally or for export. Costs in the range of \$12-\$14 per m^3 for a small woodlot up the East Coast. The small woodlot owners have the capability of putting wood in Gisborne at a cost competitive to that of the large forest in the East Coast region. The small woodlots will not have the big overhead and planning requirements as will be necessary from the likes of Mangatu forest.

Another feature of the discussion groups was the similar approach to planning and the means of logging. Also identified was the need for an on-going approach to recover capital costs. The situation over the next 10 years is far from clear but it would seem that the small woodlots can be logged cost effectively and have a big impact on wood flows within regions.

- SESSION 6 -

EVENING SESSION :

RECENT EQUIPMENT DEVELOPMENTS

Chairman : Phil Coates, LIRA

FILMS AND SHORT PRESENTATIONS BY EQUIPMENT SUPPLY AND SERVICING COMPANIES

(a) Film : FMC
Jim Williams, Hughes and Cossar

(b) New Machines for Smallwood Harvesting
- Double Drum Winches
- Bell Loger
Geoff Wells, LIRA

(c) Application of helicopters in N.Z. (Film)
John Fennel, Helicopters N.Z. Ltd

(d) Planning for a new machine development
Iwafuji Skidder
Terry Hefferen, Motor Holdings Machinery Ltd

(e) Timberjack RW30 Feller/Delimber/Forwarder (Film)
Motor Holdings Machinery Ltd.

- SESSION 8 -

FIELD TRIP

WHAKAREWAREWA STATE FOREST PARK

Tour Leader : Des Bergman, Officer in Charge,
Whakarewarewa Forest

TRIP OBJECTIVES

- To look at and discuss the implications of planning and logging in high recreation and aesthetic areas.
- To discuss needs for small coupes and directional felling.
- To look at a difficult logging area on heavily dissected volcanic soils.

WHAKAREWAREWA STATE FOREST PARK

STOP 1

COMPARTMENT 7 (Hill Road)

Stand history -

ESTABLISHED	Pinus radiata 1914
CLEARFELLED	1939 - 1954
REGENERATED	1939 - 1955
LOW PRUNED	1945 - 1948
HIGH PRUNED	1955 - 1957
THINNED (200 sph)	1962 - 1964
VOLUME PER HA	750 m^3

Sales from current clearfelling

BUTT PEELERS	Henderson and Pollard
C & I PEELERS	N.Z. Forest Products Limited
SAWLOGS	Pine Milling, Rotorua, Pukepine, Te Puke
INTERNODE PEELERS	Henderson and Pollard
PULP	Tasman

Product	41%	by volume	PEELERS
	49%	" "	SAWLOGS
	10%	" "	PULP

SMALL COUPES

Maximum size clearfelling in Whaka is 5 ha. Stand will not be re-enterd for 5 years until current logging areas have greened up.

Directional Felling Trial FRI/LIRA

FRI work under control of Glen Murphy
LIRA work under control of John Gaskin

FRI Objectives :
To assess quality increase or degrade, improved utilisation, increased value recovery and cost effects of directional felling.

LIRA Objectives :
To determine the best techniques and equipment required to directionally fell. to monitor specific results at the stump such as butt-log degrade, time and productivity and special problems.

Trial To date :
FRI set out four 2 ha plots, measured and assessed each tree within the plots and used the MARVL program to assess maximum value. The plots were :

- fell directly across slope
- fell with tops 45° up slope
- fell with tops 45° down slope
- fell directly downslope (control).

Each tree is being assessed after felling to measure stump height, butt damage, time to fell, direction of fall to intended, special requirements (and why) length of tree to first break, subsequent breaks, why tree smashed, etc.

This trial is continuing. Two plots were completed at time of this visit.

STOP 2

COMPARTMENT 22

Douglas Fir	PLANTED	1912
	LOW PRUNED	1936
	EXTRACTION THINNED	1948-56

Steep areas overlooking Blue Lake.

Discussion of future management of these stands.

STOP 3

WAIMUNGU AREA

A look at and discussion on planning and logging of heavily dissected Rotomahana mud soils now established in Radiata.

- SESSION 9 -

PRINCIPLES AND SUMMARY

Chairman : Robin Cutler, N.Z. Forest Service

(a) "PRINCIPLES OF PLANNING FOR FOREST HARVESTING"
Peter Hill, Forester, Forestry Training Centre

(b) "NEW DIRECTIONS FOR RESEARCH - AS A RESULT OF SEMINAR"
Jim Spiers, Director, LIRA

(c) "SEMINAR SUMMATION"
Robin Cutler, N.Z. Forest Service.

SESSION 9
PAPER a

PRINCIPLES OF PLANNING FOR FOREST HARVESTING

P.J. HILL
Forester
Forestry Training Centre

INTRODUCTION

The word 'planning' is used to describe anything from a series of arbitrary or dogmatic decisions to a critical and sophisticated investigation into the whole range of possible choices open to an enterprise. It is convenient to regard planning, in a general sense, as embracing three closely related activities. These are first, the collection and assembly of data, secondly the examination and testing, against the correct criteria, of the various possible courses of action and thirdly, the formulation of plans.

Planning for forest harvesting is no different from the planning of any production process. The same three stages of collection and examination of data followed by formulation of, in this case, the logging plan, have to be carried out.

I propose in this paper to describe the three broad levels of planning that apply to forest harvesting; Indicative, Tactical and Operational, and within these levels to briefly outline the data that has to be collected, the types of examination and testing that lead to decision making and the formulation of operational plans.

By this stage in the seminar, we will have examined three future harvesting problems by the case study method, therefore most of the planning steps should have become abundantly clear by now so this paper should serve as a formal summary of what we have found out for ourselves already.

INDICATIVE PLANNING

Although the seminar is aimed at discussing tactical planning which has been duly defined as, "the ways and means of logging an existing forest so that production, safety, and environmental protection are compatible at least cost, and that management and off site constraints are met", I find it necessary to extend the time horizons backwards so we can consider what previous decisions lead us to the point where tactical planning begins.

In other words, what data has to be collected, synthesised and acted on before it is decided to make the first important decision - to log this particular forest or part thereof.

There is no guarantee that all future wood supplies growing today will be logged. Certainly our history to date has proven that if the exotic resource is there we will find a use for it. However, in the not too distant future there will be wood surplus to our present requirements becoming available and if demand does not rise at the same rate as availability then the harvest planners will have some choice as to where they procure the wood from. If this situation arises then the planners may well be looking for comparative least cost areas.

Table I outlines the major factors that have to be taken into consideration before the decision will be made whether to log or not.

TABLE I: INDICATIVE PLANNING - Major Factors and Description

+ Broad Based Mensuration Data: This will be needed to give a reasonably precise estimates of age class structures, average tree sizes, potential annual volume available for harvesting and potential product types, etc. The national planning model provides this data on a regional basis.

+ The Topographic Mix - Steep to Rolling: The proportion of steep to rolling, or static to mobile system topography has to be determined. This has a direct effect on the examination of possible logging systems.

+ Potential Markets and Utilisation Plants: These will have to be determined although the information may not be accurate it is needed - (1) To ascertain potential economic viability of harvesting and processing, and (2) For the calculation of likely transport leads and maximum load sizes.

+ Likely District Council or County Attitudes to Forest Harvesting: If forestry is a conditional land use then there may be restrictions placed on harvesting. There also may be requirements that the forest owner or customer pay for upgrading and maintaining county roads.

+ Likely Catchment Board Attitudes to Forest Harvesting: If the soil types are likely to be sensitive to logging then all possible means will have to be examined to ensure that logging meets catchment board standards. It may pay to include catchment board personnel in the planning team at this stage.

+ Possible Logging Systems: The potential systems to do the job will have to be listed and the decision making process to sort out which are the most likely systems, begun. It may be necessary to conduct trials to see which systems meet management constraints.

+ Capital and Operating Costs for Logging and Transport: Following on from the potential logging and transport systems it will also be necessary to attempt to look broadly at possible capital and operating costs for these systems. Decisions will have to be made as to whether the average landed cost is acceptable.

+ Labour Supply and Skills: Will the necessary skills for logging be available in the area concerned. If not, will training programme have to be instituted or will necessary skills be imported from other regions.

+ Planning and Management Skills: Does the organisation have adequate planning, management and supervisory skills to control the operation. If not, do you train or buy in.

+ Sale Type: Is the Sale Contract, assuming there is to be one, likely to be Log Sale or Stumpage. This information will affect, to some degree, who does the planning, management and supervision but does not negate the fact that someone has to do it.

It can be seen by examination of Table I that although the factors under consideration are not of a tactical nature, there will be decisions made at the indicative level which could well affect such factors as, logging system selection, transport methods, etc., that the tactical logging planner may have to live with for a long time. However, tactical logging experts are usually called in to advise at the long term (indicative) level.

The trend today is for a team of people with skills in different areas (multidisciplinary) to be involved with indicative planning. The number of different areas to be explored require inputs from economists, hydrologists, geologists, engineers, logging planners, foresters, etc., and it is simply not possible for any one person to have the necessary skills. Therefore teams of personnel with the required skills work together to analyse the situation and make the decision whether to proceed or not and if so, give firm indications of likely methods of operation.

The time horizon for this planning level can be anywhere between two to ten years or possibly even longer. The planning teams have to build a rapport with outside agencies such as catchment boards, district councils, port authorities and the public. Without communication between all parties likely to be affected by harvesting schemes, there could well be frustrations and unnecessary delays.

TACTICAL PLANNING

If after the initial analysis it is decided to go ahead and log an area of forest, then another set of factors come in for consideration. These are outlined in Table II. They have been subdivided into two sets of factors, primary and secondary. In general, the primary factors or sets of data have to be assimilated before the secondary factors can be actioned.

TABLE II: TACTICAL PLANNING - Major Factors and Descriptions

Primary Factors

+ Detailed assessment data for volumes and quality of wood resource: This is probably the most important set of data required at the tactical level. Virtually all consequent decisions rely on precise mensuration data.

+ Sale Contract: Type of sale - this may have already been determined, i.e. stumpage or log sale.
Pricing point - Concerning log sales, on skid, on truck, at mill.

Length of sale, right of renewal etc.
Weight - volume conversion procedures.

+ Settle on logging and transport system design and equipment selection.

+ Assembly of productivity data and work study standards for costing purposes: This information is needed for each system design so that potential production from each area can be calculated along with the cost per unit of production.

+ Contractor and/or wage gang capital and cash flow requirements: This pertains to both logging and transport. If wage gangs are to be used the capital cost of equipment and cash flow requirements will need to be calculated. If contractors are to be the prime source of production and transport then annual operating costs need to be calculated.

+ Preparation of annual cutting programmes: These programmes denote what volumes of specific species are to be cut from specified areas of a forest. The total scheduled volume usually equals the annual sale volumes that a forest is committed to produce.

+ Preparation of detailed logging plans for areas to be harvested: These plans consist of topographic maps giving position of roads and landings, plus detailed analysis of how the operation is to be carried out with all relevant cost data.

Secondary Factors

+ Catchment Board approval of logging plans: In some parts of N.Z. - particularly where a section 34 of the Soil Conservation and Rivers Control Act is in force - all logging plans have to be approved by catchment authorities.

+ District Council approval of logging and transport plans: Many district councils are likely to want to control some aspects of forest harvesting. Logging and transport plans may be required to be approved before they can be actioned.

+ Forward roading: Spur roading should be formed about 12 months before logging to allow for consolidation. Road stripping and formation operations have to be planned and actioned. The logging plan is needed before this operation can begin.

+ Inform outside organisations of start up dates: If this is a new operation then organisations such as Timber Workers Union, Drivers Union, Department of Labour, etc., will need to be informed of when operations are likely to commence so they can provide the necessary servicing.

+ Advertising of logging and transport contracts - Subsequent negotiations.

+ Purchasing of equipment for wage operations.

In effect, the culmination of the tactical planning exercise is the production of the logging plan which, after approval by the harvesting organisation and any other agencies such as forest owners, catchment authorities and district councils, can then be put into action.

OPERATIONAL PLANNING

The final level of planning which is then entered into is the preparation of operational or day to day management systems. These management systems provide the control cycle for the planning-operation process. Information is needed so that the planner can ascertain if the operation is progressing according to the plan or not. If there are differences between what was planned and what actually happened, then analysis of information produced by the control systems will allow appropriate changes to be made either to the operation or the next generation of plans.

If a particular organisation has been harvesting in a region for some time then most of these control procedures will already be in operation. However, if an organisation is to be involved in harvesting for the first time, or is starting in a new region, consideration must be given to the factors outlined in Table III.

TABLE III: OPERATIONAL PLANNING - Major Factors and Descriptions

+ Production cost control: The establishment of cost control methods by which actual costs can continually be compared to estimated costs etc.

+ Quality control systems: The establishment of systems by which cutover control, residual wastewood and residual crop, if thinning, can be measured and achievement assessed.

+ Log cutting strategy: Development of systems to obtain maximum value recovery from logs.

+ Product output control: The establishment of a system so that the production of log volumes by product type can be compared against the assessment data. This enables both a check on precision of assessment data and a check on attempts to maximise value.

+ Contingency plans for fluctuating markets: How will management respond to over or under supply situations. The choices may range from shifting gangs to higher or lower productive areas, to adding or reducing production units.

+ Review of work study standards: The establishment of a system of review of work study and productivity data.

+ Accident Prevention Schemes: Setting up a system of training, education, incentive etc., to ensure the maintenance of accident free operations.

+ Logging system review: Have we got the best system/s operating???

TRAINING FOR LOGGING PLANNERS

Throughout this paper I have referred to Logging Planners and an inspection of the number of different areas in which the logging planner must have some knowledge should lead to the conclusion that such a person has to develop a wide range of skills. I accept, and indeed support, the present trend of multidisciplinary teams operating at the indicative level where the breadth and depth of the examination requires specialists in the relevant fields. However, at the tactical level the logging planner is often on his own and therefore must exhibit skills in a wide range of disciplines. Not only must he have an indepth knowledge of logging systems and their application, he must also be able to assimilate data pertaining to soils, hydrology, economics and costing, forest mensuration, work study, roading, labour skills, photogrammetry, etc.

The challenge is how do we train such a person? In the past we have relied on experience often, but not always, coupled with some degree of formal training (woodsman, ranger, forester, engineer). Will this system be able to produce the number of planners with the increased skill levels required for the future crop, much of which will be on steep country with possible environmental constraints? Formal training in logging planning in New Zealand at the moment is limited to basic coverage in the forestry degree at Canterbury, and the N.Z. Certificate of Forestry, plus 5 day short courses taught at the Forestry Training Centre. If further comprehensive courses are required the New Zealand logging planner has to travel overseas, probably to Oregon State University in the United States, which offers a ten week course in Forest Engineering. To date only two New Zealanders have attended this course both of whom are working in logging research today. I would suggest that either there is a concerted drive to upgrade the courses available in this country or we start to send our logging planners overseas for further training.

SUMMARY

1. Planning for forest harvesting can be divided into three broad levels; Indicative, Tactical and Operational. Within each of these levels data has to be collected, examined and decisions made. In the case of new operations, all three levels may have to be actioned, in the case of on going operations only the tactical level may need to be actioned.

2. The complexity of some harvesting proposals require the utilisation of specialists from many fields, particularly at the indicative level. Time horizons should be taken into account when considering harvest proposals. Communication between all parties likely to be affected by a harvesting proposal is vital to the success of the operation.

3. The logging planner may only play an advisory role at the indicative level but is the key figure at the tactical level.

4. The large volume of wood available for harvest in the near future and the fact that much of the wood is on steeper country with consequent potential environmental problems makes it imperative that full consideration is given to training logging planners in the required skills.

REFERENCES: Johnston D.R. et al. 1967 "Forest Planning", Faber.
L.I.R.A. 1979 "David Henry Scholarship Report Pacific North West North America Study Tour", N.Z. Logging Industry Research Association Project Report No. 9.

DISCUSSION

It was mentioned that extra controls would be needed in the planning process to monitor the effects on the environment from logging operations. Also discussed was the type of planner which would be needed in the future. Would planning be done by a panel of experts or would it rely on the commonsense approach by a single person. It was felt that for large complicated sale proposals, the panel of experts would be needed however, at a tactical level it was down to one man and it was hoped that he would have good commonsense.

SESSION 9
Paper (b)

J.J.K.Spiers

NEW DIRECTIONS FOR RESEARCH

The objective of this summary is to identify national research objectives in logging arising from the discussions during the seminar, aimed at general problems rather than specific regional ones.

Firstly, we need to investigate the limits of applicability of some of the new concepts shown and discussed. Such things as flexible track skidders, small versatile machines, aerial and water options for transportation. We need to test the limits of these and be able to counter the arguments of some of the inexperienced advocates of barely understood technology.

There is obvoiusly a need to continue with the development work for haulers. In particular aiming at low cost mobile and flexible units that would be suitable for difficult areas, particularly in the smaller forests.

LIRA needs to develop the application of the new technology currently available. There are two areas where this can be done in close association with the Forest Research Institute where it is important to get applied in the field the new ideas being developed. The first of these would be in the computer application to planning, so ably demonstrated by Reutebuch. In particular, LIRA has the opportunity to develop a service for its members in the application of this technology so that it can be used by the smaller organisations. With the equipment centrally operated being available to all on a service basis.

The MARVL program indicates the possibilities for immediate financial gains by control of cutting for value. One or two industry organisations have already used this technique but again it could be set up for wider use for the smaller organisations who might not be able to apply it in-house.

There is still a great need to influence approved awareness of the new tools available and increase management skills in the logging industry generally. To assist doing this LIRA should aim to :

1. Develop a course on the tactical planning of logging operations and possibly eventually aim at producing a handbook on this.

2. Investigate possibilities for a guideline check-list for smaller operators so that many of the problems covered so ably by Hampton and Wallis, can be avoided at the initial planning stages.

3. A new area of possibility is to look at guidelines for the managment of time and work in the area where Grayburn pointed out the problems of manipulating application of machine and men time in an environment of high capital costs, shift work, increased holidays and institutionalised downtime.

Although it is not LIRA's objective to work on some of the very specific problems thrown up by the case studies, it might be desirable to review the main requirements.

The East Coast has a lead time of five years. It was agreed the work here is primarily an N.Z. Forest Service responsibility to test systems. However, undoubtedly, some basic research is needed into the interaction of new track, wheel or other transport systems on sensitive soils. In the case of Mangatu this means both slope and river bottom soils, for extraction and first stage transportation respectively. Two areas not developed in the discussions warrant investigation are artificial road construction materials and long reach cable systems.

The small woodlot problem has a 15 year lead time before significant volumes come on stream. In the meantime there are plenty of areas to test possibilities on a trial basis. Obviously the main need is the development of versatile cheaper machines for small productivity requirements. The other major area is the technology transfer one in that many of the operators in such areas, have no knowledge of existing technology. Simple information material to assist in planning and operations is necessary but better distribution channels to ensure it gets into the right hands are required.

Marlborough Sounds again has a 15 year lead time which gives some time to test options. There are exciting technological options available but in the main the group discussions opted for conventional systems. Major problems in the area are political with a wide range of bodies with legitimate and imagined interests. I believe the Sounds offer a unique opportunity to apply new environmentally sound options. Every now and then a research organisation has to go against the stream or concensus and thus I believe that to take advantage of the unique situation in this region one could achieve profitability and conservation by felling very small settings, extracting those directly to an assembly point by aerial methods and that the assembly point could be the hold of an export ship. Feasibly a helicopters high hourly productivity might neatly fit ships loading requirements. I believe the major problems are political, not technical.

T.R.Cutler

SUMMING UP

My brief for this final session of the seminar is to bring out some of the major points raised by speakers and in discussion afterwards.

One of the major benefits from seminars like this one is that they provide forums for loggers, forest managers, planners and scientists from the private and State sectors to meet and discuss common concerns among themselves and with staff from regulatory authorities. All this in an easy informal setting provides a basis for good communication among all those with an interest in the logging industry.

In his keynote address the Chairman of LIRA raised a number of issues that planners need to be aware of.

1. Any plan needs to be flexible and have a reasonably long planning horizon. Forestry as one speaker said is ideally placed to have well thought out harvesting plans in view of the time we have between planting a crop and harvesting it.

2. We need to know the nature of the log supplies needed - for what - and for how long.

3. We need to improve our cutting, sorting, and control of delivery of the various products. Not only do we need to be efficient in our use of scarce resources but we will also be largely competing on overseas markets with our products.

4. We will need to improve our logging practice near public highways and other environmentally sensitive areas to reduce visual impacts and improve our public image.

5. We will need to plan the use of men and machines and the maintenance of machines more effectively to ensure their greater efficiency.

6. Because of the very substantial increase in wood supplies from the 1990s onwards we must plan for the retention of skilled loggers and the recruitment of people to train in the skills we will need.

7. I would add another point that came up in one of the papers and that was the need to remember that logging planning should not be done in isolation. Forestry as a land use is being discriminated against in many regions partly due to blind prejudice which can only be improved by encouraging a greater understanding of forestry by our opponents and partly by the harvesting implications on local authority roads. This latter one is certainly an area where logging planners will need to ensure that local authorities are kept up to date with their forward plans to ensure the smooth flow of wood from our forests in the future.

Other points that arose during the course of the seminar covered a wide spectrum of constraints and valuable observations based on practical experience. In assessing the tree crops in our forests we were reminded that a number of sophisticated mensurational systems have been developed and are available to help us to predict future volumes and piece sizes, etc.

During the panel discussion on roading it was drawn to our notice that tracks and landings are capital assets and should be the responsibility of forest owners rather than loggers. The importance of correct siting of arterial roads when a forest is being established was emphasised. Far too often when a forest is being established there is a tendency to delegate that development to relatively junior staff because we feel the work load does not justify senior staff. In fact we should have our most experienced senior staff involved at that stage.

It was encouraging to hear that the forest operations guidelines are operating reasonably well with possibly only the need to develop supplementary guidelines to suit local conditions.

In meeting some of the challenges of logging difficult sites in the future, the range of systems and machinery available here and overseas was demonstrated. An important thought was that we should not confine our thinking to the existing systems we know.

The example of helicopter logging clearly demonstrated that with high cost logging systems planning and administration must be covered to the "n' degree. It would almost be worthwile to give the manager of such an operation a stopwatch calibrated in dollars to remind him how much every second of wasted time meant on the cost of the operation. Also on the question of the very high cost of most new logging equipment the need to use that equipment fully was emphasised and also the need to give loggers sufficient security of work to enable them to invest in such equipment. Otherwise we will be obliged to take second hand, second best options.

Computers, as one speaker said, tend to frighten off most people not familiar with them. Although he succeeded admirably in explaining their utility to logging planners I suspect many were still left frightened of them, especially those from smaller companies where the acquisition and manning of such an installation might be difficult. However, if they were convinced that computers could assist them, I believe they will find that services will be available through consultants.

The special needs for logging woodlots came through very clearly. This is a field that will need a great deal of planning and innovative thinking if woodlot owners are to receive worthwhile prices for their wood.

Concluded with vote of thanks to Mr Spiers, Director of LIRA and his staff for the excellent organisation of the seminar and the delegates for their attendance.

- APPENDICES -

APPENDIX 1

REGISTRATION LIST

CLIVE ANSTEY	N.Z. Forest Service, Wellington
DR FLOOR ANTHONI	ACAC Ltd., Auckland
DAVE BAIGENT	Fletcher Forests, Putaruru
LESTER BELL	N.Z. Forest Service, Taupo
DES BERGMAN	N.Z. Forest Service, Rotorua
ROBIN BLACK	Hawkes Bay Catchment Board
GEORGE BONNER	N.Z. Forest Service, Golden Downs
BOB BOYLE	N.Z. Forest Service, Kaingaroa Forest
DAVE BRETT	N.Z. Forest Service, Taupo
FRED BREWER	N.Z. Forest Service, Gisborne
LIZ BRUNSDEN	LIRA
COLIN CASHMORE	Cashmore Contractors Ltd., Wellsford
ROGER CAULTON	Chandler, Fraser & Larsen, Rotorua
PETER CLARK	P.F. Olsen & Co. Ltd., Rotorua
PHIL COATES	LIRA
TRICA COATES	LIRA
BRIAN COCHRANE	B.R. Cochrane Ltd., Taupo
MIKE COLLEY	Fletcher Forests, Taupo
BRUCE COOPER	N.Z. Forest Service, Napier
COLIN CORNELIUS	N.Z. Forest Products Limited, Tokoroa
ROBIN CUTLER	N.Z. Forest Service, Wellington
MAURICE DALY	Dalhoff & King., Rotorua
ANDREW DAKIN	Auckland Regional Authority
RIWHI DIAMOND	Kaingaroa Logging Company, Murupara
VIV DONOVAN	LIRA
IAN DOUGLAS	Fletcher Forests, Christchurch
GRAHAM EAGER	Tasman Pulp & Paper Co. Ltd, Kawerau
LIONEL ELLIS	Henderson & Pollard Ltd., Auckland
DIGGER EVANS	N.Z. Forest Products Limited, Tokoroa
STAN EVANS	Carter Holts, Napier
DICK EVERTS	Forest Research Institute, Rotorua
PETER FARLEY	N.Z. Forest Service, Wellington
FRASER FIELD	Henderson & Pollard, Auckland
KEVIN FORD	Henderson & Pollard, Auckland
BILL FRASER	Bruce Henderson & Assoc., Tauranga
JAMIE FRY	N.Z. Forest Service, Kaingaroa
JIM GARDINER	H. Baigent & Sons Ltd., Nelson
JOHN GASKIN	LIRA
TED GAUNT	N.Z. Forest Service, Rotorua

LES GEDDES	N.Z. Forest Products Limited, Tokoroa
IAN GLENNIE	N.Z. Forest Service, Gisborne
PETER GRAVES	Fletcher Forests, Taupo
TONY GRAYBURN	N.Z. Forest Products Limited, Tokoroa
SANDY HAMPTON	Carter Holts, Napier
BRUCE HASTIE	Kaingaroa Logging Company, Murupara
TERRY HEFFEREN	Ward Hill Ltd., Rotorua
AART HEINEN	N.Z. Forest Service, Gisborne
JAMES HEKE	Fletcher Forests, Taupo
BARRY HENWOOD	International Harvester Co., Auckland
DAVE HERD	N.Z. Forest Service, Auckland
PETER HILL	Forestry Training Centre, Rotorua
MERV HODGE	Ward Hill Ltd., Rotorua
SHAUN HURST	Hydraulic Machinery Co., Pakuranga
RALF JAKOBSSON	Forest Research Institute, Rotorua
TOM JOHNSON	Forestry Training Centre, Rotorua
REX KING	N.Z. Forest Service, Palmerston North
DAVE LAMBERTON	N.Z. Forest Products Limited, Tokoroa
JOHN LEWIS	N.Z. Forest Service, Rotorua
BILL LILEY	J.G. Groome & Assoc., Taupo
PHIL MADILL	Fletcher Forests, Putaruru
BRIAN MANNINGTON	Morbark Pacific Ltd., Rotorua
PHIL MATHEWS	N.Z. Forest Service, Taupo
BRUCE MILLER	Thames Sawmilling Co. Ltd., Thames
GLEN MURPHY	Forest Research Institute, Rotorua
NEIL MYTHEN	Forest Research Institute, Rotorua
ROSS MACARTHUR	Marlborough Catchment Board, Blenheim
MIKE McCONCHIE	Forest Research Institute, Rotorua
MARK NICHOLLS	Fletcher Forests, Taupo
RON OHARA	N.Z. Forest Service, Gisborne
RON O'REILLY	University of Canterbury
DEL PACKER	Fletcher Forests, Taupo
ROBIN PETERSON	Fiji Pine Commission, Fiji
CHRIS PHILLIPS	N.Z. Forest Service, Gisborne
ANDY PIERCE	Forest Research Institute, Christchurch
IVAN PIVAC	Henderson & Pollard, Auckland
BOB POCKNALL	N.Z. Forest Service, Gisborne
JERRY POMARE	N.Z. Forest Products Limited, Tokoroa
ALBIE PORTEOUS	Pan Pac Logging Division, Taupo
ROB PREBBLE	LIRA
PETER PRICE	N.Z. Forest Service, Golden Downs

BOB PRIEST	Waikato Valley Authority, Hamilton
DAVE PYE	N.Z. Forest Service, Auckland
SANDY RAE	N.Z. Forest Service, Turangi
STEVE REUTEBUCH	Forest Research Institute, Rotorua
BRUCE RIDDOLLS	Worley, Downey, Madeno Ltd., Auckland
JIM RILEY	Fletcher Forests, Tairua
CLIFF ROBILLIARD	P.F. Olsen & Co. Ltd., Rotorua
KIM ROBINSON	Kaingaroa Logging Company, Murupara
JOHN RURU	N.Z. Forest Service, Te Kuiti
JOHN SCHRIDER	N.Z. Forest Service, Kaingaroa Forest
BILL SEWELL	N.Z. Forest Products Limited, Tokoroa
JIM SEYMOUR	N.Z. Forest Products Limited, Tokoroa
JIM SHARP	N.Z. Forest Service, Kaingaroa Forest
BRUCE SHEARER	Waipa Logging, Kaingaroa Forest
DEBBIE SIMPSON	LIRA
MURRAY SIMPSON	N.Z. Forest Service, Gisborne
LEW SKUDDER	N.Z. Forest Service, Rotorua
BOB SOBELS	N.Z. Forest Service, Kaingaroa Forest
GRAHAM SPERRY	Fletcher Forests, Taupo
JIM SPIERS	LIRA
KEVIN STEEL	Waikato Valley Authority, Hamilton
RON SUTHERLAND	Marlborough Catchment Board, Blenheim
CEDRIC TERLESK	Forest Research Institute, Rotorua
BERNIE TIENTJES	Tasman Pulp & Paper Co. Ltd., Kawerau
ALAN TIER	N.Z. Forest Products Limited, Tokoroa
KARL TOLLEY	N.Z. Forest Service, Golden Downs
JOHN TUSTIN	Forest Research Institute, Rotorua
LOUW VAN WYK	Forest Research Institute, Rotorua
SIMON VARI	Kaingaroa Logging Company, Murupara
LINDSAY VAUGHAN	N.Z. Forest Service, Blenheim
HERB VLEESHOUWER	Clyde Industries, Rotorua
PETER WALLIS	P.F. Olsen & Co., Rotorua
BOB WARD	Dalhoff & King Ltd., Rotorua
TOM WARD	N.Z. Forest Service, Rotorua
ROBIN WATSON-PAUL	Dalhoff & King Ltd., Rotorua
GEOFF WELLS	LIRA
BRUCE WILLIS	N.Z. Forest Service, Gisborne
PAUL WILSON	Fletcher Forests, Nelson
RON WREN	N.Z. Forest Products Limited, Tokoroa
WARREN YARDLEY	N.Z. Forest Products Limited, Tokoroa
MORRIS YEOMAN	Tasman Pulp & Paper Co. Ltd., Kawerau

LIRA TACTICAL PLANNING SEMINAR

APPENDIX 2

- PROGRAMME -

TUESDAY - 9th JUNE 1981

Registration 8.30 a.m.

Seminar Opening 9.00 a.m. — *J.J.K.Spiers, LIRA*

Keynote Address 9.00 a.m. — *A.W.Grayburn, NZ Forest Products Limited*

Seminar Programme & Objectives 9.45 a.m. — *Viv Donovan, LIRA*

Morning Tea 10.00 - 10.30 a.m.

SESSION 1 (10.30 a.m. - 12.30 p.m.) — *CHAIRMAN - Jim Spiers, LIRA*

Planning Constraints

(a) The Land — *Andrew Pierce, FRI Ilam*

(b) The Crop — *Pat Crequer, J.G.Groome Associates*

(c) The Management — *Sandy Hampton, Carter Holts*

Lunch 12.30 - 2.00 p.m.

SESSION 2 (2.00 - 5.00 p.m.)

Part I - Roading — *CHAIRMAN - Lionel Ellis, Henderson & Pollard*

Question and Answer Panel. Panel Members: *Colin Cornelius, N.Z.Forest Products*
Peter Farley, N.Z.Forest Service
Jim Riley, Fletcher Forests

Afternoon Tea 3.30 - 4.00 p.m.

Part II - Environmental Protection — *CHAIRMAN - Ron O'Reilly, University of Canterbury*

(a) Roading and Environmental Guielines - Are they Working? — *Bob Priest, Waikato Valley Authority*

SESSION 3 (Evening 7.30 - 10.30 p.m.)

Film and discussion evening sponsored by Pumicelands Section, N.Z. Loggers' Assoc.
(Bar Open)

CHAIRMAN - Cam Sycamore
President NZLA Pumicelands

Films: "The Tree Came Back"
"FIME 1980"

Slide discussion presentation - Planning Problems in N.Z.
"How Would Loggers' Handle these Situations" — *Jim Spiers, LIRA*

WEDNESDAY - 10th JUNE 1981

SESSION 4 (8.30 a.m. - 12.00) — *CHAIRMAN - Geoff Wells, LIRA*

(a) Principles of Selection and Design of Harvesting Systems — *Viv Donovan, LIRA*

Planning Principles for Newly Developed Systems — *CHAIRMAN - Viv Donovan, LIRA*

(b) Helicopters — *John Gaskin, LIRA*

(c) Steep Country for Smallwood — *Dave Lamberton, NZ Forest Products*

Morning Tea 10.15 - 10.45 a.m.

(d) High Speed Track Skidders — *Simon Vari, Kaingaroa Logging Company*

(e) Mechanised Operations — *Geoff Wells, LIRA*

(f) Computers for Planning (Background)
Demonstrations of Computer Technology — *Steve Reutebach, FRI*

Lunch 12.00 - 1.30 p.m. (Three sittings)

SESSION 5 *(1.30 - 5.00 p.m.)* *CHAIRMAN - Geoff Wells, LIRA*

Presentation of Study Areas

Marlborough Sounds *Lindsay Vaughan, NZ Forest Service, Blenheim*

Mungatu Forest *Robin Black, Hawkes Bay Catchment Board*

Small Woodlots *Peter Wallace, P.F.Olsen Consultants*

Assembly of Case Study Discussion Groups

Aims: (i) Recommend approach to planning and planning decisions
(ii) Recommend data information needs and experimentation or trials required.
(iii) Recommend harvesting system and transportation

Afternoon Tea 3.30 -3.45 p.m.

SESSION 6 *(Evening 8.00 - 10.30 p.m.)* *CHAIRMAN - Phil Coates, LIRA*

Recent Equipment Developments (Bar Open)
Films and addresses by machinery distributors:

(1) Hughes and Cossar - FMC equipment (film)
(2) R.C.MacDonald - Igland double drum winches and Bell Infield Logger
(3) Ward Hill - Iwafuji Skidder
(4) Helicopters N.Z. Ltd - Application of helicopters in N.Z. (film)

THURSDAY - 11th JUNE 1981

SESSION 7 *(8.30 - 10.30 a.m.)* *CHAIRMAN - Geoff Wells, LIRA*

Part 1 - Reports from Discussion Group Leaders

Part II - Final Summary of Case Study Areas

Marlborough Sounds, Mungatu Forest, Small Woodlots - Speakers as Session 5.

Morning Tea 10.00 - 10.30 a.m.

SESSION 8 *(10.30 a.m. - 3.00 p.m.)*

Field Trip
Bus departs DB Hotel 10.30 a.m. - visit to Whakawerawera State Forest Park to look at and discuss implications of logging and planning in high recreation and aesthetic areas. Also, needs of small coupes and directional felling. Visit will include visit to difficult logging terrain at Waimungu on Rotomahana volcanic ash soils. Packed lunch will be provided. Buses return to the hotel by 3.00 p.m.

Afternoon Tea 3.00 - 3.30 p.m.

SESSION 9 *(3.30 - 5.00 p.m.)* *CHAIRMAN - Robin Cutler, NZ Forest Service*

(a) Principles of Planning for Forest Harvesting *Peter Hill, Forestry Training Centre*

(b) Summary of Lessons Learnt and New Directions *Jim Spiers, LIRA*

(c) Seminar Summation *Robin Cutler, NZ Forest Service*

APPENDIX 3

SEMINAR EVALUATION

(Indicate your answer ✓)

The seminar as a whole was:

Disappointing	Good	High Value

We tried to vary the presentation in the programme. What did you think of these session

(1) Planning Constraints
This was aimed to present the basis for understanding good planning. Did it achieve its objective? Any comments on presentation? . . . .

Disappointing	Good	High Value
	Yes	No

(2) Roading Panel
Aimed to present a variety of views on roading problems, policies, location and design. Did it achieve this?

Disappointing	Good	High Value
	Yes	No

Environmental Protection
Aimed to present objective of guidelines and see how it was working. Did it achieve this?

Disappointing	Good	High Value
	Yes	No

(3) Film Evening
A relaxed way of presenting some basic information and to generate some discussion. Did it do this?

Disappointing	Good	High Value
	Yes	No

(4) Principles for New Systems

Aimed to present technical data on new systems to give a better understanding. Did it achieve this?

Disappointing	Good	High Value
	Yes	No

Computers
Aimed to present a new tool.
Do you now understand this technology?
Do you see a use for it in your organisation?
If it was avilable to you or your company as a service, do you think you would use it?

Yes	No
Yes	No
Yes	No

(5) Case Studies
Aimed to get involvement from those attending in examining future logging planning problems. Which group were you in?
Did you benefit from the discussion?
Did you find the topic of some value?

Disappointing	Good	High Value
Marlborough	Mangatu	Small Woodlots
	Yes	No
	Yes	No

(6) Evening Equipment Session
Aimed to relax, present something different and look at some new machine options. It was not well attended.
Did you attend?
If not, why? ....
Should we continuewith a machiney session in future seminars?

Disappointing	Good	High Value
	Yes	No
	Yes	No

(7) Case Study Summaries
Did you feel the conclusions gave valuable guides to planning in the study topic areas?

Disappointing	*Good*	*High Value*
	Yes	*No*

(8) Field Trip
Aimed as a break from conference room and to see some problems of relevance.
Was it worthwhile?

Disappointing	*Good*	*High Value*
	Yes	*No*

(9) Organisation
Have you and suggestions for improvement?

Poor	*Good*	*Well Run*

....

Have you any complaints - things that need to be corrected in future?

....

Have you any further comments?

ACKNOWLEDGEMENTS

LIRA is most appreciative of the assistance and effort given so readily by those persons who presented papers at the Seminar and researched the background for the case study presentations.

In addition, LIRA wishes to thank :

Those persons who chaired sessions, lead discussion groups and participated in the question and answer panel.

N.Z. Loggers Association Pumiclands Section for hosting the evening meeting.

F.R.I. and C.S.I.R.O. for the use of their films.

F.R.I. for allowing their computer to be set up and demonstrated.

Machinery distributors for their evening presentation.

N.Z. Forest Service, Whaka Forest staff for their field trip organisation.

All participants at the seminar who readily exchanged information and ideas to make this seminar a worthwhile forum on future logging planning needs for New Zealand.