SESSION I

Paper (c)

THE IMPORTANCE OF LABOUR TURNOVER IN THE LOGGING INDUSTRY

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INTRODUCTION

What is turnover? This Paper employs the general understanding of the term - "the loss of employees from an organisation for whatever reason".

The most commonly used measure of turnover is the "separation" or "labour turnover" rate, which is defined as:

$$\text{Labour turnover rate} = \frac{S}{N} \times 100,$$

where S is the number of separations during a specified period of time, and

N is the average number employed by the organisation during the same period.

Within this paper we are principally interested in the consequences of turnover on recruitment and training requirements for the logging industry. Before proceeding, it needs to be recognised that the turnover rates shown by component organisations may not correspond to turnover levels for the industry as a whole. This is because transfers are not normally included as organisational turnover. Thus, of the loggers leaving their current employer in the forthcoming year, some will leave logging altogether but others will change employers within the industry. The consequences for training are important. An example is seen in the case of NZFS Ranger trainees in the early 1970's. Within six years of starting their training, more than half had left the Forest Service, yet most of these remained within the forest industry (J. Gaskin, pers. comm.). From the total industry viewpoint their training was not being wasted.

TURNOVER IN THE LOGGING INDUSTRY

What is the level of turnover in New Zealand's logging industry? Quite simply, we don't have a precise answer. Indications have come from a variety of sources.

The Labour and Employment Gazette published by the Department of Labour produces annual summaries of the average annual turnover rates for all private industries. There is no indication of whether the logging industry lies above, below or at the average.

Labour Turnover Rates in the Private Sector Non-Seasonalised Industries (Per 1,000 Employees per Month)

	Feb 1980	Feb 1981	Feb 1982	Feb 1983
Quit rate[1]	34	30	32	25
Involuntary termination rate[2]	8	7	6	7
Total termination rate[3]	42	37	38	33
Corresponding terminations/annum (%)	50.4	44.4	45.6	39.6

1 Voluntary terminations of employment, per 1,000 employees.
2 Involuntary terminations of employment (including sackings, redundancies, deaths and retirements), per 1,000 employees.
3 Total number of termination of employment, per 1,000 employees.

Labour and Employment Gazette, September 1983.

Fenton and Terlesk (1971) noted that "...[the] labour turnover rate for a private logging company ranged from 21% (in the recession year of 1968) to 100% over the last decade [to 1971] with a mean of around 46%." In the same paper, Fenton and Terlesk discussed the labour and staff turnover in "forestry" as a whole. The rate was much higher than for logging alone which is not surprising. General forestry work included activities which are seasonal in nature, and these can influence the turnover rate significantly.

Fielder (1979), in his study of the logging labour force, did not attempt to determine a value for turnover, but made a useful contribution to the topic by surveying the two previous jobs the loggers in his sample base had held. Approximately 45% of the 125 men interviewed worked in logging in their previous job, and approximately 30% were loggers in the job prior to that. Clearly, in the Bay of Plenty at least, a substantial proportion of turnover from individual employers remains in the industry.

Canadian studies have, in some examples, pointed to staggering turnover rates. Cottell (1974) records that in Eastern Canada the average weekly turnover rate for workers in logging was about 11% of the logging labour force in 1965 (i.e. 572% per annum). The rate had shown a gradual decline from the 1952 figure of about 14%. High turnover rates were typically found in isolated logging camps where hot weather, cold weather, flies, swamps and hard physical work are the traditional deterrents. But as Loughlan (in Irland, 1974) notes, "the worst deterrent to camp life and the most difficult to deal with is grinding isolation".

The Ross Report of 1973 (quoted in Journal of Logging, 1980) examines turnover rates in logging on Vancouver Island. "In Vanderhoof - Fort St James logging operations, turnover varied from 18% to

more than 600% annually. Turnover on Vancouver Island averaged 150%."

The most thoroughly prepared and reported study on forest industry labour turnover in New Zealand is that of Smith and Wilson (FRI Bulletin, No.56, 1983). They examined the employment records of a "large integrated forestry complex" and obtain data for twelve divisions including the pulp mill, paper mill, forestry division, logging division, garage and secretarial, finance and accounting department. Since their data spans the interval 1961 to 1979, there is a wealth of comparative information. Of most interest here is the labour turnover rate in logging, illustated in Figure 1. Between 1961 and 1979 logging has had a maximum turnover rate of 53.4% and a minimum of 8.4%. The average has been 25.6%.

Figure 1 : Turnover trend for logging division of one major company.
From Smith and Wilson (1983).

(Note : Before 1971 Garage and Forest Engineering Divisions were included with logging).

Smith & Wilson's paper represents the first detailed study of New Zealand logging turnover, but how applicable are the results to the logging industry as a whole? At least two opposing factors must be considered. On the one hand this "large integrated forestry complex" seems, on subjective assessment, to have lower turnover rates than the rest of the industry by virtue of its size, stability and location. On the other hand, of those employees it loses, a proportion would find continued employment as loggers, but elsewhere in the industry. The "complex's" loss is not the industry as a whole's loss, and so it may overestimate industry turnover. To resolve the question, turnover studies of other operations large and small will be necessary.

TURNOVER AND RECRUITMENT

The New Zealand forestry sector has of recent years attempted several forecasts of the industry's likely future. Included have been forecasts of the crop (Elliot and Levack, 1981), machinery (Donovan, 1982), roading (Farley and Hill, 1981), market demand (Cavana, 1983) and manpower (Johnston, 1965, Levack and Gilchrist, 1981, Makin, Levack, 1984). The manpower predictions are of particular importance in determining training requirements, but do not in themselves tell the whole story. They are a static representation only - a snapshot of the industry at selected future dates. To determine the likely number of new recruits to the industry, and hence the number who conceivably would benefit from training courses, turnover must be taken into account.

How significant is the effect of turnover? This is not an unreasonable question when the industry is on the threshold of a major expansion. A little more reflection however, will confirm that if the workforce is to expand and the turnover rate does not decline, then the absolute numbers affected by turnover will also increase. Table 1 illustrates the relevant numbers of:

(a) new recruits necessary because of expansion in the industry, and

(b) recruits necessary to replace turnover losses.

Four rates of turnover have been chosen. Smith and Wilson's long term average of 26% is adopted with a variation of plus or minus 10% for illustrative purposes. Because the trend seems to be downwards, the rate of 6% is also used.

At rates of turnover of 16% or more, recruitment requirements resulting from turnover are considerably greater than the recruitment required to meet expansion of the industry alone. The possibility of turnover as high as 36% is a little frightening. By the year 2000 the annual recruitment required would represent two-thirds of the present labour force. Fortunately, indications are that the rate of turnover in the logging industry as a whole is lower than this level.

TURNOVER AND TRAINING

Because there is usually a job hierarchy in any occupation, logging included, the numbers who are changing their work type and therefore who could potentially benefit from a training course will be greater than the number of new recruits to the industry. This is illustrated in the following example.

Assume that the following (loose) hierarchy exists:

Foreman (Senior to:)
Fallers and machine operators (Senior to:)
Breakerouts (Senior to:)
Skiddys.

We can assume that a skiddy leaving the industry will be replaced by a new recruit who will receive training as a skiddy. The consequence of this turnover is:

1 recruit, 1 training course participant

Table 1 :

Year	Number of Harvesting Gang wage workers (after Levack 1984)	(a) Gain/(Loss) per year due to Industry Expansion	Assumed Industry workforce strength*	(b) Turnover 6%	16%	26%	36%
1981							
82							
83	3,320	(120)		200	531	863	1,195
84		(120)	3,200	196	512	832	1,152
85		(120)	3,080	185	493	800	1,109
86		(120)	2,960	178	474	770	1,066
87		(120)	2,840	170	454	738	1,022
88	2,720	108	2,720	163	435	707	979
89		108	2,828	170	452	735	1,018
90		108	2,936	176	470	763	1,057
91		108	3,044	183	487	791	1,096
92		108	3,152	189	506	820	1,135
93	3,260	350	3,260	196	522	348	1,174
94		350	3,610	217	578	939	1,300
95		350	3,960	238	634	1,030	1,426
96		350	4,310	259	690	1,121	1,552
97		350	4,660	280	746	1,212	1,678
98	5,010	392	5,010	301	802	1,303	1,804
99		392	5,402	324	864	1,405	1,945
2000		392	5,794	348	927	1,506	2,086
01		392	6,186	371	990	1,608	2,227
02		392	6,578	395	1,052	1,710	2,368
03	6,969	98	6,969	418	1,115	1,812	2,509
04		98	7,067	424	1,131	1,837	2,544
05		98	7,165	430	1,146	1,863	2,579
06		98	7,263	436	1,162	1,888	2,615
07		98	7,361	442	1,178	1,914	2,650
08	7,460		7,460	448	1,193	1,940	2,686
09							
10							

* Straightline increase (decrease) between lustrum midpoints.

However, what if a faller leaves? Various means of filling his place are possible although the first of those shown below may not be desirable.

(1)	(2)	(3)
Faller replaced by new recruit to industry	Faller replaced by skiddy who is replaced by new recruit	Faller replaced by breakerout who is replaced by skiddy who is replaced by new recruit
1 new recruit; 1 training course	1 new recruit; 2 training courses (1 fallers course for skiddy, and 1 skiddys course for new recruit)	1 new recruit 3 training courses

If certification is widely accepted and actively sought, it may encourage such job type changes as loggers seek the wide range of experience necessary to acquire senior logger status. Thus, the departure of a faller from the industry could even result in:

Faller replaced by machine operator replaced by breakerout replaced by skiddy replaced by new recruit. Consequence: 1 new recruit; four training course participants.

There will therefore be a "multiplier" greater than 1 which relates training requirements to the number of vacant positions arising through turnover. To determine the multiplier, we need an indication of:

1. The nature of hierarchy within the logging industry and how vacant positions get filled. A fictitious example of worker progression is given in Figure 2 below.
2. From what positions is turnover taking place and at what rates (e.g. fallers may have a different rate than skiddys).

Fig. 2 - Example of a system of likely worker progression within the industry

Skidder/tractor logging

Skiddys	*100% from new recruits to the industry*
Breakerouts	*70% from skiddys* *15% new to the industry* *10% from machine operators (who have not been a breakerout before)* *5% from fallers (who have not been a breakerout before)*
Fallers	*80% from breakerouts (who have not been a faller before)* *10% from skiddys* *10% from machine operators (who have not been a faller before)*
Machine Operators	*65% from fallers (who have not been a machine operator before)* *15% from breakerouts (who have not been a machine operator before)* *15% from skiddys* *5% new to the industry.*

We have no data with which to determine a multiplier.

FUTURE TRENDS IN TURNOVER

It has been demonstrated, then, that consideration of turnover is essential in predicting future numbers for training. This requires prediction of the future turnover rates.

There have been a number of studies which have examined trends in turnover, e.g. Wolf (1974), Cottell (1974), Smith (1980), Smith & Wilson (1983), Loughlan (1974), Fielder (1979) to name a few. Of the various influencing factors, the level of unemployment is one of the most pervasive. There seems to be general agreement that turnover rates for all non-seasonal employment in New Zealand has dropped substantially in recent years as the level of unemployment has climbed. Workers are cautious of leaving their jobs if there are limited other employment opportunities available.

Smith and Wilson (1983) record that "other organisational factors frequently shown to be related to the turnover are company size ... level of education, level of skill, rate of absenteeism and accident frequency. Specifically, turnover is usually found to be higher in the following classifications: ... larger companies, better educated employees, relatively unskilled employees, high levels of absenteeism, and accident frequency."

Parsons et. al. (1981) summarises the work of several authors on factors influencing the propensity to leave in all industries. These include length of service, age, sex, marital status, and level of unemployment. In general, propensity to leave decreases with age and length of service, is higher for women than men and decreases with increasing salary, status or skill. The Canadian studies referred to earlier cite isolation and accommodation as factors that have the most effect on turnover.

Of these factors, some may significantly change for the logging industry in future years. The level of unemployment for instance has historically varied considerably, although the current mood of pessimism suggests that any improvement will be shortlived and we may never again see a return to the very low levels of the 60's and 70's. High unemployment may keep turnover rates low for some time to come.

Wilson (pers.comm.) suggests that it is possible that as the industry expands, turnover rates may rise owing to the higher rates of turnover associated with new entrants. The FRI study (Smith and Wilson, 1983) showed quite a strong positive relationship between company growth and turnover. It seems reasonable to assume that during periods of strong growth induction and training may suffer and this probably serves to perpetuate the turnover process.

The level of skill of loggers should rise if the likes of LFITB and LIRA can achieve their aims. Both organisations recognise the advantage of increased skill in all aspects of logging. The LFITB's introduction of certification may also have a significant effect on logging turnover. Certification provides official recognition of skill levels obtained. It may consequently improve the logger's self esteem and the regard in which he holds his

job. Furthermore, the impression that logging is a source of employment without much future is not helped by the fact that there is not a well recognised hierarchy or progression and skill achieved. If the levels associated with certification become better recognised, such a hierarchy will be established, especially if remuneration scales are tied to certification.

Certification should also improve manpower mobility within the industry and re-entry to it. Higher levels of skill and better recognition of skill should reduce the turnover rate.

The Canadian experience suggests that isolation and the logging camp life style are major causes of turnover. Could these factors be a problem in a small country such as New Zealand?

The Bay of Plenty area currently represents 60% of the country's exotic cut and with several major centres, problems of isolation are not serious (although there is a growing number of Rotorua based commuters who avoid living in Kaingaroa!). Within ten years however, the Bay of Plenty will represent only 40% of the projected harvest with substantial expansion to take place in Southland, Northland, the East Coast and the Nelson/Marlborough region. In such areas, many of the labour force have already voted on where they wish to work "with their feet" - by moving to bigger centres, and particularly Auckland. In such areas the planners will need to address the following questions:

- Will there be an existing labour surplus in the area sufficient to meet the logging recruitment requirements?

- If not, from where can potential loggers be attracted?

- How can the loggers attracted be encouraged to stay?

- What are the likely rates of turnover, and from where are replacements likely to be available? (Interestingly, preliminary analysis at the FRI of Forest Service data show geographical variations in labour turnover rates. These differences exist for all forest activities, including logging - P. Wilson, pers.comm.).

By way of illustration, it is insufficient to know that a logging operation requiring ten employees will shortly start up in an area where 15 able bodied uncommitted school leavers are about to become available. An estimate of likely turnover is also essential If for example, turnover was 50% the local labour supply would be insufficient after just one year.

Turnover in the new logging areas may indeed be higher than what we are accustomed to here in the Central North Island. Suggested reasons are:

- There will be little or no recent history of logging in the area, and hence very little appreciation of what the work entails. Disillusionment among some of the new recruits will be inevitable.

- Those who migrate to meet the new source of employment will have demonstrated in their very migration, a tendency to transience.

- For relatively isolated locations, a lack of amenities, recreation outlets and small community living are liable to result in higher turnover.

While the provision of a more normal environment in remote areas (in particular more married accommodation with appropriate community facilities) may stabilise the workforce substantially, it would involve an enormous investment which the employer may only be prepared to spread over an extended period. In this context we must also ask what constitutes an isolated location, or a small community. To the city bred individuals who will represent an increasing proportion of the labour markets, any settlement smaller than say 5000 people may represent rusticating amongst country yokels.

Hopefully, with time, logging will become an accepted and rewarding occupation in all parts of the country and turnover rates will decline.

A further note of caution should be sounded on any attempts to extrapolate current trends in turnover into the future. The nature of the crop itself is changing. We are expecting, for instance, that trees harvested will, on the whole, be smaller, and in many cases will have been grown in more open regimes. Both of these factors will lead to a high delimbing requirement per cubic metre of wood produced, yet delimbing rates very low on most loggers' list of preferences. Furthermore, much of the expanded resource will be on steeper country which, although it may mean that the job has a view, this may be little compensation for the extra exertion required. Turnover then may vary in nature with the future crop.

THE COST OF TURNOVER

High rates of turnover are wasteful. In the first place the departing logger must be replaced, and this can entail expense or unprofitable time spent in advertising, paper work and processing and general indoctrination. If the recruit is experienced, there may nevertheless be losses in gang production while he finds his niche in the team. If he is not experienced his productivity will be low - he is at the beginning of his learning curve.

Peterson (1978) in describing the learning curve cites the works of several authors and comments that the theorists appear to consider some extensive periods of time are required to reach acceptable levels of performance.

Fielder (1979) gathered workers opinions on the time required to learn various skills. About six months was considered necessary to learn tree felling, skidder, tractor and loader operation. Breaking-out and skid work were thought to take about three months and trimming about one month (these are on the job times without the benefit of training programmes). If we were to make the simplifying assumption that all fallers stayed in the industry for a uniform period corresponding to 26% turnover (3.85 years) then, on average .5 ÷ 3.85, or 13% of fallers, would still be on the learning curve at any one time. (The assumption, incidentally, is untenable but, if anything, is likely to underestimate the number of people on the learning curve). With the same assumptions

at 6% turnover, only 3% would still be on the learning curve. As one would expect, the higher the rate of turnover the greater the proportion of the work force that will still be on the learning curve and demonstrating less than full productivity.

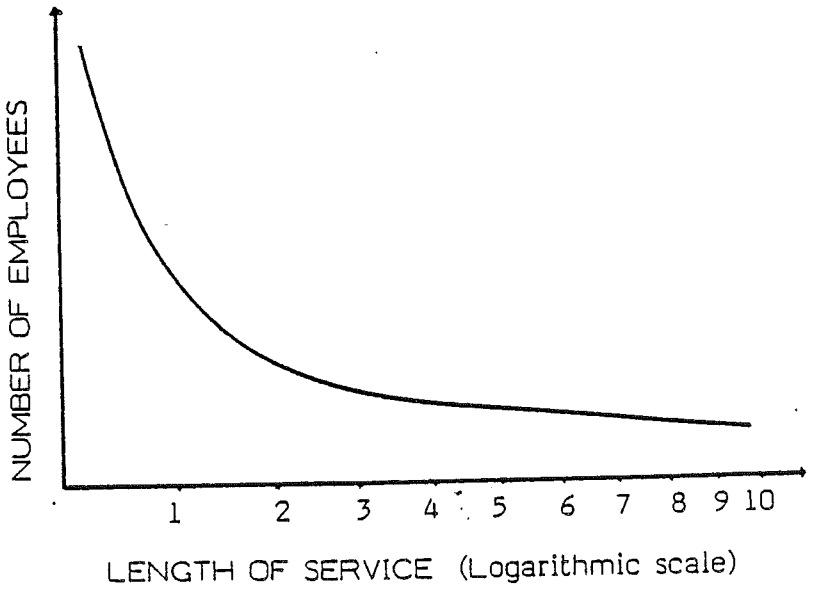
Scott and Cottell (1976) also provide estimates of the "time taken to reach average production", but unlike Fielder, their figures relate to graduates of training courses. Interestingly, although within individual worker categories there is considerable variation, the all-courses averages, at 18 weeks to reach average production, are in reasonable agreement with Fielder's results. Hancock, in Maynard (1971), discusses briefly the use of learning curves to predict turnover costs.

In discussing the cost of turnover, the link between turnover, morale and productivity is also worthy of consideration. Most logging operations are carried out in comparatively small work groups. Intuitively these small groups should be more susceptible to loss of morale through labour turnover.

INFLUENCE OF TURNOVER ON THE COST EFFECTIVENESS OF TRAINING

Higher rates of turnover are wasteful of the investment in training and result in the training effort being dispersed. Scott and Cottell (1976), in their survey of logging training in Canada, painted a gloomy picture for that country. Industry sources of data indicated that an average of only 43% of training course graduates were retained in the forest industry for one year. Their report commented that "the combination of costly training and low success rates tends to make institutional logger training an unattractive investment for the point of view of federal and provincial funding authorities".

In New Zealand, the little information on the logging turnover rates we have indicate that the retention rates for training courses should be much better. It is important to recognise however that different levels of turnover apply for different periods of service in the industry. In general a length of service curve will look like the following.



There are high rates of turnover in those recently recruited to the industry. Parsons et.al. (1981) describes an initial adjustment period where turnover is relatively high while the employer and employee decide whether they are mutually compatible (and presumably the employee decides whether he is compatible with the working conditions). After this early period of high turnover has passed, there is a tendency to remain with the organisation.

The consequence of this pattern is that formal training courses aimed at new recruits in logging may indeed represent a poor investment. At least two strategies are available. Training courses at or near induction can be kept deliberately short and cheap, or pretraining screening procedures can be introduced. The Canadian authors cite screening methods using physical, educational and age criteria, interviews and aptitude tests.

Training itself may result in reduced turnover and so in turn in reduced training requirements. Training should improve the logger's level of skill and hopefully make his work more enjoyable, satisfying and less dangerous. Productivity should also increase resulting, in theory at least, in a smaller workforce. At unchanged rates of turnover a smaller workforce will per se result in lesser numbers requiring training.

TURNOVER AND ACCIDENTS

There is a general impression that newcomers to any industry are more likely to suffer accidents. Unfortunately LIRA's accident reporting scheme has not provided any information on which are the most dangerous periods in a logger's career. The victims length of experience has not, to date, been recorded on the form. If the general impression is correct, then high levels of turnover will also correspond to higher accident frequencies. In Smith & Wilson's report, turnover was found to be directly related to accident frequency through the whole organisation. However, they noted that, "while the data corroborates the usual relationships between labour turnover and accident frequency, they do not endorse the popular explanation offered as to the cause, i.e. accident frequency is considered to rise as the numbers of new workers increase. As [data] shows, the relationship between accident frequency and the rate of change in company size (i.e. workforce) is negligible".

CONCLUSION

- We can conclude that the current level of turnover in the logging industry is not known with any precision. The most complete data is from just one large organisation. It has been emphasised that there are reasons why turnover from one industry member should not typify turnover from the industry as a whole.

- There are nevertheless indications that the level of turnover is dropping, especially while general unemployment remains high.

- The future level of turnover will depend on a number of factors which are likely to have conflicting effects. Training and certification should reduce turnover, but the locations of

future logging and the crop and terrain features of our new forests may increase turnover. Future unemployment, the politicians seem to be saying, depends on whom we vote for this coming November. Caution is obviously in order in extrapolating recent turnover trends.

Is there a need then for further research into the level of turnover? Before, or while, we do this it may be appropriate to familiarise our planners with another observation we can make: That allowance for turnover is essential in deriving likely recruitment requirement and numbers to be trained. Future estimates of manpower levels are not the same as recruitment numbers which are not the same as training requirements. Despite the distinction, recent industry reports (Farley and Hill, 1981; Chapman Berg and Rogers, 1981; Bryan, 1978, Training and Employment Subgroup, 1981) which purport to deal with future training in the forest industry have, with very few exceptions, proceeded no further than to predict future manpower levels. Such figures do not in themselves represent training requirements.

To recapitulate, the estimation procedure is described below with comments on the reliability of the information produced:

1. *Estimate future crop volumes and likely cutting schedules.*	*Forest volume production fairly reliable as the crop to be harvested in the next 25 years is already planted. Whether this is harvested on schedule is subject to marketing considerations which are harder to predict.*
2. *Determine total manpower levels necessary to achieve harvest targets using productivity factors based on piece size and location.*	*Refer Levack and Johnson in this seminar. The productivity factors are unavoidably "rough"*
3. *Estimate likely composition of future workforce by training categories, e.g. skid workers, machine operators, fallers, etc*	*Require assumptions about future logging systems. There is inherent uncertainty.*
4. *From the figures in Step 2 determine new recruitment needs due to indsutry expansion*	*Using lustrum mid points and assuming straight line build-ups. No more complicated treatment justifiable in view of imprecision in Steps 1 and 2.*
5. *Estimate future rates of turnover, ideally for each worker category*	*Considerable uncertainty.*
6. *Apply turnover rates to manpower levels, add recruitment levels from Step 4 to determine new recruitment levels*	*Mathematical exercise*
7. *Determine likely worker progressions through the different categories (patterns of intra-industry turnover)*	*There is negligible information currently available.*

8. Combine results of Steps 7 and 8 to determine numbers to be trained	*Mathematical exercise.*

Because each step uses information from the step before, the uncertainty is compounded. Until better information is obtained an unfortunate recommendation must therefore be that any predictions of manpower, recruitment or training requirements be treated very warily indeed. In fact, rather than referring to average figures in estimates, it would be more suitable if the upper and lower confidence limits were used.

If there is to be more research into the human element in logging, turnover is a suitable topic for early attention.

- A study of turnover is fundamental to likely recruitment and training needs.

- Turnover levels may provide useful indicators of organisational health and the regard in which logging is held by its employees. Current figures for turnover are necessary if we are to have a bench mark for future comparison.

- Excessive turnover is wasteful and costly. There could be considerable savings through efforts to reduce it.

Finally, without better information on likely turnover, the one conclusion we cannot make is that there will be sufficient loggers of any calibre available to log the expanded resource.

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REFERENCES

Bryan, D.G. Manpower and training. pp 110-114. In Cable Logging Seminar, Volume II. New Zealand Logging Industry Research Association Inc., Rotorua. Project Report No.6. 1978.

Cavana, R.Y. A system dynamics model for analysing New Zealand's plantation forest policies. Paper presented to the 19th Annual Conference of the Operational Research Society of New Zealand at Victoria University of Wellington, August 1983.

Chapman, W.A., P.J. Berg and T.E. Rogers. Review of New Zealand Forest Service training requirements : Report of Training Review Working Party, New Zealand Forest Service, Wellington. 1981.

Cottell, Philip L. Occupational choice and employment stability among forest workers. Yale University School of Forestry and Environmental Studies. Bulletin No.82. Yale University, New Haven. 1974.

Donovan, Viv. Prediction of machine requirements. pp 13-17. In Logging Machinery Seminar : The proceedings of a seminar held in Rotorua. New Zealand Logging Industry Research Association Inc., Rotorua. 1982.

Elliott, D.A. and H.H. Levack. New Zealand's plantation resource : Areas, locations and quantities. Paper prepared for the 1981 N.Z. Forestry Conference. Forestry Council, Wellington. 1981.

Farley, P.J. and P.J. Hill. The future manpower and training requirement to meet the N.Z.F.S. roading programme from 1980 to 2020. A report from the Forest Roading Workshop held at the Forestry Training Centre, Rotorua. December 1981.

Fenton, R. and C.J. Terlesk. Aspects of labour in New Zealand forestry. N.Z.J.For. Vol.16 No.2 (1971) : 208-222.

Fielder, M.R. A study of the logging labour force : A dissertation presented as part of the course for the Degree of Forestry Science. Canterbury University, New Zealand. 1979.

Forestry Council Social and Regional Strategy Working Party. Training and employment in forestry : Report of Training and Employment Subgroup. 1981. Forestry Conference, Forestry Council, Wellington. N.Z.

Hancock, W.M. The learning curve. pp 7.102-7.114. In Maynard (ed.). Industrial Engineering Handbook. 3rd ed. McGraw-Hill. 1971.

Johnston, A.D. Projected labour requirements for exotic forestry in the North Island. Planning Branch, Forest Economics Division, New Zealand Forest Service, Wellington. May 1965.

Levack, H.H. Estimating future manpower needs for harvesting New Zealand forests. LIRA seminar on Human Resources. New Zealand Logging Industry Research Association Inc., Rotorua. 1984.

Levack, H. and C. Gilchrist. Land, labour, machinery, buildings, costs, revenues, return on investment and other within-forest resources flows associated with five alternative national afforestation strategies. 1981 Forestry Conference background paper.

Loughlan, R.B. The Ontario forest labour situation. pp 171-177. In Irland, Z, Lloyd, C. (ed). Manpower - Forest Industry's Key Resource. Yale University School of Forestry and Environmental Studies. Bulletin No.86. Yale University, New Haven. 1975.

Makin, Kevin. The use of a local forest employment projections technique in Planning for Manpower Development. New Zealand Forest Service Reprint No.1542.

New Zealand Department of Labour. Labour and employment gazette.

Parsons, K., I.J. McGill and L. Walton. Manpower planning in public administration. State Services Commission Discussion Paper No.1. Wellington, N.Z. 1981

Peterson, R.L. Learning curves. (Notes presented at an annual N.Z.F.S. Workshop course). 1978.

Scott, D.A. and P.L. Cottell. Survey of logger training. Forest Engineering Research Institute of Canada Technical Report No.TR11. Vancouver. 1976.

Smith, Barry N.P. Technology, the work environment and industrial relations. pp 118-123. In Smallwood Harvesting Seminar : Proceedings. New Zealand Logging Industry Research Association Inc., Project Report No.13, Rotorua. 1980.

Smith, Barry and Peter Wilson. Labour turnover in a large integrated forestry complex. FRI Bulletin No.56. Forest Research Institute, Rotorua, N.Z. 1983.

Wolf, Charles H. Quit rates in wood products industries : pp 83-93. In Irland, Lloyd C. (ed). Manpower - Forest Industry's Key Resource. Yale University School of Forestry and Environmental Studies. Bulletin No.86. Yale University, New Haven. 1975.

Manpower in the 1980's : Disturbing Trends. Journal of Logging (March 1980). pp 2386-2389.