such direct comparison cannot be made, a thorough study of the natural, or even the modified, vegetation usually reveals some guides to siting.

Acknowledgement

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THE EFFECT OF PLANTATION LAYOUT ON EVENTUAL LOGGING

J. K. SPIERS

Planning for the eventual utilisation of a forest is essentially a long range objective. The lengthy rotation of most forest crops makes it difficult to foresee the economic position or to visualise accurately the utilisation practices at the time of harvesting. Consequently planning of forests must be flexible and must follow broadly based lines. Lately there has been considerable emphasis given to developing forests large enough to be economic units. It is essential also that compartments within those forests should be made large enough to be economic logging units.

In the establishment phase of most forests the forester has in the past been inclined to neglect the importance of catering for eventual extraction. The resultant layout may appear to be forester's dream but often proves to be a logger's nightmare. The forester, striving for maximum use of the land available, gives site quality major consideration, and he attempts to grow the species most suitable to each separate location. This intensive forestry approach can be uneconomic and impractical at the harvesting stages in a relatively undeveloped country such as New Zealand.

Design of forest compartment layout needs to be a compromise between the forestry ideal and harvesting economy; therefore eventual extraction should be envisaged in planning forest layout. Since topography is the most important and the only unalterable feature affecting extraction, compartments should as far as possible be designed as complete topographic units. This becomes more important as the compartment decreases in size.

Major road location is a most important feature in the early stages of forest layout. In the past these roads have often been located to suit immediate needs with little thought given to later usage. Eventually the harvesting phase is by far the most important road user, the ton/mileage of logging trucks greatly exceeding all other uses combined. This fact alone should ensure that harvesting problems are given major consideration in locating a permanent road network. In particular, all arterial roads should conform to the accepted principles for

main logging roads. A well located road with the best possible alignment and minimum grades will pay for its additional construction cost many times through the life of a forest. Roads should be located as near as possible to ridge tops on steep country where hauler extraction is envisaged. On easier topography where tractor skidding will be the method of extraction, roads should be so located that most of the produce can be brought down to them.

There are three major and inter-related factors to be considered in planning compartment layout; compartment size, compartment accessibility and topography.

COMPARTMENT SIZE

Optimum land use often envisages small compartments with species planted according to site in order to achieve maximum growth. In Europe, where nearly all produce is saleable, and selected species and grades return high values, this is quite practicable, particularly since labour costs are low and distances to markets negligible. In New Zealand these conditions do not obtain since labour and machinery costs are high and much of the crop volume is unsaleable.

From the logger's point of view, the larger a compartment is the more concentrated his operation can be, with consequently reduced costs. Most of the variable costs are in direct relationship to the logging method used, and are not greatly affected by compartment size. The fixed costs however are mostly per acre costs, and these increase considerably with the decrease in acreage logged. The more important fixed costs are establishment of landings, transport of machinery, road construction and maintenance, and supervision. Larger compartments allow the logger more flexibility in his operations and consequently he can reduce his costs.

It is difficult to formulate exact compartment size limits as these depend on the topography of each area. Mean compartment sizes will vary in different parts of the country in accordance with different geomorphological structures. Experience in the type of country usually encountered in the Rotorua area is discussed in the following paragraphs.

Tractor Areas

On gently undulating country, easy slopes, or flat areas the average area tributary to each landing is approximately 10 acres. The last 90 stands in Kaingaroa have cleared 943 acres. The tractor is a fairly flexible unit and can deal with isolated stands, smaller than these, where necessary. However it is advantageous to have a compartment comprised of several such stands.

Hauler Areas

These are mainly dependent on topography for their boundaries, and may vary in size from 5 acres to 80 acres. Most hauling units are not very mobile so that the cost of moving them is high. Therefore the acreage allotted to them should allow a reasonable period of work at

full production. One hundred acre units or larger would be advantageous. The following is a summary of hauler areas worked in Kaingaroa recently.

		ACRES		
Type of Hauler	*Number of Stands*	*Minimum*	*Maximum*	*Average*
Large Skyline	12	17	80	37
Small Skyline	9	18	40	23.5
High Lead	14	6	17	11.2
Skagit Mobile Logger	10	5	73*	19

* 2 machines

Compartment Accessibility

Individual compartments should be easily accessible so that they can be worked as separate units without interfering with other compartments. This is particularly desirable where adjacent compartments have different growth rates and rotations. A small compartment, or any compartment edge, should be able to be felled and worked without damage to the surrounding forest area. Each compartment should be accessible to machinery and have reasonable egress for loaded logging units. Often this factor is not considered when planning layout and small isolated compartments exist in some forests. The location of these compartments often prohibits logging as an economic operation. To operate in any distinct compartment the logger must be able to build a road or skidding track to it and have adequate space for landings within the compartment or adjacent to it. For example, areas planted in just one sector of a steep hillside, such as compartments with contour line boundaries, are often very difficult to extract.

Topography

It is most advantageous if each compartment is a complete topographic unit or an aggregate of these. Small gullies or basins should be complete units within any one compartment. Compartment boundaries in rough or broken country should as far as possible be on ridge tops; ridge lines make natural hauling or skidding boundaries. In planning layout it is advantageous if the forester can visualise the effect of topography on extraction methods. The illustrations given show how the nature of the topography affects the technique of extraction and how this in turn affects compartment layout. Fig. 1 shows systems of skyline hauling from above for steep and narrow gullies less than 30

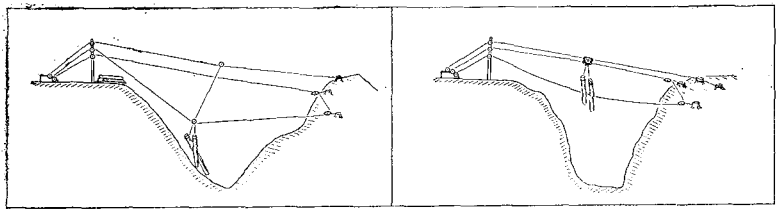

Figure 1

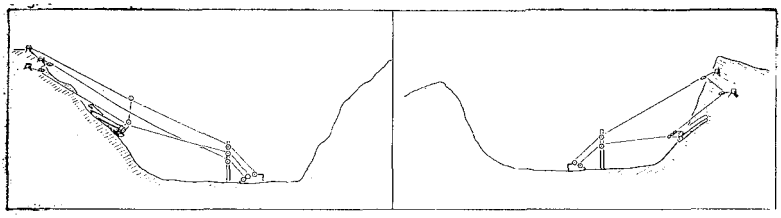

Figure 2

chains in width. It is desirable that both sides of such gullies or canyons be planted in the one species so that the whole gully can be extracted in one operation. Fig. 2 shows systems which are suitable for wide gullies. Skyline hauling from below is appropriate for gullies with irregular convex or concave sides. The hauling limit is about 25 chains, depending on topography. High lead hauling from below is suitable only for gullies with concave sides. The limit is about 15 chains. Gullies which can be worked from below could be planted with different species on each face, although the logger would still prefer to see them the same. Fig. 3 shows methods of high lead hauling on long steep faces. Hauling from above is the more desirable as it gives a longer haul. Hauling from below can be done only if the pole is set far enough back from the face to give the necessary lift. Long steep faces should be planted in one species unless a definite break, such as a ledge, exists.

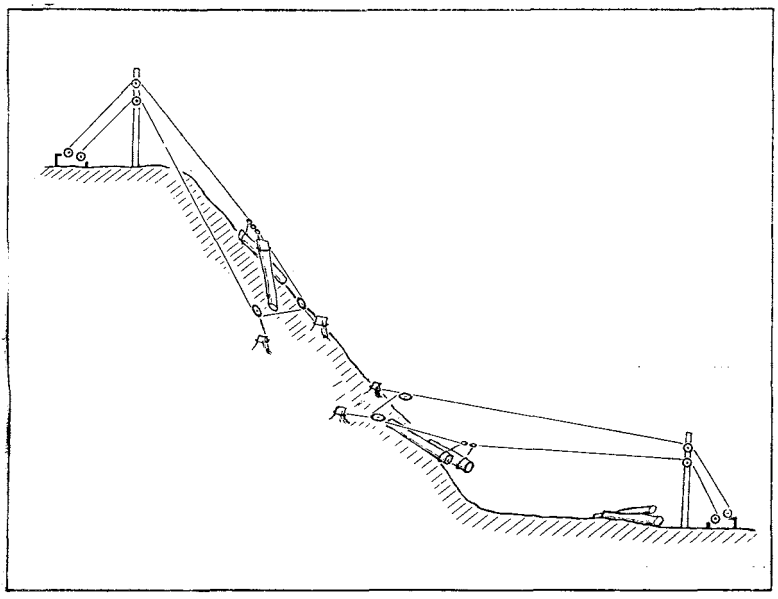

Figure 3

In considering the effect of logging on compartment size and layout it is desirable to understand the limitations and optimum working ranges of various types of equipment. Current methods can be divided into tractor skidding and hauling. The main features of these methods are not likely to change; they are discussed below.

Tractor Skidding is most economical when used on medium or easy downhill slopes. Uphill skidding is expensive and should be avoided if possible. The tractor is eminently suited to skidding logs out of a divaricating system of shallow gullies from below. Skidding distance varies with topography and ground conditions, but usually the maximum economical distances lie between 500 and 1400 feet. Because of the reduced road construction cost, skidding a longer distance than normal is economical in terminal stands on spur roads.

The major advantages of using a tractor for yarding are:

(i) It is mobile and can move itself from setting to setting.

(ii) It can do all its own "servicing", i.e. clearing the landing of slash and reject logs, moving heavy equipment, raising poles and rigging work.

(iii) It can be used on road construction and earth work as well as in yarding operations.

(iv) It is well adapted to salvage and its mobility makes it ideal for extracting isolated small areas.

Its disadvantages are that it has a high operating cost and a fairly short working life, that it cannot work over rock areas without damaging tracks, and that its effective operation is hindered greatly by adverse ground conditions such as deep mud or swampy ground.

It is sometimes of importance to remember that a tractor setting on fairly steep downhill yarding area tends to accelerate erosion problems by concentrating the water flow. Each tractor road spills its flow out into the landing area.

Hauler Operations need a more experienced crew and have a higher fixed cost of set-up but they have several distinct advantages over the tractor operation. They can operate over steep country easily, and are not affected by ground conditions such as rock, mud or snow. They are the most practical methods for up-hill yarding. Usually hauler units have much lower operating costs than tractors of comparable horsepower.

Special consideration must be given to road location in planning layout for mobile high-lead operations where "windrowing" is to be the system of cold-decking logs. The roads should be as nearly level as possible, so that hauling and loading machines are working on the level and their swing balance is not upset. The length of the setting from the roadside varies with topography and the height of the spar. Usually the distance for uphill hauling on steep hillsides is at least twice that of downhill or sidehill hauling. Uphill hauling is also less liable to cause erosion since the runoff of water is spread instead of concentrated.

FUTURE CONSIDERATIONS

Looking ahead to the end of a forest rotation is like gazing into the crystal ball. Accurate forecasting of economic conditions, of utilisation standards, and of extraction methods are all difficult. It is probably impossible to look into the economic future, but we can get some idea of the general trends in utilisation standards and extraction methods.

Utilisation standards will continue to improve, particularly with the development of new forest industries. The timber industry will become a true forest products industry, as is happening in North America. As new uses are found for sawmill waste, small pieces, bark, and possibly even branches and needles, we will tend to take increasing proportions of the whole tree from the forests. This development may mean that smaller units could economically be worked. However it is believed that any trend in this direction will be offset by the tendency for logging equipment to become bigger and more expensive. This will mean that to pay its way the machinery must be kept at high production every possible working hour. It will therefore need to operate in large areas. As an example, one logging method at present being used in Kaingaroa forest is producing 12,000 cu. ft. or more per day, involving the clear-felling of nearly 2 acres of forest per day. Even a 90-acre compartment worked that this rate would be finished in about six weeks, a short period between time-consuming and costly shifts.

During the next rotation it is considered that logging machinery will be bigger, have greater efficiency, and produce more, but fixed costs will be higher. A Le Tourneau now costs about £19,000, a Skagit £12,000, a D.8 £9,000.

Regardless of any improvement in the efficiency of machinery, it is considered that most extraction methods will be limited by the same factors as apply today, the most important being topography.* For more than any other reason, this makes it essential that topography should guide layout, and that the logger's viewpoint should be fully considered when planning a new forest.

DISCUSSION

MR ALLSOP, referring to the formation of compartments in managed forests, said he accepted Mr Thomson's views as to the desirable features, but in his opinion good, well-defined boundaries were more important than any other requirement.

MR McKEE said that the Forest Service is now beginning to use staggered settings of about 80 acres. The amount of timber lying under the skyline was important, since about ten per cent of a working day was taken up in moving rigging. From a logging point of view,

* Note. The possible future employment of helicopters on log extraction work would mean a considerable deviation from present day practice.