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PLANNING THE HARVEST OF A FOREST WOODLOT : A CASE STUDY

David Robinson

ABSTRACT

Careful planning is the key to harvesting any timber resource successfully. This report describes the process used for preparing a harvest plan for a forestry woodlot. A planning methodology is described, environmental management strategies are included, and a financial summary is given.

INTRODUCTION

Small forest ownerships or woodlots differ in many ways from the larger scale forest estates. Forest areas tend to be small, with 98% of privately owned woodlots being under 50 ha (Olsen, 1985). Depending on the original objectives for the establishment of woodlots, their shape and location are typically difficult with regard to efficiency of harvesting and transport operations. Nevertheless, when the harvest is anticipated, a suitable harvest plan should be prepared before logging commences.

The Resource Management Act (1991) has brought an increased emphasis on management for sustainability of natural and physical resources. The New Zealand Forest Code of Practice (1993) (FCoP) provides guidelines for harvest planning to ensure environmental impacts are minimised.

In 1993 LIRO undertook a planning case study with the purpose of illustrating a harvest planning procedure. The aims were to demonstrate the information requirements, planning processes, and contents of a good harvest plan primarily for the purpose of giving woodlot owners a basic understanding of what professional preparation of a harvest plan involves.

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THE PLANNING PROCESS

A harvest plan, in its simplest sense, anticipates a series of future events surrounding the felling, extraction, and transportation of timber from a forest area to a market. Three concepts underpin a good harvest plan: that it should be environmentally acceptable, physically feasible, and within these constraints, economically optimal. The process of achieving this result requires a careful and systematic investigation of crop, site, available methods, markets, revenues and costs (Figure 1).

The planning process starts with the description of the forest area in terms of the stand, topography, soils, and access. Environmental impact assessment procedures applied during field inspection assist the development of harvesting constraints. This information then influences the choice of an appropriate logging system. Further survey and analysis will verify the technical feasibility of the logging system; road and landing (log dump) locations are identified during this process.

Several harvest strategies can be developed during the planning process, and economic analysis may be used to decide which plan will give the least cost. The estimated productivity of extraction machinery and the volume to be harvested will dictate the duration of operations. In some areas, submission of the plan to the local District or Regional Council is necessary to obtain a consent for harvesting to take place.

WOODLOT CASE STUDY

The stand chosen for the study was a farm woodlot of 8.2 ha planted in radiata pine and originally established as a soil conservation area in the Wairarapa district. The stand had an average piece size of $0.77m^3$ with 760 stems per ha. A MARVL inventory (Method of Analysis for Recoverable Volume by Log type) showed the main products from the stand would be sawlog and pulp (Table 1). No pruned material was present as the stand had never received any formal tending.

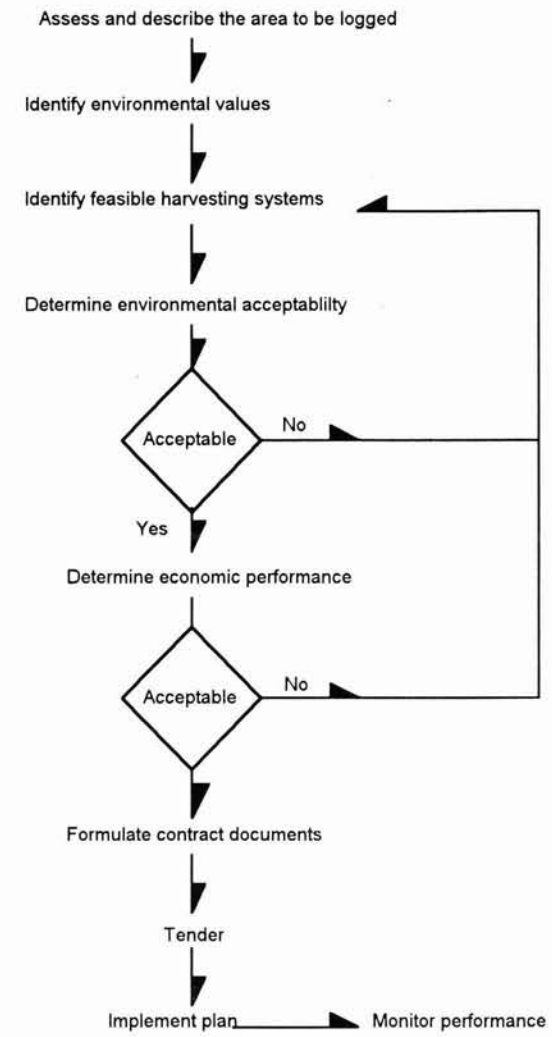

Figure 1 - The harvest planning process

The upper and lower bounds of the inventory data indicated considerable variation across the stand, with an average volume of 590 m^3/ha, and a ratio of 62% sawlog to 38% pulp wood. The total volume of wood estimated for harvest from the 8.2 ha stand was 4,840 m^3.

The site information required for harvest planning ideally includes a topographic map of suitable scale, preferably 1:5000 scale with a 5m contour interval, aerial photos, soil type, and land use capability information. Historic rainfall information is also useful for determining distribution of rainfall through the seasons. This will assist the scheduling of operations, especially where minimum standard roading is used.

Table 1- Inventory Data

	Lower bound (m^3/ha)	Average Volume (m^3/ha)	Upper Bound (m^3/ha)
Sawlog	164	368	572
Pulp	184	222	260
Total Volume	349	590	732
JAS m^3	363	614	763

No contour map was available for the woodlot under study so recent 1 : 5000 scale aerial photos were obtained. The land had a Class VII land use capability which, under the local District Council's plan, required a resource consent for the undertaking of logging operations. Inquiry at the Regional Council indicated that the woodlot was designated as a soil conservation area, and was subject to constraints on harvesting imposed under the regional plan. Constraints included:

- all radiata pine was to be clearfelled

- the total area was to be logged by cable hauler

- slash accumulations were not to be pushed into the main gully

- the site must be replanted and re-fenced.

ENVIRONMENTAL IMPACT ASSESSMENT

Before choosing a logging system, a detailed site inspection and environmental impact assessment were carried out to determine what physical and environmental factors may constrain the operation. Physical factors included access, slope, slope length and the location of fence lines, streams and ownership boundaries. The plantation was about 800m long following a steep sided creek with an average stand width of 100m (Figure 2). Slips and slumps were common throughout the area and recent tree toppling due to the combined effect of wind, height, and weak soils was beginning to accelerate erosion. The slopes into the stream were convex and relatively short, ranging from 25m to 120m. Ground slopes immediately adjacent to the creek were up to 38°. A fence line surrounded the woodlot which was located amongst farm paddocks from the same ownership title.

An impact appraisal process (rècommended by the N.Z. Forest Owners' Association) from the FCoP, was used to identify those operations which might harm the site values. Firstly, the important environmental values of the site were identified. These included soil and water, cultural, scenic, scientific and ecological values. This required liaison with government bodies and local interested parties. The next step was to identify those operations which might have an adverse effect on the previously identified values. Each operation was then rated for the duration and severity of its *potential* impact. The results were used as a means for determining the harvesting system required and the environmental strategies needed such as mitigation measures to ensure a minimal impact from harvesting and subsequent operations on the site (Table 2).

The "+" symbols indicate an expected beneficial effect while the "-" symbols indicate a harmful effect. The number of symbols used represent degrees of severity. For example, the impact of road construction for harvesting could potentially have a long term adverse impact on the water supply to the farm. Processing of trees is not expected to have any potential impact on the riparian and wetland areas, because the processing site is likely to be away from these areas. Felling trees is expected to have a long term beneficial effect on the wetland areas because they will become re-exposed to the daylight enabling them to become active in supporting the life cycles of local fauna. In order to manage the minimisation of any potential impact the FCoP contains an operations data base which can be used for deciding what machinery and methods can be used both during the harvest and after operations have ceased. This will be discussed in a later section.

LOGGING SYSTEM SELECTION

The combination of steep terrain and susceptibility of the soils to instability and erosion suggested that cable hauler extraction should be the preferred method for logging the woodlot. While a variety of machines are currently operating, many are commited to medium term contracts. Choice was limited to those readily available within the region. Of these, a Madill 009 was chosen, which although larger than would be required, did offer the capability of good control and one end suspension of the trees during extraction. These features would serve to minimise scarring and soil damage during logging.

Table 2 - Impact assessment

	IDENTIFIED ENVIRONMENTAL VALUES				
Operation	Water Quality	Riparian and Wetland Areas	Slope Stability	Erosion	Water Supply
Access					
Roading, tracking	-	na	- - -	- -	- -
Land preparation					
Herbicide applna	- -	na	na	na	- -
Over sowing	+ +	na	+	+	na
Tracking	- -	na	- -	- -	- -
Grazing	- -	- - -	- - -	- - -	- -
Establishment					
Planting	+	na	+ + +	+ + +	+ +
Releasing	na	na	na	na	- -
Grazing	- - -	- - -	- - -	- - -	- -
Fertilising	- -	na	+	+	- -
Tending					
Pruning	+ +	na	+ +	+ +	na
Waste thinning	+ +	na	+ + +	+ + +	na
Protection					
Animal control	na	na	na	na	- -
Roads maintna Short	- -	na	- -	- -	-
term	+ + +	na	+ + +	+ + +	+ +
Long term	- -	- -	na		na
Weed control					
Harvesting					
Roading	-	na	- - -	- - -	- - -
Landings	- - -	na	- - -	- - -	na
Felling	na	+ + +	na	na	na
Processing	+ +	na	na	na	na
Extraction	- - -	- -	- - -	- - -	- -
Stream crossings	- - -	-	- - -	- - -	na
Transportation	na	na	-	-	na

Table 3 - Extraction options for the woodlot

Option	Weighted Average Haul distance (m)	Estimated working days to complete	Estimated total extraction cost ($)
3 LANDINGS	282	44	148 992
4 LANDINGS	223	38	128 594

The recommended system involved extracting tree lengths to landings where they could be processed manually into log lengths, then stacked for load out. To enable the hauler to work at the most efficient level, both a Bell Logger and a front-end loader were recommended. It was intended that these operations would all occur on the same landing. A number of landings would be required in order for the hauler to reach all of the timber in the woodlot. It was anticipated that the area required for each hauler landing would be 0.25 ha (50m x 50m) although this would be confirmed with the logging contractor.

DEVELOPING THE PLAN

The next step was to decide where the landings should be located and then to determine the feasibility of getting logging truck standard access from the farm gate to the landings. Locating a landing requires the balancing of hauler reach capability with the terrain constraints. A variety of computer packages are available to assist in the feasibility analysis, although preliminary and final field checking is essential for confirming proposed landing positions.

During the preliminary check, five likely landing positions were identified. Due to the lack of suitable topographic maps, a series of ground profiles were surveyed radially from each landing position.

LOGGERPC (V3.0) was used to establish payload and reach feasibility for each proposed landing position. Two plan options were identified for the location of the hauler positions (Figure 2 and 3). Option A included three landings, and option B four.

Area, average haul distance and piece size data were used to estimate the daily production from each landing. Estimated daily costs for the operation were used to indicate the total extraction cost for each option (Table 3).

The three landing option with longer haul distances was expected to take six working days longer to complete. This resulted in a cost some 14% higher than the four landing option. Therefore, an extra $20,400 could be spent on road and landing construction before the two options broke even. The extra cost for construction was estimated at $800 which made the four landing option preferable from a financial standpoint.

Landing 2, from option A, was located on a spur and construction of this landing would have required more sidecasting on to steep slopes than the alternative landings 2 and 3 for the option B, both of which were located on flat to moderate slopes. Using the four landing option also avoids pulling logs along stream beds thereby minimising potential impacts.

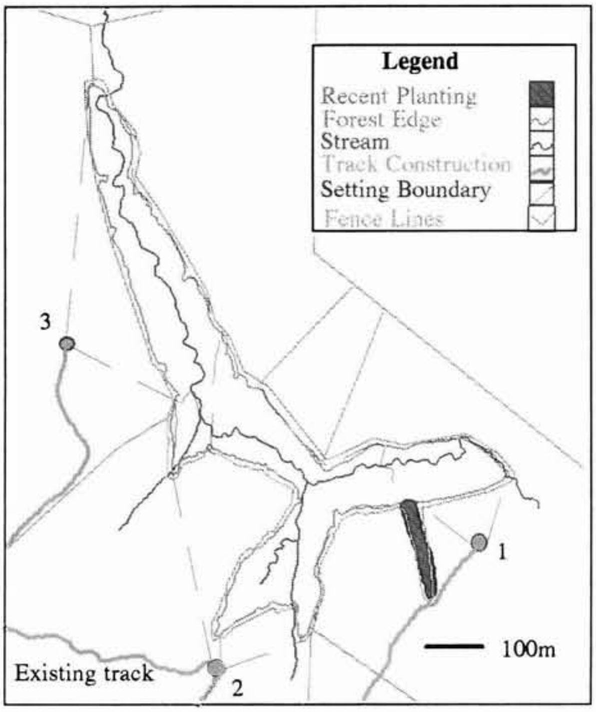

Figure 2 - Option A; three landings.

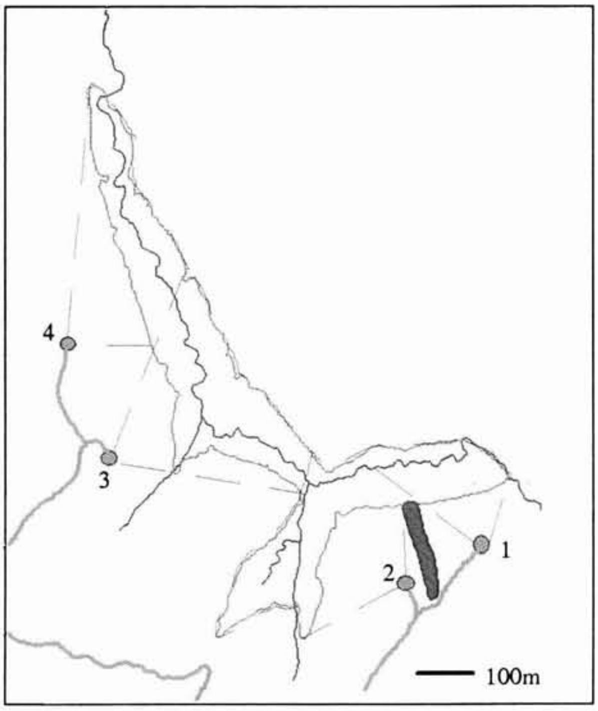

Figure 3 - Option B; four landings

ACCESS

The existing track (Figure 2) had been upgraded to truck standard during previous logging operations on the property. New construction planned for the woodlot was for an earth road due to the relatively low volume to be carted. A single lane earth road with a carriage width of 4.5m on the straights and 6.5m on the corners was planned. Construction would be carried out by a 120kW bulldozer using a sidecasting method.

ENVIRONMENTAL MANAGEMENT

The FCoP was used to develop environmental management strategies for operational aspects of the plan including access and extraction. Two further areas, operation scheduling and post-harvest management, were also included because of their importance in ensuring the harvest operations were undertaken with minimal impact to the environment.

Road grades for the new earth road were minimised and confined to natural benches and lower side slopes where possible. Although there were no streams to cross, the control of water run-off from the road was identified as an important criterion for minimising the risk of erosion and mass wasting. Culverts were specified where the road crossed significant natural drainages. Cutoffs were spaced along the road at appropriate places to control water velocity. Included in the specifications, was the requirement for compaction of the road surface. This was intended to improve both the road's bearing capacity, and its ability to shed water effectively. Compacted landing locations were planned for stable sites on easy terrain in order to minimise earthworks and avoid locating spoil near permanent watercourses.

Table 4 - Operation scheduling for the harvest plan

Operation	Timing	Duration
Construct earth road	March 1993	10 gang days
Harvest Woodlot	November 1993	37 gang days
Post Harvest Management:		
Crown and roll	January 1994	2 gang days
Oversow	Weather suiting	1 day
Replant	June 1994	8 man days
Monitor	Monthly for first 12 months	6 man days

The equipment chosen for extraction was theoretically capable of giving one end suspension to trees during extraction across the stream. Feasibility tests were carried out using computer software to ensure this was possible. Directional felling was planned particularly around stream edges to ensure a minimum of debris would fall into the watercourse. The setting boundaries were planned to aid directional felling and ensure felled stems could be easily extracted using the correct logging system. To minimise the risk of processing debris (slash) being deposited in any watercourses, flat areas away from the stream were identified for slash deposition.

At the completion of harvesting operations, the site was planned for replanting and re-fencing. Roads and landings were planned to be crowned for drainage and culverts and cutoffs would be checked to ensure they would carry and discharge run-off efficiently. Processing waste zones would be checked for stability and any exposed soil would be oversown with grass for stabilisation. Post-harvest management would also require monitoring of the site to ensure that stability of roads and landings were maintained.

The scheduling of operations is a key aspect which also may affect the degree of environmental impact and will ensure the success of the harvest plan. Each operation was scheduled according to the season to which it would be best suited (Table 4). Given the low standard of access, harvest operations were scheduled for the summer months when the weather was most likely to be fine.

FINANCIAL ANALYSIS

Owners of woodlots may not be growing their trees as a primary source of income. This gives some flexibility in the decision whether or not to harvest. However, this decision requires financial analysis (Table 5). This harvest plan contains estimated costs for the different operations.

Net estimated revenue from the harvest operation was $273,400 being equivalent to $33,300 per hectare.

SUMMARY

This report describes a method for developing a harvest plan for a forest woodlot. The plan aims to anticipate as closely as possible the progression of events surrounding the harvest of the woodlot incorporating: timing, duration, costs, revenues and environmental impact of operations. The importance of a good harvest plan is to ensure the success of a harvest. While it is difficult to anticipate everything that will happen, a methodical approach will play a major role in ensuring that the desired outcomes are achieved for all parties involved.

Table 5 - Financial analysis summary

Operation	Total Revenue ($)
Road Construction	- 5 700
Landing Construction	- 2 960
Extraction	-128 590
Transport	- 75 140
Post harvest management	- 19 100
Sawlog sale	468 120
Pulp sale	36 780
Total	273 410

The process used to develop this plan started with a description of the woodlot in terms of the stand topography, soils and access. An environmental impact assessment gave an indication of the potential impact of various operations which assisted the choice of logging system. With this information details of the plan could be put together. A combination of experience, field survey, and feasibility analysis was used to locate landings, roads, and setting boundaries. An estimate of daily productivity and costs gave an estimation of the cost of each aspect of the harvest. Revenues used were based on average log prices by log grade for the region.

A good harvest plan includes not only the location of roads and landings. Strategies for carrying out each operation on the site from initial earthworks through to the post-harvest management and monitoring play an important role in ensuring that the sustainability of the site is not compromised. Environmental management strategies from this standpoint are an integral part of any harvesting operation.

This study has been part of an ongoing project involving both the planning of this site and monitoring of the plan implementation. A further report is anticipated detailing the outcomes of the plan implementation in terms of the progression of operations, and subsequent environmental impacts after logging.

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The costs stated in this report have been derived using LIRO costing procedures. They are an indicative estimate only and do not necessarily represent the actual costs for this operation.

For further information, contact:

LOGGING INDUSTRY RESEARCH ORGANISATION
P.O. Box 147,
ROTORUA, NEW ZEALAND.

Fax: 0 7 346-2886 *Telephone: 0 7 348-7168*