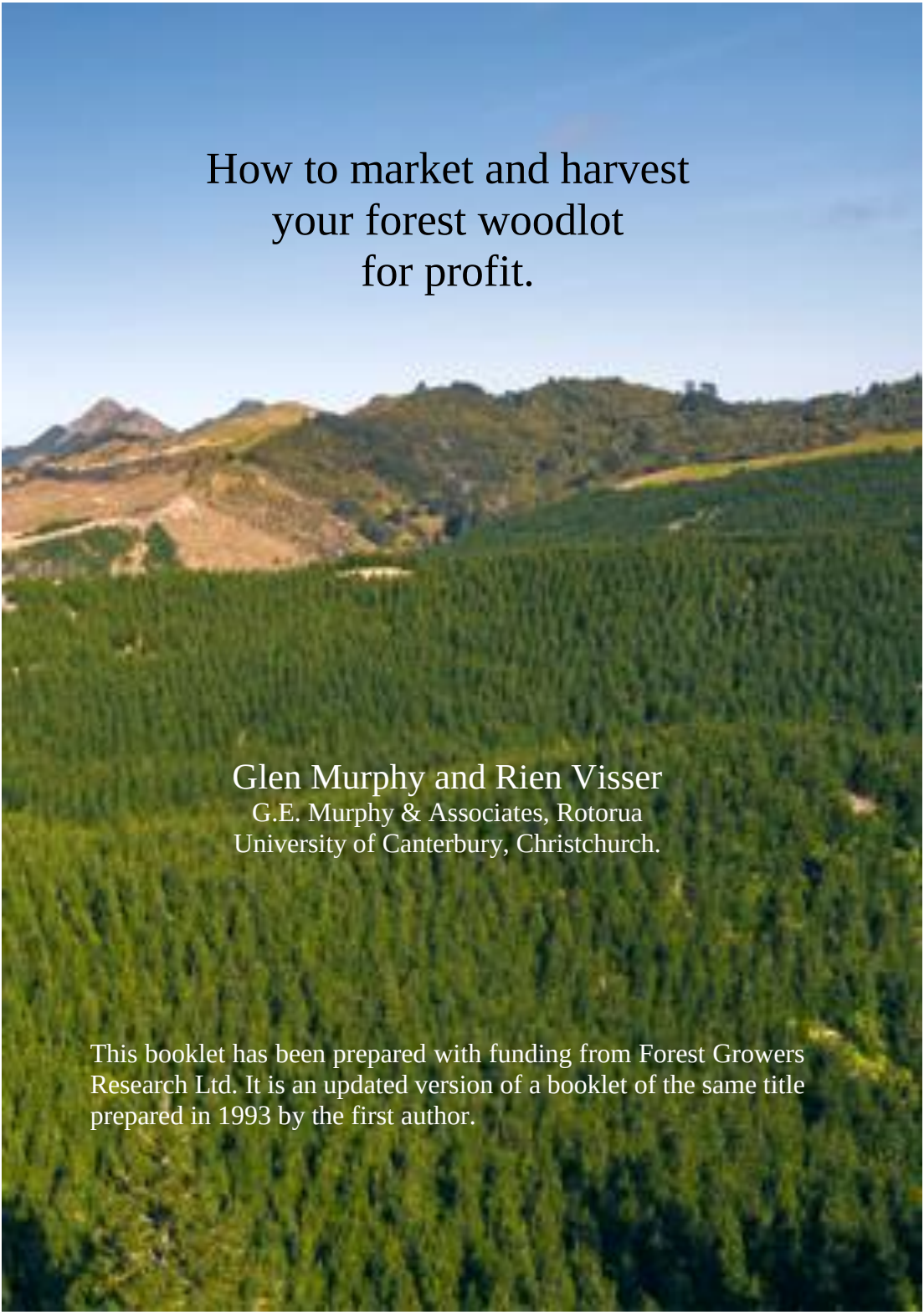

How to market and harvest your forest woodlot for profit.

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Disclaimer

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Contents

Introduction

After more than two decades of nurturing and carefully tending your woodlot you believe that the time is approaching to harvest it and reap your rewards. But how to go about it correctly? There are many woodlot owners who have managed the marketing and harvesting of their woodlots profitably. But, if you have talked to other woodlot owners, you will also have heard horror stories such as these:

"Teresa Green from the Bay of Plenty approached a small local sawmill operation with a view to a sale. She was offered the removal of the trees and a complete clean-up job for zero cost and return. A large timber company then offered her $50,000. Finally, an agent negotiated a sale on her behalf for over $160,000."

"Douglas Furr from Nelson was disappointed with the clean-up job after his woodlot was harvested. He was left with badly damaged fences and gates and logging debris on his best hay-paddock. What really upset him, however, were the large stacks of logs that were rotting at the back of the farm as a result of rain making the gully 'road' impassable. He was told he wouldn't be paid for those logs."

Since you are reading this booklet it can be assumed that you do not wish to become the victim of one of these horror stories. Knowledge is power and your protection.

This booklet is aimed at woodlot owners who are close to the harvesting stage of their woodlot operation. It is not a manual for the establishment and management of woodlots. Nor is it a textbook for logging contractors on how to carry out their business. This booklet attempts to provide you, the woodlot owner, with sufficient information to help you successfully manage the marketing and harvesting of your woodlot.

To help you better understand these needs this book has been prepared in a number of sections.

- Section 1 provides information on how important the New Zealand woodlot resource is and who the potential buyers are.
- Section 2 lets you know why it is important to assess what you have in your woodlot.
- Section 3 covers when and how you should sell your woodlot.
- Section 4 looks at how you can avoid injury to yourself and others and minimise damage to the environment.
- Section 5 describes some harvesting and transportation systems which may be suitable for your woodlot.
- Section 6 looks at how you can improve your profitability.
- Section 7 provides a step-by-step guide to using the web-based Woodlot Analysis Tool.

Return to Table of Contents

Section 1.

How important is the woodlot resource?

and

Who are potential buyers?

How important is the woodlot resource?

If a woodlot is defined as being a plantation of less than 500 hectares, then woodlots accounted for 27% of the total forest plantation area in New Zealand as at 2018 (Table 1). Over 85% of the woodlots are less than 40 hectares in area. If forestry remains attractive as a means of diversifying farm income, and provides a way to help offset farm carbon emissions, the importance of woodlots to the national wood supply will increase further.

Table 1. Number and Area of Plantations

Plantation size group (ha)	Number of land holdings with timber plantations	Total plantation area (ha)	Percentage of total area (%)
< 40 ha	>10,000	280,697	16.3
40-99	842	52,836	3.1
100-499	659	131,087	7.6
500-999	88	63,071	3.7
1,000-9,999	98	331,534	19.2
10,000 +	27	866,250	50.2
NZ Total	>11,700	1,725,476	100.0

Source: Ministry for Primary Industries, *National Exotic Forest Description as at 1 April 2018*.

The woodlots are located on more than 11,000 land holdings scattered around New Zealand. Figure 1. shows the distribution of woodlots, 0 to 499 ha in area, by region as at 2018.

Radiata pine accounts for 90% of the total forest resource and Douglas fir accounts for 6% of the resource. The remaining 4% is distributed between eucalypts, cypresses, other softwoods and other hardwoods.

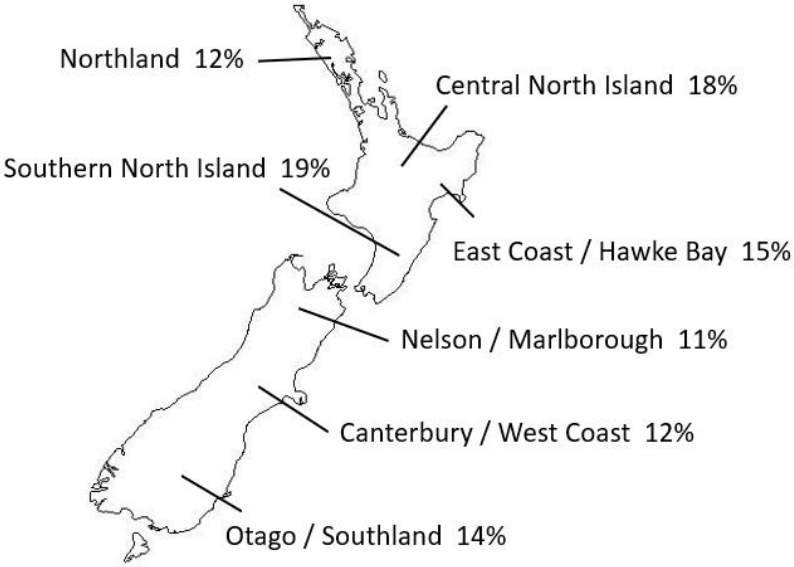

Figure 1: Location and percentage of total area of woodlots (0 to 499 ha) by region as at 2018.

Who are the potential woodlot resource buyers?

Most forest growers in New Zealand will be able to deliver their logs to both domestic markets (New Zealand regional sawmillers and other wood processors) and export markets via the closest export port. Most regions of New Zealand now have an export log business at the local port and over 60% of the total harvest is exported directly. The remainder was utilised by the many wood processing plants in New Zealand. Buyers of logs destined for export markets are usually representatives of the larger forest companies or log brokers, whereas a forest owner or forestry consultant can deal directly with a domestic processing plant.

Because of increased export log prices and reduced shipping costs the forest grower has access to international markets and they have tended to

provide the benchmark for log prices in New Zealand. In many regions forest growers will maximise financial returns by segregating logs into both domestic and export grades. To do this successfully involves higher costs, greater skill on the part of the logging contractor, good supervision of the logging and cartage operation, and good knowledge of all log markets.

Information on **How to Find Harvesting and Marketing Specialists** can be found in Section 3 of this booklet.

Domestic markets

Because of the cost of log transportation, the domestic market for most woodlot owners will generally consist of sawmills and veneer mills, fibre processing plants and roundwood processors in the immediate region (within 200 km). Figure 2 shows the location of New Zealand wood processing plants which are likely to be interested in the woodlot resource.

Sawlogs and veneer logs: The New Zealand sawmilling industry used 8,685,000 tonnes of plantation forest sawlogs in the year ended December 2017 (Ministry of Primary Industries). These mills are located in all parts of New Zealand. The majority of the logs sawn are unpruned sawlogs; pruned logs are sawn in specialist mills producing high-value solid wood products for the joinery, millwork and furniture industries, and for the production of veneer, plywood and laminated veneer lumber.

Pulpwood: More than 3,675,000 tonnes of pulpwood was used by pulp mills and reconstituted board mills (medium density fibreboard and particle board) in the year ended December 2017. Pulpwood may also be exported in log form, or as chips.

Other log types: Roundwood plants produce and preservative-treat posts, piles for houses, wharves and bridges, and poles for agricultural and horticultural uses, for construction and for use as transmission poles.

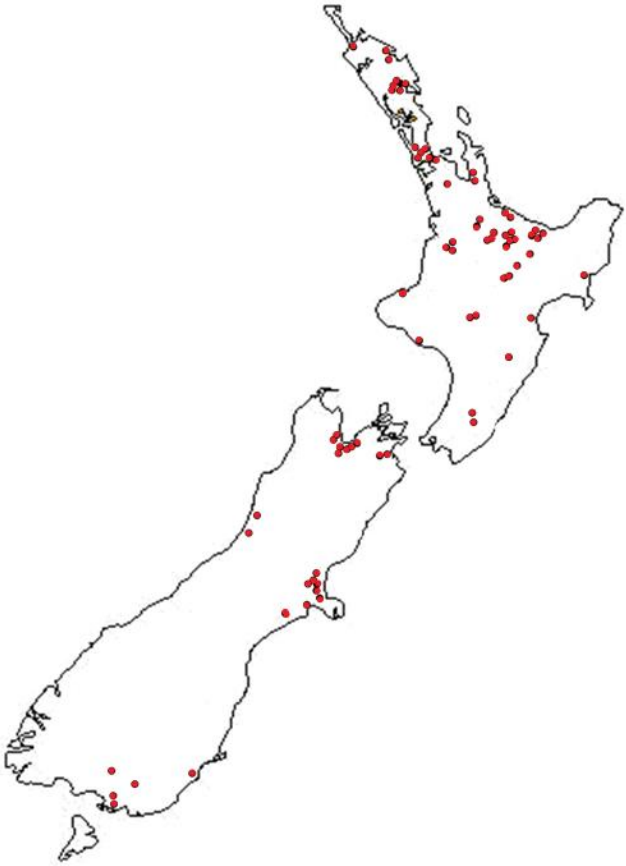

Figure 2: Location of wood processing facilities (2018)

In general, only the highest-value log products (for example, peeler logs) will be able to bear the cost of long-distance cartage. The main exception to this is marginal pulpwood to a large pulp mill. While the vast majority of the wood supply will be sourced from woodlots much closer to the mill, marginal wood may be carted up to 400 km or more when urgently required.

Export markets

Logs: The export market for logs from New Zealand has existed since the 1950s and most ports have now developed facilities specifically for log exports. When log market demand is high there are very few places in New Zealand that are not within economic access of a log export port, especially for higher grade logs. The breakdown of log exports by port is shown in Table 2 below.

Table 2. Log export volumes by Ports of Loading (Year ending June 2019)

Port of Loading	Volume ('000 m3)	Export Volume (%)
Whangarei	2,734	12
Auckland	39	0
Tauranga	7,088	31
Gisborne	2,810	12
Napier	2,399	11
New Plymouth	920	4
Wellington	1,729	8
Picton	670	3
Nelson	1,405	6
Lyttelton	522	2
Timaru	547	2
Port Chalmers	1,193	5
Bluff	722	3
Total	22,778	100

(Source: Ministry for Primary Industries. Log Exports by New Zealand Port by Quantity and Value.)

The number of export markets has also increased. In 1958 Japan was the sole market for New Zealand logs. In 2019 Japan was the 4th most important market behind China (including Hong Kong), South Korea and India (Figure 3). Log markets are predominantly those countries of Asia with low supplies of their own logs.

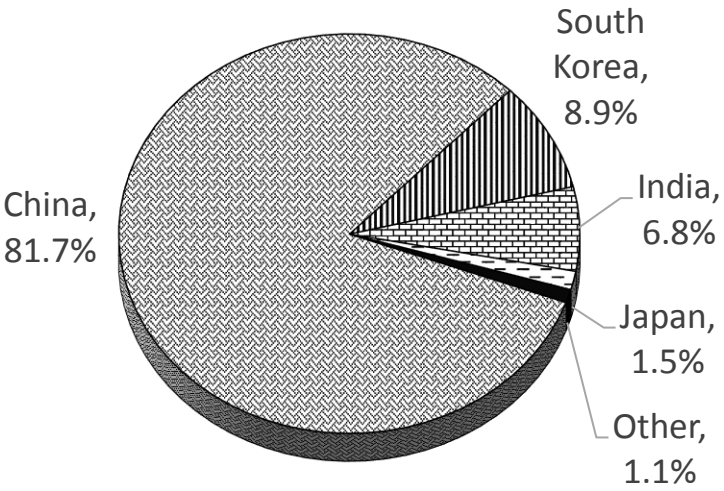

Figure 3: Markets for New Zealand log exports (year ending June 2019)

International log markets are undergoing rapid changes. For example, South East Asia and the USA were once major suppliers of logs to Asian markets but have faced increasing restrictions due to aspects such as trade restrictions, conservationists' opposition to timber harvesting and demands for forest values other than timber. Conversely, other regions, such as South America, Europe and Russia, are ramping up their supplies. International trade may affect the timing of harvest and combination of log products which should be harvested to maximise return to the woodlot owner. New Zealand log exporters are affected by the following trends:

- Export logs are a commodity, and as with all commodities, prices may fluctuate markedly as demand and supply in major markets changes.
- The range of uses for radiata pine products in export markets is increasing as traditional supplies dwindle. Use of radiata pine for furniture, joinery, windows, doors, mouldings and plywood is increasing.

- The range of countries importing logs from New Zealand has grown as the benefits of using sustainably grown plantation timber have been recognised.

While exports are dominated by logs, trees can also be further processed ('chipped') into woodchips for the pulping industry._Woodchips are currently exported mainly to Japan, in relatively small volumes (313,300 tonnes for the year ended June 2019). There are fewer ports handling chip exports, although some pulp grade material is exported as logs.

Return to Table of Contents

Section 2.

What do you have in your woodlot?

To determine what you have in your woodlot and its potential value you need to (or your agent needs to) have an understanding of log product specifications and price differentials. This information is then used in the inventory procedures to help accurately ascertain both volume and value of your woodlot.

Log product specifications

Selection of the right sets of log products to be cut from each woodlot is crucial to its profitability. The markets for radiata pine and Douglas fir logs are more established than those for other species. As a result, the range of log products is wide and log product specifications are detailed and complex. Log product specifications will include such features as acceptable log lengths; minimum and maximum small end diameter (SED) and large end diameter (LED) of logs; presence or absence of knots (from branches) and maximum knot size; permissible log sweep (log curvature); presence of stain, rot, damage and deformities on the stems; centrality of the pith and roundness of the stem.

Tables 3 and 4 provide some examples of radiata pine log product specifications for a range of export and domestic log grades. Many more log product specifications are used in different regions depending on markets being supplied.

Table 3. Example of Log Product Specifications: Export Grades

Product Name	Product Specifications
Pruned Export	Lengths: 2.9 to 5.1 m Diameters: Minimum SED 30 cm and 40 cm common diameters Branch size: No visible branches Sweep: Maximum SED/8 Wobble: Nil Roundness: Longest diameter must not exceed 1.5 times shortest diameter
A grade Export	Lengths: 3.0 to 12.0 m Diameters: Minimum SED 30 cm Branch size: Maximum 12 cm Sweep: Maximum SED/4 Wobble: Maximum 5 cm Roundness: Longest diameter must not exceed 1.5 times shortest diameter
K grade Export	Lengths: 3.8 m and 5.8 m common lengths Diameters: Minimum SED 20 cm Branch size: Maximum 12 cm Sweep: Maximum SED/4 Wobble: Maximum 5 cm Roundness: Longest diameter must not exceed 1.5 times shortest diameter
KI grade Export	Lengths: 2.9 to 6.0 m Diameters: Minimum SED 26 cm Branch size: Maximum 20 cm Sweep: Maximum SED/4 Wobble: Maximum 10 cm
KIS grade Export	Lengths: 2.9 to 6.0 m Diameters: Minimum SED 12 cm Branch size: not applicable Sweep: Maximum SED/3 Wobble: Maximum 15 cm

Table 4. Example of Log Product Specifications: Domestic Grades

Product Name	Product Specifications
Domestic Pruned	Lengths: 4.1 m and 5.1 m Diameters: Minimum SED 35 cm Branch size: No visible branches Sweep: Maximum SED/8 Wobble: None Roundness: Longest diameter must not exceed 1.5 times shortest diameter
Domestic Partially Pruned	Lengths: 4.1, 5.0 m, minimum of 2.2 m pruned wood Diameters: Minimum SED 30 cm Branch size: No visible branches Sweep: Maximum SED/8 Wobble: None
Domestic Sawlog S30	Lengths: 4.9, 5.5, 6.1 m Diameters: Minimum SED 30 cm Branch size: Maximum 7 cm Sweep: Maximum SED/3 Wobble: Maximum 15 cm
Domestic Sawlog S20	Lengths: 4.1 m Diameters: Minimum SED 12 cm Branch size: Maximum 6 cm Sweep: Maximum SED/3 Wobble: Maximum 15 cm
Housepiles	Lengths: 3.6 to 6.0 m Diameters: Minimum SED 17 cm Branch size: Maximum 4 cm Sweep: Maximum SED/4 Wobble: Nil
Pulpwood	Lengths: 1.8 m to 5.5 m Diameters: Minimum SED 12 cm Branch size: not applicable Sweep: Maximum SED/1 No rot

Price differentials

Prices for many log products are changing weekly. Indicative log prices, presented by quarter can be found on the Te Uru Rākau website https://www.teururakau.govt.nz/news-and-resources/open-data-and-forecasting/forestry/wood-product-markets/) The profitability of your woodlot can be altered substantially by being aware of these changes and altering the set of products to be cut from your woodlot to suit.

Not all woodlot owners will be paid the same price for their wood. There are significant costs associated with harvesting and transport that have to be subtracted from the price paid for wood at the processing plant or the export port. This means that in-forest log prices (stumpage) can be expected to vary between forest owners. Factors affecting harvesting and transport costs are covered in later sections of this booklet.

Table 5 provides some examples of log price differentials (relative to export pruned P40 price) that were relevant to some North Island forest operations in mid-2019. The differentials are based on 36-month rolling average prices and relate to prices at the wharf gate or mill gate.

Table 5. Examples of log price differentials for radiata pine (June 2019).

Product Name	Price ($ per tonne)	Differential (%)*
Export Pruned P40	183	0
Export A	136	-26
Export K	120	-34
Export KI	113	-38
Export Pulp	97	-47
Domestic Pruned P35	177	-3
Domestic Sawlog S30	120	-34
Domestic Sawlog S20	105	-43
Domestic Pulp	45	-75

* Differential compared with Export Pruned P40; e.g. Export A price in this example is 26% lower than Export Pruned P40.

Inventory procedures for woodlots

Assessing the potential yield of logs of various specifications is a very important step in determining the revenue that will be generated from harvesting your woodlot.

Some woodlot buyers and consultants use a "graduated eye-ball" based on years of experience to estimate the potential yields, particularly where the woodlot is small in area - but they usually tend to err on the conservative side in their predictions so as not to disappoint the woodlot owner. If your woodlot is small, getting several "graduated eye-ball" assessments might help you avoid the sort of blunders one usually discovers with the wisdom of hindsight.

A more professional assessment will include a formal Pre-Harvest Inventory (PHI) which includes detailed measurement of the area of the woodlot and a plot sample of stem sizes and qualities to determine per hectare yields of each log type. A good woodlot record system, which includes the tending history (i.e., physical data on pruning and thinning) for the woodlot, will be of significant help in assessing the potential value of your woodlot.

A forestry consultant or harvesting and marketing specialist will be able to tell you where to find a good inventory crew (see the section on **How to find harvesting and marketing specialists**).

Area

The most accurate way to obtain the area of a woodlot is to seek specialist assistance. For a very professional and accurate measure land surveyors are the most reliable people for the task. However, their services are relatively expensive and only really used when also considering the purchase or sale of the land a woodlot is on.

On-line tools, such as Google Maps, make measuring area relatively easy, although perhaps not as accurate. Once you find the location of your woodlot on the satellite image in Google Maps, you can use the Measure Distance feature to trace the boundary of your woodlot. Once you return to the starting point on the boundary, area is automatically calculated.

Figure 4 shows an example of the use of Google Maps to calculate woodlot area. You can see that an unplanted gully and a strip through the woodlot have been easily excluded by closely following the tree boundaries. There are a number of YouTube videos that show how to measure areas using Google Maps. Anyone with a post 1989 woodlot registered in the Emission Trading Scheme (ETS) can use their ETS maps as a relatively accurate guide to net stocked area. Some regional councils may also be able to provide maps.

Figure 4: Using on-line tools such as Google Maps make the task of measuring woodlot area relatively easy. The Measure Distance feature was used to trace the boundary of the above woodlot. It determined that the area inside the boundary was 379,887 m2 or 37.99 ha.

Yields per hectare

Most pre-harvest forest inventories in New Zealand today use the Plotsafe overlapping feature method (Figure 5) for describing the stems within each plot and the YTGEN software for analysing the data and determining per hectare yields. MARVL (method for assessment of recoverable volume by log-type), which is a predecessor system to the Plotsafe/YTGEN system, is still used in some areas.

The procedure entails establishing a number of fixed-size bounded plots throughout the stand. The term "cruising" refers to measuring all trees within each plot and also measuring a number of tree heights. The aim is to measure 20 to 30 stems per plot, which may require plot sizes of 0.06 to 0.08 ha.

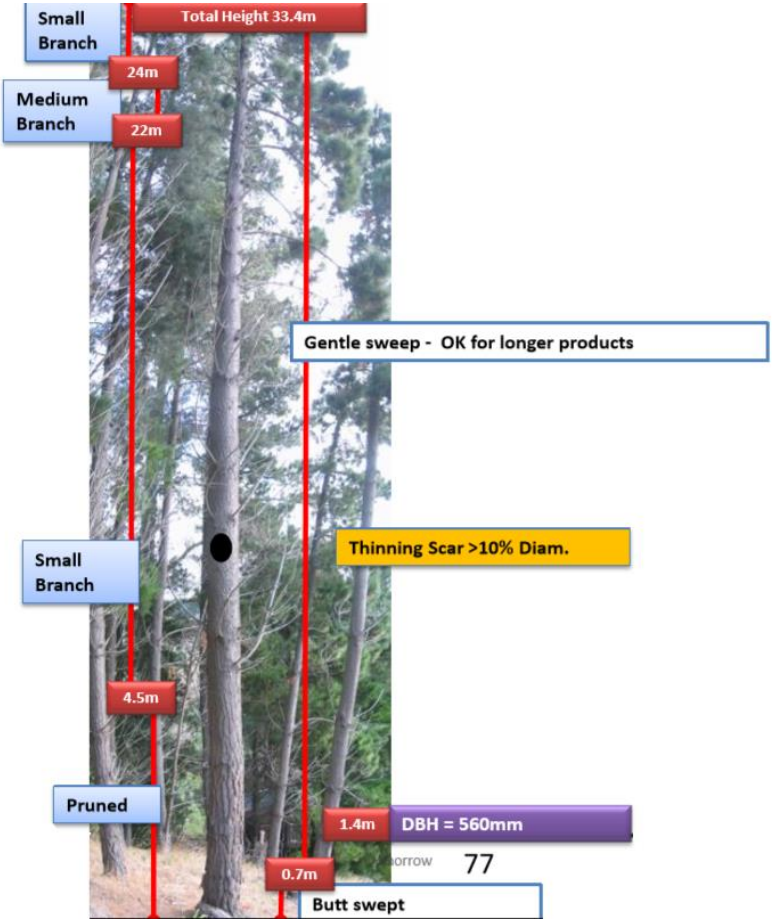

Figure 5: Example of describing stems using an overlapping feature method. (Photo: courtesy of Interpine Ltd.)

When cruising an alphabetic code is used to record stem quality (such as branching or straightness), while heights are recorded for the positions on the stem where quality changes. Other features of each tree such as forks, diameter reductions, dead and broken tops, or large merchantable branches are also recorded. Table 6 shows an example of user-defined stem quality codes for use in Plotsafe cruising.

Table 6. Examples of quality codes for Plotsafe cruising.

RAD05 Cruising Dictionary Quickcard

Code	Default	Description	Code	Default	Description
Windblown			**Branching (Br)**		
Y		Live Windblown Tree (F3 description only)	0		Pruned or completely clear
ResinCode (All Pruned Stands)			1		Epicormics \ Stem Cones <1cm
0	**YES**	**Unpruned or Pruned <3m / Wet Stems**	**7**	**YES**	**Branches less than or = 7cm**
1		Nil / Light	10		Branches less than or = 10cm
2		Moderate	12		Branches less than or = 12cm
3		Severe	25		Branches upto SED/2 to a max 25cm
Features (F)			99		Branches greater than 25cm
B10+		Butt Flare 10+	**Sweep (Sw)**		
C		Crutch or Reduction Zone greater than 0.5m	8		Sweep less than or = 1/8 over feature length 6.1m
D		Damage / Scar (>10% diameter depth)	**L**	**YES**	**Same as "S" but acceptable for 8-12m long logs.**
F5+		Fluting greater than 5cm	S		Sweep less than or = 1/4 over feature length 6.1m
F10+		Fluting greater than 10cm	3		Sweep less than or = 1/3 SED over length 4-6.1m
N5+		Nodal greater than 5 cm	1		Sweep less than or = SED/1
O1.2+		Ovality > 1.2x	X		Sweep greater than SED/1 (small sections of this only)
R		Rot	K		Kink (max distance 0.5m) (small sections of this only)
S7+		Spike knot 7-10cm in length & < 30 degrees	W		Wobble greater then 5cm over 6m
S10+		Spike knot 10-16cm in length & < 30 degrees	**Internode (I)**		
S16+		Spike knot 16-25cm in length & < 30 degrees	I		Intenode 1.2m+0.8m or 0.8mx3 sect. over 5m
S25+		Spike knot 25+cm in length & < 30 degrees	**NONE**	**YES**	**No features**
NONE	**YES**	**No features**			

** All knots are at right angles to stem.*

Specialist tools may sometimes be used to measure internal wood quality, such as wood density or stiffness (Figure 6).

Figure 6: IML Resi is an example of a tool that can be used in-forest for measuring internal wood properties.

It should be noted that the accuracy of pre-harvest inventory assessments may be low where woodlots are small, non-homogeneous, mixed age or mixed stocking blocks. Careful design of the inventory sampling system is required in these cases and greater inventory costs may be incurred. In big forest blocks one plot per one or two hectares may be sufficient. In small woodlots, it is likely that the same number of plots in total would be required, equating to three or four plots per hectare.

The cruise data collected in the forest, along with information on log product specifications and prices, are then entered into a computer program such as YTGEN. Computer analysis of the cruised trees starts with simulation of breakage and essential cuts at forks and the stump. Regional tree volume and taper models are then used to calculate the volumes and diameters of potential combinations of logs that would meet the log products specified. The analysis looks for the combination of logs that gives the highest total value from each tree.

The results from each tree are grouped at the woodlot level to derive overall estimates of volume and log production. These results are indicative of yields that can be attained by well-trained and motivated logging operators. Table 7 gives an example of the type of report generated by YTGEN. It not only provides estimates of log yields but it also provides estimates of the amount of stem residues likely to stay on site. For example, in the report shown in Table 7, 70 m^3 per hectare (12% of the total stem volume) is expected to remain in the form of broken tops and "waste" (pieces cut out of the stem to improve overall stem value).

The inventory software can also be used to simulate growth of the trees, allowing prediction of the value obtained from allowing the woodlot to continue growing for a few extra years.

The costs of undertaking a forest inventory depend on a number of factors including the size of the plots, the terrain, the amount of undergrowth, etc. Costs typically range between $100 and $300 per plot plus the costs of data analysis and report preparation.

Table 7. Example of YTGEN Reports

Stand Summary	
Harvest Type	Clearfell
Age (yr)	24.8
Basal Area (m^2/ha)	46.6
Top Height (m)	39.2
Stocking (s/ha)	257.3
Total Stem Volume (m^3/ha)	596.5
Total Recoverable Volume (m^3/ha)	516.8
Standard error of TRV (m^3/ha)	15.6
Probable limit of Error (0.05) (%)	6.2%
Plots	32
Stocked Plots	32
Value ($/ha)	44744
Area (ha)	1.0
Recoverable Piece Size (m^3)	2.07
Quadratic Mean DBH	48.0

Grade Summary	In TRV	Volume (m^3)	Value ($)	% TRV
break	No	0.0	0	
stump	No	9.9	0	
top	No	6.6	0	
waste	No	63.3	0	
Industrial	Yes	10.6	425.3	2.0
Pruned Dom	Yes	128.7	18,021.4	24.9
Pulp	Yes	0.3	8.2	0.1
Roundwood	Yes	20.2	908.4	3.9
Structural Dom	Yes	308.1	22,264.8	59.6
Unpruned Peeler	Yes	16.8	1,347.7	3.3
Utility	Yes	32.1	1,768.2	6.2

Return to Table of Contents

Section 3.

When and how should you sell your woodlot?

When is the right time to harvest your woodlot?

Growing a woodlot is a long-term investment. Most returns come at the end of the rotation, and although the value of the woodlot will continue to increase as long as the trees continue to grow, there will be a point when the profit from sale will be at a maximum. For well grown and well-tended radiata pine in New Zealand this point is often between 25 and 30 years after planting, although it will vary with growth rate, log quality, log prices and the required rate of return. Ex-pasture sites that have high residual fertiliser in the soils can bring harvest ages forward. In post 1989 ETS-registered forests, the value of carbon and the forest's ETS status may also influence the most profitable time to harvest.

Market dynamics can be a significantly greater determinant on forest value than a theoretical rotation age, however. Woodlot owners, especially those with small woodlots, will almost always be in a queue for a harvesting crew and will be unlikely to be able to specify exactly when they want their trees to be harvested. If you are "harvest ready", however, you will be in a better position to take advantage of the markets when the prices come right.

Before deciding when to harvest you should consult with your accountant to determine if there are likely to be any tax advantages from altering the timing of woodlot harvest in relation to income/expenses from your other activities. If, due to financial circumstances, you wish to harvest significantly earlier than the best time from an investment point of view, you should consider selling a 'cutting right', which assigns the right to harvest your trees to the purchaser at a future date (see Cutting Right section for more detail).

Marketing arrangements

Your financial returns from the woodlot occur, primarily, at the time of harvest, except in the case where a cutting right has been sold prior to maturity. You should, therefore, select a marketing arrangement that ensures maximum return to you, the grower. To ensure the best price is achieved you should consider tendering the sale of your woodlot.

The critical decision for the woodlot owner is the decision as to who is appointed to conduct the harvesting operation, and the existence of incentives for the agent to act in the interests of the woodlot grower. The following marketing arrangements may be followed:

- Forestry consultant
- Forestry company (that manages their own estate, but also provides harvesting services for other landowners)
- Logging contractor
- Sawmiller/wood processor
- Cooperative

A prime consideration in selecting an agent is naturally the integrity, skill and track record of the candidates. There are other considerations also as outlined below.

Forestry consultant

A forestry consultant, or a forestry company that offers harvestin and marketing management services, is an agent appointed by the woodlot owner who is independent of the timber buyer. The independent consultant will provide a forest valuation or pre-harvest inventory upon which to base negotiations with potential buyers. The forestry consultant / forestry company will organise, supervise and pay contractors (roading, logging, loading and cartage), and liaise with regional authorities where required. It is important to ask what markets the consultant has access to and their relationship with those markets.

The consultant / forestry company may be paid a fixed amount for conducting the sale, or may receive a percentage of the total net return (revenue minus costs). Paying a percentage may increase the incentive to maximise return for the forest grower. The logging manager does not buy the woodlot from the grower but assists in its sale.

Logging contractor

Logging contractors usually work to provide a specific processing plant with its log requirements. A logging contractor may not have knowledge of, or access to, other markets. If the logging contractor is paid a rate per

tonne or cubic metre that is not dependent on maximising log grade out-turn he may be motivated to reduce logging costs by reducing the number of log types cut on the landing to the detriment of the value recovered from the crop and the revenue produced for the grower.

Wood processor

The wood processor is motivated to provide wood for their own plant. It is questionable whether the wood processor should be relied upon to act in the best interests of the forest grower. In some cases, in New Zealand, the independent sawmiller is reliant on the woodlot owner for a large part of their log input. In this case the sawmiller is motivated to pay a fair price. However, the sawmiller may not be the best person to advise on export log market opportunities, since increased log exports may reduce available supplies of certain grades to the sawmiller.

It is in the long-term interest of all parties (the woodlot owner, logging and cartage contractors, sawmillers, pulp and panel manufacturers and log exporters) that a fair price is paid for logs. A fair price will provide profits to the grower and sustained future wood supply to processing plants. However, in the short term, the interests of growers and processors are in conflict, and an agent who primarily works for (or is him/herself) a processor may not be able to work as effectively on behalf of the woodlot grower as an independent and specialised consultant or logging manager. Experienced woodlot owners have recommended the use of an independent agent.

Cooperative

While cooperatives have been used successfully in other parts of the world, they have not been an enduring feature of New Zealand log marketing. A cooperative may negotiate with wood buyers to arrive at a more favourable price through collective bargaining power, as well as providing market information and information on credit worthiness of log buyers and efficiency of contractors.

Timber Sales Methods

Cutting rights

Cutting rights embody the right to use forest land for a specified period. Harvesting may occur at any time within that period, at the discretion of the owner of the cutting right. Other conditions to protect special features of the land or to require replanting after harvest may be applied. The cutting right may be tendered or bid for, using a variety of methods. The cutting right may be used to sell immature forest while retaining ownership of the land. The value of the cutting right will be based on the expected value of future harvests. If the actual realisation is higher than expected the woodlot owner will have received a lower return than if the woodlot had been sold at time of harvest, when log prices were known. The purchaser of a cutting right will probably want to register a Forestry Right on the Title. A deposit on the expected future value may be paid on purchase of the cutting rights. In selling a cutting right the woodlot owner should understand that the price will depend on expected log prices at the time of harvest and the return required by the buyer on the cutting right.

Stumpage sales

A stumpage sale is the sale of standing trees (i.e. "on the stump"). Harvest access, logging, loading, log transport, and marketing and sales are the responsibility of the buyer. There are conditions laid down to dictate the expected condition of the land, logging standards, roads and any other property, such as fences, after the logging operation is completed.

There are three types of stumpage sale, the graded ("pay as cut") sale, the composite ("pay as cut") sale, and the lump-sum sale. In the graded sale, the stumpage buyer pays a different price for each grade cut. Payment is based on the volume of timber harvested. The risk for the forest owner in this sale method is the stumpage purchaser's lack of incentive to optimise the grade outturn. In the composite stumpage sale, the buyer pays a composite price for all logs harvested. While this produces an incentive to optimise grade outturn, it is likely to result in a price discount to mitigate the buyer's risk that the grade mix is inferior to that assessed before harvesting. In the lump-sum sale the harvest volume by log type is estimated by the buyer using a pre-harvest inventory, and payment is

based solely on this assessment. The buyer assumes all risk associated with differences between predicted and actual harvest volumes, and prices. However, the return to the forest owner is likely to be less with a lump-sum sale as the buyer is likely to make allowances for these variations.

Log sales

Under a log sale agreement, the forest owner ultimately assumes responsibility for logging, and may also assume responsibility for loading and transport. A potential disadvantage of log sales is that the forest owner is likely to be an "unknown quantity" to the logging contractor and wood purchaser; they are likely to add an allowance for risk in their costings for this. The owner may, however, appoint a professional harvesting/marketing company to manage the project on their behalf. All revenues received and costs incurred from the project are the responsibility of the forest owner. In a log sales agreement, the owner takes on the market risk, and will make more money should the market rise during the operation but conversely may lose revenue should the market fall during harvest.

Table 8. Point of sale for Log Sales

Description	**Point of sale**
"At roadside"	At forest road or landing
"On truck"	Loaded on truck
"At mill door"	Delivered to mill
“At export gate/ at wharf gate”	Delivered to the exporting port

The timber sales method selected will depend on your objectives. You must ensure that the logger has adequate incentives to produce the maximum value through optimal log making, and that forest revenue is based on log quality out-turn. These conditions may be achieved through a scaled timber stumpage sale or various types of log sale. Managed log sales have been described by an experienced woodlot owner as *"...probably the fairest way to ensure that both parties get true value for what they are buying or selling...".*

The timber sales method will also depend on the size of the sale. Very small sales will probably be carried out as a lump sum stumpage sale, because the costs of detailed inventory and log segregation are not be justified by the volume of wood produced.

When to "Do it Yourself" versus hiring a specialist manager.

Unless you have extensive experience yourself, or only have a very small woodlot it is recommended that a specialist be used. Nearly all woodlot owners who had been involved with woodlot harvesting would strongly recommend this.

A good independent agent acting on your behalf should ensure, among other things, that:

- a proper assessment of the woodlot has been carried out to determine what products are in it
- the agent knows the best markets to be supplying from the woodlot and those to avoid, e.g. those in financial difficulty
- the best prices will be paid for each product
- roading and harvesting operation are properly planned
- a competent logging gang with a skilled log-maker and appropriate equipment are used
- environmental and legal requirements are met.
- the woodlot owner is paid regularly and promptly
- the site is left in a tidy, safe condition at the end of harvest
- arrangements are made for replanting if required.

Independent agents will typically charge from 4 to 8% of the price of the wood delivered to the processing plant or the export port for their management services. Some agents quote in percentage terms, others in $ per tonne gross (or net of expenses).

Woodlot buyers from large companies subtract a minimum management fee from the stumpage prices, and this typically ranges from $2 to $6.

Some consultants will not work on a commission basis and simply charge an hourly or daily consulting rate. From the woodlot owner's point of

view a commission basis is usually preferable. If a commission is involved the consultant would try to manage the harvesting and marketing operation so that their returns, along with the owner's returns, are maximised. Because the consultant is not sure exactly how much time will be involved, however, he will have to build a risk factor into their commission rate.

How to find harvesting and marketing specialists

Harvesting and marketing specialists can be found by contacting in your area one or more of the following:

- independent forestry consultants
  https://www.nzif.org.nz/home/find-a-registered-member/
- representatives of the major forest companies
  https://www.nzfoa.org.nz/resources/links/121-companies
- NZ Farm Forestry Association (NZFFA)
  https://www.nzffa.org.nz/branches/
- Te Uru Rakau, Forestry New Zealand
  https://www.teururakau.govt.nz/te-uru-rakau-forestry-new-zealand/

A web-search using the following keywords (forest harvesting marketing specialist NZ) also provides some links to many harvesting and marketing specialists:

https://nzforestry.co.nz/about-us/
https://woodmarketing.co.nz/about/
https://www.woodmetrics.co.nz/
http://www.laurieforestry.co.nz/
http://phs.co.nz/
https://forestandharvesting.co.nz/
https://www.nfp.co.nz/
https://www.paulcarruthersltd.co.nz/
https://forest360.nz/
https://www.nfml.co.nz/
https://nz.pfolsen.com/
https://www.nzfm.co.nz/
https://www.logmarketing.co.nz/

https://www.matarikiforests.co.nz/expertise/forest-and-woodlot-harvesting/
https://www.ribbonwood.co.nz/
http://www.fortus.co.nz/
https://www.ftf.co.nz/
https://forme.co.nz/
https://www.forestmanagement.co.nz/
http://www.fmnz.co.nz/

It is strongly recommended that, before engaging the services of a harvesting and marketing specialist, you ask him for references from other woodlot owners who have had their woodlots recently harvested. Good references will reduce your risk of having a bad experience.

Conditions of Sale and Contracts

The conditions of sale are the basis of the sale agreement between the buyer and the seller. The purpose of drawing up conditions of sale is to protect your interests. These can later become part of the formal sale agreement.

Matters which should be considered when arranging the conditions of sale are:

- **Basis of sale:** The species, location, quantity, form (tree or logs) and categories of produce to be sold should be stated clearly. The boundaries of the woodlot to be harvested should also be clearly identified.

- **Prices and Point of sale:** The point at which the produce becomes the property of the buyer should be stated for log sales - at roadside, on loading, on truck, at mill, or at export gate. The prices to be paid for each log product should also be specified.

- **Access:** It is desirable to specify the access road the contractor must use when crossing farmland to and from the woodlot and to require them to keep it in good order. If access is difficult during winter and is limited to summer only such restrictions should be included. If it

is necessary to construct a new access road it should be specified who is responsible for construction and maintenance.

- **Measurement:** It is necessary to state whether logs are to be weighed or scaled and if scaled, the unit of measurement and log volume table to be used. If selling by weight, the weight-to-volume conversion factor, the person who is to do the weighing, and the weighbridge where it is to be carried out should be specified.

- **Commencement and Completion Dates:** The dates at which logging will be commenced and at which all produce must be removed should be specified.

- **Cleanup and removal of equipment:** The need to heap up all debris into windrows to facilitate burning or spread so that replanting is made easier should be stated. A date by which all equipment should be removed should be specified.

- **Logging waste:** The minimum size (diameter and length) of material to be removed and maximum stump height (usually 10 - 20 cm) should be stated to ensure that the buyer does not leave saleable material in the woodlot. It should also be stated that saleable wood left after the removal date will be scaled and charged for.

- **Protection of stock and farm property:** Conditions should be specified which will protect the property and animals from unnecessary damage or disruption by logging contractors. For example, damaged fences and pasture should be restored, gates on access routes should be kept closed, etc. If fences need to be removed it should be stated who is responsible for taking them down and putting them back up and in what condition they should be replaced.

- **Fire safety:** It should be stated that fire protection equipment must be provided on site, that fires will be restricted to defined areas (if allowed at all), and that spark arrestors should be fitted to motorised equipment. In many regions there is a published daily fire risk assessment and guidance for the suitability of logging operations under those conditions.

- **Indemnity:** It should be stated that the buyer will be required to indemnify the seller against damage to property resulting from the logging and removal of produce.

- **Environmental and Safety Requirements:** It should be stated that obligations under the Resource Management Act will be met and Regional Forest Operations Guidelines followed where appropriate. It should also be stated that, under the Health and Safety at Work Act 2015 (HSWA) New Zealand's workplace health and safety law, both the forest owner and the logging and cartage contractors have certain obligations and that all due care will be taken to meet these obligations.

- **Payment:** The terms of payment should be set out. These usually include a deposit (depending on the size of the sale) and payments at regular intervals (e.g. monthly).

- **Transference:** It should be stipulated that the buyer may not transfer the rights of sale without the seller's consent.

- **Special conditions:** Any special conditions relating to the particular area of trees to be sold should also be specified. For example, if access must cross a neighbour's property it should be stipulated who is responsible for arranging logging routes and access right.

The conditions of sale, along with other provisions for arbitration, formal authority for the buyer to enter the woodlot owner's land and remove wood, penalty for late payment, etc., are included in the contract for sale - also called the memorandum of agreement. In some cases, a letter of agreement, containing a subset of the above conditions of sale, is used. In either case a solicitor should be used to draw up the sale agreement to ensure that it is legally acceptable and binding upon both parties.

The wood buyer may request that a Title Search is carried out to ensure that the land does belong to the person offering the woodlot for sale. In addition, it may be necessary for them to check that there is no mortgage

on the property. If there is a mortgage the woodlot owner does not have the right to sell the timber unless it is under separate title.

Methods of Payment

To ensure that full payment is received for your woodlot you need to be confident that good records are being kept of what volume of logs leaves your property and that the wood buyer has the ability to pay for what he takes.

Some woodlot owners advise others to keep a tally of the number of truck loads that leave the farm, or alternatively get a copy of each Log Delivery Docket written for each truck load. It is no use when the job is over thinking: "I am sure there was more wood there than that!" Wood buyers from reputable firms could be expected to arrange for a copy of the truck loading docket to be left in an agreed place for you on a regular basis, or email you digital copies of the dockets each day or week.

Guarantee of payment is very important. In the past there have been cases reported where some small sawmills have not been able to pay for loads delivered. A deposit up front should be requested if there are any doubts. Arrangements for regular payments throughout the term of the contract (e.g. fortnightly or monthly) should also be made. Do not wait until the block is finished to find out you are not going to be paid.

Some large companies arrange for direct crediting of payments on a fortnightly basis for timber they purchase from woodlot owners.

Return to Table of Contents

Section 4.

How to be safe and respect the environment?

Safety considerations

Timber harvesting has been, and unfortunately continues to be, a dangerous task. The Health and Safety at Work Act (HSWA 2015) makes it clear that all Persons Conducting a Business or Undertaking (PCBU) have a responsibility for safety. A landowner engaging in a timber harvesting activity is by definition a PCBU and should actively take part in ensuring health and safety of the people working on their land. It is unlikely that a small-scale forest owner will have the expertise to develop a detailed health and safety plan for the timber harvesting operation. The most prudent option is to engage with a professional forestry company, consultant or contractor to ensure you have the appropriate health and safety plans in place.

Figure 7: Breaking-out (hooking on logs to cables) and manual tree falling are the tasks that cause the majority of serious harm accidents in harvesting.

The forest industry has been working hard at improving its safety record and has a dedicated Forest Industry Safety Council. A comprehensive

review of the forest industry was completed by an Independent Panel and a summary document outlining some of the main shortcomings, as well as an agenda for change, was published (IFSR 2014). A number of initiatives have been undertaken including setting up 'Safetree' a website that provides resources such as documents and videos on how to complete timber harvesting safely.

WorkSafe have published a very useful document entitled "Managing a Safe and Healthy Small Forest Harvest". It provides an excellent resource in terms of practical step-by-step guides for managing your harvest. For example, one task the landowner must complete is the identification of hazards on the property and making sure they are communicated to the logger. The SafeTree website also provides a practical "How to.." process for managing critical risks – those risks which can cause serious harm.

Examples of hazards on farm woodlots can be fences, proximity to powerlines, but also the strength of stream crossing structures. You are also likely to be responsible for the safe access to the forest on your farm, so if the farm roads and tracks leading to the area to be harvested are steep and not accessible for a logging truck in wet weather, then you need to take action to restrict access.

With regard to the individual harvesting tasks, there is an Approved Code of Practice (ACOP 2012) for forest operations that is considered a minimum standard. It includes the expectation that all workers are both trained (or in training) and competent in carrying out the designated harvesting task. Best practice guides are also available from various sources including for higher risk practices such as manual tree felling or choker-setting (known colloquially as 'breaking-out' in New Zealand), or complex harvest systems such as cable logging.

Contractors often have 'tailgate' meetings to discuss safety and work before they start each day. While a small forest land-owner is not expected to attend all meetings, it may be beneficial to attend at least a few as that is a good time to interact with the contractor and their workers to assess the intended work programme – not only for safety but also for

the expected environmental performance. To help you prepare, here is a link to some 'Talking Topics' specifically for small-scale forestry.

Protecting the Environment

All landowners in New Zealand have an obligation under the Resource Management Act (RMA 1991) to look after their land – what most will refer to as having sustainable land practices. A good overview of the RMA is provided on the Environment Guide website. The actual implementation of the RMA, and how it affects a landowner, is the responsibility of the Regional and District Councils and will be written down in their Plans.

Regional and District Plans tend to be very large documents that to a layperson are hard to decipher. However, it is a legal requirement to comply with those plans. While each Region in New Zealand has different requirements, in most regions a Resource Consent is required for larger scale earthworks (i.e. building roads and landings) and may also be required for undertaking timber harvesting (typically referred to as 'Vegetation Removal' in the plans). Obtaining consents may take several weeks and incur an application fee.

Figure 8: If done well, timber harvesting will have a low impact on the environment, including protecting waterways and streamside native vegetation.

Since 2018 there has been a National Environmental Standard for Planation Forestry (NES-PF). This document provides for environmental expectations that are the same across the different regions. While all Regional and District council are required to implement the NES-PF, they may have expectations and or rules over and above those detailed in the NES-PF, so you are still required to refer to the Regional Plan. The NES-PF regulations require those undertaking an activity in a forestry block greater than one hectare to give notice to the Council.

You can expect a professional forestry company, consultant or contractor to be aware of environmental requirements, but as a landowner about to undertake either earthworks or harvesting it will be prudent to make sure someone has contacted the Regional Council to ensure compliance requirements are met.

The most common environmental impact from timber harvesting is exposing soil to erosion. When soil erodes from the land it can enter waterways, a process call sedimentation, that affects both water quality as well as aquatic habitat. The NES-PF Erosion Susceptibility Classification (ESC) is used to identify the erosion risk of land as a basis for determining where a plantation forestry activity is permitted, subject to certain conditions being met, or where it requires a resource consent because it's on higher-risk land. Extra compliance costs may be associated with higher-risk land. You can use the on-line ESC tool to find out what zone your woodlot is in - https://www.teururakau.govt.nz/growing-and-harvesting/forestry/national-environmental-standards-for-plantation-forestry/erosion-susceptibility-classification/

In addition to any rules or guidelines that Councils make available, a good reference book and guide for minimising environmental impacts is the Environmental Code of Practice (NZFOA 2009) which provides a clear list of tasks such as planning, road building and harvesting.

Building roads and landings makes a permanent change to the landscape and is typically the biggest risk for impacts on the Environment. More detailed information about building roads of a high standard can be found in the NZ Forest Road Engineering Manual. In terms of actual operating practices, the NZ Forest Road Operators Guide can be a useful tool as it is designed using a pictorial guide to better practices.

Another common concern is the risk of harvest debris (commonly called ‘slash’) entering a waterway either during the extraction process, or when accumulated at a landing or roadside where it might slide downhill during a rainstorm. Again, these risks can be minimised by following the recommended best practices for Managing Slash on Landings and around Rivers/waterways.

Return to Table of Contents

Section 5.

What harvesting and transport systems do you need?

Roading and landing options

Good access to and within the woodlot is often cited by woodlot buyers as one of the key factors affecting the ease with which the woodlot can be harvested and ultimately returns to the forest grower. Good road access allows all-season logging which may lead to lower logging costs; woodlot owners who plan on summer-only logging, with lower road standard requirements, are competing for harvesting services with many like-minded woodlot owners.

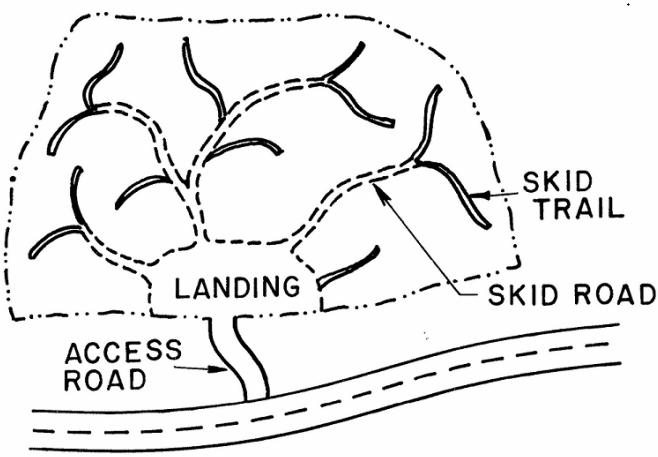

Figure 9: A woodlot road system for ground-based logging equipment. Tree stems are extracted to landings along skid trails to the landing. Trucks gain access from the public road to the landing by means of an access road.

A term commonly used for designing forest access roads is ‘fit for purpose’. The larger the harvest area, the more trucks that can be expected to pass over the road, the higher the standard of road required. Ideally roads should be constructed when weather conditions are dry and enough time ahead of logging for the roads to "settle in". This may be twelve months ahead of logging.

Roading costs vary widely depending mainly on the difficulty of the terrain, the soil type as well as access to aggregate. A higher standard

forest road (called ‘secondary’) (Figure 10) can be very expensive to construct, costing on average about $100 per metre, while a lower standard of road (called a ‘spur’ road) that is just used to access a single landing is only $40 per metre. One important trade-off in deciding a road standard is that saving money on road construction increases the risk of the operation being halted due to bad weather. While people often think about rain closing down a harvesting operation, the most common reason for having harvest delays due to weather is that the logging trucks cannot access the landing.

Figure 10: A new secondary road being constructed for accessing an area to be harvested. While a higher standard road like this provides more reliable truck access, especially in wet weather, they are also very expensive to construct.

Building roads depends on a lot of complex factors including soil type, terrain slope, available pavement materials (aggregate) and available machinery to construct it. A very good basic guide to many aspects of forest road building is the Forest Roading Engineering Manual (NZFOA 2012). This reference can really help in understanding options, design criteria and equipment used to construct the road. Most larger harvesting and marketing companies have their own roading engineers and environmental specialists, and these people are a critical part of harvest planning.

Regardless of cost, one minimum standard that must be met is the protection of the environment. Roads and their associated embankments and fill slopes are invariably at risk of erosion, especially when used in wet weather. A very practical way of being involved in ensuring that roading standards are being met is to use the Road Engineering Operators Guide (NZFOA 2014). It shows pictures of 'good' (and 'poor') practices that is an excellent resource for inspecting roads, especially near waterways.

If the area to be harvested is small, but requires a lot of new road to access, a preferred option may be to 'two-stage'. Two-staging refers to the stems being extracted to a much smaller landing (typically called a 'pad'), where they are then transferred to a robust vehicle such as an off-road truck that can work on much lower standard roads such as a typical farm track. The processing area is then placed in a location closer to the public road.

Stream Crossings

Particular attention should be given to the design of any stream crossing. While culverts are typically used for smaller waterways, drift decks and or bridge options are required for streams or rivers. Maintaining the integrity of the streambed, or at least ensuring that a stream crossing is installed in a way that allows aquatic species to migrate through, is an important design consideration and typically a legal requirement for any crossing over a fish bearing waterway. Most crossings will require a resource consent from the Regional Council and they will have specific design criteria that must be met.

The New Zealand Forest Owners website provides Forest Practices Guides that can help you design: fords, temporary crossings, single culverts and drift decks.

The cost of stream crossings varies widely depending on the span of the stream to be crossed, the type of crossing and local site conditions. Costs can range from as low as $2,500 to well over $50,000.

Figure 11: A well-designed stream crossing is wide and strong enough to accommodate truck passage, stable in high flows and minimises the impact on the waterway. The 'low-water crossing' shown retains the integrity of the riverbed and allows flood waters to pass over the structure.

Landings

The landing (also called a 'skid site' or a 'deck') is the designated area in the forest used to further process stems or trees extracted from the forest, store them, and then load out the logs. This area is usually cleared of obstacles such as trees and or stumps, and can vary in size depending on the processing, storage and loading out requirements.

The landing will accommodate the processing machinery and should be laid out for an efficient flow of logs. While most harvesting crews process the logs using machinery, smaller crews may still use 'skiddies', - workers whose primary task is cross-cutting the stems into logs using chainsaws. When skiddies are working on a landing there should be clear separation between them and the machinery. Landings must also have enough space to accommodate the log stacks, the log loading equipment as well as the logging trucks. A study of New Zealand landings showed that the average landing size in New Zealand plantation operations was 4000 m^2, with the smaller ones being 2400 m^2. This equates to a design area of 40 m x 60 m. Key factors that influenced the size include the

system productivity, number of log sorts, as well as the type of loading machine used. Front front-end loaders need more space to operate effectively compared to excavator-based loader.

Figure 12: A landing area that provides space for the yarder, a processor and a loader, and the log stacks, as well as space for a logging truck to be loaded.

An important planning consideration is the location of the landings. They are generally placed in the middle of the harvest area to minimise extraction distance as this will reduce harvesting cost. For many smaller scale forest operations using an existing cleared area (i.e. neighbouring paddock) may be the best option to minimise roading and land clearing costs.

Harvesting systems and machinery

Timber harvesting typically refers to the physical process of cutting, extracting and processing trees into logs that can be loaded out onto trucks and delivered to market. To make an informed contribution to planning

for harvesting and selecting the harvesting contractor (also known as a 'logger'), being familiar with the capabilities of the machines and systems that can be selected to carry out a harvest will be very beneficial. Therefore, an overview of the steps required to make a harvest plan is followed by a section on machinery and systems that may be used to carry out each step of the harvesting operation.

For those not familiar with timber harvesting and the landscape change it brings, a company working in Northland has made a short time-lapse video of a small 25 hectare forest being harvested (Gary Leslie – NFP).

Trees are large and heavy and for cost-effective harvesting the system must be able to handle them quickly, efficiently, and safely. To choose the right harvest system for a particular forest we need to match the equipment to the stand and the terrain conditions. For simplicity, it is possible to break down the timber harvesting into four practical steps: Felling, Extraction, Processing and Loading Out. A number of options are typically available to complete each step of the harvesting process and it is important to understand the advantages and disadvantages of each option. It is impossible to describe and discuss all the various machines and systems that have been used in the harvesting process, there have been too many! There are always new and exciting ideas being tried out to improve the harvesting process. The system chosen should ensure that:

- it is physically feasible to carry out the operation,
- it is both safe for the people involved and low impact on the environment
- it is cost effective.

Felling

Felling is defined as "severing the tree from the stump and bringing it to the ground". This can be done 'motor-manually' (a person using a chainsaw – also called simply 'manual' felling) or 'mechanically' with a felling machine.

Important factors to consider when felling a tree include minimising breakage (i.e. by not felling them across other trees or rocky outcrops), in

a manner that assists the subsequent extraction (i.e. with the butt end towards the landing) and minimises the impact on the site (i.e. keeping them out of waterways or away from native vegetation that may be protected).

Manual chainsaw felling was the preferred option for many decades. Chainsaws are relatively low cost and easily maintained or replaced and a skilled worker with a chainsaw is capable of operating on any terrain, including steep slopes and in areas with very soft soils that can limit many machines. Chainsaw felling is also likely to be the only option for very large diameter trees; most felling heads are limited to about 80 cm diameter trees.

As machinery improved, mechanised felling proved to be more cost-effective on flat or rolling terrain. This means the additional cost of operating a machine to complete the felling task was offset by increased productivity. The most common machine used for felling in New Zealand is a (modified) excavator base with boom attached called a felling head. Felling heads can be a simple grapple with saw arrangement, but they can also be highly complex (and expensive) that can not only cut, but also delimb, top and process the stem into logs.

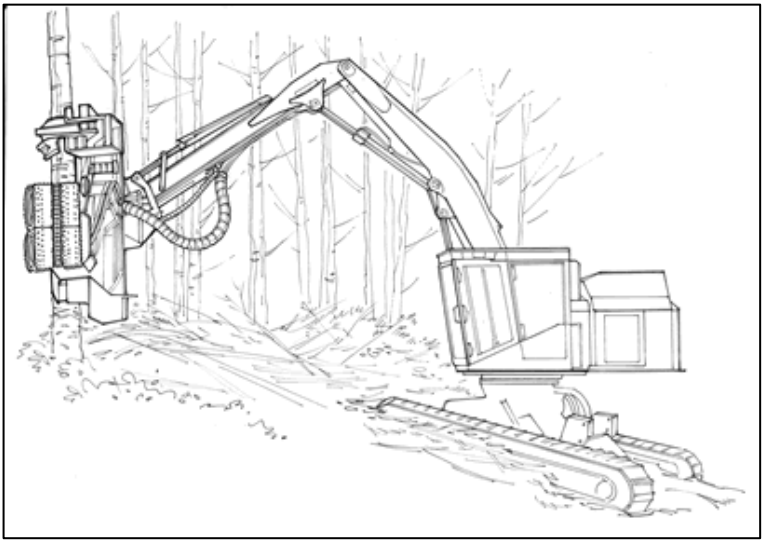

Figure 13: A typical modern grapple harvester machine comprising an excavator base and a harvesting head that can both fell the tree, as well as delimb and top it, and bunch the felled stems for extraction.

An important aspect of all machinery used in timber harvesting operations is they must meet strict requirements to keep the operator safe. Two important cab features are ROPS (roll over protective structure) and FOPS (falling object protective structure) protection. The cab must also have guarding to protect the operator from 'chainshot'. Chainshot is when a small segment of the cutting chain breaks off and is fired out of the head at a speed that can readily kill a person. A rule of thumb is to stay at least 75 m away from a felling or processing operation and never to be in line with the saw. If you can see the chain – you are in a dangerous place!

While felling is safer with a machine, machines are limited to rolling terrain with few obstacles. One innovation where New Zealand is playing a major role is the development of 'cable-assist' operations. A machine (bulldozer or excavator) with a winch is anchored at the top of the hill and lowers the harvesting machine down the slope. This allows them to

operate on very steep slopes: when soil conditions permit operating machines on 40 degree slopes becomes very possible.

Figure 14: A 'cable-assist' operation where the anchor machine (left) on the landing is using wire ropes to lower the harvesting machine (right) down the slope.

While felling simply refers to cutting the tree down, depending on the machine option, a number of processing tasks can be completed "at the stump". There are a number of advantages:

- Removing top and limbs as they have no value to avoid the additional extraction weight.
- Making the trees easier to extract by reducing their size if too large or by changing their shape if too awkward (removing large branches).
- Creating a slash mat so that the machine(s) drives over a slash mat to reduce soil compaction and/or rutting.
- Recycling nutrients back into the soil – nearly 90% of the nutrients are in the bark, branches and leaves/needles of the trees.
- Avoiding large piles of slash at the landing.

Although typically bucking (cross-cutting) the stems into logs can be done more efficiently at a landing area, in some operations the stem is processed into logs 'at the stump'. This is referred to as a "cut-to-length"

operation. In addition to benefits listed above, cut-to-length has the benefit of not needing a landing for processing. The extracted logs are typically stored at road-side for loading onto trucks.

Extraction

Extraction is the removal of the stems from the forest area to a landing (or logs to roadside in cut-to-length). This is often the defining function in the forest operation. If machines are used that move along the ground it is referred to as 'ground-based', whereas if the stems are extracted with wire ropes that are suspended in the air it is called 'cable yarding'. Because of very high costs, only in exceptional cases will a helicopter be used, and then it is referred to 'aerial logging'.

The US Forest Service has made three excellent short videos that both demonstrate the 'Ground-based Harvesting', 'Skyline Cable Yarding', 'Helicopter Yarding', providing an overview, advantages and important factors to consider when working with these systems (USFS harvesting video website).

Ground-based

Ground-based harvesting is the most common extraction method because it typically is the lowest cost and highest production option. If the stems are dragged along the ground the processing is called 'skidding'. If the stems (or logs) are lifted onto a trailer for extraction then the process is called 'forwarding'.

Skidders

The cable skidder is still the most versatile form, whereby a cable winch mounted to the body of the skidder is used to pull the logs (Figure 15). The cable skidder does not need to drive to each stem to pick it up. The cable is fed over the arch through a fairlead. The fairlead is typically a series of rollers that reduces the wear on the cable. As the cable skidder gets close to the stems the operator needs to dismount and attach the chokers. The winch pulls the logs in to the skidder. It does take more time to attach the logs and unhook the logs at the landing and requires the operator to get out of the safety of the cab.

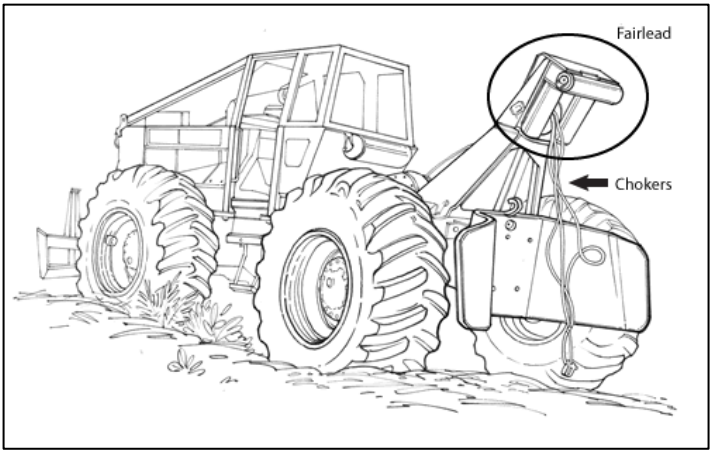

Figure 15: A cable skidder showing the fairlead and chokers that are used to hook up the stems (image from US Forest Service).

A major improvement made to skidders was an attachment known as a grapple. Where you can back the skidder to the stems that need to be extracted, the grapple skidder is both safer and more productive as the operator does not need to leave the cab (Figure 16). As such they are limited by their ability to reach the timber, but typically very well suited to mechanized felling as the stems are typically laid out in bunches (pre-bunched).

Figure 16: A grapple skidder extracting a bunch of stems (image from US Forest Service).

As a guide, rubber-tired skidders can start to slide on slopes of 15 degrees if the soil is weak or wet, and tracked machines can go up to 20 degrees. The operating range of skidders can be improved to work on steeper slopes by putting chains around the tires, or they can work on weaker or wet ground slopes with wider tires. Typically, the upper slope limit of a skidder working on strong soils is 25 degrees - but that is only with an experienced operator.

Forwarders

Forwarders are articulated machines consisting of an operator's cab and a log bunk, basically a tractor pulling a wagon load of logs. While forwarders can extract stems, they are more suited to 'cut-to-length' harvesting where the trees are already processed into logs at the stump. The most common forwarder configuration has eight wheels (two sets on each articulation). Most forwarders have a boom mounted grapple for loading and unloading material (Figure 17).

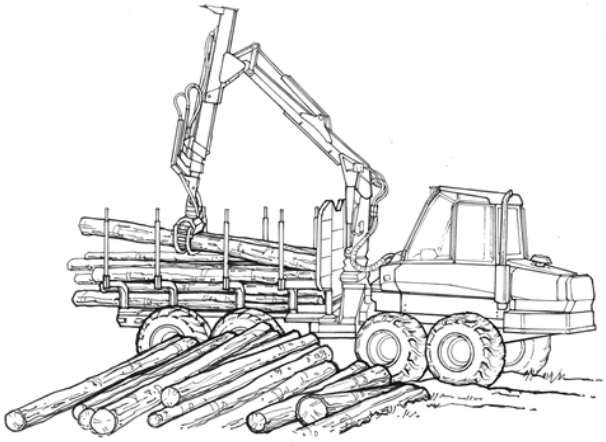

Figure 17: A Forwarder in the process of loading logs onto the bunk (image from US Forest Service).

Forwarders typically have a lower ground impact, making them a preferred extraction machine in Europe. For extraction, they are typically more expensive than the skidder over shorter distances and hence the New Zealand preference for skidders. However, factors such as longer extraction distances, the desire for lower levels of ground disturbance, or when working with fewer log sorts, mean a forwarder may be most suitable. These are all factors that are more prevalent in smaller scale harvest areas and as such forwarders are not an uncommon option for small woodlots.

Tony Brand, a logging contractor working in Canterbury has posted a short video of his system that combines an excavator based harvester with a forwarder.

Cable Yarding

Cable yarding, also known as cable hauling, is typically only used in steep harvest areas where ground-based equipment cannot safely traverse the terrain or soil conditions limit the use of ground-based machinery. As the name suggests, cable logging relies on the use of cables to extract timber from the forest. It is the one system where the primary piece of extraction equipment (in this case the yarder) is not moved in and out of the stand – and is therefore considered a very low impact system. It uses the least amount of fuel of all extraction systems (per unit of wood extracted). However, cable yarders are expensive machines to purchase and run. They require detailed planning and long set-up time, and typically are slower than ground-based systems. This combination means the cost of operating a cable system is often considerably greater than a ground-based system, but still cheaper than a helicopter system.

A cable yarder will have either a wheeled or tracked base for mobility, a tower to keep the cables off the ground (called 'providing lift'), and a series of winches to pull (or brake) the cables. There are many different types of cable yarders, and many different ways to rig them. A good overview of the many options are in the NZ Cable Logging Best Practice Guide or in the Oregon Yarding and Loading Handbook.

Figure 18: A tracked based tower yarder. This Madill 171 has four guylines to support the tower, a grapple carriage running along the skyline, and uses both a mainline and haul-back line to pull it forwards ('inhaul') and backwards ('outhaul'), respectively.

A basic rigging configuration involves a single larger cable (called the 'skyline') that is stretched from the yarder across the valley and attached to either a stump or a machine. Another line, the 'mainline' is attached to a carriage that runs along the skyline. A third line might be connected to help pull the carriage out along the line, and this is called the 'haulback' line. Most yarders will need guylines to hold up the tower. Many aspects of operating a yarder are covered in the Approved Code of Practice (ACOP 2012).

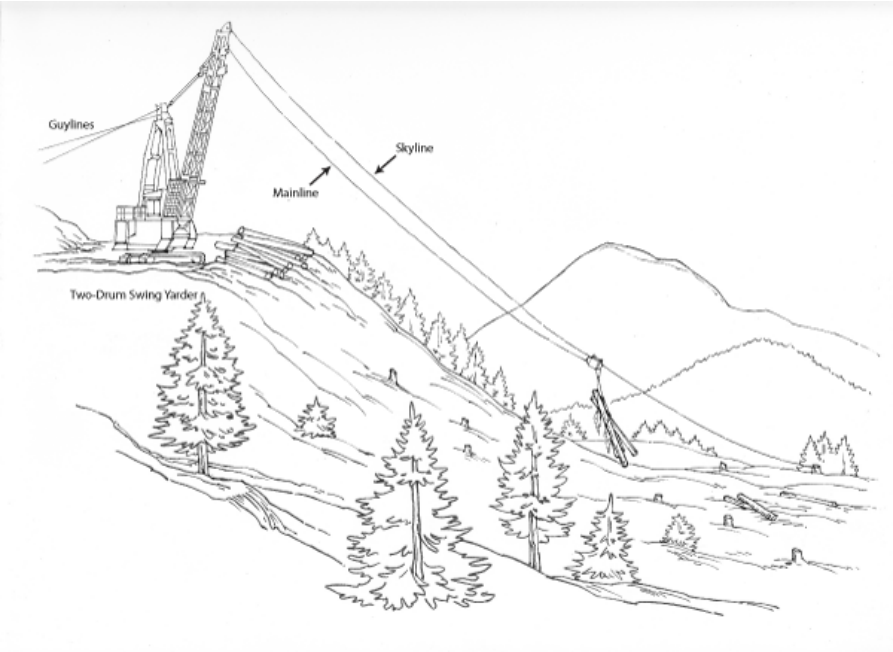

Figure 19: A basic cable yarding layout showing a swing yarder with guylines that support the tower, the skyline and the mainline that is attached to a carriage.

There are over 300 yarders working in New Zealand, most are 'tower yarders' but about one-third are 'swing yarders'. A tower yarder has a vertical tower that is stationary and typically much taller than a swing yarder. Their advantage is that they provide more lift, and are typically able to extract longer distances (up to about 500 m) and still be cost effective. However, they need larger landings and longer set-up times. The swing yarder has a shorter forward leaning boom that it can use to swing the stems up on the landing. As such it requires smaller landings. These machines tend to be very fast and effective for shorter extraction distances less than 350 m.

Another option that may be considered for smaller harvest areas are modified excavator-based yarders (Figure 20). They tend to be easy to

relocate and set up, but are typically slower and can only extract smaller payloads.

Figure 20: A modified excavator-based yarder working from a small roadside landing. These machines are cheaper to transport and set-up than tower and swing yarders but have shorter extraction distances and smaller payloads.

Processing

Processing is a very important step in the harvesting process, as that is where the real value can be recovered from the tree. With so many different local and export processing options, most harvesting operations will process the stems into 10 or more different log sorts. A log sort is defined by both quality, and physical dimension characteristics (such as length and diameter) (see Section 2).

Processing on the landing is typically done by a machine – being an excavator with a processing head attachment. These machines can delimb by using powerful rollers to pull the stem through the knives (also the holding arms of the head). All processing heads have both length and diameter measurement capability and this data is fed into the on-board

computer. It is typically done in 10 cm increments so a high level of detail is provided for the computer to optimise the cutting strategy for the stem.

Figure 21: A machine operator standing next to the grapple harvester head on his machine. Harvesting heads are powerful and complex pieces of equipment that are able to quickly and accurately process stems into logs.

If the stems are processed on the landing by chainsaw, then it is the log-makers task to decide how the stem should be cut. They will have a tape to measure length and callipers to measure diameter, and use a set of cutting instructions to decide which log sort to cut. The advantage of using a log-maker, instead of a machine, is that they can better assess the quality of the stems. The disadvantage is that measuring length and

diameter is cumbersome, and true value optimisation decisions are limited by the experience of the log-maker.

Figure 22: A log-maker is marking up stems that have been laid out on the landing. Once the stems are marked up, the 'skiddies' will come and cut them, and finally a loader moves the logs into their assigned stacks ready for loading out.

Loading out and trucking

The final step in the harvesting process is loading the cut logs onto logging trucks for transportation to market. An excavator with a grapple (commonly called a 'loader') is by far the most common loading machine found in a New Zealand logging operation. They can work in tight space, such as in between log stacks, and are very good at 'fleeting' the logs. Fleeting refers to sorting the logs after processing and placing them into their correct stacks. However, for high production operations, and when landing space allows, a front-end loader is quicker to load the trucks.

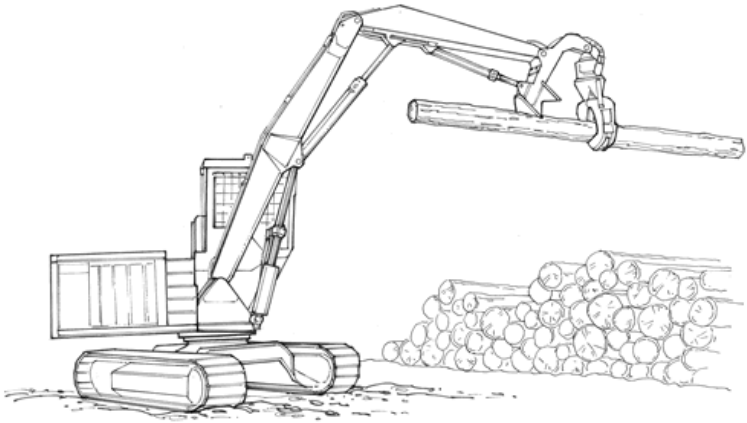

Figure 23: An excavator-based loader using its grapple to pick up and stack a cut log.

Figure 24: A front-end loader can place a larger number of logs onto the truck at once and that decreases the loading time, but it does need a lot more landing area to work effectively.

One loading alternative that can be considered for smaller harvest, or cut-to-length operations, is the use of a self-loading truck. Self-loading trucks

are very versatile in that they can pick logs from the landing or roadside without the need to interfere with the harvesting operation. The reason they are not popular is that the truck has to carry the extra weight of the integrated boom and grapple, which reduces the maximum payload it can carry, and increases transportation costs.

Figure 25: A self-loading logging truck is very versatile but the extra weight of the integrated boom and grapple reduces the maximum payload it can carry.

Clean-up after harvesting

It is often not appropriate for a landowner to be physically present during the harvesting operations as this will interfere with efficiency as well as safety. However, it is prudent to schedule regular inspections to ensure harvesting is going according to the harvest plan and the owners' expectations. If the landowner does not do this personally, the consultant or harvesting and marketing company they have hired should complete this task. The Farm Forestry 'Tree Grower' magazine regularly publishes reports where woodlot owners share their harvesting experience. The general consensus is that with good planning, a clear understanding of expectations, and regular communication during the harvest, disappointments can be avoided.

Upon completion of harvest the following aspects should be checked:

- **Merchantable timber:** Logs may be left in the cut-over or landing, so check that all logs of value have been trucked out to market.

- **Slash / off-cuts:** harvesting generates a lot of waste – typically about 10% of the total volume will be in branches or off-cuts. Check that this material has been managed appropriately. Many landowners prefer slash (i.e. the branches) to be returned to the cut-over as it recycles the nutrients and to avoid a fire risk at the landing. However, slash distribution over the site should not impede subsequent planting. On ground-based sites where slash has been left on-site, it can be wind-rowed by an excavator to enable easier re-planting. A clear risk is leaving slash over the side of the landing on steep terrain, especially on sites which have been harvested by a cable-yarder. This is commonly known as a 'birdsnest' and in a rainstorm there is a real risk of failure, that is, sliding down the hill into the waterway (debris flow). All birdsnests should be pulled back onto the landing upon completion of harvest.

- **Environmental controls:** all tracks and or roads where soil is exposed is at risk from erosion. The Environmental Code of Practice lists Best Environmental Practices for Earthworks and Harvesting.

For example, old skid trials should be closed out using waterbars. A waterbar is put in by an excavator and forces the water off the trail at regular intervals.

Figure 26: A waterbar which is constructed on skid trails to prevent water running down the trail and causing erosion.

Return to Table of Contents

Section 6.

How can you make a better profit?

Aspects to be considered when planting a woodlot

There are many decisions made during the establishment and management of a woodlot that will affect its value. For example, decisions related to stand factors such as piece size and tree quality, as well as terrain-based factors such as woodlot location, slope and woodlot size are all major factors that will influence costs and returns at time of harvest.

Figure 27: A well-managed stand, with uniform trees and good average tree size when fully grown, will result in a low harvesting cost.

Many woodlots are placed on sites of low pastoral productivity and difficult topography (steep or broken terrain). This terrain restricts the mobility of machines, and often the haul distance to the landing. Production drops as the skidder or dozer spends more time negotiating slopes and forming and using tracks. As the terrain becomes steeper and more difficult, first skidders and then tractors are no longer safe to operate, or viable both environmentally and economically. Then cable systems have to be used. For an equivalent piece size, the productivity of

a cable system is significantly lower, and costs higher, than for a ground-based system.

The smaller the woodlot, the higher the relative harvesting costs (in $/m^3 or $ per tonne) compared to a large woodlot. This is because fixed costs will be spread across a much smaller volume. For each new job the harvesting contractor will have to take time to shift in and out and will be presented with a new set of potential problems. Examples can be where roading access is not consolidated, fences and gateways need to be shifted, water supplies or power lines which have to be dealt with. A rule of thumb is that such effects on harvest costs are very pronounced for woodlots of less than 5 ha in area, but diminish beyond 15 to 20 ha in size.

Aspects to consider when preparing for harvest

Ideally, your woodlot harvest plan should be prepared at least one year in advance of harvesting. This will allow you to upgrade tracks or build new roads in the best possible locations. For many small woodlot owners, the provision of suitable access roads, capable of supporting 40-tonne-plus logging trucks, is a major cost item. The type of road you build will also determine the types of access that logging trucks will have. With a high standard of access road, more cost-effective trucks can operate.

Roading costs can be a significant component of the total cost of harvesting your woodlot (Figure 28). Costs depend on the length of road that needs to be constructed, the standard of road, and the terrain and soil types over which the road is being constructed. Costs from under $40,000 per km to over $160,000 per km are reported for forest roads around New Zealand.

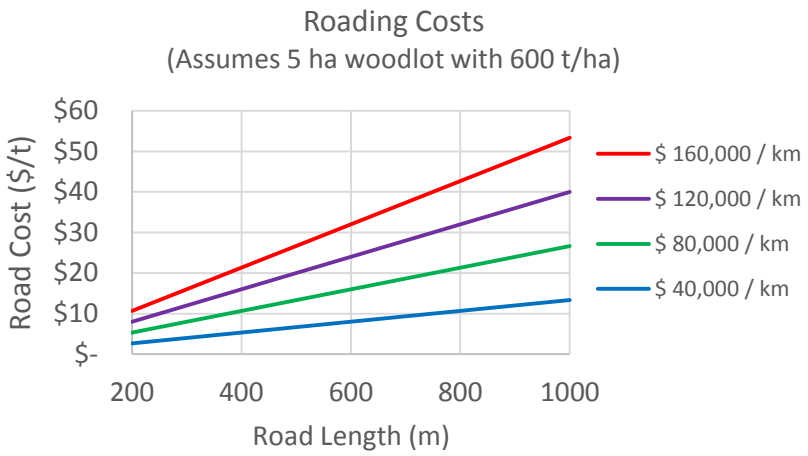

Figure 28: Roading costs can be a significant component of the overall harvesting cost.

It is tempting to build the road as you harvest, so that roading costs are offset against the timber sale income. However, using roads for truck traffic immediately after construction means they are more likely to fail and can cause a much higher environmental impact, and result in higher overall cost. Roads and landings need time to 'settle', which means they need time to dry out, compact and strengthen.

It is often also a common mistake to try and save on roads and landings. For example, placing a landing on the edge of the woodlot may seem like an easy and logical option. If wood has to be extracted from the felling site to the landing over a long distance, productivity will fall and extraction costs rise. Good harvest planners will usually try to keep the average extraction distance (i.e., the average distance wood is extracted to a landing for a particular setting) for ground-based systems down to 100 to 150 m and for cable systems to 200 to 250 m.

Figure 29: A higher quality access road to a woodlot, built well in advance of harvest, will save money on harvesting cost.

Figure 30: A landing area showing the need for space to process the stems into logs, log storage, truck turn-around, but also places to store slash.

Owners of small woodlots may decide to extract wood over longer distances and accept lower productivity to save on roading costs or save on maintenance costs in the long run if they don't intend to use the roads in the future. There are a number of options to consider when doing this; one is to use a forwarder which typically has a lower cost over longer distances, the other is to use off-road trucks (Figure 31) to extract the felled timber all the way out to the roadside.

Figure 31: An off-road truck can cart logs all the way from your woodlot to the public roadside. This might be a preferred alternative if getting logging trucks to the woodlot is cost-prohibitive.

Although difficult to quantify it is recognised that the human factor can have a large effect on productivity. The organisational skills of the harvesting contractor and the motivation, experience and training of their crew are extremely important. The reputation of the contractor will be a good indicator of these.

Aspects to consider during harvest

You will want to have a good working relationship with your harvest contractor, but also have the trust that they will complete the work competently. Remember that a larger contractor may have a total hourly cost of close to $1000, so holding them up for a 'bit of a chat' is not a good idea.

It is important to have realistic expectations, but to also communicate these clearly to the contractor ahead of time. Aspects such as fencing renewal, pasture rehabilitation, or maybe the effect of timing the operation to fit in with other farming activities (e.g. lambing) will be important to you. However, they may be very cumbersome to the contractor.

Managing harvest residues or 'slash' (Figure 32) has also become a bigger environmental issue that needs to be managed. The harvesting of one hectare of forest can produce on average about 75 tonnes of slash. So, if you require the contractor to remove that off-site, it will be very expensive. Consider if you are able to remove some for firewood, or if there is a good designated place to store the slash when it is neither at risk of entering a waterway (a legal requirement) and does not interfere with any farming operations.

Figure 32: Larger piles of slash can build up during time of harvest and are typically left behind to decompose.

Importance of good log-making

In conjunction with good marketing, log making is the key to the value of the woodlot. The ability of the harvesting & marketing company to interact well with the log maker in matching the range of log market options to the trees being cut is absolutely critical to maximising value.

Because the harvesting contractors are typically paid by the volume of wood they process, and not the value, an important part of managing a logging operation is ensuring that due care is taken during processing, so that the logs are being cut correctly. A log, if cut too short, will have little value when delivered to the customer.

Figure 33: A mechanised grapple processor delimbing, measuring and cutting logs to length. In this case the decision as to what log to cut will be made by the operator with assistance from the on-board computer. (Source: Engineering Services Rotorua Ltd.)

Log processing machines (Figure 33), with on-board computers that help the log-maker to capture maximum value, reduce but do not eliminate log making losses.

You should be concerned that the main objective in harvesting is to recover the maximum value from your woodlot (while meeting your other objectives) and not just to minimise costs. Up to 40% of the standing value of a tree can be lost through poor harvesting techniques. Tree breakage during felling, high stumps, and damage during stem extraction and loading all contribute to this loss and should be a concern to woodlot owners. However, the greatest potential for improving value recovery lies in good log-making. Failure to optimise value while meeting minimum log specifications when producing logs can result in the loss of tens of thousands of dollars to the woodlot owner (Figure 34).

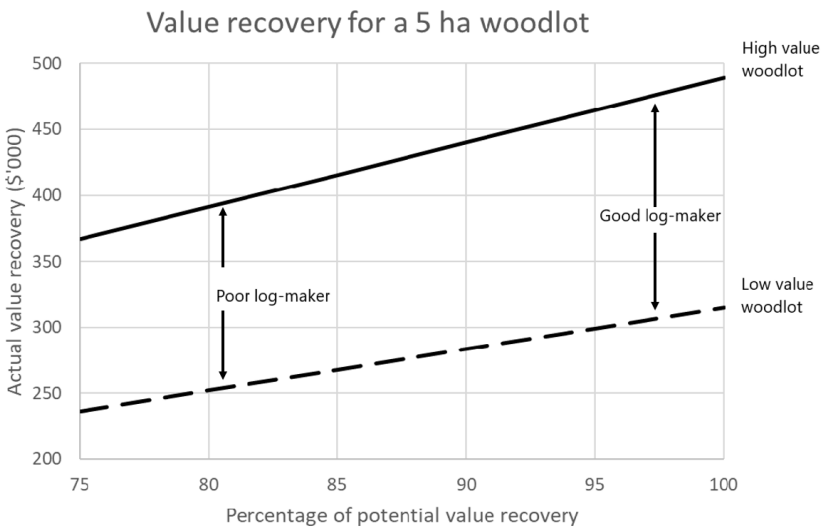

Figure 34: For the woodlot owner the difference between a good Log Maker and a poor Log Maker may be tens of thousands of dollars.

Ensuring that the maximum value is obtained from each tree during log-making is not easy. Log-makers are confronted with many challenges when trying to optimise the value of a stem. They must match tree stem attributes such as length, taper, defects, branching, sweep, and other

quality characteristics, with allowable log specifications and market prices. Studies of log-makers around New Zealand indicate that there is a wide range in their ability to recover value. Good log-makers may recover over 95% of the potential value in stems extracted to the landing. Poor log-makers may recover as little as 80%. A woodlot owner with little experience in log-making and current market conditions may recover even less value.

As shown in Figure 35, logs that do not meet the intended specifications may have to be downgraded and remanufactured, causing loss in value. Even if each log is within specification, the cutting pattern may not be the best for the tree stem as a whole.

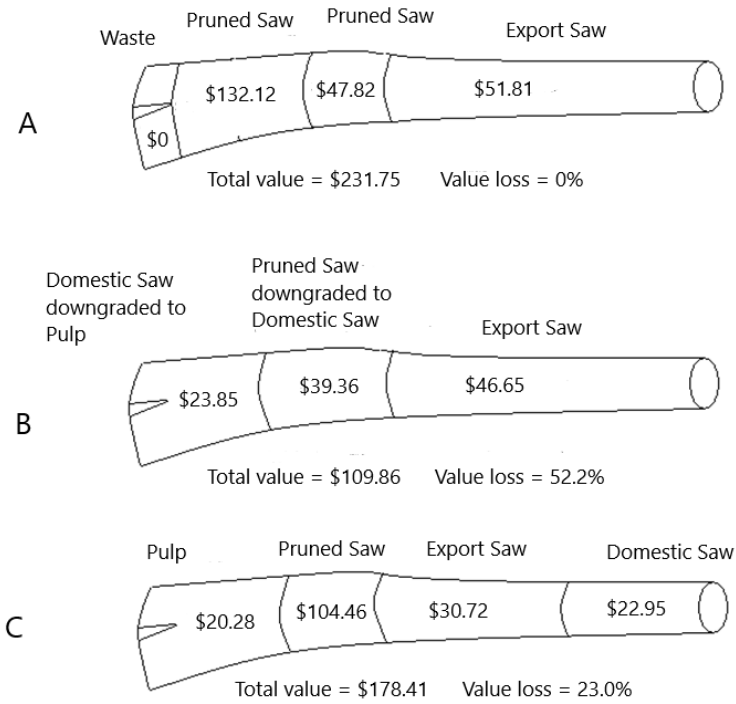

Figure 35: Illustrative patterns for cutting a stem into logs. A. Optimum pattern. B. Sub-optimum pattern, with some mis-manufactured logs not meeting their intended specification. C. Sub-optimum pattern, with individual logs meeting specification.

Larger harvesting and marketing companies often have procedures in place to monitor log quality and value recovery. It is essential that you are confident that the person converting your forest from biomass to dollars is adequately trained and competent at log-making. Value recovery performance audits can be carried out on log-makers by a few specialist consultants around New Zealand but these tend to be expensive. Perhaps the easiest way to check if a log-maker is competent is to ask for proof of certification. As of 2019 Competenz, the multi-sector Industry Training Organisation, provided qualifications in Log Making, and Mechanised Processing towards the New Zealand Certificate in Forest Harvesting Operations (Level 3 and Level 4).

Graduates of the Log Making strand of this qualification will be able to:

- Assess and mark stems to maximise value recovery and meet the requirements of log specification/cutting instructions; and
- Coordinate quality, productivity, and external communication to meet the requirements of the forest owner and the landing operation.

Importance of cost control

Making sure you are selling your trees to the right market, and making sure your harvesting contractor is making the optimal log-making decisions, are critical for maximising the return on your investment at the time of harvest. What may be less obvious is the need to help the harvesting contractor be productive and efficient so that they can offer the best cost-effective service.

Modern harvesting systems are expensive to own and operate, and the reality is that a relatively large proportion of the gross value of your woodlot will be spent on harvesting and log transportation costs.

For timber harvesting contractors, the total operating cost is often calculated as a ‘daily cost’ and includes the cost of all machines, the workers and the management of the crew. The reason a woodlot owner should take an interest in allowing the contractor to be productive is that delays or complications can often result in a much higher logging rate.

For example, if the daily cost for a harvesting system is $7,000, and the crew is able to consistently extract on average 200 tonnes per day, the logging cost will be $35 per tonne. If, however, there are considerable delays and the overall average production per day drops to 140 tonnes, then the logging cost will increase to $50 per tonne.

Logging costs for woodlots tend to be higher than are commonly quoted for large plantation harvest areas. Reasons given by organisations with experience in both large plantation and woodlot logging include:

- cost of frequent moves, equipment is not fully utilised
- operating from smaller landings, constraining production
- infrastructure, such as constructed roads and landings, is not present
- no loading out at night / early morning
- poor planting boundaries from a harvesting viewpoint
- area too small for the most appropriate equipment (e.g. a less efficient tractor is used on terrain better suited to a cable logging system)
- woodlot owner restricts landing location resulting in longer extraction distances
- restricted logging season (e.g. no logging during lambing season).

Cost increases ranging from 20% to 40% above large plantation logging costs are commonly quoted. If these impacts can be minimised or managed the contractor could be able to offer a lower rate for their services.

Importance of efficient log transportation

Transport costs are a major component of harvesting costs and depend on a number of factors, including the distance from the woodlot to the various markets (domestic saw mills or the nearest port), the type of trucking rig being used, the ease of access, whether back-loads can be applied to spread costs, and market competition between trucking companies, and so on. Costs ranging from less than 14c per tonne/km to over 35c per tonne/km are quoted; low costs are associated with long transport distances, easy access and favourable grades. High costs are associated with short hauls, difficult access, and adverse grades. Figure 36 shows the effect of cartage distance (one-way) on transport costs.

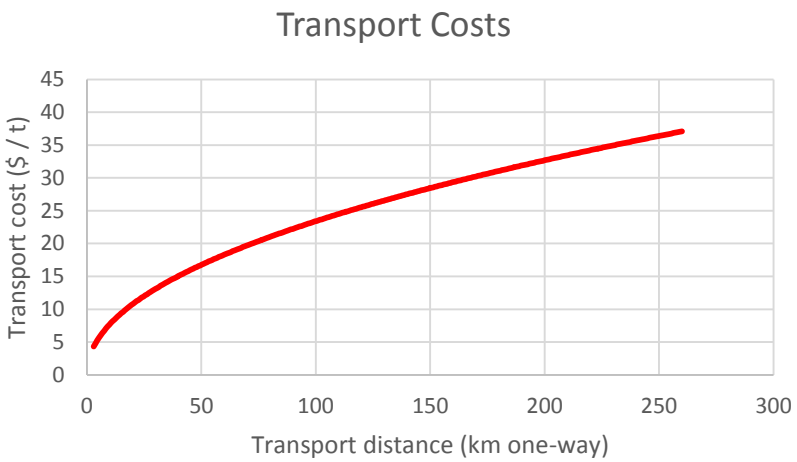

Figure 36: Effect of cartage distance on transport costs.

Competition for work/business plays a significant role in determining harvesting and cartage costs as does the availability of harvesting and cartage contractors when demand is high. As with all businesses, the lowest cost choice is not always the best option. Maximising the net returns from your woodlot while also meeting other land management objectives for your property should be your goal.

During harvesting, in addition to the harvesting crew vehicles, you may have anywhere from 5 to 12 logging trucks accessing your property every day. It is typical for log trucks to be loaded outside of normal harvesting work hours. This means the crew can work more effectively during the day because there is less interference with logging trucks and fewer logs stored on the landing at the start of each day. However, if logging trucks are coming past your family home you may have a strong preference to restrict their access to work hours only. Again, this may be a reasonable request, but it will come at a cost to the harvesting contractor – and like most costs, they will be passed on to the landowner.

Summary of factors affecting the harvest financial outcome

There is more money to be gained or lost at harvest than at any other time in the life of a forest. A summary of the factors affecting the financial outcome of the harvest is shown in the Table 9. For ease of reference, costs have been lumped into seven main groups. The costs should be treated as indicative only since they vary between regions, with difficulty of terrain, soil types, distance from markets, stand conditions, etc., etc.

Table 9. Factors affecting financial outcomes

Activity	Comments	Financial implications
Marketing and log-making	Marketing and log-making determine the gross value of the woodlot. Costs are subtracted from this amount. It is recommended that you seek professional marketing advice and know that qualified log-makers are maximising value recovery.	Marketing specialists will know where you can get the best log prices. Good log makers can recover over 98% of potential value. Poor log makers may recover 80% of less of potential value.
Harvest planning	It is recommended that you use qualified professionals to plan the harvest, to ensure that pre-harvest inventory is carried out, and to make certain that harvest operations will be environmentally compliant	Planning and compliance costs are likely to range between $4,000 and $10,000. Pre-harvest inventory costs are $100 to $300 per plot plus reporting costs.
Road construction, maintenance, and stream crossings	Road location and construction will likely be linked to harvest system options and log cartage options.	New secondary roads costs range from $40,000 per km to $160,000 per km. Upgrading existing tracks may range from $25,000 per km to $50,000 per km. Landings cost range from $4000 to $10,000 each. Stream crossings range from to $2,500 to well over $50,000 each.

Machinery transport	Factors affecting costs are the number and size of pieces of equipment to be moved, the number of times machinery has to be transported to the site, the distance they have to be moved, and whether pilot vehicles are required.	$5,000 to $20,000 per each time equipment is moved to the site.
Harvesting	The harvesting system will be determined mainly by terrain type (slope) and soil type. It is recommended that you discuss with your harvesting manager options for size of equipment bearing in mind your economic and environmental objectives.	Ground-based $20/t to $44/t Cable-yarding $31/t to $53/t
Cartage	Cartage costs are largely dependent on the distance from your woodlot to the markets but they will also depend on the type of truck used, the quality of the roads over which the loads are carted and bridge weight restrictions. Discuss with your harvesting manager the hours that wood can be carted from your woodlot	$8/t to more than $40/t depending on distance
Other	There is a range of other costs that woodlot owners incur. Although small in comparison to harvesting and cartage they can add up.	These include Forest Grower Levy Trust costs ($0.27/t), weighbridge costs (~$0.34/t), professional advice (may be separate from the harvesting and marketing specialists), site rehabilitation ($120 to $500 per ha).
Management fee	It is recommended that you use a harvesting and marketing specialist.	4 to 8% of net returns

Section 7.

Use of the Woodlot Analysis Tool

The Woodlot Analysis Tool (WATS) is a web-based tool[1] that provides semi-specific costs and returns from harvesting a woodlot described by a forest owner. A WATS user pinpoints where her woodlot is located on a digital map, gives a basic description of the woodlot, and then enters representative log grades to be harvested, yields and the log prices. WATS then reports expected gross and net returns and costs associated with the harvesting and cartage of wood from the woodlot to the wood buyers (Figure 37).

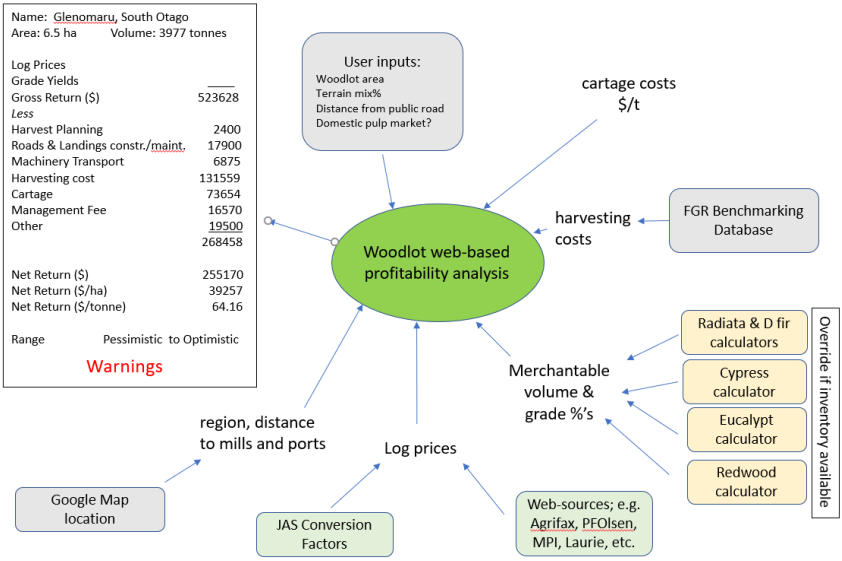

Figure 37: Flow of information into and out of the WATS.

WATS is located at https://fgr.nz/programmes/calculators/woodlot-analysis-tool/. It has been designed to run on desktop and mobile platforms, such as tablets and smartphones.

Use of WATS is demonstrated with two fictitious case studies. The locations of both of the woodlots used in the case study are real. No

[1] WATS is compatible with Google Chrome, Mozilla Firefox, Microsoft Edge, and Safari web browsers. It is not compatible with the legacy Internet Explorer browser.

attempt was made, however, to visit either of these woodlots or obtain real tree crop information related to them.

Case Study 1

The woodlot in Case Study 1 is located about 480 m from the end of Tyntesfield Road on flat terrain in the Marlborough region. Google Maps was used to measure the woodlot area (10.56 ha).

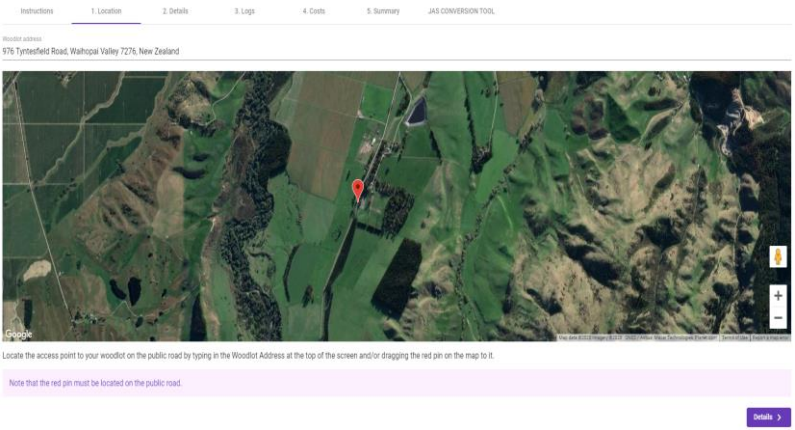

Figure 38. Screenshot from the Location page of the tool showing the Access Point (red pin) from the public road to Case Study 1 woodlot.

When you click on the Woodlot Analysis Tool you are first taken to an Instructions Page which, among other things, advises you to read this Users Guide and suggests information you should have available before you start to use the tool. After having read the Users Guide and the Instructions you next Click the Start button which takes you to the Location Page. The Location Page will have a red pin somewhere on or near a map of New Zealand. You click on Woodlot Address (top left) and enter the address – in this case Tyntesfield Road (select the Tyntesfield, Waihopai Valley, New Zealand address). The red pin moves to an approximate location on Tyntesfield Road. The woodlot you are interested in is located about 2.5 km further to the south on Tyntesfield

Road. Zoom in and drag the pin to the access point to the woodlot from the public road (Figure 38). [Note that if you get a message saying the map needs to be updated it is likely to be due to one of three things; (1) your computer is slow and is having trouble determining the coordinates (be patient and wait for a minute), (2) the red pin is not sitting on the road (go back to the map, zoom in and carefully locate it on the road), or (3) the red pin is on a road but the road is not a public road at that point and so is not included in the Google Maps road network (move the pin to a new location).]

You now select the Details Page by clicking the purple button at the bottom of the Location Page or the Details label at the top of the page.

Enter a name for the woodlot; e.g. Case Study 1 Marlborough.

Select the location zone for the woodlot using the drop-down menu. If you click the Information icon you will see approximate boundaries for the zones (Figure 39). Select NM (Nelson Marlborough).

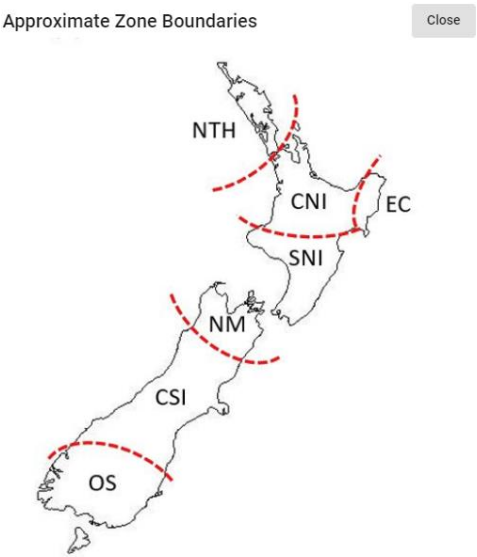

Figure 39. Approximate boundaries for the seven location zones. Some costs differ between zones.

Enter the woodlot area. It is 10.56 ha.

Enter the distance that a truck would travel from the public road to the woodlot edge. Enter 480 m.

Select from the drop-down menu whether the Woodlot Access road is New (YES) or only has to be upgraded (NO). In this case study a new access road across farmland has to be constructed, so select YES.

Describe the terrain mix in terms of fifths using the drop-down menus. For this case study select 4 fifths Flat and 1 fifth Moderate. This data is used to calculate an average slope which is used in the costing model. It is also used to determine the number of metres of roads that need to be built or upgraded and the average roading cost.

Now click the Logs button on the bottom right of the screen. On this page log price data and inventory data is entered. Inventory data preferably comes from pre-harvest inventory measurements. If that is not available, models, regional averages or "eye-ball" estimates can be used. Data for up to 10 log grades can be entered.

In Case Study 1, the Forecaster model is used to predict the volumes by grade that could be expected to be harvested from the woodlot. The Forecaster model is located at:

https://fgr.nz/programmes/calculators/forecaster-calculator/

The woodlot is assumed to have been planted at 1000 stems per hectare and to have received two lots of thinning and three pruning lifts in the first 10 years of its history. It would be 30 years old when harvested. Forecaster provided estimates of log yields in standard log grades (see yield table on next page).

Given the proximity of export facilities, you can expect to send logs to a mix of domestic and export markets. To do this you must first convert some of the standard grades to equivalent domestic and export log grades (see grade conversion table on next page). The larger pruned logs (~40%) are allocated to an export pruned grade. The remainder you allocated to a domestic pruned grade. Under most New Zealand conditions it is

reasonable to assume a conversion factor of 1:1 from m^3 to tonnes.

FORECASTER Standard domestic log grades	Yield (m^3/ha)
Pruned	133.7
S1	4.0
S2	195.8
S3	77.3
L2	68.4
L3	74.0
Pulp	42.9

FORECASTER Standard Log Grade	"Equivalent" Domestic Grade	"Equivalent" Export Grade*
Pruned	Domestic Pruned	Export Pruned
S1/S2	Structural (S30)	Export A
S3	Structural (S20)	Export K
L1/L2		Export KI
L3		Export KIS
Pulp	Pulp	Export Pulp/KIS

* Domestic and Export grades do not translate exactly to the standard FORECASTER log grades. Differences in log lengths, minimum small end diameters, knot sizes and other features make translating from one log type to another difficult.

Mill door or At Wharf Gate log prices ($ per tonne) can be obtained from a forest industry website (such as Te Uru Rakau). Note that export log prices ($ per JAS m^3) were converted to $ per tonne using the JAS Conversion tool shown at the top of WATS. The JAS Conversion Tool provides JAS[2] conversions for different export grades and zones around

[2] JAS stands for Japanese Agricultural Standard, and is simply a different way of measuring usable log volume.

New Zealand. If you use the JAS Conversion Tool and then want to move back to the Logs Page just click on Logs at the top of the screen.

Log Grade	Yield (t/ha)	Log Price ($/t)
Export Pruned	54	205
Domestic Pruned	80	198
Export A	200	159
Export K	77	140
Export KI	68	127
Export KIS	74	123
Pulp	43	48

You now enter the inventory data column by column as follows:

Using the drop-down menus select Grades, i.e., Export Pruned, Domestic Pruned (P30), Export A, Export K, Export KI, Export KIS and Pulp.

WATS uses this information and a list of mills/ports to automatically find the distance by road from the woodlot to the closest mill/port, of each market type.

You next enter the expected yields (t/ha) for each grade; 54, 80, 200, 77, 68, 74, and 44.

Finally, on the Logs Page you enter the log prices ($/t); 205,198, 159, 140, 127, 123 and 48. The gross value per grade for the whole woodlot area is automatically calculated, as is the grand total gross value ($942,924) and total volume (6294 t).

You next click the Costs button at the bottom of the screen.

Costs are shown for:

- Harvest Planning - includes inventory costs, plan preparation, resource monitoring and notification fees, resource consents, etc.
- Road and Landing Construction and Maintenance – assumes a mix of new roads and upgraded roads. Roading intensity and cost per km are terrain dependent
- Machinery transport – ground-based or cable system dependent.
- Harvesting costs – terrain and zone dependent
- Cartage costs - the distance by road to 88 mills and ports are "known" by WATS.
- Management fee – this is assumed to be 6% of net returns (gross returns minus all costs other than management fees).
- Other costs – includes forest growers' levy, weighbridge, site rehabilitation, professional advice

You can over-ride any cost – if you have better information - by typing in a new number. The total cost including management fee is updated.

You next click the Summary button on the bottom of the screen.

The Total Gross Returns ($942,853), Total Costs ($399,165) and Net Return (excluding GST) is shown for the woodlot ($543,688). Net Return is also shown on a per ha and per tonne basis. Also provided is an indicative range in Net Return – Pessimistic to Optimistic. Pessimistic assumes log prices may be down by 5% and costs up by 15%. Optimistic is vice versa.

You click the Print button to obtain a printout of the Details, Logs, Costs, and Summary pages (Figure 40). If you have over-ridden a cost, an asterisk appears beside that cost. The printout can either be in hardcopy paper format or in digital format saved as a PDF file.

If you want to make changes you can go back to the screen of interest by clicking on the name (e.g. Logs) at the top of the form. You can tweak the parameters and see what effect this has on the net returns.

Clicking on the Reset button clears all the data and takes you back to the opening Google maps screen.

Forest Growers Research
Woodlot Analysis Tool

Details

Name	Case Study 1 Marlborough
Zone	NM
Area	10.56
Volume	6,294
Distance to from public road to woodlot edge(m)	480
Fibre Mill within 200km	YES
Woodlot access new	YES

Logs

Grade	Yields	Price	Gross Returns
Export Pruned	54	$205.00	$116,899
Domestic Pruned (P30)	80	$198.00	$167,270
Export A	200	$159.00	$335,808
Export K	77	$140.00	$113,837
Export KI	68	$127.00	$91,196
Export KIS	74	$123.00	$96,117
Pulp	43	$48.00	$21,796
Total Gross Returns (exc. GST)			$942,924

Costs

Harvest Planning	$8,342
Roads & Landings Construction and Maintenance	$65,224
Machinery Transport	$5,750
Harvesting Cost	$168,961
Cartage	$108,046
Management Fee	$34,710
Other	$8,105
Total Costs (exc GST)	399,138

* Costs with an asterisk have been over-ridden by the user.

Summary

Net Return (exc. GST)	$543,786
Net Return (exc. GST) per Hectare	$51,495/ha
Net Return (exc. GST) per Tonne	$86.40/t
Net Return Range*	$436,769 to $650,802
	-20% to 20%

Figure 40: Screenshot of the Print Summary related to Case Study 1.

Case Study 2

The woodlot in Case Study 2 is near Raupiu Road to the northeast of Wanganui. Fewer explanations are provided for Case Study 2.

You enter Raupiu Road under Woodlot Address. The location pin moves to the road about a kilometre further down Raupiu Road to the south east of the woodlot. You then move the location pin to a point on the public road where you think the beginning of the woodlot access road might be (Figure 41).

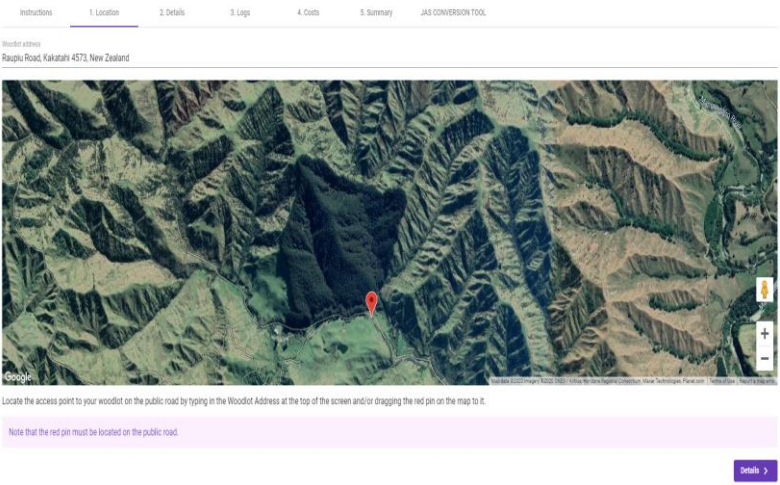

Figure 41: Screenshot of the Location page of the Woodlot Analysis Tool showing the Access Point (red pin) from the public road to the Case Study 2 woodlot.

Click the Details button.

Enter a name for the woodlot – call it Case Study 2 Southern North Island.

Select the location zone for the woodlot using the drop-down menu - SNI

Enter the woodlot area. It is 74.93 ha.

Enter the distance from the public road to the woodlot edge - 50 m.

Select YES for whether the woodlot access road is to be newly constructed.

Describe the terrain mix in terms of fifths using the drop-down menus – it is 1 fifth Steep and 4 fifths Very Steep.

Now click the Logs button.

For case study 2 it is assumed that pre-harvest inventory has been collected for the woodlot. There are only 5 grades – Domestic Pruned (P30), Export A, Export K, Export KI, and Pulp. Select these using the drop-down menus in the Grade column.

Enter the expected yield (t/ha) for each grade. - 150, 214, 121, 58 and 112.

Enter the price ($/t) for each grade - 169, 133, 121, 111 and 45.

Now click the Costs button.

Costs are shown. You have no better information than shown for costs so leave them unchanged:

Now click the Summary button to see the net returns for the Case Study 2 woodlot.

When you click the Print button and obtain a printout of the Details, Logs, Costs, and Summary pages you should see output similar to Figure 42. The cost data behind the WATS model will be updated regularly so there may be some differences to what is shown.

Forest Growers Research
Woodlot Analysis Tool

Details

Name	Case Study 2 Southern North Island
Zone	SNI
Area	74.93
Volume	49,079
Distance to from public road to woodlot edge(m)	50
Fibre Mill within 200km	YES
Woodlot access new	YES

Logs

Grade	Yields	Price	Gross Returns
Domestic Pruned (P30)	150	$169.00	$1,899,476
Export A	214	$133.00	$2,132,658
Export K	121	$121.00	$1,097,050
Export KI	58	$111.00	$482,399
Pulp	112	$45.00	$377,647
Total Gross Returns (exc. GST)			$5,989,230

Costs

Harvest Planning	$16,224
Roads & Landings Construction and Maintenance	$355,785
Machinery Transport	$11,500
Harvesting Cost	$1,908,160
Cartage	$984,476
Management Fee	$158,592
Other	$69,885
Total Costs (exc GST)	3,504,622

* Costs with an asterisk have been over-ridden by the user.

Summary

Net Return (exc. GST)	$2,484,608
Net Return (exc. GST) per Hectare	$33,159/ha
Net Return (exc. GST) per Tonne	$50.62/t
Net Return Range*	$1,659,453 to $3,309,763
	-33% to 33%

* Pessimistic assumes log prices may be down by 5% and costs up by 15%. Optimistic is vice versa.

Figure 42: Screenshot of the Print Summary related to Case Study 2.

Return to Table of Contents

In a Nutshell

In a nutshell, it is necessary for you (or your agent) to have:

- Advice from your accountant on timing of your harvest in relation to other activities
- Accurate information on the quantity and quality of wood in the woodlot to be sold
- Advertised your intention to sell so that all potential buyers have the opportunity to bid for your woodlot
- Accurate information on, and access to, domestic and export log markets that will pay the highest prices for your wood
- Experienced contractors to construct roads, and log, load and cart the logs
- Good supervision of contractors
- Good understanding of your legal responsibilities and requirements
- Accurate information on actual log outturn

Ultimately, you must be satisfied that your woodlot is being harvested and sold with all these skills and this information available.

Return to Table of Contents

Preparing for the next rotation…

In the process of managing the marketing and harvesting of your woodlot you will have built up a wealth of knowledge and experience of the effects of woodlot siting, size and access on your profits. This knowledge should now be put to good use when you arrange for the replanting of your woodlot.

Questions, among many, you might ask yourself before you replant will include:

"Was my woodlot venture profitable and a good use of the land?"

"Should I increase the size of my woodlot?"

"Can I include some easier terrain when I replant?"

"Should I relocate my woodlot closer to the public road?"

Wise decisions come with the hindsight of experience. Improvements will only come if those decisions are acted upon when you arrange the replanting of your woodlot.

Knowledge is power, but action is vital.

Return to Table of Contents

Brief glossary of terms

At Mill Door – Domestic grade logs delivered to the saw mill or pulp mill skids. Used as a pricing system by adding stumpage, logging, loading and transport costs to the mill.

At Wharf Gate – Export grade logs delivered to the nearest port. Used as a pricing system by adding stumpage, logging, loading and transport costs to the port. Not including marshalling costs or stevedoring costs.

Bucking - cutting felled trees into log lengths.

Cable logging - any logging system employing a stationary powered machine with drums, spars, blocks and wire rope to haul logs from the felling site to an assembly point or landing.

Carriage - a load carrying device from which logs are suspended which rides up and down a wire-rope cable.

Clearfelling - the total felling of a crop and the removal of all merchantable material.

Cruise - to inventory a forest stand to determine the quantity of forest products that can be derived from it.

Cutover - a term applied to a stand from which the merchantable material has been removed.

Drum - a spool around which cable is wound on a winch.

Forwarder - an articulated, purpose-built logging machine which carries the wood in short lengths rather than dragging it in long lengths.

Hauler - in cable logging, a machine equipped with winches which operates from a set position to haul logs from stump to landing.

Landing - selected or prepared area to which logs are extracted and where they may be sorted, processed, stockpiled and loaded onto trucks (also called skids, dumps, or yards).

Log-maker - a qualified person who assesses tree dimensional and quality characteristics, matches these with the most appropriate log specifications and marks the location for cutting.

Logs at roadside - trees that have been cut and extracted to a landing or roadside. Stumpage and logging costs (excluding loading) together will give log values at roadside.

Merchantable- a tree or log capable of being economically converted into a wooden product.

On truck - trees that have been cut and extracted to a landing or roadside and loaded on to a logging truck. Stumpage plus logging costs (including loading) together will give log values on truck.

Peeler or Veneer Log - a log suitable for the manufacture of rotary cut or sliced veneer.

Present net worth - the profit after costs have been subtracted from revenues and the time value of money has been taken into account.

Residues - woody debris remaining after logging. Often called 'slash'.

Road grade - the steepness of the road.

Rotation - the planned number of years between the planting of a forest stand and its final cutting.

Roundwood - logs or whole trees in round form with no processing by a saw mill or chipper. Uses include posts, poles, or house piles.

Sawlog - a log suitable in size and quality for the manufacture of sawn products - boards, beams or framing timber.

SED - small end diameter (underbark) of a log

Skidder - a self-propelled extraction machine with wheels specifically designed to haul logs from stump to landing.

Stumpage - price paid for standing trees (on the stump). Values may be expressed as $/m^3 or $/tonne.

Sweep - a gentle curvature in a portion of a tree or log.

Water bar - a small ditch placed at angles to an extraction track to divert and slow down water flow.

Wobble - curvature in more than one direction over a short length of a tree stem.