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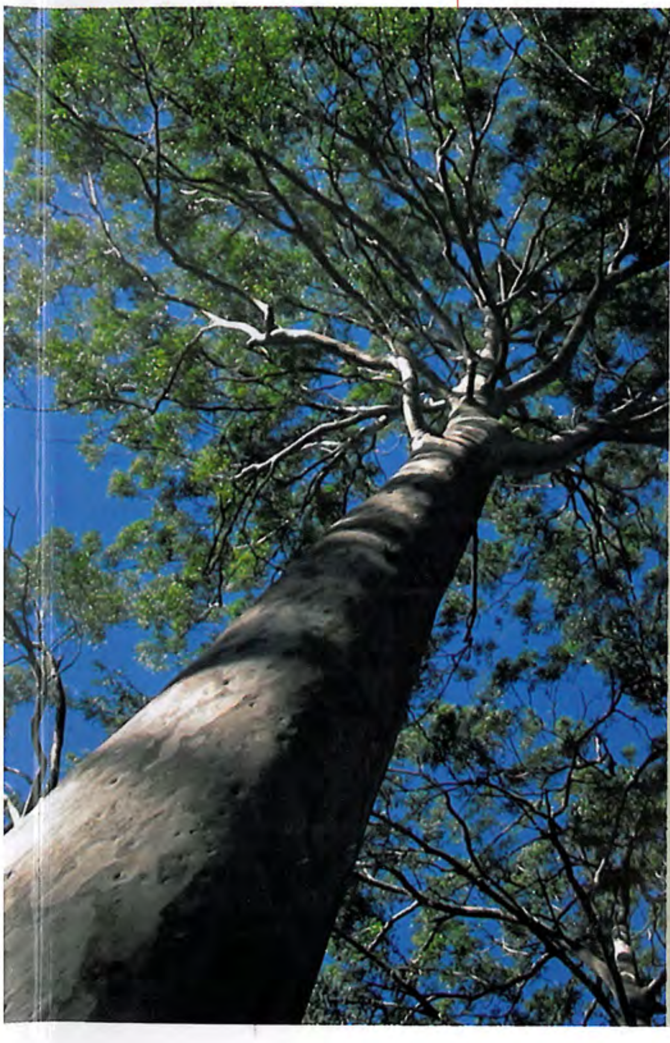


sustainable native forest management

case studies in managing private native forest in southeast Queensland

FARM FORESTRY

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

Queensland Government
Department of **Primary Industries and Fisheries**

Acknowledgements

The authors would like to thank Col and Ailsa Moorhead, Arland and Annette Usher, Andrew and Sharon Harwood and Mark and Owen Thompson for contributing their time and effort to the project, allowing unrestricted access to their properties, welcoming our advice on management decisions for their timber resources and for allowing their property to be used for the trial and subsequent field days. We are also grateful to Mark and Owen Thompson for their very considerable assistance, knowledge and interest.

Thanks also go to Tony and Daniel Fitzpatrick for their patience and milling experience and to Scott Swift, Damien Cotter, Mark McDonald and Ken Matthews, who provided skilled assistance in the field.

Peter Lazzarini contributed the section on property management planning. Arnae Denkel provided information about the legislative requirements for native-forest management and timber production and Martin Lutton supplied legislative requirements for milling and timber sales.

The authors are grateful to Cliff Raddatz, Ken Matthews, Ernie Rider, Paul Ryan, Sharon Harwood and Kate Murray for their reviewing and editing inputs to an earlier draft.

The assistance and support of the Mary Valley Sunshine Coast Farm Forestry Association executive, Mike Askham, Gordon Banks and Ernie Rider, is especially acknowledged and appreciated.

The case studies were funded by the Natural Heritage Trust as a joint-venture project between the Mary Valley Sunshine Coast Farm Forestry Association and the Department of Primary Industries and Fisheries.

Photographs are attributed to the Department of Primary Industries and Fisheries (DPI&F) and supplied by David Taylor and Sean Ryan. Graphics are attributed to DPI&F.

Editing by Susan House and Kerry Davies (Kerry Davies Publishing Services)

Graphic design by Cindy Benjamin

Printing by Gympie Printing

Preface

Private native forests play a significant role in Queensland's timber industry, contributing more than half of the native-timber harvest. Many private native forests (PNFs) in south-east Queensland are regrowth forests, often with a history of very heavy disturbance or clearing associated with agriculture. Recently, changing public attitude to native-forest harvesting promoted the Southeast Queensland Forests Agreement. This sets a target for the end of native-timber harvesting on crown lands in south-east Queensland by 2024. This heralds an increased role and opportunity for private forest to provide income to landholders as well as a resource for the sawmilling industry.

Increasingly timber is being perceived as a sustainable, greenhouse-friendly building product and the demand for timber sourced from sustainably managed forests is likely to increase. Landholders need information about how to manage these forests on a sustainable basis for the best economic returns.

To achieve this the National Heritage Trust funded a joint-venture project between the Mary Valley Sunshine Coast Farm Forestry Association and the Department of Primary Industries and Fisheries (DPI&F, formerly as the Queensland Forestry Research Institute). The aim was to provide private landholders in the Burnett–Mary catchments with confidence and skills in sustainable native-forest management and to promote the integration of forest management into their normal farm management activities.

Between 1999 and 2003 a series of demonstration sites were established as a 'hands-on' resource to raise the capacity and skills of landholders in forest management. Each of these sites was documented in a detailed case study, discussing management processes, techniques and outcomes. This book is a summary of those case studies. It is a guide for PNF managers in the Burnett–Mary catchments who are reviewing management goals for their land and want to improve the long-term productivity of their forests and develop efficient, sustainable practices and economically viable harvest returns.

The introduction provides an overview of private native forestry in Queensland, and is followed by four case studies describing the forest condition and management carried out for each.

Field days are an effective way to promote the value of farm forestry.

A recently thinned stand of regrowth spotted gum.

Disclaimer: The figures presented in the following case studies are estimates related to a single operation on a single property; that is, they illustrate each unique case and are not intended as projections or recommendations for any other case. No reliance should be placed on the figures under any circumstances and DPI&F accepts no responsibility for any loss or damage that might arise from any use of the projections or recommendations.

Introduction: Private native forest in Queensland

Privately owned forests have always been a significant source of native timber in Queensland. As timber supplies from state forests are phased out, it is more critical than ever that private owners manage their timber resources sustainably, planning for a balance between productivity, revenue and healthy forest environments in the long term.

This chapter describes some productive forest types in Queensland and summarises past and current management systems. It outlines well-researched principles of native-forest management to achieve optimum productivity and emphasises the value of ecosystem function.

Privately owned forests are a significant source of native timber in Queensland

Types of native forest in Queensland

Queensland's native forests are extensive and diverse. They range from wet forests, such as rainforest and wet eucalypt forest, to dry eucalypt, cypress and acacia forests. Of all the states Queensland has the largest area of private native forest (PNF) harvested for timber production. Of the commercial types used for timber production, by far the largest area is occupied by dry eucalypt forests (dry sclerophyll), which contain species such as spotted gum, ironbark, bloodwood, white mahogany, grey gum, forest red gum and gum topped box. While wet eucalypt forests (wet sclerophyll) are more productive, they are less extensive and include species such as blackbutt, rose gum, tallowwood and brush box.

Many of these forests are composed of a mix of tree species, with the exception of cypress forests and some small areas of blackbutt forest, which are single species. Most forest types are 'uneven aged', displaying a range of sizes or age classes within species. Dry eucalypt forest is the main type of commercial interest on private land.

Typically, dry forests have a relatively open, non-continuous canopy layer, a grassy understorey and, to a varying extent, a shrubby understorey often including acacias and regenerating eucalypts. Fire is commonly used to promote the grassy understorey and for the most part these forests are grazed for beef-cattle production.

Forest types are usually classified by species composition and age-class structure and forests may be referred to as 'old-growth' or 'regrowth' forests. In old-growth forests the dominant trees are generally large and old, containing hollows, and the crowns are senescent. Regrowth refers to a forest that has either been cleared or heavily disturbed in the past and has regenerated; trees are generally younger and crowns are not senescent. 'Remnant' forest refers to regrowth that reaches 70 per cent of the original canopy height and 50 per cent of the original canopy cove when compared to an undisturbed forest of the same type. This is a legal classification (*Vegetation Management Act 1999*) and determines whether the forest management is subject to *The code applying to a native forest practice on freehold land 2005*.

Old-growth bluegum forest, a remnant forest with large, old trees.

Most PNFs have value other than timber, including habita and environmental values, grazing, shelter and honey production. Most tangible economic benefits from forests, however, are based on income from timber production, either for milling or for farm timbers. Bee-keeping is the only significant 'non-wood' industry based on the PNF resource.

Unfortunately for timber production, most Queensland native forests share a common characteristic: in an unmanaged state these forests are relatively unproductive and management input is required if potential production is to be realised.

On a global perspective many of Queensland's native forest timbers exhibit unique qualities such as strength, durability and feature. To date the single biggest industry based on native forest has been one of sawlog for construction. Pole production, fencing and fencing timber have also utilised significant volumes of timber sourced from native forests.

An historical perspective

Early on in European settlement in Australia the extensive forested areas represented a large timber resource to the early settlers. 'Timbergetting' formed the early stages of the timber industry and timbercutters moved quickly through the forests harvesting the high-quality accessible trees. This process of taking the best and leaving the poorer quality trees is known as 'high-grading'. At the time timber resources were regarded as plentiful and little thought was given to the future. Timbercutters were often followed by early settlers who, once established, set about clearing the forest for farming, using ringbarking and fire.

Recently thinned young spotted gum stand. The good-quality retained trees are at optimum spacing.

In the early 1900s tracts of land were set aside as state forests to secure future timber resources and forest management practices were initiated. Early forest managers were faced with either 'old-growth' forests dominated by large, old and often defective trees or dense regrowth forests resulting from poor farming practice or abandoned clearings. The low productivity of these forests soon became apparent and, as early as 1919, 'silvicultural treatment', or thinning, was started to thin forests to improve productivity. Silvicultural thinning of state forests peaked in the late 1930s and 1940s and again in the 1960s with the introduction of herbicides. Early thinning regimes were conservative and did not space trees adequately, but improved as research trials clearly demonstrated that wider spacing was needed to achieve reasonable growth rates. Eventually three important principles of forest thinning were adopted:

- removing useless and non-commercial trees, by harvest or thinning, to waste
- selecting the retained stand using tree species and future log potential
- thinning the remainder of the stand to allow adequate growing space.

For the most part, however, forest management for timber production was limited to state land and silvicultural management techniques were adopted by few private landholders. By the mid-to-late 1970s silvicultural thinning started to be phased out on state land and stopped completely in the late 1980s as economic rationalism became popular. A significant amount of thinning to improve grass production was carried out on private land following the advent of tree-control herbicides. With some exceptions, however, this generally failed to capture the principles of silvicultural management for timber production.

The current situation

From the 1970s large areas of softwood plantation were developed in Queensland, providing a cheap alternative timber supply to the traditional hardwood used in construction. This reduced the price of hardwood logs for their traditional use for timber framing. As this cheaper alternative timber supply increased other markets and end uses were sought and in recent years an increasing proportion of native-forest timber has been directed towards higher value end uses such as flooring and feature timber.

Legislative changes have also had a major influence over the future of native forests for timber production. Regional forest agreements were initiated to provide some certainty for native-timber supply from state land in many parts of Australia. The Southeast Queensland Forests Agreement (SEQFA) includes phasing out native-forest harvesting on state land and establishing a hardwood plantation resource as an alternative timber supply. The *Vegetation Management Act 1999* and associated adoption of the mandatory *Code applying to a native forest practice on freehold land 2005* has also had an impact on the PNF industry.

In Queensland private forests have been an integral part of the native-forest resource throughout the life of the timber industry, delivering a significant component of the annual harvest and complementing state-sourced timber. With the implementation of the SEQFA, it is expected that demand will continue for this resource. With growing investment in the plantation resource and increasing demand for greenhouse-friendly building products, a sustainable, managed PNF resource has a critically important role in timber production.

There is wide variation in native-forest productivity and sustainable management practices. In many cases opportunistic harvesting, rather than good forest management, has dictated management practice. Consequently productivity and therefore future income for landholders has declined well below potential. Poor management decisions result from an inadequate understanding of forest processes and the growth habit of eucalypts. These dynamics have important management implications for productive mixed species and uneven-age forest.

Mixed-age spotted gum forest managed for grazing and timber production.

State forests have implemented key management principles relating to the growth habit of eucalypts, the need to keep quality growing stock and the provision of sufficient space for trees to grow. These principles must be adopted by private landholders and sawmillers alike if the PNF resource is to reach its productive potential in the future.

Principles of forest management

Forest cycle

A production forest usually has a growth cycle based around the harvest. The cycle consists of a harvest followed by a regeneration stage, a harvest interval and the next harvest. The regeneration stage encompasses seedling, lignotuber and coppice establishment after a harvest. This is followed by a harvest interval, during which trees grow until sufficient volume is available and another harvest is warranted. In Queensland 'selective harvesting' or 'single tree selection' is practised. Only a proportion of the trees are harvested at any one time, retaining a standing forest perpetually. This management system ensures that all forest values are intact at all times. The system is suited to uneven-aged and mixed-species forests, where most trees are not big enough to harvest.

An overstocked blackbutt stand ready for harvest.

At each of the three stages of the harvest cycle, regeneration, harvest interval and harvest itself, the right management decision is vital for maintaining the productivity of the forest and of the land. Most forests are managed for both grazing and timber production, and getting the balance right is critical.

Regeneration

Regeneration is needed to replace the harvested trees and maintain future productivity. In dry forests regeneration is usually from lignotubers (suckers) that are already established. In wet forests and in dry forests without existing regeneration it is critical to ensure regeneration is both established and protected through the early growth stages. Successful regeneration requires the right species in the right place. Dry forests tend to have intermittent seed crops, while wet forests have a more reliable seed crop. This means that fire (both before and after harvest), soil disturbance and grazing pressure, as well as timing the harvest, need to be managed in coordination with a seed crop or existing lignotubers.

A spotted gum forest being burnt to maintain a grassy understorey.

Stand management

Once established a forest stand must be managed for the future harvest. This is usually done by selecting desirable trees to be retained and thinning unwanted trees. Thinning can be 'to waste' when trees are too small to sell or, where possible, culled trees are sold and thinning becomes 'cost neutral'. A stand usually contains a range of size classes, mostly smaller trees and relatively few larger trees. The overall tree stocking should be appropriate for the forest type, land-productivity potential and land-use requirements. The different age classes represent future harvests and at least three harvest age classes should be represented in the stand to ensure a continuous production cycle.

Eucalypt regeneration in wet sclerophyll forest can be suppressed by an invading rainforest understorey.

During the harvest interval it is important to ensure that the retained trees:

- have adequate growing space
- are a sufficient standard of log straightness and length
- have a vigorously growing crown
- are free of defect.

Fire has an important management role but fires that are too hot will reduce tree growth or damage the lower log. A balance is often required between burning for grass production and burning for timber protection.

Harvest

The harvest is an opportunity to realise the income from timber production as well as manage the stand for optimum future productivity. In Queensland native forests the harvest interval can be between 10 and 40 years, depending on how well the stand is managed and the intensity of each harvest. Most often harvests tend to be relatively intense and a large amount of timber is removed after long harvest intervals.

Mixed species stand with spotted gum, carbeen and ironbark. Poor-quality trees and non-commercial species need to be thinned, leaving well-spaced good-quality trees.

Well-managed forests produce good-quality logs.

In some cases less intense harvests are preferable so that the non-performing stems can be thinned from the stand. Usually a combination of both is required where a intense harvest periodically 'resets' the stand to productiv potential. There are a number of important principles to b followed at harvest:

- harvest the worst trees first ('thinning from below')
- remove trees that have reached their optimum economic value
- space remaining trees for the next harvest
- only leave good-quality growing stock
- return in five years to thin the regeneration
- implement sustainable forest management.

Sustainable forest management refers to the long-term productive potential of a forest. The wider term 'ecologically sustainable forest management' refers to the maintenance of essential ecological processes underpinning long-term land productivity. This embraces the maintenance of the forest's productive capacity, soil nutrients and structure, water quality in creeks and rivers, the hydrological balance, plant and animal diversity, shade, shelter and habitat diversity. It is important to understand that a 'working forest', one actively managed for timber production, can provide these additional value as well as timber. On the other hand, an unmanaged regrowth stand often exhibits negative attributes such as little or no ground cover, soil loss and unhealthy, underdeveloped tree crowns.

As with all agricultural enterprises, good forest management protects soils from erosion and excessive compaction. It is also important to ensure that gullies and creeks are not silted by poor drainage along snig tracks, gully crossings and roads. Protecting these resources not only maintains many ecosystem functions provided by forests in the landscape but also enhances the productive potential of the forest and surrounding landscape.

Case study 1: Thinning an even-aged regrowth forest

Sustainable management by thinning for improved productivity

In eucalypt stands that have been heavily logged in the past and left unmanaged, dense regrowth is suppressed by competition for water and nutrients. The maturing stand will often contain a large proportion of defective, non-saleable trees. The suppressed stems grow little saleable wood, if any, and the resulting site productivity can be very low. Thinning the stand actively manages the future composition and structure to improve productivity of the best stems and increase the commercial value of the next harvest.

Treatment

This silvicultural treatment removes the non-productive part of the stand, allowing remaining stems more growing space and a greater share in available resources on the site, resulting in more rapid growth. Thinning manages both the number and density of the remaining trees and an optimum stocking density will vary with forest type and past management (Box 1.1). Thinning can be done at the same time as a harvest or as a separate operation.

Thinning can be achieved either by harvesting timber or 'treating' by removing and/or killing unwanted stems. Thinning treatments are essential to encourage growth to be redistributed from many stems to a selected few and to re-establish good, vigorous regeneration.

Box 1.1 Goals and benefits of thinning management

Goals

- select more valuable species or those with better potential for growth
- grow trees to saleable size within an acceptable timeframe
- remove unwanted regeneration
- remove over-mature or suppressed trees
- provide optimum tree spacing for the desired end product
- protect soil and water resources and biodiversity values
- encourage productive regeneration through overstorey management and burning regimes

Benefits

- available resources are directed to the trees for future harvests
- greater diameter and height growth
- minimal impact of defect in the stand
- better overall tree health in crown and stem
- increased product quality and quantity through successive genetic improvement
- in the long term produces faster economic return and greater commercial volume

Removing suppressed and defective trees

Suppressed eucalypts do not regain vigorous growth rate even after they have been released from competition. Competing and defective stems must be removed to allov the best (retained) trees greater access to the available resources.

On most sites stocking rates of approximately 100 stems per hectare (20+ cm diameter at breast height, or DBH) will produce an optimum growth increment for sawlogs. Pole stands need a higher stocking rate to produce a self-pruning tree, free of branches with a long bole length, that meets specific requirements for DBH and top-end diameter. For example, a 17 m pole with a 12-kilonewton (kN) strength rating needs a DBH under bark of around 40 cm, and a top-end diameter under bark of 25 cm. For a pole stand, the stocking level needs to be about 150 stem per hectare. As pole length increases, the optimum numb of stems per hectare decreases.

Regeneration management

Adequate, evenly spaced regeneration and good-quality retained trees are essential for maintaining vigour in a stand of timber and must be managed carefully. Managing regeneration reduces competition and canopy suppression, allowing the stand to develop towards the 'advanced-growth' stage, which is available for future harvest. An advanced-growth stand has passed beyond th regeneration stage and has actively growing trees (>10 cr DBH) that will achieve a codominant or dominant positic in the canopy and are not at risk from mild fire events. Regeneration development towards the advanced-growth stage can be hindered by an overtopping canopy, frequen burning, grazing and drought. Removing the overstorey increases sunlight and moisture and often triggers a substantial growth response by seedlings.

Maintaining environmental and habitat values

Biodiversity values can be protected by maintaining a mosaic of disturbed and undisturbed areas. Planning to protect resources is an important part of native-forest management and is an integral part of property management planning. Queensland has comprehensive guidelines: *The code applying to a native forest practice on freehold land 2005.*

Case study, Wamuran

This case study combined thinning a regrowth forest with a harvest, comparing the pre-harvest and potential post-harvest productivity of the stand. The site was in a mixed-eucalypt regrowth forest on a 102-hectare farm near Wamuran in south-east Queensland. Dairying was abandoned in 1946 and the farm, which had contained a range of commercial eucalypt species, was left to regenerate naturally.

The costs and benefits of thinning were analysed and marketing options for the products from the thinning operation were examined. The study suggests the operation was cost-effective, combining improved stand management and future productivity with a commercial harvest. A property management plan was developed to assist with future management. This included a description of the natural resources, productivity, markets and commercial and environmental management strategies.

A silvicultural treatment and demonstration site was established to measure the long-term growth response of the forest to different thinning regimes compared with unthinned forest. Information about growth relating to different thinning regimes will contribute to the development of silvicultural systems for the sustainable management of native forests.

Figure 1.1 The study area supported a tall, densely stocked, open, mixed grey gum forest with a brush box understorey.

The situation

This regrowth forest had been unmanaged for more than 50 years. Fire and grazing had been excluded, allowing a dense regrowth stand to develop. The understorey had been invaded by woody, shade-tolerant species and intense competition was limiting tree growth.

Objectives

- to thin the stand using an appropriate silvicultural treatment so that remaining stems could be grown on for a future commercial harvest
- to provide a cost–benefit analysis for the harvest and sale of the thinned saleable logs
- to develop a property management plan for the property
- to establish a long-term trial for monitoring growth responses to thinning treatments.

Forest description

The property is located in the foothills of the D'Aguilar Range near Wamuran in south-east Queensland. Following selection about the turn of the century, most of the farm was cleared by ring-barking and used for dairying until 1946. The dairy was later abandoned for banana production, which used only a small part of the 102 hectares and the rest left to regenerate to a natural state.

The study area is in the northern section which had moderate slopes (0-8°) and undulating, low hills. Average annual rainfall is between 1000 and 1250 mm. The soils are relatively fertile, red-brown clay loam topsoil and yellow, mottled clay subsoil. This soil type has low erodibility. The forest type is mixed tall open forest type 12.11.3 in the Regional Ecosystem Classification and its conservation status is 'no concern at present'.

The most common species included grey gum (Figure 1.1), white mahogany (yellow stringybark), tallowwood, grey ironbark, broad-leaved red ironbark, gum topped box, red (pink) bloodwood and brush box. Some rainforest

Box 1.2 Characteristics of an unmanaged stand

Overstorey trees grow faster but still compete for water and nutrients. Some understorey trees show clear signs of decline due to insect or fungal attack or crown dieback caused by inter-tree competition.

The understorey contains many suppressed small trees that are not saleable. These trees have little potential for growth, even if released from competition.

The ground or regeneration layer contains invasive species such as brush box, red ash and suppressed eucalypts with poor form.

In moist sclerophyll forests, shade-tolerant, slower growing species, such as brush box and rainforest species are favoured by little or no disturbance. These species are woody weeds and often invade the understorey of eucalypt forests in the absence of fire. They are unlikely to produce a saleable product.

The invasive species might develop to dominate the middle stratum, inhibiting seedling regeneration and the critical early-growth stage of the dominant eucalypt species. They compete with and inhibit the growth of saleable stems. Eventually species composition and forest type could change.

Fire exclusion and lack of vegetation management produces a dense stand with little value either for timber production or habitat.

species as well as rose gum and paperbark tea-tree occurred along the creek lines. The stand is representative of a large area (27,000 hectares) of private, mixed grey gum forest type in the upper Mary River catchment.

A thick understorey of lantana, brush box, red ash and mutton wood had developed as a result of irregular and infrequent burning. The regrowth areas hadn't been managed except for a limited cut in 1960, which removed some small poles, sawlogs and fencing material.

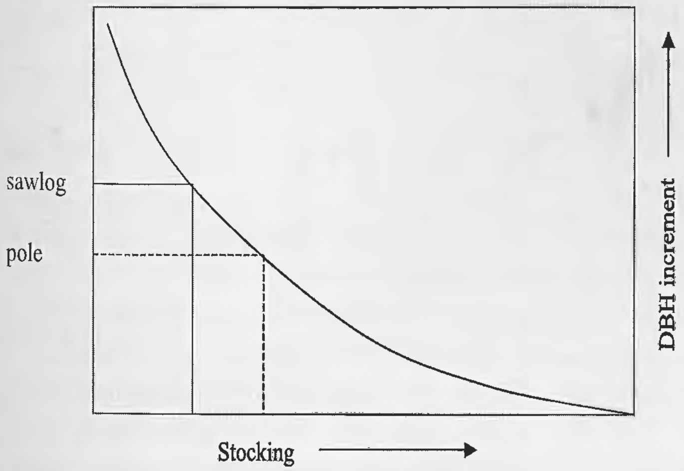
Management

This was a regrowth forest with few old-growth characteristics. Stand productivity was very low because overstocking had caused severe competition between trees (Box 1.2).

The tree stocking was between 500 and 700 trees (>10 cm DBH) per hectare, and included several commercial eucalypt species. Many trees had long straight boles free of branching and so this stand was considered suitable for pole production. The grey gum, gum topped box and ironbarks all had good form and the stand has potential to produce up to 14 m heavy poles in the future. To improve timber production and encourage a productive open forest, the stand needed to be thinned to a more appropriate stocking (Box 1.3).

Box 1.3 Stand productivity

Forest managers have to consider the optimum stocking needed to produce the best economic return for their forest. Stocking rate is proportional to diameter growth. This means that an optimum stocking rate can be found for optimum diameter growth that will produce a saleable forest product in the shortest time.



Stylised response of tree growth (DBH increment) to tree stocking.

Management to improve forest condition by thinning and to conduct a harvest follows a set of common steps provided as guidelines in Appendix 1. An assessment of stand condition was completed and this was used to plan appropriate management for the trial.

Stand condition assessment

A stand inventory or assessment gives important information about species composition, stocking rates and tree size classes, which are needed before management decisions can be made. Guidelines for conducting a stand inventory are given in Appendix 1. Stand inventory sampling was done in a series of temporary plots (1/20th ha or 12.6 m radius) on a 100 m grid at each site (Table 1.1). Long-term monitoring plots were set up during the case study (Box 1.5) so all descriptions and measurements refer to two replicate blocks, A and B.

There were few trees over 40 cm DBH and a large proportion of the stand was made up of either suppressed or non-commercial species for this site, such as brush box. Grey gums had significant insect damage caused by the longicorn beetle, probably related to intense inter-tree competition. The canopy layer was restricting further eucalypt regeneration and promoting shade-tolerant, non-commercial species.

Most tree species were ranked as durability Class 1, and so the thinnings would be suitable for a ready market as poles, round timber and fencing material.

Table 1.1 Number of stems per hectare in each diameter class for Blocks A and B

	DBH class (cm)				Stocking range (No./ha)
	10–20	21–30	30–40	40+	
Av. of 7 plots Block A	308	165	68.6	20	420–700
Av. of 5 plots Block B	348	164	56.0	24	420–700

Management prescription

Thinning management was recommended to allow remaining stems to grow on for a future commercial harvest (Box 1.1). The thinned saleable logs would be sold. Opening up the canopy by thinning, treatment and burning would help eliminate the fire-susceptible, shade-tolerant species and allow eucalypts to re-establish and develop into the 'advanced-growth' stage.

The thinning treatment and harvest had two goals:

- to harvest saleable timber while thinning the stand for increased future productivity
- to monitor how the forest responds to three rates of thinning in the long term (Box 1.5).

Thinning treatment and harvest

Harvesting was conducted in the two blocks established to monitor future growth (Box 1.5). Each block consisted of three one-hectare plots, two of which were thinned to 100 and 200 trees per hectare respectively. Logs harvested from the two blocks were separated. Tree selection and marking, preserving environmental values and habitat trees, and harvesting procedures followed the guidelines given in Appendix 1.

Tree selection and marking

Trees to be retained in the growing stand (for a future harvest) or to meet environmental requirements were selected on the basis of form, crown condition, spatial location and absence of defects (Box 1.4).

Trees were marked with paint dots or an H for a habitat tree (Figure 1.2). The marks were repeated three times around the tree. Retained stems were easily recognised, avoiding damage during harvesting. Guidelines for selecting and marking trees for retention are given in Appendix 1.

Box 1.4 Criteria for selecting trees for marking and retention

Form – bole length, straightness, shape and branches

- straight bole of > 9 m length, free of branches or branch stubs

Crown score – the Grimes crown score system (Appendix 1) scores crown health, including position, size, density, dead branches and epicormic shoots

- a high aggregate score indicates a better potential for growth
- a minimum of 19 points set for retention

Spatial location

- 200 stems/ha – nominal spacing 7 x 7 m, minimum 4 m if no other tree available and stems are co-dominant
- 100 stems/ha – nominal spacing 10 x 10 m, minimum 5 m if no other tree available and stems are co-dominant

Defects – fire scars, bumps, flutes, branch stubs, spiral grain and insect or fungal damage

- generally free of defect, but non-deteriorating defects were acceptable if insufficient, defect-free stems were available

Figure 1.2 A habitat tree marked clearly with an 'H' to avoid damage during the harvest.

Figure 1.3 The tractor used for the harvest was a 60 hp 4WD with blade and rear forks.

Harvest

The stand assessment was used to identify the harvest areas and the harvest exclusion zones. A buffer or non-logging zone (2 m) was left at the top of the creek bank. A wider, filter zone (10 m) was established adjacent to the non-logging zone as the soil was classed as having low erodibility. Four habitat trees were left per hectare.

The harvest was conducted by the landowner using standard farm machinery:

- chainsaws – '066' and '034' Stihl™
- tractor – 60 hp 4WD with rear forks (Figure 1.3)
- safety gear – safety chaps, helmet and earmuffs, sign: tree felling in progress
- axe, barking bar and cant hook.

Trees were cut low to the ground and the heads (felled crowns) were cut up to lie flat on the ground. Careful directional felling ensured that retained stems were not damaged.

Most trees harvested at this site were less than 40 cm DBH. Standard farm machinery was adequate to snig this size timber. The front end of the log could be lifted off the ground, reducing soil disturbance, which is important for soil and water conservation. Snigging chains were used to attach the logs to the draw bar but a hydraulic log grab attached to the three-point linkage would have reduced the time and cost of this operation considerably.

Figure 1.4 Round timber harvested from the study site stacked ready for sale.

This machinery will also be adequate for a future harvest, because the area set aside for timber production has a slope of less than 15°. In addition, most of the harvested products will be poles rather than large-girth sawlogs.

Unmarked saleable trees were cut and snigged to the log dump then sorted into product types using advice from local sawmill and fencing contractors. The products were rounds, poles, sawlogs and fencing material (Figures 1.4 and 1.5). The logs were cut into the best product combination to maximise financial returns. For example, poles were cut at their specified small-end diameter (SED) and the rest cut into fencing material. Each product range was stacked separately and tallied.

Figure 1.5 Poles and sawlogs laid out for a field day.

The product types harvested were:

- 3 m rails >125 mm SED
- 2.1 m heavy strainers SED
- 2.1 m light strainers SED
- 3 m stays <125 mm SED
- 2.7 m yard posts >200 mm SED
- 2.4 m yard posts >200 mm SED
- split posts
- sawlogs 2nd class
- rounds >200 mm

Herbicide treatment

Non-saleable stems >10 cm DBH that were not selected for retention and all brush box >2 cm DBH were injected with Tordon Tree Killer®. All the eucalypts died very quickly, but the brush box still maintained 50 per cent of its crown four months after treatment. A second treatment with glyphosate was carried out in spring to ensure all the trees were killed.

Residual-stand details

The residual-stand details describe the structure of the stand after a harvest or thinning treatment and represent the potential, productive trees for future harvests. Residual-stand details are given in Tables 1.2 and 1.3. The number of trees in each DBH class will be used to compare growth responses to the different treatments in the long-term assessment trial.

Monitoring growth

An additional objective of the case study was to establish a long-term trial to measure and compare growth responses to different thinning regimes (Box 1.5).

Table 1.2 Residual-stand details for Block A by DBH and thinning treatment

DBH (cm)	Av. stocking pre-treatment	200 retained/ha	100 retained/ha	control
40+	20	6	6	12
30–40	68	62	37	56
20–30	165	143	50	225
10–20	308	6	6	475
Total	561	217	99	768

Table 1.3 Residual-stand details for Block B by DBH and thinning treatment

DBH (cm)	Av. stocking pre-treatment	200 retained/ha	100 retained/ha	control
40+	13	0	6	12
30–40	52	56	43	50
20–30	166	75	69	243
10–20	352	37	0	238
Total	583	168*	118	543

*There was a high incidence of defects and large number of brush box stems, leaving only 168 good-quality stems per hectare available for this treatment.

Box 1.5 Long-term monitoring trial and experimental thinning treatments

A long-term trial was set up to measure growth responses to thinning regimes compared with an unthinned control. The thinning treatments were repeated in two relatively uniform forest blocks. The sites chosen were:

- accessible to the public for demonstration days
- at least three hectares on a moderate slope with a consistent species mix, stand quality and management history
- located in the areas identified for future timber production.

Three thinning treatments were applied, using recommendations from previous DPI&F research:

- an untouched control (retaining the current stand), with the dominant trees (tallest) in the stand spaced at about 5 to 10 m apart
- 100 retained stems greater than 10 cm DBH per hectare, which represents relatively 'free growth' conditions and should maximise DBH increment, favouring sawlog and girder production
- 200 retained stems greater than 10 cm DBH per hectare, which represents a stocking that favours pole production and should maximise returns for the site.

For the long-term trial, the thinning treatments will be monitored to assess the response of retained trees to different management regimes. The trial will yield valuable data about the growth responses of the retained stems in the different treatments. Tree volume and DBH increment would be expected to vary in response to the different treatments.

Table 1.4 Product type and value (as at year 2000) removed from Block A

Product	Number and value		Product value
3 m rails >125 mm	181	@ $10	$1810
2.1 m heavy strainers	51	@ $10	$510
2.1 m light strainers	200	@ $9	$1800
3 m stays <125 mm	100	@ $5	$500
2.7 m yard posts >200 mm	49	@ $15	$735
sawlogs 2nd class	1.763 m^3	@ $40	$65
Total			$5420

Costs, returns and marketing

To examine the costs and benefits of thinning, outcomes from the three thinning treatments were combined. The harvested product types and estimated market values are summarised in Tables 1.4 and 1.5. Estimated product values were derived from current market values (year 2000) and don't include costs, which are given in Table 1.6. The net return was about $2500 on both two-hectare blocks (Table 1.7).

Market options

There are three types of private harvest operation:

- **Disorganised harvest.** The owner (who may have little understanding of product specifications and presentation) cuts the product and then tries to sell it.
- **Organised harvest.** The product sale is organised before the harvest but the owner (who understands product specifications and buyer requirements) carries out the harvest.
- **Standing harvest.** The product is sold standing and the buyer does the harvest.

The harvest in this case study was a 'disorganised harvest'. When the detailed stand assessment was carried out, it was expected that most of the product would be fencing material, with some poles and round timbers, and that these products would be difficult to sell to one buyer. This was not the best strategy. Prior knowledge of what buyers wanted would have resulted in selling most of the product to one buyer, potentially improving profits. At the time, the market for treated round timbers was good and merchants were having difficulties supplying the demand.

Round-timber merchants (CCA treatment plants) and fencing contractors in this area require barked logs. Timber wasn't barked at this harvest, preventing a direct sale, so the products were sold to a variety of buyers, adding to costs and delaying financial returns.

Table 1.5 Product type and value (as at year 2000) removed from Block B

Product	Number and value		Product value
3 m rails >125 mm	144	@ $10	$1440
2.1 m heavy strainers	62	@ $10	$620
2.1 m light strainers	109	@ $9	$981
3 m stays <125 mm	61	@ $5	$305
2.7 m yard posts >200 mm	5	@ $15	$75
2.4 m yard posts >200 mm	25	@ $12	$300
splits	100	@ $4	$400
sawlogs 2nd class	4.2 m^3	@ $40	$168
rounds >200 mm	128 lm	@ $5	$640
Total			$4929

Table 1.6 Costs of the thinning operation (as at year 2000)

Block A – 7 x 7 and 10 x 10			
Paint mark	6 hrs	@ $18/hr	$108
Cut	42 hrs	@ $18/hr	$756
Snig	25 hrs	@ $40/hr	$1000
Measure and cut	30 hrs	@ $18/hr	$540
Treatment	8 hrs	@ $18/hr	$144
Tordon, fuel, oil			$100
Total cost			$2878
Block B – 7 x 7 and 10 x 10			
Paint mark	6 hrs	@ $18/hr	$108
Cut	36 hrs	@ $18/hr	$648
Snig	25 hrs	@ $40/hr	$1000
Measure and cut	28 hrs	@ $18/hr	$504
Treatment	8 hrs	@ $18/hr	$144
Tordon, fuel, oil			$100
Total cost			$2504

Table 1.7 Product returns

	Block A – 2 ha	Block B – 2 ha
Gross product value	$5420	$4929
Costs	$2878	$2504
Net return	$2542	$2425

It is essential to research market options before starting the operation, because merchants differ in their requirements for preferred products at any one time. Variation in market demand can have considerable impact on the planning and operation of the harvest and sale.

Future harvests for this forest were planned as 'organised harvests', with opportunity for an ongoing sale into this market.

Cost-effectiveness of timber production as a farm enterprise

Landowners usually compare potential financial returns for different enterprises before deciding on the most appropriate enterprise. At the time of this study (year 2000) bananas and pineapples were the main farm products in the Wamuran area.

Bananas and pineapples

A successful banana crop with superior blemish-free fruit requires a good-quality site and careful management. Approximately $80,000 was required to establish a 4 hectare banana plantation. This included a secondhand four-wheel-drive tractor, irrigation system, mister, fertiliser spreader, packing shed, land preparation and plant establishment. Annual income after production costs varied from $6000 per hectare for non-irrigated plantations to about $13,000 per hectare for irrigated plantations. One person could handle two hectares per year; a larger area would require additional labour.

Pineapple crop cycles need careful management and complex technology such as flower induction, sprays, fertiliser mixes and pest and disease control. Establishment and harvest labour costs are high. At the time, machinery required for a commercial pineapple farm cost approximately $140,000. This included the cost of a tractor, cultivation equipment, fertiliser spreader, bed former, planter, boom-spray, boom harvester and shed. A further $5000 per hectare was required for roads and drains and $3000 per hectare for land preparation and crop establishment. Due to soil erosion problems and safety considerations, only slopes up to 8°, or 15 per cent, are suitable for pineapple production. Income after costs averaged $10,000 to $12,000 per hectare of cultivation over a two-year production period.

Timber production from native forest

The equipment needed to manage the native forest on this property cost about $15,000, including a secondhand 60 hp four-wheel-drive tractor with front blade ($12,000), a log grab for three-point linkage ($1000), an '066' chainsaw ($1500) and treatment gear ($500).

Returns from managed native forests are considered additional income for the farm. In this case study if five hectares of forest were treated and thinned each year (4–6 weeks' work) it would return $7750 per year. In 15 years the prescribed treatment of the 70 hectares set aside for timber production would be complete. Then the treated areas could be harvested. If the harvest is also conducted on five hectares per year, removing 50 per cent of the original stand would yield at least 200 m³ of product. Using year 2000 prices, a conservative estimate would be an additional $15,000 to the farm income. Some of the harvest would also meet pole specifications, yielding additional income. A summary of this management scenario would be:

- 5 ha treated per year to year 15 — $108,500
- 5 ha per year harvested from years 15 to 30 @ 50% of original stand — $225,000
- 5 ha per year harvested from years 30 to 45 @ 50% of original stand — $225,000
- 5 ha treated per year from years 45 to 60 — $108,500

These figures are estimates only and would depend on the stand response to the thinning treatment over time and the eventual harvest outcome.

Risk assessment

Risk management is as important for timber production as for other farming enterprises and there are several potential risks to the final harvest and invested capital.

Fire

Thinning management produces a substantial build-up of fuel on the ground. This increases the risk of wildfires and severe damage to standing trees. The risk can be offset by cutting tree heads (felled crowns) to lay flat on the ground during the harvest and preventing fuel from accumulating around the base of retained trees. When the harvest is conducted during winter, tree heads can be burnt in early spring. A periodic fuel reduction burn (every three to five years) and a system of firebreaks should reduce fire risk substantially and improve the diversity of the understorey.

Figure 1.6 Longicorn beetle damage to grey gum. Insect damage is common in trees stressed from overstocking.

Insect damage

Some harvested timber in this study had been damaged by longicorn beetles (Figure 1.6) and giant wood moth larvae. A higher incidence of damage would have downgraded a proportion of the pole stand to sawlog class or reduced the value of the final harvest. Periodic pest monitoring is essential to adjust future management strategies.

Right of harvest

It is advisable to manage potential right of harvest issues with documentation in tax returns, council registration and a good property management plan, based on sustainable logging principles with measures in place for the protection of environmental values. This site was a regrowth forest and at the time was not classified as remnant vegetation or as having any protected status.

Outlook – future management

This regrowth forest had been unmanaged for over 50 years. Fire and grazing had been excluded, allowing a dense regrowth stand to develop. Shade-tolerant species had invaded the understorey and tree growth was limited by intense competition. The stand condition was assessed, some recommendations were made for future management and a thinning trial was run on a proportion of the stand. Returns on harvest products were reasonable, although an organised harvest and market survey would have improved sale outcomes.

The study showed that thinning an overstocked, regrowth forest as part of a longer term management plan can bring cost-effective returns on the harvested stems. Market options for the thinnings could be identified.

Management principles outlined here will apply to similar regrowth stands in this type of mixed grey gum forest on private land in the upper Mary River catchment. Costs, products and rates of return will, however, vary between different species mixes and site qualities.

The long-term thinning trial established during the study will yield valuable data about growth responses of the retained stems in the different treatments. Information about growth related to different thinning regimes will contribute to the development of silvicultural systems for the sustainable management of native forests.

Several conclusions were drawn from the study:

- *Thinning the stand* to a productive stocking by harvesting and thinning to waste can be cost-effective and profitable. Felled trees that can be marketed as products such as sawlog and round timber can be utilised and sold.
- *Selecting trees* for retention is based on their potential for optimal timber production. Trees with a long straight bole, free of defect and with good crown characteristics should be selected.
- *The stocking rates* chosen for retained trees reflect:
  - » retention of the most valuable species where possible
  - » number per hectare and the type of product to be grown in the future (e.g. poles or sawlog)
  - » the ability of the site to support the stocking (soil type and fertility).
- *Timber production* is a viable commercial proposition and should be managed with other land uses on a 'whole of farm' basis.
- *Maximising economic returns* depends on planning the sale and understanding product specifications in relation to available tree products. In most cases economic return can be improved significantly if the owner conducts the thinning, snigging and marketing.
- *Forest management* should meet sustainable goals, maintaining the forest's productive potential and environmental values.

From the owner

I inherited this land in 1997 and it was my home before I married. This gives the land great sentimental value. My husband and I are both from a farming background and we decided we wanted to keep it as a viable farm and dread the thought of it being subdivided into farmlets as has happened to much of the nearby land.

Forest farming seemed a good way of preserving the mature regrowth forest and replanting the old banana patches retains the nature of the land, and does not involve the use of the chemicals needed in most other produce farming. We see this project providing a guide for best management practice for the property. We want to preserve our heritage for our children and provide an income to maintain the property in our old age.

Property management planning

Planning is an essential part of a new enterprise or improving an existing one. Planning increases the likelihood of success through improved decision making and a reminder to adhere to relevant policies.

Farm forestry enterprises for plantations and managed native forests are long-term ventures and benefit from planning. The planning process allows landholders to develop strategies that will suit their own situation and needs.

Management plans for farm forestry enterprises provide security of harvest and demonstrate environmentally sustainable management. Increasingly financial institutions and government bodies require a property plan to assist in assessing a range of factors, including business performance and environmental impact.

Property management plans should incorporate:

- an outline of objectives
- an overview of the current situation
- strategies for achieving the objectives.

In developing the plan, managers should consider concepts such as sustainability, whole farm systems, strategic planning and decision making, and a farm family focus.[1]

1 To develop a property plan, land managers can contact the Department of Natural Resources and Water or use their publication, *Property resource management planning: Guidelines for landholders*.

Case study property management plan (prepared in 2000)

Owner: Col and Ailsa Moorhead

Property area: 102.2 hectares

Property goal

To maintain the property operating as an economically and environmentally sustainable rural enterprise by growing bananas, native timber plantations and native hardwood forest management.

Natural resources

Current land use

Current land use is as follows:

- 1.5 hectares timber plantation (mixture of hardwoods and cabinet timbers)
- 1.5 hectares cleared land
- 3 hectares infrastructure (buildings, dams and roads)
- 4.5 hectares powerline clearing
- 5 hectares bananas
- 16 hectares conservation zone
- 70.5 hectares native hardwood forest

Soil

The soil is a yellow duplex derived from metamorphic rocks with red-brown clay loam topsoil and a yellow mottled clay subsoil. It has a low erodibility classification.

Slope

The northern two-thirds of the property is approximately 60 m above sea level (ASL) with an undulating slope (0–8°). Areas on the southern side of the property are less than 150 m ASL with moderate to steep slopes (to 30°).

Vegetation

The forest on the property is classified by the Regional Ecosystem Classification as 12.11.3 Tall open forest on Mesozoic to Proterozoic moderately deformed and metamorphosed sediments. The conservation status of this regional ecosystem is 'of no concern at present'.

The dominant species include grey gum (*Eucalyptus propinqua, E. major*), white mahogany/yellow stringybark (*E. acmenoides*), tallowwood *(E. microcorys),* grey ironbark *(E. siderophloia),* broad-leaved red ironbark (*E. fibrosa*), gum topped box (*E. moluccana*), red/pink bloodwood (*Corymbia intermedia*) and brush box (*Lophostemon confertus*). Some rainforest species and rose gum (*E. grandis*) and paperbark teatree (*Melaleuca quinquenervia*) occur along the creek lines.

Maps

An enlarged colour aerial photo (scale 1:5000) was used to map the property's natural resources. Contour lines at vertical, one-metre intervals were marked on the photo (Figure 1.7).

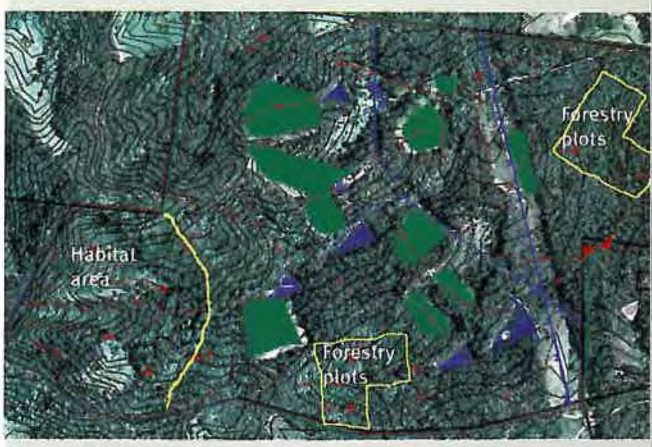


Figure 1.7 Aerial photograph of the property showing contour lines. Overlay 1 Infrastructure (blue), Overlay 2 Natural features (red), Overlay 3 Land use (green).

A series of three overlays were used to record various types of information:

- Overlay 1 was used to map property improvements or infrastructure. This included access tracks, dams, powerlines and buildings.
- Overlay 2 was used to map natural features such as drainage lines, ridges and slope.
- Overlay 3 was used to map current land use, including banana paddocks, timber plantations, trial plots and the conservation zone.

The map will be used as a tool for future management to plan treatment areas and to keep records of treatment dates and details.

Human resources

The property has been in the same family for several decades. The owners are both currently in full-time employment, so farm work is generally restricted to weekends. Experienced hired help is available if required. They have limited experience in native-forest management for forest products and will need to acquire further skills and knowledge.

Financial resources

The areas under banana production are leased out. In the short term the owners aim to at least cover the costs of forest management operations by selling thinning products. In the long term the aim is for higher returns from standing timber as poles and sawlogs.

Production

The native forest is composed of a number of commercial species. Sawlogs were harvested from the property in the mid 1960s. The native forest has had very little management since then. In the last 40 years there have been occasional light pole harvests, with the last being about 11 years ago. The current average stocking rate is 560 stems per hectare. There are areas on the property that are cleared and not growing bananas.

Markets

Currently there are local markets for a wide range of forest products. There is a ready market for thinnings and several buyers are located within a 30 km radius of the property. A number of hardwood sawmills operate within 50 km of the property. Because a large number of options are available, a market analysis should be done prior to a sale or harvest. This would make the owners aware of product specifications, qualities and special requirements by prospective buyers. Long-term contracts for thinnings would be viewed favourably as some local producers might need to enhance continuity of supply.

Management strategy

The management strategy divides the property into five management areas.

- The land currently growing bananas will continue to be leased out.
- The 1.5 hectares planted to hardwood and cabinet timbers will be managed with the aim of producing timber products in the long term.
- The remaining 1.5 hectares of cleared land was subsequently planted to a mixed native-hardwood plantation in 2001. The owners will undertake the planting and maintenance of the plantation areas.
- The conservation area will be left largely untouched, except for periodic burning to reduce fuel loads.
- Native forest areas will be thinned to a stocking rate of approximately 150 (≥ 30 cm DBH) stems per hectare.

The stand will be managed to deliver several products (listed in order of priority): poles; other rounds; sawlogs; fencing material.

The owners will aim to thin 70 hectares of native forest at a rate of four–five hectares per year over 15 years. They will start at the eastern boundary of the property and work to the western boundary using tracks, ridges and creeks to delineate blocks. The property map will be used to plan and monitor works. The thinning products will be sold to a local buyer. The potential for logging will be assessed about 15 years after the thinning operation and the then best course of action for the future will be determined (Table 1.9).

Table 1.9 Management schedule for each 4–5 ha block

Treatment	Year	
Commercial thin	1	
Treat out most non-commercial species and defective trees	1	Monitor and evaluate
Burn heads from thinnings in August–September, when seeds are mature, to promote regeneration	1	
Treat regeneration	4	
Harvest	15	

Environmental management strategy

The code applying to a native forest practice on freehold land 2005 will be used as a guide to implementing an environmental strategy.

Fire management

The owners will aim to burn every three to five years to control lantana and brush box and to promote commercia hardwood regeneration. Regeneration will be monitored prior to burning to ensure it will survive any burning activity. Burning will be undertaken in a mosaic pattern across the property.

Tracks and roads

There is already an extensive system of tracks on the property, and this will be adequate for future needs. Whc boys (cross-drains) will be constructed and maintained t minimise the long-term risk of erosion.

Habitat trees

There are currently very few live habitat trees in this young stand. Habitat trees will be recruited and maintained throughout the stand over time.

Waterway management

Buffers will be left around all designated watercourses (1:250 000 map series) where logging and thinning operations will be excluded. Trees will be felled away from the watercourse. Local government guidelines and *The code applying to a native forest practice on freehol land 2005* will be adhered to.

Case study 2: Restoring productivity in a high-graded spotted gum–ironbark forest

In the past the most common form of management in Queensland's private native forests has been a practice known as 'high grading'. This harvest method takes most of the saleable dominant trees, often leaving the stand in an unproductive state with suppressed, sometimes defective trees that have little prospect of reaching potential growth rates or a saleable product in the future. Ensuing regeneration is often very dense, producing a 'locked-up' stand where the older, relatively unproductive non-saleable trees suppress the younger regeneration. Where this has occurred much of the potential forest productivity can be lost.

To regain potential productivity two important principles must be ensured. First, defective and non-saleable trees should be removed where possible so that these do not suppress the future stand. Second, regeneration should be thinned so that the best trees are retained and provided with adequate growing space.

Management decisions need to have a long-term view, aiming to maintain growing stock for a productive, future forest and encouraging young vigorous trees for future harvests in the shortest time. Ideally, when a harvest is carried out, trees that have reached their maximum economic value are harvested and lower quality and defective trees are removed to allow better spacing. High-quality trees or growing stock yet to reach their maximum potential will be left to grow on. Regeneration resulting from a harvest will need to be thinned to space out the stems so that growth rates are optimised.

Sustainable management by restoring productivity in high-graded stands

Case study, Miva

This study examined management options for a property in south-east Queensland with a history of successive high-grading harvests in a spotted gum–ironbark forest. The stand consisted of suppressed, damaged, defective or non-commercial trees, with some advanced-growth trees (grown on from previous harvests) reaching 10–30 cm DBH. There was dense regeneration in some areas, with scattered, older, defective and non-saleable trees as well as substantial quantities of harvest residue.

The study described the forest condition, discussed how future management might be implemented using best-practice guidelines for this forest type and established a management trial on part of the property. The outcomes provide guidelines for the rehabilitation of similar native forests in the region.

Information about the management history, forest type and condition was used to consider management options and recommendations. Thinning regimes for the two residual types of regrowth stand (advanced growth and younger regeneration) were implemented on a trial basis. The initial outcomes summarised the owner's returns on the thinnings harvest and growth responses of selected trees, 11 months after thinning.

The thinning treatments were established as a management trial that can be monitored in the future. The effect of different thinning treatments on productivity will be compared by measuring growth responses at intervals.

The situation

This was a poorly managed, high-graded forest and previous harvests had left the stand in an unproductive condition. Without management, the stand was unlikely to produce commercially valuable timber in the next 20–30 years. Both the advanced-growth and regeneration stand types needed to be thinned to remove the trees without any productive potential and to provide adequate growing space for the trees selected for retention.

Objectives

- to demonstrate appropriate thinning treatments to restore future productivity in the regeneration and advanced-growth stands
- to provide information about the cost-effectiveness of thinning as a management option
- to provide a demonstration site and guide for landholders with similar high-graded forest
- to establish the thinning treatments as a management trial for future monitoring.

Forest description

The property, near Miva, north of Gympie, is typical of large areas of land used for both grazing and timber production in the Wide Bay region of south-east Queensland. The property covers 225 hectares of tall, open, dry sclerophyll spotted gum–ironbark forest with a grassy understorey. Anecdotal evidence suggests that the property was almost completely cleared for grazing at the turn of the century, and ringbarked trees are still standing from subsequent clearing. Farming was abandoned around the 1930s and when ringbarking ceased the forest quickly re-established itself. The only remaining areas of old growth followed gazetted road reserves running through the property. Over successive harvests, especially in the 1980s to early 1990s, the block was logged to a diameter limit of 35+ cm DBH, during which large numbers of sawlogs and poles were removed. Most of the farm was cut for fence posts as well until 1997, when the present owners purchased the property to manage it for timber production.

Mean annual rainfall for the region is between 750 and 1000 mm and most of the property has an undulating slope of 0–10°. This forest is a mix of species, types 12.9/10.17–12.9/10.19 in the Regional Ecosystem Classification, with a conservation status of 'no concern at present'.

The most common species include spotted gum, red bloodwood, grey ironbark, broad leaf red ironbark, white mahogany, grey gum, Queensland peppermint, gum topped box and smooth barked apple. The understorey is mostly grassy, although brush box (supple jack) and wattle are common.

The timber stands were either at the younger regeneration stage or the older advanced-growth stage:

- regeneration stands – very dense regeneration (up to 3000+ stems per hectare), 4–6 m tall, with a scattered overstorey of larger residual, suppressed or defective trees left from previous logging
- advanced-growth stands (Figure 2.1) – co-dominant or dominant trees (20–30 cm DBH, 250–320 stems per hectare), including many trees rejected at the last logging because they were non-commercial species or because they had poor form or defects.

Figure 2.1 A typical area of advanced growth spotted gum (20-30 cm DBH).

Management options and stand assessment

To develop an effective management plan for improved productivity, several questions were considered:

- How should the advanced growth be managed to ensure optimum returns?
- How should defective stems be removed?
  - » Are they marketable? Will they cover the costs of the operation in the short term?
  - » If so, will the harvest cause unacceptable damage to retained stems and the regeneration?
  - » Should stems be culled *in situ* or felled to waste?
- How should the harvest residues be managed?
  - » Is the residue a risk to the future crop; is it possible to burn without damaging retained stems and regeneration; what is the risk of the residues burning in a wildfire and destroying the crop?
- How should regeneration be managed?
  - » Is there sufficient regeneration present and does it need thinning?
  - » If insufficient, how can more trees be established?

Management to improve forest condition by thinning and to conduct a harvest follows a set of common steps provided as guidelines in Appendix 1. An assessment of stand condition was completed and this was used to plan appropriate management for the trial.

Stand condition assessment

A stand inventory or assessment gives important information about species composition, stocking rates and tree size classes, which are needed before management decisions can be made. Stand inventory sampling was done over a representative sample of the property recording:

- stocking rates by diameter class
- product range and volume
- numbers of defective trees.

The stocking rates for unthinned stands in two advanced-growth areas are shown in Table 2.1.

The stand inventories illustrated some general characteristics of this forest:

- The stand had been subject to a high-grading harvest and few stems over 40 cm DBH remained. Most trees were below commercial size, although there were some good-quality trees in the 20–40 cm diameter class.
- It was a regrowth forest and, as a result of previous clearing, had very few old-growth characteristics.
- At least 50 per cent of the trees were defective or suppressed.
- In the advanced-growth areas (200–300 stems per hectare) there was very little regeneration or coppice.
- Regeneration had been substantial in the very heavily cut (disturbed) areas.
- Much of the heavy regeneration was in the 4–6 m height range.

- The area had not been burnt for at least 10 years, since before the last harvest, leaving large quantities of logging debris.
- This forest type was representative of about 65,000 hectares of privately owned spotted gum forest type in the Mary River catchment.

The forest showed evidence of a previous poorly managed harvest operation:

- Large quantities of harvest residues had been pushed into heaps, often against healthy young trees.
- Tracks and log dumps were badly eroded, indicating they were poorly located and not drained adequately post-harvest.
- A significant number of younger trees were damaged during the previous harvest operation (Figure 2.2).

Management prescription

Using the stand condition assessment, management options were derived for the two distinct stand conditions (advanced growth and heavy regeneration) outlined separately in the following sections.

Advanced-growth areas

The advanced growth areas were stocked at approximately 200–300 stems per hectare. Spotted gum was the dominant species and there were a large number of damaged or defective trees in the stand. However, most areas had at least 100 stems per hectare that were of a satisfactory standard for future growing stock (form, vigour, defect) and removal of the useless stems would allow adequate spacing for the retained trees. The stand also had good potential for future pole and sawlog production with a dominant height over 30 metres, long, relatively straight tree boles and adequate stocking. It was recommended that the stand would be thinned by removing defective and non-saleable trees.

Opening the stand up by thinning will encourage regeneration for the next rotation. Thinning to waste, rather than treating stems with herbicide, was also adopted to allow the stumps to coppice. Previously suppressed trees, thinned to waste, were expected to coppice quickly, to take advantage of the open canopy, and to produce a faster growth rate than that of lignotuber or seedling regeneration. To be successful, stumps would have to be cut low to avoid potential 'wind-throw' of the coppice.

Regeneration areas

These areas had more species than advanced-growth areas, including brush box, ironbark and white mahogany. After the last sawlog and pole harvest, this area was heavily recut for fencing material, leaving very few potentially saleable stems. Over an extended period harvesting sawlog, poles and fencing material removed most of the overstorey and allowed dense regeneration to develop with 2000–3000 stems per hectare. This regeneration formed

Figure 2.2 Typical of the trees treated, this spotted gum has bends and a large logging scar, and would not yield saleable timber.

Figure 2.3 Multi stem coppice from a spotted gum stump that can be thinned to a single stem.

Figure 2.4 Feed trees used by the yellow bellied glider were preserved where they occurred in the study area. This tree shows the typical 'V' shaped feeding scar.

a dense, heavily competing stand of small saplings and, in the absence of thinning, natural dominance would take many years to establish.

Thinning this regeneration to an initial 4 m spacing (approximately 600 stems per hectare) will allow the retained trees to develop rapidly. A second thin to 7 m spacing in a further five–seven years will allow further selection and sufficient growing space. Thinning will enable unrestricted growth well into the advanced-growth stage, significantly reducing the length of harvest cycle.

Thinning treatment and harvest

Tree selection and marking, environmental values, habitat trees and harvesting procedures followed the guidelines given in Appendix 1. Thinning and harvesting operations were consistent with the *Code of practice for native forest timber production on state land 2002* to ensure best-practice management of the habitat, soil and water resources. Trees in the advanced-growth areas were thinned by 'tordoning', using either a 'woody weeder' herbicide-injection hammer or an axe and squirt gun. Generally the hammer was effective on smooth-barked trees only, while the axe and squirt gun were suitable for all tree species. Thinning in the regeneration areas was conducted using a small chainsaw followed immediately by a swab of the stump with glyphosate. Where multi-stemmed coppice existed from a single stump (Figure 2.3) no glyphosate was applied. In all cases trees to be retainec were paint-marked for easy identification.

Advanced-growth areas

Different thinning treatments were established to demonstrate how growth rates varied between the differer stocking levels. The thinning trial was conducted in two blocks (A and B), and it was planned that each block would be thinned to three stocking levels, 200, 100 and 70 stems per hectare. These thinning levels represent potential options for future pole or sawlog stands. In this case there were not enough good-quality stems to achieve 200 stems per hectare in the areas selected as a future pol stand on either block, but the site still has potential for poles in the future. All the areas thinned to approximately 100 and 70 stems per hectare provided good-quality retained trees.

Trees to be retained were selected using criteria such as form, crown appearance, spacing and absence of defects (Appendix 1). Where these characteristics were not available in a tree at the appropriate spacing, a lower stocking count was accepted rather than keep poorer quality trees. Four habitat trees or potential habitat trees per hectare were kept and possum-feed trees, identified by the unique V-shaped scarring to the bark, were kept wherever they occurred. All the selected trees, including habitat trees, were marked with paint so they could be identified easily during the harvest.

Thinned trees that had saleable timber were harvested and expected to coppice quickly. The remainder were treated (killed) in situ and later removed for firewood.

After thinning, the retained trees within the two blocks were measured and recorded for future comparison (Table 2.1).

Table 2.1 Unthinned and residual stand details for the advanced-growth area (Blocks A and B)

DBH (cm)	unthinned stand		200 retained stems/ha		100 retained stems/ha		70 retained stems/ha	
	A	B	A	B	A	B	A	B
40+	6	6	6	–	–	–	–	–
30–40	54	36	42	36	12	30	12	24
20–30	78	126	32	60	66	42	36	42
10–20	66	108	18	–	12	18	30	–
Total	204	286	102*	96*	90	90	78	68

*There were too few quality stems to retain 200 per hectare for the thinning trial in blocks A and B. The thinning response for these plots were assessed as 100 stems per hectare.

Early growth response

In the advanced-growth areas the effects of prolonged intense competition is likely to delay any growth response to thinning. Previous research has suggested that a noticeable response can be delayed for up to three years. Seasonal factors such as rainfall will also affect the initial scale of a thinning response. Retaining trees with good growth potential, given adequate growing space, will be productive and bring about better returns than an unthinned stand.

Regeneration areas

Methods used to select and mark retained trees, protect habitat and feed trees (Figure 2.4), and treat and harvest thinned trees were similar to those conducted in the advanced-growth stands (Appendix 1). Trees to be thinned were cut and swabbed with glyphosate on the stump. When a single stem from a multi-stemmed coppice stump had been selected and marked the others were cut but not swabbed with glyphosate (Figure 2.5). Larger trees to be thinned, which had saleable timber, were harvested and the remainder were treated (killed) in situ and later removed for firewood.

The management prescription for the regeneration areas combined thinning treatments with burning (Box 2.1) to compare growth response between burnt and unburnt

Figure 2.5 Multiple stems of a white mahogany cut to leave a single stem (top) and older aged coppice resulting from a previous harvest (bottom).

Figure 2.6 The residual stand in the unburnt, cleared section of the regeneration area.

Figure 2.7 The stacked harvest residue burnt fiercely, causing tree deaths within a wide radius of the fire.

regeneration (Figure 2.6). Burning was used as a pre-treatment in one area to reduce treatment costs, reducing heavy wattle regrowth and disposing of earlier harvest residues safely. Each block, burnt and unburnt, contained three treatments:

- clear-all (cut and swab) except retained trees
- clear a 1.2 m radius around the retained trees
- nil thinning to compare growth with the two thinning treatments.

The area was burnt in mid-August to produce a mild fire, although the old-harvest residue heaps burnt fiercely (Figure 2.7), generating localised intense heat that damaged some trees. Generally the fire was successful in removing about half of the smaller regeneration. Most wattles were killed, although the hickory wattle and most of the eucalypts rapidly re-shot from the base (Figure 2.8). The taller eucalypt regeneration selected for retention (approximately 6 m in height) appeared only mildly scorched and generally was unaffected.

The intense fire in the harvest residue caused considerable damage in and around the heaps, killing some trees in the 20–30 cm diameter range. Subsequently the owner harvested dead trees and cut up the remaining heaps across the site and sold them as firewood (a salvage harvest), making a return and reducing the fire risk in the young stand. In a grazed forest, retained harvest residue can protect young regeneration from browsing, although these early benefits are outweighed by the risk of wildfire and so it is best not to stack harvest residue near retained trees.

Early growth response

Retained trees in the treated regeneration area were measured after 11 months to assess their growth response to the thinning and burning treatments. These observations provided an early indication of the response to thinning (Table 2.2).

In the unburnt area growth response was best in the 'clear all' areas, followed by growth in the 'clear 1.2 m radius' areas. Growth of the trees in the unthinned plot was poor by comparison, averaging approximately a third of the height growth of the 'clear all' area.

In the burnt treatments the trend was less clear and, in the clear-all treatment, height growth was lower than in the unthinned control. In these plots height growth might have been influenced by burning and the advantages gained from release from competition reduced by scorch effects.

In summary, retained trees in the unburnt plots had faster growth rates in both thinning treatments compared with the unthinned plots. In the burnt areas fire treatment might have impeded the growth response at this early stage.

Box 2.1 Fire as a management tool

Why burn?

- many forest types are adapted to fire cycles
- burning controls regrowth
- burning creates a seedbed for seedling regeneration
- burning reduces the risk of wildfire
- burning controls pests and diseases
- burning encourages grasses for grazing management

When to burn

- Burn in winter to reduce:
  (a) the impact on tree growth
  (b) fire risk in spring
- Burn on a 3–5 year cycle
- Manage fuel loads to ensure fire will carry

Some facts

- If burning is too frequent:
  (a) plant diversity is lost
  (b) nutrients are lost
- If burning is too intense:
  (a) tree growth is reduced
  (b) woody weeds increase
- Good burning practice balances:
  (a) timing and intensity
  (b) fuel loads
  (c) a mosaic of burnt and unburnt areas
  (d) species mix

Figure 2.8 A lignotuber re-sprouting just four weeks after the burn (top) and coppice growth 11 months after the fire (bottom).

Table 2.2 Girth and height increments of retained stems 11 months after treatment for the regeneration area

Treatment	DBH (cm)		Height (m)	
	Average	Max	Average	Max
Unburnt				
clear-all	1.35	3.0	1.55	2.8
1.2 m radius	0.81	2.4	0.86	2.7
unthinned	0.44	1.5	0.57	1.6
Burnt				
clear-all	1.20	1.8	0.97	1.6
1.2 m radius	1.59	2.9	1.52	2.8
unthinned	0.55	1.3	1.36	2.1

Figure 2.9 Good forest management can produce high value products such as this girder.

Returns from the thinning management

Advanced-growth area

The value of saleable product from harvested trees in the advanced-growth area was estimated and compared with the costs of treatment (Table 2.3). Returns per hectare were estimated at $860 for the treatment at 70 stems per hectare and $510 for the treatment at 100 stems per hectare. In both cases a net profit was realised after investing in stand treatment. If the stand had been left as it was, future productivity would have been compromised and very little of the standing timber would have been saleable in the future. The small amount invested in treatment will ensure future productivity. This cost should be regarded as an important 'associated cost' of timber management for optimising long-term productivity.

Table 2.3 Estimated return on two treatment regimes in advanced-growth stands (Blocks A and B combined)

Treatments	70 stems per ha	100 stems per ha
Saleable products	$2140	$1400
Estimated cost of contract thinning	$1070	$690
Cost of contract treatment	$210	$200
Return per hectare	$860	$510

Regeneration area

The property owner provided an estimate of returns from the salvage harvest conducted after the fire. The products sold were fencing timber, posts and firewood, delivering a profit after costs. The percentage breakdown of gross profit was: labour 33 per cent; transport (firewood, posts, etc) 42 per cent; net profit 25 per cent. A return adequate to cover thinning costs of the regeneration was considered exceptional since the operation harvested poor-quality trees and salvage from previous harvests.

Outlook – future management

High-grading harvests leave the stand in a very unproductive state. The residual stand usually contains a high percentage of defective or suppressed stems that in turn inhibit and suppress the regeneration that might follow, or produce very dense regeneration if logged heavily enough. If left unmanaged a stand in this condition could take many years to become productive, resulting in a harvest cycle two to three times that of a well-managed forest.

In this case study a potentially productive forest had been subjected to successive harvests that had removed much of the quality growing stock, leaving trees that offered little potential for either growth or product. Little fire or thinning management had taken place between harvests to provide adequate growing space for the future crop trees or to remove the useless competition.

The stand condition was assessed and classified as two types, advanced growth and young regeneration. The management plan entailed thinning to a realistic stocking level for the future. Removal and sale of those trees not suitable for retention provided a cost-effective and profitable way of re-establishing the stand productivity.

The potential for the stand to be managed for high-quality sawlogs and poles was demonstrated by past harvests and the existing areas of advanced growth. A 12 kN pole with a length of 14–15.5 m requires a DBH of approximately 40 cm. This is considered achievable within a 40–60-year timeframe if managed correctly.

Careful selection of the growing stock will maximise the growth of trees that have the potential to develop into this type of product and ensure good economic returns from the forest (Figure 2.9). This is likely to be comparable to or better than other land uses such as cattle grazing. A tree stocking of between 100 and 200 stems per hectare is considered optimal to produce a range of sawlogs and poles in this forest type. Although this farm did not run cattle, a combination of cattle grazing and timber production would be an optimal land use, and one that is practised widely in the Burnett and Mary River catchments. Returns from the two enterprises combined would be expected to exceed that from any other farming enterprise suited to the property.

The owner inherited some environmental problems associated with accelerated soil erosion and badly constructed gully crossings from an earlier, poorly managed harvest. The project team worked with the owner to rehabilitate some areas that will be used to demonstrate appropriate management for environmental problems caused by poor practice. Some badly eroded tracks (Figure

Figure 2.10 A badly eroded access track. Erosion can be avoided by post-harvest draining all snig and haulage tracks.

2.10) were repaired by installing transverse drains and th log dumps were rehabilitated and drained.

In the advanced-growth area thinning to achieve differen spacings for pole or sawlog productivity was based on strict selection criteria for retained trees. In general a pol stand is managed at a higher stocking than a sawlog stan Although the aim was to manage a potential future pole stand of approximately 200 stems per hectare, only abou 100 trees per hectare were of satisfactory standard. Bette harvest management in the past would have resulted in less damage to the residual stand and more trees to select from. The remaining trees were thinned to 70 and 100 stems per hectare. While it is expected that some of the trees in this stocking will grow into poles, the wider spacing will favour diameter growth and sawlogs. Little response is expected for the first 12 months due to the hi level of competition within the stand before thinning.

In the heavy regeneration areas, two thinning regimes were combined with a burn treatment to determine the most cost-effective option. Thinning to leave only those trees required for the future stand produced a clear heigh growth response in the retained stems and this response will probably continue over time. In this case early intervention with two thinning treatments (initially to 5 m spacing and later to a wider 7 m spacing), will result in a more productive stand. Not thinning will result in very low growth rates caused by intense competition between the trees. Although the next harvest in the regeneration areas will be at least 25 years away, the period between harvests would have been much longer if left unthinned.

The absence of any past fire management had left the stands at risk of wildfire from elevated fuel loads. Loggin debris had contributed to the fuel loads. Regular fire management at a frequency of about three to five years will reduce fuel loads and the risk to retained trees. Heavily regenerating areas need to be protected from fire for three to five years.

A cost–benefit analysis demonstrated that the costs of thinning could be offset by sales of thinned trees and previous harvest residues.

Productivity in most eucalypt forests can be restored by silvicultural treatments using high retention standards, selection and optimum spacing regimes (thinning) for little financial outlay. Most stands retain enough saleable product to ensure that the initial process is cost-neutral an often, as was the case here, cost-positive and profitable in the short to medium term.

Case study 3: On-farm value adding for hardwood forests

Traditionally timber from private native forest (PNF) in Queensland has sold to timber processors on a 'standing in the paddock' basis. Landowners who add value by cutting, snigging or processing their own product are the exception rather than the rule.

As has been the case for native forest on crown land, PNF management has developed along 'selective logging' lines in Queensland. The management regimes imposed by individual forest owners, however, have produced variable levels of forest productivity.

Harvesting is one of the native forest owner's most important management decisions, yet in most cases owners participate minimally, only selecting the merchant who will buy the product. Few other primary products are sold with such little regard for the future viability and productivity of the crop. Unlike other forms of primary production, timber has an extended production cycle and, traditionally, the specific skills and knowledge needed for well-managed timber harvesting have been available only to those who have worked in the industry. Success in primary production today often requires diversification across a range of enterprises. An example of this is the growth of new industries, such as olive and wine production, in place of traditional enterprises such as grazing. Intensive investigation of the cropping and marketing requirements of these industries is undertaken routinely and implemented as a matter of course. The same approach is needed for efficient long-term timber production.

To ensure long-term viability, maximum productivity and returns, farm managers need to be aware of best management practices, the range and value of the products in their forests and how to obtain the best returns.

On-farm value adding of forest operations is often promoted as a process of ensuring a higher return for the grower. However, a broad range of skills and knowledge is required in the following areas:

- conducting a pre-harvest marketing survey
- cutting and snigging (or organising a cutter and snigger)
- milling or organising a miller
- product grading and sorting
- further processing if necessary (treatment, drying and dressing)
- marketing and sales

Value adding can be a solution to the poor returns commonly received by timber growers.

Sustainable management with on-farm value adding in managed forests

Case study, Tiaro

The aim of this study was not to advocate one form of value adding over another but to investigate the process of harvesting and marketing timber from stand management and harvest to sales, examining the commonly used methods, other potential opportunities for value adding and comparing returns.

For this study a property managed for both timber and grazing by Owen and Mark Thompson was selected. A total volume of 233 m^3 of logs was harvested from an 18-hectare block consisting of 190 m^3 of sawlog (average 1.03 m^3 per log) and 43 m^3 of landscape- and salvage-class logs. Two value-adding scenarios were investigated:

- Most of the logs were cut and snug by the Thompsons and sold 'at ramp' with competitive bidding by interested sawmills. In this case value adding by the landholder was represented by the cut and snig.
- Sawlogs were purchased at ramp (included stumpage, cut and snig) and sawn on-site using a mobile sawmill. Sawn product was then sold. In this case value adding by the landholder was represented by the cut, snig, sawing and sale of the sawn product.

Both scenarios were compared with stumpage; that is, the price of standing timber, which represents the 'traditional' timber-sale option.

Approximately 30 m^3 of sawlog was purchased and sawn on-site using a 10-year-old Lewis® mobile mill and then marketed and sold independently of the landholder.

The case study also considers the past management history of the property, pre- and post-harvest stand details and the forest management regime used by Mark and Owen Thompson. The results from this study have broad application for most forest types and landholders who are involved in timber production.

The situation

The property is situated in dry sclerophyll forest dominated principally by spotted gum, grey ironbark and forest red gum typical of the Mary River catchment in south-east Queensland. It is managed for timber production and grazing. The owners were willing to use a harvest operation to test on-farm value adding, showing the range and value of products and returns compared with a conventional sale of logs in the round.

Objectives

- to compare returns from on-farm and off-farm value adding, marketing and sales with returns from a conventional timber sale
- to consider marketing options for native forest owners for a range of round and sawn timbers
- to look at the product quality, range and recovery rates achieved from a mobile mill
- to demonstrate good forest management as a form of on-farm value adding
- to provide a demonstration and focus site for field days and workshops for public education on sustainable native forest management (SNFM).

Forest description

Dry sclerophyll forests dominated principally by spotted gum, grey ironbark and forest red gum form the most common forest types in the lower Mary River catchment. Many landholders rely on both grazing and timber production for income. Due to the nature of the study, the cooperation and participation of the owner was critical. The site also had to have a timber stand ready for harvest and to be easily accessible to the public.

The property is approximately 20 km west of Tiaro, 50 km south-west of Maryborough in south-east Queensland, and managed for beef-cattle grazing and timber production. Most of the property, including the study area, is undulating low hills with slopes generally less than 10°. Soils tend to be duplex with fine textured sandy clay loam over a medium to heavy clay subsoil. Subsoils are often highly sodic (and therefore dispersible) and drainage is often poor. Mean annual rainfall is between 750 and 1000 mm.

This forest is classed as forest types 12.9/10.17–12.9/10.19, mixed, tall open forest on Canozoic to Proterozoic sediments in the Regional Ecosystem Classification and its conservation status is 'no concern at present'.

The dominant species include spotted gum (Figure 3.1), red bloodwood, grey ironbark, broad leaved red ironbark, white mahogany, grey gum, Queensland peppermint, gum

Figure 3.1 This spotted gum stand was typical of the well-managed forest on this property. Only those trees with good form and vigour were retained.

topped box and smooth barked apple. Brush box also occurs in gully areas or as a sub-canopy. The understorey is mainly grasses, occasionally with shrubs such black wattle, hickory wattle and grass tree.

History

The property was acquired over many years. The first section (which contains the study area) was selected in 1912 by the owners' grandfather. At that stage the property was used mainly for grazing and as a home paddock for the bullock and horse teams. The teams were used for hauling and snigging timber in the district up until the 1930s. The block was harvested (down to 40 cm log-centre diameter) and then ringbarked soon after selection, leaving it completely cleared on the flats and mostly cleared on the slopes. Regrowth persisted through this period and, due to the owners' interest in growing trees, active management for timber production began. In 1946 the owners' father bought an adjacent 860 acres (358 hectares) specifically to grow timber, as he considered it to be a good timber block. This formalised the owners' future management intention, which was to maintain and manage the forest on his property for timber production as well as for cattle grazing.

The study area was harvested heavily in 1953, with all available timber over 40 cm centre diameter cut and sold due to the prevailing tight economic conditions. In the 1960s the forest was treated intensively (silviculturally thinned), maintaining around 60 stems per acre (144 per hectare) to retain healthy, vigorous trees at a good spacing (approximately 9 m). In 1970 a large number of poles were harvested from the study area and since then only low-intensity logging for girders or to remove dying trees has taken place, usually to top up a load from adjacent blocks.

Current farm management

The two main enterprises are timber production and cattle, which graze the whole property. The prime grazing areas on the lower flats and more fertile soil types are principally managed for beef-cattle production. Although some timber production occurs on 90 per cent of the property, approximately 50 per cent is considered good timber country worthy of intensive management. In these areas wide tree spacings are maintained for grass production and to maximise individual tree growth rates. There are approximately 700 head of cattle, breeders and stores, grazing the property and an adjacent 700 hectares of forestry grazing lease.

Case study management

Management to improve forest condition by thinning and to conduct a harvest followed a set of common steps provided as guidelines in Appendix 1. An assessment of stand condition was completed and this was used to plan appropriate management, the harvest and sales.

Stand condition assessment

The stand assessment inventory provides data on stocking rates, estimated standing volume of timber (in log form), species mix and defective trees.

For this study three strips representing 10 per cent of the 18-hectare harvest block were inventoried. The survey included strips of 10 m width at 100 m intervals running the length of the block. All trees >10 cm DBH were measured and recorded. Species, crown health, log length, DBH, defects, product type and estimated volume of sawlog (in trees greater than 40 cm) were recorded. Landscaping timber and pole volumes were not estimated. Tree-size class distribution in the sample strips is presented in Table 3.1.

Table 3.1 Number of trees by DBH class (cm) from strip survey data

	Strip			
DBH class (cm)	1	2	3	Average per ha
10-20	43	17	31	70.0
20-30	17	7	6	23.0
30-40	8	7	8	17.6
40-50	1	4	5	7.7
50-60	2	5	2	6.9
60-70	3	3	1	5.3
70+	0	1	1	1.5
Total stocking				132

The mix of tree species was:		forest red gum	9%
spotted gum	53%	gum topped box	5%
grey ironbark	19%	other*	14%

*Other included many non-commercial species. Some commercial species with only a small representation, such as red bloodwood and Queensland peppermint, were also included in this category. Over 86 per cent of the stand was made up of commercial species suitable for timber production.

Standing volume of sawlog in trees greater than 40 cm DBH was derived from estimated log length and calculated using a DBH (one-way) volume table (Table 3.2).

Table 3.2 Estimated standing volume of sawlog in trees greater than 40 cm DBH

Strip	Area (ha)	Volume (m^3)
1	0.56	7.6
2	0.44	19.3
3	0.33	11.2
Average volume per hectare		28.6

Figure 3.2 A single log is cut into a number of products to yield the best use and economic outcome. In this case a long sawlog, two shorter top sawlogs and a landscape block were cut from a single tree.

The harvest

Annual harvests on the property had produced an average of 500 m^3 per year during the previous 10 years using a cutting cycle of 15–30 years. The owners' observations on the amount of standing timber suggest that the forest growth rate was exceeding the rate of harvest. In this harvest the total sawlog cut was 190.242 m^3 and landscape block (salvage log) was 43.013 m^3. This was equivalent to removing 10.6 m^3 per hectare of the 28.6 m^3 per hectare standing or approximately 37 per cent of estimated standing sawlog volume. The total harvest time for cut and snig was two weeks.

Tree selection

The criteria for selecting trees for harvest included trees that had reached their maximum economic value (for harvest), were showing signs of defect or poor health (the tree was likely to decline prior to the next harvest), were suppressed, required spacing or were unlikely to develop potential. In this way harvesting is used as a tool for stand improvement. The criteria used for tree removal, in approximate order of priority, were:

- optimum product size or value
- declining tree health, usually assessed by crown condition
- defect such as a vertical dead limb or suspected decay from old wounds
- spacing
- severe mistletoe infestation
- suppressed trees (indicated by crown shape and condition).

Trees were not paint-marked for removal. Trees were selected during the harvest, then the range of selection criteria and potential product was considered before each tree was harvested. Poles were left standing to be felled later in the year when barking was easier.

In this case the landholder, Owen Thompson, carried out all tree selection, cutting and snigging. Owen has extensive experience in the harvesting process, having harvested timber on his property for approximately 25 years as well as undertaking contract harvesting.

Harvesting

Trees were cut on a progressive face over a two-week period using standard cutting and measuring equipment, including:

- '084' Stihl™ chainsaw, wedges and axe
- retractable length-measuring tape
- steel diameter tape (gives a diameter reading when the circumference is measured).

About eight to nine trees per hectare were harvested using directional felling to avoid damaging retained trees. This practice also minimises the amount of debris accumulating near retained trees that, if later burnt, could damage stems. Logs were left full length wherever possible to make snigging and hauling straightforward.

The block had been burnt some months before harvesting to improve access and reduce fuel loads before harvesting. This makes sure the 'top disposal' burn (disposal of the logging debris after harvest to promote regeneration) is not too intense. It also ensures that retained trees are not damaged or that later burns don't run out of control in the hotter weather conditions.

Poles were left standing, to be removed later in the year when debarking is easier, and were not included in this study.

Product assessment

During the harvest trees were given a potential product category. After felling and trimming (Figure 3.2 and 3.3) each log was measured, given an appropriate log class and stacked in separate piles at the log dump. Logs were classified as either girder, sawlog or landscape block using standard specifications (Box 3.1).

Figure 3.3 Butting the log to remove defect associated with the stump, which in this case was most likely an old fire scar.

Box 3.1 Specifications for classifying logs

girder (Queensland Department of Main Roads standard girder)

- minimum 9.6 m length
- minimum 450 mm small-end diameter under bark (SED UB)
- straight
- desired species
- minimal pipe or knots

sawlog

- minimum 2.4 m long, increasing in 0.3 m increments, plus 0.1 m for each cross cut
- minimum 30 cm (SED UB)
- limbs affecting less than 50 per cent of the circumference of the log at any point
- end of log defect affecting less than 50 per cent of the end section (large diameter), 25 per cent small diameter
- degree of bend; this varies with centre girth (as a guide: 40 cm – 2.5º, 49 cm – 5º, 50+ cm – 10º). A bent log can often be cut into two shorter straight logs

landscape block

- usually 2.4 m billets; occasionally 2.1 m lengths are accepted
- as long as the recoverable sawn timber is worth more than the cost of the log and processing (this is a subjective judgement)

Figure 3.4 A tractor and hydraulic grapple used for snigging.

Booking and tallying

Before snigging, each log was measured and tallied. Bark thickness was calculated by removing and measuring a triangle of bark at the midpoint of each log. This measurement was then doubled and subtracted from the 'over bark' log centre. The details of each log were recorded on a field tally sheet and given a number. The number, length and centre diameter under bark were then written on the butt of the log using a paint pen, for example, 125 5.4 x 43 represented log number 125, log length 5.4 m x centre diameter 43 cm. The volume for each log was calculated using two-way timber volume tables (centre DUB x length) and tallied.

Snig and log dump

Snigging was carried out using two farm tractors:

- 95 hp Fiat dozer with bull blade and a three-point linkage 5 tonne winch
- 80 hp Fiat two-wheel-drive tractor with three-point linkage hydraulic log grapple and front mounted hydraulic forks (Figure 3.4).

The dozer was used primarily to improve access to difficult logs, nudging them into a pick-up position where necessary. The wheeled tractor could then grab the log and snig it to the log dump unhindered, but logs in difficult positions were snigged using the dozer. The dozer was also used to clean up the site, pushing debris into heaps to make burning easier. Because the country was open and gently undulating and the log dumps nearby, snig distances were short and relatively straightforward, avoiding creek crossings and side cuts.

Three log dumps, approximately 100 m apart, were situated on level ground with good haul road access, room for sorting, storage and loading. Logs were sorted into log class and length (short and long) for easy inspection and loading. Girders were stored separately for a later sale.

Returns on log sales

Girders were sold directly to the Department of Main Roads purchasing officer (subject to an inspection to ensure the girders met the required specifications) and not considered further in the value-adding case study. As a general rule girders sell for approximately double the price of sawlogs per cubic metre and sawlogs approximately twice that of landscape blocks.

Three mills were given the opportunity to inspect the logs and bid on the basis of a competitive price. A summary of the successful bid is given in Table 3.3. The returns were approximately $20/m^3$ higher than the average price generally achieved at the time.

Table 3.3 Sale returns per m3 of log (figures as at 2001)

	Sale returns per m³		
	Cut and snig	Stumpage	Total at dump
Saw log	$22	$82	$104
Landscape log	$22	$28	$50

Hauling

Loading and hauling were the responsibility of the purchaser, who transported a loader on a flat-back semitrailer and a tri-axle timber jinker for haulage.

On-site milling

For this case study a representative sample of approximately 30 m^3 of sawlog was diverted to the mobile mill for processing and sale as sawn products. Pre-harvest planning was needed to locate available mobile mills, survey likely markets and products, and ascertain legislative requirements for portable milling and sale of sawn product in Queensland (Box 3.2).

Pre-harvest market survey

Using data from the stand assessment (dominant timber species, log sizes and quantity), a phone survey of potential buyers of sawn timber was conducted by contacting approximately 20 timber and hardware merchants in south-east Queensland. This verified demand, requirements and preferences for the size and form of the sawn product. The survey produced a list of products in demand and their potential value, forming the basis for the milling operation. The preference was for large-section timbers and 100 x 100 mm posts.

Mill selection

A number of operators with a variety of mobile saws were considered. As most mobile circular-saw mills perform to a similar standard, operator experience and availability was a higher priority than type of saw. Consequently a 10-year-old, 200 mm Lewis® mill with an experienced operator was chosen. The operator also had certification in visual stress grading, an important part of marketing.

Box 3.2 Current sawmill legislative requirements

The *Sawmills Licensing Act 1936* has been repealed and, since 1 January 2005, sawmills in Queensland are not required to be licensed under this Act. Sawmill operations will, however, be required to comply with other already existing state and local government legislation. These legislative requirements include compliance with environmental, vegetation management, workplace health and safety and local authority planning legislation.

There are several other laws that apply to sawmilling activities. Sawmillers are advised to contact the relevant agency to obtain advice in relation to their own circumstances.

- *Workplace Health and Safety Act 1995 (WHS Act)*
- *Timber Utilisation and Marketing Act 1987 (TUM Act)*
- *Diseases in Timber Act 1975 (DIT Act)*
- *Environmental Protection Act 1994 (EP Act)*
- *Environmental Protection Regulation 1998 (EP Regulations)*
- *Integrated Planning Act 1997 (IP Act)*
- *Vegetation Management Act 1999 (VM Act)*

In accordance with Part 2 of the Workplace Health and Safety Regulations associated with the *Workplace Health and Safety Act 1995*, a Certificate of Registration of a Registerable Workplace is required where the workplace employs more than two persons (including the employer, a self-employed person or a person employed part-time or full-time) between 1 February and 31 January of the next year.

In this case the workplace did not require registration.

Milled logs

The logs chosen for milling were a representative sample of the whole harvest, including large and small, defective and defect-free logs, averaging approximately 1 m^3. Ends of the logs to be sawn were waxed with Caltex Log Sealer® to reduce end splitting from drying too rapidly. Spotted gum, forest red gum, grey box and grey ironbark logs were sawn by the mobile mill.

Grading sawn wood

Sawn wood was visually stress graded as F14 or better, landscape or reject, according to Australian Standard *AS 2082-2000: Timber – Hardwood – Visually stress-graded for structural purposes* and the Timber Research and Development Advisory Council's (TRADAC) *Visual stress grading of timber.*

The timber was sorted and stacked into size class and product type and lengths written in white ball-marker ink on the end grain. Products sawn from each log were recorded with species, dimensions and defects, enabling recovery rates to be calculated against log size and defect.

Recovery rates

The recovery rate is a calculation derived from the volume of sawn product compared with the volume of the log being sawn (Table 3.4). A higher recovery rate was generally associated with larger log volumes. In this case the calculation was separated into A-grade timber (structural-grade timber and flooring) and landscape material (Tables 3.4 and 3.5).

Table 3.4 Example of recovery rates for A-grade timber and landscape material

Log no. 180 **Species:** grey box **Log volume:** 0.867 (m^3)

	A grade	Landscape grade	Total recovery
Sawn (m^3)	0.403	0.015	
Recovery rate	46.5%	1.7%	48.2%

Table 3.5 Summary of log volume and recovery rates from 37 logs

Total volume of log sawn	30.441 m^3
Total A-class sawlog	27.94 (av. 1.03 m^3)
Total sawn timber	12.82 m^3
A-grade (structural) sawn recovery	44.61%
Total landscape or salvage log	2.5 m^3
Total landscape-grade sawn from salvage and sawlog class	3.393 m^3
Landscape recovery	11.15%
Overall recovery	55.7%
Total sawlog harvest	190.242 m^3
Total block harvest	43.013 m^3

Sawn timber marketing legislative requirements

The timber was sold as specified by the *Timber Utilisation and Marketing Act 1987.* Under the Act, any lyctine-susceptible timber must be treated before sale.

Lyctine borer (powder post beetle) is a recognised timber pest in Queensland. The larvae feed on starch in the sapwood of some hardwoods and produce a fine powdery frass. Spotted gum sapwood is susceptible to attack and this was the main species harvested.

To improve market options, all timber was treated with copper chromium arsenic (CCA) to H4 standard. Hazard Level 4 (H4) treatment is used when the timber is likely to be subject to a severe decay hazard, such as contact with the ground, continual damp or if the sapwood is susceptible to lyctine borer attack. The treatment is designed to eliminate the likelihood of attack by insects, including termites, and decay. All treated timber was stamped H4 in accordance with the Act.

Marketing and value adding

The pre-milling survey produced a number of retail orders, accounting for almost half the final sale. A wholesaler was willing to purchase the remainder, depending on the success of the operation and demand at the time. This was sold as green off-saw, dressed (machined) and then CCA-treated as requested by the purchaser, who was responsible for the drying process. This proportion required 1430 lineal metres of 100 x 25 mm boards to be 'dressed all round'.

Returns on sawn timber sales

Costs and returns of milling the 30 m^3 sawlog are given in Table 3.6. In this case it included the purchase of the sawlogs from the owner at the log dump at the same rate the remainder of logs were sold. This meant that the landowner did not carry the cost of milling, processing and marketing.

Table 3.6 Costs and returns of mobile milling

Costs	
Sawlogs at dump (cut, snig and stumpage)	$2933
Landscape blocks at dump (cut, snig and stumpage)	$ 125
Milling 30.44 m^3 @ $115/$m^3$	$3500
Cartage to treatment works	$ 315
Treatment to H4, 14 m^3 @ $68/$m^3$	$ 952
Cartage for delivery	$ 147
Dressing @ $0.25/lm	$ 350
Total	$8322
Returns	
Dressed timber 1430 lm @ $2.20/lm	$3146
Larger section timber (retail) 0.81 m^3 @ $800/$m^3$	$ 646
Larger section timber (wholesale) 2.2 m^3 @ $765/$m^3$	$1685
Smaller section timber (retail) 1.73 m^3 @ $670	$1157
Smaller section timber wholesale $510–665/$m^3$	$1175
Larger section landscape timber 2 m^3 @ $368/$m^3$	$ 737
Small section landscape 2.15 m^3 @ $300/$m^3$	$ 645
Total	$9191

On-farm value adding – processes and returns

Property management

Beef production had always been the main enterprise of the property and was closely integrated with timber production. It is a firm belief of Mark and Owen that tree cover maintains grass production for a longer period of the year than a treeless paddock. Having timber as a second enterprise provides a safety net when cattle prices drop.

From the owner

Trees got me out of trouble on a number of occasions; 1964 was a bad recession, cattle were bad, building was slow but the price didn't really go down for timber, only the quantities. Supplying the one mill for many years gave us steady sales throughout that recession and things would have been a lot tougher without it. The price of cattle collapsed again from 1974–76 with cattle worth between $1 and $20 a beast. This time it did not coincide with a recession and timber prices and demand remained buoyant and again got us through a very rough period and reaffirmed the advantages of having the two enterprises and not being solely dependant on cattle.

Mark Thompson

This property followed the pattern of most property selection in the early part of the last century. Properties were selected and cleared progressively for beef or dairy production. Little was known of the potential hazard of extensive land clearing and, given the abundance of timber at the time, meagre value was placed on tree retention. The early appreciation by Mark Thompson of the advantages of tree cover for improved grass and timber production resulted in most of the property being managed progressively for grazing and timber production over the last 60 years.

Where timber production is the main enterprise, the forest has been maintained at around 140 stems per hectare (>10 cm DBH) by periodic silvicultural thinning, harvesting and fire. This has allowed good timber growth rates as well as adequate light and moisture conditions to encourage a grassy understorey. The more productive areas (on the most fertile soils) have been restricted to pasture production alone. Controlled burns are done on a two–three year cycle on both grazing and timber land, depending on seasonal conditions. This has kept eucalypt and wattle regrowth at manageable levels. Occasionally the wattle have been treated with herbicide, when it became dense enough to have a negative impact on grazing values.

Where the forest has been encouraged to regenerate in areas cleared in the past, high-quality stands of spotted gum have developed with the aid of appropriate thinning and harvesting. Observations of sapling growth through to harvest suggested that trees at this stocking (8–9 m spacing, approximately 140 per hectare for trees >10 cm DBH) have an annual diameter growth increment of at least 1 cm. This is consistent with a well-managed spotted gum forest growing to optimum capacity.

Salinity and erosion

One of the main drainage lines of the property rises in the old dairy farm (now part of the property), which was cleared in the 1920s. The creek originally had permanent water in a line of deep waterholes. In the 1940s, the creek bank started to erode because the sodic soils (with highly dispersible subsoil clays) were exposed by grazing and trampling pressure. By 1960, after severe flooding, the creek collapsed completely, leaving a deep erosion gully. The remaining waterholes became increasingly saline and scalding began to appear in the low-lying areas.

An early decision to allow natural regeneration over large areas of the farm resulted in the salt scalding gradually disappearing. The creek erosion still remains a problem and will only be repaired by expensive engineering works. The erosion has been slowed, however, by increasing the tree, shrub and ground cover. Areas showing any signs of erosion are allowed to regenerate naturally. This early realisation of the benefits of revegetating saline and sodic landscapes is a compelling argument for retaining a balance of forest and ground cover.

Harvest management

Before the harvest the study area had a relatively low stocking of large trees (only 21 trees over 40 cm DBH per hectare) with patches of open country. This reflected the gradual regeneration of forest into areas that had been completely cleared in the past. The large number of stems (70 per hectare) with diameters between 10 and 20 cm was also evidence of this history.

Only a few trees (eight–nine) per hectare were harvested in this study and these were mostly larger trees. Some trees in the 40 cm DBH size class were removed because of defect or declining tree health. The owner preferred trees to be at least 50 cm DBH before harvesting, but trees 60+ cm DBH were left if they were healthy, free of defect and had the potential to produce a girder (greater than 45 cm diameter at 10 m above ground level) at a future harvest. This demonstrates the value of retaining trees to realise their optimum economic potential.

Poles have to be barked at harvest and most eucalypts, including spotted gum, are easier to bark from May to September. So poles are left for harvesting later, during winter.

Following the harvest tree heads were pushed together and burnt, providing a seedbed for regeneration and encouraging grass to re-establish and allowing safer, easier access to the area for mustering. Regeneration in these forests is mainly with lignotubers that persist at ground level for many years until a gap in the overstorey allows them to progress into the advanced-growth stage.

Transverse drains were established on snig tracks that required draining to avoid soil erosion. This is essential where repeated use of the track forms a rut, exposing subsoils often prone to erosion due to high levels of sodium. Experience has demonstrated that redirecting water at regular intervals, depending on slope and soil type, onto undisturbed areas reduces erosion significantly.

Forest growth potential

Regrowth forests are potentially highly productive and productivity can be enhanced significantly with good silvicultural treatment. Silvicultural treatment involves 'selective' thinning by retaining the preferred species and trees with good growth and product potential (healthy crowns and long straight boles) and spaced to maximise growth. Trees with little growth potential are either cut for sale or thinned to waste.

Forests that have been harvested previously, particularly to a minimum DBH regime, often leave a stand of trees that are defective, suppressed or non-commercial species. It is critical that these trees are identified and removed to enhance stand productivity. A suppressed tree can usually be identified by a misshapen or declining crown (sparse with many dead branches), caused by growing under a more dominant tree. Suppressed trees generally have unsatisfactory growth rates and compete with or suppress further regeneration, significantly reducing stand productivity. It is essential to intervene with silvicultural treatment to maintain the forest at optimum productivity.

Forest stands suitable for treatment

On this property only the higher quality timber production areas are managed intensively. The type and quality of the standing forest, in this case mainly spotted gum, is dependent on soil type, fertility and position in the landscape. Some areas are better suited to grazing and, in this case, maintained at a much lower tree stocking rate. The timber production areas were all regrowth forests and, without management, would have developed high stocking levels, with slow individual tree growth rates.

Not all forests are productive and, as with other enterprises, investment in future growth needs to target those areas that will return the best profit.

Mill selection

At the time of this study it was estimated that there were more than 350 portable mills in Queensland, excluding bandsaws, twin-bladers and sleeper cutting mills. Of these, 40 to 50 were professional commercial operators. Most saws in operation have a 150, 200 or 250 mm cut with a swivel-head saw blade, allowing for an equivalent depth of cut in a vertical or horizontal position. Variations occur in the combination and type of adjustments available among models and brands of saw.

The Lewis® mill selected was 10 years old and had only 5 mm adjustment increments, whereas the newer models have 1 mm adjustments. One important advantage of the Lewis® saw is the capacity to adjust either end independently, relatively easily. This enables rapid alignment with the log taper, a change in direction of the saw cut and cutting around decayed pipe or other defects. While most of the mobile saw brands seem to have a function or a component advantage, overall performance is similar. The main variable in saw performance lies in the skill and knowledge of the operator and a skilled operator is essential to assess the rigorous requirements for quality stress-graded timber suitable for sale (Figure 3.5).

Issues affecting the quality of sawn timber

Log size and quality have a direct impact on recovery rates and the size and quality of the sawn timber end-product. The average log volume approached 1 m^3 in this case study, a very high quality product for this type of operation. The average log size in this sale reflects past high-quality forest management.

Large-section sawn timber commands a price 25–35 per cent higher than small-section timber and increases in 10–25 per cent increments for lengths over 4.8 m. For example, 250 x 50 mm timber sold for around $800/m^3$, whereas 75 x 38 mm batten material sold for $510/m^3$. Most mobile mills cannot handle logs over 6 m long due to limitations in the strength of the rails needed to support the saw and motor. Another limitation is the excess 'chatter' or vibration that develops as the saw moves through longer logs. This lack of consistency in sawn product puts mobile mills at a disadvantage compared with bench saws (Box 3.3).

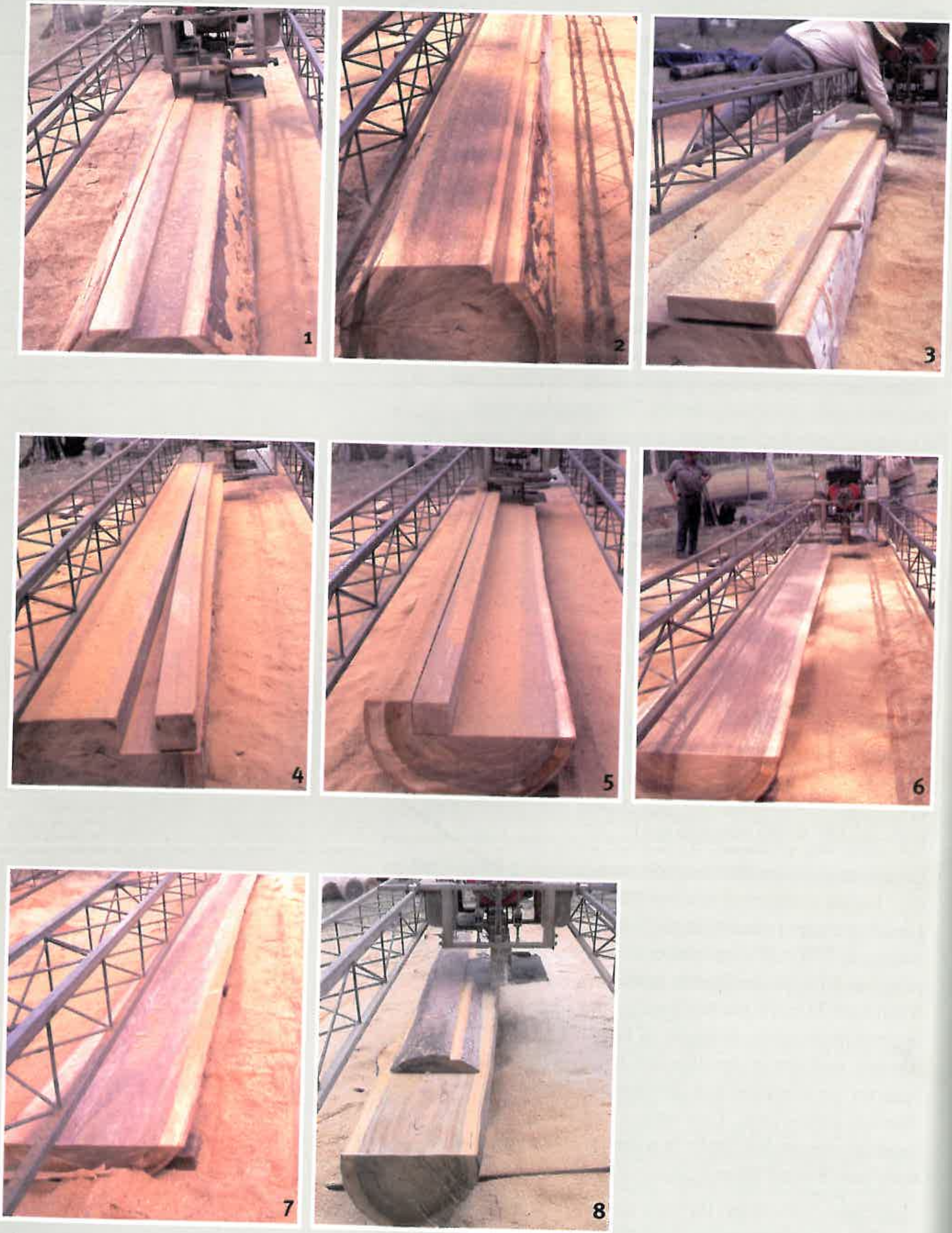


Figure 3.5 Cutting boards sequence.

1. The first boards cut were usually 15 mm palings.
2. A small flitch was cut ready for the step tread to be sawn.
3. A step tread was cut once the cut section was wide enough.
4. Log tension causing the 100 x 100 mm timber to pull away from the cut.
5. The tension left in the log below the pipe is less and the 100 x 100 timber is straight.
6. Skimming was required when a log bowed in the centre as it was reduced.
7. The remaining flitch can become unstable and difficult to cut.
8. The flitch can be placed on top of the next log and sawn further.

Box 3.3 Some potential limitations of mobile mills

- Mobile mills have limitations in relation to log length.
- Excess vibration can develop when sawing longer logs.
- Log movement (bowing or bending) occurs as the tensions in the log change with sawing.
- Timber cannot be resawn easily if size variations occur in the board due to this movement.
- There are limited options for sawing technique compared with a bench saw.
- Downgrade can be caused by 'stepped' cuts. When sawing >200 mm wide boards the saw is flipped over to saw from the opposite side. This can create a step at the junction of the two saw cuts, which varies in depth along the board and from board to board depending on the developing tensions (Figure 3.6). The product can be downgraded or might require dressing before sale.

The pre-harvest market survey showed a preference for large-section timber (in particular: 250 x 50, 250 x 38 and 100 x 100 mm sizes) as the optimum product in both value and demand. Achieving a 250 mm cut with the Lewis® mobile mill (200 mm) required back-sawing (tangential sawing) from both directions (Figure 3.7). This system produces boards that are more inclined to bow than spring. Bow is easier to straighten than spring because it occurs on the narrow axis.

Sales of sawlog and landscape blocks

Quality and value

This part of the study was carried out independently by the Thompsons and, in this case, logs were cut and offered 'at ramp' to more than one mill. Logs directed to the mobile mill were purchased at the same price paid by the successful mill.

The positive effect of past silvicultural management is evident in the quality and size class of the harvested timber. This had a significant influence on the price offered for the product because the average volume of sawlog was more than 1 m^3. Larger (both diameter and length) logs, relatively free of defect, allow higher recovery and a higher value sawn product to be cut from the log. As indicated earlier, large-section timber and long lengths are worth considerably more than small-section timber. Larger logs give a superior sawn recovery rate, so the mill is able to pay more. In summary, the high price offered at this log-dump sale was a consequence of several factors (Box 3.4).

Figure 3.6 A variable-depth sawn groove was often left on boards wider than 200 mm.

Figure 3.7 Cutting a 250 mm board required making a 200 mm cut from one side, flipping the saw over and cutting the edge board off the outside of the log and then making the final 50 mm cut.

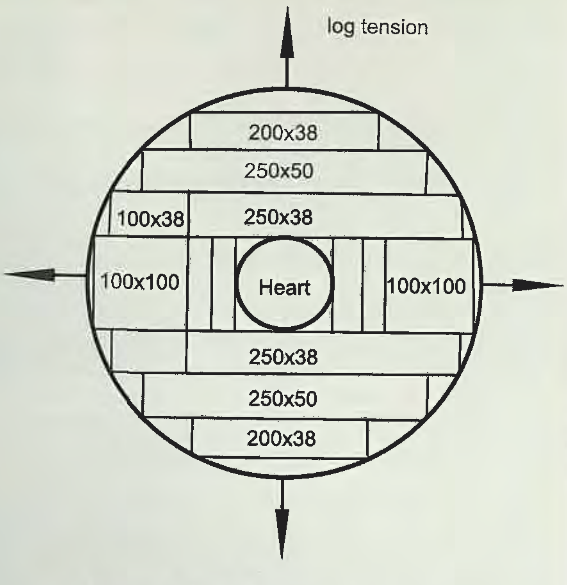


Figure 3.8 A simplified back-sawn cutting pattern. The pattern will vary with log size, pipe and other defects. The aim is to maximise recovery of large section timber.

Box 3.4 Factors influencing the high price offered at this log-dump sale

Proximity to the sawmill

A short haulage distance allowed the mill to pay more to the landowner than would have been the case for a longer distance.

Log size, species and defect

In this case past management, manipulation of species, spacing and tree quality as well as site factors had resulted in a high-quality product.

Continuity of supply

The Thompson's have a significant timber resource at a time when there has been a serious decline in the PNF resource. Uncertainty about the future resource has resulted in most mills trying to secure local, long-term supply outlets. Resource security was identified as the most important concern for small to medium mills.

Mill activity

Since the largest hardwood mill in south-east Queensland closed (October 2000), and even during the serious downturn in the building industry (February 2001), the remaining mills were quite busy and prepared to pay well for quality sawlogs.

Log sorting and sale

Log classification was a simple combination of girder, sawlog or landscape block. Individual buyers often have their own formulae for sawlog classifications, which might be A, B or C-class sawlogs, as well as landscape logs. In this case the bid was at the dump on an 'as-is, where-is' basis and accepted as either sawlogs or landscape blocks.

Girders were separated at the dump and sold direct to the Department of Main Roads purchasing officer (subject to his inspection to ensure the girders met the required specifications). Girders sell for approximately double the price of sawlogs per cubic metre, and sawlogs twice that of landscape blocks.

Log-classification skills and knowledge of allowable defect is gained through experience, demonstrated by Owen Thompson's ability to dock and sort logs into the three classes. The classifying system results in better returns since the price received will always be a reflection of the quality of the logs offered. Selling at the dump rather than as standing trees removes many uncertainties and variables for the purchaser.

Buyers are able to see precisely what they are buying, avoiding risks associated with harvesting, organising contractors and sales agreements. These savings can be included in the offer to the grower.

Sales of sawn timber

The pre-harvest marketing survey was one of the most important processes in this operation. It gave information on the state of the market, size-class preferences and price range from several merchants in a variety of locations. It provided initial contact with potential buyers and their attitude to one-off sales, species preference and prices they would be willing to pay.

Most of the timber sold was to merchants or individuals contacted during this survey and most merchants enquired about further sales. Many marketing problems encountered by private forest owners can lead to less than optimum income if not all the potential products are considered and markets are not sourced carefully.

Sawn timber sales – retail versus wholesale

In a retail sale the buyer makes an order for quantities of sawn timber, specifying both size and length. Retail sales produce a greater return but require greater organisation and skill and more tallying to meet specific orders. Cutting certain timber sizes to meet an order often results in lower value products produced from the rest of the log. Also, pieces of a specific size, such as 100 x 100 and 150 x 150 mm, have to be cut from specific sections of the log to ensure a straight product (Figure 3.8). For example, a piece of 250 x 38 mm ($800/m^3$) cut from the log means that the layer remaining from that cut must also be sawn at 38 mm. The small size of the remaining section will only produce batten material (75 x 38, $510/m^3$). Common in conventional milling, this problem can be exacerbated by the limitations of mobile mills.

Sorting, checking, stacking and strapping bundles for orders with the long lengths on the bottom in a state suitable for transportation, treatment or dressing also takes time, space and organisation. A large area adjacent to the mill was required for the 13–14 m^3 of timber sorted in this study. The timber was stacked on parallel log runners to allow strapping and loading for transport.

Wholesale selling was less complicated and the merchant agreed to buy the range of sawn timber at agreed prices. This meant the logs could be cut into the best combination of products and then stacked in appropriate size classes (Figure 3.9). The stacks could then be tallied and tagged.

Pricing the product

Pricing was generally dictated by the initial market survey, which produced a surprising variation in merchants' buying and selling prices. The final retail price fell between the prices quoted by the local mills and those quoted by the merchants in the sale area. The wholesale

Figure 3.9 Part of the sawn timber stack.

price was negotiated after sawing and the best offer was accepted for the remaining product. The merchant said this was the price normally paid for stock landed in the yard.

Goods and services tax (GST)

It is important to make sure GST (10 per cent) is included in prices obtained or supplied for all the harvesting and marketing operations. GST must be paid for every purchase, sale or service rendered. In this sale GST was paid on either the standing timber or the price at the dump, which includes stumpage, cut and snig, then the milling, transport, dressing, treatment, delivery transportation and sale of the sawn product. GST costs accumulated up to the point of sale can be claimed back. If the timber is sold wholesale and then sold on via another merchant, all the GST paid can be claimed back because GST is paid for the final product and not accumulated at each process.

Visual stress grading and quality assurance

Stress grading provides a series of standards for size (width and depth), bow, knots and twist, for example. The mobile sawmiller had a sound understanding of timber standards routinely supplied in the marketplace and knows what is acceptable. He visually stress-graded the timber

Box 3.5 Reasons for sawn timber failing the standard

Sizing inaccuracy

- For timber <200 mm the sawn product should to be within ±3 mm (width and thickness) and for timber >200 mm the product should be within +9 mm to -3 mm. Because the mobile sawmillers usually cut landscape-grade material, adhering to this requirement was difficult initially, but the quality improved markedly after the first day of sawing.
- If the log started to spring during milling the sawn board would be thin at both ends and thick in the middle. This is a common problem with mobile mills and needs to be checked constantly to avoid downgrade. If there is movement (bowing or springing), the log should be straightened by skimming 5 mm or more off the middle to ensure accurate sizing.

Heartwood (juvenile wood)

- Heartwood is non-structural wood and is only permitted in large-section timber as a standard in all milling operations.

Spring or bow

- Only a minimum is permissible. Initially this was a problem, particularly with quarter-sawn boards. Back-sawing produced a better quality product.

with reference to Australian Standard *AS 2082-2000: Timber – Hardwood – Visually stress-graded for structural purpose* (Box 3.5).

Handling and delivery

Handling and delivery was time-consuming and costly. The logs were easily snigged to the mill and then rolled into place with cant hooks. However, cutting 30 m^3 of timber with about 50 per cent recovery produces at least 13 m^3 of scrap timber and 2 m^3 of sawdust, which needs to be removed from the mill. The forks on the front of the tractor were useful for moving the scrap wood to a heap for burning. The sawdust was spread around the work area after milling finished. Transport costs included transporting a proportion of the sawn product delivered for dressing at the mill and transporting all of the product for CCA treatment and final delivery.

Continuity of supply versus a one-off sale

One-off sales, whether for log, pole or sawn timber, are disadvantaged. Merchants are more inclined to purchase if there is continuity of supply. Once a system is established as a permanent business, subsequent sales run smoothly. For larger landholders small regular sales might be a better option than bigger one-off sales.

Potential returns from value adding with on-site milling

The sales made in this study can be used to predict potential returns on value adding. There are three potential scenarios.

Scenario 1
The logs are bought at the ramp from the landowner by a third person who employs a miller (with either a mobile or static mill) to mill the timber. The product is then sold by the third person. Effectively this applies to this case study.
Scenario 2
The landowner employs a miller to saw the logs and then sells the sawn product himself.
Scenario 3
The landowner mills and sells his timber using a mobile or 'small-scale' mill.

Scenario 1: This is barely cost-effective for the purchaser after the initial stand inspection and price negotiations with the owner are taken into account. This result might improve with a property located further from the sawmill. In that case the haulage price would be higher and the potential price offered to the owner for sawlogs consequently lower. The price paid at the log dump in this study (\$2933 or \$104/m^3 including cut and snig) would be considered high by industry standards but reflected the high standard of the sawlog quality.

Scenario 2: In this study the milling (at \$115/m^3) cost \$3500. Applied to this second scenario, total costs would be \$5264, returning \$3927 (\$131/m^3) to the landholder.

Scenario 3: This is common practice in many European countries. This is probably the best option in terms of returns and level of skill. Value adding by cut, snig and milling might provide better returns than sawlog sales if the owner has acquired relevant skills and machinery and owns a large forest resource. The large resource on this property offers opportunity for a small but continuous supply, avoiding marketing problems encountered in one-off sales. This option loses appeal, however, when relevant skills, machinery and timber resources are not available.

In this study value adding by cutting and snigging has added at least 20 per cent to the standing value of the timber. Additional value adding by purchasing a mobile mill for \$14,000 to \$17,000 could improve returns still further, providing the relevant skills are acquired and sufficient time is available.

The sawn recovery for all A-grade products averaged 0.45 m^3 of sawn timber from 1 m^3 of sawlog (a 45 per cent recovery rate). The A-grade product sold for an average price of \$680/m^3, the equivalent of \$306/m^3 in log form. Estimated processing (post-milling) costs included \$68/m^3 for treatment, \$25/m^3 for dressing a proportion of the timber and \$40/m^3 for transport, a total of \$133 or \$60/0.45 m^3. This would equal a return of \$246/m^3 of log timber compared with \$104/m^3 for stumpage, cut and snig, achieved for this case study sale. The costs of running the mobile mill and the owner-operator's wages need to be subtracted from that total for a fair comparison. These should be included as opportunity costs because the time used would not be available for running the other farm enterprises. In summary:

> 1 m^3 log value at dump = \$104
> 0.45 m^3 sawn product = average \$306
> less treatment, dressing and transport for
> 0.45 m^3 = \$60
> final product value* from 1 m^3 of log = \$246
> **less running and wages costs*

The study showed that the mill and associated work was handled easily by two people who can process an average 4 m^3 of log timber per day. This produced approximately 1.68 m^3 of sawn product with an average price of \$680/m^3 in this study. Cutting and snigging 30 m^3 timber took approximately 12 hours.

Scenario 3 requires a significant portfolio of skills. To produce a consistently marketable product with a mobile mill and successful sales requires a good knowledge of the milling techniques for eucalypts, stress-grading specifications and marketing techniques.

Risks

There are inherent risks associated with the value-adding process. Meeting product specifications can mean considerable downgrade, which results in lower returns. Product quality and recovery rates can be improved by using a saw bench to resize or re-saw inconsistent timber. Value adding elements such as drying or dressing can result in a 10 per cent downgrade. Between 10 and 30 per cent of the green off-saw volume can be downgraded because of knots, gum veins, gum pockets, heart-associated defects, spring, bow or end splits.

Another risk is carrying the extra expense of processing, which includes buying a mill, treatment, cartage, dressing or drying and time invested before achieving a sale and receiving payment. Another risk is potential change in demand as the building industry goes through periods of sudden decline or growth.

Best product return

As more products are produced and sold, the process becomes more complex. The milling and marketing process will be simplified by concentrating on one product, such as flooring, but will require more time, additional processing, tight quality control and grading. There can be significant downgrade during the drying and dressing process. The green off-saw product has to be treated ($68/m^3$ plus transport) if, like spotted gum, it is lyctine susceptible. This has to be stripped out, preferably stored for one–two months and then kiln-dried, costing between $130/m^3$ and $200/m^3$. Once dried the timber is dressed through a four-sider, sorted and defects, such as end splits, docked to waste. If intended for tongue and groove, the timber has to be end-matched. This process costs 50–80 cents/lm or $200/m^3$–$350/m^3$. The end product is then sorted into select, standard or cover-grade flooring; the proportions depend on the original log quality. Retail prices vary but average prices (2000), less 20 per cent for wholesale, for these products are: cover grade $1.88/lm ($750/m^3$); standard grade $3.00/lm ($1120m^3$); select grade $4.00/lm ($1600/m^3$).

Outcomes

This case study examined the potential for value adding a harvest in dry sclerophyll forest in south-east Queensland. The returns from an on-farm operation milling a proportion of the harvest were compared with returns from selling the remaining logs in a conventional sale. The study tested all parts of the practice from stand management through to harvest, processing and sales and provided an economic analysis of the results.

The results from the study demonstrate that a high-quality, well-managed forest produced a superior product that resulted in a 20 per cent higher stumpage rate (standing value of timber) than the average market value. The high-quality logs also delivered a good sawn recovery rate, a good proportion of large-section timber and small amount of sawn-timber downgrade.

The total harvest from the demonstration site was 233 m^3 of logs from an 18-hectare block. The harvest consisted of 190 m^3 of sawlog (average log volume 1.03 m^3) and 43 m^3 of landscape or salvage logs. Of this, 30.4 m^3 was purchased and sawn on-site using a 10-year-old Lewis® mobile mill and then marketed and sold independently of the landholder.

The pre-harvest market survey showed that buyers preferred large-section timber and this was confirmed by the sale prices achieved for these products.

Limitations inherent in mobile mills include variation in board size, which is caused by log movement during sawing. Mobile mills also have fewer options in sawing technique compared with a bench saw.

The study demonstrated that, after costs, a greater return could be obtained by the sale of sawn products than from a conventional sawlog sale. However, the range of skills and knowledge required to complete this level of on-farm value adding would be acquired only after considerable time working in the industry.

This case study illustrated the value of a well-managed stand of timber, both to the grower and the processor, and the potential for value adding by the landholder, given sufficient resource, knowledge and skills.

Outlook – future management

Marketing and product sales are extremely important aspects of managing a crop. With better returns, there is greater incentive and capacity to maximise productivity and ensure sustainable management. Improved returns from sustainably managed native forests will increase the potential for forests to be a viable alternative to, or complement, other agricultural activities, which often require clearing the forest. They also provide a resource for a valuable regional industry.

Value adding is an important management decision that requires careful planning, research and education. This study demonstrated that the simplest and most effective way to add value is to keep the timber stand in a healthy, vigorous state with optimum stocking and few defective trees. The well-managed, high-quality stand in this trial produced a superior product and a premium log price, worth 20 per cent more standing than an average stand of timber. There was a good recovery rate, a good proportion of large-section timber and small amount of downgrade. Further value adding was achieved by the landholder cutting and snigging the logs and conducting the sale at the log dump.

With respect to value adding through marketing sawn timber, the trial demonstrated that a reasonable return cannot be achieved by buying the logs, employing a mobile miller and selling the timber. Owning the timber and employing a miller might achieve a higher return than that expected from a conventional sale, but this would depend on log quality, the miller's skill and experience and the owner's marketing skills. Owning and milling the timber would return a higher profit but this also depends on the level of skill attained by the owner-operator.

This study examined value adding for a one-off operation that employed a sawmill. To justify investing up to $20,000 for a mill would require a viable long-term resource as well as a major time investment to develop the required skills. It is estimated that a profitable operation requires a considerable forest resource, yielding at least 200 m^3 of sawlog per year on a sustainable basis. Growth rates of 1–2 m^3 per hectare per year can be achieved in a well-managed spotted gum forest, improving returns significantly, particularly when grazing value is added. Harvesting and milling 200 m^3 would take at least 50–60 days and additional time would be required for marketing and stand treatment. For most landholders this would need to be balanced against the time needed to complete other farm enterprises during the year.

Success in marketing the sawn products from this trial demonstrates that mobile mills can create products that meet market, industry and regulatory specifications. Limitations in moving the mill across the log, potentially causing spring or bow, however, mean that timber sizes need to be checked constantly to ensure accuracy.

The marketing survey demonstrated the advantage in offering continuity of supply and a consistent, quality product. The survey also emphasised the greater value and marketability of large-section timbers compared with smaller sizes.

Case study 4: Integrated harvesting in a eucalypt forest

The harvesting process is a key opportunity for landowners to direct their stand back into a vigorous productive state. Removing defective, senescent trees and favouring young, vigorous and well-spaced trees can boost slow growth rates characteristic of an unmanaged mixed-hardwood forest. Harvesting and marketing the removed timber as forest products is an integral part of forest management and can make a substantial difference to the level of timber-product utilisation and economic outcomes.

There are many marketable forest products in mixed-hardwood forests. Traditionally a harvest operation on private land is based on a sawlog harvest usually by selling the harvesting rights to a local sawmill that deals only in sawn timber. Consequently a large proportion of the stand is often either sold outside the optimum product range or rejected as a sawlog and left standing or on the ground as waste.

Integrating the harvest so that the full range of timber products are harvested and sold for their maximum value can improve the return on harvested timber while reducing the amount of waste. An integrated sale is an essential component of maximising economic return and utilisation levels from sustainable forest management.

A successful integrated sale requires detailed information about the stand, the saleable timber products, market requirements and other forest products.

Box 4.1 Planning, organising and implementing an integrated sale

The process starts by gathering information about:

- **the stand** – by conducting a comprehensive stand assessment, including size classes, range of products, mix of species and stocking rates
- **saleable timber products** – including product specifications, desired species and current values
- **timber merchants** – location in relation to the stand, the range of products they deal with, current demand and price structure, and preferences
- **harvest contractors** – machinery, costs and range of products they normally process
- **other forest products** – for example, seed.

Sustainable management through an integrated harvest of forest products

Case study, Kin Kin

Many private native forests (PNFs) in south-east Queensland are regrowth forests, often a result of very heavy disturbance or complete destruction by ringbarkin in the past. The dynamics of these forests are generally misunderstood. Eucalypt forests are persistent ecosystem adapted to disturbance, and many depend on disturbance for regeneration.

Unmanaged regrowth forests often have very high stocking rates that eventually lock up the growth of the stand until the next disturbance event, which can be either natural, such as a cyclone or wildfire, or a form of management intervention.

This stand portrayed many of the characteristics of an unmanaged, overstocked stand and the harvest products clearly demonstrated this. Logs revealed a very narrow sapwood band and pipe developing in many of the small size trees, indicating intensive competition and stress. Restoring this stand to full productivity will take more than a full cutting cycle and will involve significant management intervention.

The case study followed an integrated sale from pre-harvest planning, choosing a contractor, planning the harvest, selecting trees to be retained in the stand, harvesting, organising log dumps and conducting sale by competitive bid and post-harvest maintenance. Costs and returns from each product, and their specifications, are discussed.

The situation

This stand had not been harvested or thinned since 1970 and had a very high volume of standing timber and a high stocking. Dense regrowth had developed and the trees were competing for resources. Significant management intervention was needed to reduce the stocking rate by removing unproductive stems. This would provide space for the best trees to grow and bring the stand into a more productive condition. The planned harvest would optimise the use of all available products while maximising the value of each log. The harvested area was treated to remove non-saleable trees burnt after the harvest to provide a seedbed for regeneration.

Objectives

- to investigate the best economic returns from marketing options for a range of forest products, including poles, piles, rounds, sawlogs, salvage logs and fencing materials
- to utilise and market the harvested material at optimum values
- to document a fully integrated timber harvest and sale, assessing environmental constraints, costs, returns, post-harvest maintenance and rehabilitation
- to provide a site for collecting long-term data about post-harvest regeneration, stand dynamics and tree growth rates.

Forest description

Gympie messmate is the dominant species in this forest type, which has a relatively limited distribution in south-east Queensland. Only 4150 hectares of the 200,000 hectares of PNFs in the Mary River catchment and adjacent areas are dominated by Gympie messmate.

Located near Kin Kin, east of Gympie in south-east Queensland, approximately 20 hectares of the 165-hectare property is native forest. The study area is a 10-hectare block in one corner of the property, adjacent to a large area of state forest supporting a similar forest type. The dominant tree species are Gympie messmate, tallowwood, grey gum, red mahogany and red bloodwood.

The soils are deep coarse sands over a sandy clay loam, with some large sandstone boulders on the steep slopes of the plateau. Mean annual rainfall is between 1800 and 2000 mm. The forest type is mixed tall open forest, type 12.11.16 in the Regional Ecosystem Classification, and its conservation status was 'of concern'. This classification influenced the management decisions taken.

This forest was classified as remnant vegetation under the *Vegetation Management Act 1999*. Under the 2004 amendment of the Act, notification of a forest practice exempts harvesting as a clearing operation, providing the harvest process meets the requirements of *The code applying to native forest practice on freehold land 2005*.

There was evidence that this area was cleared in a 'scrub drive' during the 1920s. At that time scrub drives were commonly conducted to clear the hill country for pasture production. The drive involved three-quarter cross-cuttin through the larger trees on the slope and then felling the largest tree at the top the slope to create a domino effect down the hill, smashing everything in its path. Some of the three-quarter sawn stumps (Gympie messmate) and remaining high shards can still be seen on the property (Figure 4.1). More gradual slopes were harvested, leavin behind high stumps with springboard slots and the remai of rejected logs on the ground. This area was subsequentl left unmanaged and was taken over by natural regrowth. A lack of disturbance and the absence of fire for at least 30 years had allowed a complex understorey, composed mainly of rainforest species, to develop, excluding eucalypt regeneration. High-quality, advanced growth of Gympie messmate (to 25 cm DBH) had occurred adjacen to the fencelines, which were cleared 25 years ago. The present owners purchased the property in 1970 and harvested messmate sawlogs for the local Kin Kin sawm and round timber for yard construction.

Figure 4.1 A stump and shard (top) and Gympie messmate stumps (bottom) left from the original scrub drive.

Management

Past management practices contributed to the overstocke stand. The original clearing promoted dense seedling and coppice regeneration in the cleared areas. Over time som trees became dominant and others subdominant, graduall becoming suppressed or succumbing to competition, disease and insect attack. The stand stocking then reverte to around 50–60 very large trees per hectare with a high density of trees in the smaller size classes (up to 40 cm DBH).

When a stand is stocked very heavily, trees are in competition for available nutrients, water and light, and tree growth rates can be very slow. In some cases where trees become suppressed, growth rates inevitably remain low even when released from competition. This situation can be improved if the regrowth is thinned to an adequat spacing before competition impacts on growth, ensuring faster growing, better quality stems remain in the stand.

Evidence suggested that most of the stems over 40 cm DBH had reached their optimum product value as poles, and were deteriorating due to pipe or limb rot. Most of th smaller stems had become suppressed and had begun to develop internal pipe or decay.

Management to improve forest condition by thinning and to conduct a harvest follows a set of common steps provided as guidelines in Appendix 1. An assessment of stand condition was completed and this was used to plan appropriate management.

Stand condition assessment

A stand assessment was done by conducting stand inventories on a 100 m^2 grid of temporary plots (1/20th hectare and 12.6 m radius). For all trees greater than 10 cm DBH, species, log length and probable product were recorded and stem volume was calculated. The stocking rates (stems per hectare) and the tree-diameter class distribution are given in Table 4.1.

Table 4.1 Average stocking rate by DBH size class

DBH class (cm)				
10–20	**20–30**	**30–40**	**40+**	**Total/ha**
158	107	68	57	Av 390

The species mix was:

Gympie messmate	32.2%	red mahogany	11.9%
brush box	22.4%	tallowwood	10.3%
red bloodwood	18.1%	grey gum	5.1%

Box 4.2 The stand inventory illustrates a typical unmanaged stand

- The stand had a high stocking rate (390 stems per hectare) on soils with low fertility.
- Many trees were less than 20 cm DBH and already suppressed.
- Many trees were species that were unlikely to produce a saleable product on these soils, e.g., brush box (85 stems per hectare). Many of these were subsequently cut and found to be full of doze.
- Smaller trees were already showing signs of deterioration, such as a high incidence of pipe. These would not yield saleable products if left for a future harvest.
- There were no eucalypts under 15 cm DBH and there was no sign of eucalypt regeneration. In the absence of a natural fire regime, shade-tolerant species had begun to replace the eucalypts.
- Restoring this stand to full productivity will take more than a full cutting cycle and will involve significant management intervention.

Product range

The stand assessment suggested that the potential products from the harvest were poles, piles, sawlogs, salvage logs and fencing products (strainers, rails and stays, split posts and split rails). The poles and piles needed to be barked for sale. Bark condition was assessed by removing a section of bark from the standing tree. If the under-bark area was wet and clean then the trees would bark easily; if dry with white patches then the tree would be difficult to bark. In this case the harvest was postponed for a few months until conditions were better in the cooler, winter period.

Other forest products

The Gympie messmate carried a heavy crop of mature seed, which is in high demand from trees with good form and growth habit so a seed harvest was planned. This is normally done within two days of felling because the capsules dry quickly and seed would be released onto the ground if not collected.

Management prescription

A 're-set' or intensive harvest and thinning treatment was recommended to bring the future stand into a productive state. An integrated sale was planned to improve the returns on the harvest and thinning products.

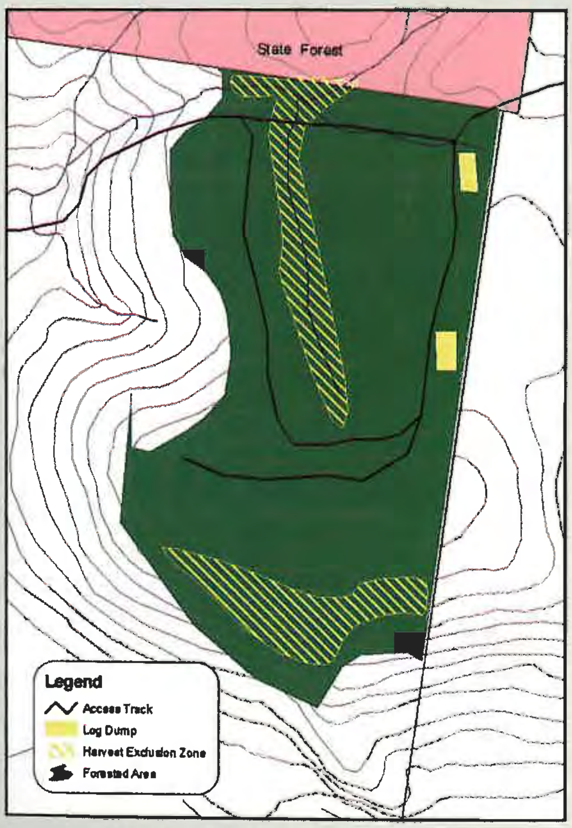


Figure 4.2 The harvest area, showing log dumps, tracks and exclusion zones.

Pre-harvest planning

This included a timber harvest plan, pre-harvest market survey, site inspections and choosing a contractor. The range of products to be harvested was identified from the stand inventory. A market survey was conducted to ascertain the best value product, demand and specifications for each product type.

Timber harvesting plan

A forest harvesting operational plan was drawn up (Appendix 4), including a map of the harvest area (Figure 4.2), documenting details of the resource, operational standards, access, utilities, environmental considerations, silviculture needed, fire protection, rehabilitation and sales. The operational standards described several working rules and constraints:

- retain and protect paint-marked trees during the harvest operation
- mark harvest exclusion zones with yellow fluorescent paint and fell trees away from this zone
- mark habitat trees with 'H' and retain
- harvest all other trees if they contain a saleable product
- sort products into appropriate classes and stack separately at the log dumps
- present only products that meet the industry standards
- number, measure all products (except fencing materials) and record on log tally sheets.

It is a good idea to include penalty clauses in the harvest plan to encourage care of the residual stand and harvest products such as poles. This can include financial penalties for damaging poles, causing product downgrade, or for trees left uncut that should have been harvested. Post-harvest maintenance also needs to be outlined clearly in the timber harvesting plan.

Pre-harvest market survey

Once quantities of different products were known from the stand inventory, a market survey of potential buyers was conducted to ascertain the best value product, demand and specifications for each product type. Marketing a range of timber products to processors generates many opinions, variations in classification and values. Each processor has their own standards, preferred products and prices they are willing to pay. For this sale two potential buyers inspected the stand prior to the harvest to assist the bidding process.

Box 4.3 Results of a pre-harvest market survey

A pre-harvest market survey gives the owner information about:

- current market demand
- which products each processor is interested in; their specifications and price limits
- options for the harvest and sales such as
  - » owner harvesting and marketing
  - » contractor harvesting under the direction of the owner who then markets the products
  - » a standing or direct sale where the mill buys the standing timber and handles the harvest (done either on a per m^3 basis or as a bulk sale for the block).

Site inspections

A number of mill representatives visited the site to indicate their interest in purchasing all or part of the harvested material. The stand had already been marked for retention, clearly showing which trees would be removed. An explanation was given of the project, the intention to use the block as a demonstration site and the harvesting standard required. In particular, the need to protect the residual stand was emphasised along with the other environmental constraints. Most were positive about the outcomes but considered it a difficult site to work. They also remarked that the number of stems to be retained would limit the harvesting process and potential harvest returns.

To gain more information about the stand's potential for poles, one of the poorer, suppressed trees was cut and barked. This log barked moderately well and appeared to meet pole specifications for a 12.5 x 12 kN pole, with solid branch stubs and minimal pipe. On closer inspection

Figure 4.3 A typical log dump with products stored into stacks.

Figure 4.4 Defect rings caused downgrade to salvage class in this bloodwood log.

and when a bump was trimmed, a large grub hole was revealed. This was caused by the larva of a giant wood moth, a stem-boring pest commonly associated with son eucalypts. Although this was considered a limitation for the pole component of the stand, the other indicators we encouraging.

Choosing a contractor

Three of the four mills inspecting the site had their own contractors for cutting and snigging and would have preferred them to do the harvesting as they were especia proficient with pole cutting and presentation. Because the contractors were not comfortable with the restriction imposed by the program, an independent operator was employed to do the cutting and snigging. The operator owned a Clark® grapple-mounted skidder and had a reputation for being an accomplished cutter. An agreed rate of $25 per m³ (including GST), which was $2 above the going rate was paid for cutting and snigging sawlogs and the standard (local mills) lineal-metre rate was paid for poles and piles.

Harvest

The harvest area was approximately 10 hectares in the north of the property. It was defined by the tree line with the property and by boundary fences adjacent to a privat landholder and a state forest reserve. The boundaries we validated using a global positioning system (GPS) and compass. The adjacent landholder's boundary on the no side was correct but the western state forest boundary w positioned 40 m beyond the fenceline. Boundary locatio is the landholder's responsibility and, since pegs could not be located, the line was resurveyed to establish the exact corner of the property. The GPS proved to be very accurate, pinpointing the corner within only a few metre of the accurately surveyed corner.

Selecting trees for retention

The tree-marking system employed for this sale was one of 'marking for retention', which meant that all trees to be retained were paint-marked at chest height with eithe three dots around the tree or a large H (for a habitat tree) The marked trees were to be protected from damage during the cutting and snigging operation. All other trees with a marketable product were to be harvested. Trees were selected for retention if:

- they were free of fault with a vigorous healthy crown in a dominant or co-dominant position
- they hadn't yet reached their optimum product value
- spacing was acceptable (optimum 7–10 m)
- they were required as seed or habitat trees
- they were a desired species.

Log dumps

Log dumps were created in two areas, each adjacent to the major access track. Log dump 1 was reserved for sawlog, poles and piles and log dump 2 for salvage logs and fencing material. At the dump the logs were processed, measured and stacked (Figure 4.3).

Booking and tallying

The cutter did all the booking and tallying at the log dump (Figures 4.4 and 4.5). Logs were docked to length at the log dump and the centre diameter under bark was measured. A standard cutter's booking sheet was used to record log number, length, centre diameter under bark (cm) and volume (m^3) (Figure 4.6). Volume was calculated using Matheson's Log and Timber Ready Reckoner.

Figure 4.5 Internal defect from a previous harvest scar being marked for identification.

Cutter name:			Code:
Date cut:			Area code:
Log no.	Length	Centre diameter	Volume
109	4.5	35	0.433
110	6.0	33	0.513
111	6.3	37	0.677
112	12.9	40	1.621

Figure 4.6 Typical cutter's tally sheet.

Figure 4.7 Logs are tallied by marking the number and dimensions on the end of each log. A circled log number indicates salvage class.

Figure 4.8 This stack of salvage logs shows pipe defect.

Sawlog and salvage

Sawlogs and salvage logs were sorted and presented at tl ramp in increments of 0.3 m, with a minimum length of 2.4 m. The log number, length and centre diameter (unde bark) were written in paint pen on the end of each log. Salvage log numbers were circled to delineate 'salvage class' (Figure 4.7) and stacked in the appropriate dump (Figure 4.8).

Logs received a salvage classification if they failed sawl specifications due to the pipe size, the number and size o limbs, the degree of bend or a small-end diameter (SED)

The harvest products clearly demonstrated that the stand was unmanaged and overstocked. Many logs revealed a very narrow sapwood band and rapidly developing pipe (Figures 4.8, 4.9 and 4.10).

Poles and piles

Poles and piles were snigged to the appropriate dump, barked and placed on skids for dressing and inspection. Poles were presented barked, dressed (branches trimmed faults proven) and number, length and strength rating (kN) written in paint pen on the base. Potential poles we assessed against the *AS 2209-1994* specifications. Rot-pockets, unsound knots and grub holes were cleaned out with the tip of the chainsaw bar.

Piles were also presented barked with the number, length and SED written on the base. Piles were checked for straightness and pipe, barked and stacked in their allocat area. They were assessed against the Australian Standard specification for piles (*AS 3818.3*, 2001).

Fencing

The fencing component of the harvest was greater than expected because it included some large logs that had failed the sawlog and salvage grades. These were Gympie messmate logs with more pipe than expected an bloodwood logs with rings.

Material that was graded durability class 1, and was unsuitable for any other product, had a ready market as split posts. These logs were delivered to the fencing dum in multiples of 2.15 m lengths. These were subsequently split for posts (Figure 4.11) by an experienced worker who, with assistance, could produce up to 170 posts per day.

Solid rounds were cut to length:

- strainers: SED 200–350 mm at 2.25 m
- rails or stays: SED 100–180 mm at 3 m

Sales

Once the harvest was well under way (after 100 m^3 of sawlog had been cut), bids were invited for the range of products at the dump (Box 4.4). Bids covered cut, snig and stumpage for the sawlogs, salvage, poles and piles. The bid could be for one or more products and either per cubic meter for sawlogs or per lineal metre for poles and piles. Expected minimum rates were given before the millers

Box 4.4 Comparing sales of standing timber with sales a the log dump

Millers are keen to make a bid for timber at the log dump, rather than for standing timber, and organise their own haulage. The buyer can see the quantity and quality of the products and assess likely recovery rates after processing. The buyer has no on-costs, such as supervising the harvest, and so can afford to increase the price. The costs of harvest supervision are carried by the landholder and will be included in the sale price. This is a form of value adding by the landholder but requires some knowledge of log and timber products and log presentation, which many landholders do not have.

Other millers prefer to buy standing timber (or per m^3), using their own contractors, ensuring the timber is harvested to their own specifications. Where the landholder doesn't have the knowledge or time, the contractor usually conducts a stand assessment to determine timber quality, species mix, harvest dynamics and access for haulage.

There are some disadvantages in the sale of standing timber:

- Unsupervised standing sales often 'high-grade' and remove all the good-quality trees, leaving a non-saleable timber stand with poor structure and poor growth potential.
- Where a contractor is employed by a sawmiller, the contractor manages the harvest to the sawmiller's specifications, rather than those of the landholder. The code applying to native forest practice on freehold land 2005 requires that both comply, putting more responsibility on the landholder.
- The criteria used for product classification tend to vary between mills. For example, some mills have three or more log classifications. Criteria for product classification need to be outlined clearly in the contract.
- Occasionally there is disagreement about what is to be harvested and what is to be left standing. Many millers expect to harvest all saleable timber so the harvest plan and contract needs to identify clearly what is and what isn't to be cut.

Figure 4.9 Internal defect from a previous harvest scar being marked for identification.

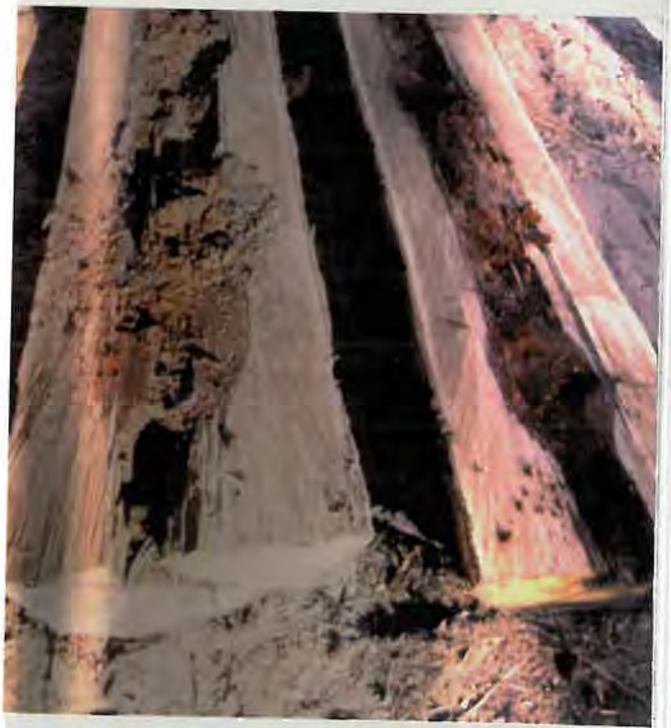


Figure 4.10 Pipe and a termite nest ball found in a salvage log.

made their bids. One bid was accepted for sawlogs and salvage and another for the poles, piles and round wood.

The fencing material was sold through several orders. The largest was for 1300 split posts at \$5.50 each, 290 strainer at \$15 and 290 stays at \$10. A complete list of products, including costs and stumpage, is given in Table 4.2.

The split posts returned as much or more than if they had been sold as salvage-grade logs. Revenue for the fencing component totalled as much as the combined sale of all other products, demonstrating clearly the value of an integrated sale where all forest products are sold at one harvest. Under many sawmill sales this product would have been left in the bush as waste.

Table 4.2 Product lists, including costs and stumpage

Sawn pole and pile products

Product	Quantity	Cut and snig (excl GST)	Stumpage owner's return	Total (excl GST)
Sawlogs	152.528 m^3	@ \$22.50/m^3 = \$3431	@ \$62.50/m^3 = \$9533	@ \$85.00/m^3 = \$12,964
Salvage logs	78.821 m^3	@ \$22.50/m^3 = \$1773	@ \$30.50/m^3 = \$2404	@ \$53.00/m^3 = \$4177
Piles	418 lm	@ \$1.78/lm = \$744	@\$2.93/lm = \$1226	@ \$4.71/lm = \$1970
2nd sawlog sale	18.834 m^3	@ \$24.95/m^3 = \$470	@ \$54.95/m^3 = \$1035	@ \$79.90/m^3 = \$1505
Poles	64 lm	@ \$3.19/lm = \$204	@ \$28.45/lm = \$1821	@ \$31.64/lm = \$2025
Total		\$6622	\$16,019	\$22,641

Fencing products

Product	Quantity	Cut and snig (excl GST)	Ripping (excl GST)	Stumpage	Total (excl GST)
Split posts	2450	@ \$0.90 = \$2205	@ \$2.50 = \$6125	@ \$2.10 = \$5145	@ \$5.50 = \$13,475
Fencing rounds					
1. Strainers	374	@ \$2.00 = \$748	@ \$5.00 = \$1870	@ \$8.00 = \$2992	\$9110
2. Rails	40	@ \$1.50 = \$60	@ \$2.00 = \$80	@ \$6.50 = \$260	
3. Stays	310	@ \$1.00 = \$310	@ \$2.00 = \$620	@ \$7.00 = \$2170	
Total		\$3323	\$8695	\$10,567	\$22,585

Seven days were needed for the harvest organisation, supervision and post-harvest management. Time costs were offset by a high return on the products and improved management outcomes for the stand.

Stand inventory and interpretation	1 day
Marking for tree retention, exclusion zones, snig tracks and log dumps	2 days
Harvest supervision, meeting mill representative, marketing	3 days
Post-harvest maintenance and burn	1 day
Total	7 days

This study demonstrated two other marketing assets:

- Harvested timbers had a high durability rating (Class 1) and sawmills can sell this for 10 per cent more than timber with a lower durability rating.
- Long log lengths were harvested and the value of sawn timber increases greatly over 6 m in length.

Seed harvest

Seed collection was done during the harvest within three days of felling, before natural seed shed (Figure 4.12). Workplace health and safety regulations were followed carefully while working among a tangle of limbs and branches in the felling and snigging area. Prices of $80/kg for up to 50 kg of clean seed were offered and enough seed was collected to make it a profitable enterprise.

Outcomes

Forest management

A stand in this condition created a management problem. Most of the stems over 40 cm DBH had reached their optimum product value and were deteriorating due to pipe or limb-associated rot. Most of the smaller stems were suppressed and with pipe developing already. The best solution to this problem was a 'reset' harvest, where a higher than usual proportion of the stand would be removed to:

- remove trees in decline or that have reached their highest value potential
- provide space for the retained trees to grow
- provide gaps in the canopy that would trigger a regeneration response, allowing rapid growth of younger trees.

Past management

Gympie messmate is not lignotuberous but readily coppices. The disturbance caused by the original scrub drive and logging operation resulted in significant levels of seedling regeneration and stump coppice that soon covered the cleared areas. Over time the dominant trees became established. Trees that had lost the dominance race and were unable to compete for the available nutrients,

Figure 4.11 Splitting posts from a bloodwood log. Posts are wedged apart from the ring, which pops as the cuts are made.

Figure 4.12 Seed capsules were just reaching maturity at the time of harvest.

water and light succumbed to repeated pathogen or insect attack and gradually died off. This could have been alleviated by treating (thinning) the regrowth befor competition affected the quality stems in the stand.

Over a prolonged period this rate of attrition would hav resulted in the stand reverting to the original stocking rates of around 40–50 very large trees per hectare. This is demonstrated by the 15 m average spacing of stumps left by the original logging and clearing operation (Figu 4.1).

The light harvest in 1970 produced a proliferation of coppice from the remaining stumps, resulting in multi-stemmed trees with 2–5 stems per tree. These did not appear to have any more or less pipe than stems derived from seedlings, but would have been of a much greater quality and value if they had been reduced to a single st shortly after coppicing.

Excluding fire or other forms of disturbance had a significant impact on the stand. Large quantities of debr still remained from the original logging and a dense understorey of scrub-woods and brush box had prevente eucalypt regeneration. Ecological values associated wit eucalypt forest environment were changing due to lack management and the deliberate exclusion of fire. In tim the flora and fauna dependent on this forest environmen as well as timber productivity, would be lost.

Harvesting

After the initial inspection and inventory survey the sta appeared to be a quality pole stand with the messmate and tallowwood showing exceptional form. There were, however, some concerns over the condition of the branc stubs and the degree of resulting degrade fault, which is common with Gympie messmate. A test tree showing signs of suppression was felled and barked and appeare to have little fault; the branches trimmed were solid, wi no apparent pipe or other fault. The last bump trimmed, however, revealed a sizeable grub hole that would eliminate it as a pole, although there were other, positiv signs that suggested a good proportion of stand would meet pole standards. Trees were therefore marked with this knowledge in mind.

Harvest plan

The informal guidelines outlined in the harvest plan were insufficient, particularly for contractors unfamiliar with this form of harvest. Due to the level of supervisio required, prearranged start and finish times were essenti to ensure both parties were present when required.

The addition of penalty clauses would be an incentive for due care of the residual stand and harvest products, particularly poles. This type of clause is standard in the employment agreements for mill-employed contractors, particularly with regard to damage to poles resulting in product downgrade (where the financial penalty is the lost revenue) or trees left uncut that should have been harvested. Post-harvest maintenance also needs to be clearly outlined.

Tree selection

Trees were marked for retention, which means that all marked trees were to remain and everything else was to be harvested (if it had saleable product) or treated to waste. This system places the emphasis on the quality of the retained stand rather than focusing on what can be harvested. It also assists during the selection and harvesting process, as the 'tree marker' can look back and easily see the number of stems retained. Likewise the cutter and snigger can see which trees are not to be damaged in the harvesting process. Once cutting commenced and the high level of pipe became evident some of the trees marked for retention were expected to have developing pipe and so were removed.

Cutting and snigging

Due to the height of the trees (>40 m) and the high stocking levels, it was clear that damage to the residual stand by felling and snigging was going to be difficult to avoid and would require an experienced and skilled operator.

With the emphasis on meeting pole specifications, logs were generally kept in full lengths (some up to 23.5 m) these were a challenge to fell without damaging selected trees or the product itself. Large amounts of old logging debris or hidden stumps could easily split the side off a pole if hit, reducing the potential stumpage value ($750 for a 23.5 m 20kN pole compared with $200 for the log as a 3 m^3 sawlog).

The tree was also required to be felled so that the log could be snug straight out onto the snig track. Turning a 23.5 m pole in the bush was extremely difficult. One method of protecting trees marked for retention was to delay felling trees adjacent to the snig tracks and allowing these to be used as 'bump trees' in the snigging process.

These difficulties were compounded once the potential poles started failing to meet the tight specifications required by the Australian standards. The cutter quickly became disillusioned with the extra work and time it was taking to get a pole to the log dump only for it to fail while being trimmed and finished for presentation. Grub holes revealed after barking were the main reason for failing. The grub holes were often associated with a branch whirl and, with careful examination and a little barking, could often be detected before barking commenced.

Product sorting and presentation at the log dump

Once the log was on the ground it was assessed for its product category. Salvage logs and fencing products wer to the eastern log dump; poles, piles and sawlogs to the western dump. At the dump they were further categorise and processed, measured and stacked.

Poles

Potential poles were examined against the hardwood pol specifications:[1]

- no fault within the critical zone
- pipe diameter <20% of circumference, length <10% of po length
- unsound knots associated with branch stubs: trenched out with a chainsaw tip until free of decay. Maximum allowab width 10% of circumference, depth 5% of circumference
- straightness – to specifications
- strength rating – circumference under bark at the D line (2 m from butt) and head in proportion to length as specified

If they appeared to meet the specifications they were the debarked and re-examined for any further fault:

- no fault in critical zone
- grub holes – cleared for drainage to W ≤25mm, L ≤150 m
- number of faults <6 and >1 m apart.

If the pole passed the specifications it was placed on skid for inspection by the purchaser prior to sale. It is essentia the poles are inspected and approved by the purchaser at the dump. Placing them on skids allows them to be easily rolled, measured and checked before hauling. The pole number, strength rating and length were written on the base in paint pen. If a pole fails the specifications, it might still be acceptable for a number of other high-valu products such as piles, rounds or private-property poles.

> *One purchaser dealing only in private sales and not with electricity authorities (they buy all poles by tender system and use the Australian Pole Standard's specifications) stated they could not sell poles that had knotholes cleaned out or that had sharp crooks or bends. The coastal market that they dealt with would not tolerate this level of fault, even though the poles would pass the specifications.*

1 Department of Primary Industries, Forestry (1999) *Hardwood pole specifications. Guidelines for measuring and classifying hardwood poles intended for use after full-length preservative treatment.*

Piles

The pile market varies widely, with some mills stating they deal only in piles with a length <9 m and SED ≤200 mm, and other processors taking up to 17 m with a 350 mm head. It is a very demand-driven market and requires prior research on current demand and specifications.

The draft pile specification is very similar to that for poles but doesn't include the critical zone criteria. This does not necessarily transfer to the marketplace.

> *One purchaser would tolerate no pipe whatsoever in messmate, after having previously purchased it with minor pipe only to have it fail once the pile was driven and trimmed. Messmate pipe tends to travel much further than in other species and often has a termite nest-ball a couple of metres off the ground (Figure 4.10). If this occurs the pile may fail while being driven or after being driven and then trimmed at ground level, revealing an unseen termite ball, failing the engineering requirements and having to be removed.*

Piles were checked for straightness and pipe, debarked and stacked in their allocated area.

Sawlogs and salvage-grade logs

Sawlogs were presented in 30 cm increments with a minimum length of 2.4 m and SED under bark of 30 cm. Sawlogs dropped to salvage class if any of the following was found:

- pipe exceeded the specifications in Table 4.3
- limbs affected 50 per cent of the circumference of the log
- the degree of bend exceeded 2½° in a <40 cm DUB at the bend; 5° for logs 40–49 cm DUB at the bend; or 10° if >49 cm DUB at the bend.

Table 4.3 Specifications for allowable pipe for sawlog

Centre diameter of log under bark (cm)	Allowable pipe diameter
30–34	5
35–39	17
40–44	20
45–49	24
50–54	24
55–59	28
60–64	34
65–69	38
70–74	42

Figure 4.13 A well-spaced residual stand.

Figure 4.14 A line of seedling regeneration along the ash heap of a burnt log.

Fencing material

The fencing component of the harvest was more than originally forecast due to the high level of pipe in the messmate and the number of large bloodwood logs failin saw and salvage grades due to rings.

Because the material was durability class 1, there was a ready market for it as split posts, which would return as much as or more than if sold as salvage-grade logs. This study emphasised the value of an integrated sale and the fencing component returned as much as the combined sale of all other products. Under most sawmill sales this product would have been left in the bush as waste.

An operator experienced in chainsaw post splitting was employed on a 'per post' basis and, with the assistance of an offsider, could produce up to 170 posts per day.

Post-harvest management

Residual stand

Overall the residual stand stocking was low, 50 stems/ha >30 cm DBH (Figure 4.13). Some areas had sizeable gap in the canopy and others had better stocking. Growth rate should improve in the retained stems but there could be a high incidence of fault because the pre-harvest stand was overstocked. Retained stems might be harvestable in 10–15 years.

If managed well, regeneration in the open areas will achieve substantially higher growth rates than those in the previous stand. The objective will be to double the growth rates achieved in neighbouring unmanaged forest and reduce the harvest cycle to 35 years. Higher levels of productivity and value are expected because defect-free trees (grown in the absence of damage or stress) will be selected.

Regeneration

Regeneration was a key management goal for this forest and it was important to time the harvest to coincide with a seed crop. In common with many other eucalypts, seed release of Gympie messmate is stimulated by fire and germination requires a bare earth seedbed.

In the burnt area most seed were shed within three days, whereas no seed capsules had opened in the adjoining unburnt area. Burning also reduces competitive weed and pioneer species that would delay eucalypt regeneration (Figure 4.14).

Regeneration was assessed by comparing photographs taken immediately after the burn in November and again four months later in March 2002 (Figure 4.15). The photographs show the regeneration and coppice response to harvest and burning. Even in unseasonably dı conditions, significant Gympie messmate regeneration ha

Figure 4.15 Photos were taken at four different sites immediately after the burn in November 2001 (left) and again in March 2002 (right). Large numbers of seedling and lignotuber regeneration and coppice have established.

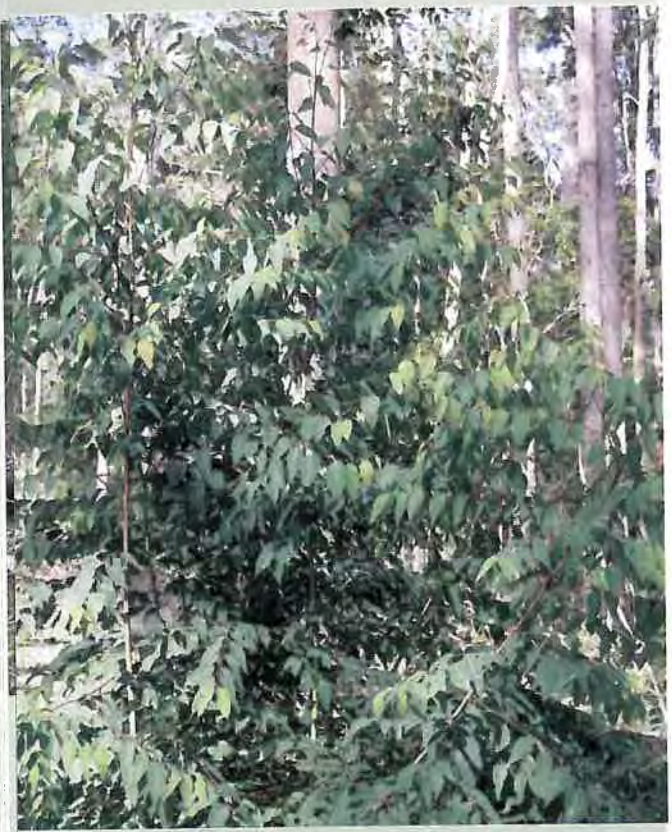


Figure 4.16 Coppice regrowth had reached 2.5 metres four months after the burn.

Figure 4.17 Enrichment planting to supplement the natural regeneration.

occurred in the burnt areas. Some tallowwood, grey gum and acacia were also regenerating.

Gympie messmate seed has a low germination rate but its ability to coppice can be a good alternative to seedling regeneration. Many stumps produced coppice immediately after the harvest in this study. The coppice should be thinned to one shoot, preferably one originating at ground level, when it reaches approximately 2 m in height (Figure 4.16). The stump height should be less than 30 cm to avoid losing the stem to 'wind-throw' or rot associated with the old stump.

Enrichment planting

Enrichment planting can improve the future stand structure in areas that are not regenerating successfully. Areas with poor regeneration were planted with approximately 200 Gympie messmate seedlings that had been raised from seed gathered from the site (Figure 4.17).

Burning

Harvesting debris was burnt to reduce fuel loads and encourage regeneration. Debris that had accumulated around retained stems was removed to reduce scorch damage to the base of the trees.

Due to a prolonged period of dry weather, the burn was delayed for several weeks and was conducted two days after 130 mm of rain. Although late in the season, the rain reduced the Drought Index to 0 and the Fire Danger Rating to low. Despite the rain, the burn was quite hot and very hot in areas where fuel was concentrated. There was very little scorch in the high residual stand canopy.

Drainage

Transverse drains were established at regular intervals along snig tracks to avoid soil erosion. Channels created by repeated use concentrate water flow and develop into gullies. Erosion will be reduced by redirecting water to undisturbed areas at regular intervals along the track.

Outlook – future management

The objective of this case study was to demonstrate the benefits of an integrated harvest that maximised the utilisation and economic returns of harvested logs. The stand was in an overstocked, unmanaged condition and was being colonised by shade-tolerant and understorey species of little or no commercial value. This forest is potentially a productive, commercially viable farm enterprise with appropriate long-term management to prevent the stand quality deteriorating in future. Management will include prescribed burning and thinning the post-harvest regeneration when competition begins to affect growth rates adversely. A potential management plan would be:

- first treatment at year 2–3 (8 m high), thinning to an average 5 m spacing
- second treatment at year 10 (25 m high), thinning to an average 10 m spacing
- exclude fire until the regeneration is tall enough to withstand a low-intensity burn.

The older, residual stand has 50 stems per hectare and can be harvested at the time of the second regeneration thinning. This will ensure a harvest before the development of pipe defect can reduce the product value from, for example, pole to sawlog. An important priority for that harvest will be to protect the young growth. The same regeneration techniques and management should be used after the next harvest.

This study has demonstrated the value of an integrated harvest and the importance of market research prior to harvesting so that product value and utilisation could be optimised with this knowledge. The income received for the fencing component equalled that for all the other harvested products. While not all tree species can be used as fencing material to the same extent, the sale of a full range of products produced an excellent economic return with little waste.

An integrated sale enables a log that fails one set of specifications to be moved into another product category, instead of being classified as salvage or waste. The integrated sale produced a high level of product utilisation and returns, validating the rigorous reset management that was needed to bring this forest back into a productive condition. Consequently the value placed on this small block of forest has been raised, avoiding the need to clear for pasture or another farm enterprise. Most importantly, the poorly performing and defective proportion of the stand was removed (with the exception of habitat trees), improving future productivity significantly.

In addition, the impact of the operation on soils was minimised because the number of snigs was reduced by snigging logs full length to the ramp before sorting into product categories. Snigging with heavy machinery causes soil compaction, and multiple passes of machinery are associated with moderate to severe compaction. This could lead to other adverse impacts such as accelerated soil erosion, reduced tree growth and loss of productivity.

Well-managed native regrowth forests have many characteristics that arguably make them superior to plantations for timber production:

- a greater capacity to maintain habitat and biodiversity values
- greater landscape heterogeneity contributed by species diversity and a range of size classes
- superior wood quality due to slower growth rates
- managed with lower environmental impact when compared with the 'establishment to clearfell' rotations required for highly productive plantations.

With the appropriate management processes established for this forest, the stand should be in a highly productive condition, supporting a high-value pole and sawlog crop with considerable future value.

Appendix 1: Guidelines for managing forest condition

The first step in rehabilitating a poorly managed forest stand is to decide if it has potential for timber production. Not all native forest areas are capable of commercial timber production or worthy of investing management time and dollars. If there is potential but the stand is in a poor condition, management such as fire, thinning or harvesting might be required to improve long-term productivity. Good management decisions depend on understanding the forest's potential for timber production. This is achieved by breaking up the forest into management units of similar forest type and condition and undertaking an inventory of a representative part the stand. Inventory information includes species, stems per hectare, DBH range, potential product range and general health of the stand and will help decisions about what management is required. Treatment, thinning or harvest operations can then be conducted as part of the long-term management plan for timber production. The management steps to successful timber production are as follows.

- Assess the stand condition using stand inventories.
- Determine management options for future timber production in a property management plan. This will include management prescriptions and a work plan for each management unit.
- If thinning or harvesting, select the trees to be retained. Whether the management option is treatment thinning, harvest thinning or harvest, retain stems on the basis of health, form and spacing.
- Conduct pre-harvest planning, including a product assessment of trees to be logged, a plan for a fuel-reduction burn six months before the harvest, market survey of potential buyers in relation to product range, completion of the timber harvesting plan (including operational and environmental constraints).
- Harvest all stems not selected for retention and that have a marketable product.
- Ensure retained stems are protected during the harvest operation.
- Conduct post-harvest operations, including protection of regeneration until large enough to thin and treatment of all useless stems, retaining regeneration only in gaps large enough for unrestricted growth.
- Meet environmental requirements set out in *The code applying to a native forest practice on freehold land.*
- Apply post-harvest management, including monitoring and fire management.

Stand condition assessment using a stand inventory

Stand condition is assessed by conducting a stand inventory. The inventory can give a reasonable estimate of the standing volume and diameter class of each species. It can also include an assessment of the potential product range in a future harvest. The inventory is usually done before a property management plan and includes a map of the property showing soils, forest type and land use.

Define the sampling area

A stand inventory is conducted in a representative sample of the forest. You need to achieve an adequate, representative sample and this will vary according to the forest area. The forest area needs to be divided into management units according to condition, species, past management history or aspect. Generally 0.5–2 per cent of the total unit should be sampled. If the unit is large or fairly uniform sample about 0.5 per cent; if it is small or quite diverse sample up to 2 per cent. There are two methods for sampling:

- Strip survey, sampling each unit using a series of 10 m wide strips usually in multiple lengths of 100 m (each 100m is 1/10 hectare). The strips might be samples at 200 m intervals across the width of the property. The strips should run perpendicular to the topography.
- 1/20 hectare circular plots: plots with a radius of 12.6 m are established, usually on a grid of 100 m intervals. This method can be inaccurate if too small a sample is taken or the plots are not representative of the whole unit.

A stand inventory to record stand condition

The inventory can be set out in a table recording stocking rate, diameter class, standing volume and species for each sample strip or plot:

- Measure tree diameter and estimate product length for all trees greater than 10 cm DBH.

Record crown health and likely product for all trees over 20 cm DBH.

- Record the species and whether the tree will be retained, harvested or treated.
- Tally tree numbers in each DBH class (this will also give a total stocking rate).
- Estimate the standing volume in trees greater than 40 cm DBH. This is calculated from the estimated log length and a DBH using a (one-way) volume table (available from Private Forestry Southern Queensland).

Species mix, future harvests and net area

Example: spotted gum (53%); grey ironbark (19%); forest red gum (9%); gum topped box (5%); other (14%). 'Other' includes non-commercial species.

Additional information relating to future harvests can be recorded:

- tree potential for future harvest (look at form, crown, defects, species)
- number of current, merchantable stems, if any
- number of potentially productive stems to retain for future harvests.

Record exclusion zones, tracks, excessive slope and other restricted areas. This is used to calculate net area. Extrapolation of a one–two per cent sample can be very inaccurate if multiplied by gross harvestable area instead of net area (net area includes only the area with trees on it or that can be harvested).

Management options for timber production

The code applying to a native forest practice on freehold land 2005 is applicable to forests subject to the *Vegetation Management Act 1999* (see Appendix 2). Management operations must follow *The code applying to native forest practice on freehold land* if it is to be exempt from requiring a development approval. The code must be consulted if your forestry practice is in remnant vegetation. The following is a guide for optimum stocking rates to maximise productivity:

As a general rule

- Numbers: 100–150 stems per hectare in the 20cm+ DBH range and with less than 50 stems per hectare in the smaller DBH classes.
- Species composition: give preference to the commercial species that perform best on the site and produce the highest value product.
- Spatial arrangement: relatively evenly distributed throughout the forest (8–10 m average spacing or 15 m for larger trees).

Regeneration stands

- A developed regeneration stand suitable for poles: maximum 200 trees per hectare with good form and straight boles (7 x 7 m average spacing).
- A regeneration stand with a shorter bole length: manage for sawlogs. This stand will be managed at a wider spacing to increase diameter growth on individual trees (10 x 10 m average spacing).

Number of trees by DBH class (cm) from strip survey data

	DBH class (cm)							
Strip or plot	10–20	20–39	30–40	40–50	50–60	60–70	70+	Total stocking
1								
2								
3								
Average per ha								

Estimated standing volume of sawlog in trees greater than 40 cm DBH

Strip or plot	Area (ha)	Volume (m^3)
1		
2		
3		
Average volume/ha		

- Younger, heavy regeneration stand with few larger trees: manage spacing at 6 x 6 m or a minimum of 4 m to maintain numbers if the stems are co-dominant. A stand like this will need further thinning over time.

Advanced-growth stands

Retain trees with a DBH greater than 10 cm (10-30 cm +) at these spacings:

- 200 stems per hectare: nominal spacing at 7 x 7 m or a minimum of 4 m if no other trees are available and stems are co-dominant (pole stand)
- 100 stems per hectare: nominal spacing at 10 x 10 m or a minimum of 5 m if no other trees are available and stems are co-dominant (sawlog stand)
- 70 stems per hectare: nominal spacing at 12 x 12 m or a minimum of 7 m if no other trees are available and stems are co-dominant (sawlog stand).

Selecting and marking trees for retention for thinning or harvest

Trees to be retained for the productive future harvest, or to meet environmental requirements are marked with high visibility paint about 1.5 m from the ground. Repeat the mark 3 times around the tree. All other trees are either harvested or treated with herbicide.

Thinning unproductive stems

Unproductive stems are usually thinned immediately after a harvest (if there are large numbers of defective stems) or three–five years post-harvest when the regeneration is large enough to gauge form and vigour. Thinning removes (culls) excess stocking by injecting herbicide into standing stems (larger trees) or felling to waste and swabbing the stump (smaller stems).

Tordon DS® is the most common herbicide used in stem injection. Tordon is used at 4:1 water:Tordon mix and applied at the rate of 1 ml per cut in trees less than 25 cm diameter at the base, or 2 ml per cut in trees with a diameter greater than 25 cm. The cuts are usually made with a sharp tomahawk into the cambium layer of the tree (through the bark and into the sapwood). The cut leaves a small pocket in the bark into which the herbicide solution is injected immediately, ensuring that the chemical cannot escape the cut. The chemical is applied using a calibrated tree injection gun similar to a sheep drench gun.

A sharp tomahawk is effective across all species, including those with thicker bark such as the ironbarks and yellow stringybark. It can also be used successfully with multi-stemmed trees.

Smaller trees are difficult to inject and may be more successfully thinned by felling with or without follow-up herbicide application to the cut stump.

When felling to waste, use either a small chainsaw or brush cutter mounted with tungsten-tipped ply cutting blades.

Environmental guidelines

For more information these papers can be downloaded from NRW's website (see Appendix 2):

- *The code applying to native forest practice on freehold land.* Department of Natural Resources and Mines (2005).
- *Queensland's new code applying to native forest practice on freehold land.* NRW Fact Sheet. Department of Natural Resources and Water (2006).

Forest practices applicable to *The code applying to a native forest practice on freehold land 2005* include felling for sawn timber or other products and silvicultural activities (thinning regeneration, mid-storey and upper-storey trees, the use of fire, soil disturbance to encourage regeneration and removing non-native vegetation). These practices are regulated by the

Criteria for retaining trees

- free of fault with a vigorous, healthy crown in a dominant or co-dominant position
- optimum product value not yet reached
- spacing (optimum 7–10 m)
- required for a seed tree or habitat tree
- desired species for the future stand

Criteria for removing trees

- optimum product size attained
- declining tree health (usually seen in the crown condition)
- defect such as hollow dead limb or suspected decay from old wounds
- bad mistletoe infestation
- suppressed trees (indicated by crown shape and condition)

code and you need to have a clear understanding of the requirements before beginning any forest operation.

Wildlife values are retained by keeping a specified number of habitat, feed, nest and shelter trees and recruitment trees; restricting the build-up of logging debris; limiting snig tracks, roads, soil disturbance and vegetation removal. Soil is protected from erosion and loss of fertility by restricting soil exposure and other earthworks, especially on slopes or in saturated conditions.

Thinning and harvesting practices are excluded from watercourse protection zones where the watercourse appears on the 1:250 000 series map. The protected zones are referred to as buffer and filter zones. Buffer zones are logging exclusion zones and filter zones are areas where trees can be removed but no bare earth is left after the log is removed. The protected distance depends on how the waterway or drainage line is classified in the code. Unstable slopes and slopes over 25° should also be protected from erosion and are generally excluded from harvesting, which can be checked by referring to the code.

Wildlife habitat trees need to be protected. These are large trees that often have several hollows. They are usually dominant in the stand and a mixture of species should be protected where possible. Habitat recruitment trees also need protection. These are dominant trees that have the potential to develop hollows in the future. They sometimes have branched, open-grown crowns or visible termite nests. Recommendations for the minimum number of habitat or recruitment trees to be retained are laid out in the code.

Fire management

In dry eucalypt forest it is recommended that the areas to be thinned or harvested are burnt in the previous season to reduce fuel load and risk of wildfire. When a pole harvest is planned, burning should be done six months beforehand because bark sticks to the logs for some time after a burn, making barking more difficult.

After thinning or harvesting, the area should be protected from fire for three–five years to allow regeneration to develop. The debris produced from thinning operations is fuel for fire and a large build-up of fuel increases the risk of damage to standing trees during wildfires. Debris should be kept clear of the base of trees.

Regular fire management should be applied in late winter to early spring on a three–five-year rotation. This will help to control excess regeneration without having a negative impact on tree growth. Regular fire management in dry forests is needed to:

- keep fuel loads down
- manage excess regeneration (particularly in the lignotuberous understorey)
- encourage a grassy understorey where this is a characteristic of the forest type
- maintain biodiversity in the understorey when used appropriately.

The Grimes crown score system

This system provides an estimate of the growth potential for stems in the stand. This information is used to decide which trees should be thinned and which should be left for a future harvest.

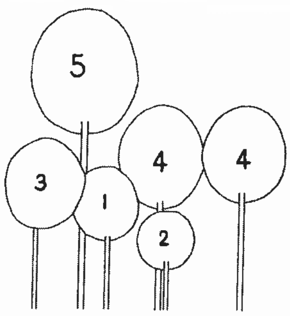
The system was developed after studying growth data from spotted gum–ironbark forests, identifying slow and fast growing trees and relating crown characteristics to tree growth rate.

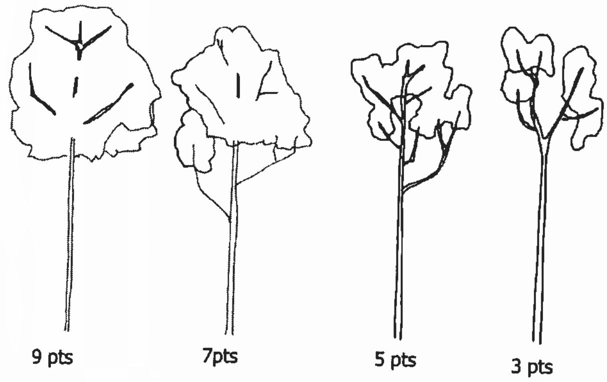
It was found that the rate of diameter growth measured at 1.3 m each year was influenced by five recognisable crown factors (crown position, crown size, crown density, dead branches and crown epicormic growth). Each crown factor is given a rating and the tree's potential for growth is given an estimate from poor to excellent.

It is essential to look at all five factors of crown health. Often it is obvious which crown is best and which crown is unhealthy and in decline. Only trees that have healthy vigorous crowns should be retained for future growth.

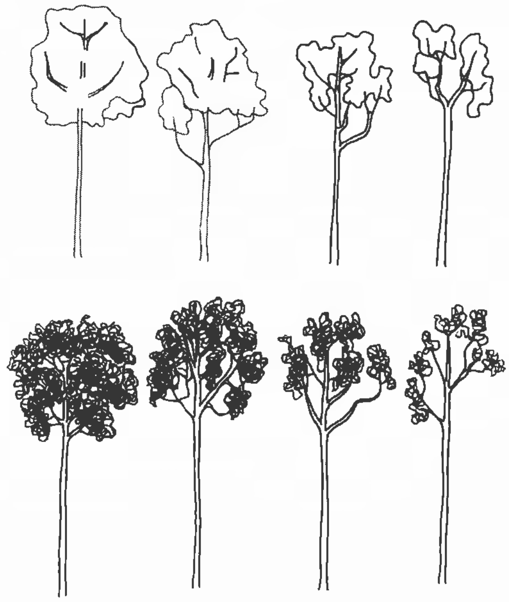
Grimes crown score system

Crown position is the position of the tree crown relative to adjacent crowns.

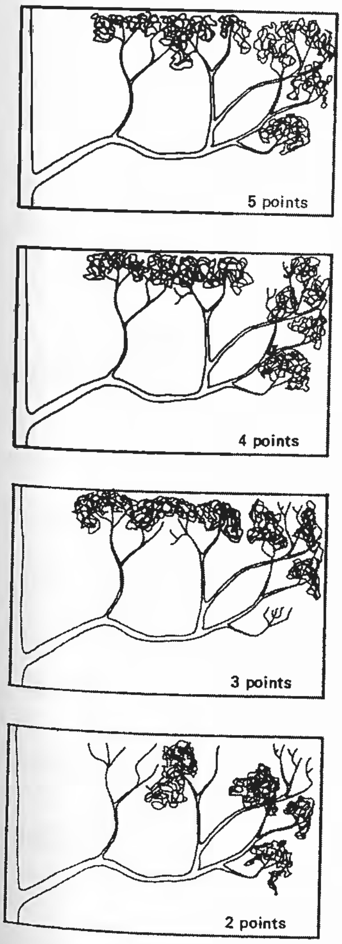




Crown size is a combination of depth, width and shape and varies with tree diameter and species. For example, spotted gum sapling and pole sizes have conical shaped crown that round off as the tree matures.

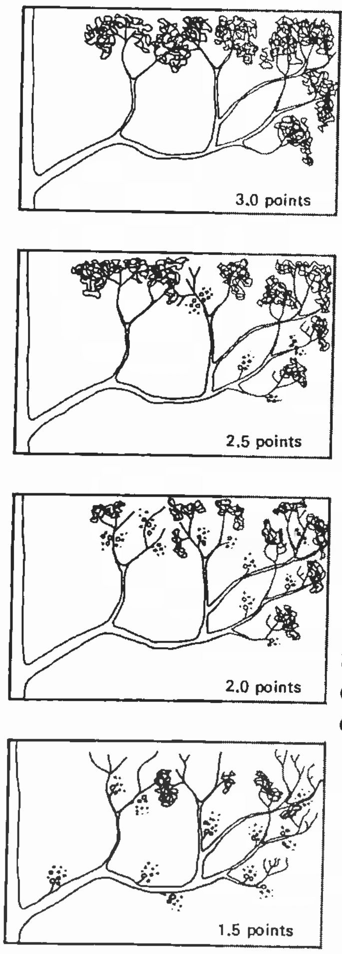


Crown density is a measure of the tree's photosynthetic area and is related to the density and distribution of the foliar clumps, which vary with species. This has five definitions on a 9-point scale and intermediate scores (such as 4 or 8) can also be given.



Dead branches

Eucalypts often shed lower branches to form clean boles, so the lower limbs of younger trees are not considered part of the actively growing crown. Also the thin, dead branches produced each year and found just inside the leaf zone are disregarded in an assessment of dead branches.




represents epicormic growth

Crown epicormic growth

The foliage of a healthy crown is concentrated at the branch extremities. Growth occurring further in along the branch and growing in an upright position is called epicormic growth. Epicormic growth normally occurs after an event such as drought, fire or insect damage has caused branch death or dieback. It is also seen in over-mature crowns that contain a number of dying branches.

Appendix 2: Meeting legal requirements for native forest management practices

This section refers to several papers that can be downloaded from government department websites. The web addresses and the document titles to search for are given here.

Agency	Document name
Department of Natural Resources and Water (NRW)	Download from: www.nrm.qld.gov.au • The code applying to native forest practice on freehold land. • Queensland's new code applying to native forest practice on freehold land. NRW Fact Sheet. • Approval form for a forest practice. • Property maps of assessable vegetation. Information sheet. • Exemptions under Queenslands new vegetation management plans.
Environmental Protection Agency (EPA)	Download from: www.epa.qld.gov.au • Regional Ecosystem Maps. • Code of practice for native forest timber production.
Department of Employment and Industrial Relations (DEIR)	Download from: www.deir.qld.gov.au • Forest harvesting industry code of practice.

Queensland's laws on vegetation management govern which clearing activities require a development approval (or permit) and which are exempt from requiring an approval. Clearing native vegetation on most tenures requires an approval from the Department of Natural Resources and Water (NRW) unless it is an exempt activity as defined in Schedule 8 of the *Integrated Planning Act 1997*. Forest practices such as harvesting or silviculture are regulated by this legislation.

Clearing for a forest practice on freehold land might be exempt from needing a development approval if conducted as part of an ongoing forestry business and the clearing is in remnant vegetation and is conducted consistent with a code applying to native forest practice. Forest practices in non-remnant vegetation on freehold land are generally exempt and do not need to comply with the code (see Box). The exception is where the non-remnant vegetation in question is covered by a Category 1, 2 or 3 in a property map of assessable vegetation (PMAV).

Restrictions related to how the vegetation is classified

In most cases restrictions on clearing vegetation are related to whether the land is classified as remnant vegetation (see Box) and the categories applied through regional ecosystem maps. To find out if your native forest is classified as remnant vegetation and what status the vegetation on your property is check the regional ecosystem mapping. Regional ecosystem maps are available from local (NRW) offices or copies of certified maps can be downloaded from the Environmental Protection Agency (EPA) website.

Laws affecting remnant vegetation

Vegetation management laws apply to remnant vegetation. Remnant vegetation is classified as vegetation that has reached 50 per cent of the original canopy cover, 70 per cent of the original canopy height and has the same species mix as the original vegetation. Remnant vegetation types are assigned Categories 1, 2 or 3 and appear coloured on regional ecosystem mapping:

1 Green – not of concern   2 Brown – of concern   3 Red – endangered

If the vegetation is classed as remnant, notification of a forest practice is required prior to harvesting or any silvicultural process being undertaken.

Harvesting is permissible in remnant vegetation:

- once notification of a forest practice is complete and sent to NRW
- if the landholder is in an ongoing forestry business and
- management actions comply with the *Code of practice for native forest practice on freehold land 2005*.

Non-remnant vegetation is coloured white and is classed as Category X after a PMAV is completed between the landholder and government. Notification of a forest practice generates a PMAV for the coloured areas only and does not lock in boundaries between remnant and non-remnant vegetation. If a full PMAV is not completed boundaries are subject to change with subsequent vegetation assessment. The code of practice does not apply to Category X areas and notification of a forest practice is not required.

Section 20A of the *Vegetation Management Act 1999* (VMA) now requires a landholder who intends to conduct a forest practice in a native forest to give notice to NRW of the location of the practice before the clearing is started. The landholder must provide a completed, approved form to NRW. You can download the form from the NRW website.

This will prompt NRW to create a PMAV for those remnant areas where a forest practice is conducted. This PMAV will only show Categories 1, 2 and 3 but not Category X which is equivalent to non-remnant vegetation.

If you wish to obtain a PMAV that will cover the non-remnant vegetation to show Category X on your property, you need to make a separate application to NRW and pay the prescribed fee.

Information sheets on property maps of assessable vegetation and exemptions under Queensland's new vegetation management plans can be downloaded from the NRW website

It is important to understand how a 'forest practice' is defined under the legislation. Definitions and information are givened in the information sheet: 'Queensland's new code applying to native forest practice on freehold land', which is available from the NRW website.

If your native forest is not mapped as remnant vegetation on the latest regional ecosystem mapping or as a Category 1, 2 or 3 in a PMAV you don't need to apply the code.

The code can be downloaded from NRW's vegetation management webpage. It is anticipated that this code will be superseded when the Queensland Forest Practices System develops a comprehensive code of practice for managing private native forests.

Relevant legislation, policies and guidelines

Managers of productive native forest should be aware of this legislation, these codes and guidelines.

Publications explaining legislation and policies affecting forest practice

Available from the NRW website:

- 'Queensland's new code applying to native forest practice on freehold land' NRM&W 2005.
- Property maps of assessable vegetation (PMAVs). NRM 2005.
- Exemptions under Queensland's new vegetation management plans. NRM 2005.

Relevant legislation

- *Agricultural Chemicals Distribution Control Act 1966*
- *Australian Heritage Commission Act 1975*

- *Cultural Record (Landscapes Queensland and Queensland Estate) Act 1987*
- *Diseases in Timber Act 1975*[a]
- *Environmental Protection Act 1994*
- *Forestry Act 1959* (applies to harvesting of timber and timber products from native forests on state lands)
- *Integrated Planning Act 1997 Schedule 8 Part 1*
- *Land Act 1994 (section 169)*
- *Native Title (Commonwealth) Act 1993*
- *Nature Conservation Act 1992*
- *Queensland Heritage Act 1992*
- *Timber Utilisation and Marketing Act 1987*
- *Valuation of Land Amendment Bill 2000* (guidelines for considering commercial forestry operations as genuine farming activities for the purposes of the *Valuation of Lands Act 1944.*)
- *Vegetation Management Act 1999*

[a] The *Diseases in Timber Act 1975* is concerned with taking measures for the extermination or the prevention or control of diseases in timber. The Act requires the discovery of any evidence of a declared disease in timber to be reported to DPI&F within 24 hours.

Codes of practice

- *Code of practice for native forest timber production* EPA (2002). This applies to state land, including leasehold land and can be downloaded from the EPA website.
- *Code applying to a native forest practice on freehold land* NRM (2005) can be downloaded from the NRW website.
- *Forest harvesting industry code of practice* DEIR (2000). This applies health and safety regulations on state land and can be downloaded from the DEIR website.

Appendix 4: Outline for a forest harvesting operational plan

(The plan template is available from the Private Forestry Southern Queensland, PFSQ www.privateforestrysthnqld.com.au/)

PROPERTY DETAILS **Property manager/landowner:** **Address:** **Property address:** **Postal address:** **Phone number:** **Home:** **Mobile:** **Property description:** **Vegetation Management Act classification/s of harvest areas (if applicable):**
HARVEST MANAGER and/or CONTRACTOR DETAILS **Name:** **Address:** **Postal address:** **Phone number:** **Home:** **Mobile:**
HARVEST CONTRACTOR DETAILS (if different from the above) **Name:** **Address:** **Postal address:** **Phone number:** **Home:** **Mobile:**
RESOURCE DETAILS **Size of area to be harvested (ha):** Gross: ha Net: ha **Forest type:** *Example* – Dry eucalypt forest, wet eucalypt forest, cypress, etc **Commercial species:** *Example* – Spotted gum, grey box, blackbutt, white mahogany, Gympie messmate, etc **Range of commercial products:** *Example* – Sawlog, salvage, poles, girders, veneer billets, fencing timbers, etc **Management unit description:** *Example* – Specific areas to be logged as per attached map (attach a map) **Utilities present:** *Example* – Powerlines, buildings, underground cables, etc, as per attached map.

OPERATION LIMITATIONS

Safety in harvest operations:
Example – All standard harvest-operation signage must be erected before and during harvest operations and placed according to Workplace Health and Safety (WPHS) Queensland requirements, including the most current WPHS Queensland Forest Harvesting Industry Code of Practice. Appropriate person protective equipment (PPE) must be worn at all times during harvest operations. No person is to enter harvest area without appropriate PPE, which includes helmet, safety boots and high-visibility vest. All harvest machinery will have appropriate 'Roll over protection systems' (ROPS) and 'Falling object protective systems' (FOPS) according to WPHS.

Buffer and no logging zones:
Example – Areas where no logging is permitted should be identified, zones to be marked with red paint and recorded on the attached map.

Filter zones:
Example – Areas where no felling of trees is permitted in the direction of any waterway or watercourse. Filter zones should be identified in-field with paint marking and then recorded on the attached map.

Stand hygiene standards:
Example – All machinery-maintenance disposal material, i.e., grease canisters, oil, drums, filters and other rubbish, must be removed from the site.

Wet/dry weather operations:
Example – In negotiation with cutters and haulage contractors, haulage from the property will only occur in dry conditions.

Harvesting slope limit:
Example – Does the steepness of the terrain limit harvest operations in certain areas? Is it necessary to specify the type of machinery allowable (e.g., rubber-tyred skidder)?

Property access points:
Example – Main access to the property is from X road.

Tree-selection basis:
Example – The logging area will be marked by Y on a 'selection for retention' basis using orange paint. All unmarked trees are able to be harvested. OR Trees to be harvested will be marked with orange paint.

Tree-marking system:
Example – Trees able to be harvested = orange dots; Habitat trees = H; Poles = P; Buffer zones = red paint; No logging zones = 3 red lines, etc.

Boundary/logging areas clearly identified:
Example – Boundaries will be identified by yellow flagging tape as per attached map. In addition the harvest contractor will be shown boundaries in the field.

Maximum stump height:
Example – Stump height should be as low as possible (should aim for 300 mm).

Equipment restrictions:
Example – A rubber-tyred skidder is the only acceptable machinery for snigging operations on this property. OR A dozer with winch may be used to access steep areas.

Roading (construction and maintenance): *Example* – Road maintenance for access to the property and maintenance of loading ramps for log haulage, if required, will be negotiated between the landowner or property manager and harvest manager and/or contractor.

EMERGENCY FIRE EQUIPMENT

Contact, contact phone, fire equipment:
Example – Blue Ridge Rural Fire Brigade 07 5996 6555, tankers, mop-up.

Water access points:
Example – As per attached map or identified to the harvest manager and/or contractor by landowner or property manager.

HARVEST MANAGEMENT

Responsibility for compliance with regulations:
Example – The harvest manager and/or contractor, '......', will take full responsibility for compliance with local, state and commonwealth government regulations that pertain to forest operations performed on this property under this agreement.

Acceptance of liability is reliant upon the accuracy of information provided by the current landowner or property manager, such as:

- property ownership details
- property boundaries
- local government preservation zones
- other harvesting operation constraint

Acceptance of liability is also reliant upon the landowner or property manager's abidance of the conditions set out within this agreement.

Loading areas and log dumps:
Example – The location of loading areas and log dumps will be negotiated between the harvest contractor and the landholder or property manager and identified as per attached map. Any further loading areas, log dumps and ramps will be negotiated.

Snig tracks:
Example – The location of all major snig tracks will be negotiated with the landholder or property manager.

Drainage and erosion control:
Example – The harvest contractor will drain all snig tracks and major road access after harvest completion in accordance with Queensland's *Vegetation Management Act 1999*, as amended, and the *Code applying to native forest practice on freehold land 2005*. All associated costs of drainage will be borne by the harvest contractor.

Special feature management areas:
Example – No machinery will traverse the designated SFMA as identified on the attached map.

Post-harvest inspection:
Example – At the completion of harvest operations and post-harvest drainage, before any harvest machinery leaves the site there will be a joint site inspection by the landholder or property manager and the harvest contractor. (The harvest contractor will provide appropriate notice of anticipated inspection date and time.)

INFRINGMENT PENALTY CLAUSES

Damage to fencing:

Example – All damage caused by harvest operations must be repaired at the harvest contractor's expense.

Penalty for felling trees into a watercourse:

Example – Harvest contractor will avoid felling trees towards watercourses; if unavoidable all tree heads must be removed immediately.

Penalty for harvesting marked or non-available trees:

Example – Any marked trees felled without the landholder or property manager's permission will have the appropriate stumpage calculated and the harvest contractor will pay double the determined value. No cutting and snig rate will be paid for unauthorised removal.

Penalty for excessive stump height:

Example – If stump height is regularly excessive in the opinion of the harvest manager, the harvest contractor will be required to re-cut all identified stumps as directed by the landholder or property manager.

Management of logging smash or damage to retained trees:

Example – The harvest contractor will avoid causing damage to retained trees by applying skilled directional felling techniques. In a case where tree weight distribution determines that the tree will cause damage to a retained tree, the harvest contractor will consult the landholder or property manager.

The harvest contractor will take all necessary care to avoid damage to marked trees during snigging and loading operations. The landholder or property manager has the right to cease all harvest operations instantly, when excessive smash or damage to retained trees is occurring

Felling debris:

Example – The harvest contractor will avoid pushing logging debris or leaving felled tree heads around the base of retained trees.

Tree hang-ups:

Example – All hang-up trees must be removed instantly unless for unavoidable reasons this cannot happen. In a case where a hang-up has to be left for a period, the danger zone of one tree length around the hang-up must be cordoned off with flagging tape and appropriate danger signage erected.

HARVEST RATES AND TERMS

Stumpage payment rate:

Example – Rate/m^3, piece, l m, etc, as per attached schedule/s.

Stumpage payment terms:

Example – Payment to landholder at ramp prior to haulage, within 14 days of receipt of timber.

Cut and snig rates:

Example – Cut = \$10/m^3; snig = \$15/m^3.

Cut and snig rates for special products:

Example – Rate to be paid for cut and snig of various products, if applicable.

Proposed commencement date:

Example – Date and approximate time harvest operations will commence.

Proposed completion date:

Example – An indication of the likely timeframe required to complete the harvest operation.

Harvest plan prepared by:

Example – Person responsible for the completion of this Forest Harvesting Operational Plan.

PROPERTY OWNER RESPONSIBILITY

Example: The landholder or property manager shall not perform any forest management activities such as controlled burning, felling, tree paint-marking, during the period of time the property is being harvested by the harvest contractor.

Once the conditions for the harvest are agreed between the landholder and the purchaser or contractor, this can be signed by both parties as a binding agreement or contract.

Appendix 5: Forest tree species names

Commercial timber species from the case studies				
Common name	Botanical name	Durability class*		Uses**
		above-ground	in-ground	
broad leaved red ironbark	*Eucalyptus fibrosa*	1	1	construction, poles, sleepers, fence posts
brush box / supplejack	*Lophostemon confertus*	3	3	flooring, panelling
grey gum	*Eucalyptus propinqua (E. major)*	1	1	heavy engineering construction, poles
grey gum	*Eucalyptus longirostrata (E. punctata)*	1	1	sleepers, flooring, retaining walls
grey ironbark	*Eucalyptus paniculata (E. siderophloia)*	1	1	construction, poles, sleepers, fence posts
gum topped box, grey box	*Eucalyptus. moluccana*	1	1	construction, poles, cladding
Gympie messmate	*Eucalyptus cloeziana*	1	1	construction, poles, fence posts
red or pink bloodwood	*Corymbia intermedia C. gummifera*	1	1	property poles, fence posts, sleepers
red mahogany	*Eucalyptus resinifera*	1	2	cladding, fencing, retaining walls,
rose gum	*Eucalyptus grandis*	2	3	construction, ply
spotted gum	*Corymbia citriodora* subsp. *variegata; C. citriodora* subsp. *citriodora*	1	2	construction, poles, flooring, balustrading
tallowwood	*Eucalyptus microcorys*	1	1	construction, poles, flooring, sills
white mahogany, yellow stringybark	*Eucalyptus acmenoides*	1	1	construction, poles, cladding

Durability class ratings*

Above-ground life expectancy	In-ground life expectancy
1 >40 years	**1** >25 years
2 15 to 40 years	**2** 15 to 25 years
3 7 to 15 years	**3** 5 to 15 years
4 0 to 7 years	**4** 0 to 5 years

* Hopewell (2006). Construction timbers in Queensland: Properties and specifications for satisfactory performance of construction timbers in Queensland. DPI&F, Queensland.
** more information about timber properties and uses can be found on DPI&F's website www.dpi.qld.gov.au.

Other species from the case studies	
Common name	**Botanical name**
brown salwood	*Acacia aulacocarpa*
black wattle	*Acacia leiocalyx*
grass tree	*Xanthorrhoea johnsonii*
hairy bush pea	*Pultenea villosa*
hickory wattle	*Acacia disparrima*
lantana	*Lantana camara*
mutton wood	*Rapanaea variabilis*
Queensland peppermint	*Eucalyptus exserta*
red ash	*Alphitonia excelsor*
smooth barked apple	*Angophora leiocarpa*
paperbark tea-tree	*Melaleuca quinquinerva*

Glossary

Units and measurements

mm	millimetre
cm	centimetre
m	metre
lm	lineal metre
m^3	cubic metre
km	kilometre
kN	kilonewton

Terms and acronyms

advanced growth	a forest stand that has passed the regeneration stage and has established, actively growing trees (10–20 cm DBH) that are likely to develop into a mature stand in time.
ASL	above sea level.
assessable vegetation	vegetation in Categories 1–4 on property maps of assessable vegetation for which a permit is needed for clearing. Category 1 – endangered; Category 2 – of concern; Category 3 – not of concern; Category 4 – regrowth from pre-1990 clearing on agricultural and grazing leases; Category X – exempt vegetation.
barked	logs with the bark removed for presentation at sales.
bump trees	Trees adjacent to the snig track left standing to protect retained trees during snigging and harvested last of all.
CCA treatment	**treatment with** chromated copper arsenate (CCA), a chemical wood preservative used in pressure-treated wood to protect wood from rotting due to insects and microbial agents.
coppice	shoots that arise from either the stump or roots after harvest or where the main stem is damaged, broken off or destroyed by fire.
DBH	diameter at breast height; the stem diameter under bark measured at breast height, 1.3 metres above the ground.
doze	internal rot or decay associated with fungus, often seen as low-density discoloured wood, and leading to the development of pipe.
DPI&F	Department of Primary Industries and Fisheries.
DUB	diameter under bark.

durability rating — a value in a four-class rating system indicating a timber species' resistance to fungal organisms that cause decay (rot).

enrichment planting — seedlings of commercial species planted after a harvest and burn when there is a high risk of natural regeneration failing.

ESFM — ecologically sustainable forest management.

GPS — geographic positioning system.

high-grading — harvesting only high-quality trees, leaving mostly defective or non-commercial trees in the stand.

knot — the part of a branch remaining on the face of a log after a limb has been removed.

lignotuber — dormant buds present as swellings at the base of many eucalypt species from the early seedling stage. Containing nutrient reserves, they are capable of vegetative regeneration if the above-ground stem is killed or damaged. They form a reserve 'pool' from which the forest can regenerate after harvest, wildfires or other disturbances.

NLZ — non-logging zone.

old-growth forests — forests dominated by old, large, over-mature trees, often associate with dying crowns and tree hollows; some old-growth trees need not be large, particularly on poorer sites.

pipe — a cavity running along the centre of a log, usually associated with rot or termites.

PMAV — property maps of assessable vegetation that show the boundaries between non-remnant vegetation (areas that can be cleared without approval) and remnant vegetation (which require a notification of a forest practice to harvest or approval for clearing).

regeneration — tree reproduction through seedling or lignotuber bank. All eucalypts regenerate initially from seeds. Some rely on bare soil or fire disturbance to provide suitable seed beds for germination, while others can develop in a litter layer or grassy understorey. Regeneration usually occurs when seed crops coincide with good rainfall years. Many species, such as spotted gum, can also resprout from lignotubers, developed in the initial establishment phase after seed germination and initial growth, if the above-ground stem is killed or damaged. After harvesting, lignotuberous regeneration may form a dense secondary layer under the overstorey, particularly in the absence of grazing or fire events.

regrowth forests differ from old-growth forests in structure and often in species composition. Regrowth refers to forests that have previously been cleared or have had major disturbances, such as a very heavy harvest and treatment. Regrowth forests generally have no large over-mature trees and often have very high stocking. Potential for timber production in regrowth forests is generally much greater than for old-growth forests.

reset harvest removes a greater proportion of the stand, particularly in high-graded forests. By removing the poorly performing portion of the stand, the aim is to trigger a heavy regeneration response so that productivity can be restored.

SED UB small-end diameter under bark.

selective harvesting removal of certain trees in a stand using specific criteria (health, defect, spacing, optimum product size). This is the opposite to high-grading.

silvicultural treatment removal of the non-productive trees in the stand to give the best stems access to available site resources and allow regeneration to grow rapidly to the advanced-growth stage.

SNFM sustainable native forest management.

snigging tracks tracks created to move logs to the log dump after felling operations.

thinning from below removing trees that are subdominant, defective, of poor form or health and that are usually suppressed. The aim is to retain trees that have superior form, growth and vigour as future growing stock.

treatment *see* silvicultural treatment.

tree marking paint-marking trees before harvest to indicate which are to be retained.

uneven-aged forest: forest with a range of size and age classes, from regeneration and small saplings and larger actively growing trees to over-mature or 'senescing' trees.

unsound knot Usually means the knot either has rot associated with it, is not solid across the face, is checked or split and is a defect on the surface of the log.

whoa boy a cross track rill of dirt constructed to direct water off the road

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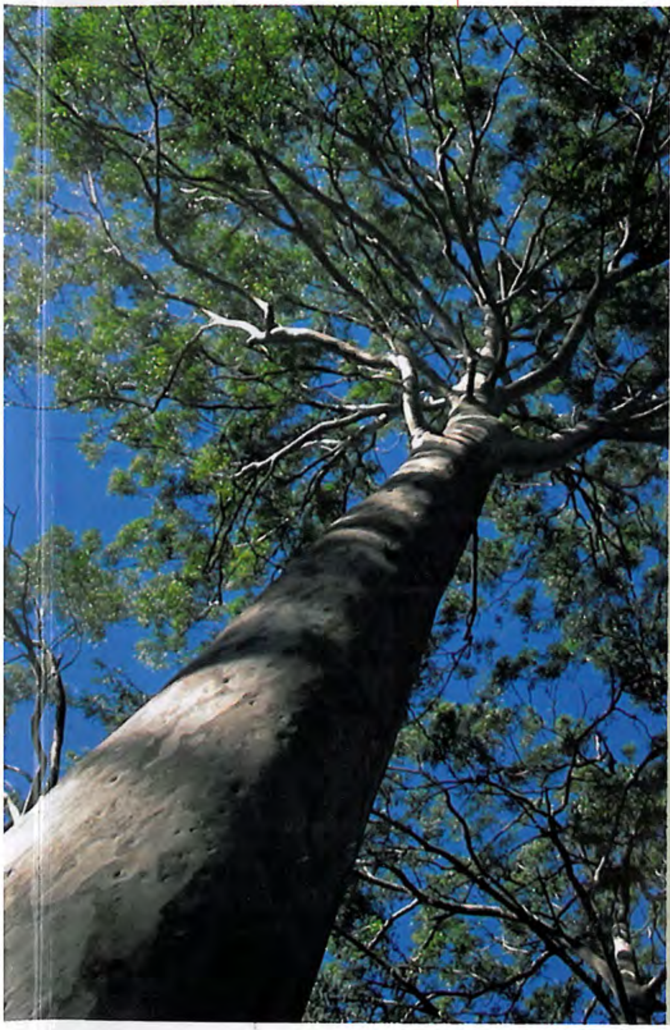

sustainable native forest management

case studies in managing private native forest in southeast Queensland

Farm Forestry

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