Case study 2

Restoring productivity in a high-graded spotted gum–ironbark forest

Sustainable management by restoring productivity in high-graded stands

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.

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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, was typical of large areas of land used for both grazing and timber production in the Wide Bay region of south-east Queensland. The property covered 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 was between 750 and 1000 mm and most of the property had an undulating slope of 0–10˚. This forest was 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 included 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 was mostly grassy, although brush box (supple jack) and wattle were 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.

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 3.1.

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 (Figure 2.3). This regeneration formed 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. Some aspects of the 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 retained were paint-marked for easy identification.

Advanced-growth areas

Different thinning treatments were established to demonstrate how growth rates varied between the different 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 pole 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 to compare growth response between burnt and unburnt 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 not advisable 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.

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
Unburnt – 1.2 m radius	0.81	2.4	0.86	2.7
Unburnt – unthinned	0.44	1.5	0.57	1.6
Burnt – clear-all	1.20	1.8	0.97	1.6
Burnt – 1.2 m radius	1.59	2.9	1.52	2.8
Burnt – unthinned	0.55	1.3	1.36	2.1

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

When to burn

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

Some facts

- If burning is too frequent:
  - plant diversity is lost
  - nutrients are lost
- If burning is too intense:
  - tree growth is reduced
  - woody weeds increase
- Good burning practice

• Burning reduces the risk of wildfire • Burning controls pests and diseases • Burning encourages grasses for grazing management	ensure fire will carry	balances: – timing and intensity – fuel loads – a mosaic of burnt and unburnt areas – species mix

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

In the advanced-growth area thinning to achieve different spacings for pole or sawlog productivity was based on strict selection criteria for retained trees. In general a pole stand is managed at a higher stocking than a sawlog stand. Although the aim was to manage a potential future pole stand of approximately 200 stems per hectare, only about 100 trees per hectare were of satisfactory standard. Better 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 high 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 height 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.

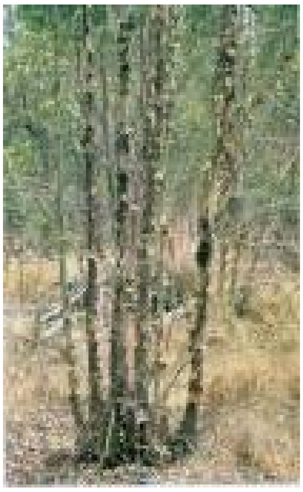
The absence of any past fire management had left the stands at risk of wildfire from elevated fuel loads. Logging debris had contributed to the fuel loads. Regular fire management at a frequency of about three to five years will reduce fuel loads and the risk to retained trees. Heavily regenerating areas 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 and often, as was the case here, cost-positive and profitable in the short to medium term.

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

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



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

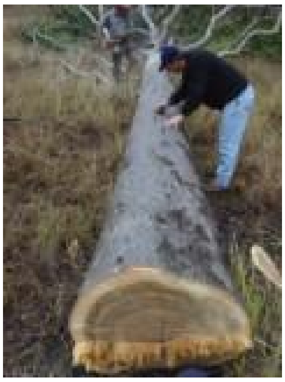
2.4 Feed trees used by the yellow bellied glider were preserv where they occurred in the study area. This tree shows the ty V-shaped feeding scar.

2.5 Multiple stems of a white mahogany cut to leave a single stem (a) and older spotted gum coppice resulting from a previous harvest (b).

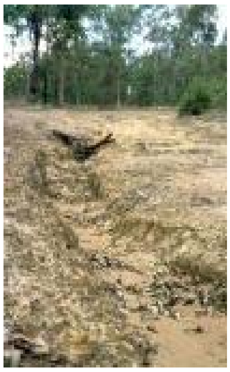
2.6 The residual stand in the unburnt, cl section of the regeneration

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

2.8 A lignotuber resprouting just four weeks after the burn (a) coppice growth 11 months after the fire (b).



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



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