October 2023

Private Forestry Guidance Materials

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Forest & Wood Products Australia

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Important information

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Researchers:

Pat Groenhout, Jill Roscoe & Tuesday Phelan
Greenwood Strategy Solutions Pty Ltd
Daylesford, Victoria, 3460

Braden Jenkin
Sylva Systems Pty Ltd
Warragul, Victoria, 3820

Mark Annandale & Chloe Annandale
Landroc Pty Ltd
Woombye, Queensland, 4559

Tom Schraenkler
TWS Project Partners
Berwick, Victoria, 3806

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GREENWOOD STRATEGY

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Introduction

Background

To meet Australia's, and the world's, increasing demand for wood fibre requires a policy approach that maximises the role of small-scale, privately owned forests in fibre supply.

There are barriers to participation of private landholders and Indigenous groups in commercial forestry. One of the most significant obstacles is limited knowledge about how plantations and native forests can be managed as a legitimate and profitable land use that contributes meaningfully to Australia's future wood fibre needs. Forest & Wood Products Australia (FWPA), with funding from the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF), engaged Greenwood Strategy Solutions Pty Ltd to undertake a comprehensive project to collect, collate, analyse and make available the large volume of historic trials and publications related to the topic and to prepare detailed Guidance Materials that will assist in breaking down these knowledge barriers.

This document focuses on private native forests. It can be read as a standalone reference or together with the other guidance materials documents, including reports and information sheets.

Purpose

This document provides a generic overview to the business of private native forestry in Australia. It is supported by a suite of more-specific documents that address each types of forest management as well as providing detail on topics of particular interest.

It is intended to inform people and organisations interested in developing private native forestry as an enterprise. It aims to provide sufficient detail to assist individuals and businesses to make well-considered decisions about forestry as a serious and viable land-use option that can provide commercial, social and environmental outcomes. This is one of several Guidance Materials publications prepared as part of the Australian Government's commitment to delivering the National Forest Industries Plan.

The Private Native Forestry Guidance Materials are not intended to provide operational instruction about how to grow forests or manage them as a business. They are an introduction to the range of considerations that landowners and businesses should take into account when managing forests for commercial outcomes.

Structure of the guidance materials

There are four guidance documents in this series, covering the following topics:

1. An introduction to the business of small-scale farm forestry, private native forestry and Indigenous managed forest lands.
2. Farm forestry.
3. Indigenous owned and managed forests.
4. Private Native Forestry.

References to relevant publications are provided within the guidance documents and can be accessed via the FWPA online database of relevant publications. The database includes actual publications and links to a vast catalogue of material that has been produced by government departments, programs and regional plantation groups over many years.

The guidance materials also include a series of information sheets and case studies that provide more detail on specific topics of interest.

Who should use the Private Forestry Guidance Materials?

Audiences that could benefit from this guidance document include:

- landowners
- advisers
- regulators
- non-government organisations
- timber processors and manufacturers.

Professional advice

Forestry is a specialist discipline and wood products markets are quite different to markets for other commodities. Many land owners will utilise the advice of professional agronomists when looking to get the most out of their cropping or grazing activities. Forestry is no different. It is strongly recommended that private native foresters seek the advice of professional forestry service providers to understand how commercial forestry can best be integrated into their specific agricultural enterprise and obtain detailed site-specific guidance on how to go about this.

Private native forestry in context

What is private native forestry?

Native forest is a forest category within the National Forest Inventory (NFI) that comprises natural forest types dominated by native tree species within their normal range at a specific location. Native forest does not include commercial plantations (even if they are of native species) or other forest categories used in the NFI[1].

Private native forest is broadly defined as natural forest or woodland that grows on privately owned land. The New South Wales Environment Protection Authority defines private native forestry as the management of native vegetation on private property for sustainable logging and timber production[2].

Privately owned native forests occur across Australia. However, their management for commercial timber production is heavily concentrated in specific regions. Queensland, northern New South Wales and Tasmania currently account for the majority of timber production from private native forests.

Private native forest description

Forest area

There are about 132 million hectares of native forest in Australia, of which about 41 million hectares are privately owned and a further 47 million hectares are on leasehold land (see Table 1).

Tenure class	Forest area ('000 hectares)	Proportion of total native forest area
Leasehold forest	47,246	36
Multiple-use public forest	9,772	7
Nature conservation reserve	21,719	17
Other Crown land	11,042	8
Private forest	41,031	31
Unresolved tenure	805	1
Total native forest	**131,615**	**100**

Table 1*: Area of native forest by land tenure (2018)*
Source: https://www.awe.gov.au/abares/forestsaustralia/profiles/australias-forests-2019

[1] NFI https://www.awe.gov.au/abares/forestsaustralia/australias-national-forest-inventory accessed on the 19/05/2022
[2] NSW EPA https://www.epa.nsw.gov.au/your-environment/native-forestry/about-private-native-forestry accessed on the 19/05/2022

Distribution

General distribution of native forests

The distribution of natural forest across Australia is broadly determined by climate and soil properties, although other factors, especially fire frequency and intensity, are also important.

Most of Australia is too dry to support forest vegetation systems. Arid or semi-arid lands occupy about 70% of the interior where average annual rainfall is less than 350 millimetres[3]. Native forests are generally in areas with an average annual rainfall of more than 500 mm, except for Mallee forests, where annual rainfall can be as little as 200 mm.

Distribution of private native forests

Private native forest is distributed throughout Australia but concentrated in northern Australia (see Figure 1). This distribution is important because the potential commercial suitability varies considerably throughout the country. There are also different legal and regulatory regimes in each state and territory that may be a barrier to commercial management of native forests. Commerciality is affected by a range of factors, including the suitability of timber species, the presence of infrastructure and the availability and proximity of markets.

Describing native forests

Native forests can be described and measured in various ways, depending on the interests and values of each forest owner. These may relate to the potential for commercial products, environmental characteristics, recreation and community interests, or a balance of multiple and interactive values. Although the following commentary has a commercial focus, the important interrelationship with social and environmental values is also recognised.

One of the most common descriptions is forest type. The categories of forest types vary depending on scale and purpose. Usually, native forests are described in terms of either the dominant species types or forest structure or some combination of these. This categorisation is particularly important when considering the commerciality of forests and the ways in which they can be sustainably managed (silvicultural regimes).

National-scale forest types

At the national level, native forests are distributed across eight broad forest types, defined by the dominant species. Within these there are three forest structure types that are described in terms of percentage crown cover (woodland – 20 to 50%; open forest – 50 to 80%; and closed forest – >80%). These forest structure types can be further described in terms of forest height (low – 0 to 10 m; medium – 10 to 30 m; and tall – >30 m). Table 2 presents the distribution of forest types by broad species category and crown cover. The majority of commercially viable, accessible and legally available native forest types are Eucalyptus species growing as medium and tall open forest. Callitris (cypress) is the next largest category. Other forest types are usually either non-commercial (e.g. Acacia and Melaleuca spp) or excluded from harvesting (e.g. Rainforest and Mangrove).

[3] https://www.agriculture.gov.au/agriculture-land/forestry/australias-forests accessed 24/06/22

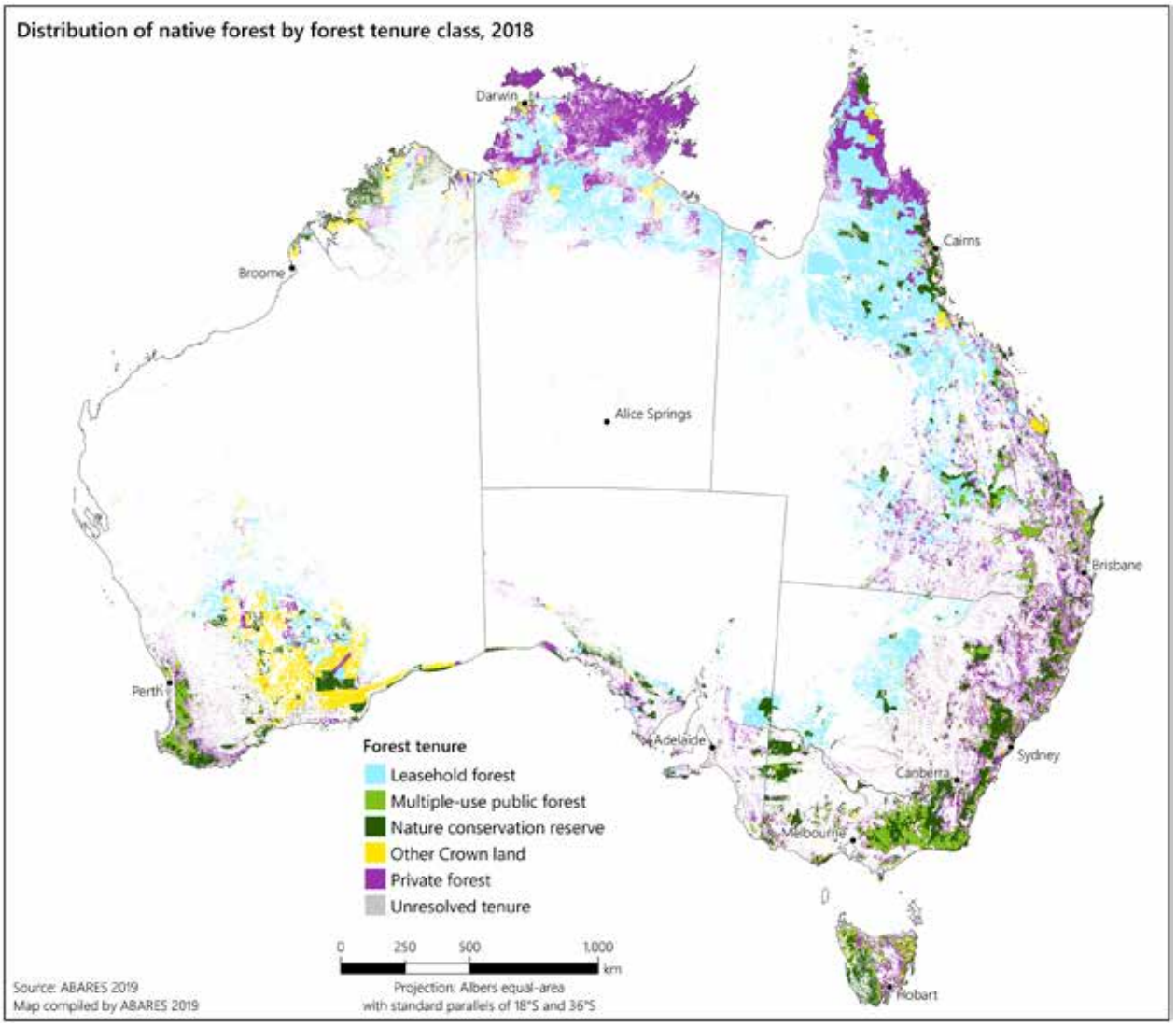

Figure 1: *Distribution of native forest by tenure class. (2018)*

Native forest type	Woodland	Open	Closed	Unknown	Total
Acacia	8,536	2,233	44	0	10,813
Callitris	951	1,060	0	0	2,011
Casuarina	1,070	150	16	0	1,236
Eucalypt	72,829	27,776	454	0	101,058
Mangrove	63	370	420	0	854
Melaleuca	5,416	938	28	0	6,382
Rainforest	0	1,006	2,574	0	3,581
Other native forest	2,590	429	85	2,576	5,679
Total native forest	**91,455**	**33,962**	**3,622**	**2,576**	**131,615**

Table 2: *Area of native forest by crown cover, 2018 ('000 hectares).*

The distribution of native forest in Australia by type and crown cover at 2018 are presented in Figure 2 and Figure 3 (Source: ABARES, 2019) respectively.

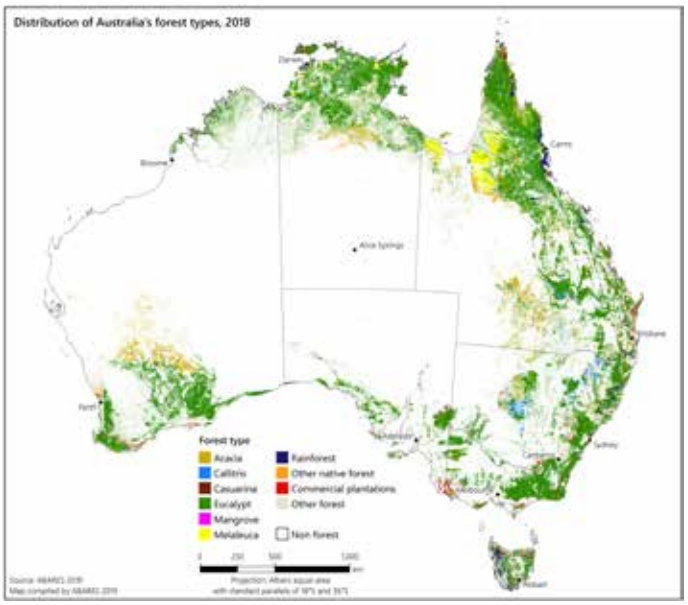

Figure 2*: Native forest distribution by type.*

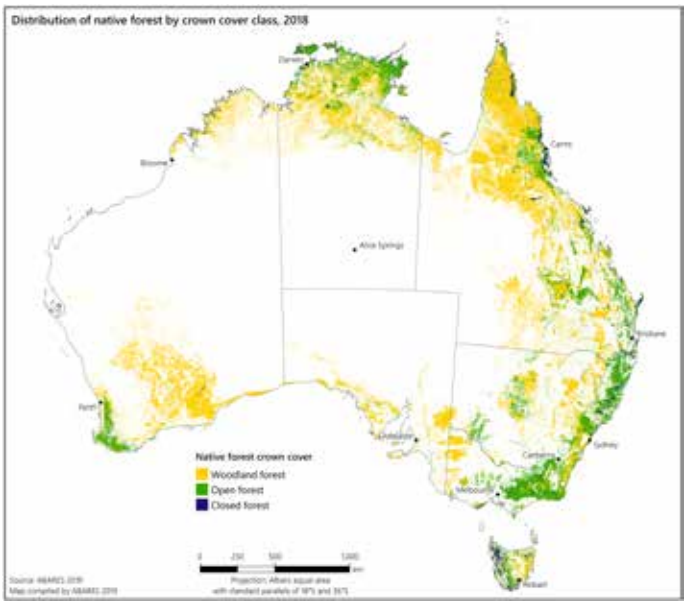

Figure 3*: Native forest distribution by crown cover.*

Regional forest types

At the regional level, description of forest types usually becomes more specific. Forest types are typically defined in terms of the dominant species combinations that occur over large regional areas. There are numerous regional-scale descriptions of forest type in Australia, many of which align with one or more of Australia's 89 recognised bioregions[4]. Their presence and distribution are influenced by regional climate, geology and other geographic factors. They include examples such as box-ironbark woodlands in Victoria and New South Wales, or red gum forests along the Murray River. These regional-scale descriptions can be a useful starting point for determining whether native forests in a specific region are likely to be commercially productive. They will often also provide a guide to the likelihood that a region's forests are protected from commercial production by legislation or regulation.

Local forest types

The localised patterns of species distribution of native forests, particularly Eucalyptus forests, are strongly influenced by site-specific factors such as topography, aspect, slope position, soil fertility and water availability (Florence, 1996). Because of the distinctive growth and appearance (e.g. crown shape and colour) of different species, the distribution of forest types at the local level can often be readily determined using aerial photography or other similar remote sensing techniques. Systems of local forest type mapping have historically been developed by state and territory government forest management agencies for application to public land but are often equally applicable to private native forests. In New South Wales, for example, there are 234 defined forest types (including artificial and non-forest categories) that are used to describe and define commercial native forests (Baur, 1965).

Native forest productivity

One of the important reasons for understanding and applying forest type descriptions is the relationship between forest types and forest productivity. Productivity is an additional measure that can be used to describe native forests. In the context of these guidance materials, commercial productivity, or the capacity of the forest to grow marketable log products, is the focus. However, productivity can be measured for a range of variables (e.g. water yield and biodiversity) depending on the objectives of the forest owner.

Measuring native forest productivity is important for determining whether or not commercial harvesting is likely to be viable. It is also essential for assessing the intensity of commercial harvesting through time (regularity of harvest events to allow the forest to recover) and across the extent of a stand or property (size of harvest units). Native forest commercial productivity is typically measured in terms of the growth capacity (sustainable yield) of the forest, or the volume of marketable log products that can be sustainably grown while maintaining forest quality and other forest values.

[4] https://www.awe.gov.au/agriculture-land/land/nrs/science/ibra/australias-ecoregions

Productivity class	Sawlog MAI range (m^3/ha/yr)
Limited	0.01-0.07
Very low	0.08-0.14
Low	0.15-0.28
Moderately low	0.30-0.49
Moderate	0.50-0.95
Moderately high	1.0-1.45
High	1.5-1.9
Very high	2.0-2.9
Extremely high	**3.0-5.6**

Table 3: *Australian native forest sawlog productivity categories*

This growth rate is expressed as Mean Annual Increment (MAI)[5] and measured in m^3/ha/yr.

Productivity of Australian native forests typically ranges from as low as 0.01 m^3/ha/yr of sawlog to 5.6 m^3/ha/yr of sawlog. Davey and Dunn (2014) undertook a comprehensive review of native forest sawlog productivity for Australian forests (see Table 3).

The work of Davey and Dunn identified about 22.3 million hectares of sawlog-growing private native forests in Australia (see Table 4). They identified a MAI of 0.08 m^3/ha/yr as the minimum viable sawlog productivity (Very low category in Table 3), meaning that about 16.5 million hectares is considered potentially commercial. Although the majority of commercially viable private native forests (10.2 million hectares, or nearly two-thirds) are in the 'very low' productivity class, there are some considerable areas (more than six million hectares) of higher-quality private forests.

Productivity class	State/territory area ('000 ha)								
	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Total
Limited	1,042	10	3,153	17	65	71	1,394	-	5,751
Very low	729	53	1,340	35	66	117	7,891	-	10,231
Low	**1,585**	71	734	-	436	200	-	-	3,025
Moderately low	**296**	109	948	-	29	187	-	-	1,569
Moderate	433	133	64	16	78	113	-	-	838
Moderately high	186	74	19	2	3	66	-	-	350
High	345	34	-	-	9	10	-	-	398
Very high	47	30	-	-	-	8	-	-	85
Extremely high	17	17	-	-	1	1	-	-	35
Total	**4,678**	**530**	**6,258**	**70**	**687**	**774**	**9,285**	**-**	**22,282**

Table 4: *Productivity classes for Australian private native forests.*

[5] Mean Annual Increment is the average yearly growth of a forest as measured at a specific age.

	Total annual native forest production ('000 m³)		Estimated annual private native forest production ('000 m³)	
Jurisdiction	**2020/21 (ABARES)**	**2030 (estimated)**	**Low**	**High**
NSW	400	400	275	330
Vic	916	15	15	30
Qld	289	250	168	220
SA	0	0	0	0
WA	415	0	0	0
Tas	1,308	1,300	276	276
NT	**0**	**0**	**0**	**0**
ACT	**0**	**0**	**0**	**0**
Total	**3,328**	**2,050**	**734**	**886**
Percentage (2030)		**100%**	**36%**	**43%**

Table 5: *Estimated private native forest production levels (2021 and 2030) compared to total production.*

Timber production from private native forests

It is difficult to source reliable data about the production of timber from privately owned native forests in Australia. However, it is accurate to say that in key regions (northern New South Wales, Queensland and Tasmania), private native forest timber constitutes a significant proportion of total native forest timber harvest.

Parsons (1999) noted that about 2.5 million m³ of logs were harvested annually from private native forests in the eastern states (including Victoria). However, that was dominated by private native forest harvesting in Tasmania, which has declined considerably from a high of 2.5 million m³ in 2000 to 276,000 m3 in 2021 (Private Forests Tasmania, 2021). Lewis *et al* (2020) estimate that 58% of all native forest timber production in Queensland is from private property and about 56% of the total in northern New South Wales. Stakeholder surveys by the NSW Department of Primary Industries in 2017 indicate that the figure for northern New South Wales is about 275,000 m³ annually, or 38% of total native forest production[6]. However, ABARES[7] (2021) statistics indicate that total native forest harvest levels declined in New South Wales from 980,000 m³ to 400,000 m³ between 2017 and 2021. That is due to the reduction in public native forest harvest, so it is likely the proportion from private land has increased. There are operations elsewhere in New South Wales but at much lower levels. Anecdotal evidence suggests that private native forest harvest levels in Victoria are probably less than 30,000 m³ annually, and even lower in Western Australia and the Northern Territory. There is no private native forest harvesting in South Australia.

Based on this evidence, it is estimated that current private native forest harvest levels are between 730,000 m3 and 890,000 m³ annually. It is important to note that, while ABARES captures annual harvest levels for Australian forests, there is a high likelihood that some private forest harvest is not recorded. ABARES reported a total native forest harvest volume (including public forests) of 3.328 million m³ in 2021. That means that private native forestry contributes up to 25% of all native forest harvest nationally. That proportion is likely to increase over the coming decade, as harvesting in public native forests is set to cease in Western Australia and Victoria. By 2030, private native forest could therefore contribute more than 40% of total native forest timber production levels.

[6] https://www.dpi.nsw.gov.au/forestry/private-native-forestry accessed 24/08/2022

[7] Australian Bureau of Agricultural and Resource Economics and Sciences

Sustainable management of private native forests

Sustainability in context

What is sustainable forest management?

Traditionally, sustainable forest management referred to maintenance of the productive capacity of forests or sustained yield. However, the concept has evolved with expanding recognition of the roles that forests play for communities, the environment and the economy. Now, sustainable forest management means management of forests to sustain the full range of environmental, social and economic benefits they offer. However, there are widely differing views about what factors should be considered important in the three sustainability categories and which of those should carry more weight. There are also different expectations about what sustainability means for natural forests compared to plantations, and for forests where people have a strong cultural connection.

Australia's sustainable forest management framework

Australia's sustainability framework for forests is well established. It includes national and state level policies, regional forest agreements, a framework for criteria and indicators to measure sustainability and independent third-party forest management and chain of custody certification.

Multiple use forests

Privately managed native forests are used for a wide range of purposes and provide numerous commercial and non-commercial benefits, including timber production and livestock grazing, honey production and environmental services such as water, flora and fauna conservation and carbon accumulation and storage (Ryan *et al*, 2002).

Balancing economic, environmental and social values

Private native forests provide important social and cultural services for both Indigenous and non-Indigenous communities, especially in northern Australia, where continued traditional use of natural forests for a range of benefits is a common aspect of community life. The cultural, social, environmental and economic needs of Traditional Owners in these landscapes are often closely intertwined. There is the potential for conflict between the needs of Traditional Owners and non-Indigenous commercial interests that need to be carefully weighed up and balanced.

There is also a strong link between livestock grazing and native forest management on private and leasehold land. Silvo-pastoral systems (those that integrate forestry and grazing) are a normal feature of private native forestry in Queensland and northern New South Wales, where open woodland supports pasture growth for broadacre grazing and is commercially viable for timber production. Even in areas where private native forest timber production is less common, natural forests often support livestock. Grazing can have adverse impacts on native forest systems, including regeneration and other environmental and biodiversity values. However, it is also a primary source of income for many private native forest owners and so there is a need to recognise and balance these two parallel land-use requirements.

Private native forests offer a range of environmental and ecosystem benefits in the form of biodiversity, carbon accumulation and storage, management of water quality and yield and soil health. These benefits accrue for individual property owners as well as at the regional scale, where private native forests complement the broader public forest estate.

Management of private native forests needs to take account of these additional ecosystem services.

Policy, legislation and regulation

When it comes to managing forests operationally, each state and territory has its own policies, egulations and planning requirements and each has a unique approach to the way in which private native forestry is regulated. It is important to understand and comply with the requirements for your location and circumstances. In some jurisdictions, the requirements for private native forest management are clearly documented and well supported so that landholders can quickly and easily determine how to go about managing their forest. In other jurisdictions, this is not the case.

There are variations as to what level of government (state or local) is responsible for approving and regulating forestry activities. Australia's State of the Forests Report (2018, Indicator 7.1a) provides a schedule of key legislation relating to the conservation and sustainable management of Australia's forests, for each state and territory[8].

Forest management certification

Forest management certification is a voluntary, market-based regulation framework that relies on independent, third-party verification against documented standards that forests and wood products supply chains are managed sustainably.

In Australia two certification standards operate: Responsible Wood, under the international Program for Endorsement of Certification Standards (PEFC), and Forest Stewardship Council (FSC). In some cases, certification is required by purchasers of forest and wood products. Not being certified can be a barrier to market entry. Certification, particularly for small private native forest owners, can be a complicated and expensive exercise. However, a number of forest management service providers in Australia offer group certification schemes that allow for affordable participation by small growers.

[8] https://www.agriculture.gov.au/sites/default/files/abares/forestsaustralia/documents/sofr_2018/web%20accessible%20pdfs/SOFR_2018_Criterion7_web.pdf accessed on 01/07/22.

Native forest silviculture

What is silviculture?

Silviculture is the art and science of forest management. It is about managing the establishment or regeneration, growth, structure and health of forests to achieve defined objectives. This concept is more complex for native forests than for planted forests. Native forests respond to disturbance in different ways depending on the characteristics of the particular tree species, the history of management and other environmental and biological factors. In natural forests, the science of silviculture aims to mimic natural disturbance and response dynamics to ensure that harvesting results in healthy, regenerating ecosystems, maintaining the wider range of forest values while also allowing for production of timber.

Clinnick *et al* (2008) describe the practice of silviculture as the employment of techniques to alter the structure of forest stands through: the removal of trees so that competition between trees is reduced and growth is encouraged; removal of damaged or undesirable trees or other vegetation components; changing the forest structure to promote desirable values (timber, biodiversity and so forth); and encouraging the regeneration of desirable species and forest structure. Most commonly, silvicultural techniques are focused on harvesting strategies and regeneration practices but can also include the use of fire, thinning and other interventions. It is important to acknowledge that many of Australia's natural forests have a very long pre-European history of intervention. Traditional Owner management practices have been well documented and included the extensive use of fire to manage forest ecosystems for preferred outcomes.

If silvicultural intervention is intended to mimic natural disturbance and response dynamics, then determining the most appropriate silvicultural regime requires an understanding of the ecology and growth habits of natural forests. Native forest timber production in Australia is dominated by *Eucalyptus* species, and they are the focus for this discussion, with a brief discussion on cypress (*Callitris* spp) forests, as they are also important sources of native forest timber production.

One of the most basic principles of silviculture is that forest trees compete to varying degrees for site resources, which include nutrients (soil), water and light. When disturbance occurs and trees are removed or damaged, it provides the opportunity for surrounding trees to respond (grow) and take up those resources. For some forest types that regenerate at a landscape scale, following intense disturbance, in dense, even-aged stands (e.g. mountain ash and silvertop ash – E. *sieberi*), more-dominant trees will outcompete less-dominant trees that subsequently die, a process known as self-thinning. In other forest types (e.g. mixed hardwood forests in northern New South Wales), a range of species will be present with varying degrees of competitiveness that can co-exist until a relatively low-intensity disturbance provides an opportunity to respond, if the remaining trees are healthy enough to do so. This is often the challenge in degraded eucalypt forests where the remnant stand is made up of older, unhealthy trees that are not capable of responding to a growth stimulus. By contrast, cypress regeneration can remain dormant[9] for many decades and still retain viability to generate a growth response to disturbance.

Florence (1996) provides the most comprehensive scientific framework for Australian native forest silvicultural practice. Jacobs (1955) provides the fundamental framework for eucalypt growth habits and forest structure that underpin modern silvicultural principles. There are also a number of more accessible and easy-to-understand guidelines (e.g. NSW EPA Silvicultural Guidelines, undated; Queensland DAF, 2018) and codes of practice (Tasmania, Victoria, New South Wales and Queensland) that can be used by landowners to apply appropriate silvicultural practice.

[9] This characteristic of cypress forests is referred to as 'stand lock-up'.

Forest health and quality

It is well documented that native forests on privately owned land are often highly degraded, whether considered in terms of commercial timber production or from a broader ecosystem health perspective (e.g. Clinnick *et al*, 2008; Ryan and Taylor, 2006, Lewis *et al*, 2020). The most common reasons are addressed below.

High-grading silviculture

Historic timber harvesting practices have often focused on removal of larger and healthier trees of preferred species for log production, leaving behind poorer-quality growing stock that is less capable of responding to disturbance and less likely to contribute to healthy regeneration. This practice is often referred to as high-grading and can result in long-term changes to the presence and distribution of species. It is a particular issue in mixed species dry sclerophyll forests.

Grazing

Grazing can be a practical parallel or integrated land-use with healthy natural forests and native forest timber production. However, cattle grazing can have a significant adverse impact on native forest health and productivity. That is especially the case with overgrazing or when inappropriate fire regimes, often those targeted at short-term improvement in bush pasture, are employed. A combination of such practices can severely limit healthy regeneration as well as contributing to a reduction in the presence and health of natural understorey.

Land clearing

In many instances, private native forest areas were previously cleared for broadacre grazing or other agricultural pursuits. While native forest species have returned in these areas, these regenerated natural forests are often quite depleted with respect to species diversity, forest health and soil quality.

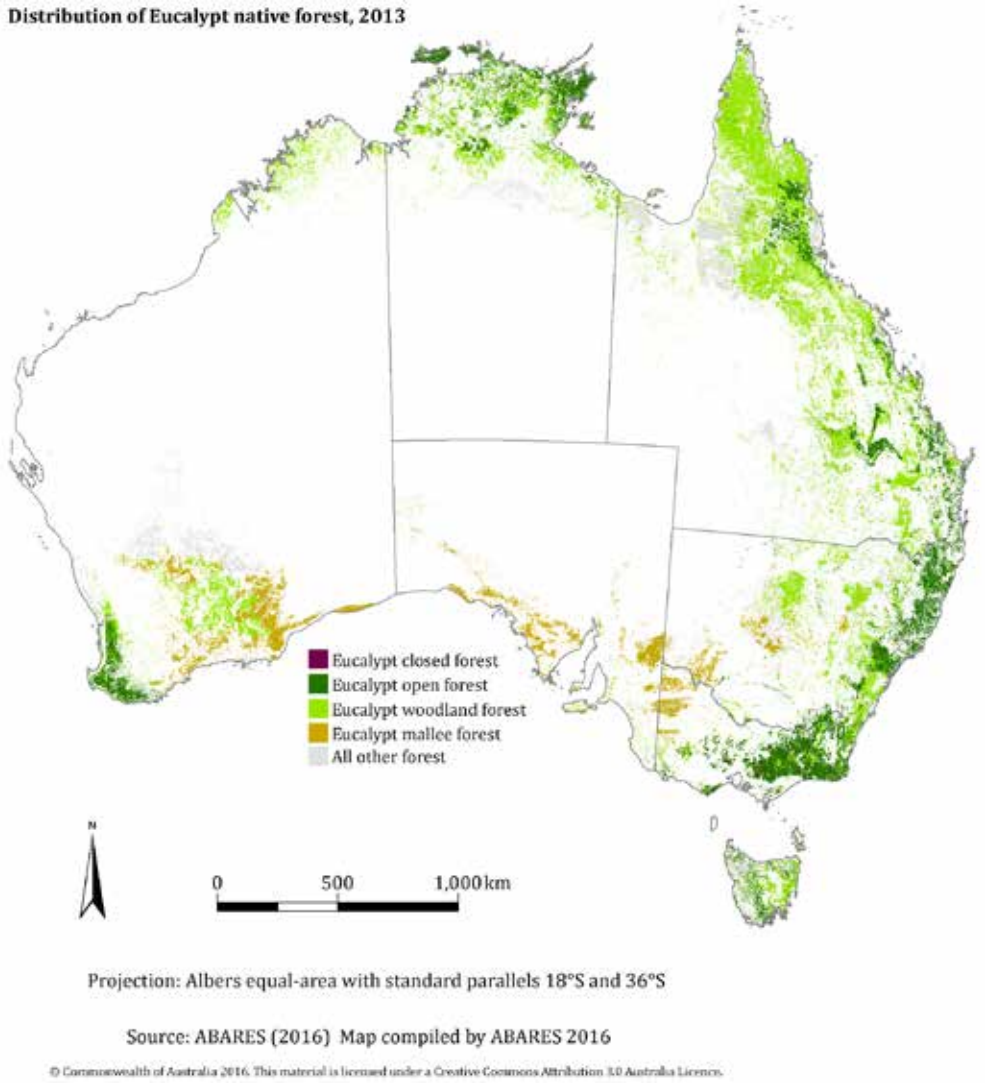

Figure 4: *Distribution of native eucalypt forests in Australia.*

Silviculture for forest health

An important focus of silvicultural intervention in private native forests is the implementation of strategies that can restore and enhance forest health, vitality and productivity, while supporting complementary agricultural land uses.

Eucalypt silviculture

What are eucalypts?

The eucalypts comprise up to 900 tree species across three botanical genera: *Eucalyptus* (e.g. *E. regnans* – mountain ash), *Corymbia* (e.g. *C. maculata* – spotted gum) and Angophora (e.g. *A. bicostata*, smooth-barked apple). More than 700 of those species are Eucalyptus, as are most of the native timber producing species, with the exception of spotted gum and some bloodwoods *(Corymbia* spp.).

Vegetation gradients

There are more than 90 million hectares of eucalypt forests in Australia (see Figure 4) and they grow across a vast range of soil types and fertility, climatic conditions, elevations and water availability. An important distinction between types of eucalypt forests is the way they grow in these different conditions. These vary from dry, low fertility sites (dry sclerophyll forests), through to moister, fertile sites (wet sclerophyll forests) and occasionally in rainforest settings.

This vegetation gradient has important implications for species preference, regeneration and forest structure, and therefore for silvicultural practice. Some species (e.g. spotted gum and blackbutt – E. pilularis) grow across a wide range of conditions and behave in different ways depending on those different conditions. Other species (e.g. mountain ash) are quite limited in their ecological range and in their regeneration and growth strategies. Figure 5 presents the vegetation gradient for common forest types that occur in New South Wales

Eucalypt regeneration strategies

Natural eucalypt forests employ a range of regeneration strategies including both sexual (seed production) and vegetative (lignotubers and coppice). Response to disturbance varies with forest types and species. Regeneration strategies are strongly aligned with species and site conditions. For example, mountain ash requires large canopy openings and intense soil disturbance to create an appropriate substrate for large-scale regeneration. In contrast, spotted gum in dry sclerophyll forests can respond to various levels of disturbance with a mix of seedling, lignotuberous (advanced growth) and coppice regeneration. River red gum (*E. camaldulensis*) requires routine flooding to ensure healthy regeneration. A limited number of widely distributed eucalypts utilise different strategies in different conditions. For example, spotted gum in wet sclerophyll forests typically regenerates only from seed, whereas in drier conditions it will use the range of regeneration strategies mentioned

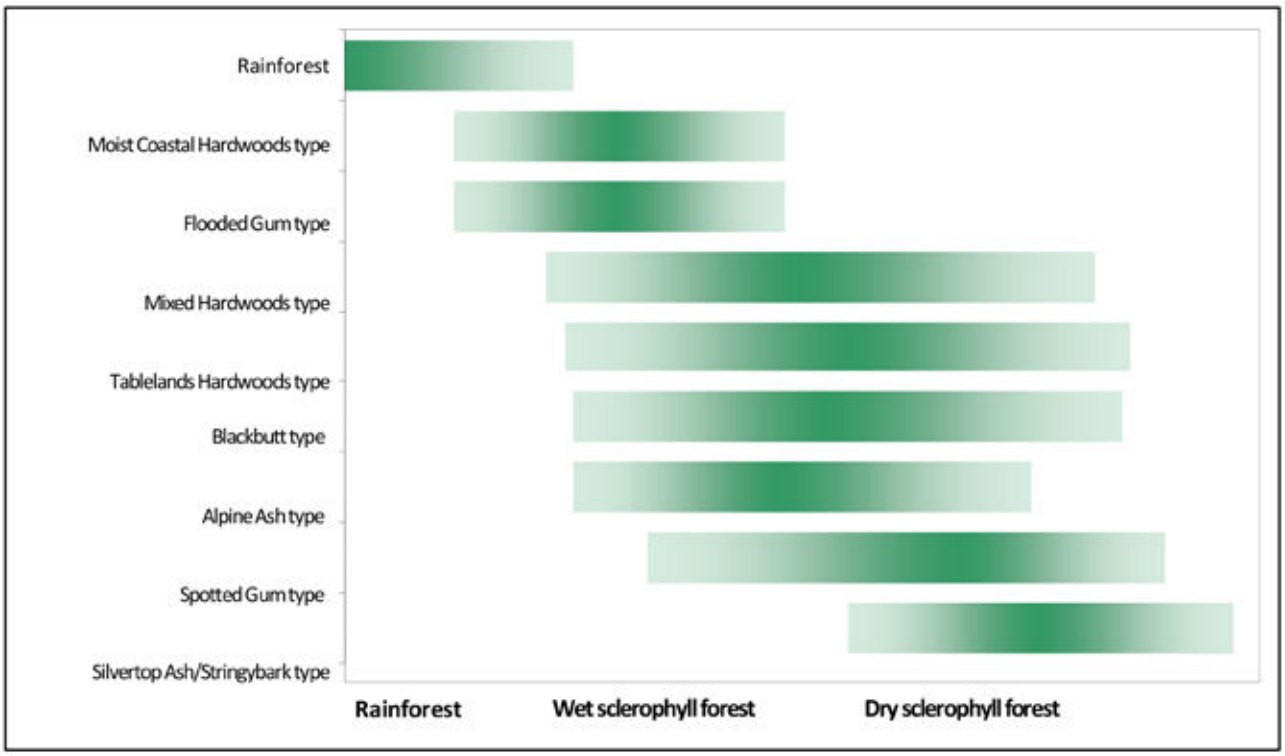

Figure 5: *Dry sclerophyll – wet sclerophyll – rainforest gradient for New South Wales eucalypt forest types. (Source NSW EPA, undated)*

above. Vegetative regeneration is much more common in dry sclerophyll forests than in wet sclerophyll forests.

For eucalypt species that rely on seed regeneration, it is important to understand the process and timing of seed production. While seed is likely to be present in mature forests in most years, the production of good seed crops occurs at intervals between two and seven years. This means that for some species, regeneration after disturbance (e.g. fire or harvest) may need to be supplemented with seed that has been collected and stored for that purpose.

Growth habits and forest structure

An understanding of the growth stages of eucalypt trees, tolerance of the species and the implications for forest structure is required to determine an appropriate silvicultural regime.

Growth stages

There are five recognised growth stages of eucalypt trees: regeneration, sapling, pole, mature and overmature/senescing (sometimes senescing is described as a separate stage). Typically, the four advanced (post seedling) growth stages can be readily recognised and described visually (see Figure 6). The five growth stages are described in Table 6.

Ironbarks and mahogany species are tolerant and can survive beneath the canopy of other, taller tree species. They are slower growing and can regenerate if small canopy gaps open up. They often occur in mixed species stands beneath less-tolerant species and can be characterised as growth restricted if suppressed for too long. Growth restriction can be a significant issue for forest health and productivity, especially if dominant higher-productivity and higher-value stems that have suppressed the understory are removed (high grading), leaving behind a growth restricted stand that has limited ability to respond to disturbance and may be too old to support regeneration. Figure 7 (based on NSW Environment Protection Authority, undated) presents examples of a species tolerance spectrum.

Forest structure

A forest structure may be simple or complex. A range of factors impact forest structure, including species, and the history of management and disturbance. A discrete stand or tract of forest may be dominated by trees at a particular growth stage (simple structure) or may comprise trees that represent a combination of various growth stages (complex structure). The forest structure will have a strong influence on determining appropriate silvicultural strategies. The structure of a eucalypt forest will reflect the numerous potential combinations of growth stages and tolerance.

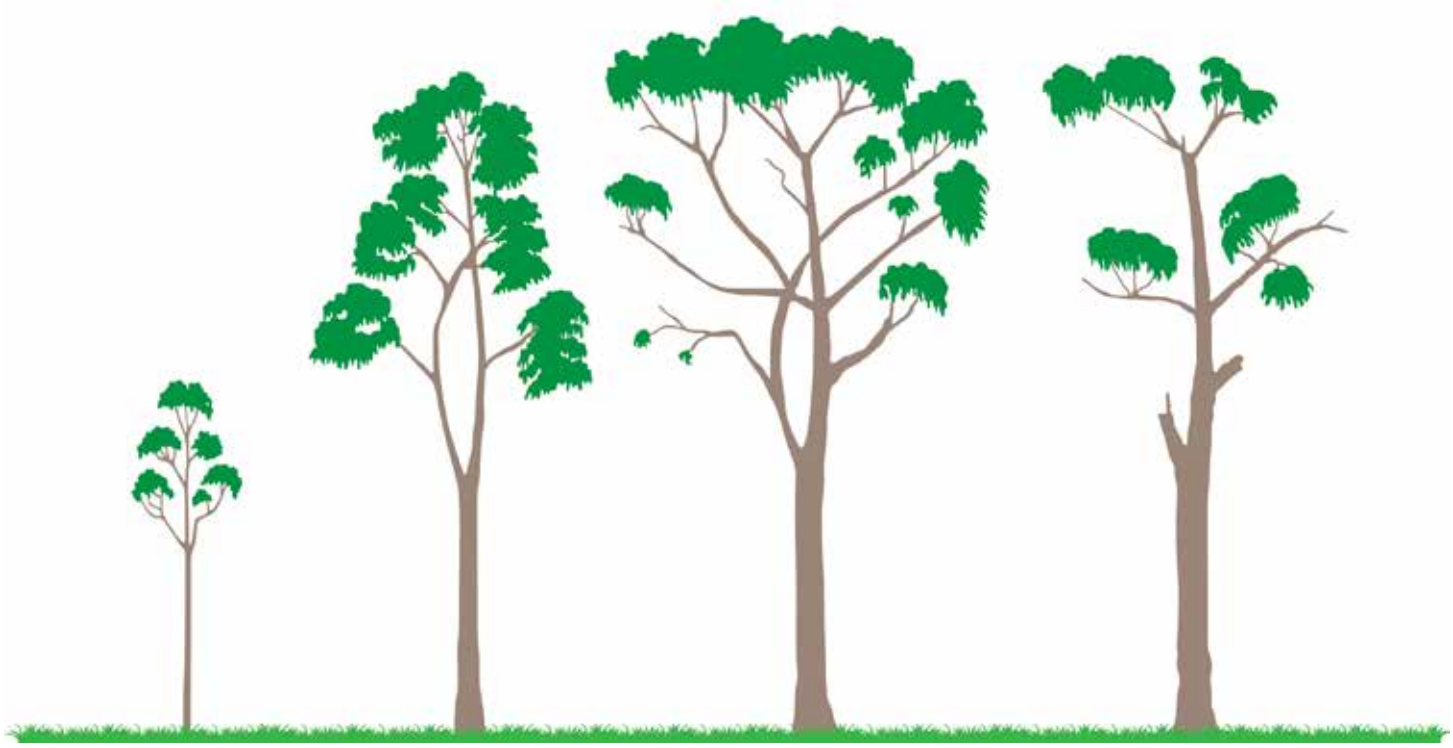

Figure 6: *Four advanced growth stages of eucalypts. (Source: NSW Environment Protection Authority, undated)*

Growth stage	Description
Seedling/regeneration	Establishment phase of new trees
Sapling	Vigorous height growth of stem. Shedding of lower branches. Small, compact crown with pyramid shape.
Pole	Slower height growth, vigorous diameter growth. Branch shedding stops and branches increase in size. Crown deepens and maintains pyramid shape.
Mature	Height growth nearly complete. Diameter growth continues. Crown structure fills out as lateral branches form and becomes rounder but remains regular.
Over-mature/senescing	Larger branches begin to drop and hollows begin to form. Crown shape becomes more irregular and thins out as branches fail and are replaced by smaller branches. As trees age and the cycle of branch breakage and replacement progresses, trees become senescent. Senescing trees are usually characterised by well-formed hollows that provide habitat value. The process from over-mature to senescent may take several centuries, depending on species.

Table 7*: Description of the eucalypt growth stages*

Silvicultural regimes and strategies for eucalypt forests

Factors to consider

Selection of the most appropriate silvicultural regime should be guided by:

- the growth and regeneration requirements of the species and forest types present in the stand
- the current condition of the stand
- the management objectives of the forest owner
- the regulatory framework in place for the specific state or territory
- the condition of the land, forest and water
- the size of the native forest under management.

Silvicultural regimes for natural eucalypt forests are either clearfell harvesting or selection harvesting. There are many variations on these two categories such that it can be considered a spectrum from large (clearfell) to small (selection) gap creation.

Eucalypt silviculture strategies are generally grouped into categories, as described in Table 7. Silvicultural systems affect the current and future capacity and integrity of a forest. Care and awareness of consequences and review of outcomes ensures the integrity of the forest is maintained over time.

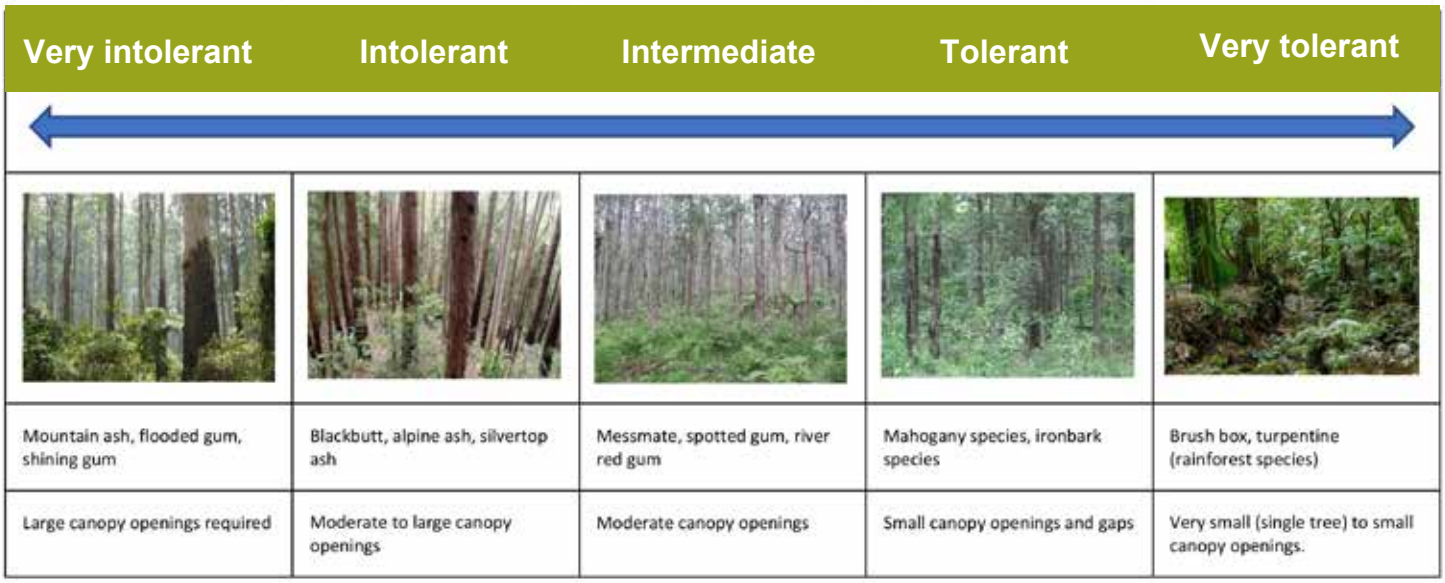

Figure 7: *Species tolerance and examples*

Strategy	Description	Canopy opening	Application	Risks
Single tree selection	Selection and harvesting of individual trees to create small canopy openings across a forest area.	Very small	Very tolerant and tolerant species; mixed species sub-tropical wet sclerophyll forests; cypress pine	High-grading can occur if not well managed.
Gaps	Harvesting small areas to create small to moderate sized canopy openings up to one hectare. Variants include group selection.	Small to moderate	Intermediate tolerance species; wide range of eucalypt forests.	Care needs to be taken to ensure gap size is appropriate for species characteristics, particularly as edges of gaps can experience poorer regeneration and growth.
Shelterwood	Patch approach where older groups or belts of retained trees are harvested after the regenerating trees are well established.	Moderate	Tolerant and intermediate tolerance species; well suited in areas where frost protection is important such as higher elevation tablelands forest types or where sensitive fauna or flora management is required.	As above.
Seed tree[10]	Larger gaps and harvest areas with regeneration achieved through the retention of seed carrying trees.	Moderate to large	Intermediate tolerance and intolerant species such as river red gum, messmate.	Need to ensure that trees with adequate seed crop retained to ensure adequate regeneration and that retained tree spacing is adequate for seed dispersal.
Clearfell	Large harvest areas to create a significant canopy opening to allow a significant regeneration event (often accompanied with fire or mechanical intervention to increase soil disturbance)	Very large	Intolerant species such as mountain ash or as a strategy to improve overall forest health and vitality of mixed species forests.	Absence of adequate seed stock may require manual seeding intervention or risk of replacement with weeds. Can leave site more exposed to further soil disturbance (e.g. erosion). Frost or soil drying could adversely affect regeneration.

Table 8: *Common silvicultural strategies used in Australian native forests.*

[10] Seed tree silviculture is also sometimes considered to be a clearfell technique.

Forest stand life cycle	Potential silvicultural interve
Regeneration	• Spacing • Stocking control • Species control • Culling (manual, mechanical or poison)
Sapling (young trees)	• Spacing • Stocking control • Selective, objective driven manipulation (for timber products, biodiversity value, etc) • Culling (manual, mechanical or poison)
Pole (immature/mid-aged)	• Selective harvesting • Commercial thinning • Selective, objective driven manipulation (for timber products, biodiversity value, etc) • Culling (manual, mechanical or poison)
Mature	• Selective harvesting • Gap creation • Manual culling • Selective, objective driven manipulation (for timber products, biodiversity value etc.)
Over mature and senescing	• Management for conservation • Selective harvesting • Seed trees • Clearfell • Regeneration control • Selective, objective driven manipulation (for timber products, biodiversity value, etc) • Deliberate disturbance • Gap creation

Table 9: *Silvicultural strategies for managing eucalypt forests at different life-cycle stages.*

Silviculture for forest health and productivity

Silvicultural interventions can be applied to forest stands at different stages in their lifecycle, to improve health, productivity and forest condition. Clinnick *et al* (2008) provide a useful outline of silvicultural options (adapted in Table 8).

Matching site requirements with silvicultural strategies

A forest's type and condition are major determinants of what silvicultural strategy is most suitable. A range of factors need to be understood when designing a successful, objective-driven silvicultural strategy. These include growth rate (site quality), species mix, location, previous management history, fire history and current management objectives.

Cypress silviculture

White cypress (*Callitris glaucophylla*) is a commercial timber species widely distributed through central New South Wales and south-central Queensland. In its natural state, it grows in mixed age stands, intermingled with woodland eucalypt species in an open woodland setting. However, large areas of white cypress forests have grown on land that was previously cleared for agriculture. One of the largest discrete forests in Australia, the Pilliga, is about 400,000 ha forest between Narrabri and Coonabarabran in northern New South Wales, and was previously cleared for agriculture. It is in this environment that white cypress best exhibits its unique growth habits, which warrant specific consideration of its silvicultural requirements.

Figure 8: *White cypress pine forest. (Source: Australian National Botanical Gardens; https://www.anbg.gov.au/photo/vegetation/callitris-forests-woodlands.html)*

Wheatfield regeneration

Cypress routinely regenerates in a wheatfield fashion. Seedfall is as high as five million seeds per hectare and actual germination response as high as one million seedlings per hectare. In this context, cypress pine regenerates in a similar fashion to the very intolerant eucalypt species such as mountain ash or silvertop ash. A key difference, though, is that cypress seed can last for a very long time in the soil, ready to respond to an opportunity to germinate.

Tolerance

While cypress regenerates in a similar fashion to intolerant eucalypt species such as mountain ash, it exhibits some very different growth and response habits. With eucalypts, stronger individual trees out-compete weaker trees, which become suppressed (tolerant species) or die (intolerant species). Even if an opportunity is presented through a canopy opening, once a eucalypt tree is growth restricted, it is rarely capable of responding. By contrast, cypress does not self-thin and individual trees can exist in a suppressed state for decades, possibly centuries, and then still respond to a disturbance event.

Silvicultural strategies

Because of these unique characteristics, cypress forests are capable of responding to the full suite of silvicultural strategies, as well as other management interventions such as fire, mechanical disturbance and grazing. They are particularly well suited to silvo-pastoral systems that mix forestry with grazing enterprises.

Private native forestry as a business

This section provides a guide to the questions you should be asking and who you should be talking to. Every forest is different, rules for harvesting vary between state and local government authorities, and markets in your region may have different requirements to other regions. It is strongly recommended that if you are considering harvesting your native forest, you seek expert advice from an experienced forestry professional.

Planning for private native forest operations

Planning framework

There are two important levels of planning for forest management. First is the forest management plan, which documents the long-term intent of the forest owner. The second level is the operational plan, which provides detailed prescriptions and directions for conducting specific forestry activities (e.g. harvesting) at a point in time. In many Australian states and territories, an operational plan is legally required before significant activities, such as harvesting or burning, can occur. A forest management plan is like a business plan for your forest; even if it is not required it is highly desirable.

Why plan?

Successful management of private native forests, like any agribusiness activity, requires long-term planning to ensure that the forest owner's objectives and requirements can be achieved, and any legal and regulatory requirements are met. The depth of planning requirements will vary depending on the size and complexity of the enterprise or forest, the owner's management objectives and any external requirements that need to be addressed.

Forest management planning is both a business plan and an ecological plan for your forest. A plan will include:

1. Current conditions (or the *'environment of the enterprise')* – measure/quantify
2. Future potential – analyse, model options and decide
3. How to get there – planning, design, actionable strategy, testing, resources.

In its simplest form, a private native forest management plan will likely include a map and description of the forest area, along with documentation about intended activities and how they will be conducted. More comprehensive planning is likely to include detailed management objectives, measurements of the forest (inventory), detailed stand mapping, location of roads and log landings, management prescriptions and other information relevant to both strategic and operational management of the forest.

Given the diverse and often complex nature of forest conditions, management requirements and options, specialist advisory services may be required through each of these phases to investigate, quantify and recommend management strategies and options that best fit the objectives of a forest owner. Like most plans, they need to be reviewed regularly, particularly if circumstances change.

Important components of a forest management plan

There is no fixed format for a forest management plan. However, a good plan typically incorporates the following elements:

1. Definition of the forest owner's objectives for management of the forest.
2. A detailed description of the forest and its current condition.
3. Identification and documentation of management options and approaches.
4. Scheduling of forest management activities.
5. A process for evaluation, review and refinement.

Management objectives

In the context of private native forestry, management objectives could cover a wide range of desired outcomes in addition to commercial timber production. They could include:

- integration of forestry with other land use objectives, such as farming
- enhancement of farm profitability
- improving grazing capacity of forested areas
- providing low-cost fencing material for farm use
- increasing biodiversity and ecosystem health
- reforestation for commercial and environmental (e.g. carbon) services
- enhancing potential for honey production
- providing traditional and cultural services and products, such as hunting, camping and traditional bush resources.

Documenting the owner's objectives for management of private native forests provides the basis for determining what should be measured, what types of management interventions to consider, how management of the forest will work with other agricultural activities and integration with local community and broader considerations, where relevant.

Forest description

In developing the forest management plan, it is important to describe the forest. This description could be discrete for the forest area itself or could apply to the forest in the context of a whole property and related agricultural and land management activities. Some private native forest owners will have information already available. In other cases, there may be detailed information available from government databases or other sources.

The first step in describing the forest is to identify property boundaries and any other legal boundaries (such as road easements) that may affect management. Then it is important to describe the geographic and environmental features of the forest. As a minimum this will include things like the climate, location and nature of waterways, the extent of the forest, topography and potentially the geology and soil types present, particularly if soils are prone to erosion.

Assessing and describing the current condition of the forest is an important preliminary step in developing detailed plans for management. This may include assessing forest age and quality, forest health, understorey condition, what forest types are present, as well as describing the management history of the forest (e.g. whether it was previously cleared or harvested, whether it has been grazed, and its fire history).

The assessment of current condition will ideally include a detailed measurement of the forest, called a forest inventory. This provides a more thorough description of the species present, the size of trees, the availability of harvestable trees, quantity of specific forest products and other variables that can assist with forest management decisions. There is no fixed approach to forest inventory and a range of techniques are available, depending on the skills, budget and requirements of the forest owner. The forest inventory will also assist in estimating likely future growth and productivity.

It is also important to describe the external factors that influence management of the private native forest. These may include:

- Legal variables, such as the requirements of state and local government regulations regarding forest management, road transport requirements, workplace health and safety obligations and whether there are any other parties with rights to forest produce (e.g. on Crown leases).
- Commercial variables, such as the nature of local markets for forest produce and the availability of harvest, haulage and professional services.
- Social and community variables, such as impacts on neighbours, that may need to be recognised in plans.

Management options

By identifying management objectives (or the preferred future state) and describing current conditions, the forest owner is well placed to develop options for management of the forest. Analysis and modelling of various management options will identify their relative strengths and weaknesses, and the costs and benefits of potential scenarios. This may also include identifying where there are information gaps that need to be resolved to inform decision-making.

Once the range of management options has been considered and a preferred approach is identified, management strategies can be refined to achieve the forest owner's objectives. An effective forest management plan is tailored to the current conditions and targeted at future potential outcomes. The potential of a forest is assessed with an understanding of current and future supply and demand, and what is realistically achievable with resources available.

The forest management plan is used as the foundation for operational management plans that describe and specify how to manage the forest to achieve the preferred outcomes. Silvicultural practices are customised to encourage various outcomes from the forest over time. These practices apply through the full cycle of forest growth including forest maintenance and protection, stand improvement activity that may include commercial or non-commercial thinning, harvesting at a prescribed intensity, and regeneration via different methods.

Activity scheduling

Once the preferred management options are confirmed, and management interventions defined, a schedule for implementation can be developed. This will ideally include routine annual activities, such as hazard reduction burning, road maintenance and noxious weed control. It may also address issues such as preferred seasonality for grazing, for example. Scheduling considers preferred timing for harvesting (recognising that this will be influenced by other factors, such as the availability of markets and contractor services).

Evaluation and refinement

The forest management plan is not a static document. As information gaps are filled, market requirements change and the forest responds to management interventions, it is important to routinely evaluate and refine the plan.

Operational Plans

Some operational plans are legally required, for example harvesting and burning plans. Their format and contents may also be subject to specific requirements by regulatory bodies. The level of detail, accuracy and quality of communication within these plans will influence operational success. Forestry operational plans document how activities are to be done on the ground. They are an important tool for instructing contractors and other parties about the standards, conditions and specifications (or prescriptions) for all activity within the operational area. The operational plan will usually include a map and detailed prescriptions for how the operation will be undertaken. Importantly, the plan must also include details about how safety will be managed during the operation, and should be formally acknowledged by all parties involved.

Operational planning may include:

- where and when the operational activities will occur
- silviculture, including non-commercial thinning, ecosystem health interventions, and management of fire, pest and disease risk
- what harvesting system will be used (e.g. mechanical or manual harvesting, snigging or forwarding)
- how much log volume is likely to be harvested and transported
- construction and maintenance of forest infrastructure such as roads, tracks, water course crossings, and log storage and loading areas
- what areas are to be excluded from harvesting and what special values need protecting
- rehabilitation, regeneration or re-stocking requirements to support post-harvest forest growth and recovery.

In most states and territories, formal or informal codes of practice are in place that provide direction or guidance about how private native forest operations are to be planned and undertaken. It is important that private native forest practitioners understand any obligations that must be met in their relevant jurisdiction. Although not exhaustive, Table 9 presents a summary of some of the typical items addressed in a code of practice.

Topic/activity	Issues addressed
Design and planning	Operational harvesting plans
Licensing and control	Relevant legal, policy and forest certification requirements
Safety	Workplace Health and Safety (WHS) Codes of Practice, legal requirements, emergency communication and evacuation
Fire precautions	Thresholds for specialist conditions and minimum standards
Site values and protected features	Flora and fauna habitat, ecology, landscape, cultural heritage, archaeology, geomorphology
Marking of harvest area items	Marking system for boundaries, access, water courses, trees (removal/retention), hazards.
Wet weather	Minimum operating prescriptions to avoid soil disturbance and water pollution
Roads and crossings	Design, use and maintenance of roads, bridges, crossings
Tree felling, processing and extraction	Standard operating procedures and specifications
Snig tracks	Design, use and maintenance
Loading, landings / log dumps	Design, use and maintenance
Water quality	Minimum standards and specifications
Soil and drainage	Minimum standards and specifications
Steep country	Thresholds for specialist conditions and minimum standards
Designated locations	First aid, fuel storage, waste collection, vehicle parking, emergency and evacuation points.
Site productivity, rehabilitation and regeneration	Minimum standards and specifications
Declarations and acknowledgements	Forest owner, contractors, site visitors, regulators

Table 10: *Typical forestry code of practice contents and requirements.*

Workplace Health and Safety

Forestry operations, especially harvesting, present a heightened safety risk. Where manual chainsaw felling of trees is proposed or where there are steep or difficult conditions this risk is exacerbated. Many forest owners may be tempted to manage costs by undertaking hazardous forestry operations themselves. Specific skills are required to undertake forestry activities and landowners are responsible for ensuring that people who work on their properties are appropriately trained for the activity they are undertaking. In most Australian jurisdictions, there are specific workplace health and safety rules in place regarding forestry activities. In all states and territories there are obligations on forest owners, contractors and other parties to ensure that the workplace and any operations are undertaken safely and that any risks of injury or death are identified and managed by those parties. Planning for safe operations is critical.

Private native forest products and markets

Overview

Private native forests are the source of a wide array of products, both commercial and non-commercial. The definition and realisation of value from those products will depend on the location of the forest relative to markets and the management objectives of the forest owner.

While a commercially focused private native forest enterprise may focus on merchantable log products, values that are essential for sustainable production (such as ecological health and pasture production) must also be integrated into the business model for ongoing success. It may be possible to generate revenue from these values. The amount of this value will depend on the forest owners' interests, the significance to other stakeholders and the current market conditions for the various products.

Private native forest timber products

Depending on market availability and proximity, and the wood properties of the species present, a wide range of log product types can be harvested from private native forests. The types of log products that are typically harvested from private native forests in different regions are presented in Table 10.

The current condition and health of a native forest will influence what products are available at that time and various ongoing forest management strategies will influence what products are likely to be available in future.

The examples in Table 10 relate to products and species that service larger-scale and commodity markets for log products. There are also niche and smaller-scale markets, particularly for rare and high-value species, sometimes referred to as speciality timbers. Tasmania has a well-established market for these speciality timbers that are sourced in much smaller volumes for high-value end products such as designer furniture.

Region	Product	Species examples
North Queensland/Northern Territory	Sawlogs	Sawlogs
South east Queensland (coastal)	Poles, piles, girders, sawlogs, agricultural fencing and landscape	Poles, piles, girders, sawlogs, agricultural fencing and landscape
South east Queensland (inland)	Poles, girders, sawlogs, agricultural and domestic fencing and landscape	Poles, girders, sawlogs, agricultural and domestic fencing and landscape
North east New South Wales	Poles, piles, girders, sawlogs, agricultural and domestic fencing and landscape	Poles, piles, girders, sawlogs, agricultural and domestic fencing and landscape
Tasmania	Sawlogs, pulplogs	Sawlogs, pulplogs

Table 11: *Examples of log products and species suitability for private native forests in different regions.*

The specification of a log product is influenced by a number of factors that must be appreciated prior to felling and merchandising a tree. These factors include log length, diameter, stiffness, density, straightness and durability of timber species. For example, a telegraph pole must meet minimum length, straightness, stiffness and strength requirements. An appearance grade sawlog must be free of unacceptable defects, while visual features are less important for a structural grade log that primarily requires strength properties. Along with market availability, tree dimensions and wood properties will determine what end use products are possible and the log specification required for manufacturing.

Once the products within a tree are determined, the tree is merchandised for optimal value recovery. The physical size and shape of a log is largely prescribed by the log transport capacity and the configuration of the sawmill or other equipment designed to process the logs. The specification details of forest products to be harvested are normally detailed in the forest product sales contract.

Australian processors are becoming increasingly more flexible with respect to the log grades they are prepared to purchase. In particular, there is an increased focus on smaller diameter, shorter and poorer formed logs. Sawmills are willing to significantly relax traditional log specifications around issues such as diameter, length and sweep in order to secure throughput volumes necessary for production efficiency and to meet growing market demand. This shift has implications for potentially making more saleable log volume available from forests than may have been previously considered to be non-commercial.

Markets for private native forest logs

Traditionally, markets for native forest logs were similar to plantation logs, largely servicing the manufacture of structural timbers for housing, as well as pulpwood for paper, packaging and manufactured timber products such as masonite. As native forest timber supplies have declined over recent decades and plantation production has increased, native forest timbers are increasingly used for higher-value end products, such as componentry (e.g. doors, windows and stairs). The higher strength and durability, and more appealing visual features, of most native forest timbers means they are well suited to these applications, along with flooring, decking and furniture.

Other private native forest products and values

While logs have historically been the most common commercial products harvested, native forests have provided many other types of products and values that continue to be in demand. There is significant potential for non-traditional products and services that continue to be explored and developed.

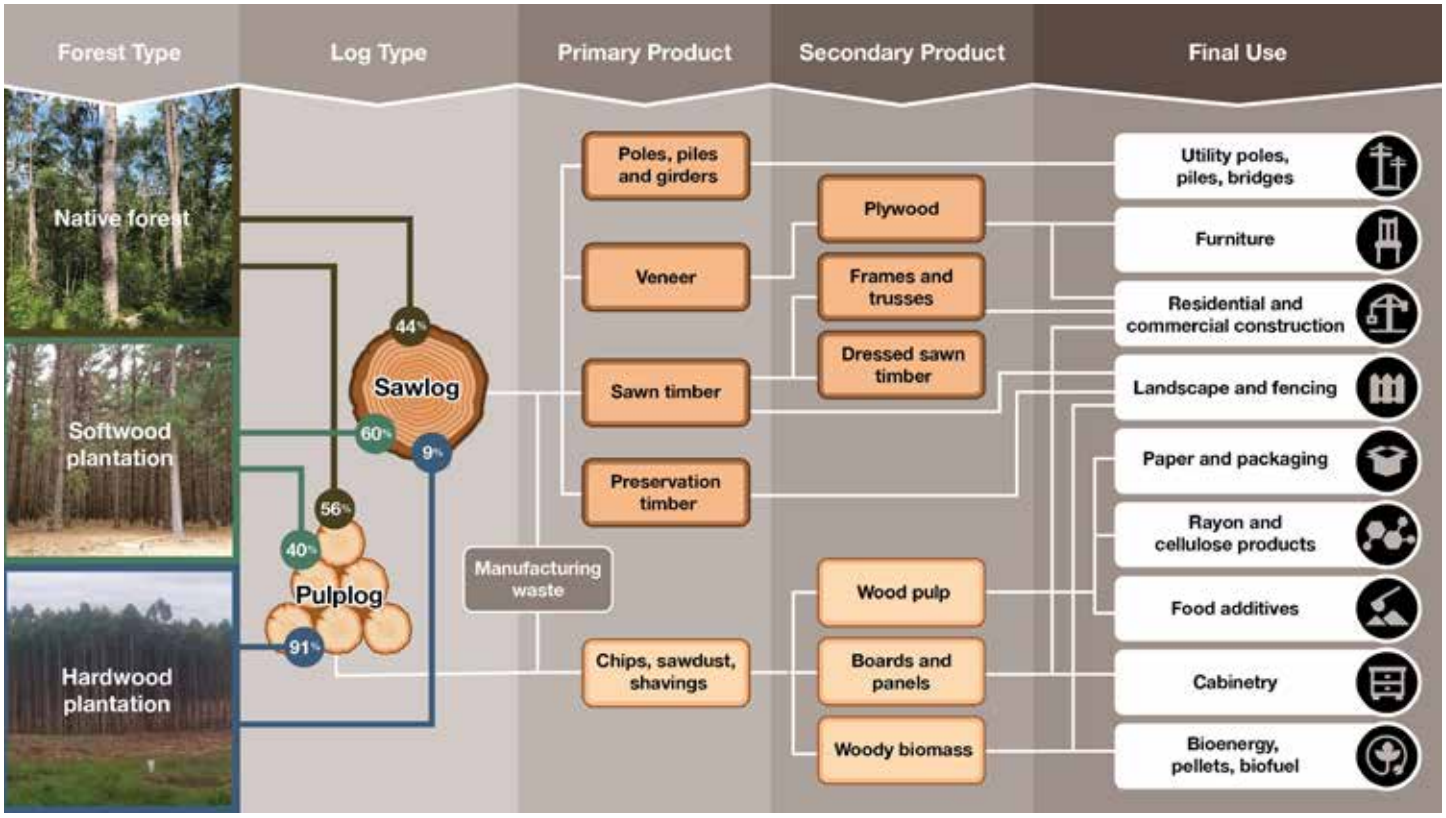

Figure 9: *How logs are used in Australia.*

Traditional and cultural products and values

There is a long and continuing history of Traditional Owners' involvement in the conventional management of native forests for timber harvesting and processing in Australia. Just as importantly, private and leasehold native forest areas are a significant and continuing source of traditional and cultural products and values for Indigenous people. This includes cultural values, sacred places and story places as well as protection of certain species that have specific cultural value or significance for Indigenous people from Country. It also includes traditional materials and foods provided from Country.

Other non-wood products and values

Private native forests provide a range of non-wood products such as pollen for honey production, livestock grazing and leafy material for distillation of botanical oils. In addition, private native forests contribute significantly at the local, regional and national level to the provision of a broad range of ecosystem services, including biodiversity conservation and ecological health, watershed protection and management, and carbon sequestration and storage. Further, private native forests may be valued for the provision of recreation values.

Non-wood products like honey can be managed for the generation of revenue. Ecosystem services may also have an economic value. For example, in some Australian states it is possible to participate in environmental services markets related to vegetation offsets and biodiversity credits. Similarly, there are opportunities to participate in Australia's Emissions Reduction Fund (ERF) to generate Australian Carbon Credit Units (ACCUs) through projects that employ specific native forest management methods.

The private native forest supply chain

Supply chains for native forest products have expanded and rationalised over recent years. The reduction in availability of logs from public native forests has meant that local forest supplies have contracted making it difficult for smaller regional hardwood processors to access timber resources. At the same time, the construction industry's increased reliance on plantation-grown softwood has meant that hardwood processors have become increasingly uncompetitive in those traditional construction markets. Native forest supply chains were traditionally limited to relatively short-haul distances, with sawmillers focused on and specialising in processing local timber species often with unique characteristics. The ongoing reduction in available native forest log supply has seen the number of sawmills decline, processing facilities rationalised and supply of input materials expanded. The range of hardwood species is now sourced from much larger catchments, including neighbouring regions, interstate and other countries, and in a wide variety of processed conditions including logs, flitches, cants and rough-sawn boards.

This situation creates both challenges and opportunities for private native forestry practitioners as the market is creating demand for more privately grown timber but additional logistics costs can put pressure on returns to growers. If a forest is beyond the viable economic haul distance to market, a grower may have to significantly discount the sale price and range of products compared to a forest that is able to maximise full value and volume recovery because it is close to multiple buyers in a diverse and competitive market. Markets are generally in larger population centres where volume of raw material, skilled labour, technology support services and viable centres for distribution of finished goods underpin economies of scale for manufacturing.

There are numerous schematics depicting forest and wood products supply chains in general terms. For the purpose of these guidance materials, the forest and wood products industry is considered to comprise three main sectors (see Figure 10). Each of these is supported by input and output transport networks for goods and services. Advanced manufacturing is separated out from primary manufacturing because of its importance to facilitate understanding of how logs and timber products move into and out of different regions.

Figure 10: *Three sectors in the native forest and wood products industry.*

Native forest supply chains vary considerably between regions in Australia. This variation is influenced by forest type and species, availability of markets and market requirements. In East Arnhem (Northern Territory), for example, native forest log products are predominantly used locally for the construction of houses and buildings for local Traditional Owner communities. In south-east Queensland, durable timber species are harvested for solid wood products including sawn timber, poles and girders. In Tasmania and Victoria, native forest species characteristics mean, as well as application for structural and appearance uses, that there is also a strong market for woodchips that are either exported or used domestically to manufacture paper, packaging and cellulose products, as well as pallets for the transport industry. That means there is no 'one-size-fits-all' description of native forest supply chains. However, there are a number of fundamental supply chain elements that are common in all instances. They include:

- forest management (silviculture)
- harvesting
- log-making and segregation
- transport to processing facilities
- processing of wood products
- distribution of processed wood products to downstream markets (including further manufacturing).

Private native forestry operations

Commercial management of a forestry enterprise requires a clear understanding of the costs involved in creating value and the revenue generated from the sale of products. As discussed earlier this is greatly influenced by the products created, the market conditions and supply chain factors. The following section sets out how these factors are quantified then analysed to describe the current and potential commercial aspects of a forestry business.

Pricing and value determination

How much money you earn from harvesting your trees will depend on a number of factors. These might include:

- what species is being harvested
- how old the trees are
- what volume of logs is present
- what log products are being sold
- the cost and complexity of harvest
- the distance from your forest to the customer
- what point along the supply chain you will be selling the logs.

Price points

The net price you receive for your trees at harvest is usually referred to as the stumpage price. This is the value you receive for your logs once the costs of planning, road works, harvesting, hauling and any other professional advisory services are accounted for. The price paid by a customer receiving the harvested products is usually referred to as a delivered price. Usually, the delivered price will be calculated at the mill door (for domestic processing) or at wharf gate (for exported products).

In most cases, smaller private growers will sell their logs on the stump. That means that the purchaser of the logs is paying for (and taking the risk on) all costs associated with harvesting and delivering the wood and paying the forest owner for the unharvested value of the trees. This is usually a low-risk option for most growers. Some growers may feel they have the capability and confidence to engage contractors themselves. Alternatively, there may be professional service providers that you can engage on an agency basis for a fee to manage the sale, harvest and delivery of your logs to a customer. Typically, these agents will work for a set fee calculated on a value per cubic metre, or for an agreed percentage of the delivered price.

Whatever approach you choose to take, it is worthwhile testing the market to understand what options are available to maximise your net returns within the levels of risk you are comfortable to accept.

Estimating what will be harvested

It is important that you are provided with a reliable estimate of what volume of logs will be harvested and what log products will be produced, along with a calculation of the estimated value you receive. This estimate is usually based on a pre-harvest inventory, i.e. an estimate made from measuring a sample of trees, identifying the harvest area and then a calculation of volume and value of logs to be harvested. You should then be provided with an ongoing record of what is harvested and sold that you can use to reconcile actual volume and value against the estimate that was provided and what you observe.

Calculating log value

Small-scale private forest growers are often concerned whether they are receiving a fair value for their logs at harvest. When you are considering harvesting and selling your forest it is useful to understand how log value is calculated.

Prices

The delivered value of a log (the price paid by the processor or exporter for logs that arrive on truck) will vary depending on the species being harvested and its quality, the end use of the log, the nature of the local market (including mill recovery rates) and the level of demand. The stumpage price will be the delivered price less the costs of getting the logs to the point of sale.

Costs

The typical costs associated with harvesting and selling logs include:

Activity	Cost units
Harvest and planning approvals	Fixed
Road and landing construction and maintenance	Unit ($/km) or by quote
Harvesting supervision	Unit ($/hour or $/$m^3$)
Harvesting	Unit ($/$m^3$)
Loading	Unit ($/$m^3$)
Haulage	Unit (cents/m^3/km)
Sales marketing and administration	Unit ($/hour or $/$m^3$)

Harvest area (ha)	50

Revenue variables	
Standing volume (m^3/ha)	250
Sawlog volume (m^3/ha)	25
Pulplog volume (m^3/ha)	225
Sawlog delivered price ($/$m^3$)	160
Pulplog delivered price ($/$m^3$)	60
Cost variables	
Distance to sawmill (km)	130
Distance to chip mill (km)	80
Haulage difficulty	Low
Haulage costs ($/$m^3$/km)	0.1
Harvest difficulty	Moderate
Harvest costs ($/$m^3$)	30
Planning, levies and advice ($)	10,000
Marketing & supervision ($/$m^3$)	3
Roads and landings ($/$m^3$)	1

Item	$/$m^3$	$/ha	$ total
Planning, levies and advice	0.80	200	10,000
Marketing	3.00	1,500	37,500
Roads and landings	1.00	250	12,500
Harvest	30.00	7,500	375,000
Haulage Pulplog	8.00	1,800	90,000
Haulage Sawlog	13.00	325	16,250
Total costs Sawlog	**47.80**	**1,195**	**59,750**
Total costs Pulplog	**42.80**	**1,926**	**481,500**
Sawlog	160.00	4,000	200,000
Pulplog	60.00	13,500	675,000
Total revenue	70.00	17,500	875,000
Net revenue (profit)	**112.00**	**6,675**	**333,750**

Net stumpage ($/ha)	
Sawlog	2,805
Pulplog	3,870
All products	6,675

Table 12: *Example of a stumpage calculation for a regrowth thinning operation,*

Calculating the stumpage

An important principle to address when calculating stumpage values is to adjust for the units in use, as well as variations for different forest products. For example, woodchips are usually sold in bone dry metric tonnes. Therefore, it is necessary to make a conversion to determine what that value means for a log that is sold in cubic metres or green tonnes. As another example, if multiple products are being sold from the same operation, they will probably be sold to different destinations and for different delivered prices. Adjustments need to be made for cost of haulage over different distances and for different price points. An example of a native forest regrowth thinning operation in Tasmania is presented in Table 11. In the example, it is assumed that the forest area is 50 hectares and that both pulplogs and small sawlogs will be harvested from the site and transported to different locations. Results are presented for stumpage value by area, by volume and in total.

Engagement of service providers

Depending on the complexity of the forest and the owner's objectives, private native forest planning and operational activities can be improved with input from specialist service providers. This may include professional advisers to measure, analyse and recommend management strategies, manage planning applications, support negotiations with customers and contractors, and with the harvest and delivery of products. Other specialists are usually involved in a shared capacity with local government, neighbours and community groups in risk and emergency response such as control of pests, disease and fire. Contractors are commonly engaged to undertake forest management and maintenance work, as well as harvesting and haulage utilising specialist equipment.

Professional service providers

Professional service providers, such as experienced forestry consultants and third party property managers can provide a suite of support and advisory services, which can range from preliminary forest assessment through to preparation of harvesting plans and even management of harvest, haulage and marketing operations. Forest owners are encouraged to consider what professional services are available and how they can assist to ensure forest management objectives are achieved. Local and state government agencies and industry and professional associations can assist in locating appropriate providers.

Operational service providers

It is usual practice to engage contractors to undertake a range of operational activities such as road construction and maintenance, harvesting and haulage. The relationship between the forest owner and contractors is important because it can mean the difference between achieving a good or a poor outcome. An important fundamental in the relationship is the contract for services, covered in more detail below, which should clearly stipulate the expectations of all parties with respect to costs, operational activities to be undertaken, required outcomes and responsibilities.

Sales arrangements

It is important to determine early in the process where along the supply chain logs and forest products will be sold. It has implications for where profit is distributed, which parties carry risk and how much active supervision of operations is required by the forest owner. Regardless of the sales point, it is essential that you have a written contract that clearly identifies responsibility for factors such as:

- property access, particularly where property is an active farm and/or owner resides on property
- responsibility for planning and approvals
- responsibility for safety management and specification of liability
- responsibility for supervision, operational control and communication
- harvest and haul contractor details and expectations of performance and behaviour
- insurance requirements for all parties
- how the harvested wood will be measured and how the measurement communicated to you (e.g. with log dockets or a similar system)
- how and when you will be paid for your logs
- how contracted parties will be paid (e.g. unit fees, percentage of stumpage, lump sum)
- whether payment is on a lump sum unconditional basis, or based on logs harvested – usually calculated by weight (tonnes) or volume (cubic metres)
- clear contractual responsibility for all costs
- what condition the site is to be left in following the harvesting.

Stumpage sales

If you are undertaking a stumpage sale, your only direct contractual relationship will be with the log buyer. The log buyer could be the harvesting contractor, an independent log buyer or a timber processor. Under a stumpage sales arrangement, risk and responsibility is heavily weighted towards the log purchaser and this should be clear in the contractual agreement.

Agency sales

It may be possible to engage the services of a third-party agent that can manage some or all of the aspects of planning and supervising the harvesting process, engaging the contractors and establishing sales arrangements with customers on your behalf. In an agency sales arrangement, risk and responsibility is distributed somewhat more evenly between the agent and the forest owner and should be clear in the contractual agreement.

On-truck and delivered sales

Dealing directly with a timber-processing company for log sales and direct engagement of harvest and haulage contractors is generally only undertaken by growers with considerable experience. In this instance, the forest owner takes on the majority of risk and responsibility, including for regulatory compliance. It is very important that the forest owner has a clear understanding of their requirements and responsibilities.

Operational risk management

Contractual arrangements

Contractual agreements are the most important tool for managing risk in forestry operations. Contracts should provide absolute clarity about which parties are engaged and responsible for which activities. In many cases, a log purchaser or agent will provide a template contract for the activity. It is essential that you take legal advice on the contract to ensure that your interests are clearly addressed. Under delivered sales arrangements, forest owners are responsible for contracts and this should also be undertaken with legal advice.

Insurances

Contracts should clearly specify which parties must hold insurance, what insurances need to be held and what value should be insured. It is usual for all parties to hold public liability insurance to an agreed level. Any party that uses employees to undertake activities must also hold workers compensation insurance. Where a party is involved in providing professional or expert advice, it is normal for them to hold professional indemnity insurance. A certificate of currency must be provided for any required insurance that specifies what the insurance is for, what value is insured, what entities are insured and when the insurance expires. Your own insurer may require to be notified about the insurance details of other parties.

Financial analysis for private native forestry

Financial analysis models

Different types of financial analysis models can be used to quantify the potential outcomes of different forest management activities. These models can be tailored to help understand a particular forest management decision or they can be developed into more sophisticated tools that utilise detailed information to analyse multiple options for different values over various time periods. As discussed previously, values can be represented in saleable wood and non-wood products, as well as important non-timber values. The following describes some common approaches with working examples to assist understanding.

Discounted cash flow and net present value

The most common approach adopted for financial analysis in forestry is the application of a discounted cash flow (DCF) analysis to calculate net present value (NPV) and internal rate of return (IRR). Using this approach, a cash flow is developed for the operation or enterprise for a predetermined time period. Future cash flows are discounted to adjust for the fact that a dollar value earned or expended today is worth more than the same dollar in the future, because of inflation. The discount rate is usually developed based on a range of factors including estimated inflation and risk.

Simple discounted cash flows

In the most basic example, a cash flow will recognise operational cost inputs and sales revenues for a forestry activity from now until an agreed point in the future, typically the point of harvest. In the simplest approach the NPV and IRR can be calculated for a single hectare and extrapolated across the whole forest, using relatively high level assumptions. This can work reasonably well for smaller blocks. However, a more accurate approach is to stratify (break the forest up into blocks with similar characteristics), undertake the financial analysis for each stratum and consolidate the analysis outcomes to develop a more robust prediction of performance.

Complex discounted cash flows

However, private native forest management is often multi-faceted. Costs may include the opportunity cost of choosing forestry over an alternative land use, in addition to operational costs. If the forest owner is engaged in rehabilitation and timber stand improvement, there may be ongoing costs (and revenues) that need to be accounted for. Benefits may include environmental services or enhanced productivity for integrated land uses in silvo-pastoral systems, in addition to revenue from log sales. Simple cash flows will address only the operational aspects of preparing for and undertaking forest management for log production and some enterprises will want to actively consider the broader range of costs and returns. In some cases, the returns may be intangible (e.g. ecological health improvements) and so an approach to valuing those must be developed.

Cost-benefit analysis

Cost-benefit analysis (CBA) is a specific technique used to capture direct and indirect, as well as intangible or difficult- to-quantify costs and benefits to determine the overall value of proceeding with a project. It is particularly useful in assessing projects and activities that involve complex natural systems or enterprises where there is a complex interface between various integrated or alternative actions.

Operational cash flows

For many private native forest owners, the primary financial motivation for harvesting will be generation of cash without consideration of historical costs or management activities. Although it may be demonstrated that the most financially attractive long-term option is to apply active management and silvicultural treatments to stimulate future forest productivity in future, it can be difficult for a landholder to make these up-front investments and forego short-term cash income.

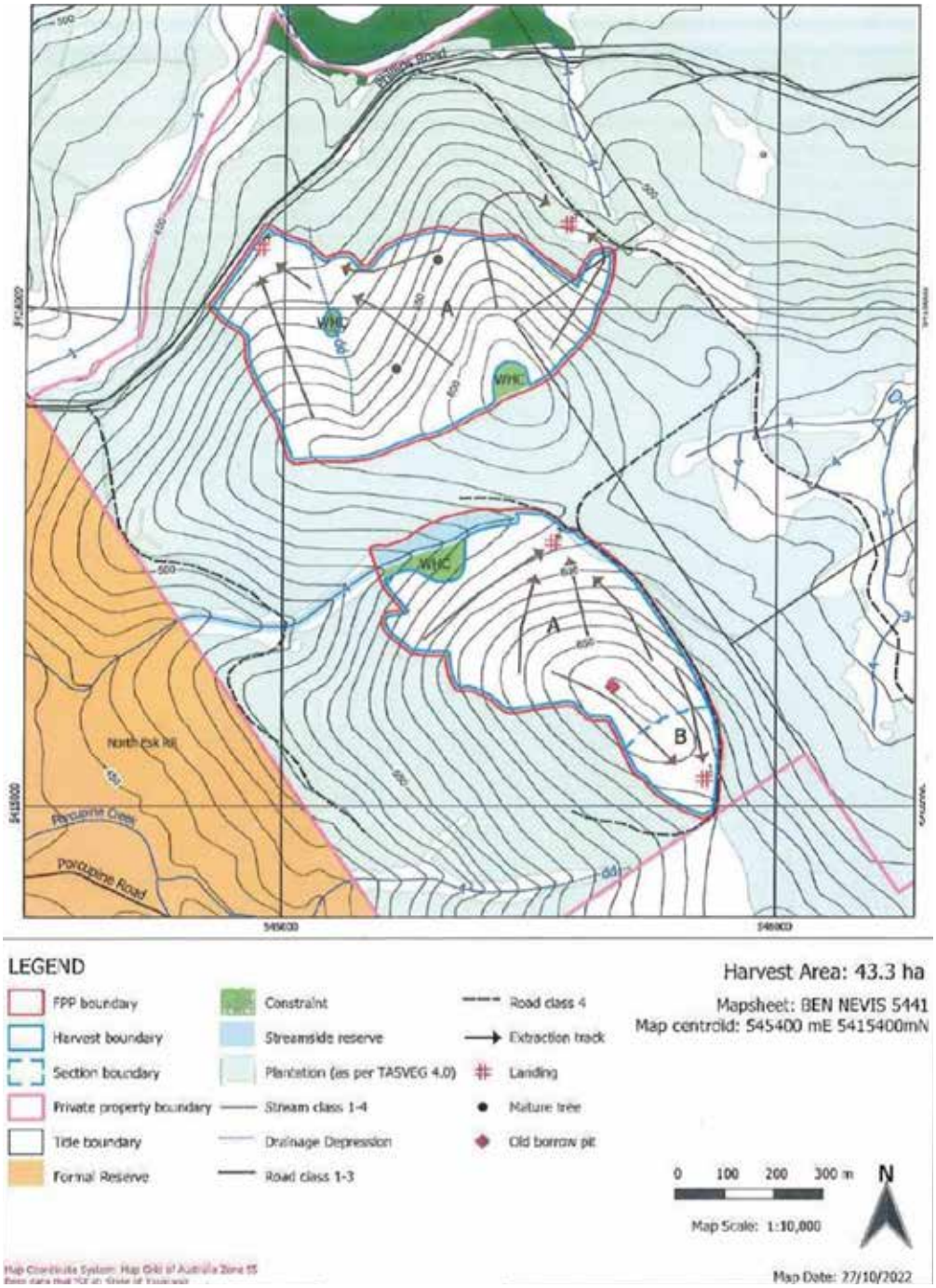

Figure 11: *Example of a forest property map.*

Information requirements

Reliable financial analysis and forecasting for private native forestry operations requires good-quality information inputs about the forest itself, proposed operations and likely sales.

Forest description

The forest description provides the basic starting point for undertaking any financial analysis. As a minimum, this would include a detailed map of the property, including the commercial forest area as well as any exclusions, roads and other important features. An example is presented in Figure 11.

Typically, the map would be supported by an assessment of the forest, including an estimate of the standing volume and growth rates. The quality of this estimate can range from simple observation by an expert through to a full inventory and growth modelling. The amount of detail required will depend on the forest owner's objectives and budget but more detail will result in better-quality analysis and decision making. A detailed forest inventory will provide quality information about the amount of harvestable wood present and what log products can be harvested.

Infrastructure description

The presence and condition of forest management infrastructure, particularly roads, tracks, crossings and landings, is important to document. Road construction and maintenance costs represent the largest ongoing cost item for native forest management, as well as one of the biggest one-off cost items at harvest time.

Markets

A key element of financial analysis is to understand the available markets for log products. Important questions to answer include:

- Where are customers located (distance to market influences the net price received for logs)?
- What products can be sold (e.g. in some regions there is no market for pulplogs)?
- What are the typical prices for those products (stumpage or delivered prices)?
- What is the current and future level of demand for log products?

It may not be possible to answer these questions accurately ahead of entering a sales arrangement, but it is a good idea to develop an appreciation of these factors through enquiry to log purchasers, other forest owners or professional service providers.

Harvest and haul costs

As with questions about markets, it may not be possible to accurately determine standard harvest and haul costs for your operation before entering a contract. However, it is important to get a feel for what they are likely to be based on similar enquiries.

Forest management costs

There are also a range of ongoing forest management costs that should be accounted for. These may include:

- road construction and maintenance
- fire prevention and management
- fencing
- weed and pest animal control
- professional forest management and planning advice
- insurances.

Financial analysis examples for different native forest management models

Private native forestry is often quite complex. Decisions about whether and when to harvest, which silvicultural system to apply and how best to integrate forest management with other land management activities can be informed by good-quality financial analysis. The examples in this section demonstrate how financial analysis can be used to determine the best course of action.

Silvicultural improvement of regrowth forests in Tasmania

Tasmania has a long history of private native forest harvesting. Wilson & Tys (2020) estimated an area of about 144,000 ha of privately owned regrowth native forest that is both viable and accessible to harvest. This comprises forests that were clearfelled between the 1960s and 2000s. Areas that were harvested in the 1980s and previously are now reaching crown closure to the point where trees are actively competing with each other for site resources. Landowners have a number of forest management and silvicultural choices available to them. These might include doing nothing, undertaking regrowth thinning to move to a multi-aged forest, or undertaking another clearfell.

Increasingly, landowners are looking to undertake the thinning option when the forest is about 50 years old. This generates short-term cash flow from the harvest of smaller and suppressed trees of lesser quality and value. It also brings forward the growth of higher-quality trees that can be harvested for sawlog over the proceeding 15 to 20 years. Some anecdotal evidence suggests that to get the same volume of high quality logs from clearfelling would take another 35 years. How does a landowner make an informed decision about whether to thin now or clearfell at a later date? Operational cash flow analysis can be used to determine the short-term cash returns from a thinning operation and whether it will be profitable. Discounted cash flow analysis can be used to compare the net present values for thinning and clearfelling over a longer period of time.

The examples below were developed to support Private Forests Tasmania in developing guidance materials for landowners in Tasmania. They are based on realistic scenarios for current operations in the state.

Operational cash flow analysis for regrowth thinning

The example in Table 13 relates to a regrowth thinning operation in a high-quality private native forest made up of preferred species and a high standing volume of about 225 m^3/ha. The operation will involve removing about half the basal area and about 40% of the standing volume.

Harvest difficulty is moderate, haulage difficulty is low and roads are established and in good condition. The harvest area is about 100 ha. The thinning activity is modelled to deliver an average \$32.23/m^3 stumpage return, or \$3,834/ha for the forest owner.

Harvest area (ha)	100

Revenue variables	
Standing volume (m^3/ha)	225
Sawlog harvest volume (m^3/ha)	13.6
Pulplog harvest volume (m^3/ha)	76.4
Sawlog delivered price (\$/m^3)	170.00
Pulplog delivered price (\$/m^3)	70.00
Cost variables	
Distance to sawmill (km)	52
Distance to chip mill (km)	33
Haulage difficulty	Low
Haulage costs (\$/m^3/km)	0.15
Harvest difficulty	Moderate
Harvest costs (\$/m^3)	32.00
Planning, levies and advice (\$)	12,000.00
Marketing (\$/m^3)	1.80
Roads and landings (\$/m^3)	2.00

Item	\$/m^3	\$/ha	\$ total
Planning, levies and advice	1.33	120	12,000
Marketing	1.80	162	16,200
Roads and landings	2.00	180	18,000
Harvest	32.00	2,880	288,000
Haulage	5.38	484	48,426
Total costs	42.51	3,826	382,626
Sawlog	170	2,312	231,200
Pulplog	70	5,348	534,800
Total revenue	85.11	7,660	766,000
Net revenue (profit)	**42.60**	**3,834**	**383,374**

Net stumpage (\$/ha)	
Sawlog	125.07
Pulplog	26.53
All products	41.42

Table 13: *Example of operational cash flow analysis for private native forest regrowth thinning.*

Forest description		Costs		Revenue	
Harvest area (ha)	100	Planning, levies, advice ($)	12,000	Sawlog delivered price ($/m³)	170
Clearfell year	1973	Marketing ($/m³)	1.80	Pulplog delivered price	70
Standing volume (m³/ha)	225	Roads and landings ($/m³)	2.00	Discount rate (post tax)	8%
Distance to sawmill (km)	33	Harvest ($/m³)	32.00		
Distance to chip mill (km)	52	Haulage ($/m³/km)	0.15		
		Annual costs ($/ha/yr)	225		

Thinning strategy		Clearfell strategy	
Thinning years	1 (regrowth age 51) + regeneration 16 (regrowth age 66) 50 (regeneration age 50)	Clearfell year	35 (age 86)
MAI (m³/ha/yr)	1.5 (Years 1-16) 1.8 (Years 16-50)	MAI (m³/ha/yr)	0.7
Sawlog (m³/ha)	13.6 (Year 1) 56.2 (Year 16) 38.6 (Year 50)	Sawlog (m³/ha)	91.0 (Year 35)
Pulplog (m3/ha)	25.8 (Year 1) 37.4 (Year 16) 38.6 (Year 50)	Pulplog (m3/ha)	158.5 (Year 35)
Net present value ($)	576,000	Net present value ($)	398,500

Table 14: *Discounted cash flow analysis and NPV comparison for two different silvicultural strategies.*

Discounted cash flow analysis

The example in Table 13 uses discounted cash flow analysis to compare the net present values (NPVs) of two different silvicultural strategies (regrowth thinning versus clearfell) for the same forest. The discounted cash flows have been projected forward over a 50-year period. In the regrowth thinning option, there are several harvest events during the 50-year projection period. For the clearfell strategy there is one harvest event at age 85. The net present value comparison indicates that regrowth thinning would deliver a NPV of $576,000 compared with $398,500 for the clearfell strategy. In financial terms, the regrowth thinning strategy makes more sense.

Silvo-pastoral systems in Queensland

Private native forestry in Queensland is typically integrated with other agricultural activities, especially beef cattle grazing. In this situation, the approach taken to selecting a silvicultural strategy can have a significant influence on the financial performance of the integrated activity, and vice versa. Discounted cash flow analysis is a particularly useful tool for assessing and comparing the financial performance of a range of scenarios in order to inform landowner decision-making.

A comprehensive assessment of three properties in south-east Queensland was undertaken with the aim of comparing five different forest management scenarios and different management objectives:

1. Clear the forest for grazing only.
2. Harvest in 2038 with no other silvicultural treatment.
3. Silvicultural treatment in 2019, harvest in 2038.
4. Harvest in 2019 and harvest in 2038.
5. Harvest and silvicultural treatment in 2019, followed by harvest in 2038[11].

The discounted cash flows were modelled over 20 years to provide a NPV comparison of the five scenarios for each of the three properties. The study also considered the overall management objectives of each landowner. The study was able to demonstrate that the active forest management strategies delivered the best long-term returns to the landowners, regardless of management objectives (see Figure 12).

This study demonstrates that detailed and comprehensive financial analysis of alternative scenarios is a very valuable tool available to landowners to assist in making well-informed management decisions to deliver commercial outcomes.

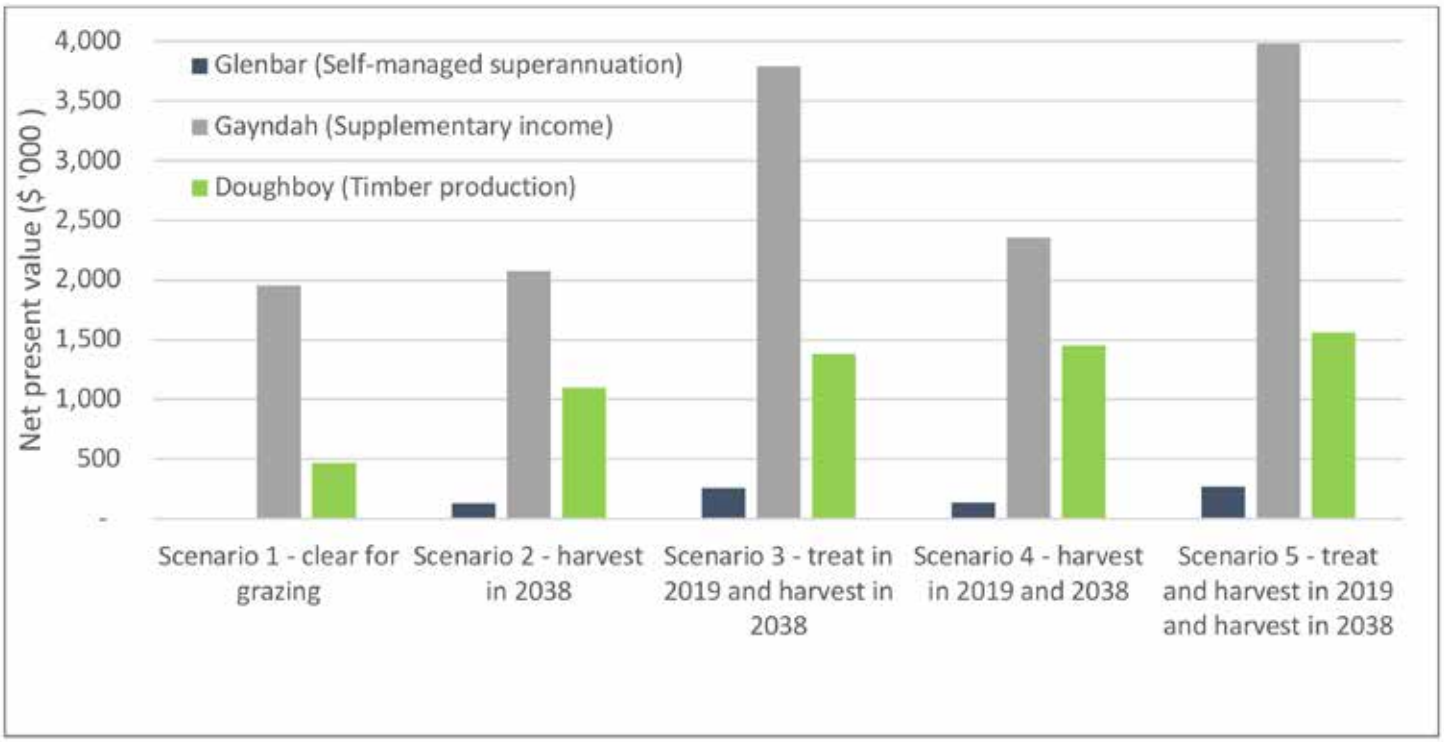

Figure 12: *NPV comparison of five management scenarios for private native forests on three properties (after Lewis et al, 2020)*

[11] Lewis *et al*, 2020

Next steps – getting started

The Private Forestry Guidance Material series provides a large amount of information that aims to improve the knowledge base of rural landowners and encourage those interested to consider small-scale forestry as a viable on-farm enterprise. It is intended to break down knowledge barriers that may prevent some landowners from seriously considering forestry. If the Guidance Material has created enough interest for you to seriously consider establishing plantations or actively managing your native forests, the question is what next?

> Define your objectives

The first step is to understand and clearly document your reasons for getting into forestry and what you hope to get out of it – your objectives. This will be different for every landowner and every situation. You may be focused on environmental and on-farm benefits, with the aim of also generating future revenue as a secondary benefit. For some landowners the objective may be to generate carbon credits to offset on-farm emissions, or you may be looking to improve the quality and productivity of a patch of native forest. Whatever your objectives and motivations, it is important to articulate and document them clearly as your starting point.

> Work out your information needs

With what you know about your own property and the local wood products industry, and with the help of these Guidance Materials, you will probably already be equipped with a lot of information to assist in working out how to progress. But you will probably require more information. Work out and document what you know already and what other information you require to make an informed and financially sensible decision.

> Undertake your own research

There is a large body of information available about small-scale private forestry that will be relevant to your specific situation. It is useful to consult Forest & Wood Products Australia's online database, talk to local contractors and timber processors, look at what other private forestry practitioners are doing in your area and attend field days. There are also organisations such as the regional forestry hubs, industry organisations and government agencies with dedicated staff and useful online resources which are available.

> Consult an expert

Even if you are an experienced private forestry practitioner, there is value in consulting expert professional forestry advisers about any aspects of the proposed forestry venture that you have concerns or questions about. A small investment in professional advice could be the difference between failure and success. It is also important that you consult your lawyer and your accountant to determine any business or personal implications of starting a forestry business.

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