Chapter 19

MANAGEMENT OF INLAND ARID AND SEMI-ARID WOODLAND FOREST OF WESTERN AUSTRALIA

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SUMMARY

Arid and semi-arid woodlands, consisting of eucalypt sclerophyll woodland and low acacia woodland, occur over an area of 280,500 km^2 of the southern interior of Western Australia.

The woodlands have a history of exploitation with the utilisation of 30 million t of timber for mining timber and fuelwood.

The harvesting resulted in a regrowth forest of 4 million ha, where regeneration was largely successful using simple silvicultural techniques.

Current management of the woodland involves a small scale industry in regrowth woodland, with emphasis on management for conservation to protect the biological resource contained in this unique forest type.

INTRODUCTION

The inland and semi-arid woodland of Western Australia occur throughout the southern interior of the State, in areas of less than 300 mm rainfall, south of 26°S and west of 125°E, covering an area of about 280,500 km^2. Included in this area are the Wheatbelt, Goldfields and Northern Goldfields regions of the State.

Within this area two distinct zones of vegetation exist. The semi-arid eucalypt scelerophyll woodland and the low acacia woodland (mulga). The woodlands of this region are unique, due to their capacity to form relatively tall productive woodlands under arid conditions with many endemic species and a high degree of habitat adaptation. They constitute a biological resource which is of national and international scientific value.

The woodlands played an important part in the development of the State, providing fuel and mining timber in very large quantities resulting in a history of management, utilisation and regeneration.

Management of the woodlands covered in this paper principally outlines the history of utilization and management. Current management is limited to small industries harvesting mining timber and domestic firewood and management for conservation. The history of utilisation and management has resulted in a large area of regrowth and cutover woodland.

Physiography

The area is part of the Great Western Plateau; a gently undulating plain between 300–500 m above sea level, derived from an eroded Miocene peneplain. An occasional ironstone-capped hill and granitic outcrop exist. There is no external drainage, internal creeks drain into numerous shallow, seasonal salt lakes and claypans.

Geology and Soils

The whole area is underlain by a basement cover of Archaean granite or gneiss with intruded metamorphic rocks. Metamorphic Pre-Cambrian sediments were further altered to granitic gneisses with widespread injections of ingneous material causing further regional metamorphism. Greenstones, mostly metamorphosed basaltic lavas, contain auriferous ore deposits of the main mining fields. Remnant laterites cover large areas with occasional granitic outcrops. Outcrops are few, as the plateau is covered with an erosional mantle.

Soils in the eucalypt woodland are generally calcareous red earths with a red-brown sandy loam surface. Some saline loams exist and in the west, where overly yellow earthy sands start to dominate. In the mulga woodland, soils are largely shallow loam or sandy loam, which overlies a silicious or ferruginous hard pan, usually at 30–40 cm.

Climate

The climate for the Goldfields region (Kalgoorlie) is classed as semi-desert with a mediterranean (winter maximum) tendency, although long term averages show there is not a large difference in summer and winter rainfall. Areas further south and west have a more reliable rainfall with a stronger mediterranean influence. There is a trend north-eastwards towards a lower, more uniform seasonal rainfall distribution.

Summer thunderstorms and extensions of monsoonal summer-rainfall (cyclones) are a feature. These are not reliable sources of rainfall.

Rainfall is between 150 and 300 mm throughout the region. Extremes of temperatures range from -3°C minimum to 45°C maximum.

Vegetation

The vegetation of the arid and semi-arid woodland includes area within the south-west, south-west Interzone and Eremaean botanical provinces and consists of two distinct vegetation zones. These are the eucalypt woodland of the south-west and south-west Interzone botanical provinces, which overlaps slightly into the Eremaean province and the low acacia woodland (mulga) within the Eremaean botanical province (Beard 1981).

A transition exists from a taller eucalypt woodland in the west into the mulga woodland in the north with the transition around the 230 mm isohyet. In the east, the eucalypt woodland merges to the low shrubland of the Nullarbor Plain (Figure 19–1).

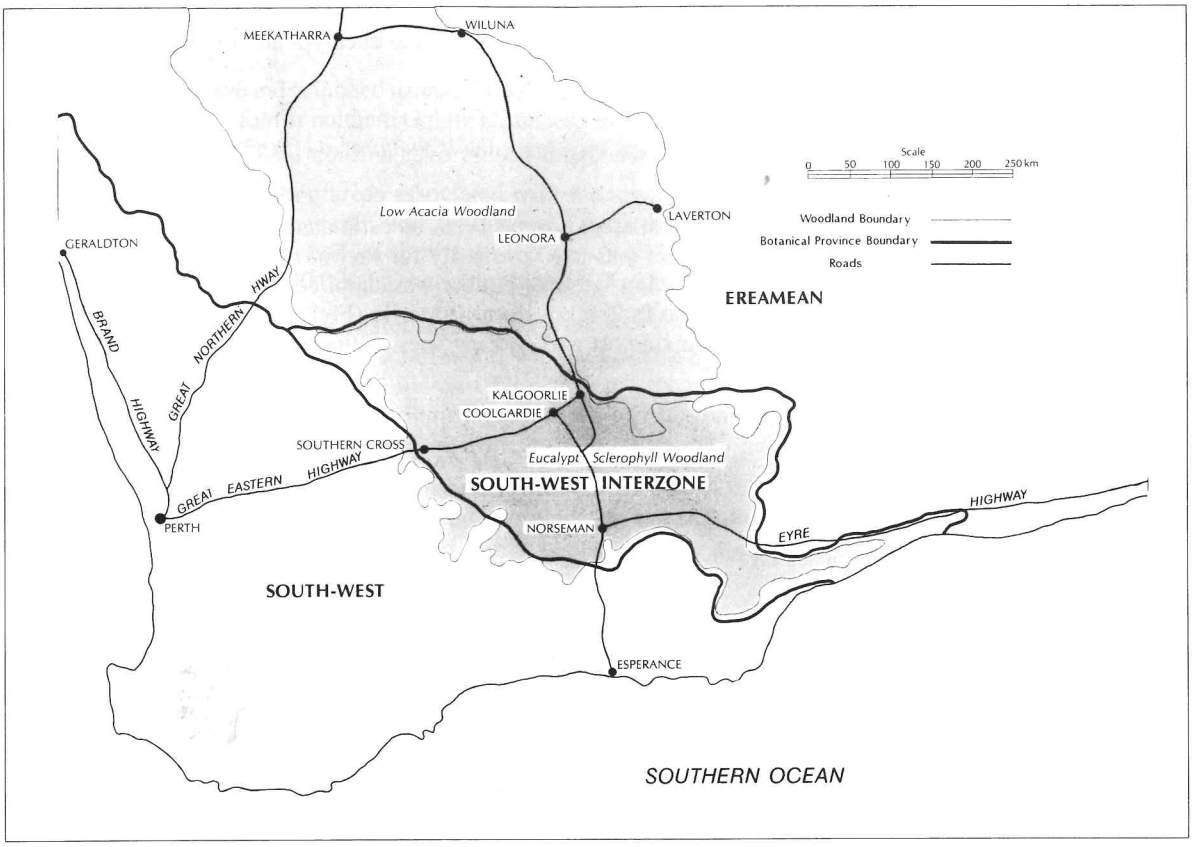

Figure 19–1: Location of the inland woodlands of Western Australia.

Vegetation characteristics of the two zones are described. Major species are listed in Appendix 1.

The eucalypt sclerophyll woodland. This is an open formation of trees dominated by species of Eucalyptus, with a sparse understorey. The woodland is interspersed with scrub heath or sand heath which increases to the west. The eucalypt woodland comprises of a variety of habitats, each with characteristic vegetation associations. On alluvial flats, salmon gum (*E. salmonophloia* F. Muell.) dominates with trees up to 25 m in heightoften associated with gimlet (*E. salubris* F. Muell.) on clayey soils. Generally it has a low shrub understorey of saltbushes (*Atriplex* sp.) and bluebushes (*Maireana* sp.).

In red loams, usually from granite, boongul (*E. transcontinentalis* Maiden) dominates with a variety of other species including merrit (*E. flocktoniae* Maiden) and tall sand mallee (*E. eremophila* (Diels) Maiden).

On rocky hills, especially from Coolgardie to Norseman, coral gum (*E. torquata* Luehm), goldfields blackbutt (*E. lesouefii* Maiden) and giant mallee (*E. oleosa* F. Muell. ex Miq.) dominate with dundas blackbutt (*E. dundasii* Maiden) in the south (Beard 1974). A wide range of other eucalyptus species also occur in this woodland (Chippendale 1973).

The acacia woodland (mulga). The acacia woodland consists of mulga (*Acacia aneura* F. Muell. ex Benth.) overstorey to 5 m. Two main forms of understorey may be present, one with grasses and forbs, the other with a shrub layer consisting of *Eremophila* sp., *Cassia* sp., *Acacia* sp. and *Maireana* sp (Beard 1976). Acacia woodland is the dominant vegetation of Australia's semi-arid and arid interior. It contains a range of species dominated by Acacia.

Eucalypts occur occasionally throughout the zone, especially in creeks (*E. camaldulensis* Dehn.) and specific habitats (eg, *E. youngiana* F. Muell. and *E. leptopoda* Benth. on sandy sites). Eucalypts increase towards the transition zone into the eucalypt sclerophyll woodland.

HISTORY OF MANAGEMENT

The arid and semi-arid woodlands of Western Australia have played an important part in the development of the State. Wood from mulga and eucalypt woodlands provided timber for fuel and mining timber in enormous quantities through some 70 years of exploitation.

Within the Wheatbelt, in areas with greater than 300 mm rainfall, most of the original woodland has been cleared for agriculture, leaving only remnants on reserves. Eastwards from Southern Cross in areas less than 300 mm rainfall, there was no clearing for agriculture; however the woodlands were extensively harvested for domestic and commercial firewood, mining timber, sleepers and fuel.

Exploitation began in 1887 in the Yilgarn Goldfields, 1890 at Coolgardie and 1895 in Kalgoorlie, continuing until fuelwood harvesting ceased in 1960. Utilisation occurred in both the eucalypt and mulga woodland with harvesting of mining timber continuing on a small scale today.

Eucalypt Woodland

The remaining uncleared eucalypt sclerophyll woodland occurs over an area of 87,500 km^2 inland from Southern Cross and south of the mulga woodland.

Utilisation. Since utilisation commenced in most areas around 1900, an estimated 30 million t of timber was harvested, principally on a clearfall basis. Timber was used primarily for fuel in steam boilers in the mining industry, in power generation and for water pumping stations. Timber was supplied by a number of companies operating steam railways (woodlines) carting up to 200 km from Kalgorlie (Figure 19–2). Timber for underground mining was also harvested to provide support and shoring logs. Suitable species were also cut for fencing material.

Timber used for mining, firewood for mines, firewood for domestic purposes and pumping stations consumed up to 500,000 t annually. The 30 million t harvested was obtained from 3.4 million ha, using clearfall techniques, at a rate of 7 to 9 tonnes per ha^{-1}.

Silviculture. Clearfelling was followed by natural regeneration and was generally very successful.

Early cutting was under Woods and Forests Department permit, although largely uncontrolled with total clearfall and salvage of all utilisable fuelwood adjacent to towns. Reserves and State forests were proclaimed in an effort to control the extent of cutting, after early reports indicated overcutting and denudation near to mining towns.

In 1918 the Forests Act was proclaimed and by the 1930s firm control and managed cutting was possible by the introduction of licences issued over defined areas with a royalty paid. Cutting was practically on a clearfell basis with conditions covering diameter limits, proper utilisation, avoiding damage to roads and fences and

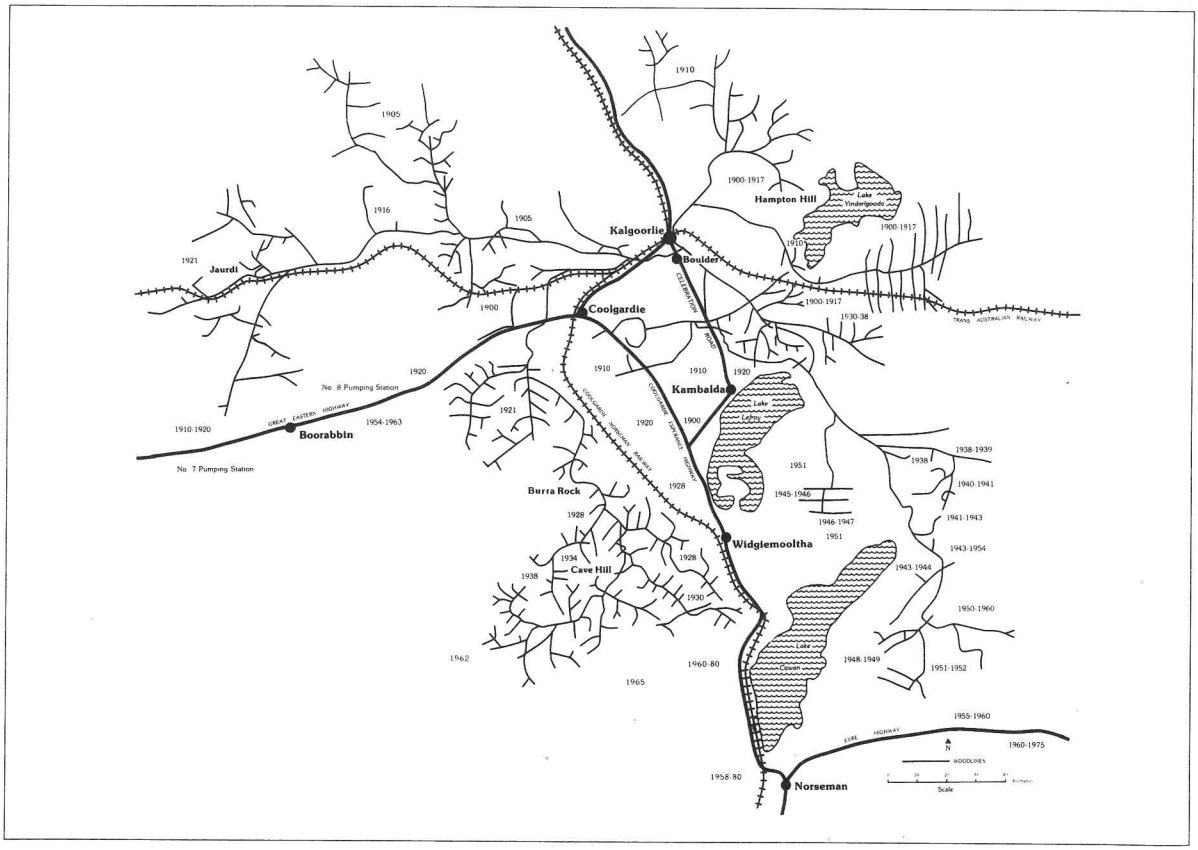

Figure 19–2: Location of railway lines harvesting timber near Kalgoorlie, Western Australia.

restrictions on cutting near homesteads, shearing shed paddocks, wells, windmills and dams. Trees remaining included those less than 12 cm diameter and scattered over-mature trees unfit for harvesting.

Regeneration from seed fall developed freely in most areas, reliant on the disturbance associated with the cutting. As most Goldfields eucalypts carry several successive seed crops, seed fall and subsequent regeneration were good. Seed originated from the slash or remaining seed trees. Normally the slash was not burnt. Regrowth from coppice also assisted regeneration with up to 10 percent of stumps coppicing. Coppice is dependent on species and environmental factors, especially moisture availability.

Harvesting decreased in the 1940s due to the introduction of fuel oil and coal. By 1960 fuelwood was displaced and the woodlines closed down.

Mulga Woodland

As the eucalypt woodland is limited to areas 70 km north of Kalgoorlie, the mulga woodland was utilised to provide fuel and mining timber for the northern Goldfields mines. The taller, better quality productive mulga woodland occurs over an area of about 128,000 km^2 south of Wiluna and north of the eucalypt woodland (Figure 19–1).

Utilisation. Two harvesting areas associated with the towns of Leonora and Laverton were utilised mainly after the 1930s. Narrow gauge tramways (woodlines) allowed harvesting up to 70 km from towns. Records for the Sons of Gwalia mine at Leonora show annual harvesting of 15,000 t utilising an estimated 750,000 t in total. Harvesting occured over 120,000 ha, removing some 5-7 t ha^{-1}.

Mulga was also harvested for charcoal production at up to 7,500 t per annum. Charcoal was excellent quality with a yield of 1 t of charcoal from 3 t of wood. Mulga was also extensively harvested for fencing material due to its excellent durability.

Silviculture. Slow growth rates, heavy grazing pressure and non-annual seeding, all affected successful regeneration. Stricter harvesting conditions were imposed to ensure regeneration and prevent erosion. Licences required that cutting be restricted to denser patches and the retention of seven living trees over 7 feet (1.2 m) high per square chain (400 m^2). Despite these conditions, regeneration within the mulga woodland was less successful than in the eucalypt woodland. Some areas regenerated well although seed availablity was often limited, resulting in poor regeneration in many areas. Pressure from grazing and the inability of mulga to coppice also contributed. It is estimated that at least 50 years is required for mulga to regrow to 5 m height from felling (Fox 1981).

Sandalwood

Sandalwood (*Santalum spicatum* (R.Br.) DC.), a valuable aromatic timber, has been harvested and exported from Western Australia since 1845. Early harvesting was associated with agricultural clearing extending eastwards with the development of pastoralism and mining.

Sandalwood has been harvested within the eucalypt and mulga woodland under licence since early development allowed access. Due to the distribution characteristics of this species and the use of harvesting as alternative employment, the impact of harvesting was minimal over a wide area within the eucalypt and mulga woodlands.

HISTORY OF CONSERVATION

Conservation of the arid and semi-arid woodlands was achieved through reservation and attemps to modify utilisation through harvesting conditions and management. Following early exploitation and uncontrolled overcutting, the Government gazetted numerous timber reserves and State forests throughout the Wheatbelt and semi-arid woodlands. These reserves, gazetted under the Woods and Forests Department and after 1918 the Forests Department, were to protect the woodlands and ensure sufficient local supply of fuelwood close to towns. Most mining towns and pumping stations had timber reserves and State forests surrounding them. Most reserves were harvested, often as economic pressure on the firewood companies forced them to seek resource closer to the mines.

Within the mulga woodland, where pastoral leases were well developed, additional "Timber Reserves for pastoralists requirements" were created to reconcile the conflicts between the miners, pastoralists and fire wood cutters. Many of these reserves still exist along with reserves also created for conservation of sandalwood.

With expansion of agriculture in the eastern Wheatbelt, a number of State forests and reserves were cancelled and often released for agriculture. Many of the current valuable conservation reserves in the Wheatbelt are former State forests and timber reserves. As the demand for firewood and mining timber in the goldfields reduced, the need for large reserves declined. In 1971, 686,000 ha of timber reserves and State forests were cancelled.

Increased activity in the Goldfields during the 1970s nickel and gold boom renewed interest in conservation reserves, primarily for conservation of flora, fauna and landscape. This applied especially to previous State forests that were uncut. In 1975, numerous additional reserves were gazetted in the area, to be managed for conservation of flora, fauna and landscape (Richmond 1973).

Table 19–1: CONSERVATION RESERVES WITHIN ARID AND SEMI-ARID WOODLANDS.

Reserve	Area (ha)	Year Gazetted	Purpose and Comments
Brockway Timber Reserve	3,724	1975	Conservation, virgin eucalypt woodland
Majestic Timber Reserve	2,226	1975	"
Randals Timber Reserve	16,350	1975	"
Kambalda Timber Reserve	3,334	1975	"
Kangaroo Hills Timber Res.	6,600	1975	Conservation, cutover eucalypt woodland
Karramindie State Forest	781	1925	"
Goongarrie National Park	60,335	1981	Conservation mulga woodland
Emu Rock Sandalwood Res.	8,816	1928	Sandalwood and eucalypt woodland conservation
Quartz Peark Sandalwood Res.	4,556	1926	"
Coonana Sandalwood Res.	37,061	1928	"
Bullock Holes Sandalwood Res.	13,313	1928	"
Lakeside Sandalwood Res.	3,787	1926	"
Calooli Sandalwood Res.	3,121	1926	"
Yellari Sandalwood Res.	6,102	1926	"
Scahill Sandalwood Res.	6,916	1927	"
Kambalda Nature Res.	3,680	1975	Conservation of virgin eucalypt woodland
Kalgoorlie 20km Green Belt	86,000	-	Conservation of eucalypt Woodland
Dundas Nature Res.	780,883	1975	"

Table 19–2: MEASUREMENTS OF 84 Y.O. Eucalyptus salmonophlola REGROWTH FOREST.

Dominance Class	No. of Stems	MeanDBHOB (cm)	MAI (mm yr^{-1})	Stocking (sph)	Co-dominant Height (m)
Edge trees	18	25.5	3.0	19.4	11.5
Dominants (crowded)	53	17.0	2.0	57.0	11.5
Co-dominants (crowded)	28	13.0	1.5	30.1	11.5
Subdominants	57	9.0	1.1	61.3	11.5
Total Stand	152	14.5	1.7	167.8	
Mortality (since 1936)	62			67	
Total stand ha^{-1}				235	

Stocking in eucalypt woodland is highly variable, depending on the history of utilisation and species.

A mature salmon gum woodland is expected to have a stocking of around 100-150 stems ha^{-1}. In regrowth woodland, the stocking depends on the success of natural regeneration. Stockings of above 10,000 stems ha^{-1} to below 100 have been recorded in 40 year regrowth. With slow regrowth rates, variable stocking and the lack of large scale utilisation, management through thinning is very limited.

The existing conservation reserves within the arid and semi-arid woodland area are outlined in Table 19–1.

Conservation of eucalypt woodland through reservation is believed to be adequate. Mulga woodland is poorly represented in reserves and few areas within the mulga woodland area remain available for reservation.

CURRENT MANAGEMENT

Current management is limited to a small utilisation industry and management of conservation reserves.

The history of utilisation, especially within the woodlands has resulted in 3.4 million ha of regrowth eucalypt woodland and 200,000 ha of cutover mulga woodland. An estimated 5.3 million ha of virgin eucalypt woodland and 12.6 million ha of virgin mulga woodland occur in the area.

Impacts on the arid and semi-arid woodlands are many. Most of the mulga woodland and about half of the eucalypt woodland are under pastoral lease and subject to grazing which in some areas has a major impact (Harrington, Wilson and Young 1984). Mining and mineral exploration is also experiencing a boom with an increasing impact on the woodlands through clearing and mining activity as well as infrastructure development.

Utilisation

Growth rates within the woodlands are very slow. The only increment plot within the eucalypt woodland is located in 1898 regrowth salmon gum (*E. salmonophloia*) woodland. This plot, established in 1917, was measured in 1936 by Kessell and Stoate, (1936). The plot was relocated and re-established in 1982. Mean diameters and mean annual increments for four categories of trees in the stand at 84 years of age were determined from measurements of all 156 trees in the plot (0.928 ha area). Results are summarised in Table 19–2.

The existing mining timber industry uses about 6,000 t per annum harvesting two classes of product:

- Logs, for support in shafts, mainly over 150 mm diameter in varying lengths.
- Lagging, for shoring and supports, mainly under 125 mm diameter in varying lengths. This product is obtained from regrowth woodland.

With the current harvesting level, about 1,000 ha of regrowth eucalypt forest is thinned each year. Use of mining timber is decreasing, due to the expense of underground mining and development of alternative mining techniques.

Firewood harvesting for domestic use is concentrated around major towns. Kalgoorlie/Boulder uses an estimated 20,000 t with cutting restricted to dead timber obtained from regrowth woodland, fire killed areas and drought deaths.

Cutting and grazing is restricted in Greenbelts around towns as a conservation measure to reduce the generation of dust. Seed collection is an increasing activity within the woodlands. National and international demand for seed from arid areas is increasing with major uses in rehabilitation, reafforestation and horticulture. The unique nature of trees and shrubs from Western Australia's arid and semi-arid woodland has led to increasing demand for seed of many species.

Utilisation within the mulga woodland is restricted to firewood and small scale fencepost cutting.

Sandalwood

Sandalwood orginally occurred throughout the Wheatbelt, pastoral and arid lands into South Australia. Due to agricultural clearing and past harvesting, it is now mainly available in commercial quantities within 42 million ha of the pastoral areas and Vacant Crown Land of the Eastern Goldfields, Murchison district and adjacent desert areas. The best stands occur within the mulga and eucalypt woodland areas.

Harvesting is strictly controlled with a small but very valuable industry. An annual quota, set by the Sandalwood Export Committee, of 1,800 t is obtained under Department of Conservation and Land Management licence by nine full-time and eight part-time contractors. Licence conditions are very strict including:

- restrictions on areas harvested;
- minimum size restrictions (greater than 400 mm circumference, overbark, at 150 mm from the ground) for green stems;
- complete utilisation of stem, roots and branches;
- restrictions on the proportion of a quota harvested as green wood.

Harvesting of dead wood is encouraged for conservation reasons with 55 percent of the 1986 quota being dead wood.

A recent resource level inventory has shown sandalwood occurs over 42 million ha in which the total merchantable resource is 117,000 t. In commercial stands, sandalwood stocking is low, around 2 stems total ha^{-1} of commercial sized stems (Caporn, Kealley and Williamson in prep.).

Grazing

The pastoral industry, through grazing, has an impact on the eucalypt and mulga woodlands. In some areas, poor management has led to overgrazing and extensive damage. Grazing has an impact on regeneration of many species and changes the composition of shrublands through its selective nature. Successful management of the pastoral industry is essential to adequately conserve the arid and semi-arid woodlands (Wilcox 1986).

Reserve Management

The 1.05 million ha of conservation reserves within the arid and semi-arid woodland are managed for conservation of flora, fauna and landscape. Management is limited due to resources and the large area. It includes protection from fire, control of mining and grazing activities and environmental protection (WA Forests Dept. 1982).

Fire is a major threat to the conservation values of the woodlands. Fire is not part of the environment of the eucalypt and mulga woodland with most species sensitive to fire. Extensive wildfires throughout the eucalypt and mulga woodland in 1975/76, following successive above average seasons, were the first major fires recorded for the area. These fires killed large areas of eucalypt and mulga. Regeneration was good in eucalypt woodland but variable in the mulga. Where mulga seedlings became established after the fire, height growth was 80-150 cm over the following 11 years (Fox 1986).

Conservation through reservation of representative ecosystems for the biological, landscape and recreational values is the main mangement objective in the remaining arid and semi-arid woodlands.

FUTURE PROSPECTS

There is a large resource of timber and forest products located in the virgin and regrowth woodlands of the interior of WA. It is unlikely the demand for utilisation of the arid and semi-arid woodlands will increase beyond the current small industries and a possible specialist craftwood industry. Certainly the large scale operations experienced at the beginning of this century are unlikely to be repeated.

The value of the arid and semi-arid eucalypt and acacia woodland lies in the unique nature of this woodland and its biological resource of scientific value to Australia and the world.

The woodland with its species diversity, habitat adaptation, the capacity to form tall woodlands and produce considerable volumes of timber under low rainfall regimes and its resiliance and regeneration ability makes it unique.

The character of the landscape and the ecosystems will be managed and preserved, since their conservation is of national importance.

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APPENDIX 1

Common species occuring in the arid and semi-arid woodlands of Western Australia and their use.

SPECIES	FORM	USE	ZONE	SOIL TYPE
Eucalyptus calycogona	T	F	E	H
Eucalyptus camaldulensis	T	F, MT	M	M
Eucalyptus campaspe	ST	F	E	H
Eucalyptus celastroidies	M	F	E	H
Eucalyptus dundasi	T	F, MT	E	M
Eucalyptus eremophila	ST	F	E	S
Eucalyptus flocktoniae	T	F, MT	E	M
Eucalyptus gracilis	M	F	E, M	H
Eucalyptus griffithsii	M	F	E	M
Eucalyptus kingsmillii	M	F	M	S
Eucalyptus lesouefii	T	F, MT	E	M, R
Eucalyptus longicornis	T	F, MT	E	H
Eucalyptus melanoxylon	T	F, MT	E	H
Eucalyptus oldfieldii	M	–	E	S
Eucalyptus oleosa	M	F	E, M	H
Eucalyptus redunca	T, M	F	E	M
Eucalyptus salubris	ST	F, MT	E	H
Eucalyptus salmonophloia	T	F, MT	E	H
Eucalyptus sheathiana	T	F, MT	E	M
Eucalyptus stricklandii	ST	F, MT	E	M, R
Eucalyptus torquata	ST	F	E	R
Eucalyptus transcontinentalis	T, M	F, MT	E	H
Eucalyptus youngiana	M	F	M	S
Acacia anuera	ST, S	MT, F, FP	M	H
Acacia tetragonophylla	S	–	M	H
Acacia acuminata	S, ST	FP	E	R
Casuarina cristata	ST	F	E, M	H, R
Allocasuarina heugeliana	T	–	E	R
Brachychiton gregorii	ST	–	E, M	R
Pittosporum phylliraeoides	ST	–	E, M	H
Heterodendrum oleifolium	ST	–	E, M	H
Malaleuca pauperiflora	S	FP, F	E	M
Atriplex sp.	S			
Maireana sp.	S			
Cassia sp.	S			
Eremophila sp.	S			

Notes:
Form –Treee (T), Mallee (M), Spreading Tree (ST), Shrub (S)
Use – Firewood(F), Fenceposts (FP), Mining Timber (MT)
Zone – Eucalypt woodland (E), Mulga woodland (M)
Soil Type – Heavy (H), Medium (M), Sandy (S), Rocky (R)

Figure 19–3: Mature salmon gum (*E. salmonophloia*) woodland with saltbush (Atriplex sp) and bluebush (Marieana sp) understorey near Kambolda, Western Australia.

Figure 19–4: Regrowth salmon gum 90 years old near Kambolda.

Figure 19–5: Mature mulga (*Acacia aneurz*) woodland near sandstone, Western Australia.