

WEST VICTORIA

**COMPREHENSIVE REGIONAL
ASSESSMENT REPORT
(VOLUME 1)**

July 1999

Prepared by officials to support the West Victoria Regional Forest Agreement Process

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FOREWORD

This report describes those components of the detailed Comprehensive Regional Assessment (CRA) that have been undertaken in Victoria's West Regional Forest Agreement (RFA) region in relation to:

- biodiversity (Midlands and Otway regions);
- world heritage;
- social values;
- forest resources;
- tourism and recreation;
- streams and catchments;
- minerals;
- forest based industries; and
- ecologically sustainable forest management.

Separate CRA reports will be published in September 1999 covering old growth, the remaining biodiversity assessment (in particular for the Portland and Horsham regions) and National Estate (including wilderness).

Following the release of the CRA reports, meeting with local communities and interest groups will be held to discuss the documentation and its implications, and to consider issues to be addressed in the RFA. Further consultations will take place following the release of the remaining CRA reports and the Directions Report for the West region RFA. These consultations and assessments will provide a basis for the Victorian and Commonwealth Governments to develop a Regional Forest Agreement for the West region RFA.

The RFA will define the commitments made by both Governments to forest conservation, use and development, and the development of those industries based on the forest resources of the region. The RFA will operate for 20 years.

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1. BACKGROUND TO THE RFA PROCESS

1.1 INTRODUCTION

For over two decades the competing demands of conservation and industry on our forests have been an area of debate and controversy. The National Forest Policy Statement (NFPS), agreed by the Commonwealth, State and Territory Governments, provides the framework for the resolution of this issue.

The NFPS sets out how the Commonwealth and States will jointly aim to achieve ecologically sustainable management of forests through comprehensive assessments of the natural, cultural, economic, and social values of Australia's forests and negotiated Regional Forest Agreements (RFAs) that will:

- establish and manage forest reserve systems which are comprehensive, adequate and representative (CAR reserve system);
- establish ecologically sustainable management of forests; and
- develop an efficient, internationally competitive timber industry.

A central aim in the RFA process is to take account of the full range of forest values and consider both benefits and costs in making policy or resource use decisions. RFAs also recognise the range of economic and environmental obligations of each tier of government in managing and protecting forest values.

The detailed information required to negotiate each RFA is drawn together through a comprehensive regional assessment (CRA) of forest values for the regions agreed by the Commonwealth and each State. In Victoria, East Gippsland became the first region in Australia for which a CRA was completed followed by an RFA. Subsequently, CRAs and RFAs have been completed for Tasmania, the Central Highlands region of Victoria and Western Australia. The CRA for the North East Victoria RFA has been completed and the RFA is currently being finalised. The major steps in the RFA process are shown in Figure 1.1 and are described in more detail in the next section.

RFAs are intended to provide stability through the establishment of a sustainable resource base for industry, while at the same time ensuring the protection of Australia's biodiversity, old-growth forests and wilderness through a CAR reserve system and complementary off-reserve management.

1.2 LEGISLATIVE AND POLICY FRAMEWORK FOR THE RFA PROCESS

The following is a discussion of Commonwealth and State legislation and policies that are the framework for the RFA process.

The National Forest Policy Statement

The NFPS sets out the vision of the Commonwealth and State Governments for Australia's forests and forest industries based on the principles of ecologically sustainable forest management. The elements of that vision are described in the NFPS and comprise:

- forest conservation;
- wood production and industry development;
- integrated decision making and management;
- private native forests;
- plantations;
- water supply and catchment management;

- tourism and other economic and social opportunities;
- employment, workforce education and training;
- public awareness, education and involvement;
- research and development; and
- international responsibilities.

The RFA process implements key elements of the NFPS.

National Reserve Criteria

In accordance with the NFPS, the Joint Australian and New Zealand Environment and Conservation Council (ANZECC) and the Ministerial Council on Forestry, Fisheries and Aquaculture (MCFFA) NFPS Implementation Sub-committee - known as JANIS - agreed on national criteria for establishing a CAR reserve system (JANIS 1997).

The National Reserve Criteria include provision for the protection of biodiversity, old growth and wilderness, as well as recognising the role of off-reserve management in meeting conservation objectives. Further details of the criteria are provided in the biodiversity, old growth and wilderness chapters of this report.

Commonwealth Legislation

The Commonwealth's principal involvement in forest issues derives from the *Export Control Act 1982* that regulates the export of woodchips and unprocessed wood. In assessing applications for export under this Act, the relevant Minister is required to ensure that a range of Commonwealth obligations is met. The major legislation includes:

- *Australian Heritage Commission Act 1975*
- *Endangered Species Protection Act 1992*
- *Environment Protection (Impact of Proposals) Act 1974*
- *World Heritage Properties Conservation Act 1983*.

Victorian Legislation

The States and Territories have enacted legislation to fulfil their responsibilities for the protection and management of values and resources in public and private forests. The major Victorian legislation includes:

- *Archaeological and Aboriginal Relics Preservation Act 1972*
- *Catchment and Land Protection Act 1994*
- *Conservation, Forests and Lands Act 1987*
- *Crown Land (Reserves) Act 1978*
- *Country Fire Authority Act 1958*
- *Environment Conservation Council Act 1997*
- *Environment Effects Act 1978*
- *Environment Protection Act 1970*
- *Extractive Industries Development Act 1995*
- *Fisheries Act 1995*
- *Flora and Fauna Guarantee Act 1988*
- *Forests Act 1958*
- *Heritage Act 1995*
- *Heritage Rivers Act 1992*
- *Land Act 1958*
- *Land Conservation (Vehicle Control) Act 1972*
- *Mineral Resources Development Act 1990*

- *National Parks Act 1975*
- *Planning and Environment Act 1987*
- *Reference Areas Act 1978*
- *Victorian Conservation Trust Act 1972*
- *Victorian Plantations Corporation Act 1993*
- *Water Act 1989*
- *Wildlife Act 1975*.

Further details on the scope and operation of the legislation in relation to the RFA process is provided in Appendix 1.

Indigenous Issues

The RFA process addresses indigenous issues in two distinct ways: consultation on the outcomes and process in general (as part of the wider consultation process); and cultural heritage, through the National Estate assessment.

As with all communities and stakeholder groups with an interest in the West RFA, Aboriginal communities in the region and appropriate representative bodies are already involved and will continue to be consulted throughout the RFA process.

The *Native Title Act 1993* recognises and protects native title rights and interests. In recognition of this Act:

- where any Government action to implement an RFA could affect native title, the action will be taken in accordance with the Native Title Act; and
- an RFA is not intended to influence in any way native title claims that may arise.

Accreditation

To the maximum extent possible Governments will accredit existing data sets and processes used in the RFA process under the provisions of the Intergovernmental Agreement on the Environment (IGAE) (Commonwealth of Australia 1992a). Under these provisions, the Commonwealth or Victoria will endorse a process used by the other's jurisdiction as having accommodated part or all of the interests of the accrediting government.

The data sets and processes used in the assessments described in this report have been accredited for the West RFA.

1.3 THE RFA PROCESS IN VICTORIA

Background

During 1995 the Commonwealth and the States of Victoria, Tasmania, New South Wales and Western Australia identified interim (or deferred) forest areas which may be required for a CAR reserve system and should be protected pending the completion of RFAs. In January 1996 the Commonwealth and Victoria signed an Interim Forest Agreement (IFA) which makes provision for the protection of such areas. A variation extending the IFA was signed in June 1998.

The Prime Minister and Premier also signed a Scoping Agreement committing Governments to arrangements and timetables for the completion of the RFAs.

The RFA process is managed by a Joint Commonwealth-Victoria Steering Committee, supported by a Technical Committee. The membership of these committees is listed in Appendix 2.

Victorian RFA Regions

Victoria has a land area of 22.7 million ha, of which some 40 per cent is publicly owned. Of the public land, 42 per cent (3.8 million ha) is reserved for conservation purposes, including 2.5 million ha of forests. A further 3.5 million ha of public land is also forested, of which about 1.2 million ha is available for timber harvesting.

Victoria has five RFA regions:

- East Gippsland;
- Central Highlands;
- North East;
- Gippsland; and
- West.

On 3 February 1997, the Prime Minister and the Premier of Victoria signed the RFA for the East Gippsland region and the Central Highlands region RFA was signed on 27 March 1998. The West is the fifth region in Victoria in which an RFA is being developed.

Stages in the RFA Process

The major stages in the RFA process are depicted in Figure 1.1 and outlined below.

Comprehensive Regional Assessment (CRA)

In this report, the following assessments are included:

- biodiversity assessment for the Midlands and Otways FMAs;
- world heritage;
- social;
- wilderness;
- resource;
- streams and catchments;
- tourism and recreation;
- minerals; and
- economic.

Assessment of biodiversity for Portland and Horsham (part) FMAs, National Estate and old growth is continuing and will be reported later in 1999. In addition, more detailed reports will be published for the biodiversity, old-growth forest, wilderness, social, minerals and ecologically sustainable forest management assessments.

The CRA draws on a wide range of studies conducted in recent years. Relevant technical papers are referenced in the report.

The CRA provides a synthesis of the information on which the RFA can be developed and agreed between the Victorian and Commonwealth Governments. It makes no judgements or interpretations of information where this might pre-empt the development of the RFA. Furthermore, both Governments are committed to consultation with the community and other interested stakeholder groups, within the context of the NFPS.

RFA Directions Report

The Directions Report builds upon information contained in the CRA report and the results of consultations with the community. The Directions Report will address:

- how the proposed CAR reserve system addresses the national forest reserve criteria;

- the elements of ecologically sustainable forest management (ESFM) which are part of the RFA;
- industry development opportunities; and
- the links between the RFA process and other statutory processes, particularly environmental impact assessment, World Heritage, National Estate and endangered species.

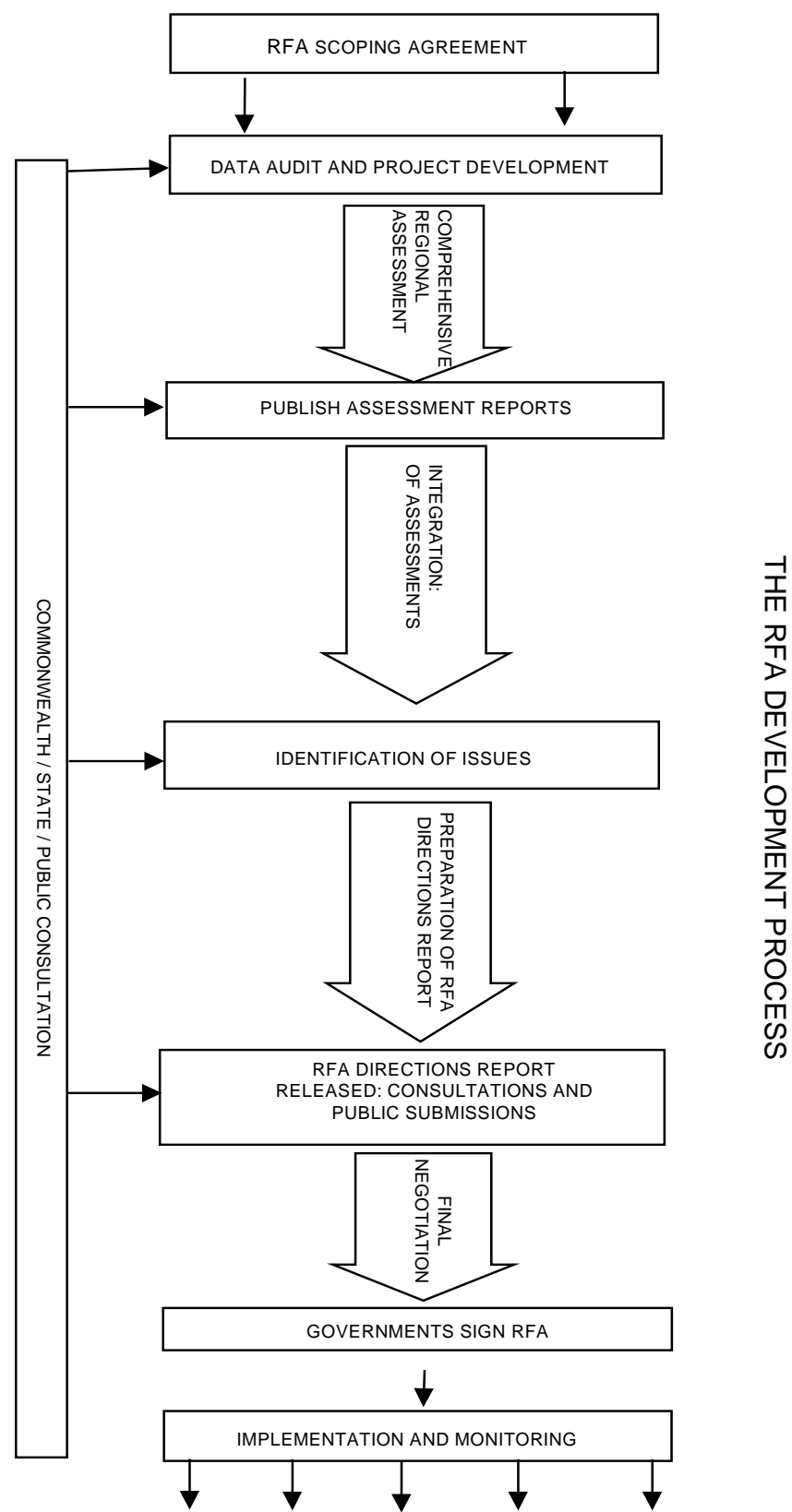
The West RFA Directions Report will be released later in 1999.

The community and stakeholder groups will be consulted both during the development of the Directions Report and following its release through a series of workshops held in the West and Melbourne over the next few months. These consultations will focus on the issues that need to be addressed in the RFA. The first workshops will be held shortly after the release of the CRA report and will familiarise stakeholders with the information which it contains. Any deficiencies in the data or methods identified at that stage can be taken into account in the development of the Directions Report.

RFA Finalisation

Following the release and consultation on the Directions Report, the Commonwealth and State Governments will negotiate the Regional Forest Agreement. The RFA is scheduled to be completed in 1999.

Figure 1.1: Major Stages in the RFA Process



2. WEST REGION

2.1 LOCATION

The West region covers approximately 5.8 million hectares of Victoria, from the western outskirts of Melbourne to the Victoria-South Australia border. The Great Dividing Range forms much of the northern boundary.

The region covers the Shires of Glenelg, Moyne, Corangamite, Colac-Otway, Surf Coast, Greater Geelong, Golden Plains, Moorabool, Ballarat, Southern Grampians and Ararat. Sections of the Shires of Hepburn, Pyrenees, Northern Grampians, Horsham, Yarriambiack and West Wimmera are also included in the region.

2.2 LANDSCAPE AND CLIMATE

The climate in the West is temperate, with patterns of precipitation and temperature related to geography, topography, altitude and proximity to the coast.

Western Victoria is generally lower in elevation and relief than the east of the state, and the landscape is undulating to hilly. Major peaks include Mt William (1167 m) in the Grampians National Park and Mt Macedon (1001m). The western end of the region is dominated by the Dundas Tableland. In the south of the region, the Otways Ranges are characterised by highly dissected, undulating terrain.

The region is distinguished by the Western Volcanic Plains, which form an area of low relief between the Otway Ranges and uplands to the north. These plains were formed from volcanic flows of basalt lavas and their low relief is a factor that restricts direct drainage of water to the sea. As a consequence, many rivers flow into a series of lakes, the largest being Lake Corangamite.

The Grampians and Otway Ranges are the dominant landform features in the region. These ranges have a significant influence on weather patterns, which in turn affects vegetation distribution and fire risk conditions.

The Otway Ranges receive high rainfall, generally over 2000 mm per annum, and at their highest elevations are characterised by wet montane forests. However, a distinct rain shadow effect is produced to the north and east of the Otway Ranges, with markedly lower average rainfalls between the ranges and the western side of Port Phillip Bay. Rain shadow effects are also evident east of the Grampians. In these rain shadow areas, summers tend to be hot and windy and the rainfall is relatively low, averaging less than 500 mm between Werribee and Cressy.

To the west and north of the region, annual rainfall progressively increases, exceeding 800 mm in the Portland area and 1000 mm around Trentham. Snowfalls occasionally occur in the region at higher elevations.

Temperature varies according to proximity to the coast and altitude. January and February are the hottest months of the year when mean maximum temperatures range from the low 20s near the coast and at higher elevations to the low 30s in the north. Minimum temperatures occur in the winter months and average maximums range between 10°C and 15°C. Strong winds are a feature of the region, particularly near the coast, which is evidenced by the 'windswept' nature of the vegetation.

2.3 SIZE AND TENURE

The West region covers approximately 5.8 million ha. Private land comprises 4.8 million ha, or 83 per cent of the region, and is mostly cleared and used for a range of agricultural and industrial pursuits. Extensive areas of privately owned plantations exist in the south west and east of the region.

Public land comprises 1 million ha, or 17 per cent of the area, and is covered mostly by native forest. Areas of public land are generally concentrated in the Otway Ranges, along the Great Dividing Range and in the south-western corner of the region. Public land in the West region is known for its mountain and coastal landscapes, diverse range of flora and fauna, timber resources, and tourism and recreational opportunities.

State forest occupies 411 000 ha, or 41 per cent of the public land. Conservation reserves, including National Parks, State Parks and Flora and Fauna Reserves, occupy a similar proportion of the public land, or approximately 437 000 ha. The remaining public land in the West region, as shown in Table 2.1, includes other public land and water bodies. Although the formerly government-owned plantations are now privately managed, these areas are also included as public land as the land is leased from the Crown.

Table 2.1: Land Tenure in the West

| Land Tenure | Area (ha) | Proportion of All Land (%) | Proportion of Public Land (%) |
|-----------------------|------------------|----------------------------|-------------------------------|
| State Forest | 410 906 | 7.12 | 40.90 |
| Conservation Reserves | 436 829 | 7.56 | 43.47 |
| Other Public Land | 71 374 | 1.23 | 7.10 |
| Water Bodies | 85 721 | 1.50 | 8.53 |
| Public Land Total | 1 004 830 | 17.41 | 100.00 |
| Private Land | 4 767 381 | 82.59 | |
| Total | 5 772 211 | 100.00 | |

Source: NRE unpublished data (1999)

Note: Plantations licensed to Hancocks Victorian Plantations are included in the private land category.

2.4 POPULATION

In 1996, the total population of the West region was 570 188. The largest city in the West region is Ballarat with a population of 64 831 people. Warrnambool (26 052), Horsham (12 591), Bacchus Marsh (11 279), Colac (9793), Portland (9664) and Hamilton (9248) are also large population centres in the region. Numerous smaller towns exist across the region including Ararat (6890), Stawell (6272), Port Fairy (6232), Camperdown (3153), and Daylesford (3278). Geelong is adjacent to the eastern boundary of the West region and has a population of 125 382.

Many of the large population centres are located on the Western and Princes Highways, the major access routes through the region, with large industrial ports at Geelong and Portland. Towns that have developed along the coast include tourist destinations such as Apollo Bay, Lorne, Port Fairy, Port Campbell and Warrnambool.

More detailed demographic information is provided in Chapter 11, Social Assessment.

2.5 REGIONAL ECONOMY OF THE WEST REGION

Victoria's gross state product (GSP), by industry, is shown in Table 2.2. Access to native forest resources provides at least part of the base for agriculture, forestry and fishing; mining; accommodation, cafes and restaurants; and cultural and recreational services. These industries accounted for about 10 per cent of gross state product in 1996 (ABS 1996). However, only a small proportion of the gross state product associated with these broad industry groupings can be attributed to forest based industries. Other sectors rely in part on native forest resources, e.g. the manufacturing category includes output from the wood processing industries.

The West region is a relatively large and diverse area compared with other RFA regions within Victoria. The region includes the agricultural and grazing districts of the Western District and the Wimmera; large regional centres of Hamilton and Ballarat; and the western fringes of Geelong and Melbourne. Thus the region can be expected to account for a relatively large proportion of total Victorian gross state product compared with other RFA regions.

Table 2.2: Industry Contribution to Victorian Gross State Product (in 1995-96 dollars)

| | 1990-91 | Share ^a | 1995-96 | Share ^b |
|---------------------------------------|---------------|--------------------|----------------|--------------------|
| | \$m | % | \$m | % |
| Agriculture, forestry and fishing | 2 472 | 2.7 | 3 725 | 3.4 |
| Mining | 3 600 | 4.0 | 3 150 | 2.9 |
| Manufacturing | 16 460 | 18.3 | 19 880 | 18.0 |
| Electricity, gas and water | 3 550 | 3.9 | 3 642 | 3.3 |
| Construction | 6 152 | 6.8 | 6 149 | 5.6 |
| Wholesale trade | 6 100 | 6.8 | 7 135 | 6.5 |
| Retail trade | 6 388 | 7.1 | 8 085 | 7.3 |
| Accommodation, cafes and restaurants | 1 454 | 1.6 | 2 111 | 1.9 |
| Transport and storage | 4 034 | 4.5 | 5 011 | 4.5 |
| Communication | 2 537 | 2.8 | 3 738 | 3.4 |
| Finance and insurance | 2 715 | 3.0 | 4 684 | 4.2 |
| Property and business services | 8 397 | 9.3 | 10 890 | 9.9 |
| Government administration and defence | 3 012 | 3.3 | 3 216 | 2.9 |
| Education | 4 560 | 5.1 | 5 643 | 5.1 |
| Health and community services | 5 606 | 6.2 | 7 137 | 6.5 |
| Cultural and recreational services | 1 215 | 1.3 | 2 105 | 1.9 |
| Personal and other services | 1 650 | 1.8 | 2 354 | 2.1 |
| Ownership of dwellings | 8 586 | 9.5 | 9 761 | 8.9 |
| General government | 1 620 | 1.8 | 1 816 | 1.6 |
| Total | 90 108 | 100 | 110 232 | 100 |

^a Industry share of Victorian GSP in 1990-91. ^b Industry share of Victorian GSP in 1995-96.

Source: Australian Bureau of Statistics (1996).

The region is estimated to have accounted for 15 per cent of employment in Victoria in 1996 (Table 2.3), the latest year for which data are available (ABS 1999a,b). The main employment sectors for the West were Wholesale and retail trade (19.9 per cent); Health and community services (18.6 per cent); Manufacturing (16.2 per cent) and Finance, insurance, property and business services (9.7 per cent). Generally, the breakdown of employment by industry group in the West region reflects the overall state breakdown.

It is estimated that the Victorian timber industry (defined as the forestry and logging sector and the wood and paper products manufacturing sector) directly employed around 29 865 people. Within the West region, the timber industry directly employed 3718 people in 1996,

accounting for approximately 12.4 per cent of total employment in the Victorian timber industry in that year. In terms of regional employment, the timber industry was not a big source of employment in 1996 in the West region. The forestry and logging sector directly accounted for 0.14 per cent of employment in the West region, while employment in the wood and paper products sector accounted for 1.2 per cent of regional employment.

It is important to note that the employment numbers reported in Table 2.3 cover employment.

Table 2.3: Employment in the West region and Victoria, by Industry ^a

| | West Victoria | | | Victoria | | |
|---|-------------------|-------------------|--------------------|-------------------|-------------------|--------------------|
| | 1991 ^c | 1996 ^c | Share ^b | 1991 ^c | 1996 ^c | Share ^d |
| | no. | no. | % | no. | no. | % |
| Agriculture, forestry and Fishing | 21 113 | 22 657 | 8.1 | 71 759 | 74 178 | 3.9 |
| <i>Forestry and logging ^e</i> | 284 | 404 | 0.1 | 1 409 | 1 833 | 0.1 |
| Mining | 893 | 910 | 0.3 | 5 697 | 5 626 | 0.3 |
| Manufacturing | 41 918 | 45 254 | 16.2 | 298 007 | 308 677 | 16.3 |
| <i>Wood and paper products ^e</i> | 2 725 | 3 314 | 1.2 | 25 832 | 28 032 | 1.5 |
| Electricity, gas and water supply | 3 091 | 2 200 | 0.8 | 25 882 | 13 497 | 0.7 |
| Construction | 14 769 | 17 535 | 6.2 | 97 526 | 111 471 | 5.9 |
| Wholesale and retail trade | 47 201 | 55 503 | 19.9 | 348 676 | 381 489 | 20.0 |
| Transport and storage | 12 906 | 13 638 | 4.9 | 76 430 | 74 857 | 3.9 |
| Communication | 4 382 | 5 311 | 1.9 | 34 508 | 43 119 | 2.3 |
| Finance, insurance, property and business services | 19 943 | 26 997 | 9.7 | 200 300 | 244 789 | 12.9 |
| Government administration and defence | 16 519 | 12 293 | 4.4 | 94 386 | 71 416 | 3.8 |
| Health and community services | 47 605 | 51 942 | 18.6 | 323 280 | 365 381 | 19.3 |
| Cultural, recreational, personal and other services | 15 188 | 21 148 | 7.6 | 112 253 | 142 905 | 7.5 |
| Not stated or classifiable | 780 | 3 850 | 1.4 | 6 852 | 60 554 | 3.2 |
| Total | 246 308 | 279 238 | 100 | 1 695 556 | 1 837 405 | 100 |
| Share of Victorian Employment (%) | 14.5 | 15.2 | | 100 | 100 | |

^a Estimates from 1991 and 1996 census data based on statistical local areas (SLAs). Parts of some SLAs included here do not lie completely within the West Victoria RFA region. ^b Share of West Victoria RFA region employment in 1996. ^c As at May 1991 and 1996 respectively. ^d Share of Victorian employment in 1996. ^e Subcategory of major category above (major category estimate includes subcategory).

Source: Australian Bureau of Statistics (1999a,b).

for both the native hardwood and plantation (softwood and hardwood) sectors. Additionally, employment attributable to the wood resources of the native forests of the West region extends beyond the West region boundary and is not included in these statistics. Timber processors and pulp and paper producers located outside the region that source wood from the West region are an example. Industry linkages are discussed in more detail in Chapter 5.

Between 1991-96, employment in the Victorian forestry and logging sector increased by 30 per cent, while in the wood and paper products sector, employment increased by 9 per cent. In the West region, employment in these sectors over the same period reflected these movements, with employment increasing by 42 per cent and 22 per cent respectively. The

increases largely reflect the increased establishment, harvest and utilisation of the plantation resource in the West region.

2.6 HISTORY OF THE WEST REGION'S FORESTS

According to the reconstruction by Clark (1996) the Aboriginal language groups existing in the West region consist of (commencing at Melbourne) Woi Wurrung, Djadja Wurrung, Watha Wurrung, Gulidjan, Gadubanud, Djargurd Wurrung, Girai Wurrung, Djab Wurrung, Jardwadjali, Dhauwurd Wurrung and the Buandig which extends into South Australia. From observations in post contact times, Aboriginal people used the whole landscape for their economy. The culture of Aboriginal communities was based on an intimate and dynamic relationship with the environment through activities such as gathering and hunting, and through association of places with religious beliefs and obligations. Aborigines shaped the environment through their activities. Forest resources such as timber and bark were traditionally used to make shelters, weapons and tools. In the Stony Rises and Lake Condah area, shelters of wood with stone foundations were constructed. The forests also provided food such as emus, koalas, wallabies, possums and starch from tree ferns. Fire was used to encourage regeneration, particularly of edible plant foods, and to expose edible roots.

Lieutenant Grant, in command of the *Lady Nelson*, made the first recorded European sighting of the coastline in 1800, naming Capes Patten and Otway. However, Victoria's first permanent European settlement was not until 1834, when the Henty family arrived at Portland. Later reports of 'Australia Felix' by Major Thomas Mitchell and his party, who reached the mouth of the Glenelg River in 1836, encouraged the influx of settlers not only from Tasmania and New South Wales but also from Great Britain. Town names such as Killarney, Penshurst and Belfast are a legacy of the many immigrants from Ireland and Scotland to this region.

John Batman, in 1835, attempted to form a treaty with the local Aboriginal people of the Port Phillip district. From 1837, squatters began moving westward from Port Phillip to settle areas north and west of the Otway Ranges. In 1840, the first land sale was made in Portland and further settlement occurred on the plains, particularly near Port Fairy. Until the land reforms of the 1860s, squatters' runs were large, sometimes up to 20 000 acres (8100 ha) although few agricultural improvements were made to the land. The extensive areas of forested land were thought to be more suited to intermittent grazing than to intensive agricultural settlement.

By the 1850s most of the land had been taken by settlers. Aboriginal people were forced off their traditional hunting grounds, which caused numerous conflicts resulting in skirmishes between settlers and Aboriginal people, and massacres of Aboriginal people. This, and the introduction of new diseases, decimated local Aboriginal populations and their traditional social and subsistence base. In 1838, a Protectorate system was established but was abandoned 10 years later. A Central Board for the Protection of Aborigines was appointed in 1860 to oversee the interests of the Aborigines in the Colony of Victoria. This Board funded the establishment of missions, and several reserves were set aside between 1836 and 1861, including Lake Condah, Ebenezer Mission, Framlingham Forest and Franklinford in the West region. Aboriginal people at Framlingham and Lake Condah fought the system to stay on their land.

The discovery of gold in 1851 at Clunes and Buninyong transformed the eastern half of the region. Gold drew migrants from Europe and south eastern China and, by 1861, the goldfields held 228 000 people, compared with 125 000 people in Melbourne. Ballarat's goldfields were exceedingly rich and yielded a total of 9.44 million ounces of gold (CVTC 1997). Supported by significant investment accrued from gold mining, the economic base of Ballarat diversified and a wide range of manufacturing industries developed. By 1880, eight iron foundries, 13 breweries and four flour mills existed in the city.

The gold rushes of the 1850s also increased the demands for timber, and whole forests were cleared to provide props for tunnels, tramway sleepers and to line the shafts of mines. Mine boilers consumed hundreds of thousands of tons of firewood annually.

During the 1860s, four major Land Acts transformed the region from a grazing to an agricultural economy. These 'free selection' Acts encouraged new settlers and reduced the squatters' runs. The Land Act 1869 provided for selection of land, including some of the pastoral estates across the region. This led to clearing of forests in much of the region. In the Otways, although initial attempts were made to reserve areas of forest, virtually all land was made available for selection. The poor access and the immense difficulty of clearing the mountain forests by ring-barking, felling and burning meant that many allotments were only partially cleared. Many abandoned selections were reclaimed by the Crown.

Wildfire occurred frequently in the West region due in part to the settlers' use of fire. The first notorious and perhaps the most devastating fires documented were the 'Black Thursday' fires of 1851. Other major wildfires in the region occurred in 1886, 1898, 1919, 1926, 1939, 1951, 1962, 1977, 1983 and 1995. Major fires were recorded every summer from the turn of the century to 1919, when 50 000 ha of Crown Lands in the Otway Ranges and the Grampians were devastated by bushfire.

Of the Victorian forests damaged by fire in 1939, those in the West region were the least affected. Outside the dense forests of Mount Macedon, the Otways and the Wombat State Forest, the open nature of the red gum and box-ironbark forests, grazing by stock and rabbits, and the non-fire-dependent ecology of the forest type contributed to low flammability and small amounts of damage (Evans 1999).

Graziers, miners and selectors felled large quantities of bush timber. Government authorities used hardwood species for railway sleepers, piles for piers and docks, and electricity poles, and timber companies processed a range of forest products. Forests were intensively cut for mine supports, heavy construction timbers and fuel wood, which left many hillsides denuded. The timber was felled by axe and crosscut saw, then sawn into manageable sections for transportation to the mill by horse and bullock teams or timber tramway. The first sawmills were located close to their log supply. Power was supplied by steam using stationary engines and water-powered mills.

Although harvesting had started in the West region during the 1840s, timber cutting in the east of the region intensified during the gold rushes. Sawmilling commenced in 1855, south of Ballarat around Buninyong, Warrenheip and Smythes Creek, to service the mines at Ballarat and, although these mills were few in number, Victoria's first large mills were constructed here. North and east of Ballarat, sawmilling commenced in the western Wombat Forest or, as it was locally known, the Bullarook Forest. Further west, the sawmilling industry in the Heywood and Port Fairy regions also developed during the 1850s while sawmills were established in the Otway region during the 1880s. Sawmills generally supplied local demands for sawn timber.

In the latter half of the 19th century, the Mount Cole and Pyrenees forests were heavily cut for construction timbers, for developing centres such as Ballarat, Avoca and Stawell. During its peak, over 30 sawmills were in operation in the Mt Cole State Forest. However, by 1904, its sawlog resources were exhausted and the forest remained closed until 1947.

Sawmilling in the Wombat State Forest was the first large-scale operation in Victoria and its development had important consequences for the future of the industry. The proximity of the Bullarook end of the forest to Ballarat and Bendigo meant that this part of the forest was the first to be exploited on a large scale. It was in this area of forest that Victorian timber

tramway technology was largely developed and tested, including a pioneering tramway haulage system using a steam locomotive (Evans 1999).

Sawmilling had already started in the West region when the first steam-powered railway in Victoria was completed in 1854. Location of the markets and the supply of timber initially dictated the location of sawmills, with the sawmill being sited as conveniently as possible between the two. When the first country railways in the West region were constructed, their route was dictated by the needs of either gold mining and its associated commerce, or pastoralism. The sawmilling industry in the West region did not attain sufficient size and economic importance that it could influence railway construction as happened in the forests of the Central Highlands and Gippsland regions.

The first legislation enabling the government to reserve forested areas for the protection of timber resources was granted under the Land Act of 1862. As a result, large tracts of forest, including the Wombat State Forest, were reserved across the State. This legislation, however, brought no effective measures for the conservation of forests. A series of reports from the 1870s recorded details of huge waste in the timber industry, and irresponsible and ineffective management of the forest resource. Forestry Bills were introduced to Parliament between 1879 and 1892, but none was enacted.

A Royal Commission on Forests, which sat from 1897 to 1901, led to the *Forests Act 1907*, which established the Department of Forests. This legislation was strengthened by the *Forests Act 1918*, which established the Forests Commission of Victoria. The 1918 Act gave the Commission the revenue to protect, conserve and develop the indigenous forest and maintain an adequate area of softwood plantations.

The Forests Commission was able to directly influence the location of timber extraction and sawmilling through its log allocation system. Annual licences were granted to remove specified volumes of timber from defined areas of State forest. The Commission's roading program also assisted the expansion of the timber industry.

The Forests Commission began rehabilitation of the Wombat State Forest, which had been heavily cut-over. Through a program of thinning, overwood removal and selection, sawlog production increased through the 1920s to early 1940s. By the late 1940s, regrowth forests arising from exploitation during the goldmining era approached an age when they could start producing sawlogs. In 1947, the high quality Mt Cole forests were also re-opened to allow timber utilisation. This, and neighbouring areas of forest, provided a valuable supply of timber in the post-war years and an extensive roading program was carried out.

The Royal Commission, following the 1939 bushfires, directed that sawmills should no longer be sited in the forest. This required the improvement of the road system for hauling logs to urban centres. Licensees became responsible for the construction of the roads in their area. The improvement in roads, and an advance in technology after the Second World War, encouraged the increased mechanisation of logging operations.

Changes in cutting and sawmilling technology led to a dramatic increase in the volume of timber harvested in Victoria. Tractors for snigging and motor vehicles for hauling logs and sawn timber replaced bullock teams and timber tramways. Diesel and electric power replaced steam at the mills. Crawler tractors fitted with dozer blades facilitated road making, which gave access to previously inaccessible areas, and bulldozers with winches snigged logs from deep gullies. Chainsaws also revolutionised cutting practices in the forests.

Residents of the West region also used the forests for recreation. Organised bushwalking tours that began in the late 1890s had become well established by the 1920s and boomed in the 1930s. By 1900, the Lorne area had become popular for holidays and guesthouses and hotels

were scattered along the coast. Construction of the Great Ocean Road commenced in 1918 with the concept that it would be a tourist road of 'world repute' (CVTC 1997). The first section from Anglesea to Lorne was completed in 1922 and, by 1932, had been extended to Apollo Bay, leading to an increase in visitor numbers from Melbourne.

Post contact Aboriginal people remained in the areas and worked on the many stations in the districts as shepherds, farm hands, kitchen maids, cooks, shearers etc. Many of the Aboriginal people living in the region today are descendants of the original language groups of Western Victoria. They use the forests for providing medicine and craft materials. The forests contain places of Aboriginal significance and Aboriginal people visit the forests for cultural and educational purposes.

Elsewhere, Daylesford gained its reputation as a spa town following the discovery of mineral-rich springs in 1836. For many years, it was fashionable to 'take the waters' until the springs were overshadowed by goldfield activity. The opening of the railway line in 1880 again boosted the Daylesford and Hepburn tourism industry, and guest houses, restaurants and tea rooms were established. Between 1900 and the early 1930s, the mineral springs enjoyed periods of popularity.

The Grampians and Port Campbell National Parks are two of the most popular parks in the state and are located in the West region. These and other parks, reserves and State forest, have a history of recreational use including picnicking, bushwalking, horse riding and nature observation. Across the region, the popularity of these activities and others such as four-wheeled driving, trail bike and mountain bike riding has steadily increased.

The former Land Conservation Council (LCC) conducted a number of land use reviews during the 1970s and 80s and, through these, shaped the West region's character. These reviews led to the creation of new and enlarged National, State and Regional Parks and reserves, and identified forests that would be available for timber production and other land uses. In some instances, land for plantation extension was identified.

2.7 LAND CLASSIFICATION

Conservation Reserves

The West region has an extensive system of National Parks and other conservation reserves. The system has been established to protect a range of significant natural and cultural values, and to provide opportunities for recreation, tourism and education.

The reserve system occupies 437 000 ha, or 43 per cent of public land in the region. It includes the Grampians National Park and Port Campbell National Park. The biodiversity, old growth and national estate assessments provide information on the reserve system and the values that it contains. Map 1 shows the location of the reserve system.

State Forest

State forests are managed for both conservation and sustainable resource utilisation. Within State forest provision is made for:

- water supply;
- catchment and stream protection;
- hardwood timber production;
- conservation of natural and cultural values;
- recreation and tourism;
- mineral exploration and mining; and

- other forest uses, such as honey production and grazing.

State forest also has an important role in complementing the management of parks and reserves for conservation, recreation and eco-tourism. Forest management plans direct the management of State forest for the protection of environmental values while providing for the sustainable management of the natural resources.

Management plans exist for two of the four Forest Management Areas (FMA) covered by the West region. The plans for the Otway and Midlands FMAs provide a strategic land-use framework in State forest and are based on 'management zones' that set priorities and specify permitted activities for different parts of the forest. The three management zones are:

- The **Special Protection Zone (SPZ)** — managed for conservation with no timber harvesting permitted. This zone is designed to link and complement established conservation reserves.
- The **Special Management Zone (SMZ)** — managed to conserve specific features where timber harvesting is still permitted under certain conditions.
- The **General Management Zone (GMZ)** — managed for a number of uses where timber production is the main priority.

A Plan for the Horsham and Portland FMAs will be developed by 2001.

2.8 MANAGEMENT ARRANGEMENTS

Land management arrangements, central to the achievement of Ecologically Sustainable Forest Management (ESFM), vary according to tenure and the objectives of management on each tenure. Legislation and policies define the broad management arrangements applicable to different lands. Implementation of such arrangements is achieved through planning processes, management plans, codes of practice, guidelines and environmental prescriptions that are applied at a strategic and operational level.

3. FOREST MANAGEMENT AND RESOURCE UTILISATION

Forest management on public land aims for the conservation of natural and cultural values while providing resources for the community's economic benefit.

This chapter outlines the processes of State forest planning and management in the West region. Further information about the forest management planning process is provided in the Ecologically Sustainable Forest Management (ESFM) reports (VicRFASC 1996b and VicRAFSC 1997b).

3.1 STATE FOREST MANAGEMENT

The principles for State forest management in Victoria are set down in the Timber Industry Strategy (Victorian Government, 1986). This document states that forest management will be:

- economically viable;
- environmentally sensitive;
- sustainable for all forest values; and
- assisted by public participation in planning.

A number of acts of Parliament, such as the *Forests Act 1958*, the *Conservation, Forests and Lands Act 1987* and the *Flora and Fauna Guarantee Act 1988*, as well as Government and Departmental policies, guide forest management planning in Victoria.

Implementation of many principles in the Timber Industry Strategy is provided through the development of the Code of Forest Practices for Timber Production, Forest Management Plans (FMP), Wood Utilisation Plans, Forest Coupe Plans and forest operator licensing provisions.

Code of Forest Practices for Timber Production

The Victorian Parliament ratified the Code of Forest Practices for Timber Production (the Code) in May 1989 in accordance with Section 55 of the *Conservation, Forests and Lands Act 1987*.

Since its implementation in 1989, several reviews of aspects of the Code have been undertaken (Victoria Auditor-General 1993, CNR 1995b; CNR 1995d; CNR 1995c; O'Shaughnessy 1995a). A second version of the Code was developed by NRE using a process of scientific review and community consultation. This included a review of the Code by the CSIRO based on scientific evidence, and experience and observation of its effectiveness in achieving environmental care. The revised Code was ratified by Parliament in December 1996.

The Code's purpose is to ensure that commercial timber growing and harvesting activities are carried out on both public and private land in such a way that: an internationally competitive timber industry is promoted; activities are compatible with the conservation of a wide range of environmental values; and ESFM is promoted.

To this end, the Code provides Statewide goals, guidelines and some minimum standards to be applied to timber production operations both by NRE, as forest managers, and by forest operators. These goals and guidelines apply to timber harvesting, timber extraction roading, regeneration and reforestation, and are to be used during the formulation of detailed plans and prescriptions, which include:

- Forest Management Plans that address the management of environmental, cultural and resource values in a Forest Management Area (FMA).
- Forest Management Prescriptions for the control of timber harvesting in native forests.
- Wood Utilisation Plans that detail the type and quality of wood to be produced over the duration of the plan, together with a plan for the allocation of wood to processors. Plans are generally produced to cover a three-year period and are updated annually.
- Forest Coupe Plans which identify the areas to be harvested and a schedule that incorporates the specifications and conditions under which each operation is to be administered and controlled.

The Code will be reviewed at least every 10 years to take account of new research information and field experience.

The Code is primarily implemented at a local level through the application of FMA management prescriptions. These detailed prescriptions take account of local conditions such as climate, forest type, topography, elevation, soil type, and various management activities. They must be consistent with the Code and Forest Management Plan strategies, based on relevant scientific input, and reviewed periodically. These prescriptions for the Forest Management Areas in the West region were reviewed in 1997-98 to incorporate the requirements of the revised Code (NRE 1997a, 1997b, 1997c, 1997d).

Compliance with the Code on public land is required under the conditions of licences issued in accordance with the provisions of the *Conservation, Forests and Lands Act 1987* and the *Forests Act 1958*. The Timber Harvesting Regulations 1989 require all forest operators to be licensed to carry out timber harvesting operations. Breaches of particular terms or conditions of Forest Operator Licences can result in the accumulation of penalty points and may lead to the suspension or cancellation of the licence. Licensed forest operators are also issued with a set of prescriptions, which contain provisions directly relevant to their responsibilities in carrying out timber harvesting operations.

Local government authorities are responsible for monitoring the application of the Code on private land. Amendment S13 under the *Planning and Environment Act 1987* extended the application of the Code in 1993 to provide a sound environmental basis for timber production on private land. A pilot program in municipalities in the Gippsland region recently trialed the accreditation of forestry professionals relating to planning for forest operations on private land.

Forest Management Plans

The Timber Industry Strategy divided Victoria into 15 Forest Management Areas (FMAs) for the purpose of preparing and implementing Forest Management Plans. These plans direct the use and care of forests for planning periods of 10 years, with provision for more frequent review if circumstances warrant. The planning process provides opportunities for public consultation and participation in resource use and protection. Advisory Committees, made up of people with a range of interests from communities across the region, advise on the preparation of Forest Management Plans.

These plans must be in accord with requirements of relevant Victorian Government Acts and policies, including the *Flora and Fauna Guarantee Act 1988*, the *Catchment and Land Protection Act 1994* and the *Forests Act 1958*, the Code and the National Forest Policy Statement 1992. Accordingly, plans are required to consider:

- ecologically sustainable management, including the maintenance of environmental values and the sustainable use of natural resources;

- the contribution of conservation reserves to, and the impact of private land activities on, the determination of appropriate protection levels for environmental values in State forest;
- Catchment Management Strategies, and requirements of Special Area Plans made under the *Catchment and Land Protection Act 1994*;
- protection of all flora and fauna listed as threatened under the *Flora and Fauna Guarantee Act 1988*;
- the requirement for sustainable yield under the *Forests Act 1958*;
- protection of regional biodiversity;
- continuing opportunities for recreation, scientific study and education;
- public participation in plan development; and
- monitoring and review of management performance.

To meet these requirements, the planning process sub-divides the State forest into zones, as discussed in Section 2.7, which identify where environmental, cultural and timber resource values are to be given priority. Combined with land scheduled under the *National Parks Act 1975* and other conservation reserves, these forest management zones provide for an integrated reserve network and a framework for sustainable forest use.

The West region covers all of the Midlands, Otway and Portland Forest Management Areas, and parts of the Horsham, Dandenong and Central FMAs. Forest Management Plans have been prepared for both the Midlands FMA (NRE 1997a) and Otway FMA (DCE 1992). An FMP for the Portland and Horsham FMAs is scheduled for completion by the end of 2001.

State forest represents approximately seven per cent, or 411 000 ha of the West region; this area of State forest has been determined from detailed land use studies by the former Land Conservation Council (LCC). The South Western 1 (LCC 1974), Melbourne (LCC 1979a), Corangamite (LCC 1979b), Ballarat (LCC 1983a) and South Western 2 (LCC 1983b) study areas cover the West region. Reviews of earlier public land use studies have been undertaken for the South West 1 (LCC 1984) and Melbourne District 1 (LCC 1987) study areas. Other LCC reviews that cover the West region include Special Investigations of Rivers and Streams (LCC 1991a), Wilderness (LCC 1991b) and South West Historic Places (LCC 1997). The Environment Conservation Council (ECC) is currently carrying out a Marine, Coastal and Estuarine investigation (ECC 1998) which encompasses the entire coastline of Victoria.

The ECC is currently undertaking a study of the Box-Ironbark forests. The draft recommendations are expected to be available by the end of 1999.

Wood Utilisation and Coupe Planning

Forest Management Areas are subdivided into a hierarchy of blocks, compartments and coupes for recording and management purposes. Of these, compartments are the smallest permanent forest-planning unit.

Coupes, or harvesting areas, are selected for harvesting to supply the required quantities and mix of wood products to meet annual wood supply commitments. A three-year schedule of coupes, and associated access roading, forms part of a Wood Utilisation Plan (WUP) which is prepared for each FMA annually. Its preparation involves specialist expertise relating to flora, fauna, soils, water protection and cultural heritage; uses sound silvicultural practices; and ensures environmental care. These plans are made available for public comment prior to finalisation. Special plans may also be prepared and approved to carry out salvage of timber or regeneration of stands following fire, storm or other events.

Timber harvesting operations are implemented according to a Forest Coupe Plan prepared with reference to the Wood Utilisation Plan, and other regional plans and forest management prescriptions. Each plan provides a detailed description of the coupe, including a map

identifying the area to be harvested and conditions to apply to all operations. Prior to harvesting, coupe boundaries must be marked in the field. Boundaries may be determined by natural features, such as ridges or other prominent features. Requirements for coupe planning and harvesting are detailed in the Code of Forest Practice for Timber Production (NRE 1996b). FMA prescriptions, as discussed earlier, provide operational guidelines for coupe marking and harvesting.

3.2 SILVICULTURE

Silviculture is the theory and practice for managing forest establishment, species composition and growth to achieve specific forest management objectives. Silvicultural treatments can include harvesting, site preparation, sowing, planting and tending operations such as thinning and fertilising. A review of the theory and practice of silviculture was provided in the East Gippsland Resource and Economics Report (VicRFASC 1996b) and is also relevant to the West region. Further details on eucalypt silviculture are available in Florence (1996). A summary of silvicultural techniques used in the West region, including an outline of current NRE policy, management practices and research in silviculture, is provided in the following section.

State forest in the West region is dominated by mixed species eucalypt forests, with smaller areas of ash-type eucalypt, Red Gum and Box-Ironbark forests. These forest types differ in their ecological responses to disturbance, particularly its effects on regeneration. For example, ash-type eucalypt stands are generally killed by all but low intensity fires, whereas the mixed species stands can withstand fires of higher intensity. As a result, a range of silvicultural techniques may be appropriate, depending on the ecological characteristics of each forest type, plus environmental, economic and social factors.

Ash Forests

In the West region, ash forests are dominated by Mountain Ash (*Eucalyptus regnans*) which occurs only in the Otway Ranges.

Mountain Ash forests typically form pure, relatively even-aged stands. However, at the limits of their range, they may be found in association with Messmate (*E. obliqua*), Manna Gum (*E. viminalis*) and Mountain Grey Gum (*E. cypellocarpa*). In the Otway Ranges, these forests occur at altitudes between 150m and 670m where the average annual rainfall exceeds 1000 mm.

Regeneration systems

Squire *et al.* (1989) concluded that three conditions are likely to be essential for the successful regeneration and healthy growth of Mountain Ash:

- the creation of gaps larger than two to three tree heights (150-250 m), as the interception of light by competition is likely to be the main limiting factor in the successful establishment of seedlings;
- a severe setback to the understorey e.g. through fire or mechanical disturbance; and
- an adequate seed on or in a receptive seedbed.

Through operational experience in the application of these principles, the clearfelling regeneration system has proved to be an efficient method that satisfies the requirements for successful regeneration of Mountain Ash forests (DCE 1992).

Using this system, all merchantable trees, not retained for environmental purposes, are removed. Generally, debris remaining after harvest is burnt and the site is artificially sown with seed collected from the coupe or nearby areas. Burning produces a high quality seedbed,

which assists in early germination of seed and seedling establishment. Where burning is not appropriate, or conditions would result in burning at lower intensities (which are not as effective), mechanical disturbance of the soil is required for adequate regeneration. It is common practice to regenerate by sowing seed. However, when seed availability is restricted or has failed to germinate, seedlings may be planted to achieve prescribed stocking levels (NRE 1997g). Mountain Ash seeds have no general dormancy (Cunningham 1960), and therefore germinate when soil moisture and temperature conditions are suitable, either in autumn or spring.

Assessments of regeneration have found that success rates in Mountain Ash forests in the West region have been excellent, with generally 93 per cent of coupe area being adequately or well-stocked after a single regeneration treatment in the period July 1989 to June 1993 (Murphy and Fagg 1996). Coupes identified as being under-stocked are monitored further and re-treated, where necessary, to achieve prescribed stocking levels. In the same period, all re-treated Mountain Ash coupes were successfully regenerated.

On sites that previously carried Mountain Ash forests and where the vegetation has been modified by clearing or fire, similar site preparation and establishment techniques have been used.

Regrowth management

Clearfelling and high intensity wildfire often result in dense regeneration leading to competition for light and nutrients between individual stems. As a result, some stems become dominant and grow strongly, while others are suppressed. Although eucalypt forests naturally self-thin as they mature, artificial thinning of *E. regnans* regrowth leads to increased growth in diameter and basal area (and thus, volume) in the retained trees, thereby contributing to increased sawlog production (Webb 1966, in Jeremiah and Roob 1992). However, physical damage to retained trees during commercial thinning operations can affect wood quality. White and Kile (1991) found that after wounding, longitudinal extension of decay and discolouration continued at a relatively constant rate for up to 23 years. In recognition of this, prescriptions for ash thinning require that damage be limited to a maximum of 15 per cent of retained trees (CNR 1992a). To date, there has been no pre-commercial or commercial thinning of Mountain Ash forests in the West region.

Mixed Species Forests

Various forms of mixed species forest occur across the West region, which arise from interaction between site factors such as rainfall, topography, soils and aspect, and past utilisation.

Messmate is the predominant species in areas used for timber production across much of the region, occurring in association with Brown Stringybark (*E. baxteri*) and Narrow-leaved Peppermint (*E. radiata* and *E. willisii*) in the south west of the region. In the east of the region, Messmate occurs with Manna Gum, Mountain Grey Gum on better quality sites in the Otway Ranges and in the Wombat State Forest with Candlebark (*E. rubida*) and Narrow-leaved Peppermint. In the Mt Cole and Pyrenees State Forests, Blue Gum (*E. globulus*) tends to replace Manna Gum and Candlebark. On poorer quality sites of the Wombat State Forest, Messmate is associated with Narrow-leaved Peppermint and Broad-leaved Peppermint (*E. dives*). These Messmate-dominated forests provide the bulk of the region's sawlog supply.

Regeneration systems

Shelterwood, group selection, seed-tree and clearfelling systems are commonly used in the messmate-dominated mixed species forests of the West region as they provide sufficient disturbance for consistent and adequate regeneration and growth.

The techniques that result in even-aged forests, such as clearfelling, seed tree and shelterwood, are predominantly used in the Midlands and Otway FMAs. The adoption of these systems is the result of operational experience and research. The shelterwood system was adopted after the selection system previously practiced in the Wombat State Forest was identified as affecting the growth and species composition of regeneration (NRE 1996a) while research has indicated that clearfelling and seed-tree systems should be used to minimise the impact of *Armillaria luteobubalina* (Honey Fungus).

The presence of an adequate seed crop may also affect the choice of silvicultural system. Seed tree and shelterwood systems can be effective silvicultural systems where adequate seed crops are present. If seed crops are not adequate, then clearfelling may be the most appropriate way of achieving regeneration.

Uneven-age stands, which are more common in the lower foothill areas, lend themselves to selection harvesting, thinning or overwood removal (sometimes referred to as cull ringing) to reduce competition from overwood and poorer quality stems, thus stimulating the growth of retained trees. Group selection is applied in the foothill forests in the Otway and Portland FMAs.

Slash burning is the most common means of site preparation, although mechanical disturbance is used, particularly when sites are being retreated for regeneration or where there is a high risk of damage to retained trees. Site preparation works are required to follow principles and procedures set out in the NRE guideline (NRE 1998c). The choice of regeneration technique is strongly influenced by the method of harvesting and the species/structural characteristics of the stand.

In shelterwood and seedtree systems, seedfall is induced by burning, while clearfelling sites are artificially sown by hand. Gaps created by selection fellings are sown through natural seedfall from surrounding trees. Where seed supply is limited, seedlings may be raised and planted to achieve prescribed stocking levels as detailed in forest management prescriptions, although this technique is considerably more expensive than natural or artificial sowing methods.

Regeneration success rates in low elevation mixed species forests, where even-aged silviculture has been practiced, have been satisfactory. In the period 1989 to 1993, generally 93 to 96 per cent of the harvested area was adequately or well stocked at the first regeneration treatment; in the same period, all areas surveyed following re-treatment were well-stocked (Murphy and Fagg 1996). However, results are variable across the region due to some technical and operational problems, such as browsing by herbivores of the regeneration in the Mt Cole and Cobaw State Forests (Wallace and Fagg 1999).

Regrowth management

Thinning of stands can also be undertaken in mixed species forest to increase the merchantable sawlog yield by concentrating growth on a smaller number of retained stems. In the West region, commercial thinning of even-aged regrowth using mechanical harvesting practices is currently taking place in the Otway and Portland FMAs. Such operations are required to follow the NRE Guideline on Thinning of Mixed Species Regrowth (NRE 1997g).

The current sustainable yield for the Midlands FMA is based on a number of factors, including the implementation of a young regrowth management program in medium and high productivity sites in the Wombat State Forest. Significant increases in sawlog growth rates are expected following thinning of this regrowth at 10 to 15 years and subsequently at 30 to 50 years. The introduction of such a thinning program is predicted to contribute around 12 per cent annually to the sustainable yield (CNR 1995g). The regrowth thinning program

commenced in the Midlands FMA in 1995-96. If funds and/or markets are available, other suitable stands of mixed species forest may be thinned, where appropriate, to lead to increased sawlog productivity and stand quality.

Red Gum and Box-Ironbark Forests

River Red Gum (*E. camaldulensis*) and Box-Ironbark forests occur on the drier plains to the north and west of the region. These forests occur at lower elevations, and on low rainfall sites where the annual precipitation is less than 700 mm. Their slow growth produces higher density, more durable timbers than the mixed species forests.

River Red Gum generally forms pure stands although associations are formed with Yellow Box (*E. melliodora*) and Yellow Gum (*E. leucoxylon*) on higher ground and Scent-Bark (*E. aromaphloia*) on the sandy rises. In the West region, these forests can range from even-aged stands to a wide range of size classes, including scattered dominant trees and suppressed stems.

The open forests of Box and Ironbark species are dominated by Grey Box (*E. microcarpa*), Yellow Gum (*E. leucoxylon*), and Red Ironbark (*E. tricarpa*). Other associated species include Red Box (*E. polyanthemos*), Red Stringybark (*E. macrorhyncha*) and Yellow Box. The structure of these forests has been affected by past utilisation including timber harvesting and grazing. These forests are mainly used for minor forest products such as round timbers and poles.

Regeneration systems

In the West region, Red Gum and Box-Ironbark forests are generally managed on a single tree selection system. However, in Red Gum forests, this system is modified according to stand conditions to thin the stands to a prescribed basal area. As overwood has an inhibiting influence on regeneration, the removal of large trees not required for habitat or cultural purposes provides gaps of about two hectares, which are necessary for the establishment of regeneration. These gaps are generally sown through natural seedfall from surrounding trees.

Cultivation is used to create a receptive seedbed, which may remain receptive for two to five years, for the regeneration of Red Gum (NRE 1998c). Livestock is excluded where necessary to allow successful regeneration.

Coppice from cut stumps often provides a useful contribution to coupe stocking, particularly in Box-Ironbark forests. Fire is not used as a means of site preparation where there is a high risk of damage to retained trees.

Although no formal regeneration surveys have been required for forests where uneven-aged silviculture is practiced, regular observations by forest officers indicate that these coupes are generally adequately stocked (Murphy and Fagg 1996). Guidelines have recently been developed for regeneration surveys in uneven-aged forests (NRE 1997stock) and surveys are now required in these forests. Data from these surveys are not yet available.

Regrowth management

Young Red Gums have poor apical dominance and benefit from being grown through the sapling stage in fairly dense clumps. Relatively high initial stockings and follow-up thinning are important to ensure good control over stem form (Squire *et al.* 1991). In addition, as Red Gum exhibits poor self-thinning, the removal of poor quality stems allows for increased growth on retained dominant stems. The time of manual thinning depends on site quality but is generally only necessary when 'dead topping', or decline of suppressed stems, commences within the stand.

Much of the Box-Ironbark regrowth is thinned for firewood and posts. Through thinning programs, a balanced size class structure is maintained, retaining better quality trees for improved growth.

Silvicultural Policy and Management

Whilst the application of silviculture is usually based on the ecological characteristics of the forest type — such as the need for high site disturbance in Ash-type forests — other considerations are also taken into account. The range of ecological, environmental, social and economic considerations for silviculture is contained in the Code of Forest Practices for Timber Production. These are implemented through Forest Management Plans, forest management prescriptions, Wood Utilisation Plans and Forest Coupe Plans.

The Code of Forest Practices for Timber Production provides a series of goals and guidelines for the establishment and tending of timber stands on public land which address:

- management of regeneration and reforestation;
- establishment, including tree species and seed sources;
- stocking and early growth;
- tending; and
- maintaining forest health.

In accordance with the Code, harvesting and regeneration systems in the West region are managed to:

- provide for adequate regeneration of the original species;
- obtain the desired growth;
- maximise sawlog yield;
- minimise environmental impact;
- incorporate social and economic considerations; and
- protect regeneration from excessive damage (NRE 1996b).

Silvicultural systems are applied to both ash-type and mixed species forests to maintain a non-declining yield of sawlogs. This is currently achieved through:

- harvesting ash forests using clearfelling systems on a nominal 80 year rotation, and
- harvesting mixed species forests using a number of systems including shelterwood, clearfelling, seedtree, thinning and group selection.

Recommended techniques and standards for the major silvicultural operations are documented in NRE's 'Native Forest Silviculture Guidelines' series.

Current forest management plans for the Midlands FMA (NRE 1997a) and Otway FMA (DCE 1992) identify several silvicultural systems that are currently used, or are potentially available, for the FMAs. Harvesting in areas of State forest, not currently covered by a forest management plan, is carried out in accordance with the requirements of the Code.

Silvicultural objectives of the Otway Forest Management Plan include the implementation of appropriate practices and to ensure adequate regeneration. The plan discusses silvicultural systems including clearfelling, group selection and shelterwood for use in that FMA based on forest types. It gives high priority to monitoring regeneration results to determine the optimum silvicultural prescriptions for mountain and foothill forests (DCE 1992). A further priority is to monitor thinning trials to assess suitability of this practice for the FMA.

The Midlands Forest Management Plan provides guidelines for the choice and application of silvicultural systems. These systems are summarised as:

- **Seed tree systems** should be applied where only one commercial harvest can occur and where trees with adequate seed supply in their crowns can be retained at the required spacing.
- **Clearfelling** should only be applied where there is a risk of an outbreak of Honey Fungus (a root fungus disease native to Victorian forests) or for salvage purposes.
- **Shelterwood** should be used where two economic harvests can occur and sawlog trees of suitable size and form, and capable of an enhanced growth rate, can be retained. New shelterwood (first cut) coupes should be limited to 40 ha in size. The second shelterwood cut should be carried out 10-15 years after the first harvest. Regeneration burns following the first shelterwood harvest should be conducted between 12 and 24 months after harvesting, if an assessment indicates inadequate number and distribution of seedlings, or for fire protection purposes.
- Other systems, including **group** or **single-tree selection**, may be applied in areas where specific values limit the application of even-aged systems or where the silvicultural characteristics of the forest type permit establishment and growth of regeneration in small gaps. For example, selection systems should be used to minimise landscape impacts or for the protection of other values in the Special Management Zone (SMZ). (NRE 1996a).

Each FMA is annually required to report on its silvicultural performance in terms of coupe regeneration, reforestation, thinning, seed collection and stocking surveys. Where problems are identified, remedial action is undertaken to improve results.

Silvicultural Research

Whilst clearfelling is an operationally efficient silvicultural system, and was seen to meet the biological requirements for successful regeneration, the appropriateness of the system in terms of its ability to meet other criteria has been questioned. In response, the Victorian Government commenced a long-term research program now known as the 'Value Adding and Silvicultural Systems Project' (VSP). It incorporates the 'Silvicultural Systems Project' (SSP) and the 'Value Added Utilisation System' (VAUS) Trial. The aims of the VSP are:

- to investigate silvicultural alternatives to clearfelling in Mountain Ash and mixed species forests; and
- to determine the response of forest ecosystems to integrated harvesting (Squire *et al.* 1987; Squire 1992).

The SSP compared clearfelling of Mountain Ash and mixed species forest with a variety of alternative systems, including seed tree retention, strip selection, group/gap selection and shelterwood systems. These alternatives were assessed in relation to success of regeneration, operational costs and safety. A second phase of the study will involve an evaluation of the ecological, operational and social aspects of the selected alternatives.

Reports thus far have indicated that systems other than clearfelling and seed tree systems can produce adequate regeneration of Mountain Ash. However, height growth of seedlings is markedly reduced by increasing overwood retention and/or reducing harvested gap size. This drawback, together with the severe operational problems such as safety risks in felling, damage to surrounding trees during felling and snagging, and increased soil compaction in the gap selection system, means that generally the clearfelling and seedtree systems will continue to be used to harvest and regenerate Mountain Ash (Campbell 1997a, 1997b), particularly where timber production is a high priority.

Details of SSP and VAUS trials are summarised in Squire (1992) and Campbell (1997a, 1997b).

Departmental and CSIRO research into thinning of ash eucalypts has occurred over many years. Results have indicated that, given suitable machinery and sites with low levels of old log debris, thinning can be commercially viable and can have other benefits in the longer term (Webb 1966, Kerruish and Rawlins 1991). Thinning trials in Mt Cole State Forest during the 1960s and STANDSIM (Incoll 1983) analyses indicate that mixed species sawlog growth rates can also be significantly improved by thinning regrowth, and reducing competition by felling unmerchantable mature trees other than those required for habitat purposes (CNR 1995e). However, early thinning, at 10-15 years, was the only thinning operation considered feasible on sites where Honey Fungus occurs in Mt Cole State Forest.

An even-aged harvesting and regeneration system (shelterwood) was introduced during the 1970s in mixed species forests of the Midlands FMA after studies showed that the form of selection system being employed discouraged regeneration and prevented younger trees from growing satisfactorily. This was supported by a study in 1981 (Kellas 1988) that examined the effects of harvesting intensities on species composition, form and growth of the regenerating forest which, in turn, have implications for the long-term productivity of merchantable timber from the forest. This study found that harvesting at lower intensities favours regeneration of more shade-tolerant species (peppermint), which are considered to be of inferior timber quality. Kellas *et al* (1994) found that the basal area retained in the forests of the Wombat State Forest was a critical factor in the species composition of regeneration. However, he concluded that with an adequate supply of seed, from natural or artificial sources, and receptive seedbeds, successful regeneration of both Messmate and Narrow-leaved Peppermint could be obtained under a range of overstorey stockings, but that further study to determine the appropriate levels of overwood for optimal seedling growth was required.

Kellas *et al*. (1994) formally reviewed the shelterwood system used in the Wombat State Forest and found that the system is meeting its basic objectives, generally resulting in reliable and satisfactory establishment of regeneration. They found that no silvicultural evidence supported a move away from the system and concluded forest management considerations rather than silvicultural ones would determine those changes. This review also identified research priorities to improve the performance of the system.

A series of trials have been established in mixed eucalypt regrowth within the Midlands FMA to determine the response of fire-induced regrowth to thinning and/or fertilising. These trials commenced in 1995 and involve a multi-disciplinary approach to assess the impacts of these treatments on tree growth, soil microflora and microfauna, and the rate of applied fertilisers.

The Forest Technology Program, a collaborative program involving CSIRO, University of Melbourne and the Australian Logging Council, is investigating ways of minimising soil disturbance in Victorian and Tasmanian forests using appropriate machine technology, and integrated harvesting and site preparation. Elements of this program have been undertaken in the Wombat State Forest.

Four species of *Armillaria* have been recorded in Victoria, with the most common *A. luteobubalina* (Honey Fungus) identified in the Mount Cole and Wombat State Forests. In 1978, a trial was established at Mount Cole to examine the effects of various treatments on the development of *Armillaria*, comparing conventional clearfelling, with and without ripping, with whole tree pushing, again with or without ripping (Kile *et al*. 1982). As yet there is no conclusion about the most appropriate site treatment for the control of *Armillaria*. However, indications to date are that heavily infested areas should not undergo partial cutting, but need to be clearfelled (CNR 1995i).

Research and Development Action Groups have been established to provide an effective mechanism for linking research to field needs. In the West region, the South West Research and Development Action Groups (SWRDAG) exists to improve silvicultural management in the mixed species forests of the region (Fagg and Flinn 1997). Other Research and Development Action Groups provide input into the management of the Mountain Ash, Box-Ironbark and Red Gum forests. Their responsibilities include production of review, discussion and operational papers that provide further knowledge of silviculture in these forest types, and assist the efficient application of silviculture systems.

3.3 FIRE PLANNING AND MANAGEMENT

Fire is an integral part of the ecology of forests. It is a disturbance to which most of the native flora and fauna are generally well adapted. The wildfire hazard in the West region is potentially as severe as anywhere in Australia.

The Department of Natural Resources and Environment is responsible for the prevention and suppression of fires in State forests, National parks and other protected public lands. The Department also has responsibility for fire prevention on private land within 1.5 km of State forests, National parks and protected public land that has not been excised by legislation. By definition under the *Forests Act 1958*, these lands are referred to as the 'Fire Protected Area'.

The Country Fire Authority (CFA) is responsible for fire prevention and suppression in the 'Country Area of Victoria', which excludes the metropolitan fire district and most public land.

The Code of Practice for Fire Management on Public Land (CNR 1995b) provides a framework for fire management on public land in Victoria. As a requirement of this Code, regional fire protection plans must be prepared and provide strategies for fire prevention, preparedness, suppression and recovery. The Midlands/West Port Phillip, Otways, Portland and Horsham Regional Fire Protection Plans apply in the West region.

Regional fire protection plans are developed after extensive consultation with municipal and regional fire prevention committees and other interested parties, including agency specialists in flora, fauna, parks, forestry, fire management, land and water protection, the Country Fire Authority and the community. They are reviewed every five to seven years. The current Otways Regional Fire Protection Plan was completed in 1995 while reviews of the Midlands/West Port Phillip, Portland, and Horsham plans will be completed during 1999.

Fire prevention, based on the general principle of minimising the incidence of preventable wildfire, includes strategies for education, enforcement and operations such as fuel management. In accordance with the Code of Practice for Fire Management on Public Land, regional fire protection plans include a fuel management strategy for fire prevention and preparedness, which aims to reduce the rate of wildfire spread and improve the prospects for controlling wildfire close to assets and in strategically located regional corridors.

The fuel management strategy primarily includes fuel management burning based on five zones:

- Zone 1: asset protection (especially adjacent to private property);
- Zone 2: strategic fuel reduced corridors;
- Zone 3: broad area fuel reduced mosaic;
- Zone 4: specific flora and fauna management and
- Zone 5: exclusion of prescribed burning.

Fuel reduction burns are undertaken in only three of the strategically located zones to maintain fuel to defined levels. Areas containing significant biological, cultural or economic values that can be damaged by fire are generally located in Zone 5 where prescribed burning is excluded, or Zone 4 where the ecological requirements of an area are given priority. Before fuel reduction burning is undertaken on Public land, the Code of Practice for Fire Management on Public Land and regional fire protection plans require that each burn must be the subject of an approved plan.

The selection of sites and frequency of burning depend on the priority for fuel reduction, the rate of fine fuel accumulation and biological values in accordance with the priority zones (CNR 1995b). In strategic areas, non-burning methods such as slashing are used to reduce fuel levels.

The fuel management strategy zoning takes into account natural values and principles of environmental care. The development of fire suppression and rehabilitation strategies also includes consideration of values at risk from wildfire or suppression activities. Where necessary, NRE prepares a rehabilitation plan which details activities required to assist the recovery of infrastructure, other assets and environmental values from the impact of wildfire and fire suppression.

3.4 PEST AND DISEASE MANAGEMENT

Pest plants, and animals and diseases impact on the environmental, social and economic values associated with public lands and forests. They reduce agricultural and forest productivity, displace native species and contribute to land degradation. The direct cost of weeds to Victorian agriculture is estimated at more than \$360 million per year (NRE 1998e).

Both the Commonwealth and Victorian Governments have implemented a number of strategies and programs aimed at pest plant and animal control that involve all levels of government, industry, landholders, land managers and community groups. Major Commonwealth initiatives for the control of pests are implemented through the National Heritage Trust, including the National Weed Strategy and the National Feral Animal Control Strategy. The Victorian Weeds Strategy (NRE 1998e) builds on the National Weeds Strategy and also takes account of recommendations in the Victorian parliamentary inquiry 'Report on Weeds in Victoria' (ENRC 1998). The Victorian strategy sets out a range of actions that will establish a cost-effective long-term approach to weed management in Victoria.

A number of State-funded programs including the 'Weed Initiative', and the 'Good Neighbour' and 'Rabbit Buster' programs are run in conjunction with National Heritage Trust projects. These projects, on public and private land, reflect priorities in Regional Catchment Strategies, which are implemented under the *Catchment and Land Protection Act 1994*. The Act provides for the categorisation of pest plants and animals, and for their eradication or control. Occurrences of pest plants and animals are recorded on NRE's Pest Management Information System (PMIS).

Other legislation is also relevant, including the *National Parks Act 1975*, which requires exotic flora and fauna to be eradicated and controlled. The *Flora and Fauna Guarantee Act 1988* also influences pest control on public land, through listing the predation of native wildlife by the introduced Red Fox (*Vulpes vulpes*) and Cat (*Felis catus*), and the spread of gravel infected by Cinnamon Fungus (*Phytophthora cinnamomi*) as potentially threatening processes.

The National Forest Policy Statement calls for forest management agencies to monitor and appropriately control the threat to publicly owned native forest ecosystems posed by pest plants, and animals and diseases. Consistent with this, the Code of Forest Practices requires

that care must be taken to prevent the introduction and/or spread of disease or insect and plant pests in timber production forests. The Midlands and Otway Forest Management Plans include programs and guidelines for the management of a number of pest plants and animals on State forest. Strategies establishing priorities for the control of pest plants and animals exist for the Otway, Portland, Horsham and Midlands FMAs.

A number of pest plants, animals and diseases have been identified in forests of the West region including:

- Plants — Blackberry; English Broom; Furze (Gorse); Cape Broom; Serrated Tussock.
- Animals/Insects — rabbits; foxes; feral dogs, pigs, goats and bees; European and English Wasps.
- Diseases — Cinnamon Fungus; Honey Fungus; Myrtle Wilt.

The Good Neighbour Program allocates resources towards weed and pest animal control programs on both private and public land. In 1997-98, expenditure of approximately \$560 000 funded by the Good Neighbour Program targeted pest species such as blackberry, cape broom, serrated tussock, feral dogs, rabbits and foxes on public land in the West region. Projects on State forest in the region accounted for 38 per cent of this expenditure, while 27 per cent was spent on parks and reserves and the remaining 35 per cent on other public land. Many of these projects on public land work in conjunction with adjoining landholder groups.

Three main diseases affect forest health in the West region. Cinnamon Fungus is primarily spread through the use of infected gravel in road construction, and in soil transportation and water run-off from infected sites. It has been identified in the east of the region. A Cinnamon Fungus management zone was identified in the Midlands Forest Management Plan (NRE 1996a) in which active measures are to be taken to minimise the risk of movement of the disease into uninfected areas. Management practices for control of the disease are also detailed in a 'Policy and Procedures Manual' (NPS 1994); this guideline also applies to all lands managed under the *National Parks Act 1975*. The control of Honey Fungus generally relies on the choice of appropriate silvicultural systems to minimise the impact of the fungus (CNR 1992b).

Myrtle Wilt is a fungal disease of Myrtle Beech (*Nothofagus cunninghamii*) caused by *Chalara australis*; it is a major cause of mortality of Myrtle Beech in the Otway Ranges. Management of the disease has two main aspects: prevention or minimisation of the disease through special prescriptions for roading and timber harvesting; and rehabilitation of infected stands, including active management to promote seedling regeneration and growth of Myrtle Beech (NRE 1996g).

3.5 FOREST RESEARCH

Significant research has been undertaken in the forests of Victoria including the West region. The Compendium of Forest Research (VicRAFSC 1998b) contains an annotated bibliography of research and other scientific literature, and a synopsis of research in progress. The compendium addresses forest research relating to sustainability indicators, silviculture, forest hydrology, fire effects studies, forest flora and fauna, soils and nutrition, plantation establishment and management, pests and plant diseases, forest entomology and tree breeding genetic development and seed supply. The Compendium is available on request.

Particularly relevant to the mixed species of the West region are research programs being conducted in the Wombat State Forest. An extensive program of fire research has been underway in the Wombat State Forest since the mid 1980s. This research program has addressed fire behaviour, fuel dynamics, vegetation responses, fauna (including bats, reptiles, mammals and birds) responses, soil chemistry, tree growth and defect, and climate. Major

silvicultural studies are also being conducted in the region, a number of which are discussed in Section 3.2.

3.6 MONITORING AND REVIEW

The Department of Natural Resources and Environment has a number of procedures established to monitor and review implementation of the plans and policies described in this chapter. These processes are considered further in the Statewide ESFM report (VicRAFSC 1997b).

Review of codes and management plans are required every 10 years, public participation is required in planning processes, and procedures are monitored and independently audited. These reviews provide the basis for adaptation of plans, ensuring they remain relevant.

Regular audits of harvesting operations on State forest are also undertaken to review the implementation of the Code of Forest Practices for Timber Production. Independent auditors from within NRE compare operations to the requirements of codes and prescriptions. These auditors are actively involved in the day to day implementation of the Code and are stationed outside the FMA being audited. In the East Gippsland RFA, Victoria committed to publish future reports of internal audits of compliance with the Code of Forest Practices for Timber Production. The 1996-97 and 1997-98 Statewide Code audit results have been published (NRE 1997f, NRE 1998f). In the West region, the Otway FMA was audited in 1996-97 and the Midlands FMA was audited in 1997-98. Portland FMA was audited in 1998-99.

4. MANAGING FOR TIMBER PRODUCTION

This chapter describes and evaluates the past, present and future arrangements used by the Department of Natural Resources and Environment (NRE) for inventory, data handling and yield forecasting for sawlogs and residual logs in the West region.

4.1 FOREST TYPE, EXTENT AND MERCHANTABILITY

The classification and description of forest types for commercial purposes is based on the predominant commercial species, and the quality and quantity that will provide sawlog material. Subject to a number of constraints, including tenure and zoning, forests are generally considered to be commercial if potential stand height exceeds 28 metres. There are exceptions to these stand height criteria in the West region:

- in mixed species stands in the Portland and Midlands Forest Management Areas (FMA), where forests exceeding a potential height of 24 metres are considered to be commercial;
- Box-Ironbark forests; and
- Red Gum forests.

For timber production purposes, the commercial forests of the West region have been classified into five forest types:

- Mountain Ash;
- Mountain mixed species;
- Foothill mixed species;
- Red Gum; and
- Box-Ironbark.

Mountain Ash (*Eucalyptus regnans*) forests, which occupy the higher elevations above 800-1000 m, are generally regarded as the highest quality forest in the region. Mountain Ash occurs with Messmate (*E. obliqua*) and Manna Gum (*E. viminalis*), with some pure Mountain Ash stands at the highest elevations. Mountain mixed species also occur on the higher slopes in the south of the region. These stands are often even-aged with a potential height exceeding 40 m. The main commercial species include Messmate, Manna Gum, Mountain Grey Gum (*E. cypellocarpa*) and Blue Gum (*E. globulus*). In the West region, both these forest types occur only in the Otway FMA.

The Foothill mixed species forests are the most widespread forest type in the region, generally occurring on the lower slopes of the ranges and the western plains. Messmate is the predominant commercial species in these forests across much of the region. On highly productive sites, Messmate occurs with Manna Gum and Mountain Grey Gum in the Otway Ranges (Otway FMA) and Wombat State Forest (Midlands FMA). In the forests of Mt Cole (Midlands FMA), Blue Gum tends to replace Mountain Grey Gum. On lower productivity sites in the West region, Messmate is associated with Brown Stringybark (*E. baxteri*), Narrow-leaved Peppermint (*E. radiata*, *E. willisii*) and Broad-leaved Peppermint (*E. dives*). Foothill mixed species forests are classified according to site productivity into quality classes 1 and 2 mixed species with the latter producing around half the sawlog volumes of quality class 1 mixed species. Foothill mixed species forests in Portland and Horsham FMAs are not divided into quality classes.

Box-Ironbark forests, including species such as Red Ironbark (*E. tricarpa*), Grey Box (*E. microcarpa*) and Yellow Gum (*E. leucoxylon*) and River Red Gum (*E. camaldulensis*) forests occur generally in the north and west of the region.

Forests are also classified by age or maturity:

- Regrowth — 0-60 years of age;
- Advanced regrowth — 61-80 years;
- Mature (M) — greater than 80 years; and
- Overmature (OM) — greater than 120 years, with evidence of senescing crowns.

In the West region, forests are categorised into two broad age class strata:

- Pre 1900 (Mature and Over-Mature, or M/OM);
- Decades after 1900 (Regrowth, Advanced Regrowth and Mature).

The spatial location and extent of the commercial forest types in the West region are shown in Map 5.

The net productive area for commercial forest types in the West region is described in Table 4.1. Current estimates of net productive area of forests for Horsham and Portland FMAs are based on data held in the NRE Hardwood Area Resource Information System (HARIS) database. HARIS provides a standing volume for sawlog and residual roundwood for the Mature and Overmature (M/OM) forests. Estimates of net area for the Midlands and Otway FMAs have been derived from forest mapping held in NRE's geographic information system (GIS). Net productive area will be updated on the completion of the Statewide Forest Resource Inventory (SFRI) in the West region, scheduled to be completed by the end of 2001.

Table 4.1 Net Productive Area (ha) for Commercial Forest Types in the West Region

| Forest Type | Otway FMA | Midlands FMA | Portland FMA | Horsham FMA | TOTAL |
|------------------------|---------------|---------------|---------------|---------------|----------------|
| Mountain Ash | 13 910 | - | - | - | 13 910 |
| Mountain mixed species | 11 020 | - | - | - | 11 020 |
| Foothill mixed species | | | | | |
| Quality Class 1 | 25 110 | 30 690 | - | - | 55 800 |
| Quality Class 2 | 9 250 | 19 760 | 35 780 | 14 120 | 78 910 |
| River Red Gum | - | - | 2 040 | 3 430 | 5 470 |
| Box - Ironbark | - | - | 400 | 2 010 | 2 410 |
| Non-eucalypt | 7 080 | | | | 7 080 |
| TOTAL | 66 370 | 50 450 | 38 220 | 19 560 | 174 600 |

Source. HARIS database; CNR (1995c); DCE (1992)

Forests in the West region are generally mixed age or even-aged regrowth stands originating from a range of silvicultural systems including single tree and group selection, clearfelling and shelterwood systems. Older forests, with a history of selective harvesting and many with associated regrowth, are found in the Otway FMA and Portland FMA. Forests in the Midlands FMA are generally more even-aged as a result of widespread harvesting associated with the gold rushes late last century.

Data pertaining to forest types in the West were derived from regional assessments and various Forest Inventory Reports. A number of assessments were carried out in the Otway FMA prior to the commencement of the forest management planning process, and forest mapping and sampling was also carried out as part of the forest management plan and review of the sustainable sawlog yield for the Midlands FMA (DCE 1992, NRE 1996A).

Standing volume estimates in Midlands FMA have been determined using growth and yield information derived from the 1995 review of the sustainable sawlog yield and the Midlands

Forest Management Plan (FMP). Estimates of standing volume for the Otway FMA are derived from growth estimates, age classes and area statements from extensive timber assessments in the late 1980s for the Otway FMP. HARIS and a timber assessment completed in 1984 provide a standing volume for sawlog for the mature forest types in Horsham and Portland FMAs.

Growth rates used in the forecast of sustainable yield are usually derived from surveys or inventories of forest plots in representative forest types. Permanent Continuous Forest Inventory (CFI) plots were established in the Mount Cole and Wombat State Forests in the 1960s and data from these were used in the 1995 forecast of sustainable yield for the Midlands FMA.

The Statewide Forest Resource Inventory (SFRI) project will result in a marked improvement in estimates of both net productive area and of growth and yield for all FMAs when completed.

The HARIS database was described and appraised by the University of Melbourne for the East Gippsland CRA Report (VicRAFSC 1996b). An independent evaluation of methods used in the preparation of the Midlands sustainable yield forecasts concluded they were appropriate and consistent with international best practice (CNR 1995c).

SFRI data will update and improve spatial information and estimates of standing volume for forest stands in the West region. New inventory design and reporting standards will, however, make direct comparison with HARIS data difficult. In general, previous inventories collected resource data using standard inventory techniques and applied prevailing sawlog and pulpwood standards. This meant that volume estimates could not be readily recalculated when forest product standards changed or new products were developed. The SFRI will provide strategic level forest resource estimates independent of forest product standards. It is discussed in more detail in Sections 4.3 and 4.5.

Legislation requires that sustainable yield rates apply on an FMA basis. However, it should be noted that the West region does not correspond exactly to the boundaries of the Midlands, Central, Dandenong, Otway, Portland and Horsham FMAs. The region includes all of the Midlands, Otway and Portland FMAs, approximately half of the Horsham FMA and a small area of the Central and Dandenong FMAs. The area of the Horsham FMA in the region includes the majority of the commercial forests and produces hardwood sawlog, while the area of the Central and Dandenong FMAs in the West region are not subject to commercial sawlog production.

Log Classification

Sawlogs are graded according to their size and quality, and sometimes by species. The actual grading is regulated by sawlog grading instructions, and a grade from A (highest quality) to D (lowest quality) is assigned to all non-durable sawlogs. When discussing sawlog allocations, it is usual to refer to a minimum allocation grade, such as C+ or D+. The term C+ denotes C grade and better sawlogs, whilst D+ denotes D grade or better — in effect all sawlogs are D+. The basis for licence allocations and sustainable yield forecasts was changed in 1996 from C+ sawlogs to D+ sawlogs to align the standards used for licensed sawlog allocations with the legislation governing sustainable yield. More details are provided in Section 4.3.

Logs not meeting the D grade requirements are termed E grade or residual logs.

Grading of durable species such as Red Gum and Red Ironbark are based on separate sawlog grading instructions. Logs may be graded as standard or second grade depending on diameter, length or defect. A dunnage grade (now referred to as residual log) also exists to enable logs

lower than second grade to be utilised. Minimum diameter limits for harvesting ensure that growing stock is protected and maximises the value of potential products.

Specifications for sawlog and residual logs are given in Appendix 3.

Timber Resource

The most productive forests in the West region are the Mountain Ash forests, occupying 13 910 ha (5 per cent) of the total net productive area of the region.

The mixed species forests in the West are important for timber production, occupying 145 750 ha (83 per cent) of the region's net productive area.

In 1997-98, approximately 110 500 m³ of D+ net sawlog was harvested in the West region. Of this total, mixed species accounted for 98 900 m³ (89 per cent) and Mountain Ash for 12 000 m³ (11 per cent).

River Red Gum and Box-Ironbark forests occupy 4 per cent of the region's net productive area, and in 1997-98, Red Gum forests supplied approximately 1130 m³ of sawlog material.

Approximately 1500 m³ of specialty timbers such as Blackwood (*Acacia melanoxylon*) were harvested in the region during 1997-98 in conjunction with sawlog harvesting operations and reforestation programs.

Regrowth

Regrowth forest accounts for 13 900 hectares (45 per cent) of the net productive area in the highly productive Mountain Ash and Mountain mixed species forests. These forests will provide the significant part of the future timber volume due to their higher growth rates and higher proportion of high quality sawlog. A significant increase in sawlog growth rates is also expected on medium and high quality sites of Foothill mixed species regrowth in the Midlands FMA, with the implementation of a young regrowth management program. This program commenced during 1997 and is expected to contribute 6900 m³ per year to sustainable yield as a result of increased growth rates of the thinned stands and greater scheduling flexibility.

Data for regrowth volumes and growth rates are very important, as these will determine the future availability of sawlog for industry.

Residual Log

Victorian Government policy for native forest timber production is geared towards sawlog production and value adding. The Timber Industry Strategy (Victoria Government 1986) sets the context for Departmental policy regarding the production of residual logs. Residual logs are either too small or too defective to meet current sawlog specifications, but may be salvaged mainly for non-sawlog end-uses such as pallet material, firewood, craftwood or wood-fibre products. Residual logs are produced as a by-product of harvesting for sawlogs, or from silvicultural activities such as thinning or overwood removal which are designed to enhance future sawlog production.

Currently, about 172 000 m³ gross of residual logs are generated from harvesting activities in the West region each year. Improved estimates of residual log availability will be produced when the sustainable yield for sawlog is reviewed using new data from the Statewide Forest Resource Inventory.

4.2 LEGISLATIVE, POLICY AND PLANNING FRAMEWORK FOR SUSTAINABLE YIELD

Sustainable yield, as the term applies in Victoria, is the annual rate of hardwood sawlog production that can be achieved from the forest, taking into account the structure and condition of the forest, without impairing the long-term productivity of the land.

Sustainable yield is forecast on the basis of sawlog production, as timber harvesting in Victoria is sawlog-driven with residual logs produced as a by-product of sawlog operations. The availability of residual logs is therefore determined by the sustainable production of sawlogs. Nevertheless, as part of the management strategy to supply sawlogs, commitments can be made to supply regular levels of residual logs so that silvicultural regimes for sawlog production can be implemented and waste minimised.

The *Forests Act 1958* (as amended in 1990) defines the legislative requirements for the determination of sustainable yield for sawlogs and the relationship with hardwood supply levels, ie. the volume of sawlogs made available to industry. The Act specifies that the total hardwood supply level in a Forest Management Area be within a permitted margin (2 per cent) of the sustainable yield rate forecast over a 15 year Timber Supply Period. The short-term (annual) hardwood sawlog supply level is more flexible. In determining the short-term supply level, the factors which are considered include the long-term sawlog supply level; planning and socio-economic factors; bushfire and other natural disasters; and agreements or decisions by the Commonwealth (*Forests Act 1958*, Sections 52A and 52B).

The *Forests Act 1958* also specifies that the sustainable yield rates for the harvesting of hardwood sawlogs are to be reviewed in each five year period from 1 July 1991 to determine whether they are still appropriate. The Minister is required to review sustainable yield as soon as possible outside the specified five yearly timetable if 'the Minister considers that there has been a significant variation in the hardwood sawlog resources in any State forest available to be exploited commercially'. The Minister may also review sustainable yield at any time 'if he or she thinks it is appropriate to do so' (*Forests Act 1958*). On completion of the review, the Minister may 'decide that sustainable yield rates should remain unchanged; or recommend to the Governor in Council new sustainable yield rates for all or any of the forest management areas' (*Forests Act 1958*), given significant changes in the available sawlog resource.

The major objectives associated with the forecast of sustainable yield are to:

- provide a non-declining supply of grade D+ sawlogs (all grades in the case of durable species);
- provide the highest yield available (on a sustainable basis) at any given point in time; and
- eventually achieve a balanced age class distribution throughout the forest and approach the maximum potential productivity of the forest (the long-term sustained yield) (NRE 1996b).

For each forest type, the forecast of sustainable yield requires data for:

- net productive area of mature/overmature forest;
- standing volume of grade D+ sawlogs for the mature/overmature forest;
- net productive area of regrowth forest;
- age (year of origin) of the regrowth and an average minimum harvesting age;
- growth rates, or Mean Annual Increment (MAI), of regrowth forest; and
- allowances for known risks (for example wildfire) or other factors.

From the available data, sustainable yield is forecast using an integrated process that considers wood production in the context of other forest values.

4.3 SUSTAINABLE YIELD IN THE WEST REGION

The current legislated Sustainable Yields for the Midlands, Otway, Portland and Horsham FMAs are provided in Table 4.2.

Table 4.2: 1996 Legislated Sustainable Yields of Sawlogs (m³/year)

| Forest Management Area | Volume (D+ m ³ /year) |
|------------------------|----------------------------------|
| Midlands FMA | 58 000 |
| Otway FMA | 44 400 |
| Portland FMA | 14 000 |
| Horsham FMA | 800 |
| Total | 814 |

Source: NRE 1997b (or Forests Act 1958, Third Schedule)

As previously noted, 48 per cent of the Horsham FMA occurs within the West region however, legislation requires that sustainable yield figures be provided on an FMA basis.

Historical Development of Sustainable Yield Forecasts

The following discussion outlines the major factors that have influenced the development of the sustainable yield forecasts that apply to the Forest Management Areas within the West region.

Government decisions on public land use, including the availability of land for timber harvesting, have been based largely on recommendations of the former Land Conservation Council (LCC). LCC recommendations, which have determined current public land use in the West region, were published between 1974 and 1997.

1984-85 Board of Inquiry into the Timber Industry

The Timber Industry Inquiry (Ferguson 1985) established by the Victorian Government was required to investigate and report on all aspects of the timber industry in Victoria. Sustainable yields were forecast for forest districts and groupings of forest districts. The departmental (Forests Commission) Hardwood Resources Information System (HARIS) database was updated across the State for the Inquiry.

Forecasts were determined using manual spreadsheet techniques and data extracted from the HARIS database. These forecasts were based on conservative assumptions and the prevailing management strategies, and included a conservative approach to land use allocations that sought to allow for a number of environmental issues that had not been formally addressed prior to the Inquiry. As a result, a 25 per cent reduction was applied to the forecast figure to account for the unquantified potential loss in available area and volume associated with protection of arboreal mammal habitats, rainforest, and sites of high recreation and landscape value. The forecasts were submitted to the Inquiry and the Chairman, Professor Ian Ferguson, concluded at the time that the forecasts were adequate, but recommended that more advanced planning methods and forecasting be used in the future (Ferguson 1985).

Since the Timber Industry Inquiry, various factors have resulted in changes to timber resource availability in the region. The following account summarises these changes and their implications for sustainable yield forecasts.

1986 Timber Industry Strategy

The Timber Industry Strategy (TIS) (Victoria Government 1986), resulting from the Timber Industry Inquiry, established the basis for the application of regional sustainable yield to the

harvesting of sawlogs from State forest in Victoria. The regions established for this purpose are called Forest Management Areas (FMA) and are based on areas of native forest supplying sawlogs, the location of major conversion centres and consolidation of supply commitments to individual sawmills.

The TIS identified the need for a comprehensive forest management planning process to develop plans as per Section 22 of the *Forests Act 1958*, for each FMA in Victoria. These plans provide for sustainable timber production as well as the protection of environmental values in State forests, and incorporate community input. Each plan includes a management strategy and zoning scheme that defines those areas that are set aside as part of the protection strategies for a range of biodiversity and other forest values.

In addition, the Timber Industry Strategy established the processes and methodology for forecasting sustainable yield. Sustainable sawlog yield rates for each FMA were determined from available resource and growth data, FMPs and existing sawlog utilisation standards. Forecast estimates in the TIS were made to 2014/15.

On the basis of the available information and the net productive area of State forest, it was expected that sustainable yields from Midlands and Portland FMAs would decrease from 1985 levels. Subsequently, sustainable yield was reviewed in 1990 and in 1996. In the Otway FMA, the Government entered into licence commitments with the sawmilling industry to reduce harvesting to a sustainable level, which was estimated to be 40 000 m³ per year. Forecasts for timber availability in Horsham FMA were not made in the TIS as it was considered that sawlog availability would decline to less than 1000 m³ per year following once-only harvesting in areas of the Grampians National Park.

1988 Uniform Log Grading Rules

Statewide sawlog grading standards were introduced in 1988. Four grades of sawlog were established, based on the relative quality of logs for sawmilling. These grades (A, B, C and D) were applied to all native hardwood species except the durable species from Red Gum and Box-Ironbark forests. Durable species are still graded according to local, and not Statewide, sawlog standards and comprise standard, second and dunnage log classes.

The lowest grade (grade D) sets the minimum standard for sawlogs from non-durable species forests across the State.

The new grades replaced local sawlog standards, which varied considerably across the State, and between forests of differing age and type. The significance of this change was that, in some parts of the State, more timber was defined as sawlog. In the West, sawlogs equated to grades A, B and C (C+). The new grading effectively represented the formalisation of a classification of sawlog that was previously purchased outside of the C+ allocation arrangements. Given that this was essentially an administrative amendment, this change did not affect the sustainable yield forecast from the West for C+ sawlogs.

1989 Long-term Licences

Long-term (15-year) licences were first issued in 1989 to provide the timber industry with a secure supply of resource, and to encourage investment in value adding of sawn output. The licences that were subsequently issued generally specified grade D and better (D+) sawlogs. Only a limited number of purchasers, who were already adding value to a substantial proportion of their output, were issued with licences for grade C and better (C+) sawlogs. The 1995 review of sustainable yield in the Midlands FMA recommended a sustainable sawlog yield rate of 58 000 m³ per year for the FMA. At the time of the review, licensed commitments in the FMA totalled 70 400 m³ of all grades of sawlog per year. To meet this revised sustainable sawlog yield level and to avoid industry disruption, a phase-down period

of five years from 1 July 1996 was established. The results of this review were used to negotiate changes in the rate of sawlog harvesting with licensees.

Current licence allocations for FMAs in the West are shown in Table 4.3.

Table 4.3: Current Sawlog Licence Allocations (m³ / year)

| | Otway | Midlands | Portland | Horsham |
|----------------|--------|----------|----------|---------|
| C+ | 31 285 | 48 700 | - | - |
| D+ | 41 154 | 58 600 | 13 950 | - |
| Durable | - | - | - | 880 |

Source. NRE (1999)

Code of Forest Practices for Timber Production

The Code was first produced in 1989 (CFL 1989) to formalise the large number of regional harvesting and regeneration prescriptions into a single Statewide document. It was adopted by the Victorian Parliament in 1989, and was independently reviewed by the CSIRO in 1996 (NRE 1996b). A revised Code was adopted by the Victorian Parliament in early 1997. Given that regional prescriptions were already in place it was judged that the introduction of the Code had a minimal impact on resource availability in the West region.

1990 Sustainable Yield Legislation

In 1990, as part of the implementation of the Timber Industry Strategy, the *Forests Act 1958* was amended to provide for a legislated sustainable yield rate for each FMA.

The 1990 legislation adopted the sustainable yield rates for the Midlands, Otway, Portland and Horsham FMAs, as shown in Table 4.4. The legislated sustainable yield rates were determined using TIS forecasts.

Sustainable yield rates are specified in the Third Schedule of the *Forest Act 1958* and are periodically reviewed as required by legislation.

Table 4.4: 1990 Legislated Sustainable Yields of Sawlogs (m³/year)

| Forest Management Area | Volume (C+ m ³ /year) |
|------------------------|----------------------------------|
| Midlands FMA | 70 000 ^(a) |
| Otway FMA | 38 000 ^(a) |
| Portland FMA | 14 000 ^(a) |
| Horsham FMA | 800 ^(b) |
| Total | 922 |

Source: Forests (Timber Harvesting) Act 1990; (a) A, B and C grades; (b) All grades

The sustainable yield rates for the Otway and Midlands FMAs were reviewed in 1992 and 1995 respectively in conjunction with the forest management planning processes and are discussed later in this section.

1991 Land Conservation Council (LCC) Rivers and Streams Investigation and LCC Wilderness Investigation

Following the final recommendations of the Land Conservation Council (LCC) Statewide Investigation of Rivers and Streams, four Heritage Rivers were designated in the West region. No Essentially Natural Catchments were designated in the region. For these areas, the LCC estimated the reduction to the sustainable yield forecast up to the year 2000-1 would be 0.9 per cent for the Midlands FMA and negligible in the other FMAs in the region (LCC 1991a).

The final recommendations for the LCCs Statewide investigation of wilderness were published in 1991 (LCC 1991b). In the West region, all 'Other Areas with Remote and Natural Attributes' are in National Parks; no Wilderness Areas were recommended.

1992 Otway Forest Management Plan

The Otway FMP was released in June 1992 (DCE 1992) and was the first FMP to be developed in Victoria.

The FMP assigns areas of State forest and Bushland Reserve within the FMA to at least one of the following zones: Production, Conservation and Fire Protection. The first two zones do not overlap each other while the Fire Protection Zone overlays parts of both other zones (DCE 1992). These zones are based on a preferred management option selected from five strategies, or options, that were developed by the planning team in conjunction with the FMA advisory committee. The effects of all options were analysed using the FORPLAN model.

A series of yield curves, derived from the model STANDSIM (Incoll 1983, Opie 1972), were used in the calculation of sustainable yield and are listed in detail in Brinkman (1990). There was no fire or error risk applied in this model.

The level of sawlog allocation considered to be sustainable under the Otway FMP's strategies and prescriptions is 44 400 m³ per year. This level was calculated using the FORPLAN model and assessed timber yields. It is considered that, under the option chosen, long-term (100 year) sustainable yield may increase to 60 000 m³ per year as the substantial regrowth stands mature and the long-term sawlog production is enhanced through programs of reforestation and regeneration of currently low-yielding stands (DCE 1992).

1994-95 Statewide Forest Resources Inventory (SFRI)

The Statewide Forest Resources Inventory (SFRI) commenced in Victoria in 1994-95 (NRE 1996c). The SFRI will map around 3.5 million ha of State forest, with sampling of productive regrowth, mature and over-mature forests to determine the standing volume of sawlogs. The program will also provide the necessary base data to enable development of new growth models for a significant number of forest types, thereby enhancing the capacity to forecast future timber yields from both mature and regrowth stands. The inventory is scheduled for completion during 2001. Specifically the new inventory will:

- update the State's timber resource data, replacing data collected primarily in the 1960s, 1970s and 1980s;
- be the State's first complete forest resource inventory based on a single inventory design and standard;
- enable new growth and yield models to be developed for many of the State's native forests;
- enable resource estimates to be made to a uniform standard of utilisation;
- have the capacity to adjust to new utilisation standards; and

- provide a basis for resource estimates, sustainable yield forecasts and management planning well into the next century.

1996 Midlands Forest Management Plan

The Midlands FMP, released in June 1996, contains detailed information on how the forests of that FMA will be managed. This plan introduced a forest management-zoning scheme, including constraints on harvesting in some domestic water supply catchments.

A review of the Midlands FMA sustainable sawlog yield rate (CNR 1995g) was carried out in conjunction with the development of the FMP, and incorporates the impacts of the forest zoning on timber resource availability (CNR 1995h). Analyses were based on the net productive area available for harvesting (Table 4.1) and revised growth rates for various management options. The review of the Midlands FMA sustainable yield rate was undertaken using the Integrated Forest Planning System (IFPS), which is discussed in detail in Section 4.5. A number of alternative silvicultural and management options were modelled as part of the sustainable yield rate review process.

The review observed that the implementation of the proposed FMP would have the following effects on sustainable yield:

- the shelterwood system is expected to contribute 3600 m³ per year more to the sustainable yield than a silvicultural option based on clearfelling;
- the regrowth management strategy detailed in the FMP would contribute 6900 m³ per year to the sustainable yield; and
- the impact of management strategies outlined in the proposed plan is estimated to reduce sawlog volumes by 900 m³ per year.

Sustainable yield rates adopted in the 1990 legislation were based on TIS forecasts and included a reduction factor to allow for areas of low productivity and areas which may be unavailable. These factors were included in the process of defining net available area for the 1995 review of sustainable yield in Midlands FMA, so an overall reduction was not applied. The sustainable yield rate for the Midlands FMA has been based upon a provision for the probable impact of wildfire on future sawlog growth. During the period 2005 to 2014, when the forest age class structure will be undergoing considerable change, the average fire loss was calculated to be 1500 m³ per year. In addition, volumes for the young regrowth management regime were reduced by 10 per cent to account for variations such as the impacts of regeneration delay and overwood suppression from the use of shelterwood.

The forest management zoning was adjusted following the review as a result of submissions to the proposed plan. Overall, the net productive area was reduced by 300 ha but it was considered that these changes would have little impact on the forecast sustainable sawlog yield (NRE 1996a).

At the time of the review, Midlands FMA's licensed volumes were greater than the revised sustainable yield rate. However, processes to adjust volumes were introduced. Provisions were made in the sustainable yield forecasts for a continuation of sawlog availability of 70 400 m³ per year to 30 June 1996, and a phase down from that level to the new sustainable yield, of 58 000 m³ per year, over a five-year period from 1 July 1996.

1996 Statewide Review of Sustainable Yield

The *Forests Act 1958* requires the Minister to review all sustainable yield rates every five years. This follows an amendment to the Act in 1990 and the relevant provisions commenced in 1991. The first review was conducted in 1996.

At the time of the review, FMPs, which included zoning schemes to define areas available for timber production, had been completed for the Otway and Midlands FMAs. The revised sustainable yield rate in the Midlands FMA is based on the 1995 Proposed FMP and a re-assessment of resources, as discussed previously. The revised sustainable yield rate in the Otway FMA was based on FORPLAN analyses carried out in conjunction with the 1992 FMP.

Sustainable yield rates for Portland and Horsham FMAs were not changed from the 1990 levels. The resource data, growth data and areas defined as suitable and available for timber production were not significantly different from those used to establish the sustainable yield rate in 1990. It was considered appropriate that a review of sustainable yield be completed when this information becomes available.

At the time of the review, the SFRI project had commenced in the West region. However, data were not available to update existing information.

One change made for all FMAs, except Portland and Horsham, as part of the 1996 sustainable yield review was the conversion of sustainable yield rates from C+ to D+ log grade, based on the proportion of each sawlog grade sold in the 1995/96 financial year for each FMA. A log grade audit, conducted in 1996, was used to adjust these figures. This was judged to be the most robust and transparent method of conversion, in the absence of new resource information. The 1990 sustainable yield rate for Portland FMA was already based on utilisation standards which produce D grade and better sawlogs, thus the sustainable yield rate was not changed. This change did not apply to durable species.

The 1996 sustainable yield rates for D+ sawlogs are given in Table 4.2.

4.4 APPRAISAL OF SUSTAINABLE YIELD METHODOLOGY

The Timber Industry Inquiry established the need for improved estimates of sustainable yield (Ferguson 1985), and this is being implemented through the Timber Industry Strategy which established Forest Management Areas and an improved process and methodology for forecasting sustainable yield. As a result, the sustainable yield rates in the West region have been based on the Timber Industry Strategy and subsequent new resource estimates.

As outlined in Section 4.5, the Sustainable Yield Spreadsheet (SYSS) methodology for forecasting sustainable yield has been externally reviewed and accredited through the CRA/RFA process, and the HARIS data collection process was reviewed for the East Gippsland RFA and was considered adequate. The review suggested improvements to the methodology and these have been addressed through the provision of SFRI data and implementation of the Integrated Forest Planning System (VicRAFSC 1996d).

The availability of the SFRI data and use of the Integrated Forest Planning System (IFPS) will enable improved forecast estimates to be made in the review of current and in the development of future FMPs. The IFPS methodology has been peer-reviewed and also approved by an external consultant.

Confidence in the sustainable yield forecasts can be enhanced through formal documentation of the methodology used to determine resource availability for the preparation of the FMPs, including stated assumptions, and exposure to risk using sensitivity analysis, as well as formal documentation of actual versus predicted yields.

4.5 STRATEGIC FORECAST OF SUSTAINABLE SAWLOG YIELD

Strategic forecasts of sustainable yield for FMAs in the West region will be based on FMPs, the Statewide Forest Resource Inventory (SFRI) and Integrated Forest Planning System (IFPS) as outlined below.

Forest Management Planning

The TIS identified the need for a comprehensive forest management planning process to develop plans for each FMA in Victoria. These plans provide for sustainable timber production, plus the protection of environmental values in State forests, and incorporate input from the community. Each plan includes a management strategy and a zoning scheme that defines areas that are to be managed to meet particular objectives, including timber and a range of biodiversity and other forest values. The zoning scheme will therefore allow for the requirements of sustainable yield under the *Forests Act 1958*. As discussed in Section 4.3, plans exist for the Midlands and Otway FMAs. The FMP for Portland and Horsham FMAs is scheduled for completion by the end of 2001.

Management guidelines developed as part of a FMP will determine the availability of the resource, through definition of forest management zones, and establishment of guidelines for the timing of timber harvesting. Thus, the general reduction factor applied to earlier sustainable yield estimates will not be applied as available areas are quantified as part of this process of developing forest management zones.

The analysis of implications of proposed plans on sustainable yield will be carried out using the SYSS module of the Integrated Forest Planning System (IFPS). Following publication of final plans, formal reviews of sustainable yield can be made using the full version of the IFPS.

Future calculations of sustainable yield will incorporate zoning from FMPs to allow reporting on an FMA basis.

Statewide Forest Resource Inventory (SFRI)

The future forecasts of sustainable yield for FMAs in the West will be based on new inventory data provided from the Statewide Forest Resource Inventory. The SFRI will update and improve spatial information and estimates of standing volume and revised growth and yield models for ash and mixed species stands. Data will be spatially referenced and stored in a GIS database.

An estimate of net productive area, which is the area of forest capable of producing merchantable timber, will be produced by the SFRI. The net available productive area is the actual area from which sawlogs can be harvested under current management prescriptions as defined by the Code of Forest Practices (NRE 1996b). This area excludes productive forest located in streamside buffers and on steep slopes. Areas, which are deemed to be unmerchantable due to accessibility constraints, are also excluded.

Integrated Forest Planning System (IFPS)

The analysis methodology applied to sustainable yield forecasts has progressed from a manual spreadsheet approach through various stages of computerised spreadsheets known as the Sustainable Yield Spreadsheet (SYSS). SYSS is one component of the Integrated Forest Planning System. It is used to test management strategies using aggregated data. Other components of the IFPS include GIS, growth and yield, optimisation and monitoring modules (Lau *et al.*, 1996). Specifically, the IFPS interactively links Arc/Info, FORPLAN/SPECTRUM, Lindo, SIR DBMS (Scientific Information Retrieval Data Base Management System), ERMapper, and an array of smaller components.

The concept behind the integration of such a diverse array of tools is to create a link between the forecast of sustainable timber flow and spatially locating the timber contributing to this flow.

The IFPS offers forest planners a structured, well-organised approach to forest management issues. It provides scientifically based estimates of the sustainable yield of forest resources and a means for monitoring change in the forest. It also enables alternatives to be considered and answers 'What if?' questions related to management options. This enables the objectives of ecologically sustainable forest management to be met.

IFPS models are run many times with different constraints to investigate alternative strategies and to determine the impact that forestry activities will have in both the short and long term. The IFPS attempts to find an optimal solution, within the constraints imposed, which achieves a balance between the social, economic and environmental aspects of forest use.

The ability to visualise results spatially, in context with maps and remotely sensed data, allows feasibility testing to be conducted. This important process may significantly alter the final forecast of the sustainable yield. However, it usually results in a modified set of prescriptions. Testing options continues in an iterative manner until feasible results are achieved.

The Midlands FMA sustainable yield review (CNR 1995g) is an example of the use of the IFPS to incorporate detailed harvesting prescriptions for specific areas.

Monitoring

NRE is currently undertaking a comparison of the area and volume predicted to be harvested, the actual area and volume harvested, and the licensed volumes for each FMA for the period 1991-92 to 1995-96. This will form part of the on-going reconciliation of sustainable yield with licensed sawlog levels as required in the Forests Act.

Review of SFRI and IFPS

In an external review of the SFRI, both inventory and yield data collection and analysis techniques were seen to be effective and useful methodologies that should result in statistically valid and unbiased estimates of volume and yield appropriate for strategic level planning (Brack and Turner 1996). Brack and Turner (1996) also identified the need for sensitivity and jackknife analyses to estimate the effects of SFRI sub-models on the overall reliability of the model estimates.

In the absence of growth data from permanent plots, it is proposed to use stem analysis to develop growth and yield models. This process was considered to be sound by the consultants, and will be used to develop appropriate models.

The HARIS data collection process was reviewed in the CRA/RFA for the East Gippsland FMA, and was considered adequate (VicRAFSC 1996c). The SYSS methodology has been externally reviewed and accredited through the CRA/RFA process (VicRAFSC 1996c).

The IFPS methodology was reviewed and approved by an external consultant, Brian Turner (CNR 1995g) for its application in the Midlands FMA. The use of this methodology in conjunction with good quality GIS-based inventory data was considered to be consistent with best international practices.

5. TIMBER INDUSTRY

5.1 CURRENT POSITION AND OUTLOOK

State Forest Log Production and Value

The West region accounted for around 12.6 per cent of total State sawlog production and 15.4 per cent of total State residual log production in 1997-98 (Table 5.1). In 1997-98, the region produced 110 492 m³ of sawlog, and 172 235 m³ of residual log. Ash sawlog production in the region in 1997-98 was 11 938 m³, and comprised 3 per cent of total State ash sawlog production for that year. The West region produced 98 554 m³ of mixed species sawlogs, or around 20.5 per cent of State sawlog production of these species.

Table 5.1: Gross Volume of Logs Harvested from the West Region, 1997-98 ^a (cubic metres)

| Log grade ^b | A | B | C | D | D+ | R | Other | Total |
|------------------------|-------|---------|---------|---------|---------------------|---------------------|--------|-----------|
| Otway | | | | | | | | |
| Ash | 329 | 3 281 | 7 223 | 1 105 | 11 938 | | | 11 938 |
| Mixed species | 117 | 3 036 | 16 295 | 3 187 | 22 635 | 9 921 | | 32 556 |
| Speciality | | | | | | | 1 530 | 1 530 |
| Mixed species/Ash | | | | | | 73 606 ^c | | 73 606 |
| Total | 446 | 6 317 | 23 518 | 4 292 | 34 573 | 83 527 | 1 530 | 119 630 |
| Midlands | | | | | | | | |
| Mixed species | 110 | 14 927 | 38 589 | 8 687 | 62 313 | 87 264 | 328 | 149 905 |
| Portland | | | | | | | | |
| Mixed species | | | | 42 | 42 | | | 42 |
| Mixed species | | | | | 13 564 ^d | 1 444 | | 15 008 |
| Total | | | | 42 | 13 606 | 1 444 | | 15 050 |
| Horsham | | | | | | | | |
| Durable | | | | | | | 1 134 | 1 134 |
| West | 556 | 21 244 | 62 107 | 13 021 | 110 492 | 172 235 | 2 992 | 285 719 |
| Total Victoria | 4 416 | 185 111 | 525 352 | 165 049 | 879 928 | 1 118 928 | 26 417 | 2 204 676 |

^a The West region includes all State forest areas in the Otway FMA, Midlands FMA, Portland FMA, 48% of the Horsham FMA (and contains all of the commercial forests in that FMA), and small areas of the Central FMA and the Dandenong FMA, which do not contain commercial forest areas. ^b Log grades A to D represent sawlogs of diminishing log quality respectively. Log grade D+ is the sum of Log grades A to D. Log grade R represents residual or pulplog. Other grades include ungraded sawlogs and in the Horsham FMA, all standard, second and Dunnage grade logs. ^c Not all residual logs in the Otway FMA are segregated into Ash or Mixed species. ^d Classified as D grade and better logs. Source: NRE (1998a).

The West region contributed around \$5.2 million in log royalties in 1997-98, or 13.2 per cent of total State forest log royalties received in that year. The majority of these royalties were associated with B and C grade sawlogs. In 1997-98, sawlog royalties received from the region were approximately \$3.4 million, while residual log royalties were approximately \$1.6 million.

In addition to royalty payments, in 1997-98 sawmill licence fees for the West region were around \$584 000.

Log Pricing and Allocation Arrangements

Hardwood sawlogs harvested in the West region are classified according to their size and quality (the potential for processing beyond the green sawntimber stage) and sometimes by their species using a system of log grades in diminishing order of sawlog quality from A through to D (Red Gum, Yellow Gum, Box and Ironbark species are termed durables and are not graded from A to D). Presently, B and C grade sawlogs account for the bulk of the sawlogs produced from the West region (Table 5.1). Logs that do not make the D sawlog classification are called residual logs. These are generally logs which are either too small or too defective to meet current sawlog specifications, but which may be utilised to produce other wood products.

Royalty rates are determined using the 'royalty equation system'. In principle, royalty rates are set so that the sum of royalty rates and the transport costs involved in sending a base grade of sawn timber to a defined key market will be the same for all operations accessible to that market. There may be adjustments to account for variations in timber quality from the base grade, provision of access roads or other factors. Details of the 'royalty equation system' are contained in the Victorian Timber Industry Strategy (Victorian Government 1986).

Fifteen year sawlog licences were introduced in 1989 and specified the volumes and grades of sawlogs to be supplied. Long-term licences were introduced to provide a greater degree of certainty regarding the supply of wood resources for the timber industry and to promote further investment in value adding. The volume of logs a mill is allocated is sometimes covered by more than one licence. The licence may be for sawlog and/or residual logs.

Sawlog licence allocations may be specified in net or gross volume terms. Allocations specified in gross terms include the percentage of defective material in the log that is unsuitable for sawmilling, while allocations specified in net terms exclude defect material. Sustainable yield forecast rates are in net volume terms. Sawlogs sourced from State forests in the West region are currently sold at the stump. That is, royalties are charged on the sawlog before any processing occurs, and licensees incur the costs of harvesting and log haulage costs.

Provision has been made in the licence arrangements so that licensees can elect to receive logs above or below their annual allocation by up to 30 per cent in any one year. This allows for fluctuations in market conditions. Allocations to individual licensees must not be exceeded over the licence period, with no more than 110 per cent of the annual allocation being obtained in any five-year period.

The proportion of sawlog grades which are allocated to licensees are negotiated on the basis of the degree of further processing being undertaken. If licensees are engaging in further processing they may be allocated an increased proportion of higher-grade logs. However, the total allocation of D+ logs does not vary through this process.

For the region as a whole, the total sustainable yield (see Chapter 4) has in effect been fully allocated, with regional licensed allocations (Table 5.2) closely matching the sustainable yield estimates. Therefore, there is little scope for expansion in the sawmilling sector pending the SFRI and the subsequent review of the sustainable yield rate. In the longer term, the sustainable yield rate may increase as the condition of the forests are improved for sawlog production through programs of commercial and pre-commercial thinning, reforestation and regeneration of currently low yielding stands.

Table 5.2: Licensed Allocations for the West Region, (cubic metres per year)

| Forest Management Area | Current Licensed Allocations |
|------------------------|------------------------------|
| Otway ¹ | 41 400 |
| Midlands | 58 600 |
| Portland | 13 950 |
| Horsham | 920 |
| West Region | 114 970 |

1. A further 1700 cubic metres of Blackwood sawlogs is licensed for sale from Otway FMA.

Source: Department of Natural Resources and Environment, unpublished data.

The availability of residual logs is directly tied to and determined by the sustainable production of sawlogs. The allocated resource of residual logs totalling around 224 000 tonnes (Table 5.3) is in line with estimates of the available supply. A further resource of 20 000 tonnes of small diameter logs from thinning regrowth stands is also allocated. However, volumes harvested in recent years have fallen well short of the available supply.

Table 5.3: Residual Native Hardwood Log Licensed Volumes for the West Region

| Forest Management Area | Licensed Volumes (tonnes/year) | |
|------------------------|-----------------------------------|---------------|
| | Residual logs | Thinning logs |
| Otway | 42 000 | 12 000 |
| Midlands | 98 000 ¹ | 3 000 |
| Portland / Horsham | - | 5 000 |
| West Region | 224 000 ² | 20 000 |

1. Includes 70 000 tonnes (approximately 62 300 cubic metres) annual supply to CSR Wood Products Ltd, under the *Forests (Pulpwood Agreement) Act 1959*. 2. Includes a proportion of a 134 000 tonne licensed allocation to be supplied to Midway Pty Ltd from Midlands, Otway and Portland FMAs and the Central Highlands region.

Source: Department of Natural Resources and Environment, unpublished data.

Log Harvesting and Haulage Arrangements

In three of the FMAs, a single syndicate/company is responsible for the logging and haulage of logs within each FMA. Contractors are engaged by sawmill owners/managers or logging syndicates to harvest and transport logs from the forest to one or more mills. The first of the logging syndicates was introduced in 1990 to the Midlands FMA where the logging and haulage is undertaken by the Central Victorian Forestry Company (a syndicate of sawmill owners in this FMA). In 1995, the Otway Logging Company became a NRE contractor responsible for the management of logging and haulage in the Otway FMA. Recently, the Kawarren Logging Company became responsible for the management in the Portland FMA. In the Horsham FMA, logs area is extracted by individual mills or their contractors.

In addition to the companies managing the logging and haulage of logs from State forests, there are other companies operating in the West region involved in the logging and haulage of softwood and hardwood logs from plantations and other private land.

All recipients of logs from State forests in the West region pay a roading charge to NRE that is used to build and maintain the roads required for log extraction. These charges are separate to the royalty payments by mills for logs harvested from State forests in the region.

In 1997-98, there were approximately 30 full time logging and transport crews employed by the four main contracting companies, employing 186 persons in total. These crews harvested

and transported approximately one million cubic metres of State and private log utilising approximately \$31 million in capital and receiving over \$21 million for services provided. In addition to these crews, there were a number of other crews directly contracted to or operated by individual mills. These crews are largely part-time operators and accurate employment numbers for these operators were not available.

5.2 STRUCTURE AND VALUE OF THE HARDWOOD-BASED INDUSTRIES

In 1997-98 there were 22 hardwood sawmills and 3 pulpwood processors receiving logs from State forests and sawmill residues in the West region. The location of State forests and sawmills in the West region is shown in Map 5.1.

The 22 hardwood sawmills are involved in a range of sawntimber processing activities, including a high proportion of further processed products such as kiln dried and appearance grade products for both domestic and export markets. The quality and volume of available sawmill resources, the scale of sawmill operations and further processing capacity largely determine the range of products produced at each mill. The log input capacities of the sawmills processing hardwood sawlog resources from the West region are shown in Table 5.4.

Table 5.4: Capacity for Sawmills Processing Sawlogs Sourced from the West Region, 1997-98

| Log input (cubic metres/year) | Number of sawmills |
|--------------------------------------|---------------------------|
| 0 – 5 000 | 9 |
| 5 001 – 10 000 | 7 |
| 10 001 - 20 000 | 3 |
| 20 001 + | 3 |

In 1997-98, residual logs and sawmill residues from the region were processed into pulp for use in paper manufacturing, chipped for export as woodchips and used for hardboard production.

The structure of the hardwood-based industry in the West region in 1997-98 is shown in figure 5A.

The forestry and wood-based industries using wood sourced from the West region presently accounts for an estimated 546 direct wood-based industry jobs. The estimated gross value of turnover of the sawmilling industry in the West region is \$29.9 million, while the gross value of pulpwood (assessed at the point of leaving the chip mill prior to being further processed) is estimated at \$23.2 million (Table 5.5).

Figure 5.A: Structure of the Forestry Industry in the West Region in 1997-98

Table 5.5: Key Economic Features of West Region Hardwood-based Industries, 1997-98

| | |
|---|----------------------|
| Total gross value of wood-based industries (product value) a | \$ million |
| Sawmilling industry | 29.9 |
| Residual log-based industries | <u>23.2</u> |
| Total | 53.1 |
| Total forestry and wood-based industry employment | no. persons |
| Forest management | 33 a |
| Residual log-based industry | 64 b |
| Sawmilling industry | 310 b |
| Logging and haulage | <u>139</u> |
| Total | 546 |
| Total log volumes produced | m³ |
| Total sawlogs produced | 113 484 |
| Total residual log produced | <u>172 235</u> |
| Total | 285 719 |
| Total State forest royalties received | \$ million |
| Total sawlog royalties received | 3.6 |
| Total residual log royalties received | 1.6 |
| Total sawmill licence fees received | <u>0.6</u> |
| Total | 5.8 |

a Department of Natural Resources and Environment, 1998. This figure includes NRE staff directly associated with commercial wood production and does not include permanent or part time forest work crews or NRE staff who spend part of their time on commercial forest activities. b Calculated by multiplying the percentage of total intake sourced from the West region by the relevant total employment, production or gross value of production figures.

The flow-on effects industry to the State economy from the wood-based industries using wood sourced from the West region may be broadly estimated using appropriate input-output and employment multipliers. Drawing on available multipliers for wood-based industries in the Victorian economy, it is estimated that the value of turnover from the sawmilling and residual log-based processing industries drawing hardwood resources from the West region contributed around \$99.3 million to State output in 1997-98. This estimate is based on a State output multiplier of 1.87 for the sawmilling sector (National Institute of Economic and Industry Research, 1985).

The sawmilling and residual log-based processing industries receiving logs from the West region contributed 713 and 198 jobs respectively to the Victorian economy in 1997-98. These estimates are based on a State employment multiplier of 2.3 for the sawmilling sector (with 310 direct jobs) and 3.1 for the paper products sector (with 64 direct jobs). It is also estimated that in the West region, the commercial forest management sector (with 33 direct jobs) and logging and haulage sectors (with 139 direct jobs) contributed 361 jobs to the Victorian economy in 1997-98, using a State employment multiplier of 2.1 for the forestry sector. The total level of employment attributable to hardwood resources sourced from the West region from the forestry, logging and haulage, sawmilling and residual log-based processing industries is therefore estimated at 1272 jobs for the Victorian economy in 1997-98.

The native hardwood resources sourced from the region also contribute to a range of further solid wood manufacturing activities, such as furniture manufacturing, joinery and craft wood industries. In Table 5.6, estimates are provided for employment by major industry category for people working in wood-based industries in 1996 and who were resident in the Statistical Local Areas comprising the West region. Based on these figures, the wood-based industries accounted for 3718 direct jobs in 1996, or 1.3 per cent of total regional employment (Australian Bureau of Statistics 1999b). It is important to note, however, that these figures include solid wood-based manufacturing activities using both native hardwood and

plantation-based timbers and possibly imported timber. The figures do not take account of wood-based industry jobs that are linked to hardwood resources sourced from the West region, but are not located within the RFA region. An example of such an enterprise would be jobs in the Kimberly Clark pulp mill, which sources its eucalypt wood resources from a number of RFA regions. In 1997-98, it employed 770 persons and utilised both hardwood and softwood, but is located outside the RFA region at Millicent, South Australia.

Table 5.6: Total Forestry and Wood-based Industry Employment Resident in the West Region, 1996

| Industry | Employment 1996 |
|--|--------------------|
| | no. |
| Forestry and logging | |
| Forestry and services to forestry | 95 |
| Logging | 197 |
| Forestry and logging undefined | 112 |
| Total | 404 |
| Wood and paper products manufacturing | |
| Wood chipping | 26 |
| Log sawmilling | 547 |
| Timber resawing and dressing | 194 |
| Plywood and veneer manufacturing and fabrication | 21 |
| Wooden structural component manufacturing | 553 |
| Fabricated wood manufacturing | 275 |
| Prefabricated building manufacturing | 17 |
| Wood product manufacturing NEC | 420 |
| Furniture manufacturing | 181 |
| Wooden furniture, upholstered seat manufacturing and furniture | 643 |
| Pulp, paper and paperboard manufacturing | 210 |
| Paper and sack manufacturing | 38 |
| Solid paperboard container manufacturing | 52 |
| Corrugated paperboard container manufacturing | 65 |
| Paper product manufacturing NEC | 72 |
| Total | 3 314 |
| Total forestry and wood-based industries | 3 718 |

Source: Australian Bureau of Statistics (1999).

5.3 THE HARDWOOD SAWNTIMBER INDUSTRY

In order to provide an accurate assessment of the economic circumstances underlying the competitiveness and value of the hardwood sawmilling industry, an economic survey of sawmills receiving logs from the West region was conducted in 1999 by the Australian Bureau of Agricultural and Resource Economics (ABARE).

The survey contained a series of questions designed to assess the economic conditions underlying the long term competitiveness and value of the industry and was conducted over two weeks in April 1999, involving face-to-face interviews with sawmill owners or managers. All hardwood sawmill owners/managers of mills sourcing logs from the West region were contacted as part of the economic survey, with questionnaires completed for 100 per cent of the hardwood sawmills receiving State forest hardwood logs from the West region in 1997-

98. In log intake terms, the survey responses accounted for 100 per cent of total State forest logs received by the sawmilling industry in the West region in 1997-98.

Information derived from the survey has been used in conjunction with other market-based information to estimate the total gross and net economic value of the West region hardwood sawmilling industry. The method used to derive estimates for the West region sawmilling industry is outlined in Box 1.

Box 1: Derivation of estimates for the sawmilling industry in the West region

All of the 22 hardwood sawmills receiving logs from the West region in 1997-98 responded to the survey.

In some instances, only partial responses to the questionnaires were supplied. For omitted data, estimates calculated from average costs, prices and returns were used. As a number of mills also use logs sourced from outside the West region, projections for key variables attributable to logs sourced from the West region are provided. For each mill, the employment, gross value and net value of production attributable to the resources sourced from the West region are calculated by weighting these key variables according to the percentage of total log intake sourced from the West region in 1997-98.

Sawmill Industry Analysis

In 1997-98, there were 22 hardwood sawmills receiving logs from State forests located in the West region. The following information on the hardwood sawmilling industry relates to the 1997-98 financial year, the latest year for which complete mill and financial records are available.

For the 22 hardwood sawmills, around 76 per cent of their total log intake (which includes some residual logs which are processed into sawntimber products) came from State forests located within the West region in 1997-98 (Table 5.7). The remaining logs received were sourced from State forests located in other RFA regions in Victoria, and a small amount (14 per cent) was sourced from private forests within the region. Furthermore, four of the sawmills receiving logs from the West region purchased raw wood inputs from other sawmills, from within and outside the West region.

Table 5.7: Intake for the West Region Hardwood Sawmilling Industry, 1997-98 ^a

| | Intake | Share of Total Intake |
|---------------------------------|----------------------|----------------------------------|
| | m³ | % |
| West region State forests | 134 535 | 75.9 |
| West region private forests | 24 359 | 13.7 |
| Other than West region b | 13 820 | 7.8 |
| Raw wood material intake | 4 542 | 2.6 |
| Total intake by sawmills | 177 256 | 100 |

^a Estimates based on sawmill survey. ^b Includes public and private sources.

The total value of turnover (or gross value of production) for the hardwood sawmilling industry in the West region is estimated at \$33.3 million in 1997-98 (Table 5.8). Because sawmills differ in how they treat payments to owner operators and partners, a consistent approach has been adopted to estimate this type of expenditure. Estimates were obtained of the amount of time that owner operators and partners spent working at the mill, and labour

costs were then estimated at the rate of around \$22 000 a year. It is estimated that total labour costs for the sawmilling industry (including imputed labour costs for owner operators and partners) totalled \$10.5 million in 1997-98, approximately one third of the estimated total operating costs of \$32.4 million. As a result, the total net value of production (or net profits earned) for 1997-98 for the hardwood sawmilling industry in the West region is estimated at around \$0.87 million. However, when account is taken of receipts of logs purchased from the West region only and costs apportioned on the basis of source of logs, it is estimated that the net value of production of logs attributed to the West region only is -\$0.12 million.

Table 5.8: Key Financial Features of the West Region Hardwood Sawmilling Industry, by Product, 1997-98 ^a

| | | Sawmill production | |
|---|----------------|--------------------|--|
| | | Total | Attributable to West region ^b |
| | | \$ million | \$ million |
| Gross receipts from sawntimber and products | | 29.847 | 27.739 |
| Gross receipts from sawmill residues (woodchips etc.) | | 2.486 | 2.398 |
| Gross value of production | | 33.279 | 30.137 |
| Labour costs (wages and salaries paid) | | 10.536 | 9.872 |
| Total operating costs ^c | | 32.407 | 30.257 |
| Net value of production (GVP minus total operating costs) | | 0.872 | -0.120 |
| Capital investment by sawmills in 1997-98 | | 2.113 | 1.378 ^d |
| Replacement value of fixed capital | | 28.932 | 26.459 ^d |
| Logs purchased | m ³ | 174 623 | 160 923 |
| Logs processed | m ³ | 168 094 | 154 395 |
| Sawntimber production | m ³ | 71 225 | 65 248 |
| Timber recovery rate | % | 42.4 | 42.3 |

^a Estimates based on sawmill survey. Estimates are based on single-year data and are not necessarily representative of long term trends. ^b Estimates are totals for the sawmilling industry based on log intake from the West region. ^c Operating costs include labour costs, wood purchasing and delivery costs, repairs and maintenance, depreciation and interest payments. ^d Estimated by apportioning total value by share of log input attributable to the West region.

In absolute terms the largest returns are associated with the six mills with intakes greater than 10 000 m³. In 1997-98, these mills accounted for 70 per cent of total log intake and 66 per cent of total gross income for the West region's sawmilling industry. They also made 86 per cent of the investment in new plant and equipment in 1997-98. However, average timber recovery rates in the nine smallest mills (annual log intake of less than 5000 m³) were much higher at 46.3 per cent, compared with an average 42.2 per cent for the remaining 13 mills.

It is estimated that the level of employment at sawmills attributable to the West region resource is 310 people (out of a total of 343 persons employed by these mills). Approximately 81 per cent of these employees are full time workers. Total individual mill employment at the 22 mills using wood resources from the West region ranges from around two people in the smallest mill to around 45 people at the largest mill.

Major Sawntimber Products and Markets

Seasoned sawntimber was produced at 17 of the 22 hardwood sawmills using wood from the West region (all 22 mills produced unseasoned sawntimber). In total, 14 855 m³ of seasoned

sawntimber was produced from logs sourced from the West region in 1997-98 (Table 5.9), accounting for 21 per cent of the total sawntimber production of 55 437 m³ and 37 per cent of the gross value of timber produced. Of the remaining 79 per cent of hardwood timber produced, scantling (55 per cent) and palings (31 per cent) made up the bulk of unseasoned sawntimber produced in 1997-98.

Table 5.9: Production of the West Region Hardwood Sawmilling Industry, 1997-98 ^a

| | Attributable to West Region ^b | | Total | |
|---|---|-------------|----------------|-------------|
| | m ³ | % | m ³ | % |
| Seasoned sawntimber | | | | |
| Veneer | | | - | |
| Appearance – select | 3 613 | 2.4 | 3 868 | 2.4 |
| Appearance – standard | 3 397 | 2.3 | 3 650 | 2.3 |
| Structural | 6 973 | 4.6 | 8 033 | 5.0 |
| Further processed | <u>872</u> | <u>0.6</u> | <u>1 474</u> | <u>0.9</u> |
| | 14 855 | 9.9 | 17 025 | 10.6 |
| Unseasoned sawntimber ^c | | | | |
| Appearance – select | 24 | 0.02 | 24 | 0.01 |
| Appearance – standard | | | - | |
| Structural | 44 | 0.03 | 44 | 0.03 |
| Further processed | 703 | 0.5 | 703 | 0.4 |
| Scantling | 30 493 | 20.3 | 32 916 | 20.4 |
| Palings and pallets | 17 328 | 11.5 | 18 182 | 11.3 |
| Other sawn | <u>6 845</u> | <u>4.6</u> | <u>7 327</u> | <u>4.5</u> |
| | 55 437 | 36.9 | 59 196 | 36.7 |
| Total sawntimber | 70 292 | 46.8 | 76 221 | 47.3 |
| Woodchips | 63 731 | 42.4 | 68 684 | 42.6 |
| Other residues | 16 221 | 10.8 | 16 221 | 10.1 |
| Total residues | 79 952 | 53.2 | 84 905 | 52.7 |
| Total | 150 244 | 100 | 161 126 | 100 |

^a Estimates for industry based on sawmill survey. ^b Estimates are totals for the sawmilling industry based on log intake from the West region. ^c Unseasoned sawntimber category includes green sawntimber that was sold for further processing to become seasoned sawntimber. Categories for which this applies are those from appearance select through to further processed.

As part of the survey, sawmillers were asked to identify the major markets for their sawntimber, their current product mix in 1997-98 and their anticipated product mix in 2007-08. The results are shown in Table 5.10. Sawmillers currently utilising logs from the West region anticipate that the proportion of output sold as seasoned timber will increase from 22 per cent to around 37 per cent of total output by 2007-08. Responses in the survey indicate that, if sufficient high quality sawlogs were available in the future, sawmills would undertake to increase their production of (high value) appearance grade products at the expense of unseasoned sawntimber production.

The major markets for each product were also identified (Table 5.10). The unseasoned timber products were mainly distributed to Melbourne and regional Victoria. The bulk of seasoned timber production was also sold in Victorian markets with some timber going interstate (usually South Australia) and a small amount of select appearance grade products is exported.

Table 5.10: Current and Anticipated Sawntimber Production in the West Region and Major Markets, 1997-98 and 2007-08 ^a

| Product | Production share | | Major markets in 1997-98 ^b |
|---|--------------------|--------------------|--|
| | 1997-98 % | 2007-08 % | |
| Seasoned sawntimber | | | |
| Appearance grade – select | 5.1 | 5.7 | Melbourne |
| Appearance grade – standard | 4.8 | 11.4 | Melbourne |
| Dried structural grade | 10.5 | 15.5 | Melbourne, regional Victoria, interstate |
| Further processed | <u>1.9</u> 22.3 | <u>4.6</u> 37.2 | Melbourne, regional Victoria |
| Green sawntimber sold for further processing | 0.9 | 1.0 | Melbourne, regional Victoria |
| Unseasoned sawntimber | | | |
| Structural | 0.1 | 0.03 | Melbourne, regional Victoria, interstate |
| Scantling | 43.2 | 35.4 | Melbourne, regional Victoria, interstate |
| Palings and pallets | 23.9 | 23.1 | Melbourne, regional Victoria |
| Other sawntimber | <u>9.6</u> 76.8 | <u>3.2</u> 61.7 | Melbourne, regional Victoria |
| Total | 100.0 | 100.0 | |

^a Preliminary estimates for industry based on sawmill survey. These estimates exclude specialist recovery mills. ^b Markets recorded in order of importance.

5.4 THE HARDWOOD RESIDUAL LOG PROCESSING INDUSTRY

Residual logs are those logs arising from integrated sawlog harvesting that are too defective or small to meet sawlog specifications. They can be used for pulpwood, firewood or craftwood. Current residual log allocations from the West region amount to 244 000 tonnes per year.

Under the *Forests (Pulpwood Agreement) Act 1959*, there has been an agreement to supply CSR Wood Products with 70 000 tonnes of pulpwood annually. In 1998, CSR ceased operations at their Bacchus Marsh plant, rationalising hardboard production at their other two plants in New South Wales and Queensland. There are also current licensed commitments to supply pulpwood and residual log material to Kimberly-Clark Australia (36 000 tonnes from the Otway FMA) Farleighdale (8400 tonnes from the Otway and Midlands FMAs), Daylesford Sawmills (23 600 tonnes from the Midlands FMA) and Midway Pty Ltd at Geelong (approximately 85 000 tonnes from the Otway, Midlands and Portland FMAs from a total of 134 000 tonnes licensed from a supply area which also includes part of the Central Highlands RFA region).

Prior to the closure of the CSR plant, the allocated resource of residual logs totalling 224 000 tonnes closely matched the available supply. A further resource of 20 000 tonnes of small diameter eucalypt logs from thinning operations has also been allocated to Midway through to 2002. However, many of the licensees are not taking their full allocation and, in 1997-98, only 172 000 tonnes were harvested (Table 5.1).

5.5 PLANTATION-BASED INDUSTRIES

Geographically, the West region plantations are found in three main localities namely Portland (53 per cent of plantation area within the region), Ballarat (20 per cent) and Otway (17 per cent). In the past, plantation-based industries have been dependent on private and public softwood resources, which are used in the production of sawntimber, particleboard and export woodchips. The plantation resource harvested from the West region forms all or part of the fibre wood resources used by the companies listed in table 5.11. More details of the operations undertaken by these companies are provided in the next chapter. The softwood industries in the West region are vertically integrated as each of the four companies operating the major sawmills also own plantations and either own or are part owners of woodchip export operations. Midway Pty Ltd also owns a significant area of softwood plantation and sells softwood sawlogs to other processors.

Table 5.11: Major Industries Processing Softwood Plantation Logs

| Company | Location | Logs processed | Products |
|------------------------------------|---------------------|----------------|------------------|
| Green Triangle Forest Products Ltd | Dartmoor & Portland | Sawlogs | Sawntimber |
| Auspine Ltd | Portland | Residual logs | Export woodchips |
| | Tarpeena (SA) | Sawlogs | Sawntimber |
| | Portland | Residual logs | Export woodchips |
| AKD Pty Ltd | Colac | Sawlogs | Sawntimber |
| Laminex Industries. | Ballarat | Residual logs | Particleboard |
| Midway Pty Ltd | Geelong | Residual logs | Export woodchips |
| SPE (Management) Pty Ltd | Geelong | Residual logs | Export woodchips |

In addition to the major softwood processing industries, there are softwood timber preservation plants located at Heywood, Colac, Timboon, Terang, Bungaree, Beaufort and in South Australia, and a sawmill to process timber for export has been built at Lara near Geelong.

Prior to 1990, there were minor hardwood plantations in the West region, but the area under hardwood plantations has been expanding rapidly, particularly in the Portland FMA. To date, little of the hardwood plantation area has been harvested, although the focus of the investments in hardwood plantations is for the export wood chip market.

The softwood and hardwood plantation-based industries are discussed further in Chapter 6.

5.6 OUTLOOK FOR WOOD PRODUCT INDUSTRIES

The discussion below is a broad overview of the factors influencing the market outlook for Australian hardwood forest product industries. Based on available data, trends in international markets are analysed and related to the outlook for Australian native forest products industries in terms of the major forest product groups — sawntimber, wood-based panels, and pulp and paper products.

While there is no pulp and paper industry established in the West region, the outlook for the international pulp and paper industry will be an important determinant for the demand for export woodchips. Similarly, no native hardwood residual logs from the West region are now being used for the production of panel products. However, with the growth in the hardwood plantation resource, the native hardwood resource could be used as a minor component of the

wood fibre furnish should a panel product plant be established in the region later in the RFA period.

Macroeconomic assumptions

The following outline of ABARE assumptions on the world economic outlook form the basis for the industry outlook in this section. World economic growth is assumed to improve gradually from an average annual rate of 3.2 per cent in the period 1996 to 2000, to around 3.4 per cent in 2001 to 2005 and 3.6 per cent in 2006 to 2010, before easing to around 3.5 per cent thereafter until 2020. Despite the recent downturn in South East Asia, Asia is expected to remain the strongest growth region in the world economy, with levels of income per person converging towards OECD country levels over the projection period.

Reflecting a recovery from the recent downturn in economic activity, economic growth in the Asian region is assumed to improve slightly from an average annual rate of 5.5 per cent between 1996 and 2000 to 5.8 per cent between 2001 and 2005 and 6 per cent between 2006 and 2010, before easing to 5 per cent between 2011 and 2020. The proportionate population growth rate for the Asian region is forecast to be close to the world average, but well above those forecast for OECD countries.

Outlook for forest product markets

North America dominates the production of all forest product categories, accounting for at least 30 per cent of global output. Western Europe and the Asia-Pacific region are the principal importing regions, while the Nordic countries and North America are the principal exporting regions.

In recent decades, the rapid industrialisation of countries in Asia such as Japan, South Korea and Taiwan has resulted in an increase in consumption of wood products per person, particularly paper products. Its proximity and its potential for significant increases in consumption mean that the Asia-Pacific region is likely to be the main market focus for any expansion of Australia's forest product industries. Economic developments over the past decade have resulted in significant changes to trade in wood products in the Asia-Pacific region. Most notably, trade in unprocessed logs has declined as a result of the imposition of log export bans in Indonesia (since lifted during 1998) and Malaysia, moves to promote value-added domestic processing, and increased domestic demand for wood products in traditional tropical wood supplying countries.

The downturn in economic activity in many of these countries over the past year has caused a decline in consumption of forest products in the region. Exacerbating the problem has been the rapid expansion in production capacity for several products including pulp, paper and medium density fibreboard (MDF). The combination of declining demand and excess capacity has led to a fall in world prices (measured in US dollars) during 1998 for most forest products. These depressed market conditions are expected to continue through 1999 until economic activity gradually picks up in the Asia-Pacific region.

In its recent review of world forest products markets, the Food and Agriculture Organization of the United Nations (FAO) concluded that product prices will not rise significantly in the period to 2010 (FAO 1999). Many regions have ample or excess wood product manufacturing capacity. It is only for the higher grades of timber products that any upward pressure of prices is foreseen, with any price increases restrained by the availability of cheaper wood and non-wood substitutes. There is expected to be more in-country processing, with less trade in semi-processed and commodity grade timber products and more trade in higher-value products.

Australian Trade Position for Forest Products Markets

The Australian market for timber products is strongly influenced by the international market because Australia imports or exports most forest products. Australian trade in most forest products is small in comparison with world trade, and domestic prices are largely determined by the landed price of imports.

The Asian economic downturn in 1997-98 has had rather diverse short-term trade impacts on the Australian forest products trade. The fall in demand for forest products in the Asian region in 1997-98 has generally led to a decline in world prices (measured in US dollars) for forest products. However, relative exchange rate movements meant that prices for imported softwood timbers into Australia rose while prices for tropical hardwood timbers fell. World softwood timber prices tend to be set by North American market conditions, but the weakening Australian dollar, measured against the US dollar, tended to offset any advantage gained by North American suppliers in the Australian market from lower world prices. On the other hand, the appreciation of the Australian dollar against the currencies of Australia's major Asian hardwood suppliers led to a fall in the price of imported tropical timbers within Australia.

The volume and value of imports of forest products into Australia rose in 1997-98. The value of forest products imports in 1997-98 reached \$2.71 billion, up from \$2.55 billion in 1996-97 (ABARE 1999). The rise largely reflects increases in value and volume of softwood sawntimber imports. Australia's strong economy, continued high level of housing activity and lower world prices for sawnwood contributed to the growth in imports. Plywood imports, mostly structural plywood from New Zealand and Indonesia, were another major contributor to the rise in the value of imports. The value and volume of paper product imports also rose, largely through increases in imports of newsprint, and paperboard and industrial packaging imports.

The value of exports of forest products from Australia rose by 13 per cent, or \$143 million, to \$1.25 billion in 1997-98. The main contributor to the rise was a \$128 million increase in the value of woodchip exports. Shipments of woodchips, which were almost solely directed to Japan, increased 30 per cent in 1997-98. While world woodchip prices (measured in US dollars) declined in 1997-98, Australian exporters to some extent were buffered against the decline in world prices. Prices in contracts negotiated by Australian exporters to sell woodchips to Japan are written in Australian dollars, and because the Australian dollar fell markedly against the US dollar in 1997 and 1998, Australian woodchips were priced competitively against those from suppliers selling in US dollars. The yen equivalent of the average Australian woodchip prices in June 1998 was 20 per cent below the US price and 14 per cent below the price from all sources (Ausnewz 1998).

The economic downturn in Asian countries has also had an impact on export of other forest products with falls in the volume and value of Australian roundwood, sawntimber and particleboard exports in 1997-98. Australia's net trade position is not expected to improve during 1998-99.

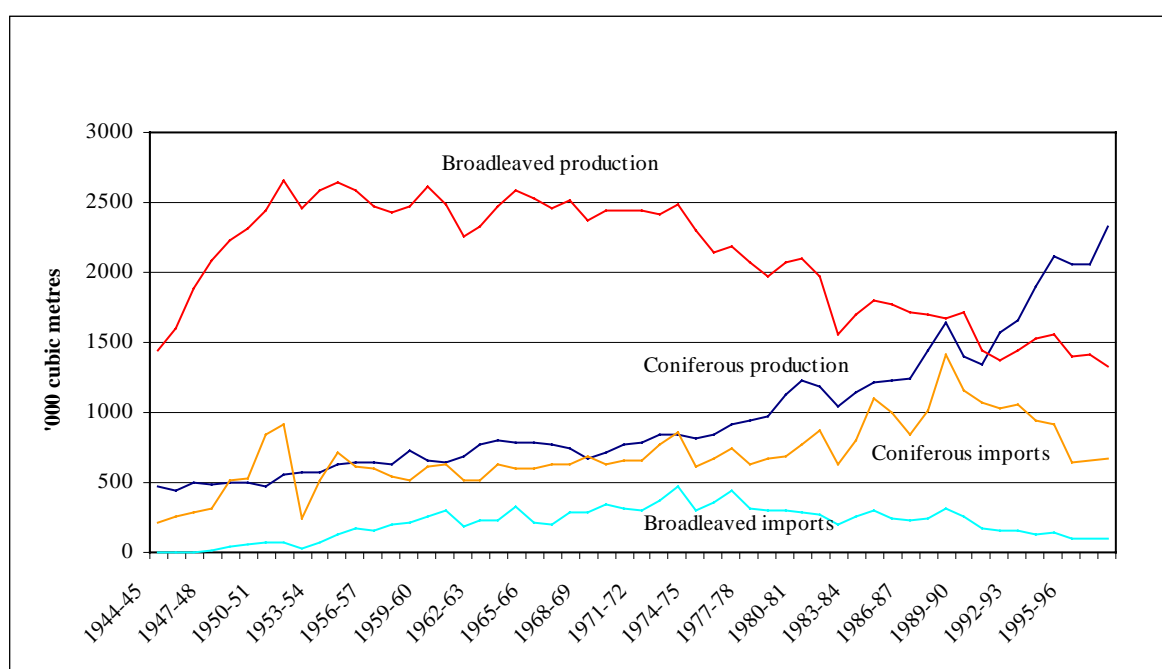
Sawntimber

Global production of sawn hardwood increased from 110 million m³ in 1980 to 130 million m³ in 1991, but has since declined slightly. The production of sawn hardwood in Asia is expected to continue to decline, given the decreasing availability of tropical hardwood logs. However, the Asia-Pacific forest products sector is expected to meet projected consumer demand and, as a result, significant real price increases are not expected. Demand is expected to be met through a combination of more efficient use of existing Pacific Rim timber resources and the establishment of manufacturing capacity to produce non-traditional

products such as MDF, oriented strand board (OSB) and other reconstituted panels (Johnson 1997).

Australian production of sawn hardwood has declined from a peak of 2.6 million m³ in 1954-55 to 1.32 million m³ in 1997-98 (Figure 5.B), largely as a result of reduced resource availability in native forests and the increased substitution of softwood for traditional hardwood sawntimber. Annual sawn hardwood production is expected to fall from current levels until around 2000, before rising gradually over the next two decades as hardwood regrowth and possibly some hardwood plantation logs become available for harvesting. Softwood sawntimber production is also expected to rise as existing softwood plantations mature. Australia is likely to have a small exportable surplus of softwood sawntimber by 2005-06 (Love, Yainshet and Grist 1999).

Figure 5.B: Australian Sawnwood Production, Consumption and Trade



Hardwood sawntimber production in Australia has traditionally been focused on producing timber for building applications and other structural end uses. Historically, the competition between softwoods and hardwoods for internal building applications was influenced by the greater availability and lower price of hardwood sawntimber. Competition from softwoods for external applications and other structural end uses was constrained by the natural advantages of hardwoods, such as strength, durability and resistance to biological degradation.

However, there have been dramatic falls in softwood production costs, which have been reflected in lower softwood timber prices, in recent decades — mainly a result of large automated softwood mills being commissioned and an increasing softwood resource base. The average cost of sawntimber produced by a new softwood mill was earlier estimated to be around 10 per cent lower than that for a new hardwood mill producing predominantly unseasoned sawntimber (Jaakko Pöyry 1993). The lower price has enabled softwood sawntimber to increase its market share of internal building applications where softwood sawntimber is directly substitutable with hardwood timber.

More recently, competition from softwood sawntimber has also contributed to a decline in the market share of hardwood in external building applications. This has been possible as a result of the increasing size of the softwood resource and the decline in softwood production costs, combined with improved processing technologies and treatments for the preservation (for external applications) and lamination (for structural uses) of softwoods. These factors have allowed softwoods to be increasingly substituted for hardwoods in numerous external building applications, albeit from a small base.

A range of other minor sawntimber products is produced from forests — e.g. posts, stakes, trellising, decking, pallets and packing cases. The natural advantages of hardwoods in these applications have also been offset by the improved treatments available for the preservation and lamination of softwoods. Softwoods are increasingly likely to be used as a substitute for hardwoods in many of these applications.

The competitiveness and increased availability of softwood sawntimber is indicated by the declining market share of hardwood sawntimber in total domestic sawntimber consumption. Apparent consumption of hardwood sawntimber was approximately 2.04 million m³ in 1984-85 (or 47 per cent of total apparent consumption) but only 1.41 million m³ (or 32.0 per cent of total apparent consumption) in 1997-98. Domestic annual production of softwood and hardwood sawntimber is estimated to have been 2.33 million m³ and 1.32 million m³ respectively in 1997-98.

The growth in the production of softwood plantation timber has also resulted in an almost 50 per cent decline in the volume of timber imports. Other factors contributing to the replacement of imports of sawntimber have been the dramatic increases in prices of imported timbers in the mid 1990s, the declining supplies of tropical hardwood sawntimber from South East Asia and the increasing availability of native hardwood timbers which have been processed beyond the rough sawn stage.

Increased use of softwood sawntimber in building applications and other structural end uses over the medium and longer term is expected to continue — especially in Western Australia and Tasmania where hardwood sawntimber consumption still exceeds that of softwood sawntimber (reflecting the previously small softwood resource base). However, in line with projected increases in the softwood resource base and the consequent rise in the availability of softwood sawlogs, softwood consumption in these States can be expected to increase.

The impact of substitution away from unseasoned hardwoods to lower cost softwoods in housing construction has been partly offset by hardwood sawmillers diversifying into, and expanding, markets for kiln dried timber — for example, furniture, flooring, mouldings and other value-added products (Neck, Curtotti and Sar 1996). Many of these applications involve further processing and the replacement of imported products.

The continuing ability of the hardwood sawmilling industry to maintain profitability and compete against domestic softwood and imported timbers will depend on the underlying cost competitiveness of the industry. In addition to the future level of hardwood availability, the perceived dependability of future access to hardwood resources will affect the level of investment in the hardwood-based industry, which, in turn, will influence the cost competitiveness of the industry. Increasingly, the focus is likely to be on the production of appearance grades of timber used in furniture and joinery, to capture the potential higher returns from the marketing of specific timber species that have distinct natural attributes. Many of these specific features may be exploited in product markets for furniture, linings, flooring, architraves, skirtings and seasoned beams.

It is unlikely that prices for imported timber will rise in the next few years. Weakening demand in the main consumer markets such as Japan, a continuing high value of the US dollar

relative to East Asian currencies and slow economic activity in many South East Asian countries are likely to lead to declining US dollar prices for meranti and other tropical timbers (Adams and Johnson 1998). Despite the limited potential for price increases, an expected tightening in the supply of hardwood sawntimber in the Pacific Rim could provide continued opportunities for the use of high grade hardwoods for appearance purposes and certain structural applications.

Wood-based Panels

Wood-based panels comprise three main product categories — particleboard, MDF and plywood — and are used in a wide range of building, construction and furniture applications. Total world consumption of wood-based panels increased by around 400 per cent from the level in 1960 to reach around 148 million m³ in 1996. The growth in world production and consumption of composite wood panels and other engineered wood products reflects the growing market acceptance and competitiveness of these products in a diverse range of end-use markets. Plywood is the most important panel produced in the Asia-Pacific region in volume terms, accounting for over 70 per cent of total panel production of about 30 million m³ in 1996. However, in line with decreasing availability of veneer logs, plywood production in the Asia-Pacific region is expected to decline and investment in the processing capacity of other panel products is increasing.

Of the wood-based panel products currently available, MDF has recorded the strongest market growth over the past decade. Rapid growth in the consumption of this product since the early 1990s in domestic and international markets is attributed to the widespread application and growing consumer acceptance of MDF products in building and furniture making.

Total annual consumption of wood-based panels in Australia exceeded 1.5 million m³ in 1997-98, up from almost 1 million m³ in 1985-86. Australia was a net importer of wood-based panel products up to 1994-95, but in 1995-96 and 1996-97 was a small net exporter. The recent downturn in economic activity in Asia and the subsequent availability of surplus panel products on world markets resulted in Australia becoming a net importer again in 1997-98.

In Australia, competition from softwood residues has affected demand for hardwood on two fronts: as an alternative input into wood-based panels and the use of these softwood-based panels as a substitute for hardwood sawntimbers and other residual hardwood products. Use of residual hardwood roundwood in composite wood-based panels has decreased over recent years with the increasing availability of softwood residue. This has occurred as a result of the increasing size of the softwood resource, rising mill throughputs and the consequent increase in the availability of low-cost residual softwood roundwood. Users have also been substituting composite wood panels for hardwood sawntimbers in internal building applications such as floors, ceilings and walls.

Future opportunities for Australian producers of hardwoods will be assisted by the forecast reduction in the supply of tropical timbers. An expected tightening in supply of hardwood timber in the Pacific Rim could also provide continued opportunities for the use of high-grade hardwoods in select appearance applications. Australian veneer production, for example, which targets the high value decorative veneer market, is likely to continue to be competitive. The main factors influencing the ability of these producers to expand their market base are the future availability and quality of the resource, and the price competitiveness of substitute products such as medium density fibreboard. Limited marketing opportunities exist for new panel producers in supplying the Australian market. Any new producer would need to rely mainly on expanding export markets in the Asia-Pacific region.

Pulp and Paper

Growth in world paper consumption closely follows changes in economic activity. Consequently, growth in consumption of paper products over the longer term is expected to be particularly strong in the Asian region. World paper and paperboard consumption has been projected to increase from the current level of about 280 million tonnes a year to around 394 million tonnes a year by 2010 (FAO 1999). The projected annual rate of growth in world paper consumption to 2010 (around 2.3 per cent a year) is well above projected world population growth rates (around 1.5 per cent a year). This reflects growing urbanisation and the expected increase in demand for paper as world literacy rates continue to rise. However, growth in paper consumption from 2010 to 2020 is expected to slow slightly, reflecting the slowdown in economic growth rates in developing countries.

A supply and demand analysis carried out by the FAO suggests that the capacity of the forests and other sources of fibre will be sufficient to meet demand in the foreseeable future, although producers in Africa and South Asia will continue to have to use a range of non-forest supply sources to meet their needs (FAO 1999). Furthermore, pulp prices will be under pressure from increased use of recovered/waste paper, particularly in the production of lower quality paper products.

Australia has been a significant importer of paper products and pulp in recent years. This means that an expanding domestic industry could replace imports to some degree. By world standards, Australian paper manufacturers already use a high proportion of recycled paper in their fibre furnish and only limited growth in the use of recycled paper can be expected in line with the rate of increase in paper consumption.

Australian hardwood pulplogs and woodchips are either used in domestic pulp production or exported to Japan. In Australia, given the historical shortage of softwood and the abundance of eucalypt, the domestic pulp and paper industry has used eucalypt pulp instead of softwood pulps in higher proportions than used elsewhere in the world. With the availability of softwood pulplog supplies unlikely to increase over the medium term (Love et. al. 1999), the use of eucalypt pulp in these applications will remain high over time.

Australian hardwood pulpwood is also exported (as woodchips) and is primarily used in the production of bleached hardwood kraft pulp and, consequently, for high quality printing and writing papers. Japan is the only significant market for Australia's woodchip exports, accounting for over 99 per cent of Australia's hardwood and softwood chip exports in 1997-98. There has been little growth in Australia's hardwood woodchip exports in recent years, with shipments averaging 2.74 million tonnes (dry basis) over the five years to 1997-98.

Paper consumption in Asia has declined over the past year, but Japan's pulp and paper companies forecast woodchip imports will rise in the medium term once economic activity in the region recovers (Iida 1998). To assure future supplies, they have been investing in overseas plantations of eucalyptus in Australia, Chile and other countries in the Pacific Rim regions. Thus over the life of the RFA, woodchip demand is projected to increase, although plantation wood is expected to form a greater proportion of the overall export market.

The absence of a suitable softwood substitute in the bleached hardwood kraft pulping process is likely to result in rising demand for Australian hardwood woodchips and/or pulp, to meet the expected increase in Asian demand for printing and writing papers. The major factor influencing the future supply of Australian native hardwood chips appears to be access to suitable forest resources.

5.7 INDUSTRY DEVELOPMENT OPPORTUNITIES

As part of the economic assessment underlying the future development of a West RFA, an examination of timber industry development opportunities in the West region was undertaken by Kevin Wareing and Associates Pty Ltd. This assessment included an analysis of the feasibility of future development of the native wood-based industries of the West region. This section outlines the main findings of that study, taking into account forest product markets and the availability and quality of hardwood resources. The discussion below is based on the assumption that sustainable yields for native forests will be maintained.

Hardwood Availability

Sawlogs

The availability and quality of hardwood resources from the West region will have a bearing on development opportunities. Subject to new sustainable yield analyses based on SFRI data, there appears to be little scope in the sawmilling sector for industry development in terms of resource quantity at least until 2001.

In the longer term, sustainable yields may further increase as the conditions of the forests are improved for sawlog production through programs of commercial and non-commercial thinning, reforestation and regeneration of currently low yielding stands. This will depend to a large degree on the strength of demand for fibre-based products, and the extent to which available supplies of residual logs can be utilised and funds are allocated for these programs.

Residual logs

Residual logs are produced in conjunction with sawlog harvesting operations, and so their availability is directly tied to the sustainable level of sawlog production. Currently, some 220 000 m³ of residual logs become available each year as a by-product of normal sawlog harvesting operations. In 1997-98, nearly 80 per cent of this resource was utilised. Future usage of residual logs appears to becoming increasingly dependent on the export woodchip market.

Hardwood Sawmilling Development Opportunities

Development opportunities for the hardwood sawmilling industry in the West region will be determined in part by the level of sawlog availability. However, in recent years, the Victorian hardwood sawmilling industry has:

- increased the proportion of sawntimber seasoned;
- recognised that a number of species other than ash can be seasoned and used in applications where their properties provide a competitive advantage;
- refined sawing, drying and further processing techniques to improve the recovery of appearance grade products;
- increased the utilisation of lower grade logs and experienced an increase in the demand for accurately sized timber for pallets;
- developed a greater range of products and a broader customer base; and
- developed a coordinated approach to the development of export markets and introduced quality assurance procedures.

The progressive transition of production from predominantly unseasoned to seasoned products by the Victorian hardwood sawmilling industry is expected to continue (Gooding 1999).

Specific development options that could be considered by the sawn timber industry sourcing hardwood sawlogs and residual logs from the West region include:

- increasing the proportion of sawn timber that is kiln dried. Most producers processing logs from the West region have the capacity to increase the proportion of their production that is kiln dried and re-processed;
- increasing the processing of residual logs through investment in plants specifically designed to process logs that are smaller and more defective than sawlogs;
- developing networks between timber processors to facilitate investment in the specialised equipment needed to produce highly processed wood products;
- strengthening links with the furniture industry; and
- continuing to identify and expand markets where the properties of the various hardwoods from the West region (durability, appearance, strength and hardness) provide a competitive advantage.

These development options have been successful for a number of firms and there would appear to be scope for the sawmilling industry processing logs from the West region to extend their successful application.

Residual Log Processing Development Opportunities

Although it is estimated that the supply of residual logs in the West region will be around 220 000 m³ per year for at least the next 20 years, the resource is widely dispersed and variable with respect to species, age, log size and quality. It is thus unlikely to be available to support the development of competitive new industries such as panelboard or pulp and paper production based solely on the native hardwood resource. Any development proposals planning to use the native hardwood resource would have to use the resource in conjunction with available plantation logs. Other potential uses of residual logs are in the production of hardwood plywood and laminated veneer lumber (LVL). While undoubtedly there would be some residual logs suitable for this purpose, the critical issue is whether such logs can be economically segregated and markets developed.

Development Opportunities in conjunction with Plantation Resources

The rate of softwood plantation expansion declined sharply in the 1990s and, although there is some potential to increase the current available volume of sawlogs and residual logs, it is unlikely that the increase will be sufficient to justify the establishment of any new major industries. A more likely scenario is the continued rationalisation of existing processing plants.

Future availability of softwood sawlogs and pulplogs has been made on the basis of forecasts by the National Plantation Inventory (NPI) in 1997. These estimates have been adjusted as the West region does not exactly correspond with the boundaries used in the NPI study (Table 5.12). No increases in availability are anticipated in the Ballarat and Otway regions over the next 20 years. The forecast for Portland suggests that softwood production will initially fall from current production levels of around 930 000 m³ then increase slightly to 1 098 000 m³ per year in the period 2020-24. While the pulpwood forecast does not increase over the forecast period, the sawlog component is expected to increase by 28 per cent. While these forecasts incorporate plantation owners' plans for expansion at the time the NPI study was undertaken in 1996, they do not appear to take into account potential expanded planting rates that could be expected through recent government initiatives such as the Plantation 2020 Vision.

A number of programs have been initiated to develop blue gum plantations in south east South Australia and south west Victoria in the past few years, often with overseas

involvement. As a result there has been a rapid expansion of hardwood plantations particularly over the past five years. All but one of these programs are export oriented, based on producing the export woodchip market.

Table 5.12: Woodflow Forecasts from Softwood Plantations in West Region (cubic metres per year)

| | 2000-04 | 2005-09 | 2010-14 | 2015-19 | 2020-24 |
|--------------------|------------|------------|------------|------------|------------|
| Ballarat and Otway | | | | | |
| Sawlogs | 287 | 296 | 296 | 297 | 281 |
| Pulplogs | <u>96</u> | <u>94</u> | <u>94</u> | <u>96</u> | <u>97</u> |
| Total | 383 | 290 | 390 | 393 | 378 |
| Portland | | | | | |
| Sawlogs | 612 | 630 | 559 | 632 | 818 |
| Pulplogs | <u>277</u> | <u>190</u> | <u>236</u> | <u>252</u> | <u>280</u> |
| Total | 889 | 820 | 795 | 884 | 1 098 |

Source: Based on National Forestry Inventory (1997).

6. PLANTATIONS

6.1 INTRODUCTION

Plantations can contribute significantly to wood supply, particularly pulpwood and small diameter sawlogs for industry. They can contribute to regional economic development, especially if they are linked to downstream processing industries as they are in the West region. Plantations on farms can also provide environmental and agricultural production benefits to landholders and the broader community.

Plantations in south-eastern Australia are typically of the exotic Radiata Pine (*Pinus radiata*) referred to as ‘softwood’, or of native species (predominantly *Eucalyptus* spp.) referred to as ‘hardwood’. To date, hardwood plantations have been managed mainly on short rotations to produce pulpwood for paper manufacturing. However, with improved technology and emphasis on value adding, it is anticipated these plantations with appropriate silvicultural regimes will increasingly be used for sawlog or veneer production similar to softwoods.

Current Victorian Government policy prohibits the clearing of native forest on public land to establish plantations. Native forest can be cleared on private land for plantation establishment subject to native vegetation retention controls to protect flora and fauna, and in accordance with local government planning requirements. Consequently, opportunities for plantation development are available only on public lands that do not presently contain forest, which are limited in area, and on predominantly cleared areas of private land that satisfy the vegetation retention and planning controls.

Whilst the primary focus of RFAs is on public native forests, and where necessary private native forests, the Scoping Agreement for Victorian RFAs also provides for analysis of a region’s potential for plantation expansion as an input to considerations of potential industry development and infrastructure options. However, it is important to note that the use and management of cleared private land is not covered by RFAs.

This chapter outlines the substantial West region plantation resources and their potential for further development.

6.2 POLICIES, PROGRAMS AND INITIATIVES

Policies and Programs

State and Commonwealth Governments have developed policy and program initiatives to allow for plantation development and management in the context of economic efficiency, social considerations, and environment and heritage issues. It is a policy position of Victoria and the Commonwealth in the National Forest Policy Statement (NFPS) (Commonwealth of Australia 1992) that:

The wood products industry is drawing and will continue to draw wood from a mix of sustainably managed softwood and hardwood plantations and native forests.

This position was reaffirmed in the Wood and Paper Industry Strategy (WAPIS) (Commonwealth of Australia 1995).

National Forest Policy Statement

The NFPS sets several goals for forest management. For plantations:

... One goal is to expand Australia’s commercial plantations of softwoods and

hardwoods so as to provide an additional, economically viable, reliable and high-quality wood resource for industry. Other goals are to increase plantings to rehabilitate agricultural land, to improve water quality, and to meet other environmental, economic or aesthetic objectives.

Objectives in the NFPS directed towards achieving these goals for Australia's plantation resource are to:

- increase commercial plantation development on cleared agricultural land and, where possible, to integrate plantation enterprises with other agricultural land uses;
- improve the productivity of existing plantation areas by means of improved technology, breeding of genetically improved stock, and selection of species; and
- encourage industrial growers, and where appropriate public forestry agencies, to expand their plantation base to satisfy specific requirements.

Governments also agreed through the NFPS that:

- Decisions to establish plantations for wood production should rest on their economic viability. The States will adopt commercial approaches for their plantations and will continue to ensure that the public plantation resource is actively managed in order to maximise net returns.
- State and local governments will provide a planning framework that facilitates the development of large-scale industrial plantations by ensuring that impediments to plantation development are minimal in areas such as taxation, planning and access to information.
- Consistent with ecologically sustainable management objectives, the States will not clear public land for plantation establishment where this would compromise regional conservation and catchment management objectives. In particular, Victoria has a policy of not clearing public native forests for plantation development.

The plantation objectives of the NFPS are being implemented through a number of initiatives, including the Wood and Paper Industry Strategy (WAPIS). The WAPIS is a four-year initiative of the Commonwealth Government, which commenced in 1996, to encourage investment, value adding, and growth in employment in forest related industries. To this end, it will promote continued development of a diverse, internationally competitive industry based on ecologically sustainable management practices, and assist the integration of industry and conservation objectives for Australia's native forests and plantations.

Notable features of WAPIS include removal of impediments to plantation development in areas such as taxation; improved planning and access to information; review of pricing policies and export controls; and promotion of plantation research and development.

WAPIS acknowledges that plantation industries can contribute to regional economic development by locally value-adding to primary production, resulting in more jobs. When developed on farms, plantations also provide substantial benefits to landholders and the broader community in relation to greenhouse, environment, landcare and agricultural productivity.

The Commonwealth Export Control (Unprocessed Wood) Regulations have been amended under the *Export Control Act 1982* so that an export licence is no longer required for timber sourced from a plantation if the Minister for Primary Industries and Energy has approved a code of plantation practice for the State from which the wood is sourced. On 25 March 1997, following consideration of assessment reports prepared by the CSIRO and other relevant

information, the Minister approved the Victorian Code of Forest Practices for Timber Production, which covers both plantations and native forests, and associated procedures.

The Victorian Private Forestry Program and the Commonwealth Farm Forestry Program are implementing initiatives addressing the NFPS objectives on plantation resources. In addition, Commonwealth and Victorian legislation pertaining to plantation development has been reviewed. Victorian forestry rights were approved by Parliament in 1996 under the Victorian *Forestry Rights Act 1996*, providing for Forest Property Agreements between landowners and tree growers that give legal title for trees separate from the land. This allows investors to grow and harvest plantations on land under separate ownership, which promotes the trading of trees through a legal market.

The Victorian *Planning and Environment Act 1987* was amended in 1993 to include specific provision for timber production to facilitate plantation expansion on cleared privately owned land in accordance with the Code of Forest Practice. It also provides for establishment of forestry plantations up to 40 ha in some areas without a planning permit. Whilst this is not the case for all councils, it applies to the majority. State Planning Review Panels are developing recommendations for amendments to the planning provisions to allow true 'as of right' timber production (without an area limit) while providing for Council concerns over potential costs (CVFP 1999). Large plantations may be placed in areas consistent with local land-use planning regulations.

Plantations 2020 Vision

In 1996, the Ministerial Council on Forestry, Fisheries and Aquaculture (MCFFA) agreed to a national goal to treble the area of Australia's plantations by the year 2020. The Standing Committee on Forestry (SCF) was required to report on how the target might be accomplished. The SCF and industry have since formulated an implementation plan titled 'Plantations for Australia: The 2020 Vision', which was endorsed by the MCFFA in 1997 (MCFFA 1997).

The Vision states that:

By 2020, plantation forestry in Australia will be a sustainable and profitable long rotation crop with significant private sector investment.

The plantation growing and processing industries will:

- *operate in the global marketplace;*
- *be internationally competitive; and*
- *be commercially oriented, market driven and market focused in all their operations.*

Returning trees to the landscape as a profitable crop will also significantly benefit the environment.

To treble the 1996 plantation estate of one million hectares will require a national average of 80 000 ha per year of new plantations from 1996 to 2020. This compares with a national average expansion rate between 1960 and 1994 of around 25 000 ha per year and the recent increase of around 65 000 ha in 1998. Governments and industry will collaborate to create an environment that will attract private investment to implement the plantation program and enhance the growth of forest industries to contribute to the Australian economy, rural communities and regional development.

In 1996, the Victorian Government established a Ministerial Taskforce to develop a strategy for private forestry in Victoria aimed at increasing plantation development in Victoria, in line with the national 2020 Vision. The taskforce's report, *Towards a Victorian Private Forestry Strategy*, was presented to the Victorian Government in May 1997 and resulted in the

appointment of a Private Forestry Council (PFC) by the Minister of Agriculture and Resources. Its membership is taken from key stakeholders in the private and public sectors and members are appointed for three years. The Council's task was to develop a strategy and produce an implementation plan for achieving the target of the 2020 Vision (PFCV 1997). The taskforce report underpinned the preparation of the State strategy, *Private Forestry in Victoria: Strategy Towards 2020*, released in May 1998, which aims to guide the expansion of plantations on private lands from the 1996 figure of 250 000 ha to 750 000 ha by the year 2020.

The Strategy has six elements:

- achieving broad public support for private forestry — *embracing community support*;
- providing clear roles for state and regional bodies to facilitate private forestry — *forging better links*;
- identifying suitable land for commercial tree growing — *finding the commercial land base*;
- strengthening local government support for regional private forestry development — *developing the partnership with local government*;
- encouraging investment in private forestry — *recruiting capital into the sector*; and
- increasing the competitiveness of the private forestry sector — *gaining the competitive edge* (PFCV 1998).

Achievement of the vision will have benefits such as:

- increased investment in plantations infrastructure and processing;
- increases in regional jobs;
- increased farm incomes where private forestry is fully integrated with other agricultural enterprises;
- a change from a national trade deficit to a surplus in wood and wood products; and
- providing catchment protection and other environmental benefits.

Commonwealth Farm Forestry Program

The Commonwealth's Farm Forestry Program commenced in 1993. It aims to promote commercial wood production on cleared agricultural land and, where possible, the integration of plantation enterprises with other agricultural land uses.

Both the NFPS and WAPIS provide the framework for implementing the aims and objectives of the farm forestry program in relation to plantations. The key strategic aims are:

To develop and enhance regional farm forestry strategies, focusing in particular on industry development but also on integrating commercial tree growing activities with other land, water and vegetation management strategies.

Other actions that contribute to the aims of the program include the establishment of Regional Plantation Committees (including Central Victorian Farm Plantations Inc and Green Triangle Regional Plantation Committee); enhancement of communication and cooperation amongst all stakeholders; training and education; local government planning reform; and research into farm-forestry, including methods for on farm land suitability assessment, growth projections and inventory.

Through WAPIS, the Commonwealth Government has provided around \$17 million nationally for some 50 projects over the period of 1996 to 2000, including nearly \$5 million for 11 projects in Victoria.

The Natural Heritage Trust (NHT), which commenced in 1998, will implement programs with the intention of developing sustainable agriculture and natural resource management while protecting biodiversity. Under the NHT, the Commonwealth has provided \$22 million to enhance the Farm Forestry Program during 1997-98 to 2000-01. Nationally an additional \$14.5 million has been allocated to the Farm Forestry Program from Bushcare: National Vegetation Initiative to develop and promote commercial wood and non-wood products, especially where priority is given to biodiversity and land degradation issues, such as the use of native species in lower rainfall regions. Of the additional \$14.5 million Bushcare funds, \$0.65 million was allocated for projects in Victoria in 1997-1998, and \$0.97 million for 1998-99.

Central Victorian Farm Plantations Inc

Central Victorian Farm Plantations Inc (CVFP) was established as a WAPIS project in July 1996 under the Commonwealth Farm Forestry Program, with initial funding of \$0.5 million over four years and subsequent National Heritage Trust (NHT) extra funding of \$0.1 million for 1998-2000. The project is managed by the CVFP Committee comprising representatives of wood processing and agricultural industries, farm forestry and conservation networks, local government, regional catchment and regional development agencies, business/marketing interests and NRE.

The project's vision is:

The integration of commercial tree species into rural landscapes and farming systems to capture multiple benefits - agricultural, social, economic and environmental (CVFP 1999).

CVFP's goals include:

- development of the regional plantation resource, specifically on cleared agricultural land, with the target of trebling the present resource by the year 2020, from the 1997 benchmark;
- expansion of the local processing industry to help meet import replacement needs;
- development of localised farm plantation co-operatives and other suitable marketing bodies;
- development of co-ordinated and effective product marketing systems; and
- expansion of the export wood production market (CVFP 1997).

To achieve these goals, the Committee has identified the key objectives as:

- represent the interests of farm forestry and plantation stakeholders across the Central Victorian Region;
- develop a regional farm forestry and plantation strategy that recognises the opportunities and risks associated with the expansion of plantations on cleared agricultural land and ensures that such development is undertaken in a way that benefits local communities and has widespread community support;
- advise and liaise with government agencies and interest groups on matters relating to farm forestry and plantation development within the region and respond to issues as they arise;
- improve communication and understanding between existing and potential stakeholders of the issues pertaining to the establishment, management, utilisation and marketing of plantations; and
- encourage the development of a commercially viable regional farm forestry industry in a way that is sensitive to the environmental and social needs of the region (CVFP 1999).

The CVFP region in central and south west Victoria covers 14 local government areas with the majority in the eastern half of the West region. The CVFP region covers dryland areas with plantation potential and good growing conditions, especially in the south and north east of the region. Proximity to a range of major buyers and export facilities and a history of plantation management and associated industries are positive attributes towards plantation development. The Committee has produced a regional profile to further interest in 'farm forestry or institutional plantation development in this region' (CVFP 1999). A regional strategy document is in a draft stage. Actions needed to most effectively implement the CVFP goal of a trebling of the private forest resource from 1997 levels will also be addressed in the strategy.

Green Triangle Regional Plantation Committee

The Green Triangle Regional Plantation Committee (GTRPC) was established as a WAPIS project in July 1996 under the Commonwealth Farm Forestry program. The project is managed by a Committee comprising representatives of plantation growing interests, wood processing industries, farm forestry networks, local government State government and other interest groups.

The project's principal objective is:

To encourage and sustain a timber resource for the long term economic and environmental benefit of the Green Triangle Region" (GTRPC 1998).

In order to achieve this objective, GTRPC is promoting activities to:

- double the area of pine plantations;
- establish 100 000 ha of Blue Gum (*Eucalyptus globulus*) plantations;
- expand farm forestry to at least 10 per cent of farm area; and
- process a significant proportion of the resource in the region (GTRPC 1998).

The GTRPC region in south west Victoria and south east South Australia covers 10 Victorian local government areas in the western half of the West region. They cover dryland areas with established plantation potential and proven growing conditions, especially in the south west corner. Locational advantages include proximity to a port with export facilities, established and substantial wood processing industries, and a long history of plantation management that has resulted in communities adjusted to the plantation industry.

The Committee has produced three booklets; a Strategy Plan, a Landholder Document and an Investment Document. The Strategy is to achieve a target of 400 000 ha of plantations by 2020 through the involvement of farmers and other landholders, current commercial producers and processors, and investors.

Victorian Private Forestry Program

The major role of the Department of Natural Resources and Environment's (NRE) Private Forestry Program is to facilitate the development of the commercial private forestry sector. There are two main areas in the West region which have potential for plantation expansion; around Hamilton and Portland and to the west and north west of Geelong.

In addition to \$5 million from the Commonwealth Farm Forestry Program for 1996-2000, Victoria will provide at least \$5 million to enhance the uptake of farm forestry. These funds will support extension, demonstration, education and training, information gathering and dissemination, planning and coordination, practical research and development activities, including inventory of private forests, land capability assessment, and growth modelling.

With the release of the State Private Forestry Strategy in 1998, the Victorian Government allocated a further \$2.7 million for a range of initiatives including:

- sponsoring regional infrastructure studies;
- expanding the Timber Harvesting Plan accreditation process statewide to support local government;
- developing better regional market and technical information to assist new growers/investors;
- providing incentives for whole farm planning and plantation management training to landholders;
- staged establishment regionally of private forestry industry development officers as a one-stop shop to deal with inquiries from farmers and investors;
- providing further research and development resources to assess commercial and environmental outcomes of plantations; and
- marketing Victoria's potential as an excellent grower of forest products both domestically and overseas.

Another initiative of the NRE Private Forestry Program is to actively encourage landowners to incorporate tree establishment and management as regular farm activities to contribute towards the trebling of the plantation estate by 2020.

A further initiative is the Replanting Victoria 2020 - 'Carbon Cropping' project which offers eligible landowners the opportunity to invest in farm forestry and integrate forestry into the agricultural landscape as well as fulfilling an important objective of Catchment Management Authorities (CMAs) by contributing to improved catchments through supporting strategic revegetation. The aim is to promote the establishment of quality farm plantations, mainly in areas of greater than 700 mm/year rainfall; encouraging and supporting regional development; and generating greenhouse and other environmental benefits.

Social and Environmental Implications of Plantations

Past experiences with plantation expansion in farming landscapes have revealed both favourable and unfavourable perceptions of their socio-economic and environmental consequences (Spencer and Jellinek 1995). Therefore, plantation expansion under the 2020 Vision will require careful attention to these issues in the planning and implementation phases. Plantations affect different sectors of society in different ways and generate a variety of concerns according to individual and group perspectives. Economically, agriculture and forestry exhibit major differences in cash flows, but these can be evaluated through cost-benefit analysis (Trapnell and Lavery 1989). Environmentally, plantations can confer many benefits. However, in the past, land purchase by governments and corporations for plantation establishment has led to concern by some landholders and rural communities about:

- population decline, leading to loss of community services and erosion of local government rate bases;
- falls in land value; and
- costs of maintaining road networks.

To address the issues, the Victorian Government initiated a State Plantations Impact Study (SPIS), which resulted in a comprehensive report on impacts to stimulate discussions (Centre for Farm Planning and Land Management 1989), followed by a report (SPIS 1990) with 41 recommendations relating to plantation development and management on cleared agricultural lands, covering:

- current and future wood demand;

- procedures for land purchase;
- relative socio-economic benefits of forestry and agriculture;
- socio-economic impact;
- plantation share-farming;
- fire management;
- environmental impact of plantations; and
- hardwood plantations.

Many of these recommendations have been subsequently addressed, either directly or indirectly, through reforms to administrative and operational procedures stemming from the NFPS. For example, the Victorian Government's Code of Forest Practices for Timber Production (NRE 1996b) directs plantation development and harvesting in a manner consistent with the principles of environmental care and is designed to ensure that appropriate attention is given to environmental aspects.

In agricultural landscapes many socio-economic and environmental benefits can be gained from further plantation development, including:

- protection for soil and water values;
- groundwater management;
- waste water disposal;
- landscape improvement;
- crop and stock protection; and
- diversification of farm income.

Active involvement of farmers in such development can improve their understanding and support of plantations and encourage a sense of local ownership. This in turn can help to achieve expansion targets in ways that maximise community benefits and economic viability.

6.3 CURRENT RESOURCE AND MANAGEMENT

Current Resource

Softwood Plantations

There are some 250 000 ha of plantations in Victoria; 220 000 ha principally of radiata pine, and 30 000 ha of various eucalypts. Following the sale of the Victorian Plantation Corporation (VPC) plantation resources to Hancock Victorian Plantations in December 1998, effectively all plantations are in private ownership. This compares with a national average of approximately 36 per cent private ownership.

The West region encompasses the Central Victoria and part of the Green Triangle plantation regions; two of Australia's 15 softwood plantation regions identified in the National Plantation Inventory (NPI) (BRS 1997). The Central Victoria plantations are concentrated around Ballarat and the Otway Ranges, south of Colac, with outliers at Castlemaine, Mt Cole and The Grampians. The Green Triangle plantations straddle the Victoria-South Australia border, with most of the Victorian plantations being west of Heywood, Casterton and Edenhope.

The total area of plantations in the West region is approximately 92 300 ha, with about 35 100 ha in the Ballarat-Colac area and approximately 57 200 ha in the south west. In the Ballarat-Colac area the majority of plantations are owned by Hancock Victorian Plantations (HVP), Midway Pty Ltd, AKD Softwoods, Central Highlands Water, Calco and up to 10 smaller owners. In the south west HVP, Auspine Limited, Green Triangle Forest Products Limited, AKD Softwoods and some smaller firms are the major plantation owners. Softwood

plantations in this area have increased consistently over recent years, with generally an annual increase of around 600-1 200 ha of new plantations.

Current supplies to industries in the West region from these softwood plantations are estimated at 1 007 000-1 020 000 m³ of sawlogs, 149 000-161 000 m³ of roundwood for preservation purposes and 606 000-671 000 m³ for pulpwood. These figures exclude industry's estimate of the South Australian component of the Green Triangle resources.

Major regional sawmilling industries supplied from the Ballarat-Colac area are located at Colac (AKD Softwoods) and Lara (TASCO) whilst the Green Triangle supplies one Victorian mill at Dartmoor (Green Triangle Forest Products Limited). Additional supplies are provided to South Australian mills at Mount Gambier (Green Triangle Forest Products Limited, Carter Holt Harvey Ltd), Mt Burr (Carter Holt Harvey Ltd) and Tarpeena (Auspine Limited). Smaller sawmills are located at Ballarat (Central Highlands Timber), Marshall (Marshall Pallets), and Moolap (Geelong Box and Timber) and at Mount Gambier (Whitehead's Timber Sales, South East Pine Sales) in South Australia. The main products are used for house framing, structural grades, furniture, housing boards and packaging.

At least eight firms have preservation treatment plants for pine roundwood and sawn timber and are located at Colac (Shelton Timber Treatment Co Pty Ltd), Terang (Kamdas Treated Timber), Timboon (McVilly Timber), Heywood (Portland Pine Products), Beaufort (Beaufort Treated Timbers) and Bungaree (A Woodward Forest Products Pty Ltd) and outside the region in South Australia at Mount Gambier (Carter Holt Harvey Ltd) and Kalangadoo (Auspine Limited).

Residual roundwood is utilised for particleboard at Ballarat (Laminex Industries); and at Mt Gambier (CSR Timber Products), and for paper products at Millicent (Kimberly Clark Australia), both in South Australia.

Sawlogs and pulp logs from the region are also exported to Asia through ports at Geelong and Portland by Radiata Exporters Pty Ltd. In addition, softwood chips are exported through Geelong by SPE (Management) Pty Ltd and Midway Pty Ltd, and through Portland by Auspine Limited and Green Triangle Forest Products Limited for the Japanese market.

The region's softwood plantations are a mix of first, second and third rotation forests. Replanting of harvested areas uses enhanced silvicultural practices including cultivation, weed control, nutrition management and genetically improved cuttings or seedlings. Generally, the plantations are managed on a rotation of 28 to 35 years depending on location and the demand for different products from thinnings and final fellings by established and new customers. The introduction of the export woodchip market in the early 1980s, has enabled most plantations to be thinned.

The area of private plantations is increasing, with additions by small growers as well as large industrial plantation companies. Share farming, rather than outright land purchase, is becoming more common. The area of private plantations, especially small woodlots, is difficult to quantify at present. However, the situation is being addressed by the National Farm Forestry Inventory being developed by the Bureau of Rural Sciences.

Hardwood Plantations

Commercial forestry plantings of Blue Gum commenced in the late 1980s with a major focus in the Green Triangle region. There are currently about 27 000 ha of Blue Gum plantations, but the area is rapidly expanding. From an estate of around 1 500-2 000 ha in 1995, there are now about 26 000-27 000 ha with an estimated 85 per cent in the south west. The minimum sized plantations are 20-40 ha and shelterbelts of 60-100 m width are quite

common. In 1998, approximately 6 000 ha of Blue Gum plantation were established, which is expected to increase to 15 000-20 000 ha of new plantations in 1999. This expansion is occurring on cleared agricultural land and is being promoted by both companies and individuals involved in the establishment and/or management of new plantations. Most of the new plantations are being grown on a short rotation of 10-12 years to produce chips for export to Japan and other Asian markets.

The main Blue Gum plantings are within a marketable distance of 150-170 km from the export ports at Geelong and Portland respectively in areas where rainfall exceeds 600-700 mm per year. A variety of arrangements are used to establish the plantations, including:

- individual farmer or company owner-grower;
- cooperative of owner-growers ;
- share farming (where the land owner provides the land and may do a proportion of the work) with a set percentage of revenues at clearfall divided between the land owner and plantation investor;
- joint ventures (where the land owner does the management and a purchaser is guaranteed);
- purchased land through investment funds or prospectus company; and
- leased land either through investment funds provided by prospectus or by company funds.

There are about 20 firms involved in Blue Gum plantation establishment and management in the south west of the region, including Timbercorp Eucalypts Limited, Integrated Tree Cropping Limited, Green Triangle Plantation Forest Company of Australia Pty Ltd, Timber 2000 Pty Ltd, Midway Afforestation Limited and Great Southern Managers. Midway Pty Ltd is the most significant in the Ballarat area. Other companies have also expressed interest in both areas and new plantation firms are establishing each year.

Sugar Gum (*E. cladocalyx*) provides a significant historical form of eucalypt plantations in the region where extensive shelterbelts were established by direct seeding and have had a major impact on the landscape. A survey by the Corangamite Farm Forestry Network estimated that there are approximately 932 ha in the CVFP region. Sugar Gum was also extensively planted in the GTRPC region, but there is no reliable estimate of the overall resource. Sugar Gum and other dryland eucalypt species were established earlier this century for commercial timber production in the You Yang ranges, north of Geelong.

Plantation Management

Plantation management in Victoria must comply with the Code of Forest Practices for Timber Production (Code) (NRE 1996b). The Code provides Statewide goals and guidelines for plantation establishment and management, and a number of Statewide minimum standards (such as set back reservations along streambanks).

The Victorian Code and associated controls have been accredited by the Commonwealth Government as the basis for removing export controls on plantation products.

Compliance with the Code on private lands, including land licensed to HVP, is required through Planning Schemes administered under the *Planning and Environment Act 1987*. Monitoring of operations on these lands is the responsibility of local municipalities through their planning scheme provisions.

HVP acquired the perpetual rights to grow and harvest timber on licensed State-owned land for as long as the land use is restricted to plantation forestry and timber production. The company acquired the rights over approximately 168 000 ha, with a net plantation area of approximately 107 000 ha of softwoods and 8 000 ha of hardwoods. About 40 000 ha of softwood are in the Western (West region) zone and managed from Ballarat.

Currently, a document is being produced by the GTRPC, on behalf of the four Victorian Regional Plantation Committees titled *Guidelines for establishing and managing timber plantations in Victoria*. It will cover legislation, codes, plans, planning and approvals, site preparation, establishment, tending and harvesting. The guidelines will be endorsed by NRE, the PFC, the Municipal Association of Victoria and Australian Forest Growers. This document will complement a similar publication produced for South Australian plantations titled *Guidelines for establishing and managing commercial forest plantations in South Australia* (ForestrySA 1998)

6.4 PLANTATION POTENTIAL

Although the region has the physical capability to support a variety of species, only a few would be commercially appropriate for large-scale plantations. This is due to the availability of markets, which are strongly related to the composition of existing plantations in the region. Three species identified as having immediate commercial potential are Radiata Pine, Blue Gum and Spotted Gum (*Corymbia maculata*).

Land Capability and Suitability

Plantation land capability assessment identifies locations where the biological growth requirements of a species are satisfied (Bush *et al.* 1998). The capability of cleared private land in the eastern part of the West region for Radiata Pine, Blue Gum and Spotted Gum plantations has been assessed and mapped by CVFP (CVFP 1999). Of the 1 689 000 ha of cleared private land in the CVFP region, it was estimated that 360 000, 227 000 and 448 000 ha are suitable for Radiata Pine, Blue Gum and Spotted Gum plantations respectively. Further work is underway to more accurately define the productivity classes in terms of their potential mean annual increments (MAI).

No comparable land capability assessment work has been undertaken on behalf of the GTRPC, but various past estimates have been made for pine plantations (Stephens *et al.* 1998). For example, a study undertaken for the former LCC in 1982 (Allan and Associates 1982) for the Victorian section of the Green Triangle region concluded that there were considerable areas of private property that were both capable of growing pines and suitably located for industry, but suitability for hardwoods was not assessed. In addition, there may be other unpublished capability and suitability assessments prepared for a variety of investment purposes.

Land that is capable of growing commercial plantations may not always be suitable for this purpose. Land suitability analysis involves the integration of biophysical (i.e. land capability) and socioeconomic factors to determine the economic viability and social acceptability of using land for a particular use (Bush *et al.* 1998). In some instances, for example, there may be alternative uses that yield a superior economic return or the land may be too steep or too distant from processing plants to be suitable for commercial plantations. A plantation suitability analysis has not been completed for the eastern part of the West region, and is being considered by Central Victorian Farm Plantations Inc.

Economic Analysis of Land Suitability

Discounted cash flow analysis can be used to estimate the value of land for softwood and hardwood plantation development. These values are then compared to current land values in order to determine economic suitability.

It should be noted, however, that specific plantation investment proposals are a matter for commercial decision by corporations, companies and individuals, and need to be evaluated on a case by case basis after detailed resource and economic assessment.

Local and export markets for pine plantation products are generating pressures to expand the existing softwood estate into traditional farming areas. This expansion must now compete with the demands of new and anticipated markets for hardwood chips. The result is increased competition and prices for land suitable for plantations.

There is also considerable interest in Australia in growing hardwood plantations for sawlogs for high value products with appearance and strength properties that are superior to pine products.

The potential for expanding farm forestry or agroforestry is less dependent on the price of land and size of property. Landowners pursue small scale forestry activities for various reasons, including:

- environmental benefits — as part of a whole farm management strategy;
- relatively low maintenance in comparison to agriculture (attractive to absentee landlords);
- taxation purposes; and
- diversification of income.

6.5 PLANTATION OPTIONS

There are a number of options for establishing plantations in the West region. At one end of the spectrum, plantations could be established to augment the current large scale commercial investment, whilst at the other, farm-forestry, agroforestry and land protection may be feasible options in certain circumstances. Most softwood producers are expected to replant with second/third rotation plantations with a minor expansion to the current estate. However, the opportunity exists for increasing the area of softwood and hardwood plantations on private land on sites with suitable rainfall and soils, to supply products to existing and future industries.

The integration of farm forestry (agroforestry and land protection) into Australian farming systems contributes to:

- delivery of environmental benefits;
- diversification of agricultural enterprises;
- enhanced agricultural production;
- sustainable land management practices;
- land rehabilitation;
- habitat enhancement and biodiversity conservation; and
- aesthetic enhancement (RIRDC 1996).

Examples of broad options are represented in Figure 6.1 and outlined below.

Industrial or off-farm investor plantation options include:

- Sawlog-driven softwood plantation — close spacing, 2-3 thinnings for pulp or preservation and clearfelling for sawlogs at 30+ years;
- Clearwood sawlog-driven softwood plantation — high lift pruning operations, thinning to lower stocking for faster, increased diameter growth;
- Eucalypt pulpwood plantation — close spacing, short (10-20 year) rotation; and
- Eucalypt sawlog/veneer plantation — normal spacing, high pruning, thinning to lower stocking for faster diameter growth, on a medium (30-60 year) rotation.

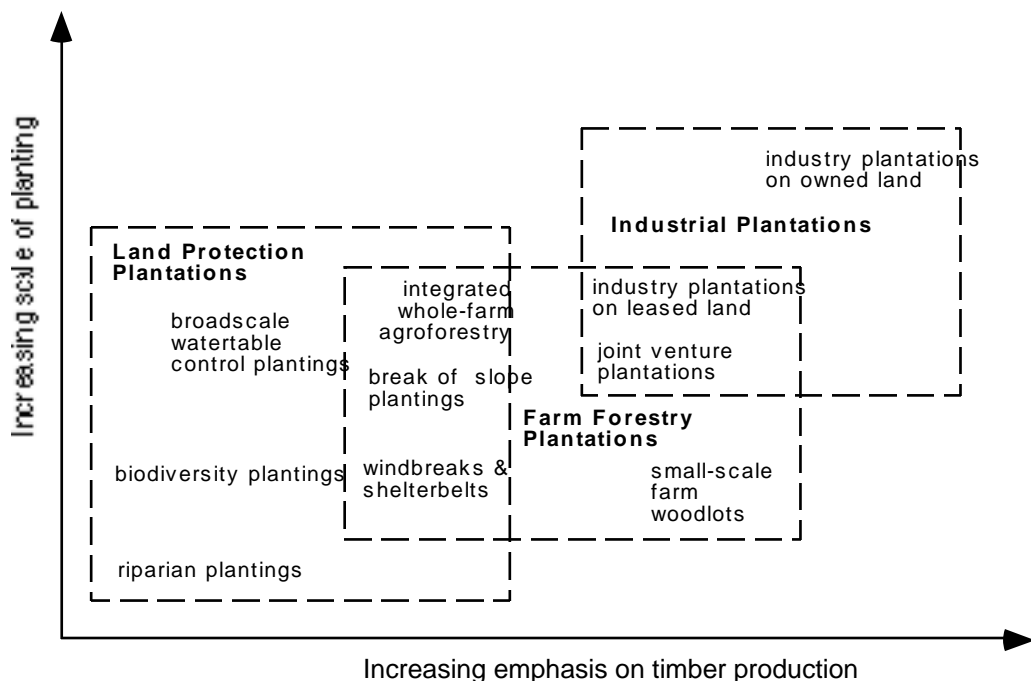
Farm forestry/agroforestry options, which are integrated with a property's agricultural pursuits and are applicable to both softwood and hardwood:

- Timberbelts — alley farming system managed for timber with pruning and thinnings, while providing shelter for agricultural land;
- Wide spaced trees pruned for clearwood with grazing or inter-cropping; and
- Woodlots (small plantations) with lots greater than 10 ha becoming more economically efficient — suited to joint venture arrangements or subject to Government funding initiatives (NRE 1997a).

NRE is promoting the planting of specialty timbers on farms in south west Victoria with a range of acacias, eucalypts, cypress and sheoaks having been planted in research and demonstration plots. The plots are being managed to produce high quality clearwood logs through pruning and thinning. Results to date indicate that the species best suited to the region include Spotted Gum, Sydney Blue Gum (*E. saligna*), Monterey Cypress (*Cupressus macrocarpa*), Mexican Cypress (*C. lusitanica*), River Sheoak (*Casuarina cunninghamiana*) and Black Wattle (*Acacia mearnsii*). NRE and local agroforestry networks are encouraging the planting of such species in small woodlots and shelterbelts in ways that integrate them into commercial farming systems. This activity is supported by Greening Australia, Glenelg-Hopkins CMA and the GTRPC.

As an adjunct to NRE's interest in specialty timbers, CVFP are conducting a study to investigate the feasibility of growing, processing and marketing a wide range of products from black wattle.

Figure 6.1: Plantation Options: Scale and Purpose



For plantation expansion to occur in the region, a number of elements need to be brought together; land, capital, expertise, and markets for plantation products. Plantations are, and will be, grown by a range of entities for a variety of purposes. Table 6.2, prepared by Gippsland Farm Plantations Inc, provides a general summary of the characteristics and needs of existing and future participants in the plantation industry (GFP 1997).

Table 6.2: Plantation Grower Characteristics and Needs

| Increasing scale → | | | | | | |
|-----------------------|---|-------------------------|--|-------------------------|--|-------------------------|
| Grower Type | Farmer | | Investor | | Industrial/Corporate | |
| Objectives | Income diversity Farm value Farm productivity | | Dollar return Income diversity Tax offsets | | If Grower only: Dollar return If Vertically Integrated Processor: Resource security Price control | |
| Characteristic | Own land | | Own capital | | Own capital | |
| Variations | Own capital | Other's capital | Own land | Other's land | Own land | Other's land |
| Needs | | Joint Venture agreement | | Joint Venture agreement | | Joint Venture agreement |
| | Establishment & silvicultural advice; Markets | | Establishment & silvicultural advice; Markets | | Markets, if not vertically integrated; Resource supplementation | |

Source: Gippsland Farm Plantations Inc. Business Plan 1997-2000 (1997)

7. OTHER FOREST PRODUCE

Forests of the West region supply a range of products and benefits in addition to the sawlog and residual wood discussed in Chapter 4. These include minor forest produce such as posts and poles, other hewn timber, firewood, wood chop blocks and specialty timbers, and uses including grazing and apiculture. The current economic values arising from these activities and future opportunities for other forest produce are described in this chapter.

Other forest uses include recreation and tourism; water production; and mineral exploration and mining (including extractive industries such as gravel and stone). These uses are discussed in Chapters 8, 9 and 10 respectively.

7.1 MANAGEMENT

Like larger scale sawlog and residual wood production, management for other forest produce is aimed at sustaining supply while minimising environmental impacts.

Management planning and supervision normally increase in relation to the potential impact of the activity, but with minor products, the large number of individual operators can have a significant impact on organisational overhead costs. As a result, costs of supervision may outweigh revenue raised from minor forest operations, e.g. domestic firewood collection. However, low returns to NRE should be considered in relation to the benefits gained by the wider community.

Activities associated with minor forest produce sometimes complement other forest activities, e.g. firewood collection following timber harvesting. Forest produce such as specialty timbers (Blackwood), stakes and round posts may be derived as by-products of harvesting or salvage operations. Other activities such as apiculture may be separate.

In the West region, the Otway (DCE 1992) and Midlands (NRE 1996a) Forest Management Plans provide further information on the management of State forest for the supply of other forest products.

7.2 PROFILE OF EXISTING SUPPLY, USAGE AND DEMAND

Minor Forest Produce

Much of the harvest for minor forest produce is undertaken under short-term, small quantity licences, issued to individuals for private and small-scale commercial use. Annual licences may be issued to commercial cutters for the production of posts, poles and firewood. Generally, areas from which minor forest produce is taken, including commercial firewood, posts and poles, are included in the wood utilisation planning process discussed in Chapter 3.

Licences are required for the removal of all minor forest products. Commercial cutters in State forest are required to hold a Forest Operator Licence, a Forest Product Licence and operations are subject to conditions set out in Forest Coupe Plans.

Total royalties received by NRE for commercial activities related to other forest produce in the West region was \$329 032 in 1996-97 and \$245 588 in 1997-98 (Table 7.1). This excludes revenue from grazing and apiary licences, which are discussed later in this chapter.

Table 7.1: Other Forest Produce Royalty Revenues, West Region

| Product | 1996-1997 | 1997-1998 |
|---------------------------------|------------------|------------------|
| | \$ | \$ |
| Hewn timbers | 84 | 3 327 |
| Bush sawn/Split timbers | 6 356 | 10 643 |
| Round timbers | 2 625 | 3 903 |
| Stakes and props | 0 | 760 |
| Craftwood and specialty timbers | 502 | 585 |
| Wood-chop blocks | 2 496 | 1 651 |
| Firewood | 313 999 | 223 840 |
| Poles | 2 824 | 71 |
| Seed capsules/extracted | 118 | 808 |
| Other | 28 | 0 |
| Total | 329 032 | 245 588 |

Source: NRE Annual Reports 1996-97 and 1997-98; Other may include eucalyptus oil, sleepers or floral arrangement material.

Firewood

Firewood licences sold in the West region during 1997-98 returned \$223 800 in royalties (Table 7.1), which was for approximately 33 200 m³.

There is significant demand for firewood from domestic users in the West region, particularly close to urban centres such as Melbourne, Geelong, and Ballarat. Numerous other towns including Bacchus Marsh, Colac, Horsham, Hamilton, Warrnambool and Portland, and rural users across the region also have high demand for firewood. In addition, firewood is supplied to towns outside the region such as Mt Gambier.

Firewood is supplied from designated areas of State forest, Shire roadsides and private property, including areas associated with private plantation establishment. Durable timbers such as River Red Gum (*Eucalyptus camaldulensis*), Yellow Gum (*E. leucoxydon*) and box species are often preferred by firewood collectors because of their higher density. These durable species are generally collected from forests in the north of the region, close to Ararat, Horsham and Casterton and in the Pyrenees State Forest. Other species utilised include Messmate (*E. obliqua*), Brown Stringybark (*E. baxteri*), Scentbark (*E. aromaphloia*), Manna Gum (*E. viminalis*), and peppermint and other foothill forest species collected from State forests near Colac, Portland and Heywood, and in the Wombat, Scarsdale and Enfield State Forests.

Many firewood-collection areas are open to the public during the drier months of the year, and some suitable sites are open all year. Firewood can be supplied from:

- residual material remaining after normal timber-harvesting operations;
- salvage operations, following for example, wild fire;
- thinning operations;
- timber stand improvement works; and
- timber on the ground throughout areas of State forest, some regional reserves and roadsides.

In all areas, firewood must be collected from material on the ground, as private firewood collectors are not permitted to fell trees.

Over 100 commercial cutters regularly remove firewood from State forest across the West region. Commercial cutters collect firewood from logging residues following sawlog harvesting or during thinning operations.

The management of firewood collection may require input to address issues such as the provision of winter access, minimisation of road damage, supervision of firewood cutters, marking of areas available for collection, operator and general public safety, and licence and fee collection. The timing of regeneration burns in harvested areas available for firewood collection is another important consideration, to ensure removal of as much of the resource prior to regeneration of the stands.

Posts, Poles, Round Timbers and Other Hewn Timbers

While a number of commercial cutters supply posts, poles and other hewn timbers to the local market, some landowners have traditionally met their own requirements under licences issued over nearby forest. Provision of post and pole material varies across the region depending on the availability of durable species in some locations. River Red Gum, box and other durable species and Messmate from low foothill forests and woodlands are utilised from State forest and private property. Fluctuations in availability and demand for hewn, bush sawn/split or round timbers and poles are reflected in the revenues detailed in Table 7.1.

Limits on the area cut or volumes of minor produce harvested have been introduced in parts of the region, particularly in smaller forest areas around Geelong and in the Pyrenees State Forest.

Specialty Timbers and Craftwood

Species such as River Red Gum, Blackwood (*Acacia melanoxylon*), Satinwood (*Phebalium squameum*) and Cherry Ballart (*Exocarpos cupressiformis*) produce timber with attractive colour and figure, making them sought after for use in, for example, furniture manufacturing and woodturning. Burls and fiddleback stumps from trees removed for log production are also sought after by woodturners. Small amounts of these timbers may become available during sawlog harvesting, reforestation operations or road construction, and are generally sold by tender or licence. Craftwood licences are issued for smaller quantities.

In the West region, the market for specialty timbers is small, and is variable depending on the availability of suitable species. Specialty timbers and craftwood, with the exception of Blackwood in the Otway Ranges, are generally obtained by small sawmillers, local producers and individuals.

Blackwood sawlogs are an important specialty timber resource of mountain forests in the south of the region. In the Otway Forest Management Area (FMA), these sawlogs are generally a product of normal harvesting operations. Blackwood sawlogs are also produced from a program of Mountain Ash reforestation of former farmland in the Otway Ranges. In 1997-98, approximately 1500 m³ of Blackwood were sold under sawlog licences from this FMA; the revenue of \$115 200 accounts for nine per cent of the FMA's sawlog royalties. Revenue from Blackwood is considered in the discussion of sawlog royalties from the region in Chapter 5.

Grazing

Sheep grazing has a long association with public land in the West region, dating back to the mid to late 1800s. Grazing activities are carried out throughout the year and usually as an adjunct to private property. Graziers must obtain a licence to graze cattle or other livestock on public land. Currently, over 1 000 grazing licences are issued in the West, as shown in Table 7.2. These licences are issued subject to conditions in accordance with the relevant legislation

under which the land is managed, namely the *Land Act 1958*, *Forests Act 1958*, *Wildlife Act 1975* and *National Parks Act 1975*. A large number of these licences, approximately 90 per cent, are issued for grazing under the *Land Act 1958*, which covers unreserved public land such as unused roads and water frontages (Table 7.2); these areas are not necessarily forested. Licences issued under the *Forests Act 1958* are bush grazing licences and are generally issued for a 12 month period. Conditions to all licences usually include restrictions on the number of stock, access dates and transfer of these licences.

Near Ballarat, Colac and Geelong, grazing on forested public land is mostly restricted to small allotments on the edge of townships. However, larger areas of Red Gum forest near Balmoral, Woohlpooer and on the western Black Range are used for grazing sheep for wool production. Although demand for public land in the north west of the region remains high, many areas traditionally used for grazing are unavailable under current management practices, which encourage the regeneration of Red Gum forests. Some of these areas are available for periodic agistment while many may become available for grazing on a continuing basis.

Grazing on public land may be economically significant for individual farmers, supplementing grazing on freehold land, although it is not possible to quantify the contribution that public forests make to agricultural industries.

Grazing licences issued in the West during 1997-98 returned \$175 700 in royalties to NRE.

Table 7.2: Number and Area (ha) of Grazing Licences Currently Issued in the West Region

| Licence Type | No. | Area (ha) |
|--------------------------------|-------------|-----------|
| <i>Land Act 1958</i> | 972 | 12 550 |
| <i>Forest Act 1958</i> | 53 | 6 730 |
| <i>Wildlife Act 1975</i> | 54 | 3 000 |
| <i>National Parks Act 1975</i> | 5 | 25 |
| Total | 1084 | 28 |

Source: NRE Land Information Management System (LIMS), February 1999.

Apiculture

Apiarists use forests of the West region for honey production. Eucalypt forests including species such as Yellow Box (*E. melliodora*), Yellow Gum (*E. leucoxylon*), River Red Gum, Messmate, Brown Stringybark, Manna Gum, Red Box (*E. polyanthemos*) and Red Stringybark (*E. macrorhyncha*) are particularly valuable. Other shrub and understorey species including tea tree, banksia and heath vegetation also provide useful nectar sources. In addition, conditions found in warm coastal areas in the West region make them suitable localities for over-wintering hives (LCC 1972).

Many apiarists monitor flowering patterns, shifting their hives to take advantage of the different flowering times of various species. As flowering declines at one site, hives are moved to another site where flowering is at its peak due to different species and/or site conditions. When conditions are highly favourable, apiarists may bring hives from other regions into the West region. However, a proportion of forest in the region is not used by beekeepers, primarily due to poor access, inappropriate site conditions or unsuitable flora. Within the West region, apiaries are excluded from areas proclaimed under the *Reference Areas Act 1978*. Beekeeping is permitted in State forest except where it conflicts with specific uses or management aims.

Apiculture on public land is controlled through the issue of annual licences for annual sites and temporary permits (three and six months) for temporary bee sites. Licences and permits

allow access to a site for locating hives and use of forest nectar and pollen resources within a radius of 1.6 km or 0.8 km for annual and temporary sites respectively. Currently, there are 108 annual bee sites and 434 temporary bee sites licensed in the West region (Table 7.3). There are numerous other temporary sites in the region, which are not currently licensed.

Table 7.3: Licensed Bee Sites in the West Region

| Land Tenure | Annual | Temporary | Total |
|--------------------------------|------------|------------|------------|
| <i>Land Act 1958</i> | 35 | 130 | 165 |
| <i>Forest Act 1958</i> | 73 | 224 | 297 |
| <i>National Parks Act 1975</i> | - | 80 | 80 |
| Total | 108 | 434 | 542 |

Source: NRE Land Information Management System (LIMS) February 1999

In 1997-98, NRE received approximately \$38 000 in royalties from apiary licences and permits in the West. However, these royalties represent only part of the economic value derived from beekeeping activities. Honey is the major product of the Victorian apiary industry, of which approximately half is exported. Other produce includes beeswax, pollen and royal jelly. Pollination of food and seed crops is an external benefit of apiculture. It has been estimated that increased food and seed crop production through pollination is approximately \$251 million in Victoria (Gibbs and Muirhead 1997).

The West region contributes a considerable part of Victoria's honey production. It is not possible to quantify the contribution that public forests make to this industry, although it is considered to be significant. However, according to Gibbs and Muirhead (1997) eucalypt species represent the bulk of available honey and pollen resources for Australian honeybees.

Other Produce

Presently there is low demand for other forest produce such as floral arrangement material, eucalyptus oil, tea-tree stakes, sawdust, bark and live plant specimens. Protected flora species can only be taken from public land by permit under the *Flora and Fauna Guarantee Act 1988*. A permit for harvesting of minor forest produce and payment of a royalty are usually required.

NRE provides suitable material to the organisers of wood chopping events. Mountain Ash (*E. regnans*), Messmate or other non-durable species are preferred for woodchop blocks. The market for this product is unlikely to increase in the future.

NRE employs contractors to collect seed for regeneration of logging coupes. In addition, quantities of seed are collected by private companies and other organisations under permit and a royalty is paid by capsule weight.

7.3 OUTLOOK AND DEVELOPMENT OPPORTUNITIES FOR OTHER PRODUCE

Minor Forest Produce

Due to the close proximity and size of the potential markets for minor forest produce in the West region, the demand for produce could increase in the future. However, supply of some products such as specialty timbers and seed depends on their availability. The demand for other products is affected by competing products, e.g. hardwood posts and poles compete with treated pine and steel products for market share. The product with the most potential for increased production in the West region is firewood.

Firewood

Steady growth in demand is expected with the increasing number of domestic wood burning stoves and heaters being installed in homes. While the long-term demand for fuel wood is linked with the price and availability of major energy sources such as natural gas, the demand for firewood is expected to continue to increase in line with population growth.

Residual timber remaining after timber harvesting operations is currently underutilised and opportunities exist for commercial operators to harvest firewood from State forests for sale in local, Melbourne and interstate markets. Firewood collection operations may also benefit silvicultural operations through reducing harvesting residue or by using products from thinning operations. However, demand for Red Gum and other durable species is expected to remain high, as a strong preference for these timbers exists in larger markets such as Melbourne, Adelaide and regional markets.

Future reduction in the availability of durable species from private property, due to native vegetation retention controls, has the potential to increase the demand for firewood from public land.

Specialty Timbers and Craftwood

At present, only small amounts of specialty timber species, other than Blackwood, become available through normal forest operations in the West region. Across much of the region, supply of these species is generally linked to the extent of sawlog harvesting operations; therefore, a significant increase in availability is not possible.

Demand is, however, developing for River Red Gum craftwood in the Horsham area, for specialty furniture timbers. Specialty timbers from this species are a product of sawlog operations and single tree selection. Strong demand for Blackwood is also expected to continue.

With forecast increases in population growth and economic activity, it is likely that market opportunities for specialty grade timbers will increase.

Grazing

Grazing of domestic stock on public land provides direct agricultural benefits to producers. In the West region, demand for grazing public land is likely to continue at the current scale.

Apiculture

Roads developed for timber production and other purposes potentially increase access to areas of State forest for beekeeping. However, due to the preference for particular forest tree species and access to suitable apiary locations, it is expected that current levels of demand for access to public land are likely to continue.

8. TOURISM AND RECREATION

8.1 INTRODUCTION

The West region provides a range of opportunities for natural and cultural experiences for which the region's forests, coasts, rivers, lakes and ranges provide an important focus. The region is characterised by a wealth of attractions, including the Grampians and Port Campbell National Parks, and historic goldfields.

The region offers a combination of natural and developed tourism attractions for visitors to experience. Public land in the West region provides the basis for a diverse range of recreation activities including bushwalking, picnicking, fishing, surfing, diving, forest drives, camping and four-wheel driving. Developed attractions including the goldfields, mineral springs and wineries add to the overall appeal of the region. The coastal environment includes the Twelve Apostles, shipwreck sites and high limestone cliffs.

The tourism and recreation industries provide an important contribution to regional economies throughout Australia. In 1995-96, tourism and recreation (calculated as the sum of cultural and recreational services, and accommodation, cafes and restaurants) contributed around 3.8 per cent (\$4.2 billion) of Victoria's gross state product (ABS 1996). For the same period, employment in the recreational, personal and other services accounted for 7.5 per cent, or 142 900 people in the State.

In 1995-96, cultural, recreational, personal and other services employed over 21 148 people or 7.6 per cent of the total employment in the West region. This does not, however, include the contribution of tourism and recreation to the retail and wholesale industries. Combined, these industries were the largest employer in 1995-96 in the West region, employing approximately 76 651 people, or 27.5 per cent of the total workforce (ABS 1996). Overall, retail and wholesale industries contributed 13.8 per cent of Victoria's gross state product for the same period (ABS 1996).

Tourism is significant to the local economies of many centres in the region. Visitor expenditure along the Great Ocean Road is estimated to be in excess of \$458 million annually (CVTC 1996). In Geelong, Lorne, Warnambool and other towns along the coast, significant investment has been made in facilities for accommodation and entertainment to capitalise on this expenditure. Elsewhere, attractions celebrating Ballarat's goldmining history, including Sovereign Hill and associated Gold Museum, attract over 1.3 million visitors to the region each year. Sovereign Hill is Victoria's premier theme park and visitors to this attraction annually spend \$12.7 million (Tonge and Associates 1997a). The Hepburn Spa Resort near Daylesford attracts 155 000 visitors each year while tourism in the Macedon-Daylesford region directly employs 1335 people and contributes \$47.4 million into the region's economy (KPMG 1997).

Regional Tourism Development Plans have been prepared for the 13 tourism regions across Victoria. These plans are strategically important in the economic development of the region, and to the improvement of marketing and product development in the tourism industry. The Goldfields (Tonge and Associates 1997a), Great Ocean Road (CVTC 1996) and Grampians (Tonge and Associates 1997b) tourism development plans cover the West region and provide a guide to the tourism industry in the region. These plans consider natural attractions such as the Grampians and those along the Great Ocean Road as being nationally and internationally significant, and that destinations across the region offer some of Victoria's highest quality nature-based experiences, Aboriginal and European cultural heritage, and special-interest products.

8.2 OVERVIEW OF TOURISM AND RECREATION IN THE WEST REGION

Tourism Victoria defines a 'visitor' as an Australian resident or international visitor undertaking a trip within Victoria. A 'trip' is a tourism journey within Victoria and a 'visit' is a stay of one or more nights to a place during a trip. A 'day tripper' is a Victorian resident undertaking a day trip within Victoria (Tourism Victoria 1996a).

In 1995 over 3.5 million visitors spent a total of 10.5 million visitor nights in the West region (Table 8.1). The majority of these, 2.42 million visitors, visited attractions along the Great Ocean Road. It is the most popular tourist destination outside Melbourne, with 15 per cent of all visitors to Victoria travelling this route.

Table 8.1: Characteristics of Visitors to the West Region, 1995

| Visitor Origin | Per cent |
|---|------------------|
| Melbourne | 47 % |
| Country Victoria | 34 % |
| Victoria (total) | 80 % |
| Interstate | 18 % |
| International | 2 % |
| Total Visitors | 3 508 000 |
| Average length of visit-nights (all visitors) | 3.0 |
| Average expenditure | |
| Per Visitor Night | \$40 |
| Per Trip | \$119 |

Source: Tourism Victoria (1996a); Note: numbers have been rounded and as such may not sum to totals.

Melbourne is the region's major visitor origin, which affects visitor characteristics across the region. Visitors to the Grampians, which is around three hours drive from Melbourne, tend to stay longer on average (3.6 nights) than in other areas of the West region. In comparison, visitors to attractions closer to Melbourne such as those at Ballarat, Macedon and Daylesford spend an average of only 2.4 nights in the region, the lowest level in Victoria. A high proportion of interstate visitors is also attracted to the Grampians, with 24 per cent of all visitors to this area from interstate.

The majority of visitors to the West region are on holidays, with approximately 60 per cent of visitors travelling for this purpose.

Visitors to the West region in 1995 spent around \$412 million, mostly on accommodation, food and transport. Although visits to the Goldfields region are short, the average expenditure per visitor night of \$46 is the highest trip expenditure outside Melbourne. This expenditure is due to the provision of a wider range of developed tourism attractions that encourage visitation. Low expenditure in other areas of the West region is a reflection of the large number of visitors travelling to the region for day trips (e.g. Great Ocean Road) and visiting parks or forests (e.g. the Grampians National Park) (CVTC 1996).

Driving to sightsee or for pleasure is a popular activity, with more than half of all visitors to the West region participating in this activity (Table 8.2). Natural attractions, including forests, provide the basis for activities such as bushwalking and visiting national parks or forests, which are undertaken by one third of all visitors to the region. These activities are particularly popular with visitors to the Grampians where 68 per cent of visitors to the area drive to sightsee, 64 per cent visit a national park or forest, and 58 per cent participate in bushwalking. Swimming, diving and surfing are popular along the Great Ocean Road.

Table 8.2: Most Popular Visitor Activities in the West Region, 1995

| Activity | Visitors participating % |
|-----------------------------------|---------------------------------|
| Drive to sightsee/pleasure | 53 |
| Shopping | 49 |
| Restaurants/dining out | 46 |
| Visit friends and relatives | 42 |
| Visiting national park/forest | 31 |
| Bushwalking | 29 |
| Visit a museum or historic site | 22 |
| Visit an art gallery/craft centre | 21 |
| Swimming/diving/surfing | 18 |
| Visit a park or garden | 17 |

Source: Tourism Victoria 1996a. Note: percentages may not add up to 100 as visitors may have participated in more than one activity.

During the same period, 4.52 million day trippers visited attractions in the West region, spending a total of \$163.7 million, or an average of \$40 per trip. The average day trip expenditure in the Grampians area, \$50 per trip, is the highest spending by day trippers in Victoria (Tourism Victoria 1996b). Ballarat, Daylesford and coastal attractions are the most popular day trip destinations, visited by more than 20 per cent of all Victorian day trippers.

The most popular activities for day trippers in the West region are visiting friends and relatives (36 per cent), shopping (31 per cent), picnicking (18 per cent) and driving to sightsee or for pleasure (16 per cent) (Tourism Victoria 1996b).

Tourism and recreation in the West region are generally focused on the natural environment, with adventure and recreation activities, touring and heritage being the region's main tourism products. Public land across the region provides the basis for many activities, and Port Campbell and the Grampians National Parks are the major tourism destinations in the region; each receive four times more visitors than each of Australia's most well-known national parks — Uluru and Kakadu (Tonge and Associates 1997b). The Rocklands Reservoir and Lake Fyans are also significant attractions, providing for nature-based activities such as camping, water skiing and fishing. The Glenelg and Lerderderg Rivers are also popular locations for water-based recreation activities.

Other natural attractions in the region are internationally renowned. Rock climbing and abseiling sites in the Mt Arapiles-Tooan State Park are recognised worldwide and the level of climbing activity on Mt Arapiles is steadily increasing (Tonge and Associates 1997b). Overseas, Bells Beach is one of the most well known Australian surf beaches, with competitions attracting international publicity. Other popular beaches in the region are at Port Fairy, Lorne and Warnambool.

A number of vehicle-based touring routes have been developed in the region including the Goldfields and Historic Shipwreck Trails that link historic attractions. Part of the Major Mitchell Trail, Victoria's first long distance (2100 km) cultural trail, crosses the West, retracing the journey of Mitchell and his party.

In the Portland area, the Great South West Walk passes through areas of park and State forest, following the Glenelg River and Discovery Bay.

Seasonal variation in visitor numbers is evident in the West. January to March is the most popular time for visitors to the coast and the Grampians. In contrast, April to June are the most popular months for visitors to the Goldfields. Most day trips to the region are, however, undertaken in the summer months. The variation in visitation across the region may reflect the available activities and tourism features in different parts of the region.

8.3 TOURISM AND RECREATION ON PUBLIC LAND IN THE WEST REGION

Areas of public land in the West region, such as the Grampians and Port Campbell National Park, are some of the most popular natural attractions in Victoria. In the region, both State forest and parks and reserves are popular and complement each other as visitor destinations. Major attractions on public land in the region include:

- the Grampians National Park for camping and bushwalking;
- Mt Arapiles for rock climbing and abseiling;
- the Twelve Apostles and other attractions in the Port Campbell National Park;
- the Glenelg, Wimmera and Wannon Rivers, and many other rivers and streams, which are popular for fishing, canoeing and rafting;
- Lake Elizabeth, Triplet Falls and Sabine Falls in the Otway State forest;
- Rocklands Reservoir, Lake Fyans and Lake Merrimu for boating and water-skiing;
- mountain biking, and two-wheel and four-wheel driving opportunities on roads and tracks throughout the region;
- a variety of forested landscapes used for camping, horse riding, bushwalking and nature observation;
- relics of Aboriginal heritage, mining, grazing and timber production across the region; and
- the mineral springs near Daylesford.

Tourism has been widely advocated as an industry for regional economic growth as the West region has a diversity of natural resources. National Parks and State forests contribute to the overall attractiveness of the region as significant tourist destinations. However, there are some differences in the recreation opportunities available in National Parks compared with State forests. The types of activity that occur in individual parks and forests are largely governed by regulations, which vary with tenure, and the management plans for the park, reserve or forest. There are generally tighter constraints placed on recreation and tourism in National and State Parks in comparison with State forests.

Regional Tourism Boards coordinate tourism promotion, including the distribution of promotional material. Membership of these Boards is drawn from local tourist operators, business, and local and State Government representatives. Parks Victoria has membership on behalf of NRE on some of these Boards and liaises with them, local tourism associations, municipalities and Tourism Victoria to promote attractions in the region. Information about NRE facilities and recreational opportunities is made available to the Regional Tourism Boards for inclusion in tourism promotion activities.

NRE and Parks Victoria play major roles in the development and promotion of public land in the West region as a tourism and recreation destination. A wide range of information is provided for school groups and the general public for educational and promotional purposes. A number of education and information centres provide a basis for interpretation and activities, and numerous pamphlets, guides and brochures provide information on facilities and activities in individual areas.

Tourism and Recreation in National Parks and Reserves

Land reserved under the *National Parks Act 1975* is managed to preserve and protect flora, fauna and other natural features, and to provide appropriate opportunities for enjoyment by visitors.

Visitor numbers to parks in the West region are shown in Table 8.3. A 'visit-day' is defined as a person staying in a protected area for a day or part day; each overnight stay counts as an additional visit day.

Table 8.3: Visitation to Parks in the West Region Managed under the National Parks Act
Total Visit-Days ('000) 1989 – 1998 ^(a)

| Park | 1989-90 | 1990-91 | 1991-92 | 1992-93 | 1993-94 | 1994-95 | 1995-96 | 1996-97 | 1997-98 |
|-------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Brisbane Ranges NP | 88.5 | 91.3 | 106.7 | 103.3 | 77.0 | 84.0 | 70.3 | 89.8 | 106.4 |
| Grampians NP | 1 656.3 | 1 587.4 | 1 655.3 | 1 430.0 | 1 709.0 | 1 444.2 | 1 468.9 | 1 509.4 | 1 228.3 |
| Lower Glenelg NP | 65.5 | 79.1 | 75.7 | 61.6 | 65.8 | 89.0 | 227.0 | 222.5 | 183.2 |
| Mount Eccles NP | 15.1 | 28.2 | 29.3 | 22.1 | 26.0 | 27.3 | 33.1 | 18.1 | 31.5 |
| Mount Richmond NP | 17.0 | - | 16.9 | 16.0 | 16.0 | 13.1 | 24.9 | - | n/a |
| Otway NP | 73.9 | 65.0 | 67.0 | 100.0 | 159.1 | 231.0 | 248.6 | 388.4 | 432.7 |
| Port Campbell NP | 399.4 | 987.5 | 927.9 | 900.0 | 743.0 | 806.1 | 775.4 | 1 062.3 | 1 533.0 |
| Angahook-Lorne SP | 210.3 | 186.8 | 256.0 | 260.0 | 426.0 | 400.0 | 372.3 | 367.2 | 539.5 |
| Black Range SP | 15.0 | 14.4 | - | - | 8.0 | - | 1.0 | - | 1.7 |
| Cape Nelson SP | 10.9 | - | 8.6 | 9.0 | 9.0 | - | 8.3 | 1.2 | n/a |
| Cape Nelson LS | - | - | - | - | - | - | - | - | 1.1 |
| Carlisle SP | - | - | - | - | - | - | - | - | 1.7 |
| Dergholm SP | - | - | - | - | - | - | - | - | 0.6 |
| Enfield SP | - | - | - | - | - | - | 4.5 | - | 1.7 |
| Langi Ghiran SP | 10.7 | 7.7 | 7.7 | 3.6 | 3.8 | 3.8 | 4.0 | 4.0 | 4.8 |
| Lerderderg SP | 86.9 | 26.0 | 8.7 | 108.5 | 150.9 | 171.0 | 188.6 | 196.1 | 122.9 |
| Mount Arapiles-Tooan SP | 71.0 | 64.0 | 116.8 | 120.0 | 126.5 | 122.3 | 124.0 | 140.0 | 136.7 |
| Mount Buangor SP | 18.8 | 24.0 | 25.2 | 16.5 | 17.0 | 16.5 | 19.9 | 19.9 | 20.8 |
| Mount Napier SP | - | - | - | - | - | - | - | 60.0 | n/a |
| Werribee Gorge SP | 14.0 | 6.4 | 6.5 | 32.0 | 29.6 | 25.3 | 24.7 | 14.1 | 15.0 |
| Bay of Islands CP | - | - | - | - | - | - | 457.8 | 581.4 | 511.0 |
| Discovery Bay CP | 106.6 | 103.0 | 103.0 | 100.0 | 106.0 | 100.0 | 38.1 | 33.6 | 22.5 |
| Steiglitz HP | 39.6 | 30.6 | 30.6 | 35.5 | 38.4 | 29.2 | 34.5 | 35.7 | 40.5 |
| Woodlands HP | 74.6 | 84.9 | 107.6 | 105.7 | 133.8 | 112.9 | 80.4 | 80.4 | 87.5 |
| Total | 2 974.1 | 3 386.3 | 3 549.5 | 3 423.8 | 3 844.9 | 3 675.7 | 4 206.3 | 4 824.1 | 5 023.1 |

Source: Parks Victoria unpublished data (1998); NP = National Park, SP = State Park, HP = Historic Park; CP = Coastal Park, LS = Lightstation (a) Figures have been rounded

Across Victoria, land managed under the *National Parks Act 1975* received approximately 12.3 million visit days in 1997-98, of which approximately 41 per cent were to parks in the West region. The Port Campbell National Park, attracting 12 per cent of visits to all parks and reserves in Victoria in 1997-98, and the Grampians National Park (10 per cent) are the most popular parks in the region. Many visitors also enjoy other parks and reserves in the West region. Approximately 360 000 visits are made each year to the Tower Hill State Game Reserve, and the Macedon and You Yangs Regional Parks.

Activities in the region's parks and reserves include picnicking, camping, fishing, bushwalking, nature observation, horse riding, rock climbing, rafting/canoeing, cycling, and four-wheel and pleasure driving. Coastal parks also provide the setting for activities such as boating, sailing, swimming, surfing and diving. In some cases and under special conditions,

organised or competitive events, such as foot races, rogaining and orienteering, may be permitted in some areas.

In order to preserve the natural environment in parks and reserves, recreation activities are managed with the general aim of minimising impacts on the environment. Park regulations and management plans specify which activities are permitted in Parks. General restrictions also apply across National Parks, including the prohibition of pets such as cats and dogs. Voluntary codes of practice have been developed in association with user groups for activities such as horse riding, bush camping, trail bike and mountain bike riding, and bushwalking.

Management zones and overlays are designated in management plans to provide a geographic framework in which to manage a Park. Zones indicate which management objective has priority in different parts of the Park. The six primary zones are reference, wilderness, conservation, conservation and recreation, recreation development and education. The zoning system is designed to reduce conflicts between various types of visitor use and protection of other park values. Overlays are used to reinforce or modify the management of the underlying zone and can include land use designations to provide for legislative requirements, special protection areas or special management areas.

Tourism and Recreation in State Forest

Read Sturgess and Associates (1995) estimated that State forests in the West region attract around 720 000 visitor days per year (Table 8.4). Of these, State forests in the Midlands Forest Management Area (FMA) account for 56 per cent of the visits. However, based on the method used to estimate visitor usage, the authors consider it is likely that visitor numbers are underestimated, particularly those for the Otway FMA.

State forests are popular for activities such as picnicking, forest drives, four wheel driving, horse riding, trail bike riding, mountain bike riding, bushwalking and nature observation. Forests in the Midlands FMA are close to large population centres at Ballarat, Geelong and Melbourne, making them popular destinations for forest recreation. Resulting from this proximity, 30 per cent of all visitors to State forests in the West visit the Midlands FMA for a day trip.

In the more remote areas of State forest, camping is popular. In the Horsham FMA, around 75 per cent of forest use is by campers, generally in State forest surrounding the Rocklands Reservoir. Read Sturgess and Associates (1995) identified this area as one of the most popular areas of State forest in Victoria. Visitors to the Rocklands Reservoir are generally attracted to the area by the water-based activities. Other lakes and rivers in State forest are also commonly used for fishing and boating.

Table 8.4: Recreational Usage of State Forest in the West Region, 1994-95

| Forest Management Area | Day Visitors | Campers | Disperse^(a) | Total Number of Visitor Days |
|-------------------------------|---------------------|----------------|-------------------------------|-------------------------------------|
| Horsham ^(b) | 46 000 | 145 000 | 2 000 | 193 000 |
| Midlands | 223 000 | 22 000 | 160 000 | 405 000 |
| Otway | 24 000 | 15 000 | 16 000 | 55 000 |
| Portland | 35 000 | 2 000 | 33 000 | 70 000 |
| Total | 328 | 184 | 211 | 723 |

Source: Read Sturgess and Associates' (1995); (a) 'disperse' usage of State forest is not specific to a certain site. (b) Figures for the whole FMA.

In managing State forest, NRE aims to provide a wide range of recreational opportunities while conserving the natural environment. NRE also promotes many of the voluntary codes of practice, mentioned previously for parks and reserves, as being equally applicable to State forest.

Outdoor Education

Outdoor education is an important forest-based activity undertaken by a number of commercial operators, school groups and clubs in the region. Activities include bush walking, kayaking, mountain bike riding, wildlife observation, historic site interpretation and camping. There is an increasing focus on the environment in outdoor education, with these activities used as a link to environment awareness. Activities usually include an interpretation component, particularly those for the Victorian Certificate of Education (VCE) subject 'Outdoor Education', which has components related to human impacts on the natural environment.

Currently, 47 commercial operators conduct educational and training tours in the forests of the West region, with the Grampians National Park being one of the most popular sites for outdoor education in Victoria. Commercial tour operators may be used by school groups, depending on the activity to be undertaken or the skills of the teacher. The outdoor education industry estimated that, in the Central Highlands RFA region, the industry was growing at a rate of 15 to 20 per cent per annum (VicRFASC 1997c). This estimate may also apply to the industry in the West region.

School groups, from primary to tertiary level, are the most prolific users of public land for educational purposes, particularly around the major population centres. As many schools from within and outside the region utilise its resources, it is not possible to accurately estimate student numbers engaged in outdoor education.

A number of formal education and interpretation facilities exist in the West region. Privately operated outdoor education centres are located in the region and provide educational services to schools utilising forested public land. The Brambuk Living Cultural Centre at Halls Gap, established by local Aboriginal communities, provides an understanding of their culture, past and present, through guided activities.

Commercial Tourism Operations on Public Land

The private sector's role in providing a range of services to tourists and recreationists is increasing in importance, and commercial tours are becoming a popular means for tourists to enjoy forest areas.

Regulation of commercial tours is through a Commercial Tours Permit System that operates across all public lands. These permits set out conditions for tour operations and are renewed annually. However, three-year permits can be issued to industry-accredited operators. Parks Victoria administers this system on behalf of NRE.

There are currently 113 commercial tour operators licensed to use public land in the West region, which represents about 29 per cent of all commercial tour operators licensed by NRE in Victoria. The majority of commercial operations are centred on the parks and reserves in the region.

In the West region, bushwalking tours are most popular, with 39 per cent of the commercial tour licences issued providing for this type of activity. Other licensed tour activities include rock-climbing and abseiling, horse riding, vehicle-based tours, water-based activities, and natural history tours as shown in Table 8.6. Although many tour operators are licensed to

utilise public land in the West region, tours may be seasonal or run on an irregular basis. Bushwalking and horse riding are the most regular form of tour undertaken.

Table 8.6: Commercial Tour Operators on Public Land in the West Region

| Activity | No. of Commercial Tour Operators |
|--|---|
| Bushwalking | 44 |
| Rock climbing, abseiling and caving | 39 |
| Vehicle-based tours | 26 |
| Natural history/nature observation | 21 |
| Rafting/canoeing/kayaking | 18 |
| Horse riding | 15 |
| Four-wheel drive tours | 12 |
| Mountain bike tours | 11 |
| Other, including camping, fishing and trail bike tours | 14 |

Source: Parks Victoria (1998), unpublished data; Note: numbers may not add up to 113 as tour operators may provide for more than one activity.

8.4 ECONOMIC VALUE OF TOURISM IN NATIONAL PARKS AND STATE FOREST

A study by Read Sturgess and Associates (1995) suggests that the net economic value of recreation in Victorian State forests is within the range of \$6-18 per visitor day. Another study (Read Sturgess and Associates 1994) suggests a net value of \$18 per visitor day for the Grampians National Park; however, caution is required in extrapolating this figure to other Victorian parks. An economic assessment of all Victorian parks is in progress and is due for completion in 1999.

In 1994-95, there were 723 000 visitors to State forest and 3 675 700 visitors to national parks in the West region. Using the estimates from the above reports, this equates to a total net economic value for tourism and recreation of between \$4.3 million and \$13.0 million in State forests in the region, whereas parks may have a net economic value for tourism and recreation of \$66.2 million.

The 1995 study also suggests that a range of \$20-50 per visitor day be used as a guide to calculate the stimulus of tourism and recreation in State forests to the regional economy. On this basis, State forest is estimated to contribute between \$14.5 million and \$36.2 million per year to the economy in the West region. Using an estimate of \$131 per visitor day as a guide to calculate the stimulus of tourism and recreation to the regional economy derived from the 1994 Grampians study, parks in the region could generate up to \$481.5 million. However, as indicated above, caution is required in extrapolating these figures to other Victorian parks. Based on these aggregated figures, tourism and recreation based on public land in the West is estimated to contribute between \$496.0 million and \$517.7 million per year to the regional economy.

In their study, Read Sturgess and Associates (1994) determined that, using visitor travel costs to estimate the value placed on the park, the economic value of the Grampians National Park is around \$55 million per annum. They estimated that, through expenditure and the associated multiplier effects through the Victorian economy, visitors to the Grampians contribute around

\$174 million to the local economy and a further \$220 million to the State's economy. Read Sturges and Associates (1994) also considered that the recreational use of the Grampians National Park by interstate and overseas visitors added around \$100 million to economic and increased employment by 1270 jobs.

These estimates suggest that tourism and recreation are a substantial part of the economic value derived from the region's publicly owned forests.

8.5 DEMAND FOR TOURISM AND RECREATION IN FORESTS

Tourism is one of Australia's fastest growing industries. The Tourism Forecasting Council predicts that during the period 1997 to 2007, domestic visitor nights in Victoria will increase by 1.8 per cent per annum. This growth rate is slightly higher than the expected national average of 1.1 per cent per annum (ONT 1998a). Total international visitor arrivals are expected to grow at an average annual rate of between 3.6 and 6.1 per cent to reach 5.9 million to 7.5 million visitors in 2006 (TFC 1997), depending on economic conditions in Asian countries.

Both internationally and domestically, the tourism industry is currently undergoing a transition. The industry is changing from traditional mass-market tourism to a more diverse market seeking new and experiential products (USE 1997). Short breaks and ecotourism are examples of these new tourism trends.

Ecotourism, or nature-based travel, has broad appeal among international visitors and domestic tourists, and the demand for ecotourism experiences in Australia has increased with growth in the nature-based travel market. Ecotourists generally appear to be seeking travel experiences that involve areas or attractions of natural beauty, are away from crowds and have some level of interaction with the environment (ONT 1998b). Increased sales of four-wheel drive vehicles, camping and outdoor equipment have also led to an increased demand for places for recreation. In addition, the production of specialist recreational magazines, and an increased awareness of activities such as abseiling and paragliding have also led to an increase in the number of people participating in these activities (Pannell Kerr Forster 1997).

Work commitments and decreasing leisure time are contributing to growth in the short break market. In Victoria, short breaks, or trips of between one and three nights, account for 53 per cent of domestic nights, which is higher than the national average; the majority of trips undertaken by Melbourne residents (80 per cent) are short breaks, mostly to regional Victoria. In contrast, medium and longer-term holidays are not growing and in Victoria, account for only 47 per cent of nights compared with 60 per cent nationally (Tourism Victoria 1998).

Regional tourism development plans (Tonge and Associates 1997a; CTCV 1997) identified proximity to Melbourne, compactness of the Goldfields and Great Ocean Road regions, and the natural attractions of the Grampians region, as tourism strengths based on these trends in tourism. In addition, areas in the West region such as the Port Campbell National Park, the arts and craft regions of Apollo Bay and Daylesford, and rainforest regions in the Otway Ranges add to these strengths through the ability to compete against similar attractions in other regions (USE 1996).

The Victorian National Parks Visitor Segmentation Study was completed by NRE in March 1996. The main findings relating to the total population of park visitors were similar to those of the Office of National Tourism (ONT 1998b) and included:

- visitors were concerned with doing things with the family and enjoying the great outdoors during their leisure time;
- there was strong interest in educational and adventure activities;

- visitors had a high interest in rainforests and a moderate interest in forests, rivers, beaches and mountains;
- main reasons for visiting parks included picnicking, day bushwalking, visiting historic sites and experiencing Aboriginal culture; and
- visitors had large, but mainly unrealised interests in experiencing four-wheel driving, canoeing, learning about Aboriginal culture/history, white-water rafting, scuba diving, rock climbing and abseiling, hang gliding and working as volunteers in parks.

This visitor segmentation study also indicated that the key market segments for the West region are those seeking to participate in nature-based and activity-based activities or seeking opportunities for picnicking, scenic driving and short, accessible walks.

Using these findings as a guide, public land in the West region is well suited for much of the population, particularly the key market segments listed above. For example, the West region provides opportunities for family activities and enjoying the outdoors. Educational opportunities are provided for visitors and there are opportunities for adventure activities such as canoeing and four wheel-driving; and settings for scenic drives, picnics and short bushwalks. The trend toward nature-based tourism over recent years suggests a potential increase in tourism and recreation in forests of the West region in the years to come.

The growth in visits to Victorian State forests has been estimated to remain at least in the order of 3 to 5 per cent per annum until the end of the decade (Read Sturgess 1995). Applying these growth rates to the 1995 visitation levels in the West region, between 744 700 and 759 200 visits are expected in the region's State forests by 2000. Visits to National Parks in Victoria averaged around 5 per cent per annum in the eight years to 1996-97, and this growth is expected to continue.

9. WATER AND CATCHMENTS

9.1 INTRODUCTION

Water is an important resource that is harvested from forested areas within catchments in the West region. Water is essential for maintaining natural environments and for agricultural, industrial and domestic uses. Catchments are also used for a range of other activities such as recreation, conservation, agricultural production and timber production. Any activity within a catchment has the potential to affect both the quality and quantity of water supplies.

The relationship of water, forests and forest use is complex, and based on many variables including climate and geology, soils and vegetation. Links exist between the properties of soils, the forest structure, the impacts of land use (including both the area and spatial distribution of uses), and water quality and quantity.

Activities within catchments, such as agriculture, recreation, timber harvesting, roading or major disturbances, such as fire, have the potential to affect water quality and quantity. The significance of these effects depends on physical factors such as soils, topography, vegetation and climate, as well as the scale and spatial distribution of these activities.

This chapter describes the policy and planning framework that governs water management in Victoria, and examines water resources, production and use in the context of the current land uses in the West region. These descriptions include a brief review of relevant research underpinning forest management.

A major consideration of the RFA process is the implementation of ecologically sustainable forest management (ESFM). Principles of ESFM encompass the protection of water and other resources, including maintaining both quality and quantity of these resources. A review of the Statewide systems for ESFM is described in a separate report (VicRAFSC 1997b) and summarised in Chapter 16 of this report.

9.2 WATER RESOURCES IN THE WEST REGION

Water resources can be broadly classified as surface water or ground water. Water enters a forested catchment as rainfall, snow, fog or sleet, and is usually intercepted by vegetation before reaching the soil. At the soil surface, water infiltrates until saturation occurs, then runs off as surface flow. This surface flow contributes to short-term river flow following rainfall, whereas infiltration contributes to underground water (aquifer) reserves which may be discharged into rivers and streams over a longer period.

Infiltration is a function of soil porosity and storage capacity. Sands and loamy soils absorb water more quickly than clays or rock, but have limited storage capacity. When soil becomes saturated, or rain falls quicker than it can infiltrate, overland flow occurs which can lead to erosion. Vegetation disperses the energy of water before it hits the ground and has the capacity to bind soil, thus stabilising slopes. Vegetation also uses water to maintain physiological functions. Water use by forests varies with forest type and age. For example, a very young forest uses less water than a mature forest, but the greatest demands for water are usually associated with vigorously growing, even-aged juvenile forests.

Human activities can affect water values through their impact on vegetation cover and the levels of disturbance associated with different patterns, types and intensity of land use. Management arrangements and practices implemented at the local level can also influence *in situ* as well as downstream water characteristics. The relationships between land use and

catchment values at the local level are well documented and these are considered in Section 9.5.

At the broader level, all catchments in the West region have undergone complex land use or management changes including:

- modification of vegetation cover;
- resource production;
- mining and quarrying;
- industrial development;
- modification of waterways to supply water for domestic and industrial purposes;
- application of fertilisers, herbicides, pesticides and other chemicals;
- road construction, maintenance and use;
- various forms of recreation; and
- urban and rural residential development.

Although the CRA is concerned largely with public lands, water bodies such as the Rocklands Reservoir, Lake Bellfield and Lake Corangamite also draw water from other tenures including private property, which covers 4.8 million hectares (83 per cent) of the region. Land uses on private property in the West region include urban/rural residential; industrial; agriculture and horticulture, including irrigation districts at Bacchus Marsh and Werribee; and extensive plantations. These uses have significant implications for water yield and quality.

On public land, recreation, tourism, grazing, extractive (e.g. gravel) and other production activities may also impact on water quality and yield. Public land accounts for 1.1 million ha, or 17 per cent of the region. State forest accounts for 411 000 ha (41 per cent) of this area.

Map 1 shows land tenures in the region and the detail of public land tenures is provided in Chapter 2 of this report.

Surface Water Resources

The Australian Water Resources Council (AWRC) has divided Australia into 12 Drainage Divisions, which are further sub-divided into river basins. The West region is partially in the South East Coast and Murray Darling Divisions, and covers sections of 16 river basins, which are described in Table 9.1.

Basins in the Murray Darling Division, including the Goulburn, Campaspe, Loddon and Avoca River basins, drain northward to the Murray River and rivers in the South East Coast Division flow to the ocean. The Millicent Coast basin, although dotted with swamps and lakes, contains no perennial streams, while the Wimmera River is the only major Victorian river that does not flow to the ocean. Instead, it flows northward into a terminal lakes system that includes Lakes Hindmarsh and Albacutya. However, water loss through evaporation and seepage into the sandy soils means Lake Albacutya rarely fills with water (DWR 1989). The Lake Corangamite basin also has no natural drainage to the ocean. It is distinguished by large saline lakes, of which Lake Corangamite is the largest in Victoria.

The Goulburn and Yarra River basins are also considered in detail in the Central Highlands and North East CRA documents (VicRAFSC 1997a, VicRAFSC 1998a).

Table 9.1: Drainage Basins in the West Region

| | AWRC Basin and No. ^(a) | Major Rivers in the West region ^(a) | % in the West region ^(b) | Land Tenure ^(b) | Total Area (ha) ^(b) | % Forest Cover ^(b) |
|----|--|---|--|---|---|--|
| 5 | Goulburn River | Goulburn River | 6.4 | Public land Freehold Total | 2 717 105 409 108 125 | 45.8 13.6 14.4 |
| 6 | Campaspe River | Campaspe River Coliban River | 13.1 | Public land Freehold Total | 7 930 46 954 54 884 | 85.6 21.3 30.6 |
| 7 | Loddon River | Loddon River | 8.1 | Public land Freehold Total | 21464 101 253 122 717 | 86.6 16.2 28.5 |
| 8 | Avoca River | Avoca River | 2.9 | Public land Freehold Total | 10 081 25 186 35 267 | 95.7 17.4 39.8 |
| 15 | Wimmera - Avon River | Wimmera River Avon River | 31.1 | Public land Freehold Total | 151 692 599 461 751 152 | 80.6 8.5 23.1 |
| 29 | Yarra River | - | 5.2 | Public land Freehold Total | 2 256 19 094 21 350 | 6.2 2.5 2.9 |
| 30 | Maribyrnong River | Maribyrnong River | 89.6 | Public land Freehold Total | 9 312 119 205 128 517 | 79.7 15.1 19.8 |
| 31 | Werribee River | Werribee River Lerderderg River | 93.9 | Public land Freehold Total | 53 051 133 976 187 027 | 83.4 9.7 30.6 |
| 32 | Moorabool River | Moorabool River Little River | 98.6 | Public land Freehold Total | 36 142 184 098 220 240 | 51.6 10.1 16.9 |
| 33 | Barwon River | Barwon River Leigh River | 98.9 | Public land Freehold Total | 46 442 335 521 381 963 | 70.4 7.8 15.4 |
| 34 | Lake Corangamite | Woody Yaloak River | 100 | Public land Freehold Total | 59 028 359 060 418 088 | 21.5 5.6 7.8 |
| 35 | Otway Coast | Gellibrand River Curdies River Aire River | 100 | Public land Freehold Total | 141 991 238 572 380 563 | 90.9 24.6 49.3 |
| 36 | Hopkins River | Hopkins River Merri River | 100 | Public land Freehold Total | 43 380 951 806 995 186 | 43.7 2.7 4.5 |
| 37 | Portland Coast | Moyne River Eumeralla River Fitzroy River | 100 | Public land Freehold Total | 64 234 332 588 396 822 | 83.5 7.4 19.8 |
| 38 | Glenelg River | Glenelg River Wannon River | 100 | Public land Freehold Total | 308 636 942419 1 251 055 | 86.3 13.6 31.5 |
| 39 | Millicent Coast | (no permanent surface water supplies) | 34.6 | Public land Freehold Total | 46 303 271 887 318 191 | 80.0 11.4 21.4 |

Source: a) DWR 1989a; b) NRE unpublished data (1999); forest cover is defined as vegetation > 2m height or > 10% crown density; land licensed to Hancock Victorian Plantations is included in freehold land.

Areas of public land in the West region have high proportions of forest cover, although clearing on freehold land has significantly reduced the total forest cover across these catchments (Table 9.1). The Drainage basins are predominantly freehold with a low level of forest cover on these lands. For example, the Hopkins River and Lake Corangamite basins are generally freehold, with forest covering less than 5 per cent and 8 per cent respectively. Forested public land is concentrated in river basins such as the Glenelg and Otway Coast. In the West region, approximately 461 000 ha, or 9.7 per cent, of private land is forested.

Estimates of the area and mean annual streamflow of each basin are provided in Table 9.2. Rivers in the west of Victoria generally have very low flow, as indicated by the low mean annual streamflow, and only 20 per cent of the State's total annual stream flow occurs in the west of Victoria (DWR 1989). The mean annual streamflows in the Yarra River, Goulburn River and the Otway Coast basins are a reflection of the higher levels of precipitation in the Victorian Alps and Otway Ranges, where these basins have their headwaters.

Table 9.2: Mean Annual Streamflow of River Basins

| River Basin | Total Area (ha) | Mean annual streamflow (ML) | Mean annual streamflow (ML/ha) |
|-----------------------|-----------------|-----------------------------|--------------------------------|
| Goulburn River | 1 619 158 | 3 040 000 | 1.9 |
| Campaspe River | 417 914 | 280 000 | 0.7 |
| Loddon River | 1 531 998 | 250 000 | 0.2 |
| Avoca River | 1 235 246 | 85 000 | 0.1 |
| Wimmera - Avon Rivers | 2 401 130 | 210 000 | 0.1 |
| Yarra River | 409 562 | 1 100 000 | 2.7 |
| Maribyrnong River | 142 073 | 120 000 | 0.8 |
| Werribee River | 197 300 | 95 000 | 0.5 |
| Moorabool River | 217 042 | 115 000 | 0.5 |
| Barwon River | 388 007 | 300 000 | 0.8 |
| Lake Corangamite | 418 794 | 160 000 | 0.4 |
| Otway Coast | 389 919 | 765 000 | 2.0 |
| Hopkins River | 968 217 | 400 000 | 0.4 |
| Portland Coast | 399 904 | 245 000 | 0.6 |
| Glenelg River | 1 266 030 | 725 000 | 0.6 |
| Millicent Coast | 958 466 | 4 000 | 0.0 |

Source: DWR 1989

Australian rivers and streams have highly variable flows (Table 9.3). Much of this variability is a function of seasonality, with most streams carrying the greater proportion of their annual flow in winter and spring. About 60 per cent of the State's average annual flow occurs during these months. However, in the West region, this proportion approaches 75 per cent (DWR 1989), with many rivers ceasing to flow in dry years. As a result, water storages in the West region, such as the Rocklands Reservoir, are used to modify and regulate streamflow in major rivers for reasons such as irrigation and flood mitigation.

As water storages are used to artificially regulate stream flows, allocations for the use of water are required to make provision for the maintenance of ecological values. Under the *Water Act 1989*, all future water resource developments are required to make provision for the maintenance of *environmental flows*. These minimum flows, also known as passing flows, are provided along rivers in the West region such as the Werribee and Wimmera Rivers for maintaining aquatic ecosystems.

Table 9.3: Mean Annual Discharge, Maximum and Minimum Daily Discharge for Selected Watercourses in the West Region.

| Watercourse | Gauging station | Mean daily discharge (ML) | Min. daily discharge (ML) | Max. daily discharge (ML) |
|------------------------------|------------------|---------------------------|---------------------------|---------------------------|
| Avoca River | | | | |
| Avoca River | Amphitheatre | 16.8 | 0.0 | 1 096.0 |
| Wimmera - Avon Rivers | | | | |
| Wimmera River | Eversley | 61.0 | 0.1 | 1 303.0 |
| Maribyrnong River | | | | |
| Maribyrnong River | Keilor | 313.5 | 22.9 | 1 414.0 |
| Werribee River | | | | |
| Lerderderg River | Sardine Creek | 76.6 | 0.0 | 1 750.0 |
| Moorabool River | | | | |
| Moorabool River | Batesford | 106.8 | 0.0 | 2 251.8 |
| Barwon River | | | | |
| Barwon River | Forrest | 43.1 | 0.0 | 2 364.0 |
| Lake Corangamite | | | | |
| Woody Yaloak River | Cressy | 194.2 | 0.1 | 7 296.0 |
| Otway Coast | | | | |
| Gellibrand River | Upper Gellibrand | 144.9 | 0.7 | 5 158.0 |
| Hopkins River | | | | |
| Hopkins River | Wickliffe | 193.6 | 0.0 | 11 723.0 |
| Portland Coast | | | | |
| Moyne River | Toolong | 155.6 | 0.7 | 5 576.0 |
| Glenelg River | | | | |
| Glenelg River | Dartmoor | 2 793.7 | 21.0 | 59 526.0 |

Source: NRE (1996f)

Surface water quality varies from poor to good in the West region. Water quality in the lower reaches of most major rivers is poor, with contributing factors being nutrient inputs from agriculture and urban development, and riverbank erosion. Extraction of water for irrigation purposes may also affect water quality by reducing flows and effectively increasing the nutrient and sediment concentrations of the river systems.

Examples of surface water quality across the West region are listed below:

- The Otway Coast basin, of which 49.3 per cent is forested, has the best water quality in the region with low levels of salinity (salinity < 500 mg/l Total Dissolved Solids (TDS)) and turbidity in most streams.
- North-flowing rivers are generally in poor condition, although the upper reaches of these rivers are characterised by low salinity and turbidity. For example, salinity levels are low (salinity < 500 mg/l TDS) in the forested headwaters of the Coliban River, but flows into Lake Eppalock are five times these levels (DWR 1989).
- Salinity is significantly lower on the forested slopes of the Grampians (salinity 500 to 1500 mg/l TDS) than in developed areas downstream of Horsham (salinity > 1500 mg/l TDS).
- Flow in the Glenelg River and its tributary, the Wannon River, is generally unfit for human consumption or irrigation in the south west of the region, due to high salinity levels resulting from dryland salting (salinity > 1500 mg/l TDS).
- High turbidity levels in river basins to the east of the region, particularly in the Werribee and Maribyrnong River basins, can be attributed to urbanisation, extractive industries, agriculture and irrigation (DWR 1989).

Ground Water Resources

The West region lies within the Highlands, Murray, Otway and Port Phillip groundwater provinces. Numerous aquifer systems occur in these provinces, with considerable variations in the depths, yields and salinities of the different formations. The main aquifer systems utilised in the West region are shown in Table 9.4.

Table 9.4: Main Aquifer Systems in the West Region

| Aquifer System | Depth to Aquifer | Aquifer Thickness | Salinity (mg/L TDS) | Uses |
|---|--|---|--|------------------------------------|
| Highlands Province | | | | |
| <ul style="list-style-type: none"> confined fractured rock aquifer in basalt and basaltic clays near Woodend - Kilmore and Ballarat - Daylesford - Maryborough | out-cropping | 0 to 100 m | 500 to 3500 | stock, domestic, irrigation |
| <ul style="list-style-type: none"> Silurian - Devonian sediments generally in the Grampians | out-cropping | 0 to 100 m | 500 to 2000 | domestic, stock |
| <ul style="list-style-type: none"> Palaeozoic sedimentary and igneous rocks | mostly out-cropping | 0 to 100 m | 1000 to 5000; can be greater than 10 000 | stock, irrigation, mineral springs |
| Murray Province | | | | |
| <ul style="list-style-type: none"> confined sheet-like Duddo Limestone aquifer | 50 to 190 m | 50 to 130 m | 1000 to 3500 | stock, domestic |
| Otway Province | | | | |
| <ul style="list-style-type: none"> unconfined fractured Newer Volcanics of basalt, scoria and tuff | out-cropping | up to 120 m; mostly less than 70 m | 100 to 8000 | stock, irrigation, domestic |
| <ul style="list-style-type: none"> Port Campbell Limestone, partially confined beneath basalt | generally out-cropping | 100 to 250 m | 500 to 7000 | stock, irrigation, domestic |
| <ul style="list-style-type: none"> Dilwyn Formation of quartz sand, clayey sand and silt | out-cropping otherwise at depth of 1 000m | 50 to 250 m in east; over 1 000 m near Portland | 500 to 1500 | urban |
| Port Phillip Province | | | | |
| <ul style="list-style-type: none"> unconfined sand and gravel shoe-string aquifers of the Werribee Delta | out-cropping | up to 30m | 500 to 6000 | irrigation, stock |
| <ul style="list-style-type: none"> Newer Volcanics of multi-layered fractured rock aquifer system with sheet like basalt aquifers separated by clay layers | out-cropping | 50 to 150 m | 100 to 6000; mostly greater than 2 500 | stock, irrigation, industrial |
| <ul style="list-style-type: none"> Moorabool Viaduct Formation | out-cropping or underlying Newer Volcanics | less than 30 m | greater than 3000 | salt production, stock |
| <ul style="list-style-type: none"> sheet-like Werribee Formation | up to 400 m | from 20 to > 150 m | 2000 to 5000 | industry, irrigation |

Source: NRE 1998b

Twenty Groundwater Management Areas (GMA) exist in the West region. Permissible annual volumes (PAV), to insure against over use of groundwater and to provide a volumetric limit for licences, exist for each GMA. Four of these GMA — Nullawarre 2 and Yangery (near Warnambool), Deutgam (near Werribee) and Bungaree (near Ballarat) — have been identified as priority areas for declaring as Groundwater Supply Protection Areas (GSPA), on the basis that the available volume has already been issued or over-issued. However, these areas are primarily beneath agricultural land and are generally unaffected by native forest management activities on public land.

9.3 WATER USE AND STORAGE IN THE WEST REGION

Water derived from the region is primarily used for domestic, industrial, agriculture, irrigation and recreation purposes, and for maintaining stream environments. Major water storages constructed in the catchments of the West region are listed in Table 9.5.

Table 9.5: Major Surface Water Storages in the West Region

| River Basin | Storage | Capacity (ML) | Primary Purpose | River |
|-----------------------|-------------------------|---------------|-----------------------------|-------------------------------------|
| Campaspe River | Lauriston Reservoir | 20 000 | domestic, industrial, | Coliban R |
| | Upper Coliban Reservoir | 31 500 | commercial, irrigation | Coliban R |
| Wimmera - Avon Rivers | Lake Wartook | 29 500 | domestic, stock, irrigation | MacKenzie R |
| | Lake Lonsdale | 65 500 | | Mt William Ck |
| | Lake Fyans | 21 000 | | off - river |
| | Lake Bellfield | 78 500 | | Fyans Ck |
| | Pine Lake | 64 000 | | off-river |
| | Taylor's Lake | 36 000 | | off-river |
| Maribyrnong River | Rosslynne Reservoir | 24 500 | urban, irrigation | Jackson Ck |
| Werribee River | Pykes Creek Reservoir | 24 000 | irrigation, urban | Pykes and Myers Ck |
| | Melton Reservoir | 17 000 | | Pyrites, Djerriwarrah and Arnold Ck |
| Moorabool River | Lake Merrimu | 35 000 | | Pyrites Ck |
| | Moorabool Reservoir | 6 740 | domestic, industrial | Moorabool R (west) |
| | Bostock Reservoir | 7 460 | | Moorabool R (east) |
| | Lal Lal Reservoir | 59 000 | | Moorabool R (west) |
| Barwon River | West Barwon Reservoir | 20 900 | domestic | Barwon R |
| | Wurdee Boluc Reservoir | 19 100 | | off-river |
| | White Swan Reservoir | 14 060 | | off-river |
| Glenelg River | Rocklands Reservoir | 348 000 | domestic, stock | Glenelg R |
| | Moora Moora Reservoir | 6 300 | | Moora Ck |

Source: DWR 1989

Water also flows into large storages outside the region. In the Campaspe and Avoca River basins, water flow into reservoirs such as Cairn Curran and Lake Eppalock. These large reservoirs supply Bendigo and surrounding towns, and irrigation districts to the north of Victoria, outside the RFA region.

The Wimmera-Mallee Domestic and Stock Water Supply System covers 47 000 ha in the north west of Victoria. Numerous storages, such as the Rocklands Reservoir, have been constructed in the Grampians to supply water to this system for irrigation, and for rural and domestic users from Horsham to Robinvale and Swan Hill. To maintain this system, water is exported from the Wimmera-Avon River basin to the Mallee, Loddon and Avoca River basins; a further 76 000 ML of water is exported from the Glenelg River basin to this system.

Surface water use in the West region is shown in Table 9.6.

Irrigation is a major consumer of water from the region. Water is contributed to irrigation districts in the north of Victoria including the Merbein, Robinvale and Goulburn-Murray Irrigation Districts via the Wimmera-Mallee Domestic and Stock Water Supply System. Within the region, irrigation districts at Werribee and Bacchus Marsh use over 80 per cent of the developed surface water in the Werribee River basin.

The Otway Ranges are an important source of domestic water for extensive areas of the south west including Geelong and Warrnambool. Water is exported from the Otway Coast basin to the Hopkins and Barwon Rivers and Lake Corangamite basins.

To supply urban and industrial users, water from the Barwon River basin is also supplemented by imports from the Moorabool River basin. Water in the Moorabool River basin is harvested extensively, with around 82 per cent of the divertible resource already developed. Although the majority of this water is used for irrigation, 23 per cent of water

Table 9.6: Surface Water Resource use in River Basins in the West Region

| River Basin | Irrigation | | Urban/Industrial | | Rural | | Total Use |
|-----------------|------------|-----------|------------------|----------|--------|----------|-----------|
| | Local | Imported | Local | Imported | Local | Imported | |
| Goulburn | 724 728 | 6 380 | 14 850 | - | 24 900 | - | 770 858 |
| Campaspe | 52 600 | 176 460 | 1 920 | 3 390 | 12 420 | - | 246 780 |
| Loddon | 44 100 | 1 170 746 | 8 220 | 19 890 | 8 300 | 22 180 | 1 323 496 |
| Avoca | - | 21 910 | 2 130 | 310 | - | 41 790 | 66 140 |
| Wimmera - Avon | 21 000 | 6 980 | 7 450 | - | 37 350 | 12 780 | 85 560 |
| Yarra | 7 040 | - | 1 010 | - | 170 | - | 8 220 |
| Maribyrnong | - | - | 3 760 | - | 370 | - | 4 130 |
| Werribee | 23 080 | - | 4 130 | - | 920 | - | 28 130 |
| Moorabool | 2 020 | - | 220 | 80 | - | 30 | 2 350 |
| Barwon | 2 450 | - | 2 330 | 7 680 | - | 140 | 12 600 |
| Corangamite | 880 | - | - | 3 550 | - | 1 520 | 5 950 |
| Otway Coast | 1 970 | - | 920 | - | 760 | - | 3 650 |
| Hopkins | 3 840 | - | 2 380 | 6 140 | 70 | 710 | 13 140 |
| Portland | 1 190 | - | - | - | - | - | 1 190 |
| Glenelg | 1 140 | - | 2 630 | - | 40 | - | 3 810 |
| Millicent Coast | - | - | 370 | - | - | - | 370 |

Source: DCE (1991); Local = water sourced from within basin; Imported = water imported into basin

utilised is exported to major population centres at Ballarat and Geelong (DWR 1989). Surface water in parts of the Hopkins and Glenelg Rivers and Portland Coast basins is highly saline making it unsuitable for domestic, stock or irrigation purposes. In these areas, water is supplied either through imports or drawn from groundwater resources.

Groundwater is important for domestic and agricultural purposes in Portland, Heywood and in adjacent areas of South Australia, including Mt Gambier. In recognising groundwater is a shared resource, the South Australia/Victoria Groundwater Agreement was developed in 1985 and is managed, in Victoria, under the *Groundwater (Border Agreement) Act 1985*. This Agreement established groundwater use limits for a 40 km zone centred on the state border.

Groundwater also provides the town water supply for many smaller towns in the region including Woodend, Trentham, Gordon, Learmonth, Waubra, Avoca, Glenthompson and Wickcliffe. The Portland aquifer provides a back-up supply for Hamilton. Aquifer systems in the Barwon Downs area, including the Mepunga and Pebble Point Formations, are also used in the Geelong water supply.

Groundwater from the Highland province is mineralised in the Hepburn Springs-Daylesford area. Exposed fractured rock aquifers along the crest of forested hills in the region are significant zones of recharge for aquifers including the mineral springs (CNR 1995a). These mineral water aquifers are an important component of regional tourism while aquifers to the south of Daylesford are bottled; approximately 30 ML of mineral water are bottled each year (Shugg 1996). Issues relating to the mineral springs water quality are covered in Section 9.5.

A number of water diversion schemes exist in the region. In the Barwon River basin, the Woody Yaloak River diversion and the Lake Colac/Lough Calvert drainage scheme divert water into the Barwon River to assist in flood control around Lakes Colac and Corangamite. In a separate scheme, water is diverted from the Lerderberg River and Goodman Creek to flow into Lake Merrimu. Water supplied from this reservoir is used for both irrigation and urban supply. The Wimmera-Mallee Domestic and Stock Supply System has been discussed previously.

The streams and catchments of the region also have significant ecological, heritage, tourism and recreation values. Many of the forested catchments of the West region provide for a

diverse range of water-based and water-enhanced recreational activities in State forest, and parks and reserves. Activities include fishing, canoeing/rafting, boating, water skiing, swimming, and associated activities such as camping and nature observation. Rivers including the Glenelg and Lerderderg, and water storages such as the Rocklands Reservoir and Lake Fyans are popular for water-based recreation. Further discussion of tourism and recreation is included in Chapter 8.

9.4 LEGISLATIVE AND POLICY FRAMEWORK

Commonwealth Policies and Initiatives

Under the Australian constitution, responsibility for water resource planning and management lies with the State and Territory Governments. The Commonwealth Government has a complementary role in natural resource management. This relationship is best demonstrated in the Council of Australian Government (COAG) Water Reform Framework.

COAG Water Reform Framework

In 1994, COAG agreed to a strategic framework for water reform in Australia. This framework has a key role in improving the sustainability of natural resource use, achieving better environmental outcomes and contributing to the overall micro-economic reform agenda. In the case of rural water services, the framework is intended to generate the funds to maintain supply systems and through a system of tradeable entitlements, to allow water to flow to higher value uses subject to social, physical and environmental constraints.

The key elements of the framework are:

- pricing reform;
- clarification of property rights;
- allocation of water to the environment;
- adoption of trading arrangements in water;
- institutional reform; and
- public consultation and participation.

The framework also includes the adoption of an integrated catchment management approach to water resource management.

The State and Territory Governments are currently implementing this framework with a view to completion by 2001. In Victoria, property rights are being formalised and the water trading has been established where property rights are in place. Implementation will be measured progressively by determining whether or not milestones have been met by the States. The implementation of the framework is linked to payments to State and Territory Governments by the Commonwealth Government that will be made available under the Competition Principles Agreement (COAG 1994).

Each State and Territory is currently in the process of developing approaches to implement the framework. This has been assisted by the work of the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC). ARMCANZ developed a paper entitled 'Water Allocations and Entitlements — A National Framework for the Implementation of Property Rights in Water' (ARMCANZ 1995), and ARMCANZ and ANZECC developed the 'National Principles for the Provision of Water for Ecosystems'.

National Water Quality Management Strategy (NWQMS)

The NWQMS has been developed since 1992 and consists of a number of separate documents that outline national approaches and guidelines for different water qualities. The objective of the NWQMS is to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development. The NWQMS provides for a nationally consistent approach to water quality management through the cooperative development of guidelines. These guidelines promote a shared national objective while allowing flexibility to respond to regional and local differences.

One of the guiding principles of the Strategy is the adoption of an integrated approach to water quality management. Such an integrated approach to resource management includes:

- a holistic approach to natural resource management within catchments, marine waters and aquifers with water quality considered in relation to land use and other natural resources;
- coordination of all the agencies, levels of government and interest groups within the catchment; and
- community consultation and participation (ARMCANZ/ANZECC 1995).

As part of the NWQMS, guidelines have been developed for Fresh and Marine Waters which collate available scientific information to recommend water quality guidelines for aquatic ecosystems; drinking water; recreational water; and industrial and agricultural water (ANZECC 1992).

National River Health Program (NRHP)

The objective of the NRHP is to improve the management of Australia's river systems through improved information bases on the state of rivers (PMSEC 1996). The NRHP was primarily established to implement the Monitoring River Health Initiative that aims to develop a national approach to river health monitoring. Under this program, the Australian Rivers Assessment Scheme (AUSRIVAS) has developed a number of predictive models to evaluate and report on river health. Another major component of the NRHP is developing means of assessing the water requirements that are necessary to maintain a healthy functioning river ecosystem (NRHP 1993).

National Rivercare Initiative

The National Rivercare Initiative will build on existing programs to help ensure the sustainable management, rehabilitation and conservation of rivers outside the Murray-Darling Basin. It is intended that the Initiative will provide financial assistance for catchment management planning and implementation. Local communities will be encouraged to develop catchment and sub-catchment management plans to ensure water resources are managed sustainably according to local goals that are consistent with NWQMS guidelines (PMSEC 1996).

Murray-Darling Basin Commission

Established in 1985, the Murray Darling Basin Ministerial Council coordinates land management within the basin. The Council consists of representatives from all governments covered by the Murray Darling Basin, including the Commonwealth Government, and provides a strategic focus for planning and management for the sustainable use of the basin's natural resources. Since 1985, the Council has put in place a wide range of initiatives through its executive arm, the Murray-Darling Basin Commission (MDBC). The Commission is involved in the following initiatives:

- the implementation of a broadly based Natural Resource Management Strategy (NRMS) that includes a significant level of support for community-based works and measures;

- an ongoing program of investigations and the construction of salt interception schemes under the Salinity and Drainage Strategy;
- a coordinated Drainage Program of joint government and community works, and measures to combat land salinisation and waterlogging;
- the regulation of the River Murray to distribute water to New South Wales, Victoria and South Australia;
- the ongoing community consultation activities of the Community Advisory Committee; and
- cooperative education and information programs throughout the basin.

Objectives of the NRMS are implemented by several national and state strategies including the National River Health Program, National Water Quality Monitoring Strategy and the Victorian Nutrient Management Strategy.

In June 1995, the MDBC decided a 'cap' had to be set on water usage across the whole basin to prevent water usage becoming unsustainable. This cap sets physical limitations on the use of water and is the 'volume of water that would have been diverted under 1993-94 levels of development' (MVEC 1997). A single cap exists for all of Victoria's Murray use and is currently 1621 GL per annum on average.

Victorian Policies, Legislation and Initiatives

Victorian State Government Policy, as reflected in recent initiatives and legislation, emphasises that land and water are inseparable and, consequently, the State Government has directed public authorities to aim for stable, well managed systems which will protect and not damage rivers and their environments. State Government policy to protect water quality is implemented through a range of policy and legislative mechanisms, including:

- *Water Act 1989*;
- *Catchment and Land Protection Act 1994*;
- State Environment Protection Policies declared under the *Environment Protection Act 1970*;
- *Environment Conservation Council Act 1997*;
- the former *Land Conservation Act 1970*;
- management planning, Code of Forest Practices for Timber Production and regional prescriptions enacted under the provisions of the *Forests Act 1958* and the *Conservation, Forests and Lands Act 1987*; and
- management planning under the provisions of the *National Parks Act 1975*.

Provisions of the Water Act 1989

Water authorities and river management authorities were appointed for catchments under the provisions of the Water Act. The general objectives of water authorities are related to the management of the major water systems, the provision of bulk supplies to (non-metropolitan) urban and rural water authorities, and delivery of irrigation water, domestic and stock supplies, and drainage services. Through amendments to the Catchment and Land Protection Act in 1997, River and other waterway management authorities no longer exist as separate statutory bodies.

The *Water Act 1989* establishes a system of allocating the available water resource outside the Melbourne metropolitan area and provides for the integrated and sustainable management of water resources across the State. The Act sets up a system of well-defined rights, which partitions the water available to each consumptive user and to the environment. The Act allows for these rights to be traded among water authorities.

Table 9.7: Special Water Supply Catchment Areas in the West region

| Name of Catchment | Area (km ²) | For the protection of: | Special Area Plan | Slope (°) | Seasonal Closure | Stream Buffers (m) | Filter Strips |
|--|-------------------------|----------------------------|-------------------|-----------|-----------------------|--|---------------|
| Avoca | 10 | Town | Yes | | | 100 ^(a) 40 ^(b) , 10 ^(c) 20 ^(d) | |
| Ballarat | 98 | Town | | | | | |
| Barwon Downs Intake Area (Geelong) | 77 | Town | | | | | |
| Cairn Curran | 1 594 | Irrigation | | | | | |
| Creswick | 33 | Town | | | | | |
| Djerriwarrh | 26 | Town | Yes | | | 1 chain | |
| Eppalock | 2116 | Irrigation | | | | | |
| Eppalock (Kyneton) | 12 | Town | Yes | | | 2 chain ^(f) , 1/2 chain ^(g) | |
| Eppalock (Newham Parish) | 14 | Town | Yes | | | | |
| Fiery Creek and Tributaries (Beaufort) | 8 | Town | | | | | |
| Forest Creek (Amphitheatre) | 3 | Town | | | | | |
| Gellibrand River | 507 | Town | Yes | 25 | 1 June – 31 October | | |
| Gellibrand River (South Otway) | 183 | Town | Yes | 25 | 1 June – 31 October | | |
| Gisborne- Sunbury | 6 | Town | Yes | | | 1 chain | |
| Konong Wootong Reservoir (Coleraine) | 11 | Town | | | | | |
| Lake Merrimu | 85 | Irrigation, Industry | Yes | | | 5 chain ^(h) , 1 chain ⁽ⁱ⁾ | |
| Lake Merrimu (Goodmans Creek) | 39 | Irrigation, Industry, Town | Yes | | | 5 chain ^(h) , 1 chain ⁽ⁱ⁾ | |
| Lake Merrimu (Lerderderg River) | 218 | Irrigation, Industry | | | | | |
| Lal Lal Reservoir | 219 | Town | | | | | |
| Lal Lal Reservoir (Res. Environs) | 18 | - | Yes | | | | |
| Lancefield | 19 | Town | Yes | | | 1 chain | |
| Langi Ghiran Reservoir (Ararat) | 1 | Town | | | | | |
| Learmonth Borefield (Learmonth) | 59 | Town | | | | | |
| Little Tea Tree Tributaries (Hamilton) | 4 | Town | | | | | |
| Loddon River (Laanecoorie) | 1830 | Town | | | | | |
| Lorne | 28 | Town | | 25 | 1 May – 30 November | | |
| Macedon | 3 | Town | Yes | | | 2 chain ^(j) , 1 chain ^(k) | |
| Mason Creek (Willaura) | 16 | Town | | | | | |
| McCallum Creek | 187 | Town | | | | | |
| Merino | 51 | Town | | | | | |
| Mollison Creek (Pyalong) | 166 | Town | | | | | |
| Monument Creek | 9 | Town | | | | | |
| Moorabool River (She Oaks) | 460 | Town | | | | | |
| Mortlake Springs (Mortlake) | 14 | Town | | | | | |
| Mt Macedon | 3 | Town | Yes | | | | |
| Musical Gully and Troy Reservoirs (Beaufort) | 1 | Town | | | | | |
| Painkalac Creek (Aireys Inlet) | 34 | Town | Yes | 25 | 1 June – 30 September | 200 ^(l) , 40 ^(m) | |
| Parwan | 157 | Irrigation | | | | | |
| Pennyroyal, Matthews and Gosling Creeks | 74 | Town | | 25 | 1 June – 30 September | | |
| Picnic Road (Ararat) | 1 | Town | | | | | |

| | | | | | |
|---|-----------------------|-----|----|------------------------------------|-----------------------------------|
| Pykes Creek Reservoir and Werribee River | 237 Town | | | | |
| Riddell's Creek | 5 Town | Yes | | | 1 chain |
| Rocklands | 1 342 Irrigation | | | | |
| Rocklands Reservoir Environs | 160 Irrigation | Yes | | | |
| Romsey | 9 Town | Yes | | | |
| Rosslynne Reservoir (Jackson Creek) | 85 Town | Yes | | | |
| Rosslynne Reservoir (Riddell Creek) | 21 Town | | | | |
| Serra Range Tributaries (Dunkeld) | 48 Town | | | | |
| Skenes Creek | 8 Town | Yes | 25 | 1 May – 30 November | 20 |
| St Enochs Springs (Skipton) | 79 Town | | | | |
| Stony Creek (Geelong) | 26 Town | Yes | | | |
| Sunbury | 18 Town | Yes | | | |
| Trawalla Creek | 108 Stock, Domestic | | | | |
| Tullaroop Reservoir | 722 Town | | | | |
| Upper Barwon | 145 Town | Yes | 25 | 1 June – 31 October ⁽ⁿ⁾ | 5 chain ½ chain ^(o) |
| Wannon River Tributaries (Lake Bellfield) | 2 Town | | | | |
| West Barham River | 12 Town | | 25 | 1 May – 30 November | |
| Wimmera Systems | 4 383 Stock, Domestic | | | | |
| Malakoff Creek - Landsborough | 29 Town | Yes | | | |
| Woodend | 4 Town | Yes | | | 1 chain |
| Yuppeckiar Creek Reservoir (Glenthompson) | 1 Town | | | | |

Source: *Catchment and Land Protection Act 1994*; 1 chain = 20.12 metres

Note: in the Otway FMA a maximum 25° slope limitation will be applied in special water supply catchment areas; 20° and 15° slope limit will be applied in areas of Land Degradation Hazard Class 4 and 5 respectively (DCE 1992 p. 48). Seasonal closures are specified for designated catchments in the Midlands FMA (O'Shaughnessy and Associates 1995b, p53).

(a) full supply level at Sugarloaf and Lead Reservoirs; (b) the upper side of water races; (c) the lower side of water races; (d) watercourses as shown on Plan No. S-221; (e) full supply level of reservoirs; (f) banks of streams, springs or watercourses; (g) off-take weir; (h) streams, springs and watercourses within catchment; (i) storages and off-take pipes; (j) banks of watercourses and springs specified on Plan No. 1297; (k) full supply of reservoir; (l) streams shown by heavy line on Plan No. S 789 otherwise 20 m on streams shown; (m) full supply level of the West Barwon Reservoir and West Barwon River for 10 chains upstream from full supply level of reservoir; (n) seasonal closure on Upper Barwon (Dewing's Creek) from 1 June – 30 September inclusive; (o) streams, channels and off-takes as specified on Plan No. 1044

The Act provides for entitlements, known as 'bulk entitlements', to be granted to water authorities and other public bodies. Furthermore, it provides for the rights that are allocated from the bulk entitlement to an authority to be passed on to private individuals. These allocations, for example, may be a licence to take and use water from a waterway or groundwater resource.

Bulk water entitlements are currently being established in the West region. Victoria has made some progress in meeting the COAG reforms in relation to clarification of property rights by formalising existing bulk water entitlements (both consumptive and environmental). The bulk water entitlement conversion process is based on recognition of existing infrastructure, and community investment, of each water supply system. In many systems this may result in bulk entitlements being issued for greater volume than is currently used. Under these arrangements there is the potential for the environment to suffer and so Victoria has established an environmental review panel to assess the likely impact on downstream flow and review storage operation to identify opportunities for increased environmental flows (Allan and Lovett 1996).

Bulk entitlements are in place for the Werribee River, and progress has been made in the development of entitlements for a number of rivers including the Loddon, Campaspe, Avoca, Otway and Maribyrnong systems.

The Catchment and Land Protection Act 1994

Catchment Management Authorities (CMA) were established under the *Catchment and Land Protection Act 1994* to facilitate implementation of the Regional Catchment Strategies. These CMAs combine the roles of a range of former groups including CALPs, river management authorities and other waterway management groups. Five catchment management authorities cover the West region including Corangamite, Glenelg-Hopkins, North Central, Port Phillip and Wimmera. The objectives in implementing the regional catchment strategies include the maintenance and improvement of the quality of water and condition of rivers, and conservation and protection of the diversity and extent of natural ecosystems.

Land managers are required to have regard to any regional catchment strategy applying to the land.

Areas within catchments warranting particular attention, such as areas required for water supply, can be declared Special Areas by CMAs under the *Catchment and Land Protection Act*. In the West region, there are 47 Special Areas classified as Special Water Supply Catchments (Table 9.7). These areas were formerly called Proclaimed Water Supply Catchments under the now repealed *Soil Conservation and Land Utilisation Act 1958*. Special Water Supply Catchment Areas are identified because of their significance as a source of water.

Under the Act, Special Area Plans, which can be prepared for declared areas, specify how particular land management issues in the special areas will be addressed. Land Use Determinations previously prepared for proclaimed water supply catchments are now regarded as Special Area Plans under the *Catchment and Land Protection Act*.

Land managers, including NRE, must have regard to any Special Area Plan applying to land under its control. Special Area Plans within the West region place specific requirements on forest management, including seasonal restrictions on harvesting in particular areas, and restrictions on the level, type and location of activities, including recreation and extractives. The Gellibrand River Water Supply Catchment provides an example of this form of management arrangement. Provisions set out in a Special Area Plan relate to the protection of off-take locations and watercourses through the retention of protective buffers and generally to water catchment protection through the reservation of protective forest, including all forested land with slopes greater than 25°. Further specifications are made relating to forest use, including timber production and recreation; plantations; grazing; road construction; and extractive industries.

The Code of Forest Practices for Timber Production (Code) requires that water quality and yield be protected in water supply catchments. These requirements are discussed in more detail in Section 9.5. Where Special Area Plans do not exist or specify minimum standards, the Code or regional prescriptions provide minimum requirements for seasonal closures, stream buffers, filter strips and slope limitations. Minimum widths for stream buffers and filter strips are a function of the soil type, stream class and slope, and can vary from 10 to 40 metres depending on soil permeability and potential for overland flow.

Land Conservation Council Recommendations

The *Environment Conservation Council Act 1997* came into operation on 1 July 1997. This Act which established the Environment Conservation Council (ECC), revoked the *Land Conservation Act 1970*, and replaced the Land Conservation Council (LCC). The ECC

advises the Victorian Government on public land use planning and has a wider role than the LCC, being able to advise on all natural resource matters, taking account of all relevant issues that may impact on their use. Orders-in-Council, to approve and require implementation of previous recommendations made by the LCC, continue to apply.

Under the *Land Conservation Act 1970*, the LCC completed reviews of public land use in the West region. Through these reviews, the LCC recommended that a range of public land tenures, namely State forest, National Parks and State Parks, within the West region also be used for water supply and to protect stream and water catchments. No catchment in the West region is used solely for water production although the immediate surrounds of some reservoirs near Ballarat are closed to the public. Other areas such as buffers surrounding diversion works and storages must be managed to protect water quality, which may restrict the type of activity permitted in these zones.

1991 Rivers and Streams Special Investigation

In recognising the diverse values of streams and water catchments within the West region, the LCC made specific recommendations for the protection of Heritage Rivers, 'Essentially Natural Catchments', River Zones in State forests and Natural Feature Reserves (i.e. Public Land Water Frontage reserves passing through freehold and public land Streamside Reserves).

Heritage Rivers were identified in the LCC's statewide investigation into Rivers and Streams (LCC 1991a). The Council was required to 'carry out an investigation of the scenic, recreational, cultural and ecological values of rivers and streams in Victoria, and to make recommendations on the use of these rivers and how their identified values can best be protected.' Recommendations for the management of heritage rivers included:

- protection of the specified values;
- provision of a range of recreational activities;
- structural barriers or impoundments that impede flow or the passage of in-stream fauna should not be constructed;
- establishment and maintenance of appropriate environmental flows;
- timber harvesting should not be permitted except where specified;
- strict controls on grazing;
- road construction should minimise on-site sediment losses to the stream network; and
- controls on the location of new roads and bridges relative to watercourses.

In the West region, the corridors of the Lerderderg, Aire and Glenelg Rivers have been designated as Heritage Rivers and are protected under the *Heritage Rivers Act 1992*, which implements the LCC recommendations described above.

Those catchments that have not been subject to physical or biological processes that leave the environment impaired or changed have been designated as Essentially Natural Catchments in this investigation. However, in the West region, no catchments were identified with a naturalness that met the criteria necessary to be recommended as Essentially Natural Catchments.

The Heritage Rivers Act overlays, but does not change existing land tenure. However, it may require changed management objectives to achieve protection of special values. A draft management plan for heritage rivers in the West region was released for comment in November 1997 (NRE 1997j). This plan was prepared by NRE as the principal land manager in these areas in conjunction with Catchment Management and other waterway Authorities.

Representative Rivers have also been recommended by the LCC (LCC 1991a) as a part of this investigation. These rivers contain significant natural or scenic values and are representative of distinct river-catchment types found across Victoria. The six rivers designated as Representative Rivers in the West region are the Avoca, Loddon, Lerderderg, Moorabool, and Gellibrand Rivers and Tomahawk Creek. The primary aim for the protection of these Representative Rivers is to maintain examples of these river types and thus to avoid or prevent modification to their geomorphological and hydrological attributes (LCC 1991a).

State Environment Protection Policy — *Environment Protection Act 1970*

The *Environment Protection Act 1970* provides for the declaration of State Environment Protection Policies (SEPP) for defined areas in order to maintain environmental quality sufficient to protect existing and anticipated beneficial uses. State Environment Protection Policies relevant to the West region include:

- State Environment Protection Policy (SEPP) (Waters of Victoria) 1988 applies to surface waters throughout the State except when varied by separate SEPPs, clauses or schedules for specific areas, which include Schedule F1: Waters of the Werribee and Little River Catchments, and Schedule F2: Waters of the Maribyrnong River and Tributaries;
- SEPP (The Waters of Port Phillip Bay) 1975;
- SEPP (The Waters of the Western District Lakes) 1982;
- SEPP (The Waters of Lake Colac and Catchment) 1982;
- SEPP (The Waters of Lake Burrumbeet and Catchment) 1983;
- SEPP (Waters of the Wimmera River and Catchment) 1985;
- SEPP (Waters of the Yarra River and Tributaries); and
- SEPP (Groundwaters of Victoria) 1988.

Each of these documents sets out the beneficial use to be protected, objectives for various water quality indicators and a program for attaining these objectives. Water quality monitoring assesses the status of water resources relative to these indicators and objectives.

Controls Enacted under the *Forests Act 1958*

The Timber Industry Strategy (Victoria Government 1986) cites ‘ensuring the sustained capability of forests to maintain and enhance water quality and yield’ as one of six objectives for environmental management. It also indicates that priority will be given to water production in those catchments with limited stream flows that service regions with high current or potential water demand. The strategy for achieving this water quality and yield objective includes undertaking land capability assessments to delineate hazardous areas; preparing appropriately detailed codes of practice/prescriptions to set required standards; and, monitoring adherence to standards, together with periodic re-evaluation of the standards themselves. To maintain or enhance yield, the forest-age class distribution, forest structure and rotation lengths may be manipulated.

The implementation of management arrangements under the *Forests Act* is considered in Section 9.5. These include provisions of the Code of Forest Practices for Timber Production, forest management plans and regional harvesting prescriptions.

Provisions of the *National Parks Act 1975*

National Parks and State Parks are managed in accordance with the *National Parks Act 1975* that requires that a plan of management be prepared for each park. Management zones and overlays are designated in these management plans to provide a geographic framework in which to manage the park. The zoning system is designed to reduce conflicts between various types of visitor use and protection of other park values. Overlays are used to reinforce or

modify the management of the underlying zone and can include land use designations to provide for legislative requirements, special protection areas or special management areas.

Management plans have been completed for the 10 National and State Parks in the West region.

Through this management framework, plans aim at minimising risk to water quality and quantity through managed recreation, fire protection, soil conservation and the protection of vegetation. They must have regard to special area plans for declared catchments in or adjacent to the park boundary.

Victorian Water Quality Monitoring

There are two major Statewide environmental water quality-monitoring programs in Victoria:

- the Victorian Water Quality Monitoring Network (VWQMN), managed by NRE; and
- a network of fixed sites, run and funded by the Environment Protection Authority (EPA).

Under these programs, physico-chemical, biological and salinity monitoring is undertaken at a number of sites across Victoria. The water quality monitoring and reporting arrangements were reviewed in 1991 and 1996, resulting in proposed extensions to the Statewide coverage of the VWQMN and changes in the parameters monitored. The VWQMN currently monitors water quality and algae in rivers and streams, lakes and wetlands across Victoria.

Extensive and intensive regional water quality monitoring programs are also conducted as part of the Major Storages Operational Monitoring Program. Water quality in storages in the West region is monitored as part of this program. Regional Water Authorities may also undertake water quality monitoring within their boundaries.

9.5 ISSUES FOR WATER MANAGEMENT

The major issues for water management are related to the quality and quantity of water. As discussed earlier, many water quality issues are related to land tenure, as this is a major determinant of the condition and level of disturbance as well as the use of the land, which largely determines the access and management arrangements applicable to an area.

Water Quality and Quantity

The physical, chemical and biological characteristics of water determine its quality. A significant loss of quality can have a deleterious effect on aquatic ecosystems and the value of the resource for a range of human uses. Catchment conditions and water quality are closely linked. Undisturbed and forested catchments generally ensure high water quality while, in contrast, agricultural and urban environments are often associated with lower water quality. As a result, some domestic water supplies in the region require treatment to ensure that water quality is suitable for domestic consumption. Land use practices resulting in erosion and the transport of nutrients, as well as urban runoff and point discharges of pollutants, are major causes of poor water quality in streams.

Water quality issues in some areas of the West region include nutrient enrichment, sedimentation, eutrophication and turbidity of surface waters. In general, water quality is good within the forested areas of the West region. However, there is a trend for water quality to deteriorate in the lower catchments in response to land uses in non-forested areas. For example, high levels of salinity and turbidity in streams of the Maribyrnong and Werribee River basins have been attributed to intensive land use, including industrial development and agriculture.

Recreational activities can adversely affect water quality where activities, such as camping and recreational vehicle use, result in significant soil compaction, erosion or bacteriological contamination of surface water. A reduction in water quality through erosion of roads and tracks attributable to forest activities and recreational vehicle use has been identified within some areas in the West region, though this is not widespread.

The mineral springs near Daylesford are economically important as tourist attractions and as a source of bottled water. Pollution of the springs has occurred in the past as a result of septic tank effluent leaching into the aquifer. The Midlands Forest Management Plan has identified the potential for similar contamination from State forest recreation sites. Accordingly, the design of any recreation facility in close proximity to mineral springs, or likely recharge areas within State forest, must include measures to prevent pollution of mineral water aquifers (NRE 1996a).

Research by the CSIRO Division of Soils in South Australia has identified that the rate of recharge of shallow aquifers is lower under pine plantations than beneath agricultural land (LCC 1984). Groundwater monitoring bores located in or adjacent to pine plantations in Victoria also show a decreasing trend in levels of the watertable, and previous studies have indicated that plantations have a significant but localised effect on groundwater levels. These trends have been attributed to high water usage by plantations, resulting in reduced vertical recharge relative to cleared land. However, the impacts of this on the groundwater hydrology of the West region are unclear (BGARC 1997).

Water quantity (including surface and groundwater) is influenced by a range of land use activities occurring in a catchment, and is therefore an important consideration in forest management. The potential for forest management activities to impact on water quality and water quantity, and aquatic values is well recognised, and a large amount of information has been compiled on this subject both in Australia and overseas. The following sections outline research and management arrangements relating to water quality and quantity.

Research on Water Quality and Yield

Much research on water quality and yield has been undertaken in forested catchments of the Central Highlands region, given the importance of these catchments to Melbourne's water supply. About half of Melbourne's forested water supply catchments are covered by ash-type forests, with the remainder covered by mixed species eucalypt forest. The ash-type forests yield 70 to 80 per cent of Melbourne's water and, therefore, most catchment research has concentrated on the ash forests. Results from this research are relevant to ash-type forests in the West region and, more generally, to other forest types.

In the Central Highlands, catchment experiments have been established in both mature and regrowth dominated catchments. Studies have included the affects of fog drip, canopy interception, soil moisture depletion, transpiration and plant water relations on water yields in Mountain Ash (*Eucalyptus regnans*). This research has also investigated the effects on water yield of:

- the conversion of old forest to regrowth stands, through wildfire and clearfelling;
- the selective cutting of mature stands;
- thinning in regrowth stands; and
- initial stand stocking at the time of regeneration.

Furthermore, aspects of water quality have been investigated through studies on:

- fuel reduction burning;
- wildfire; and

- the effect of traffic patterns and road maintenance procedures on the generation of silt from unsurfaced roads (O'Shaughnessy and Jayasuriya 1987).

The effects of 'best practice' forest harvesting and regeneration operations on water yield and water quality were investigated in the Corranderrk Experiment, which involved a comparative study based on analyses of long term base data, a control catchment, and two roaded and logged catchments. One of the logged catchments was clearfelled and regenerated and the other was selectively felled (O'Shaughnessy and Jayasuriya 1991). The results to date indicate that water yield in the selectively felled catchment declined less than in the clearfelled area. However, the more intensive road network of the selectively felled catchment affected water quality for 10 years, compared with five years for the clearfelled catchment (Langford *et al.* 1982).

The hydrology of 1939 regrowth ash forests has been studied using 15 catchments receiving various treatments since 1969 as part of the North Maroondah Experiments. These treatments include:

- **Thinning** — a 54 per cent patch cut and a 50 per cent uniform thinning increased stream flows by about 20 per cent over 12 years, with the 50 per cent thinning being more persistent. The thinned forest maintained its annual growth rate because the remaining trees grew faster (O'Shaughnessy and Jayasuriya 1991).
- **Clear felling and regeneration** — at densities of 500, 2 000 and 20 000 trees per hectare. Monitoring of the effects on streamflow is continuing, but a longer data run is required before conclusions can be drawn (O'Shaughnessy and Jayasuriya 1991).
- **Strip thinning** — alternate 35 m wide strips cut along the contour have increased streamflow by 20-25 per cent (O'Shaughnessy and Jayasuriya 1991, O'Shaughnessy *et al.* 1993). Overall reduction in annual growth rate by approximately 40 per cent has occurred because growth response to thinning has been restricted to the boundaries of the retained strips (O'Shaughnessy and Jayasuriya 1991).

A study by Grayson *et al.* (1993) in catchments in the Central Highlands concluded that the impact of well-supervised timber harvesting on water quality is small. They noted that the suspension of logging during wet weather, the use of buffer strips, and the management of runoff from roads, snig tracks and log landings, eliminated contaminated runoff into streams.

O'Shaughnessy (1995) noted that roads and tracks may present a greater hazard than timber harvesting with regard to sedimentation of streams. Preliminary results of monitoring in the Traralgon Creek catchment by Sadek *et al.* (1998) showed that the existence of unsealed roads in forested catchments have an impact on stream turbidity and suspended sediments. The research by Grayson *et al.* (1993) and work by Haydon *et al.* (1991) also suggests that there is a positive relationship between the frequency of road use and the production of coarse sediment and total sediments. This highlights the need for high standards of road construction and management to help prevent the entry of runoff into streams (Haydon *et al.* 1991).

Dargavel *et al.* (1995) also discussed the impact of timber harvesting and roads on water quality. Based on local and overseas studies, they concluded that avoiding direct stream disturbance and preventing turbid inflows provided a high level of protection. Dargavel *et al.* (1995) highlighted the importance of developing standards, and the application and monitoring of these in forest management. These include the application of codes to road construction and maintenance.

The literature demonstrates that different silvicultural systems have different impacts on water yield and quality within the harvesting areas, but that the greater impacts are caused by associated infrastructure and roading. In clearfelling operations, for example, much of the

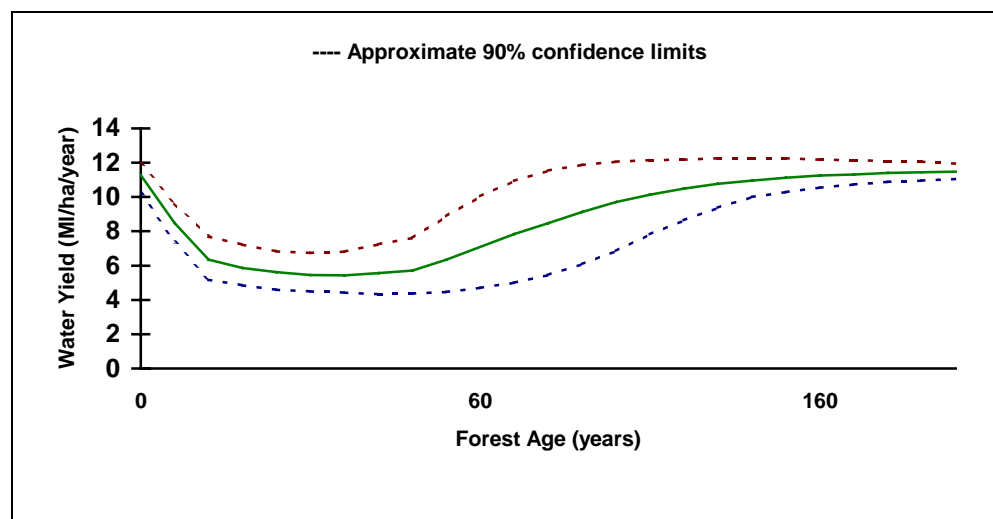
road network can be closed and revegetated after harvesting, whereas the alternative selection systems might require more regular access, hence the need to maintain the road network (O'Shaughnessy and Jayasuriya 1987). In this sense, alternative silvicultural systems may generate higher sediment loads in comparison with clear felling systems.

Hydrological research in the Central Highlands also indicates that large-scale regeneration or reforestation activities following timber harvesting or wildfire may reduce long term water yields in Ash forests (Kuczera 1985), as young, fast growing forests use more water. A significant reduction in water yield has the potential to adversely affect aquatic values and may also necessitate additional water storage capacity to maintain domestic and irrigation water supplies.

In a study of water yields of regenerating Ash forests following the 1939 bushfires, Kuczera (1985) established a model for predicting changes in water yield following wildfire. The model indicates that immediately following wildfire there is an initial increase in water yield due to increased surface run-off and groundwater flows. As the forest regenerates, water yield decreases to a minimum of about half the original yields at 20-30 years, and then steadily increases to pre-fire yields at around 150 years (Figure 9.1). This relationship between forest age and water yield in Ash forest also applies to areas subjected to clearfelling, which can be considered as a silvicultural replication of wildfire disturbance. Kuczera (1985) also showed that for every one per cent of mature forest converted to regrowth, a decline of 6 mm in annual water yield could be expected some 30 years later. The model has wide confidence limits, particularly for forests aged between 50 and 120 years, and Kuczera (1985) indicated that another 30-40 years of data are required for validation of the model.

Monitoring of sub-catchments under controlled conditions has shown the effects of clearfelling/regeneration in the Melbourne Water experimental catchments to be broadly consistent with the Kuczera model. In the Piccaninny catchment, a decline in water yield to 50 per cent of the pre-treatment level has been recorded in response to clearfelling and regeneration of 80 per cent of the catchment.

Figure 9.1: Relationship between Forest Age and Water Yield in Ash Forests of the Central Highlands



Source: Abbott *et al.* 1993

In a study of the effect of timber harvesting on stream flows in the Otway Ranges, Moran (1988) concluded that changes to water yield following timber harvesting would be similar to those at the lower level of change in Central Highlands forests. Moran identified differences

between the Otway and Central Highlands Mountain Ash forests that would affect the response of water yield to harvesting. These include:

- a larger mixed species component in the mountain ash forest association;
- the presence of relatively unstocked, mixed age mountain forest; and
- slower growth rates in the Otways, attributed to higher summer moisture stress from shallow soil profiles and therefore lower soil water availability.

The effects of timber harvesting and wildfire on water yield in mixed species forests are less well understood. Read Sturgess and Associates (1994), in a study of the Thomson catchment, noted that water yields from mixed species forests are much lower than in ash forests because these forests grow in areas with lower rainfall and have higher evapotranspiration rates. Mixed species forests are generally found in the more exposed, lower elevation areas and on northern and western slopes at higher elevations, where fire occurs more frequently, but at lower intensity than in ash. Consequently, mixed species forests are dominated by fire-resistant eucalypts, such as the stringybarks and peppermints. They are capable of recovering from low and medium intensity fire disturbance and are usually of mixed age, with fewer areas of regrowth forest created after a given disturbance event (Kuczera 1985).

Accordingly, fire may not have as significant an effect on the water yield in these forests as in ash type forests. There are no recent long term catchment results available for mixed species forests on the eastern seaboard that indicate the effects of clear felling and regeneration on stream flows (Dargavel *et al.* 1995). However, following clearfelling of mixed species forest in the Reefton experiment in the Central Highlands, Nandakumar and Mein (1993) estimated that a reduction of 10 per cent in the catchment forest cover led to a corresponding 33 mm increase in runoff. Water yields peaked two to three years after the clearing and then declined to pre-treatment levels after five to eight years. These results should be regarded as preliminary at this stage.

Other research which addresses water yields and silvicultural practices in mixed species forest has produced variable results. The yields from these forests, according to Moran (1988), vary considerably depending on the location and vigour of stands and possibly the forest age, with little or no change in catchment yield with age in the drier forests and changes similar to low rainfall ash forests in the wetter areas. O'Shaughnessy *et al.* (1995) showed that in the Lerderderg mixed species forest there was no statistical long-term effect on water yield, after logging 16 per cent of an area. However, work by Cornish (1993) in high rainfall (non-ash) forests of Karuah in northern NSW has shown a similar response to Victorian ash forest over the six years since harvesting. In response to these disparate results, Dargavel *et al.* (1995) recommended that further research was required into the hydrological responses in mixed species forests.

Forest Management Arrangements

On State forest, water quality is protected through a range of techniques that limit the opportunities for soil or high-energy water to flow directly into drainage lines. Forest operations in the West region are regulated in accordance with the Code of Forest Practices for Timber Production (NRE 1996b) and regional prescriptions which provide for the protection of filter strips and buffers on drainage lines and streams, and set limitations on timber harvesting operations in steep terrain. Standards for the design, construction and maintenance of roads consider soil properties and their management to protect water quality. Timber harvesting and road use are constrained seasonally in response to weather conditions, through the application of road closures and harvesting restrictions to minimise adverse effects on water resources.

The Code provides the basis for detailed harvesting prescriptions and the preparation of individual coupe plans, taking account of local conditions such as soil type, rainfall and the type of harvesting operations. Minimum standards are provided as guidelines, but these may be increased to enhance environmental protection through regional prescriptions in coupe plans. Forest operations in the West region are also conducted in accordance with FMA timber harvesting prescriptions, which include specifications for the construction, drainage and maintenance of roads and tracks.

Key features and provisions of the Code for minimising soil erosion and protecting water quality in forest areas are summarised in the box below. However, it is emphasised that the full Code and regional prescriptions contain significantly more detail on measures to protect water quality and aquatic habitat.

The road and track network in forests of the West region is managed by NRE, Parks Victoria, Hancock Victorian Plantations (HVP), local municipalities and the Roads Corporation (VicRoads). The majority of roads in State forest and plantation areas were built prior to the introduction of the Code of Forest Practices for Timber Production. Since the release of the Code, there has been a progressive improvement in the standard of road construction and maintenance. However, some of the road network, established prior to the Code, does not meet current standards and therefore is a potential source of sediment. Many of these roads were built to carry traffic for a short period, or to cater for infrequent use in the drier periods of the year, but they are now used for recreation purposes throughout the year. The use of these roads and tracks can be unsafe during wet conditions and can cause serious degradation to environmental values. Restrictions on the use of roads occur in some water supply catchments.

Increased stream sedimentation is regarded as a threat to species e.g. the Variegated Pygmy Perch (*Nannoperca variegata*) in the Portland area. Therefore, management prescriptions, including special requirements, are in place for stream buffers, roads and stream crossings in catchments containing these species.

The affect of timber harvesting and regeneration on water quantity and quality can also be managed by spatial (size and distribution) and temporal (time) controls on timber harvesting operations in catchment areas.

| Overview of Code of Practice (NRE, 1996a) Relating Specifically to Water Quantity and Quality Issues | |
|---|--|
| ISSUE | CODE OF PRACTICE |
| Water Quantity | Priority to be given to the protection of catchments with limited streamflow which service regions with high current or potential water use. Consultation required with appropriate authorities. Adoption of longer rotations, control of stand density by thinning to maintain streamflow, limits on annual harvest areas (if appropriate) or other techniques as research knowledge becomes available. |
| Water Quality and Aquatic Habitat | Maintenance of buffer and filter strips, the minimum width of which will be determined by stream classification and will take account of local conditions including soil erodibility, rainfall erosivity and slope. |
| Slope limitations | Harvesting operations should be excluded from slopes >30°, or on lesser slopes of unstable soil where erosion risk is high. |

| | |
|------------------------------------|---|
| Log landings and dumps | Lower slope limitations will apply as necessary according to soil type, stability and moisture content, intensity and magnitude of the harvesting, the type and size of logging machinery, and season. |
| Snig tracks and forwarding tracks | Located, constructed and maintained to minimise soil disturbance and water quality deterioration. Stockpiling of topsoil should occur, where appropriate, for later use during rehabilitation. Rehabilitation required when no longer used. Must not be located parallel to drainage lines. Crossing of filter strips is to be limited. |
| Fuel dumps and machinery servicing | Located to minimise pollution of streams and wetlands. |
| Wet weather restrictions | Snigging and forwarding operations must be suspended when stream quality is threatened by compaction, rutting or soil mixing, or when water begins to flow along tracks. Flexible prescriptions for closure when climatic conditions make timber harvesting detrimental to the environment. |
| Roading | |
| Design | Roads must accommodate anticipated frequency, type and speed of traffic, soil and subgrade conditions, road drainage and water quality requirements. |
| Location | Roads must be located to minimise the number of stream crossings and interference with natural drainage. Align roads with topography, avoiding steep side slopes and damp southern aspects. Roads should not be located in or closely aligned to natural drainage lines or areas of poor or restricted drainage. Avoid steep and unstable slopes, and any disturbance to streams, buffer strips, riparian vegetation and rainforest in areas not associated with approved crossings. Avoid entry of sidecast material into streams or drainage lines. |
| Construction | Road surface runoff to be discharged away from streams and drainage lines, as far as practicable. Undertaken when climatic and site conditions minimise impact on water quality. |
| Culverts and drains | Must be installed concurrently with road construction. Draining by cross drains or outsloping required if construction is to be left over winter or an extended period. |
| Partially built roads | Closed to traffic until completed. Temporary stabilisation works required for drainage and erosion control. |
| Drainage | Roads must be cross-sloped and crowned to minimise concentrated flows and to < runoff velocities. |
| Provision of silt traps | Drainage must discharge onto undisturbed vegetation or energy dissipating structures. |
| Stream crossings | Fill positioned to minimise sediments being transported into streams. Earth embankments revegetated or surfaced, or retaining walls constructed. |
| Maintenance | Road drainage must be maintained to minimise discharge of turbid water into streams |

As noted in the text, it is emphasised that the full Code and regional prescriptions are detailed documents and this description provides an indication of the mechanisms that are employed to protect water quality and aquatic habitat.)

The standards established by the Code provide a high level of security to water quality and yield over the majority of forests in the West region. However, for some catchments used for domestic water supply, and where treatment is minimal, an additional level of security for the water supply may be warranted. In catchments where State forests comprise a large proportion of the catchment, the catchment is relatively small or where minimally treated water storages lie within or adjacent to State forest, water yield and quality may be influenced by forest operations. In these instances, special management strategies may be defined in Forest Management Plans to apply to these designated catchments, including seasonal suspension of operations, maximum coupe size and annual harvest area, and road and track management.

The Code of Practice for Fire Management on Public Land (CNR 1995d) lays down principles, standards and guidelines that apply to fire management on all public land in Victoria. This code is complementary to the Code of Forest Practices for Timber Production. It provides guidelines for fire preparation, suppression and rehabilitation activities to ensure the conservation of water catchment values. They specify that:

- fire preparation activities should be conducted in a manner that protects water values by minimising the impact of these activities, e.g. location of water points must include consideration of impacts on wetlands, riparian and aquatic communities;
- soils should be protected to prevent destruction of physical and chemical properties, and to promote stabilisation of bare or disturbed earth;
- fire control lines should be constructed outside stream beds and riparian zones, and be constructed around the contour on sloping ground;
- rehabilitation works should consider the risk of erosion, particularly in water supply catchments; and
- fire access tracks must, where practicable and without compromising their primary purpose, be constructed and maintained to minimise soil disturbance and erosion.

Forest Management Planning Process

Maintaining the quality and yield of water supplied from State forest is a key objective of forest management planning. A Forest Management Plan establishes a series of management actions and guidelines to protect water yield, and prevent soil erosion and stream sedimentation. Planning objectives in relation to water and catchments include maintaining biological values associated with rivers and streams; ensuring water quality is suitable for current and likely future use; and maintaining at least current water yields from catchments used for domestic and irrigation supply.

The forest management planning process must consider the range of legislation and policies discussed in Section 9.4 that are relevant to State forest. Prescriptions set out by Special Area Plans prepared under the *Catchment and Land Protection Act 1994* are applied where relevant. Similarly, requirements of the *Heritage Rivers Act 1992* for Heritage Rivers and Essentially Natural Catchments are incorporated into the planning process.

The development of strategies to protect the quality and yield of water requires consideration of a wide range of issues in the context of a management plan, several of which are briefly discussed below.

- **Coupe planning and design:** The planning process provides direction for harvesting within catchments to prevent loss of water quality and yield. Guidelines can relate to the need for varying silvicultural practices, limitations on annual harvest area, management and location of landings, and grade and location of snig tracks.
- **Roading:** Planning considers the extent and condition of the road network, and may incorporate guidelines relating to road location, design, construction, use and maintenance

activities. It also reviews the need for seasonal, temporary or permanent road closures based on the requirements of harvesting, recreation and fire management activities, and environmental protection.

- Fire: The planning process, in conjunction with the Code of Practice for Fire Management, considers the effects that fuel reduction burning may have on water quality and yield, and aquatic habitat, providing guidelines for the use of fire in water supply catchments.
- Other forest uses including recreation and extractive activities: The impact of these activities is addressed through the use of forest management zoning or the implementation of management actions aimed at protecting water quality and yield, such as the rehabilitation of redundant gravel pits.

Forest management plans exist for the Otway (DCE 1992) and Midlands (NRE 1996A) FMAs and the following is a description of strategies to maintain water quality and yield set out in these plans. Portland and Horsham FMAs currently do not have forest management plans and as such the Code of Forest Practice, Forest Management Prescriptions and Special Area Plans (as prescribed in the Catchment and Land Protection Act) are applied to ensure the maintenance of water quality and yield.

Otway Forest Management Plan

The Otway Forest Management Plan (DCE 1992) sets out a number of actions and objectives to protect water quality and quantity. Regard is given to the requirements of Special Area Plans that apply on State forest. For example, as a result of the Gellibrand River Special Area Plan, harvesting is excluded from State forest in the West Gellibrand and Arkins Creek sub-catchments.

To protect land from degradation that may be caused by forest management practices, land degradation hazard classes in the Otway FMA were mapped. Land systems were assessed in terms of the risk of erosion, nutrient decline, compaction, trafficability and potential contribution to stream turbidity and sedimentation when subjected to harvesting and regeneration, roading and, fire protection and suppression; hazard classes are described in DCE (1990). Minimum harvesting prescriptions are specified for each class (Table 9.8).

Table 9.8: Harvesting Prescriptions to Prevent Land Degradation, Otway FMA

| Prescription Type | | Land Degradation Hazard Class | | |
|--|--------------|-------------------------------|-------------|------------|
| | | Classes 1 – 3 | Class 4 | Class 5 |
| Seasonal Suspensions (inclusive) | | June – Aug | June – Sept | June – Oct |
| Streamside reserves (min. horizontal width) | Major Stream | 40 m | 40 m | 60 m |
| | Perm. Stream | 20 m | 20 m | 30 m |
| Filter Strip | Temp. Stream | 5 m | 5 m | 10 m |
| Slope Limitations (maximum) | | 30° | 25° | 20° |

Source: DCE (1992).

In addition, extended seasonal suspensions and slope limits apply in special water supply catchments. The following actions to protect water quality are required in such catchments:

- a maximum 25° slope limit in all special water supply catchments; 20° and 15° in declared catchments in areas of Land Degradation Hazard Class 4 and 5 respectively;
- 200 m buffers around high water level of all storages in declared catchments;
- use of chemical toilets for extended periods of dispersed camping in water supply catchments; and
- exclusion, where possible, of fuel reduction burning in Domestic Water Supply Zone B.

Almost half the Otway FMA is within special water supply catchment and, accordingly, the forest management plan gives consideration to the affects of timber harvesting and regeneration on water quality and yield in these catchments. Moran (1988) developed a methodology, based on Kuczera's model for Central Highlands Mountain Ash forests, to estimate the effects of harvesting and regeneration on average streamflow yield in the Otways. This model was used in developing forest management strategies to ensure water yields are not decreased in domestic catchments. Only existing special water supply catchments were rated and, in some cases, broken into sub-catchments for ease of management.

Further water protection measures were applied to ensure water quality. Catchments were grouped into three levels of sensitivity of disturbance, for the purposes of forest management planning, based on rainfall, land degradation hazard, catchment size and forest cover.

Measures to protect water quality and yield in the Otway FMA include restrictions on the type, extent and timing of harvesting and recreation activities, and protective buffers around water storages (Table 9.8). Maximum limits on the extent of harvesting in each special water supply catchment, per year and per decade, are detailed in the forest management plan (DCE 1992). From 1988-89 to 1997-98, 1658 ha (2 per cent) of the available catchment area in these Special Water Supply Catchments were harvested.

Midlands Forest Management Plan

The Midlands Forest Management Plan considers that the continued application of standards established by the Code of Forest Practices and, where relevant, the requirements of Special Area Plans, provide appropriate levels of water quality protection in the General Management Zone.

Table 9.9: Designated Catchments in the Midlands FMA

| Catchment | Proportion of State Forest % | Winter closure | Max. coupe size (ha) |
|---------------------------|-------------------------------------|-----------------------|-----------------------------|
| Blackwood | 68 | 1 June - 31 October | 35 |
| Bullarto | 59 | 1 June - 31 October | 20 |
| Colbrook | 75 | 1 June - 31 October | 5 |
| Collier Gap | 100 | 1 June - 31 October | 2 |
| Djerriwarrh | 50 | 1 June - 30 September | 15 |
| Hickmans Creek (Elmhurst) | 100 | 1 June - 31 October | 40 |
| Korweinguboora | 36 | 1 June - 31 October | 15 |
| Lal Lal Lake Environs | 8 | 1 June - 31 October | 5 |
| Long Gully | 100 | 1 June - 31 October | 15 |
| Merrimu | 45 | 1 June - 30 September | 40 |
| Moorabool | 21 | 1 June - 30 September | 10 |
| Mount. Cole | 70 | 1 June - 31 October | 20 |
| Musical Gully | 78 | 1 June - 30 September | 2 |
| Pykes Creek | 41 | 1 June - 30 September | 40 |
| Rosslynne | 38 | 1 June - 30 September | 40 |
| Shepherds Creek | 92 | 1 June - 31 October | 40 |
| Sugarloaf | 83 | 1 June - 30 September | 20 |
| Troy | 100 | 1 June - 30 September | 2 |
| White Swan | 37 | 1 June - 31 October | 20 |
| Wombat | 57 | 1 June - 31 October | 20 |

Source: NRE (1996)

There are, however, a number of catchments used for domestic water supply in which water quality or yield may be influenced by State forest management operations. These catchments, where State forest comprises a substantial proportion of the catchment (greater than 25 per

cent), or where water storages lie within or adjacent to State forest, warrant an additional level of security. Twenty catchments were identified as meeting these criteria and are included in the Special Management Zone (Table 9.9).

Several strategies for the management of these designated catchments will be applied:

- seasonal suspension of harvesting and stand tending operations that involve the use of heavy machinery as specified in Table 9.9;
- application of 'Guidelines for the Prevention of Soil Erosion' (NRE 1996A) to minimise soil disturbance;
- schedule timber harvesting to limit the proportion of regrowth up to 20 years old (including post-shelterwood one areas) to a maximum of 20 per cent of the area of public native forest in designated catchments;
- limit clearfell, seed-tree or first-cut shelterwood operations to 5 per cent of the area of public land in designated catchments over any three-year period;
- review the design and use of roads and stream crossings in designated catchments, and ensure a high priority in annual maintenance programs;
- apply seasonal and permanent road closures and
- limit the proportion of public land subject the fuel-reduction burning to no more than 20 per cent in one year. Avoid fuel-reduction burning in very small catchments or close to water storages. Avoid the destruction of riparian vegetation.

9.6 MONITORING

The management arrangements in place for the protection of water values are not static, and are subject to review through Victoria's environment management systems, which are considered further in the ESFM assessment in Chapter 16 of this report. However, the major processes and actions relevant to monitoring and reporting of hydrology-related issues include:

- regular audits of timber harvesting operations against the Code and regional prescriptions; and
- regular monitoring of water quality in State forest streams through the Victorian Water Quality Monitoring Network, including monitoring by the EPA. Data from this is used to detect trends in water quality and yield in forest catchments.

10 MINERALS

10.1 INTRODUCTION

The aim of the regional assessment of minerals potential is to draw together new and existing information to aid the consideration of economic effects of forest use options to be considered in the development of the RFA. In particular this assessment contributes to the evaluation of:

- the nature of mineral resources in forested land;
- current and potential uses of forested land;
- economic value of mineral products;
- structure and regional significance of the mining industry; and
- resource, infrastructure and policy requirements for the establishment of minerals industries.

The National Forest Policy Statement recognises the need to consider access for mineral exploration and extraction activities in deciding on land use for public native forests. Access for mining and exploration varies with land tenure. Due to the incomplete nature of information on minerals resources and the fact that exploration is a dynamic information-gathering process, continued access to land is a significant issue for the mining industry and for future mineral development.

This chapter outlines: identified mineral deposits; the potential for a number of deposit types; indicators of the region's potential mineral value; and factors affecting this value. Mineral deposits outside but close to the boundary of the region (within 15 km) are noted if they are considered to have significance for mineral potential within the region. In this chapter the study area is referred to as 'the West region' or as 'the region'.

Brown coal, gold and various construction materials are currently mined and extracted in the West region. It is estimated that the gross value of the mineral production in the region in 1998 from these operations was approximately \$200 million (ABARE estimate).

The region is a major source for construction materials and about half of Victoria's total production in 1997-98, worth approximately \$294 million, was extracted in the West region under the *Extractive Industries Development Act 1996*. Important industrial minerals and construction materials quarries in the region supply Melbourne, Ballarat-Bendigo, Portland-Warrnambool and other regional centres.

Brown coal is mined for power generation from the Anglesea coalfield near Geelong at a rate of just over 1 million tonnes per year.

There are large sub-economic mineral sands deposits in the northwest of the region. Recent exploration in the Murray Basin, however, has delineated three potentially economic strandline type deposits. Results from current exploration suggest that the Murray Basin could be a very significant heavy mineral sands province.

The Stawell gold mine is the largest gold producer of the region and Victoria. Three of the other 83 gold tenements in the region produced more than one kilogram of gold in 1997-98. An open-pit gold mining operation is proposed at Big Hill, near Stawell. The region was a major gold producer last century, and many old deposits have recently attracted exploration interest. Resources have been identified at a number of prospects within the region or immediately adjacent to it.

The region is highly to moderately prospective for a number of mineral deposit types and is therefore likely to contain a number of undiscovered deposits.

Where access for exploration is possible, both undeveloped and as yet undiscovered deposits may be mined in the future, subject to normal approval processes, and yield economic benefits.

10.2 KNOWN AND POTENTIAL RESOURCES OF METALLIFEROUS AND EXTRACTIVE MINERALS

Geological Setting

The regional geological setting is shown on Map 10.1, and the main geological and mineralising events are summarised in Tables 1a and 1b (refer Appendices 4 and 5).

Palaeozoic basement rocks in the West region are grouped into four structural zones:

- *Adelaide Fold Belt (Glenelg Zone)*: The oldest rocks in the West region are the Neoproterozoic to Early Cambrian rocks of the Glenelg Zone. This sequence commenced with a period of basaltic volcanism followed by deposition of marine sediments and episodes of mafic intrusion now represented by the Glenelg River Beds. The occurrence of sedimentation contemporaneous with basaltic volcanism suggests that the Glenelg River Beds were deposited in a tectonic rift environment (Gibson & Nihill, 1992). Intrusions of granitoid during the Cambrian were associated with widespread metamorphism and the formation of low-grade metamorphic rocks. During the late Cambrian, the sediments and volcanics were deformed by the Delamerian Orogeny of the Adelaide Fold Belt resulting in the development of high-grade regional metamorphics. During the Lower Devonian there were major eruptions of acid volcanics (Rocklands Rhyolite). Following deformation, the Cambrian rocks were intruded by post-tectonic granites during the Upper Silurian to Lower Devonian.
- *Lachlan Fold Belt (Stawell Zone, Bendigo-Ballarat Zone, Melbourne Zone)*: During Cambrian to Mid Devonian (ca 500-370 Ma), the development of the Lachlan Fold belt in the region comprised cycles of marine and non-marine deposition alternating with two major phases of rock deformation (Benambran (ca 430 Ma) and Tabberabberan (ca 385 Ma); involving folding, faulting, intrusion of granites (Lower Devonian to Upper Silurian), volcanism and metamorphism. The basement rocks to the Lachlan Fold Belt are Cambrian greenstones (including the Stavelly Volcanics). Most of the mineral deposit formation in the region took place during this episode; it is associated with magmatic, volcanic and metamorphic processes, and with phases of major deformation.
- *Otway Basin*: The Otway Basin comprises a sequence of Cretaceous–Tertiary sediments. The formation of the basin involved two main tectonic phases — an Early Cretaceous rift phase marked by rapid subsidence, and a Late Cretaceous–Tertiary post rift phase characterised by slower subsidence (Tickell, Edwards & Abele, 1992). The Otway Basin is of interest for oil and gas exploration. Several small gas fields have been discovered.
- *Murray Basin*: By mid Cretaceous, erosion had produced a landscape of low relief over the entire region. Deposition of a thick sequence of marine and terrestrial sediments, including brown coal within the Murray Basin commenced in the Cretaceous and continued to the present. The heavy mineral sands were deposited in the basin during late Miocene to early Pliocene.

Known Occurrences and Resources of Metalliferous and Extractive Materials

Map 10.2 shows 7852 mineral occurrences, old mines and deposits in the West region. Many of the 5805 gold occurrences occur within 51 goldfields. The Stawell gold mine is the largest gold producer of the region and Victoria. Three of the other 83 gold tenements in the region

produced more than one kilogram of gold in 1997-98. An open-pit gold mining operation is proposed at Big Hill, near Stawell.

Important industrial minerals and construction materials quarries in the region supply Melbourne, Ballarat-Bendigo, Portland-Warrnambool and other regional centres. Brown coal is mined for power generation from the Anglesea coalfield near Geelong at a rate of just over 1 million tonnes per year.

There are large sub-economic mineral sand deposits (fine-grained WIM150 type) in the northwest of the region. Strandline type heavy mineral deposits have been recently discovered at Cottesloe, Acapulco and Bondi, and their economic significance is currently under investigation.

Gold

Victoria's total gold production until 1988 was approximately 2450 tonnes of gold (Ramsay and William, 1988), of which in excess of 550 tonnes was produced in the West region. The most significant gold resources, as recorded in 1996, are about 35 tonnes of gold at Stawell, 31 tonnes at Ballarat East Project, and 22 tonnes at Ballarat East Gold Mine.

Small-scale alluvial gold mining is taking place at the Avoca Gold Project, near the town of Amphitheatre. Other small resources are yet to be mined and exploration is taking place to the south west at Breccia Hill.

The Stawell goldfield has recorded production of almost 90 tonnes of alluvial and primary gold. Since 1980, underground gold production has come from the Wonga and Magdala mines. Production for the year to end December 1998 was 2.5 tonnes (MINMET 1999). An open pit gold mine operation is proposed at Big Hill, near Stawell, but resource figures for this deposit are not available (Buckley 1999).

An estimated 155 tonnes of gold was recovered from surface alluvial workings in the Ballarat East goldfield from 1851 onwards and subsequent hard rock mining continued until 1917 with 37.2 tonnes produced from 14 significant mines. A medium to large inferred underground gold resource has recently been delineated below the historical underground workings at the Ballarat East Project, located on the edge of Ballarat city. Surface drilling, refurbishment of an old shaft with associated drives (tunnels), and tunnelling of a new decline (with exploration drives to provide underground drilling access) will enable better definition of the resource (Snowden Corporate Services 1998).

A medium-sized gold resource remains at the Ballarat East gold mine and the mine is currently being reevaluated with a view to reopening it (William Resources Inc 1996 Annual Report, 1997 Quarterly Reports, Goldminco NL Annual Report 1998).

Base metals

Significant copper mineralisation occurs at the Mt Ararat copper deposit, near Ararat. Exploration in the early 1970s identified a gossan and a small pyrite-chalcopyrite-sphalerite lode associated with previously known copper mineralisation. A small resource was delineated and is open at depth (Cochrane, 1982 cited in Bush *et al* 1995a).

Copper mineralisation is also associated with gold at the Glendhu Reef and Fiddlers Creek deposits. Old mine workings at the Nolan Creek (or Roseneath) silver-lead deposit, north of Casterton, were reported to have produced gold, silver, lead and copper (Ferguson 1894, cited in Bush *et al* 1995b).

Platinum group metals

Minor platinum group metal mineralisation is associated with gold mineralisation at the Glendhu Reef, west of Avoca (Weston 1992, cited in Bush *et al* 1995a) and recorded at 36 other gold occurrences (VICMINE 1996).

Tungsten

A small deposit of wolframite occurs at Henry's Hill, just north of the region, where coarse bladed wolframite occurs in quartz veins (McKenzie & Nott 1981, cited in Bush *et al* 1995a).

Molybdenum

There is a small occurrence of molybdenum at Neild's Gully, west of Ararat (King 1985).

Tin

Alluvial tin concentrations occur at several localities in the west of the region, but the only reported historical workings were on Mather Creek in the early 1900s (Bush *et al* 1995b).

Bismuth

Bismuth mineralisation has been located at Redbank and in gold mineralisation at the Glendhu Reef (Weston 1992, cited in Bush *et al* 1995a).

Iron Ore

Thin lateritic ironstone deposits, of possible Tertiary age, occur at Lal Lal, Little Whipstick Forest and north of Ballark. Resources of 750 000 tonnes at about 48 per cent iron at Lal Lal (Krause 1880, cited in Roberts 1984) and iron was mined here in the late 1800s.

Nickel

Low-grade nickel in serpentinite occurs at The Hummocks, north of Casterton (Bush *et al* 1995b).

Antimony

A small number of antimony occurrences are located in the Blackwood Goldfield and the Coimadai area with only the Coimadai Antimony mine having recorded substantial workings (Roberts 1984).

Silver

Silver mineralisation closely associated with gold is found at Glendhu Reef (up to 1 800 grams per tonne) and Fiddlers Reef (up to 100 grams per tonne) (Jenkins 1901, cited in Bush *et al* 1995a). Silver is associated with copper and gold mineralisation at Mt Ararat and native silver occurs as small specks and filaments at the Glendhu reef. At Fiddlers Reef, silver possibly occurs in solid solution in galena or as fine disseminations of discrete silver sulphides (Cayley and McDonald, cited in Bush *et al* 1995a).

Mercury

Stirling (1898), cited in Bush *et al* 1995b, reported the occurrence of fine globules of mercury, highly permeated throughout a bright red clay on Pine Hills station, about 20 km east of Edenhope.

Mineral Sands

Given favourable market conditions, the massive deposits of the southern Murray Basin in

Victoria have the potential to be a world class, future source of mineral sands (Bush *et al* 1995a).

Five very large flat-lying fine-grained mineral sands deposits of good grade have been delineated to the south and east of Horsham, and they are amenable to large scale dredge mining. Four of the deposits lie within the region, while the WIM 250 deposit lies just to the north of the region. Fine grain size of the minerals prevented development of the deposits despite promising mineral recoveries achieved in pilot processing plant testing in the late 1980s, using agglomeration and flotation techniques (CRA Ltd 1988, Wimmera Industrial Minerals 1990, CRA Ltd 1992).

Exploration in the region, 60 km south west of Horsham, recently located coarser grained strandline heavy mineral deposits named Cottesloe, Acapulco, and Bondi (Craton Resources NL 1999). These deposits occur in the Toolongrook strand system. Cross section widths of mineralised sands range from a few hundred to over a thousand metres with significant thicknesses of 10-20 m. Ilmenite is the dominant ore mineral with significant amounts of rutile and zircon.

Brown coal

Brown coal occurs in the Otway and Murray Basins within the region. All production and economic resources are in the Tertiary age sedimentary sequences of the Otway Basin, but there are also significant resources of poorer quality coal in the Tertiary age sediments of the Murray Basin.

The Anglesea coalfield, south of Geelong, is the highest grade large deposit of brown coal in Victoria. Current production is about 1.1 million tonnes of coal per year. There are up to eight seams of more than three metres thickness, with the thickest (25-40 m) upper A1 seam providing the bulk of the coal mined. Economic coal also occurs in three to six seams lower in the sequence. The coal is used to generate power for the nearby Point Henry aluminium smelter (Gloe *et al* 1988).

In the Altona-Bacchus Marsh coalfield, west of Melbourne, brown coal seams from one to 40 m thick have been drilled in many boreholes between Newport and Bacchus Marsh. Sediments overlie the coal at the western end, but the rest is covered by basalt, which is locally up to 100 m thick (Gloe and Holdgate 1991). It is likely that an area of 50 000 ha between Altona and Bacchus Marsh is coal bearing. Coal has been mined at Altona, Bacchus Marsh, Parwan, Lucifer, Star, Boxlea and Maddingley No 1 & 2 open cuts (Gloe *et al* 1988).

Production of brown coal in the Lal Lal coalfield between 1914 and the 1950s amounted to about 57 500 tonnes (Gloe *et al* 1988).

In the Wensleydale coalfield, south of Winchelsea, open cut mining produced 17 000 tonnes of brown coal from 1923 to 1932. Latest production was 2 945 200 tonnes of brown coal to 1959 (Gloe *et al* 1988).

In the Otway ranges south of Deans Marsh, the Benwerrin coalfield contains a thin (2-3 m) brown coal seam from which 7 000 tonnes of coal were produced from 1899 to 1903, and 4620 tonnes from 1943 to 1948. This coal has the lowest moisture content and highest calorific value of any Victorian brown coal (Gloe *et al* 1988). Production in the Deans Marsh-Bambra coalfield, just north east of Deans Marsh, from a nine metre brown coal seam amounted to 5875 tonnes from 1901 to 1905, and 5360 tonnes from 1950 to 1952 (Gloe *et al* 1988).

The Tertiary Dilwyn Formation in the far west of the region contains thin (60 per cent were less than one metre thick) uneconomic seams of Tertiary brown coal found in bores (Bush *et al* 1995b).

Black Coal

Black coal deposits are found within early Cretaceous non-marine sediments belonging to the basal sequences of the Eumerella Formation in the far west of the region. Thin seams of black coal (less than one metre thick) are found outcropping at Merino and Dwyers Creek, (Bush *et al* 1995).

Peat

A large peat deposit 10 m deep over an area of 650 ha has been identified at Swan Marsh for use in soil conditioning, horticulture and fertiliser (McHaffie and Buckley 1995).

Oil Shale

Shales containing small amounts of oil have been found in the Dilwyn Formation, in the far west of the region. Analysis of 10 samples of dark brown and black muds and clays recorded yields of up to 14 litres per tonne with an average 5.7 litres per tonne (Meyer 1982, cited in Bush *et al* 1995b).

Oil and Gas

The first petroleum exploration well was drilled near Port Campbell in 1959 and some 25 wells followed. Commercial quantities of gas were discovered in North Paaratte 1 well in 1979, and a small gas field supplies Warrnambool with natural gas (Tickell *et al* 1992). In 1994, oil and gas was found in Mylor 1 well, three kilometres north west of Port Campbell, and also in three other wells in the area (Edwards *et al* 1996). The Minerva gas field was discovered 12 km offshore of Port Campbell and is planned to come into production in the near future.

Limestone

Tertiary age limestone suitable for cement making is extracted from two large quarries at Batesford and Waurn Ponds, near Geelong. The Batesford Limestone has been used for cement making since 1890. It has also been used for lime production and building stone. Resources at Batesford and Waurn Ponds are probably sufficient for a quarry life of over 50 years at each location (McHaffie and Buckley 1995).

The Tertiary age Port Campbell Limestone is quarried at Heywood, Moyne, Allansford, Timboon and Curdie Vale for road making and also for agricultural lime at Timboon. Quaternary age dune limestone is extracted for road making at Princetown (Tickell 1992). Potential Tertiary age limestone resources also exist at Tyrendarra, Bald Hill, Princetown-Warrnambool area, Kawarren-Gellibrand area, Aire, Aireys Inlet-Torquay area, in the Whalers Bluff Formation and the Coimadai area (McHaffie and Buckley 1995).

Quaternary dune sands are quarried near Portland, Tyrendarra and Warrnambool for agricultural lime and road making (McHaffie and Buckley 1995). Quaternary age limestone was worked for agricultural lime in small pits near Lara (Spencer-Jones 1970, cited in Abele 1977), as were dune sands on the Nepean Peninsula (Keble 1950, cited in Abele 1977).

Silica

Silica sand of particular economic significance occurs in three main areas in the region:

- The Tertiary units in the Otway Basin comprising the Wiridjil Gravel, Moomowroong Sand and the Dilwyn Formation, in an area north east of Princetown.
- The Tertiary Werribee Formation in the Bacchus Marsh area.
- The Malanganee Sand in the southwestern part of the region.

Pebble and cobble mine dumps from deep lead-gold mining are significant future sources of lump silica. Dumps from the Berry Lead, near Allendale, are being worked and other suitable deposits may be identified, especially in the Avoca-Clunes-Maryborough-Creswick area (McHaffie and Buckley 1995). Quartz pebbles from deep lead mine tailings dumps in the Ballarat area are crushed and used to make aggregate for facing buildings, or further milled to a powder for use in ceramics, paints and abrasives (King 1985).

Construction materials

Construction materials and industrial minerals have become increasingly important within the Melbourne Supply Area (MSA) for many uses including housing, buildings, roads, railways, ports, and bridges (Olshina and Jiricek 1996). Construction materials worth about \$294 million were extracted in 1997-98 in Victoria under the *Extractive Industries Development Act 1995*, and about half of this was produced in the West region (Department of Natural Resources and Environment, 1999). A small part of the region in the east overlies about one third of the MSA and contains major resources and quarries of these commodities.

Within the Supply Area and around Ballarat, Extractive Industry Interest Areas have been identified (see Figure 10.2) for construction materials by taking into account commodity resources, cultural, environmental and competing land use factors. However, resources are not limited to these areas (Olshina and Jiricek 1996).

There are 334 active or intermittently active construction materials Work Authority Licence tenements in the region and some are grouped to form an area big enough to support a larger quarry. One hundred and thirteen tenements are for sand/gravel, 74 for basalt, 33 for scoria, 29 for limestone, 28 for clay/clay shale and the rest are for volcanic tuff, sedimentary rocks, quartzite, soil, granite, hornfels, trachyte, slate and rhyodacite. Work Authority tenements do not cover all of the many small pits and quarries throughout the region that local government authorities use to extract large volumes of stone, sand and gravel for road construction. About eight million tonnes of hard rock, and about 2.5 million tonnes of sand and gravel were extracted in 1994-95 for construction purposes in the North/West Region of the MSA, which overlaps the eastern end of the West region (Olshina and Jiricek 1996).

Aggregate

Basalt of the early to mid-Tertiary Older Volcanics is mined from major quarries at Kilmore East and Bulla. Newer Volcanics basalt quarries exist at Werribee, Deer Park, Melton, Point Wilson and near Ballarat. Scoria is mined at Mount Fraser, Mount Anakie, She Oak Hill and Rockbank (Olshina and Jiricek 1996). There are 29 scoria pits and 14 tuff pits operating between Portland and Colac (McHaffie and Buckley 1995). Scoria and tuff are used for local minor road construction in the central southern part of the region.

Hornfels (rock hardened by heat and pressure), often found around the margins of igneous rock bodies, is quarried at Greenvale and Stawell. Granitic rocks are also extracted at Greenvale (McHaffie and Buckley 1995). Cambrian cherts and siliceous shales are used locally for road making in Romsey Shire (Olshina and Jiricek 1996).

Acid volcanics of the Rocklands Rhyolite in the central west of the region are exploited by one major rhyodacite rock quarry located north west of Hamilton (McHaffie and Buckley 1995).

Near Portland, there are some large operating limestone quarries and limestone deposits are quite widespread further to the north. Other sites of limestone are used intermittently for road-making and agricultural purposes.

A granite and hornfels quarry is located at Oaklands Junction, near Bulla, and hornfels is quarried at Quarry Hill, just east of the region (Olshina and Jiricek 1996).

Sand and gravel

The bulk of the sand extracted in the eastern end of the region comes from the Tertiary age Werribee Formation north of Bacchus Marsh and Quaternary age deposits at the You Yangs. Major extraction of Tertiary sand and gravel, suitable for concrete and aggregate, up to 30 m thick takes place from a number of pits around Darley (Olshina and Jiricek 1996). Resources were estimated at 20-30 million m³ with further potential resources to the west of Darley (Roberts 1984). Significant resources of granitic coarse sand and fine gravel occur south and east of the Pykes Creek Reservoir, while potential major sand and gravel resources are located between the Lal Lal Reservoir and the western end of the Parwan Valley (Roberts 1984). Sand and gravel for road construction have been quarried extensively in the Gherang area, near Anglesea (Tan 1971, cited in Abele 1977), and there is potential for major sand resources overlying brown coal at Anglesea (McHaffie and Buckley 1995).

Tertiary age quartz gravels, deep lead mine tailings, granitic sands, weathered Paleozoic age sediments and lateritic gravel are all used for road making. The Tertiary gravels are widespread in the Ballarat area and they provide the potential for long-term regional gravel resources. Granitic sand/gravel is quarried intermittently at Mount Misery, Mount Beckworth, Mount Bolton, Mount Emu, Nanima Hill, Mount Bute, on the Stawell granitoid pluton, and in the Langi Ghiran-Mount Cole area (Olshina and Jiricek 1996).

A number of Extractive Industry Work Authorities allowing the removal of rock, sand and gravel are current in the far west of the region. Late Cainozoic flows of basalt and, to a lesser extent, scoria are widespread throughout the far west of the region. Ironstone or 'buckshot' gravel suitable for unsealed road sheeting is also widespread and is well developed in the extensive laterite horizon capping much of the Dundas and Merino Tablelands. The Quaternary Malanganee Formation is widespread throughout much of the far west of the region and contains very large deposits of wind blown siliceous sand suitable for filling and concrete (Bush *et al* 1995b). Sand extracted from this Formation west of Portland is exported to Hawaii for cement making (McHaffie and Buckley 1995).

Clay

Large Tertiary age secondary (or sedimentary) clay deposits are located in the Parwan Valley/Darley and Lal Lal areas.

Extensive clay deposits occur in the Ballarat, Buninyong and Enfield areas and host a number of quarries (McHaffie and Buckley 1995). In Stawell white clay is taken for brick making from a number of pits, and red clay from tailings dumps around the town (King 1985).

Red firing clays are readily available locally, but the resources of local white clays are diminishing. Increasingly, white clays are being sourced from deposits within the region at Enfield and Rowsley (Olshina and Jiricek 1996).

Potential sources of high purity, low plasticity kaolin occur in thick, extensive kaolinised zones in granite in the Morchup-Pittong, Yendon-Lal Lal areas and near Ararat (Eversley Pluton). Deeply weathered intermediate composition dykes in the Egerton and Lal Lal area

also offer potential. Secondary kaolinitic ball clay potential exists in old lake/basin fills (eg. Rowsley and Lal Lal Basins) and old river channels (eg. Campbellfield). Areas of interest for kaolin deposits are shown in Figure 10.2 (McHaffie and Buckley 1995).

Dimension Stone

Basalt has been the most widely used Victorian building stone since the 1930s and over the past 20 years it has come mainly from Port Fairy and Deer Park. Small amounts of basalt have been used in buildings but its primary use is in paving. Victorian basalt production was 10 785 tonnes in 1995-96 (King and Weston 1997).

Small quantities of grey granite from small quarries at Bulla were used for building in Melbourne. Red granite from Dergholm has been used intermittently for Melbourne buildings, while pink and red granite also occur nearby at Baileys Rocks and Poolaijelo respectively. Pink granite at Mount Misery has not been quarried but its potential is rated highly, with testing planned by the industry (King and Weston 1997).

Barrabool Sandstone, Stawell Sandstone (Grampians Group) and Permian age sandstone from Bacchus Marsh-Lauriston are the most widely used sandstones in Victoria. The Stawell Sandstone is homogenous and extremely durable, but most of the other sandstones outside the Grampians have significant deterioration problems. Pink to brown sandstone, Stawell Sandstone, is quarried at Dunkeld and Mount Bepcha (King and Weston 1997). Sandstone in the Bacchus Marsh area has been extracted for local use as dimension stone from a number of small quarries and for several Melbourne buildings from the Bald Hill Upper Quarry, but it deteriorates badly. More durable sandstone is found in the Greendale and Little Whipstick Forest areas. Barrabool Hills sandstone has been used extensively in Geelong, Bendigo and Melbourne buildings, but its weathering properties are extremely variable (Spencer-Jones 1970, cited in Abele 1977).

Batesford Limestone was used for dimension stone around 1930. Quarrying for cement has rendered the Batesford and Waurm Ponds quarries inaccessible, but potential still exists for durable dimension stone quality limestone at Batesford (King and Weston 1997).

Slate is quarried at Percydale, in the north of the region, where production for paving is small. Disused slate quarries are located north west of Coimadai and the slate was used for ornamental facing and paving (King and Weston 1997).

Kaolin

Deeply weathered, kaolinised, decomposed granite occurs in the Pittong and Gong Gong-Lal Lal areas. Medium sized kaolin extraction occurs at Lal Lal and Pittong for paper manufacture, ceramics and other uses (King 1985).

High-grade siliceous china and stoneware clays derived from weathered, kaolinised dykes occur at Stawell, Clunes, Snake Valley and south east of Ballarat (King 1985).

Secondary (or transported) kaolinitic clays at Rowsley have been mined for 60 years and currently produce semi-ball clay for ceramics and firebricks. Large resources are available relative to current production (McHaffie and Buckley 1995).

Dolomite

The Coimadai Dolomite was worked for agricultural lime from the early part of the century until the 1980s. Alkemades, Hjorths and Burnips were the main quarries of several located east of Coimadai (Roberts 1984).

Precious and Semi-precious Stones

The Daylesford area is the most significant sapphire and zircon source in Victoria, but there has been no commercial production (Birch and Henry 1997).

The deep leads and modern drainages of the Ararat region have concentrated gems derived from the erosion of basalts and granites. Gems include bright blue to near black sapphires, emeralds and orange to reddish brown zircons derived from basalts and red garnets, colourless to pale blue topaz, and coloured varieties of quartz derived from granites (McHaffie and Buckley, cited in Bush *et al* 1995a).

Gemstones can be found in dumps from deep lead mining in the Ballarat and Creswick area (King 1985), and in decomposed and lateritised conglomerates overlying Rocklands Rhyolite to the west of Glendinning homestead (Bush *et al* 1995b). Other locations of gemstones include Mouchong Creek (opaline quartz) and Wennicott Creek (King 1979, Rickards 1991 cited in Bush *et al* 1999b).

Some small yellow diamonds, along with sapphires and rubies, were recovered from gold-bearing gravels of the Mathers Creek goldfield, in the far west of the region, in the late 1890s (Birch and Henry 1997).

Talc

Several occurrences of talc in serpentinite have been reported in the Wando Vale area, north of Casterton (Bush *et al* 1995b).

Bentonite

Bentonite production at the Greenwald deposit, south of Coleraine, has been intermittent and generally less than 1000 tonnes per annum, with a total of 7064 tonnes produced between 1979 and 1989. There has been no production in recent years. Drilling has outlined, measured and indicated resources, and extensions of the resource are likely in adjacent areas (McKenzie 1976, cited in Bush *et al* 1995b). At Gellibrand, measured and indicated resources ranges have been delineated, but this material would require sodium beneficiation and the deposits are currently uneconomic (Bowen and Darragh 1970, cited in McHaffie and Buckley 1995).

Low swelling, calcium rich bentonite occurs at Charley's Creek where resources are between 57 000 and 341 000 tonnes, depending on quality specifications (Edwards *et al* 1996).

Bentonite has been recorded in the Lower Cretaceous Otway (Merino) Group, south west of Coleraine, in bentonitic shales beneath lateritic capping.

Salt

Minor amounts of salt have been produced intermittently from seawater evaporation ponds at Lara and Point Henry, near Geelong (McHaffie and Buckley 1995).

Small and intermittent salt production has been recorded from a number of small natural salt lake deposits in the far west of the region (Bush *et al* 1995b).

Diatomite

Diatomite deposits have been worked at Moranding and Newham, each producing over 1000 tonnes of diatomite. Smaller production has occurred at Mickleham and Allestree. A small diatomite resource occurs at Happy Valley, near Linton, and some production from it occurred from 1943-73.

Diatomaceous earth of fair quality was reported from the Lal Lal swamp to the north of the Lal Lal railway station (Baragwanath 1948, cited in Roberts 1984). Unworked deposits occur at Bacchus Marsh, Bunker's Hill, Lancefield and Daylesford (Atkinson 1988). Over 30 000 tonnes of diatomite has been produced from Lillicur (Atkinson 1988). Surface-indicated resources are about 40 000 tonnes, but several times this figure is possibly covered by basalt (McHaffie and Buckley 1995).

Magnesite

Secondary magnesite nodules up to 18 kilograms were reported from the river alluvium of Spring Creek, near Bacchus Marsh. Magnesite joint fillings are also found in the Pentland Hills Volcanics and Newer Volcanics in the Bacchus Marsh area (Roberts 1984).

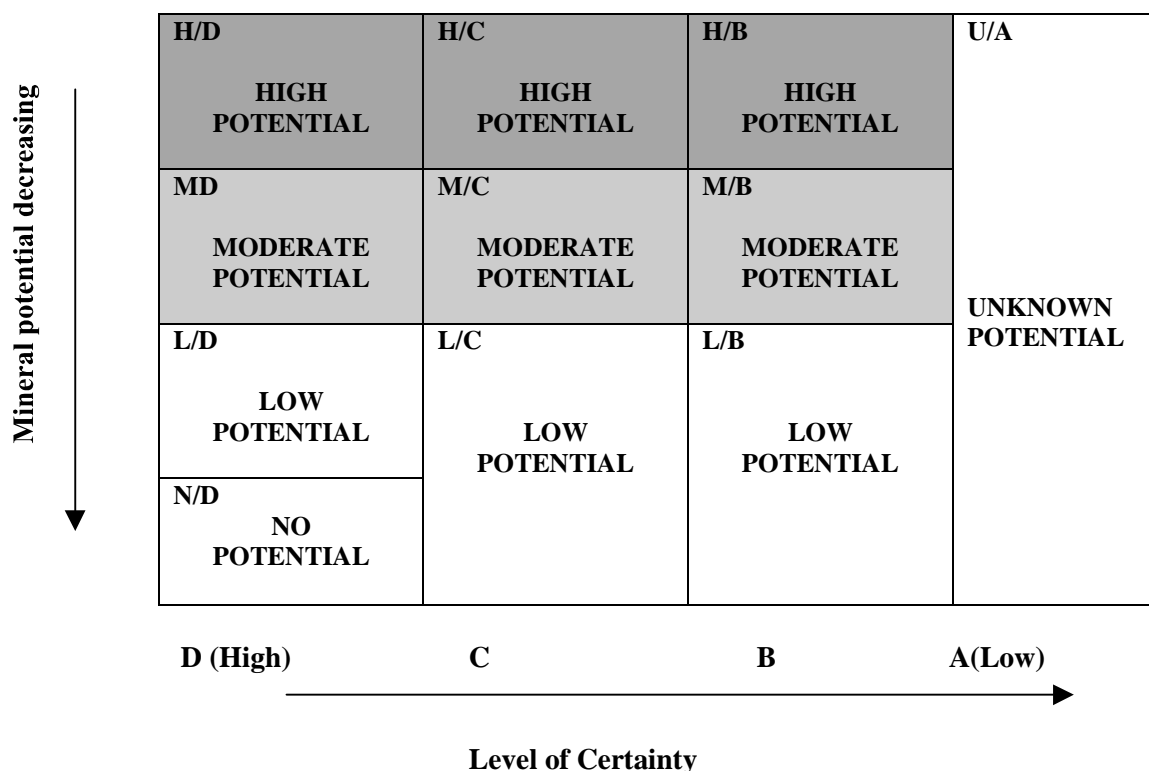
Potential Mineral and Extractive Resources

Mineral Potential Assessment Methodology

A qualitative assessment of the potential resources of an area is an estimate of the likelihood of occurrence of mineral deposits that may be of sufficient size and grade to constitute a mineral resource. The term 'mineral resource' is restricted to material, the extraction of which is judged to be potentially viable, either now or within the next 25 years.

The mineral potential of the West region has been assessed by determining the types of mineral deposits likely to be found within the geological framework known or believed to exist there. This approach identifies geological units (tracts) which could contain particular types of mineral deposits. The general methodology was developed by the United States Geological Survey and has been used successfully for mineral resource assessments of wilderness areas in North America and elsewhere. A summary of the qualitative assessment methodology is described by Marsh *et al* (1984), Taylor & Steven (1983), and Dewitt *et al* (1986).

Figure 10.1: Relationship between Levels of Resource Potential and Levels of Certainty



An assessment of a region's potential mineral resources combines knowledge of its geology, geophysics, geochemistry, mineral deposits and occurrences with current theories of mineral deposit genesis and results of mineral exploration. The assessment uses available geoscientific data to determine the history of geologic processes and environments. Geologic environments judged to have characteristics known to be associated with specific types of mineral deposits are then identified. In particular, the assessment draws on regional and local characteristics of mineral deposit models to establish whether or not specific types of deposits are likely to occur.

The mineral potential of an area — that is, the likelihood of a particular type of mineral deposit occurring — is ranked as 'high', 'moderate', 'low' or (where there is insufficient data) 'unknown'. To reflect the differing amounts of information available, assessments of mineral potential are ranked from A-D according to levels of certainty, 'A' denoting the lowest level of certainty and 'D' the highest (Figure 10.1).

As geological knowledge of an area can never be complete, it is not possible to have a 'final' assessment of potential mineral resources at any given time. Mineral resource potential needs to be monitored and periodically reassessed to take account of new data and advances in geological understanding, including new mineral discoveries. Advances in mineral exploration and mining technologies and market changes may also change the mineral resource potential of an area.

Table 10.1: Summary of Potential Mineral Resources as at December 1998

| Deposit type | Mineral potential | Certainty level | Area of tract (sq km) | % of region covered by tract* | % of tract in Exempt Crown Land** |
|---|-------------------|-----------------|-----------------------|-------------------------------|-----------------------------------|
| Heavy mineral sands strandline | High | C | 8 208.8 | 0.4 | 4.1 |
| Heavy mineral sands flat-lying, fine-grained (WIM type) | Moderate-High | C | 8 208.8 | 0.4 | 4.1 |
| Slate belt gold | High | B-C | 8 701.1 | 1.2 | 9.1 |
| | Moderate-High | B-C | 4 622.7 | 1.1 | 1.3 |
| | Moderate | B-C | 7 420.3 | 0.7 | 0.0 |
| | Low-Moderate | B | 9 792.2 | 1.4 | 12.4 |
| | Low | B | 2 168.9 | 0.3 | 0.0 |
| | Unknown | A | 4 342.2 | 0.6 | 0.2 |
| Disseminated gold | Moderate-High | C | 1 694.1 | 1.2 | 0.0 |
| | Moderate | B-C | 12 099.1 | 0.2 | 9.9 |
| | Low-Moderate | B | 19 580.8 | 1.0 | 56.2 |
| | Low | B | 2 364.8 | 0.6 | 0.0 |
| | Unknown | A | 4 471.0 | 0.8 | 0.2 |
| Alluvial gold | High | C-D | 1 856.0 | 1.5 | 0.4 |
| | Moderate-High | B-C | 14 995.1 | 1.7 | 5.0 |
| | Low | C | 6 581.6 | 1.0 | 26.9 |
| | Unknown | A | 17 803.8 | 1.4 | 26.3 |
| Epithermal gold-silver | Moderate | B | 2 107.4 | 0.2 | 0.9 |
| | Low-Moderate | C | 166.0 | 0.3 | 0.0 |
| | Unknown | A | 1 130.6 | 0.2 | 2.5 |
| Porphyry copper-gold | Moderate-High | B-C | 182.8 | 0.3 | 1.0 |
| | Moderate | B | 547.9 | 0.9 | 9.5 |
| | Low-Moderate | B | 613.0 | 1.1 | 1.2 |
| | Unknown | A | 6 681.6 | 1.2 | 4.1 |

| | | | | | |
|--|---------------|-----|----------|-----|------|
| Volcanic associated massive sulphide base metals | High | B-C | 3 069.1 | 0.1 | 5.0 |
| | Moderate-High | B-C | 210.8 | 0.4 | 0.7 |
| Volcanic associated massive sulphide gold | High | B-C | 3 069.1 | 0.1 | 5.0 |
| | Moderate-High | B-C | 210.8 | 0.4 | 0.7 |
| | Unknown | A | 571.3 | 1.0 | 0.0 |
| Tin veins | Low | B | 4 786.7 | 1.4 | 0.9 |
| | Unknown | A | 1 130.6 | 0.2 | 2.5 |
| Tungsten–molybdenum veins | Moderate | C | 6 728.1 | 1.3 | 9.6 |
| | Unknown | A | 15.1 | 0.0 | 0.0 |
| Brown coal | High | D | 14.9 | 0.0 | 0.0 |
| | Moderate | C | 1 012.7 | 0.0 | 1.4 |
| | Low-Moderate | B | 1 952.9 | 1.7 | 0.8 |
| Black coal | Moderate | B | 3 756.3 | 1.3 | 8.8 |
| Brown and black coal | Unknown | A | 22 327.3 | 0.6 | 15.8 |
| Dimension stone | High | B | 1 249.3 | 0.4 | 33.8 |
| | Moderate | B | 2 989.3 | 1.7 | 11.0 |
| | Low | B | 438.8 | 0.8 | 0.5 |
| | Unknown | A | 1 951.6 | 1.7 | 7.5 |
| Limestone | High | B | 52.4 | 0.1 | 0.0 |
| | Moderate | B-C | 1 052.9 | 0.1 | 3.4 |
| | Low | C | 735.5 | 1.3 | 0.2 |
| Silica sand | High | C | 155.2 | 0.3 | 1.2 |
| | Moderate-High | C | 2 180.8 | 0.3 | 3.8 |
| | Low | C | 86.3 | 0.1 | 0.0 |
| Kaolin | High | C | 512.1 | 0.9 | 0.0 |
| | Low-Moderate | C | 1 630.4 | 1.1 | 6.3 |
| Construction materials | High | D | 1 471.4 | 0.8 | 0.0 |
| * Total area of region is 57 722.25 sq. km. | | | | | |
| ** Reserves (Exempt Crown land – 3110.9 sq. km.) in this column comprise National and State Parks Wilderness and Reference Areas | | | | | |

Mineral Potential in the West Region

Mineral potential tracts were identified for nine types of metallic mineral deposits, five types of industrial minerals, and for coal (Table 10.1). ‘Interest’ areas for construction materials were considered as representing tracts with high potential for construction materials.

The tracts of mineral potential for various types of mineral deposits have been combined and summarised in two different ways in Maps 10.3 and 10.4. Extraction sites for low value construction materials are often dictated by other land uses and by costs of transport, and mineral potential for construction materials is included only as specific designated ‘interest’ areas in combined mineral potential Maps 10.3 and 10.4. These interest areas were identified in previous reports by Olshina and Jiricek (1996) in vicinity of Melbourne and by Olshina and Jiricek (1997) around Ballarat.

The levels of mineral potential for the various types of mineral deposits are listed in Table 10.1. Descriptions of the favourable geological tracts for deposit types are summarised in Appendix 5.

Map 10.3 is a composite of mineral potential tracts over the West region and shows the highest level of mineral potential assessed (in June 1999) for any particular area in the region. Where tracts for different types of deposits overlap, this area is assigned the highest potential level of all the overlapping tracts. In this approach, the tract having the highest mineral potential in any particular area obscures tracts of lower mineral potential.

In terms of mineral potential, the region can be subdivided from north to south into three broad areas:

- In the northern part of the region the areas of high potential are dominated by high potential for heavy mineral sands in the Murray Basin in the north west. In the central north, the areas of high potential are for slatebelt gold, alluvial gold and smaller areas of high potential for volcanic-associated base metals and gold, dimension stone, silica sands and kaolin. Smaller areas of high potential in the eastern part of the region are tracts of high potential for construction materials (designated 'interest' areas).
- The area of moderate to high potential in the central and north east portions of the region represents the potential for alluvial gold in the central part of the region and for alluvial gold, slatebelt gold and disseminated gold in the north east.
- In the southern part of the region there is an extensive area of unknown potential. This represents the area where Palaeozoic basement is overlain by more than 500 m of sediments of the Otway Basin. Tertiary and Quaternary volcanics overlie parts of the basin sediments. This area has an unknown potential for coal. There is also an unknown potential in the underlying basement rocks for slatebelt gold, disseminated gold, copper/gold porphyry, and for volcanic associated base metals and gold.

In the coastal zone of the region there are areas of moderate to high, and high potential for silica sand, limestone and dimension stone.

Map 10.3 is a composite of mineral potential tracts for different types of mineral deposits that do not have equal economic values. For example, a tract with moderate to high potential for slate belt gold may be considered to have a higher economic value than a tract with moderate to high potential for dimension stone.

The mineral potential tracts are superimposed on Map 10.4 to highlight areas with overlapping tracts. This presentation takes account of the diversity of mineral resource potential as well as the level of potential. This was done by allocating standard scores according to a subjective ranking of levels of mineral potential as follows: high potential (18), moderate/high (12), moderate (6), low/moderate (2), low (1), unknown potential (no score). In those areas where tracts overlap, the scores are added and this cumulative score is assigned to overlapping areas. For example, where there is an overlap of high potential for slate belt gold (score 18), moderate to high potential for disseminated gold (score 12), moderate potential for limestone (score 6) and low potential for dimension stone (score 1), then this area will have a cumulative potential score of 37.

It should be understood that the areas with overlapping tracts highlighted by Map 10.4 emphasise the diversity of deposit types and their mineral potential, but these areas are not necessarily more prospective than a single tract of high potential, for example, slate-belt gold. As with Map 10.3, the relative economic potential of different deposit types has not been accounted for. The relative economic significance of the tracts for different types of mineral deposits, as perceived by mining companies, would be influenced by their perceptions of prospectivity, future market conditions, land access and other factors.

The area with the highest cumulative scores (50-109) in the region, lies along the north west trending belt of the Mount Stavelly Volcanics in the central north portion of the region. This part of the region has high, and moderate to high potential for strandline and for flat lying (WIM150) type of heavy mineral deposits. In addition, there is moderate to high and high potential in the underlying Palaeozoic basement for slatebelt gold, disseminated gold and volcanic-associated base metals and gold in the Stavelly Volcanics, which have some similarities with the highly mineralised Mount Read Volcanics in Tasmania.

Other areas of elevated cumulative scores are in an arcuate belt in the south western part of the region which has high, and moderate to high potential for strandline and WIM150 types of heavy mineral sand deposits and for silica sand. In the eastern part of the region, areas with higher cumulative scores are due to the combined high and moderate to high potential for construction materials in the interest areas together with various types of gold deposits and for some types of industrial mineral deposits.

10.3 EXPLORATION, MINING AND POTENTIAL ECONOMIC VALUE

The potential economic value of the region's mineral resources is affected by a number of factors including: mineral prospectivity; exploration costs; geological knowledge base and intensity of data over the region, timing and significance of discoveries; future metal prices and mining costs; and rules and regulations governing exploration and mining.

The mineral potential assessment provides an indication of areas of land, which are more likely to be most prospective for particular minerals. However, an assessment of the potential value of mineral resources in these areas is not possible without an estimate of the number and type of deposits likely to occur in a particular region. Therefore, it has not been possible to compare the 'mineral' value of particular areas of land that have been assessed as prospective for minerals with other land (whether prospective or not). These limitations, when combined with the dynamic information-gathering nature of exploration, have significant implications for land access arrangements for exploration and mining in these areas.

Current and historical exploration expenditures provide some indication of the potential value of the undiscovered mineral resources of the West region. This is because a decision to invest in exploration is based largely on a company's perception of the mineral potential of an area, i.e. exploration expenditure will tend to be higher in areas of higher perceived mineral potential. However, given the uncertainty, different risk attitudes of companies and the difficulty of exploration, expenditures only provide an approximation of true prospectivity. Sometimes deposits are found in previously unprospective areas when new ideas or technology are applied where little previous exploration has occurred.

Exploration

Currently there are significant extractive operations for industrial minerals and construction materials as well as a few gold mines in the West region. Exploration expenditure totalled about \$7.7 million in 1997-98. The major commodity target was gold and, to a lesser extent, heavy mineral sands, with minor interest also in coal and base metals and other minerals.

Alluvial gold was discovered at Clunes north of Ballarat and on Campbells Creek south of Castlemaine in mid 1851 and was followed almost immediately by a rush of diggers numbering up to 30 000 seeking their fortune. The alluvial diggings and the subsequently discovered hard rock gold mines encompassed the now famous major gold mining centres of Bendigo, Castlemaine, Ballarat, and Maldon, Creswick, Clunes and Stawell, each of these centres ultimately producing more than 30 tonnes of gold.

Mining of alluvial gold was extended when gold was found in deep leads and old river channels covered by relatively young basalt flows. In the 1890s and early 1900s, the introduction of low-cost alluvial dredges or floating large-scale processing plants on pontoons along many creeks and alluvial flats around Maryborough, Avoca, Clunes, and Castlemaine allowed much lower grade gold-bearing gravels to be worked. Dredge activity continued intermittently until 1957.

An Exploration Licence (EL) system was introduced by the Department of Mines and Industrial Development in the mid 1960s which allowed exploration of larger areas than

would normally have been covered by a mining lease, search permit or a prospecting area licence. This greatly facilitated company-scale exploration for minerals and launched a new era of exploration and discovery.

Exploration in some portions of the area has been hampered by rough topography and thick vegetation, resulting in difficult access, and at least some exploration programs in the region may have been largely ineffective and significant mineral deposits may remain undetected. Hence, a number of quite prospective areas may remain to a large degree untested. Since 1965, over 600 ELs have been granted over the West region (Figure 10.3).

The exploration targets sought since 1965 have varied in accordance with relative metal prices, perceived prospectivity, relative recovery costs of metals and new exploration paradigms or mineral deposit models.

Commodities sought in the region include gold, silver, copper, lead, zinc, platinoids, tin, tungsten, molybdenum, heavy mineral sands, uranium, coal, diamond, phosphate and clay.

During the period 1965 to 1968, 22 ELs were granted, mostly for gold and phosphate.

The mining boom of the late 1960s, coupled with strong copper and base metal prices in 1970, led to a peak of 11 ELs being granted in 1970. The main commodities being sought included gold, base metals, tungsten and phosphate.

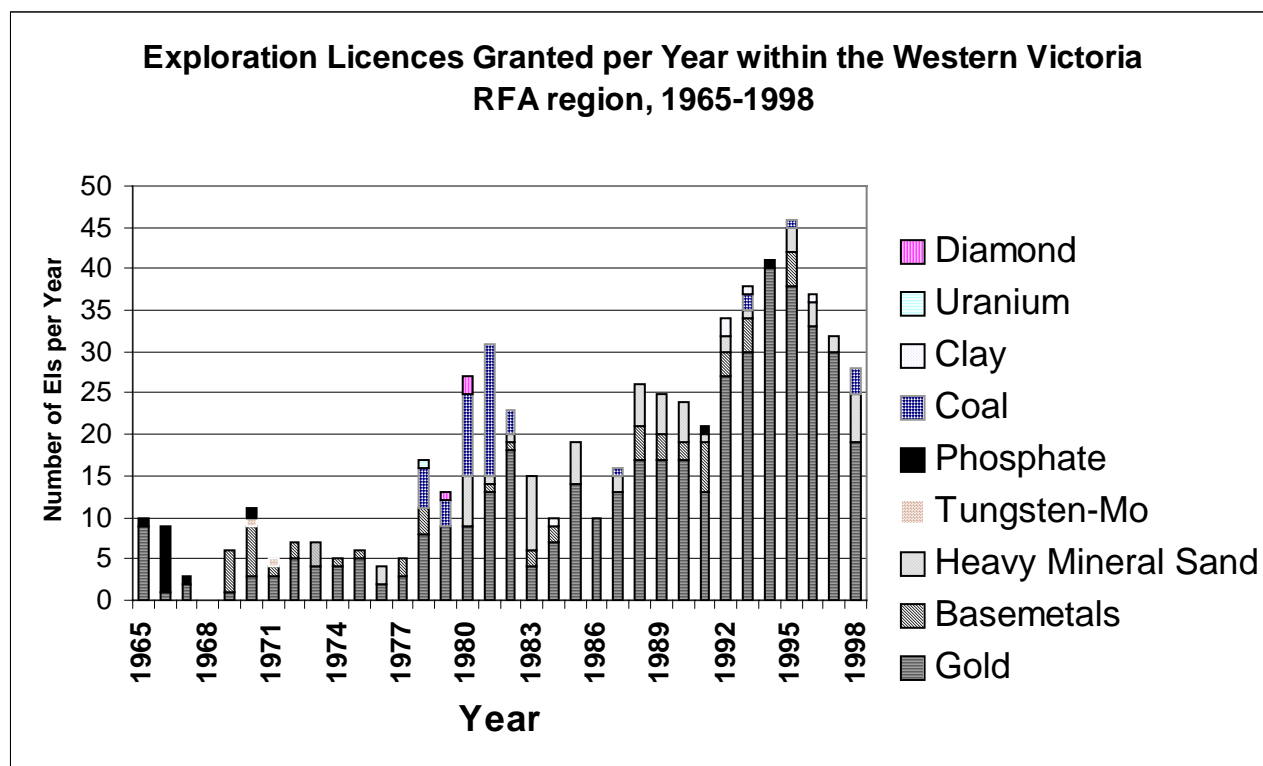
There was a lull in exploration activity in the early to mid 1970s, with granted ELs averaging about five or six per year, mainly for alluvial or reef gold but to a lesser extent for basemetals. In 1976, AO Australia was granted two ELs for heavy mineral sands in the Glenelg River area.

Exploration activity picked up again in 1978 with a renewed interest in energy minerals and gold as a result of rising prices in oil and gold. Most of the ELs for coal were situated over Otway Basin sediments in the southern half of the region, although CRA took out a number of ELs for coal over Murray Basin sediments in the north west of the region. The main commodities being sought included diamonds and uranium but exploration for gold became increasingly dominant after 1978.

The total number of ELs peaked at 31 in 1981.

The years 1984 to 1987 inclusive saw a general falling off of exploration interest with an average of around 14 licences granted per year, mainly for gold.

From early 1988 onward, a more sustained interest in gold exploration targets generally was evident. Unlike previous periods, almost all the gold targets sought were for hard-rock gold with only a small proportion of the ELs directed at alluvial gold potential. The 11 year period from 1988 to 1998, with its high interest in gold, was also accompanied by renewed interest in base metals associated with interpreted and outcropping Cambrian mafic volcanics and intrusives, mainly in the Stavely, Ararat and Glenelg areas. In the light of the WIM150 discovery earlier in the decade (1984) and other technical exploration successes for heavy mineral sands in the following periods, strong interest also persisted for heavy mineral sands on the southern edge of the Murray Basin during the 11 years to the end of 1998.

Figure 10.3: Exploration licences granted for the West region

At the time of this assessment, there were 106 active ELs in the West region, distributed among a variety of companies. In 1997-98, total exploration expenditure in the West region was about \$13.7 million (Minerals and Petroleum Victoria 1997), being \$7.7 million on ELs and \$6 million on exploration under Mining Licences (Tables 10.2 and 10.3).

Table 10.2: Mineral Exploration Expenditure on Exploration Licences, West Region, 1991-92 to 1997-98 (1997-98 dollars)

| Year | Western Region Exploration Expenditure (\$) | Victorian Exploration Expenditure MRD Act (\$) | Western Region exploration expenditure as a percentage of Victorian exploration expenditure |
|---------------|---|--|---|
| 1991-92 | 871 868 | 12 630 933 | 6.9 |
| 1992-93 | 821 087 | 18 207 611 | 4.5 |
| 1993-94 | 1 093 606 | 22 382 803 | 4.8 |
| 1994-95 | 1 973 748 | 46 151 801 | 4.3 |
| 1995-96 | 7 449 928 | 36 ,311 376 | 20.5 |
| 1996-97 | 6 084 640 | 37 857 964 | 16.1 |
| 1997-98 | 7 686 896 | 36 900 000 | 20.8 |
| Totals | 25 981 773 | 210 442 489 | 12.6 |

Note: Figures include private mineral exploration expenditure on Exploration and Mining Licences, as derived from Mineral and Petroleum Victoria records. Expenditure expressed in current dollars in each financial year has been converted to constant 1997-98 dollars using changes in the consumer price index.

Table 10.3: Expenditure on Mining Licences in the West Region, 1991-92 to 1997-98 (1997-98 dollars)

| Year | Mining licence exploration expenditure (\$) | Mining licence other expenditure (\$) | Total expenditure mining licences (\$) | Number of mining licences* |
|---------------|--|--|---|----------------------------------|
| 1991-92 | 40 819 | 37 302 732 | 37 343 551 | 7 |
| 1992-93 | 5 689 978 | 23 656 142 | 29 346 120 | 13 |
| 1993-94 | 1 753 682 | 38 649 482 | 40 403 164 | 21 |
| 1994-95 | 16 704 199 | 32 762 493 | 49 466 691 | 37 |
| 1995-96 | 3 193 399 | 21 997 322 | 25 190 720 | 51 |
| 1996-97 | 4 227 382 | 27 907 762 | 32 135 145 | 59 |
| 1997-98 | 6 056 988 | 26 792 370 | 32 849 358 | 61 |
| Totals | 37 666 447 | 209 068 303 | 246 734 750 | |

*Number of licence reported

Note: Figures derived from Mineral and Petroleum records. Expenditure expressed in current dollars in each financial year has been converted to constant 1997-98 dollars using changes in the consumer price index.

Mining and Quarrying

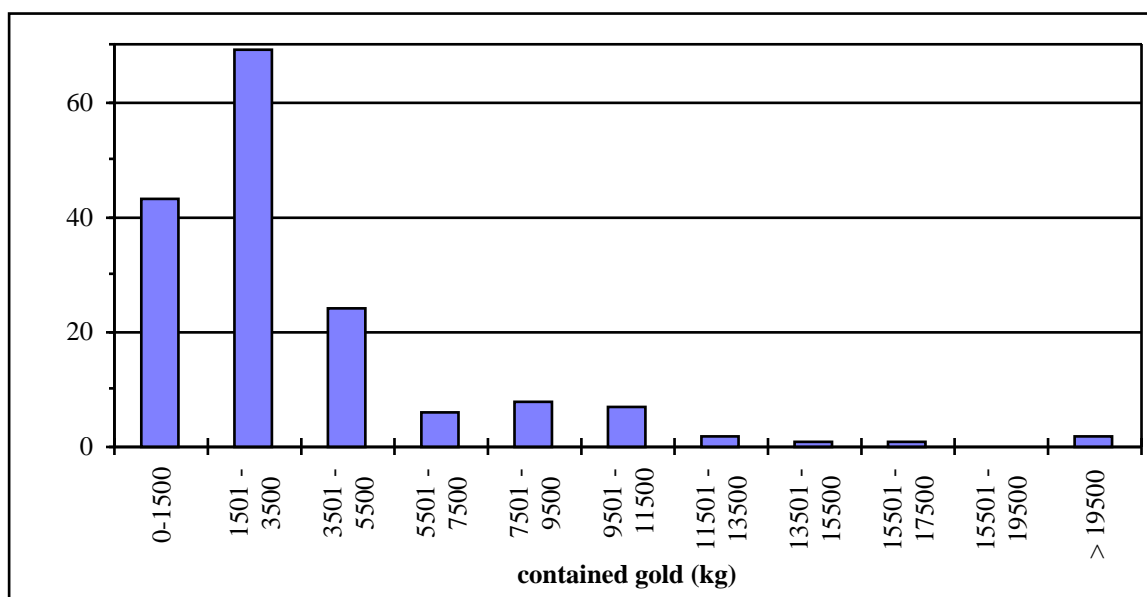
There are 334 active or intermittently active construction materials Work Authority tenements in the region and some are grouped to form an area big enough to support a larger quarry. One hundred and thirteen tenements are for sand/gravel, 74 for basalt, 33 for scoria, 29 for limestone, 28 for clay/clay shale and the rest are for volcanic tuff, sedimentary rocks, quartzite, soil, granite, hornfels, trachyte, slate and rhyodacite.

Case Study: Slate Belt Gold and the Nagambie Mine

While the resource assessment found that the region is prospective for slate belt gold deposits, no assessment was made of the potential number or size of undiscovered slate belt gold deposits that may lie within the West region. However, the size of identified slate belt gold deposits in Victoria (which contain virtually all the gold mined in Victoria to date) provide an indication of the potential size of undiscovered slate belt gold deposits that may lie within the region.

Of the 163 Victorian slate belt gold deposits surveyed by Bowen (1974), 85 per cent had a total production of between 1000 and 6228 kilograms (Figure 10.4). The Nagambie mine, which lies just outside the study area and recently closed after production of 4185 kilograms (Register of Australian Mining), provides an example of a gold deposit within this range. Moreover, the Nagambie mine was found close to a small rural town and the history of the Nagambie operation provides a useful insight into the effect that such a mine (if found in the West region) could have on local towns and regional economies.

The Nagambie gold deposit was discovered in 1985 by Frank Green of East Union Prospecting (Hughes 1990). Perseverance Corporation acquired the title over the area in 1987 and began a program of drilling to delineate a resource of 7 million tonnes at a 1.2 grams per tonne gold grade using a 0.4 grams per tonne cut off grade (Hughes 1990). Ore was mined from July 1989 until June 1993. However spraying of the heap leach to extract minor amounts of gold continued until March 1997. The mine generated gross revenues of around \$74 million over the eight year mine life. Direct employment and gross revenue flows from the mine over its operating life are shown in Table 10.4.

Figure 10.4: Production from Slate Belt Gold Deposits in Victoria, 1857-1974**Table 10.4: Gross Revenue and Direct Employment, Nagambie Gold Mine. Real 1995-96 dollars**

| Year | Gross revenue (\$) | Direct employment (no.) |
|------|-----------------------|----------------------------|
| 1989 | 2 663 377 | 90 |
| 1990 | 25 129 676 | 178 |
| 1991 | 18 095 995 | 105 |
| 1992 | 12 370 433 | 125 |
| 1993 | 11 155 253 | 34 |
| 1994 | 3 387 699 | 32 |
| 1995 | 1 251 428 | 21 |
| 1996 | 351 320 | 14 |

Source: J. Kelly, Perseverance Corporation Ltd, personal communication, February 1997.

Adding to the net economic benefits associated with the rents from production (not calculated in this report), the Nagambie mine also generated considerable indirect benefits which have been detailed by Sinclair (1991):

- It was estimated that the mine resulted in the stimulation of an additional 73 jobs in Victoria and 7.5 jobs within the Nagambie region through indirect employment multiplier effects.
- Perseverance spent \$465 000 on local infrastructure, which included upgrading the electricity relay station and road improvements. These enabled a \$1.5 million mushroom farming business to establish in the area that created eight new jobs in the region. These benefits are in addition to the multiplier effects described above.
- The mine introduced a variety of workers into the region, increasing the diversity and level of skill in the Nagambie region's occupational structure (31 of the mines' employees were new residents to the area). In addition, the population growth in the region was around 4.5 per cent over the period 1989-91 — reversing the previous trend of population decline in the area.

Mines like Nagambie may be temporary (three to 10 years life in many cases) but it is apparent that these projects — in addition to bringing economic benefits to the local and wider economies during their operating life — also provide infrastructure and demographic benefits to smaller communities, which can have lasting effects.

Outlook for Mineral Production

Developments in markets for mineral and energy resources will affect development opportunities for the minerals industry in the West region. The outlook for gold, base metals, brown coal and heavy mineral sands is reviewed in this section. Detailed market outlook assessments for gold, base metals, brown coal and titanium minerals are given in Allen and Evans (1999), Haine and Berry (1999), Bush *et al* (1999), and Anderson (1999).

Gold

Historical and projected real gold prices are shown in Figure 10.5. It can be seen that real gold prices have experienced a clear declining trend since 1980. This trend in price reflected important changes in the structure of the world gold market, which are expected to continue into the coming decade. Over this period, annual gold consumption (measured by net additions to stock holdings) declined, while annual non-investment gold consumption (mainly jewellery) increased. The growth in world consumption of non-investment gold has stemmed mainly from rising incomes in a number of developing regions (notably India and Asia). Although non-investment gold consumption has increased faster than world mine production (tending to increase prices), real prices have fallen due to sales of investment gold bars and coins (by governments and private investors).

The change in patterns of gold holding and consumption behaviour that underlie the easing real price is expected to continue into the medium term. However, it is envisaged that real price falls will be mitigated by three important market influences. First, the official sector faces strong incentives (collectively) to control the rate at which their extensive holdings of monetary gold are sold (and replaced with higher yielding alternative reserve assets). These incentives stem from the requirements of central banks to maintain international financial stability, and the prospect of faster disposal rates rapidly eroding the prices received and therefore returns from such sales. In addition, recent currency crises may provide encouragement for official purchases in some countries.

Second, demand for non-investment gold use (primarily jewellery) is expected to continue growing strongly, in response to lower gold prices and higher incomes in developing economies which have strong cultural affinities for gold jewellery consumption, notwithstanding shorter term economic disruption in Asia. Third, downward pressures on price will be moderated to the extent that lower prices bring about slower growth of world gold mine output, although it is clear that the gold mining industry is continuing to lower its costs.

Overall, the forecast for strong world demand for gold is expected to be met by expanding mine supply and from official and investment sources. While periodic market imbalances are likely, particularly some shorter term price volatility, the easing trend in real prices seen over the past two decades is expected to be maintained, at least over the medium term.

Base Metals

Asia (including Japan and China) accounted for 33 per cent of world base metals consumption in 1998, down from 36 per cent in 1997. The fall reflects the current economic downturn in parts of Asia. The share of developing Asian countries is expected to fall further in the short term. Over the medium to longer term, Asia's share of world base metals consumption is

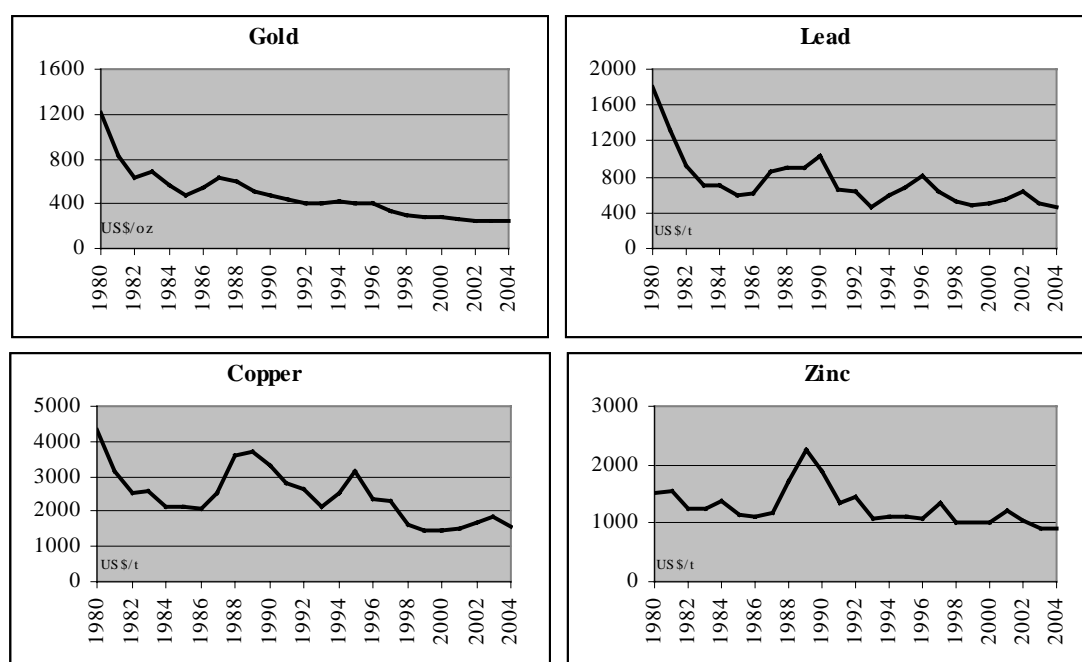
projected to increase, reflecting a resumption of relatively fast economic growth in these countries.

The developed market economies, which accounted for around 51 per cent of world base metals consumption in 1998, are assumed to continue to expand. Thus, demand for base metals in these countries is expected to continue to grow. Overall, world base metals consumption is projected to increase at around 2.0-2.5 per cent a year over the medium term before easing gradually over the longer term, reflecting expected trends in world economic growth and industrial production.

World mine supply of the three base metals is expected to rise in 1999. World refinery production of the three base metals is expected to keep pace with increases in mine production. A number of large, committed and planned development projects are expected to be the major contributors to the projected rise in base metals supply over the next few years. Substantial increases are projected up to the end of 2000 as low cost mines, primarily copper mines in Chile and zinc and lead mines in Australia, commence production. However, these rises are expected to be partially offset by the closure of some older, high cost, producers which are likely to become uneconomic with projected lower prices, particularly for copper.

Over the longer term, continuing technological developments can be expected to place downward pressure on costs. Thus, together with projected demand growth, the long-term downward trend in real prices experienced for each of the base metals is expected to continue. Price projections to 2004 are shown in Figure 10.5.

Figure 10.5 Base Metals and Gold Prices (1998 US dollars)



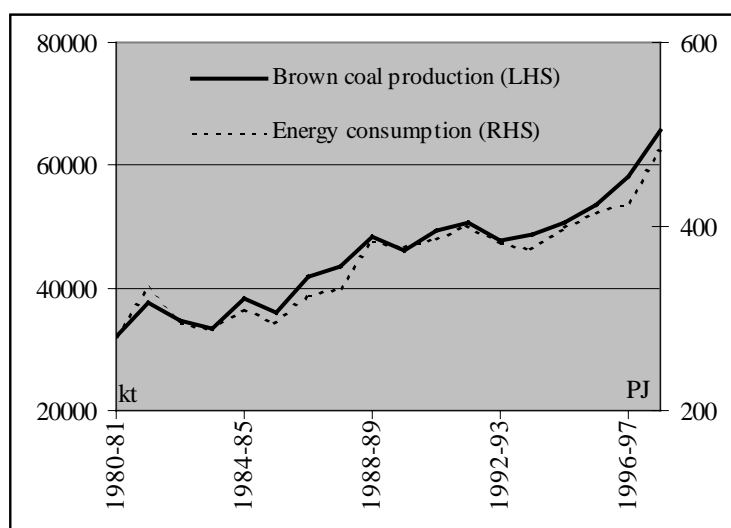
Brown Coal

Brown coal is used almost exclusively for electricity generation by power generators in Victoria. The strong growth in energy consumption in the Victorian electricity generation sector over the last three or four years, apparent in Figure 10.6, is linked to the effects of recent microeconomic reforms, including the construction of a national electricity market (Bush, Dickson, Beil, Harman and Anderson 1999).

The share of brown coal as an energy source (excluding hydroelectricity) increased from 42.3 per cent to 47.9 per cent within the interconnected electricity market of New South Wales, Victoria and South Australia over the five years to 1997-98, making it the main fuel source for thermal generation in that market. In addition to underlying growth in electricity demand, greater use of brown coal largely reflects that brown coal generators are very low-cost producers of electricity.

Over the longer term, however, brown coal production and consumption may decline for two main reasons. First, improvements in the competitiveness of alternative fuels (particularly natural gas) as the national electricity market matures are expected to increase the usage of other fuels. Second, power generation from brown coal is likely to become more efficient in itself (and require less coal per unit of power output) as old plant is gradually replaced over time.

Figure 10.6 Energy Consumption for Electricity Generation and Production of Brown Coal in Victoria, 1980-81 — 1997-98



Bush *et al* (1999)

Titanium Minerals

Modest declines in prices for most titanium minerals are expected over the next two years. However, prices for most titanium minerals are projected to firm moderately over the period beyond to 2004.

Titanium Dioxide Pigment

Prices for titanium dioxide pigment are projected to weaken in the short term as consumption growth in Europe and the US eases. Supply constraints and renewed consumption growth in the longer term will support stronger prices to 2004.

Titanium Feedstocks

Tight supplies of sulfate and chloride grade ilmenite are forecast to lead to an increase in the average export unit ilmenite price over the short term. Average rutile prices are expected to decline slightly in the shorter term as a result of weaker demand for natural rutile in titanium metal production. However, stronger demand for titanium metal in Asia beyond 2001 is expected to lead to a slight firming in rutile prices over the remainder of the outlook period. Real prices for synthetic rutile and leucoxene are projected to decline from current levels over

the next few years, but then to show some recovery from 2002-03 in line with a firming pigment market.

Zircon

Increasing world supplies of zircon and reduced demand mean that the price received by Australian zircon producers is forecast to decline over the first few years of the outlook period. However, over the medium term, constrained world supplies are expected to reverse the declining price trend.

10.4 LEGISLATION AND LAND ACCESS

Access to land is an important issue for exploration and mining. The implications of the RFA for exploration and mining in the West region are not yet known.

It is important to note that no area can ever be classified as unproductive and no assessment of potential mineral resources can ever be considered 'final'. New information, new concepts and better understanding of geological processes continually change the perceived prospectivity of a region and the availability, usefulness and implication of these can change over time. There are also dynamic aspects to market information that will affect perceptions of a region's prospectivity, e.g. mineral prices and extraction costs may change substantially over time.

The nature of access for mineral exploration and mining has a large bearing on the level, and type of exploration and mining that occurs in a region. Transparent and well-defined access arrangements reduce uncertainty and facilitate exploration and mining activities. Access provisions of relevant legislation are outlined below.

More detailed discussions of resource access issues relating to exploration, mining and environment can be found in Industry Commission (1991), Cox, Beil and Waring (1994) and in Murray, Cox and Allen (1995).

Legislation and Regulation Relevant to Exploration, Mining and Extractives

In Australia ownership of mineral resources and control of mineral exploration and development largely lies in the hands of the state and territory governments. The Commonwealth Government has control over mining and exploration activities outside three nautical miles offshore and over radioactive substances in the Northern Territory. It also exercises its constitutional powers to exert control over the way States and Territories access and use their mineral resources.

The principal legislation covering mining and exploration licences in Victoria is the *Mineral Resources Development Act 1990* (MRDA) which was amended in 1993 and 1994. This Act is the responsibility of the Minister for Agriculture and Resources and is administered by the Victorian Department of Natural Resources and Environment. It sets out the rules for granting licences and attaining approval to start operations.

All exploration and mining activities are subject to a range of environmental requirements before, during and after the life of the project, including:

- lodging a rehabilitation bond, before starting an exploration or mining program, to serve as a security should the company be unable to satisfy its rehabilitation liability,
- ;
- exploration and mining is subject to standard conditions, and where appropriate supplementary site-specific conditions;
- regular reporting of exploration activities;

- mining and exploration only starting after a work plan has been approved and other approvals obtained; and
- monitoring of environmental management activities by government officers.

Under the MRDA there are four main land types:

- private land;
- exempt Crown land (for example, National Parks, State Parks and Wilderness Areas);
- restricted Crown land (for example, flora and fauna reserves and historic reserves); and
- unrestricted Crown land (e.g. State forests).

No exploration or mining activities can be carried out on exempt Crown land, unless the licence was in place before the land became exempt. The approval of the Minister for Conservation and Land Management is required before exploration or mining can be carried out on restricted Crown land. On unrestricted Crown land, the Minister for Conservation and Land Management's consent is not required. However, the Minister must be consulted. Work can start on private land once the consent of the owner and occupier is obtained or compensation arrangements are made.

The principal legislation covering extractive industries in Victoria is the *Extractive Industry Development Act 1996* (EIDA), which provides for granting work authorities for extractive operations. The four main land types under the EIDA are the same as those in the MRDA. Land owner consent is required before extractive activities can be undertaken on freehold land, and land manager consent for operations on Crown land.

Mining and exploration is currently excluded from 5 per cent of the land in the West region (Table 10.5). The consent of the Minister for Conservation and Land Management is required for exploration and mining to be carried out on restricted Crown land which is a further 3 per cent of the region.

Table 10.5: Land Use Categories as a Proportion of Total Land Area, West Region

| Land use category | Area (ha) | Proportion of West region (%) |
|-------------------------|--------------|----------------------------------|
| Exempt Crown land | 311 117 | 5 |
| Restricted Crown land | 183 863 | 3 |
| Unrestricted Crown land | 487 240 | 9 |
| Freehold land | 4 751 280 | 83 |
| Totals | 5 733 500 | 100 |

Source: Data supplied by NRE, Victoria 1999

Nature of Exploration and Mining

Mineral exploration is the assessment of the earth's crust to determine if mineral deposits which can be commercially mined are present. Mining is the commercial extraction of mineral deposits from the earth's crust. Whilst there is often a close relationship between exploration and mining, they are effectively two quite separate activities.

In order to examine the implications of alternative land access arrangements for exploration and mining, it is important to understand both the nature of exploration and its likely costs and benefits.

The potential benefits for a private firm from an exploration program derive from the economic returns that will accrue from the discovery of an economic deposit. Given that exploration is a high-risk activity (i.e. there is a small probability of any one venture being

successful), companies will approach exploration in a sequential and systematic fashion. This enables the decision to abandon or keep exploring in the area to be made in an efficient manner.

The cost and duration of exploration programs vary from company to company and across commodities. Clark (1996) suggested that the development of a typical major deposit (worldwide) involves a five to 20 year lead time. This estimate results from a typical three to 10 years exploration program before the mine development phase.

Exploration is primarily an information gathering process so it is necessarily dynamic, and most regions can never be regarded as 'completely explored'. Many recent Australian discoveries have occurred in known mineral provinces that have been the subject of exploration efforts for over 100 years. There are a number of reasons for continuing exploration in such areas. Technology and scientific understanding of geological processes continue to develop with time. These advances not only encourage exploration in areas where prospectivity was previously considered low, but also lower the costs and increase the efficiency of exploration (eg in highly prospective areas such as Kanowna Belle in Yilgarn, WA, and Century in the Mount Isa Inlier, Qld, or in areas not previously known to be of very high potential, e.g. Olympic Dam on Stuart Shelf, SA). Further, changing economic conditions (for example, changes in metal prices or the costs of extraction) affect the expected returns from exploration and can significantly affect the level and type of exploration.

The exploration process starts with assessments of very large regions and is then systematically narrowed down as the exploration target becomes better defined. The direct costs facing explorers increase as the target area becomes smaller and exploration methods become more intense. The environmental impact associated with exploration also increases as the area being explored becomes smaller and the exploration methods used become more invasive (e.g. drilling), unless special steps are taken to reduce such impacts.

Exploration methods used in the West region include:

- Regional reconnaissance using remote sensing techniques such as satellite imagery, aerial photography and regional mapping. This exploration phase has little, if any, impact on the land. Activities may cover hundreds of square kilometres in order to identify areas of exploration interest. Geological mapping involves the search for and examination of rock outcrops and exposures in a licence area.
- Sampling in the field which usually involves taking small rock chip, soil or stream sediment samples. Samples are typically obtained by shovel, hand auger or hammer. More intensive sampling and localised mapping may also be carried out using trenches or small pits. All of the above may occur on a surveyed grid.
- Geophysics uses a range of techniques to look for anomalous physical properties indicating structures or mineralisation not visible at the surface. The geophysical properties being assessed include magnetism, electrical conductivity, resistivity or capacitance; gravity; and natural radioactivity or seismic properties. Surveys can be airborne for regional surveys, or ground based. The impact of ground-based survey is generally very low, but will vary depending upon the extent of grid and track development required.

The above methods are broadscale in scope and provide information that builds up a picture of where mineralisation is most likely to occur. The most economical way to assess in detail the possible presence of an ore body is by drilling, which may be supplemented by bulk sampling:

- **Drilling** is usually carried out by truck-mounted equipment to yield samples for mineralogical, chemical or metallurgical analysis. Drill holes are usually around 10 cm in diameter. Follow-up drilling may be required should earlier drilling show positive results. The impact of drilling on the environment depends on the openness of the vegetation and the topography. Usually drilling rigs can be manoeuvred around trees or the drill hole relocated to avoid disturbance of trees. A small level pad, typically around six metres square, may need to be constructed to accommodate the drilling rig.
- **Bulk sampling** gives another level of confidence in the drilling results, particularly when gold is not evenly dispersed throughout the ore and coarsely grained. The 'nugget-effect' can give rise to misleading reserve assessments and large samples are needed to overcome it. Bulk samples are usually excavated from a site, typically less than five metres deep and 10 metres square.

Rehabilitation of areas disturbed by exploration is required in Victoria.

Compared with exploration, mining generally covers relatively small areas, involves greater disturbance to the land surface in the immediate area of the mine, and may leave changed landforms when mining is finished. Mining is generally seen as posing greater difficulties in terms of compatibility with other land uses.

Many potential environmental effects of mining activities can be eliminated or mitigated, though at a cost to the mining company. Relatively limited areas of land are disturbed by the operation of a mine. However, off-site impacts such as water pollution may represent a potential threat to the environment and must be carefully managed. This can be controlled by using techniques such as impoundment and evaporation of tailings, sedimentation, filtration and pH neutralisation. Rehabilitation of mine sites is mandatory in Victoria. Modern site rehabilitation, at the completion of operations, can restore many of the features of the landscape that existed before mining began, substantially, replacing and assisting the re-establishment of vegetation and reducing the potential for pollution from the former mine site.

All mining projects in Victoria require approval under local government planning controls or by preparation of an Environmental Effects Statement. Both processes provide for public input and independent scrutiny of projects. Detailed assessments of impacts on natural values are a routine aspect of mining approvals. Such assessments may include impacts on flora and fauna, water supply, catchment management and public safety.

11. SOCIAL ASSESSMENT

11.1 INTRODUCTION

There has been a growing awareness by government, industry and the community of the importance of considering the social implications of decisions. Social assessment is a tool used to predict the future effects of policy decisions upon people, their physical and psychological health, well-being and welfare, their traditions, lifestyles, institutions and interpersonal relationships (D'Amore, 1978).

A social assessment provides a 'snapshot' of the people and communities that may be affected by planning and policy decisions. Detailed information is collected on the social and biophysical environment, the historical background of an area and its response to change, contemporary issues, political and social structures, culture, attitudes, social-psychological conditions, community vitality and population statistics. This information is then used to predict the likely impacts, both positive and negative, which may be experienced by individuals and groups within the community and to determine ways in which such impacts may be managed. As Armour (1990) has outlined, such impacts may include changes that occur in:

- people's way of life (how they live, work, play and interact with one another on a day-to-day basis);
- their culture (shared beliefs, customs and values); and/or
- their community (its cohesion, stability, character, services and facilities).

Social assessment is also a mechanism that facilitates stakeholder and community participation in a decision-making process. Through participatory techniques such as workshops and public meetings, people can become involved in the collection of social information relating to their area. This information is considered critical in the social assessment process, as people who may be directly affected by a particular policy proposal are in the best position to say how such events are experienced.

Information collected in the assessment phase may be used as a platform from which impact predictions can be made during the integration phase of the Regional Forest Agreement process.

A variety of data collection methods and data sources have been used as part of the West region social assessment to strengthen the study design and validate the results. The methods included documentary analysis, secondary statistical analysis, mail and telephone surveys, personal interviews, participant observation, informal networking and workshop techniques.

Information gained from the various study methods showed that the West region can be divided into distinct regional groupings or clustering of towns. The geographic clustering of towns, known as Town Resource Clusters (TRCs), are shown in Map 11.1. The four TRCs consist of Midlands, Otway, Portland and Horsham. The regional profile, and the analysis of the mail and telephone surveys are based on these TRC regions.

Mail surveys were distributed to forest contractors, timber processing industries, forest user businesses (eg apiarists, seed collectors, graziers, firewood collectors, prospectors and miners), and tourism operators. A total of 817 surveys were distributed to businesses with an overall response rate of approximately 20.3 per cent (variations were evident across different forest user groups). Separate questionnaires were distributed to the employees of these

businesses. A total of around 3104 surveys were administered, with a response rate of 10.7 per cent.

The community telephone survey undertaken as part of the social assessment work was based on a sample size of 880 households. The telephone survey was stratified over the four TRCs located within the West region.

More detailed assessment work was undertaken in a series of case studies covering six communities across the region: Apollo Bay, Colac, Ballarat, Daylesford, Dunkeld and Heywood. These communities differed in terms of their population size, dependence on forest uses and values, diversity of the local economy and geographic location.

This chapter contains the views of many people in the West region or those with an interest in the forests of the region. The views expressed are not necessarily those of the Victorian RFA Steering Committee or the Commonwealth or Victorian Governments.

This chapter provides a summary of the technical report on social assessment. The technical report will be published by the Victorian RFA Steering Committee following the CRA report.

11.2 SOCIAL AND ECONOMIC PROFILE

In 1996, the total population of the West region was 570 188 persons, with a 15 per cent increase in the population of the West region between 1986 and 1996. There has been a proportionately bigger increase in the number of residents over 40 years of age, and some decline in the number of younger families and younger residents within the region.

The percentage of residents born overseas was slightly higher (13 per cent) than the average in rural Victoria (10 per cent). Some variation was also found across sub-regions, with the Midlands TRC having 16 per cent of residents born overseas and the Horsham TRC having comparatively fewer residents born overseas (5 per cent).

The main employment in the West region occurred in industries associated with manufacturing and retail trade. Although employment in the agriculture, forestry and fishing sector was lower in the West region (8.4 per cent) when compared with rural Victoria (13.1 per cent) there was significant variation in employment in this industry sector across the four TRCs. The Otway (29 per cent), Portland TRC (19 per cent), and Horsham (16 per cent) TRCs had the highest levels of employment within this industry sector, while the Midlands TRC (4 per cent) had the lowest level of employment in this industry sector.

There has been some decline within the West region during the 10-year period in the number of residents attending pre-primary, primary and secondary educational institutions, and there has been an increase in the number of residents attending TAFE and universities.

The unemployment rate within the West region has increased from 7 per cent in 1986 to 9.7 per cent in 1996. The rate in 1996 was similar to that found in rural Victoria. Across each of the four TRCs the unemployment rate varied from 7.3 per cent in the Otway and 7.6 per cent in the Horsham TRC, to 9.4 per cent in the Portland, and 9.5 per cent in the Midlands TRCs.

11.3 CHANGES IN FOREST LAND USE

In the West region, changes in both Federal and State government policies have required some readjustment of the management of forest resources with subsequent implications for communities in the region. The continual updating of information concerning forest production, conservation, recreation, water, historic and cultural heritage, and social values,

and the need to balance the provision of these uses and values in management, has provided the impetus for policy change. In Victoria key policy changes have resulted from:

- Victoria's Timber Industry Strategy (1986);
- Code of Forest Practices (1989);
- State Plantations Impact Study (1990);
- National Forest Policy Statement (1992); and
- numerous studies by the former Land Conservation Council (LCC).

In the 1970s, 1980s and 1990s, the LCC conducted a series of land-use studies in the West region. These studies included regional investigations and statewide theme investigations such as wilderness. Each study considered the full range of values and uses of public land in the region, including assessment of socio-economic impacts.

The LCC collected a large volume of social and economic information on a range of values and uses in the West region, and took this into account in making its recommendations in the various studies. This information was also used to minimise the social and economic impacts of various recommendations on individual enterprises and local communities.

The delineation of boundaries for conservation reserves of various kinds has also been undertaken to ensure the protection of significant values while aiming to minimise any adverse impacts on other uses and values.

11.4 STAKEHOLDER VIEWS

In recent years, there has been a growing interest in forest issues and a considerable increase in the number of groups wishing to influence forest use and management. These groups often bring quite different perspectives and values to particular issues. Often it is those groups in close proximity to the forest, those with pre-existing rights, local knowledge and high dependency that have less power or influence in the forest debate (Colfer, 1995). An analysis of the main issues and the response of different stakeholder groups is useful in predicting how individuals and groups may respond to different policy alternatives. The views presented below have been synthesised following a theme analysis of qualitative data. The views of the Aboriginal communities were obtained through six workshops organised by the Environment Forest Taskforce and Aboriginal Affairs Victoria, as part of the first stage of the RFA Aboriginal heritage consultation program.

Timber Industry

Issues raised by these groups related predominantly to access to the forest and resource security. In the past, they have been affected by reductions in resource, affecting their financial situation and employment stability. Those involved sought better public education on the timber industry. They expressed the desire for long-term planning in harvesting operations to allow them to pursue new business and market opportunities, and facilitate job creation. There was also a desire to achieve a balanced outcome on forest use, based on scientific facts.

Tourism, Recreation and Outdoor Education

Tour operators believe there should be recognition of the importance of forests for recreation. They felt that tracks and trails were not being maintained and that links between trails needed to be created to establish a useful network. Operators were concerned about some forest management practices, particularly the visual impact of clearfell harvesting on their operations. There was support for increased investment in plantations and agroforestry. Access was identified as an issue and the need to be informed about harvesting and forestry

activities, which may restrict access to public forests. There was a desire to have greater involvement in the management of forests by user businesses. Opportunities related to the development of sustainable, low-impact, eco-tourism to provide regional employment opportunities in the West area.

Conservation

Conservationists expressed concern about whether their requirements would be met under an RFA. They expressed a desire for more areas, especially water catchment areas, to be placed in National Parks and State parks and reserves. Stakeholders raised issues in relation to loss of biodiversity, wilderness and old growth values, water quality and sustainable yield. They were also concerned about particular forest management practices and their impact on the environment. They were also keen to see local knowledge used in the management of forests. Major opportunities included expansion of nature based tourism to support other regional economic developments.

Other Forest Uses (Seed, Firewood, and Craftwood Collection)

Those involved in forest uses, other than timber harvesting, questioned particular management practices in relation to their business. Concerns were also expressed in regard to changes in Government policy and the need for all forest uses to be fully considered. Need to improve access to forest produces and the availability of long-term licenses for seed, firewood and craftwood collection. There was a desire to increase understanding for their products in the management of forest. Opportunities lie in continued multiple use of forest areas, access to waste wood after harvesting and the ability to cut dry wood.

Apiculture

Apiarists perceive a loss of access to hive sites when forest areas are reserved in parks. They maintain that apiculture has little or low impact on forests or other recreational activities. Apiarists believe that harvesting and fuel reduction burns affect honey and pollination, although selective harvesting enables better retention of mature trees need for honey. Concern was also expressed over the maintenance of roads and sites, which need to be cleared to put hives down. Stakeholders also felt that outsiders have too much influence on issues that directly affect the local community.

Forest Grazing

Graziers felt that there was increased public pressure not to graze on forest areas and that they had been affected by changes in Government policy and management. They were supportive of continued grazing licenses and access to long-term licenses. Graziers raised the issue of improving forest fencing, clearing forest waste and a need for fuel reduction burns. They felt that grazing can benefit forest areas by reducing fire hazard.

Mineral Production

Access to public land was a prominent issue for miners and prospectors, who believed that they have been excluded from enough areas, and that exploration and prospecting have little impact on the forests. They expressed a desire to achieve a balanced outcome that allowed for the continued access for multiple use. They believe investment in prospecting and mining has been affected by uncertainty regarding access. They felt recognition needs to be given to the income their industry generates for rural towns, and also be valued as a hobby which can provide exercise for families and retired couples.

Aboriginal Groups/Communities

Aboriginal community participants were concerned about the lack of adequate consultation with Aboriginal people on forest management. They wanted to have greater access to State

forests, and be more involved in decisions about them, as forests were central to their way of life. Aboriginal people across the region use the forests for cultural purposes and obtaining craft materials. They stated that forests as a whole were important rather than particular sites, and were also concerned about damage to individual cultural sites such as scarred trees. They all felt cross-cultural awareness training is required for all people working in forest management and industry. The various Aboriginal communities had different regional views about other issues, and some groups expressed specific regional concerns about forests.

11.5 COMMUNITY TELEPHONE SURVEY

The views of the West community were obtained through a telephone survey of the region. The results illustrate a range of attitudes and views towards the use and management of native forests in the region. Map 11.1 indicates the sub-regional sectors from which the respondents were sampled. The sample reflected a small bias towards female respondents. However, the sample ages were within five per cent of census percentages for the same age ranges.

Eighteen per cent of respondents or household members of respondents were employed in one or more forest-based industries. Of these 68 per cent were employed in grazing, with a further 15.3 per cent employed in tourism and 6.9 per cent in recreational prospecting. All four sub-regions had similar concentrations of residents participating in activities and industries that use land in public native forests.

Nine per cent of the total respondents indicated that they have been involved in native forest management, planning or conservation in Victoria. Over 33 per cent have been involved in tree planting on a farm, school, or organised event, while a further 23 per cent have been involved in environmental groups such as Landcare.

Within the last year, 55 per cent of respondents had visited a National Park in Victoria. However, there was a significant variation in the use of National Parks with relatively few respondents in the Midlands (44 per cent) and Otway (44 per cent) sub-regions and relatively more respondents in the Horsham (78 per cent) and Portland (60 per cent) sub-regions visiting National Parks. Nevertheless, visitations to National Parks were significantly higher than for State forests. During the last year only 38 per cent of respondents indicated that they had visited a State forest, with relatively higher percentage visiting State forests in the Otway sub-region than respondents from either the Midlands, Portland or Horsham sub-regions. The primary activity when visiting either a National Park or State forest was walking or bushwalking. However, more visitors to National Parks (84 per cent) reported this as an activity than did visitors to State forests (59 per cent). Other major activity in National Parks included picnics or barbecues (33 per cent), drive or 4WD travel (28 per cent), camping (19 per cent), and sightseeing (18 per cent). In comparison, other major activity in State forests included drive or 4WD travel (34 per cent), picnic or barbecues (28 per cent), sightseeing (16 per cent), firewood collection (7 per cent), and camping (8 per cent).

Eighty nine per cent of respondents were interested in being involved in the management and use of National Parks and 85 per cent of respondents were interested in being involved in the management of State forests, with no significant differences across sub-regions. When asked to nominate the three most important things that needed to be considered in the management of National Parks in Victoria, 35 per cent indicated protection and preservation of native flora and fauna, 19 per cent indicated maintaining or improving fire management practices, and 13 per cent of respondents indicated maintaining public access. In comparison the three most important issues in State forest management were fire control and management (23 per cent), replanting and reforestation (20 per cent), and better management of logging (19 per cent). However, 25 per cent of respondents were not able to identify issues important to the management of National Parks, and 26 per cent were unable to identify issues important to the management of State forests.

Respondents were also asked if there had been any changes in the use of native forests in the last five years which affected their community. Twenty two per cent indicated that there had been a change. However, there was some variation in these responses when a sub-regional comparison was made. In the Horsham sub-region, 29 per cent of respondents indicated there had been a change in the use of native forests which had affected their community, compared with 25 per cent in Otway, 23 per cent in the Midlands, and 16 per cent in Portland. The three most common changes included restrictions on firewood collection (12 per cent), loss of forests through logging (8 per cent) and an increase in mining operations (8 per cent).

The results of the survey indicate that the people in the West region value forests for their environmental values, with the vast majority interested in being involved in their management. The most frequently visited National Parks during last year were the Grampians National Park (63 per cent), Lower Glenelg National Park (7 per cent) and Port Campbell National Park (6 per cent). The most frequently visited State forests were the Otway Ranges (30 per cent), Wombat State Forest (13 per cent) and Mt Cole State Forest (8 per cent).

The results also highlight that people are aware of the importance of the forests to their social and economic well-being. Seventy seven per cent of respondents believe that National Parks are important to the local economy of the area they live in, and 70 per cent of respondents believe that State forests are important to the local economy of the area they live in.

11.6 FOREST INDUSTRY ACTIVITY AND LINKAGES

This section provides an analysis of industry mail surveys conducted as part of the social assessment for the West RFA. It identifies communities that are reliant on forest-based industry activity in the region, and identifies significant relationships between specific areas of forest resource in the region and communities dependent on that resource.

The analysis is based on four township resource clusters (TRCs) identified in the West region, which are communities geographically distinct from other areas. The four TRCs include Midlands, Otway, Portland and Horsham.

The four TRCs were defined on the basis of the geographic distribution of mills and resource drawn from the Forest Management Areas (FMAs) in the West region. The West includes all or part of six Forest Management Areas (FMAs). The three FMAs of Midlands, Otway and Portland are wholly within the West region, approximately 50 per cent of the Horsham FMA is within the region, while small portions of the Central and Dandenong FMAs are included on the eastern boundary of the West region.

Native Timber Processing Industry

There are 24 timber processing industries currently drawing their resource from FMAs located within the West region, including 22 hardwood mills and 2 pulpwood processors. Another pulpwood processor operated in the West region but recently closed. They directly employ 406 people.

The Midlands TRC consisted of 11 mills and has 58.8 per cent of all industry employees, and the Otway TRC has four mills and 17.7 per cent of all industry employees. The Portland TRC has two mills and 3.2 per cent of all industry employees, while the Horsham TRC has two mills and 0.7 per cent of all industry employees. The remaining mills are located outside the West region, and not included in the TRCs.

The majority of all employees who work in mills, which draw their resource from the Midlands FMA, live in the Midlands TRC. These employees reside in the towns of Daylesford, Woodend, Geelong, Beaufort and Ballarat. Any change in resource status from

this FMA, which may impact on employment, has the potential to effect these towns. Mills located in Otway TRC draw the majority of the resource from the Otway FMA. Employees of mills in this TRC reside in the towns of Colac and Forrest. Again, any change in the status of the resource in the Otway FMA, which may effect employment is likely to impact on these towns. Mills in the Portland TRC draw the majority of their resource from the Portland FMA, with employees residing in the towns of Heywood and Portland. Mills in the Horsham TRC draw the majority of their resource from the Horsham FMA, with employees residing in the towns of Horsham and Stawell.

Industries located in the Midlands TRC source many of their goods and services from the towns of Geelong, Ballarat and Daylesford, while industries in the Otway TRC source their goods and services primarily from Colac.

An examination of the profile of forest industry employees indicates that 93 per cent of mill employees are male, and the mean age is 40 years. On average these employees have been working in the current business for eight years, and have worked in this industry sector for 12 years. The majority of employees are long-term residents of the town they live in and have lived there for an average of 24 years. Forty seven per cent of employees have an education level of year 10 or less. Two thirds of all employees are married, with 20 per cent of employed partners working in the same industry.

In relation to household expenditure, timber processing industries located in the region generate \$6.2 million in annual household expenditure. Of this, the mills around Daylesford generate the most annual household expenditure, with \$1.4 million, and the mills at Colac and Beaufort each generate \$0.8 million in annual household expenditure. Overall, employees drawing a percentage of their resource from the West region generated \$7.7 million in annual household expenditure.

Forest Contractors

An estimated 24 contracting businesses access forest resources within the West region. The majority of contractors (67 per cent) were located within the Otway TRC and in particular the town of Colac (42 per cent). It was also estimated that there were 123 employees of contracting businesses, with the Otway TRC having 77 employees and the town of Colac having 51 employees. As survey information was not available for the majority of contracting business employees, it was not possible to identify the residential location of all contracting business employees. However, analysis shows that most employees live in the same TRC as the one in which they are employed.

The profile of contractor business employees indicates that 95 per cent are male and have a mean age of 40 years. On average employees have been working in the current business for 11 years and have worked in this industry sector for 17 years. The majority of employees are long-term residents of the towns they live in and have lived there for an average of 30 years. Of the employees 59 per cent have an education level of year 10 or less, 80 per cent are married, with 31 per cent of all employed partners working in the same industry.

In relation to household expenditure, contracting businesses located in the region generate \$2.3 million in annual household expenditure. The majority of this occurred within the Otway TRC (\$1.5 million). Contractors within the Midlands TRC were found to generate \$400 000 in annual household expenditure among their employees.

Other Forest-related Industries

Other forest-related industries within the region include grazing, apiary, tourism, mining and prospecting.

Grazing

The return rate of questionnaires from businesses that held grazing permits was low (7.4 per cent), as was the return rate for employees of those businesses. Therefore, the only analysis possible was to examine the town location of grazing businesses. Of the 201 grazing businesses identified, 64 (32 per cent) were located in the Horsham TRC, 44 (22 per cent) were located in the Portland TRC, while an additional 28 (14 per cent) were located in the Midlands TRC.

Apiculture

The return rate for questionnaires from businesses that held apiary permits was 31.8 per cent. Of the 88 apiculture businesses identified, 23 (26 per cent) were located outside the West region in Bendigo and towns south of Bendigo. In addition, 21 (24 per cent) were located in the Horsham TRC, primarily in the towns of Horsham and Stawell and 18 (21 per cent) in the Midlands TRC. The majority of apiarist businesses had operated in the region for some time, with the average business having operated for 32 years.

An examination of the profile of employees in apiculture businesses indicates that 86 per cent of employees are male, and the mean age is 44 years. On average these employees have been working in the current business for 18 years, and have worked in this industry sector for 18 years. The majority of employees are long-term residents of the town they live in and have lived there for an average of 29 years. Sixtytwo per cent of employees have an education level of year 10 or less. Two thirds of all employees are married, with 73 per cent of employed partners working in the same industry.

Prospecting and Mining

The return rate for prospecting and mining businesses was 32 per cent. The majority of prospecting and mining businesses located within the West region were found in the Midlands TRC (62 per cent) and the town of Ballarat. Outside the West region, a significant number of these business were located in Bendigo (38 per cent).

Responses from prospecting and mining employees show that 91 per cent of all employees were male, with a mean age of 49 years. On average, employees have been working in the current business for seven years and had worked in this industry sector for 15 years. The majority of employees are long-term residents of the town they live in, having lived in their current town for an average of 21 years. Twenty two per cent of employees had a year 10 or lower level of education. Eighty per cent of all employees were married with 31 per cent of partners working in the same industry as the employee.

Tourism

Twenty five per cent of tourism businesses that held permits for activities in public forests responded to the questionnaire. Although, only 31 employees of these tourism businesses completed questionnaires, an employee profile of these tourism businesses was developed.

Of the tourism businesses that were known to operate in public forests in the West, 45 per cent were located outside the region, with 27 per cent of all tourism businesses based in the Melbourne metropolitan area. Of the 55 per cent of tourism businesses located within the West region, approximately one third were located in the Midlands TRC.

Of the 113 tourism businesses that had permits to access public land within the West region, 46 per cent operated in the Grampians, 38 per cent operated in areas along the Coast, while a further 16 per cent operated in the Basalt Plains area.

The questionnaire distributed to tourism businesses (permit holders) asked each business operator to identify those towns in the West region they considered tourists were most likely to visit. Although only based on 26 responses, the main towns identified were Halls Gap (100 per cent), Apollo Bay (84 per cent), Lorne (81 per cent), Port Fairy (81 per cent), Anglesea (69 per cent) and Warrnambool (69 per cent).

A profile of tourism business (permit holder) employees, shows 71 per cent of employees were male and the mean age of employees was 39 years. On average, employees had been working in their current business for five years and had worked in this industry sector for nine years. The majority of employees had lived in their current town for an average of 12 years. Of the employees, 74 per cent had a year 12 or higher level of education, 68 per cent were married, with 55 per cent of all employed partners working in the same industry.

11.7 COMMUNITY CASE STUDIES

As part of the social assessment process, detailed assessment was undertaken in six communities across the region: Apollo Bay, Colac, Ballarat, Daylesford, Dunkeld and Heywood (Map 11.2). A variety of methods were used to develop a detailed profile of each community. Information was obtained through secondary data source such as Australian Bureau of Statistics (ABS) statistics, local government reports, government department publications, community service directories and through community workshop and extensive fieldwork in each of the communities. This information was collected in order to provide an assessment of the socio-economic structure, historical response to change, community attachment and to identify forest values and attitudes towards forest use and management.

Apollo Bay

Apollo Bay has a relatively small permanent population, which doubles with tourists and holiday makers in the summer months. It tends to be an older population because of retirees, and there has been limited employment opportunities to keep young people in the town. The increase in newcomers to the area makes it a diverse community with people from different backgrounds. Participants felt that in recent years the community has become more political, and involved in development issues affecting the town. The locals see the RFA as a significant issue for the township and the area. They believe the community has a high degree of environmental awareness, and there are strong sentiments about logging of native forests especially in the Otway Ranges. Some participants were concerned about the impact of harvesting forests, the traffic hazard of logging trucks, and the damage to the roads. Participants felt that the future vision for the town lies in development of tourism opportunities.

Colac

Colac has experienced significant changes in the 10-year period with the restructuring of State and local government, the rural recession and restructuring of the rural sector, especially the amalgamation of dairy farms, and the consolidation of timber mills. As a service town to the outlying district, the rural recession has had a reported impact on retailing and trading in the township. Participants believed that young people are leaving the town because of the lack of vocations and educational opportunities. In response to these changes, the community is attempting to broaden its economic base by diversifying into new products and market niches. The timber mills in the town have an increased focus on value adding. There is recognition of the importance of the Otways for forestry, water supplies and tourism. Participants felt that the strategic location of the town should be capitalised on in future development.

Ballarat

Ballarat is one of the largest inland settlements in Australia. It has a diverse population with a relatively high number of 15-24 year olds attending the educational institutes in the town. Ballarat's rich history of gold, its wealth and historic buildings makes it a major tourist destination especially for interstate and overseas visitors. Despite the value of tourism, the downturn in the rural sector and manufacturing sectors has meant that there are high unemployment rates, especially among youth in the city. Participants see employment generation as critical for the future prosperity of Ballarat, and envision establishing Ballarat as a centre for commerce within the region. Participants also described a proposal to create a fast, daily commuter train to Melbourne to retain families in Ballarat. However, there was some concern that a dramatic increase in population may jeopardise the quality of life in Ballarat.

Daylesford

Daylesford, renowned for its mineral springs, is experiencing an increase in tourism. The area, promoted as the 'Spa Centre' of Australia, has seen a substantial increase in B&Bs and tourist accommodation since 1992. The accommodation and restaurants generate significant economic investment for the district. The area has also attracted new residents seeking alternative lifestyles, generating additional new commercial activities. However, participants felt that the increase in tourism has had some major impacts on the town with the cost of food and real estate rising significantly. Locals are also concerned that Shire money is being spent on tourism needs, not on local infrastructure. Participants wished to see that the environmental values, which attracted them to the area, would be maintained. They had concerns specifically about harvesting in the Wombat forest, and possible impacts on water catchments. Participants expressed the view that Daylesford is a vibrant community reliant on tourism and the spa industry. Participants wanted to see the economic base of the town diversified.

Dunkeld

Dunkeld is a small town with an aging population. Although the district has been prosperous in the past, many of the properties currently are enduring a rural recession associated with the decline in wool and beef prices, accompanied by a reduction in the farming population. Participants felt that the closure of the bank two years ago, followed by the closure of general store, impacted heavily on the town as more locals source all their goods and services from nearby Hamilton. Despite these setbacks, participants felt that in the last five years of the survey period the town has been actively selling itself as the 'Southern Gateway' to the Grampians. The development of the Tourist Information Centre and streetscape works has helped to encourage tourists to stop. The renovation of the Royal Mail Hotel has been a significant investment for Dunkeld. Rural families are developing a tourist focus and refurbishing empty cottages as tourist accommodation. The participants value their new tourism focus but want the town to retain its uniqueness.

Heywood

Heywood is a service town for the outlying agricultural hinterland services, as well as a commuter town to Portland. Some downsizing in the community has been attributed to the restructuring of local government, government agencies and service delivery, and the general decline in beef and wool prices. However, Heywood on the whole has been able to maintain an economic base because of its dairying industry. Participants were concerned about the increased numbers of agricultural properties being converted into blue gum plantations. While they acknowledged that it enables farmers to sell their farms or earn alternative income, there are fears that the plantations will result in a loss of population and amenity. Participants believe that the plantations are not labour intensive, and will be of little benefit to the local community. The community is promoting the district to increase tourism through a 'Timber

Wine and Roses' festival, the promotion of the Great South Western Walk and new boutique vineyards.

Forest Values and Usages

Forest values and uses were also examined across the six case study areas. 'Representation of Place' maps generated by community workshop participants were used to capture the range and diversity of values people ascribe to their local environment.

It is evident from the community workshops that people living within the West region participate in a variety of economic, recreational and cultural forest-related activities and identify with a range of forest values. The following table is a summary of the forest values and uses nominated by workshop participants across the six case study areas. Maps and further information from the community workshops are included in the West Social Assessment report (VicRFASC, 1999). This information provides an insight into the variety of values and uses that people associate with the forests of the West region. However, given that it was derived from workshop participants it should not be viewed as a comprehensive assessment of the range of uses or the only locations where those activities or values occur.

| Forest Values and Usage |
|---|
| Historic e.g. historic towns, gold mines and fields, saw mills, cemeteries, tramways, labour camps, Aboriginal cultural sites, heritage rivers, trails and bush blast furnace. |
| Aesthetic e.g. sightseeing, scenic views and drives, lakes and river surrounds, bird and other fauna watching, landscape, wildflowers, Great Ocean Road and waterfalls. |
| Environment e.g. Mountain Ash forests, cool-temperate rainforest, water catchments, Lerderderg River, mineral springs, River Red Gum, Landcare and National Heritage Trust projects, habitat links, remnant native grasslands, orchids, wildlife, brolgas, bird, (red-tailed black cockatoos and owls), koalas, Otway Ranges, Grampians, salinity problems, bushfires and need for fuel reduction burns. |
| Recreation e.g. fishing, camping, horse riding, 4WD, water recreation, swimming, surfing, picnicking, barbeques, mountain bike riding, horse riding trails, rock climbing, bushwalking, Trans-Otway Walk, Great South Western Walk, port and coastal walks. |
| Economic e.g. tourism, firewood collection, apiary (limited access for bees), farming, aquaculture, timber harvesting, high-value timbers, plantations, farm forestry, geological activity, prospecting, gem collecting, gold exploration, restaurants and eco-tourism. |
| Social/ Cultural e.g. lifestyle attractions, sheer enjoyment, holidays, family ties, galleries, arts and cultural activities, forest festivals, and visiting friends and family. |
| Education e.g. nature study, school trips and hikes, school camps, low cost recreation for youth, forest interpretation, field naturalist activities, nature documentation and retreats. |

11.8 CONCLUSION

The information collected as part of the social assessment process indicates that there are a range of positive and negative impacts that may be associated with changes in forest policy within the West region. These impacts will vary according to geographic location, regional/community context and by stakeholder group. Based on the data gathered, social impacts will be studied further during the development of a proposed reserve design for the West region.

While the data collected in the social assessment will be used to inform the RFA decision making process, it is anticipated that this information will be useful in facilitating future social and economic development within the West region.

12. BIODIVERSITY

12.1 INTRODUCTION

Biological diversity is the variety of all life forms and is usually considered at three levels:

- ‘Genetic diversity’ refers to the variety of genetic information contained in all individual plants, animals and micro-organisms.
- ‘Species diversity’ refers to the variety of living species.
- ‘Ecosystem diversity’ refers to the variety of habitats, biotic communities and ecological processes.

The National Forest Reserve Criteria (JANIS 1997), jointly developed by the Commonwealth and States, identifies the following objectives of biodiversity conservation:

- to maintain ecological processes and the dynamics of forest ecosystems in their landscape context;
- to maintain viable examples of forest ecosystems throughout their natural ranges;
- to maintain viable populations of native forest species throughout their natural ranges; and
- to maintain the genetic diversity of native forest species.

To achieve these objectives, the National Forest Reserve Criteria include a number of biodiversity criteria for establishing a Comprehensive, Adequate and Representative (CAR) reserve system. These are outlined in the box below.

The strategy for conserving biodiversity relies not just on a CAR reserve system, but also on the application of ecologically sustainable forest management practices in off-reserve areas.

Both the Commonwealth and Victoria have a number of responsibilities in connection with the conservation of biodiversity. A list and description of key Commonwealth and State legislation relating to RFAs in Victoria is given in Appendix 1.

Summary of the biodiversity criteria

1. As a general criterion, 15 per cent of the pre-1750 distribution of each forest ecosystem should be protected in the CAR reserve system.
2. Where forest ecosystems are recognised as vulnerable, then at least 60 per cent of their remaining extent should be reserved.
3. All remaining occurrences of rare and endangered forest ecosystems should be reserved or protected by other means as far as is practicable.
4. Reserved areas should be replicated across the geographic range of the forest ecosystem to decrease the likelihood that chance events such as wildfire or disease will cause the forest ecosystem to decline.
5. The reserve system should seek to maximise the area of high quality habitat for all known elements of biodiversity wherever practicable, but with particular reference to:
 - the special needs of rare, vulnerable or endangered species;

- special groups of organisms, for example species with complex habitat requirements, or migratory or mobile species;
 - areas of high species diversity, natural refugia for flora and fauna, and centres of endemism; and
 - those species whose distributions and habitat requirements are not well correlated with any particular forest ecosystem.
6. Reserves should be large enough to sustain the viability, quality and integrity of populations.
 7. To ensure representativeness, the reserve system should, as far as possible, sample the full range of biological variation within each forest ecosystem.
 8. In fragmented landscapes, remnants that contribute to sampling the full range of biodiversity are vital parts of a forest reserve system and should be protected.

12.2 METHODS USED IN BIODIVERSITY ASSESSMENT

The Victorian and Commonwealth Governments have agreed that the West region biodiversity assessment should be undertaken at the species and ecosystem levels (see above, and should include reviews of the main threats to such biodiversity in the region. Because information about genetic variation within species is very limited and costly to obtain, genetic diversity was not assessed, although it is recognised that it does overlap with species and ecosystem diversity and these are addressed by the National Forest Reserve Criteria.

The biodiversity assessment has, therefore, been based on an analysis of information about forest ecosystems and communities, flora and fauna species and their habitats, and the threats to these in the region. This chapter is based on the findings of the West Regional Forest Agreement Biodiversity Assessment Report for the Comprehensive Regional Assessment (VicRFASC in prep.). Additional references relating to the information provided in this chapter can be found in the Biodiversity Assessment Report.

Data Review

Biodiversity assessment relies on having adequate information about the distribution of species. It is important to know whether or not surveys undertaken for species or groups of species have been adequately distributed across the range of environments represented within the region. As part of this assessment, analyses were undertaken to determine where surveys for biodiversity were undertaken in the West region, which species were targeted, and whether survey sites are reasonably distributed to detect most species in most geographic or environmental components.

This data review is currently being completed and will be made available as part of a supplementary report to be published shortly.

Ecosystem Assessment

Ecological Vegetation Classes (EVCs) have been used as the basis of the forest ecosystem diversity assessment for the West region. EVCs are derived from a Statewide level of vegetation classification and are considered to be the most appropriate units for assessing biodiversity conservation at the landscape scale in Victoria (VicRAFSC 1996a). The assessment involved determining and mapping the types of forest communities occurring in

the West region today and the area occupied by each. An analysis and mapping exercise was also completed to determine how much of each forest type may have occurred prior to European settlement in order to provide an assessment of the extent to which each type is protected in proportion to its pre-1750 extent, and how much of each type has been lost.

This EVC mapping information is available for the Midlands and Otways Forest Management Areas (FMAs) within the West region. EVC mapping is currently being finalised for the sections of the Region within the Portland and Horsham FMAs and will be made available as part of a supplementary report to be published shortly.

Target Flora and Fauna Groups (Priority Species)

Species which are threatened (endangered or vulnerable to extinction), declining in numbers, patchy in distribution, migratory or mobile, good indicators, or unique to the region have been reviewed in this assessment. All nationally endangered or vulnerable forest species listed under the Commonwealth *Endangered Species Protection Act 1992* and known to occur in the region were considered a high priority, as were species listed under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act).

Currently, this information is available only for the fauna species in the Region. Similar information for plant species is currently being compiled and will be made available as part of a supplementary report to be published shortly.

Vulnerability Assessment

The degree to which a species is vulnerable to extinction is influenced by a number of factors. These include characteristics or attributes of the species itself, such as its habitat requirements, reproductive output and longevity. Other factors such as rarity and whether populations are increasing or decreasing (possibly due to extrinsic factors), are also important in determining the risk of decline or extinction. Vulnerability assessments are conducted for several West region flora and fauna species of conservation significance. This information assists in identifying and prioritising those species that are most in need of management actions to improve the prospects for their long-term survival.

Currently, this information is available only for the fauna species in the region. Similar information for plant species is currently being compiled and will be made available as part of a supplementary report to be published shortly.

Reservation Analysis

Reservation analysis is another component of the Comprehensive Regional Assessment process. Essentially it is an analysis to identify the degree to which a species or vegetation community is known to be represented in reserves within the region. The results of such analyses can be used to assist in the identification of species and communities that require particular attention because of their special conservation needs. Conservation objectives can, in some cases, be met by increasing representation of populations and communities within reserves and/or minimising the impacts of threatening processes throughout the forested estate. Reservation analyses are conducted for flora, fauna and EVCs.

Currently, this information is available only for the fauna species in the Region and EVCs in the Midlands and Otways FMAs. Similar information for plant species and for EVCs in the remainder of the Region is currently being compiled and will be made available as part of a supplementary report to be published shortly.

Disturbances (Threatening Processes)

The decline of species can be largely attributed to the impacts of disturbances, both directly on the species and indirectly on essential components of their habitat. For example, predation of Broad-toothed Rats by introduced species such as Foxes and feral Cats has a direct effect on population numbers, whereas grazing of its habitat by domestic stock can indirectly affect its chances of survival by altering essential components of its habitat, such as food and shelter. Disturbances which can have negative effects (direct or indirect) on a species are referred to as potentially threatening processes. This assessment describes potentially threatening processes relevant to the West region and the management arrangements currently in place to address these.

12.3 DATA REVIEW FOR TERRESTRIAL SPECIES

The data review is currently being completed and will be made available as part of a supplementary report to be published shortly.

12.4 FOREST ECOSYSTEM ASSESSMENT

Introduction

Assessment of forest ecosystems is important to determine whether representative examples of these ecosystems and the natural ecological processes that support them are maintained throughout their natural range. The assessment of forest ecosystems has involved describing, mapping and analysing the distribution and variation of these ecosystems in the region. Due to the size of the region and complexity of the task, the vegetation assessment has been conducted in two parts. One part deals with the subregion consisting of the Midlands and Otways Forest Management Areas (FMAs), and for which the survey results are presented in this volume, and the other covers the Portland and lower Horsham FMAs, the results of which will appear in a forthcoming volume. The two parts will subsequently be merged for the purposes of developing a regionwide perspective on ecosystem representation.

Ecological vegetation classes (EVCs) are the basic mapping units used for biodiversity planning and conservation assessment at landscape, regional and broader scales in Victoria. They are derived from large-scale forest type and plant community mapping, and are based on the following types of information:

- plant communities and forest types (including species and structural information);
- ecological information relevant to the species that comprise the communities (including life form and reproductive strategies); and
- information that describes variation in the physical environment (including aspect, elevation, geology and soils, landform, rainfall, salinity and climatic zones).

Each EVC represents one or more plant communities that occur in similar types of environments. The communities in each EVC tend to show similar ecological responses to environmental factors, such as disturbance (e.g wildfire). As well as representing plant communities, the EVCs can be used as a guide to the distribution of individual species and groups of species, including animals, and lower plants such as mosses and liverworts.

Ecological Vegetation Classes have been accepted as robust and appropriate units for assessing forest ecosystem diversity and conservation at the landscape scale, provided that the variability within widely distributed EVCs is also considered as part of the assessment. A detailed description of the EVC concept can also be found in that report VicRAFSC 1996a.

A total of 96 EVCs have been identified as currently occurring in the Midlands and Otways FMAs. These EVCs have been mapped across all land in the region at a scale of 1:100 000.

They are listed in Table 12.1. A detailed description of each EVC will be available in the West region Biodiversity Assessment Report for the CRA. It should be noted that approximately one third of the EVCs in the Midlands and Otways are described as mosaics or complexes (see Table 12.1 footnotes for definitions).

To allow a comparison of the current distribution of each EVC with its approximate distribution prior to European settlement, a map of the pre-1750 distribution of EVCs has been constructed (see Map 3). The map is based on predictions derived from existing vegetation, a variety of physical environmental attributes, and expert knowledge.

Many of the EVCs, which are primarily confined to fertile soils, are poorly represented on public land. The pre-1750 mapping exercise was primarily focused on private land and served to clarify the distribution and understanding of these EVCs.

Reservation Status of Ecological Vegetation Classes

A reserve system that is comprehensive, adequate and representative in its regional coverage of forest ecosystems is an important component of the Regional Forest Agreement for the West region. The extent of representation of EVCs in conservation reserves has been used as the basis for evaluating the current reservation status of forest ecosystems in the region.

Table 12.1 shows the distribution of EVCs across all land tenures in the Midlands and Otways FMAs. Descriptions of some of the land tenure categories represented in the table are as follows:

Conservation: includes all dedicated National and State parks and other conservation reserves such as flora and fauna reserves, and Heritage Rivers.

Other Parks and Reserves: includes regional parks and historic and cultural features reserves, where timber harvesting may be permitted.

Other Public Land: includes land managed by Government agencies such as water supply authorities.

Private Land: includes freehold land and plantations licensed to Hancock Victorian Plantations.

Table 12.1: Representative Conservation (Percentage Reservation Status) of EVCs in the Midlands & Otways FMAs (and Adjacent Sections of Dandenong and Central FMAs within the West Region) based on pre-1750s Vegetation Mapping

Table 12.2 Representative Conservation (% Reservation Status) of EVCs in the West Region (part) by FMA

Twenty of the EVCs occur predominantly on private land, with the remaining 76 occurring mainly on public land. For those EVCs that are not considered endangered, vulnerable or rare, the national reserve criteria reservation target of 15 per cent of the pre-1750 extent has been met for all but six EVCs. These are: Lowland Forest, Riparian Forest, Heathy Dry Forest, Grassy Dry Forest, Sedgy Riparian Woodland and Stream-bank Shrubland.

An analysis of the per cent reservation of pre-1750 EVCs within each FMA can assist in evaluating the extent to which the reserve system encompasses regional variation in forest ecosystems. The results of this analysis are presented in Table 12.2 — only EVCs with a pre-1750 extent of at least 5000 ha (representing 95.5 per cent of the region) are shown in the table.

Sub-regional Reservation of Ecological Vegetation Classes

The West region has not been divided into Geographic Representation Units because of the highly fragmented nature of the region's remnant forest. Sub-regional representation of EVCs will be considered on a Forest Management Area (FMA) basis. These FMAs are shown on Map 1. Information on EVCs for the Portland and Horsham FMAs is currently being finalised and will be presented in the supplementary report to be published shortly.

Reservation of floristic variation across EVCs

The extent to which the reserve system includes a representative sample of the floristic communities within each EVC has not yet been assessed. This analysis will be presented in the West region Biodiversity Assessment Report for the CRA and will assist in evaluating the extent to which the reserve system encompasses regional variation in forest ecosystems.

Threatened Forest Ecosystems

The conservation status of EVCs in the West region has been assessed using the criteria derived from the National Forest Reserve Criteria (JANIS 1997) (see Table 12.3).

Table 12.3: The National Forest Reserve (JANIS) Criteria Used to Assess the Conservation Status of EVCs

| Status of EVC | Criteria |
|---------------|---|
| Rare | R1. Total range generally less than 10,000 ha. R2. Total area generally less than 1,000 ha. R3. Patch sizes generally less than 100 ha. |
| Vulnerable | V1. Approaching greater than 70% lost (depletion). V2. Includes EVCs where threatening processes have caused: <ul style="list-style-type: none"> • significant changes in species composition, • loss or significant decline in species that play a major role within the ecosystem, or • significant alteration to ecosystem processes. V3. Subject to continuing threatening processes. |
| Endangered | E1. Distribution has contracted to less than 10% of original range. E2. Less than 10% of original area remaining. E3. 90% of area is in small patches subjected to threatening processes. |

A total of 74 EVCs from the Midlands and Otways have been classified as endangered, vulnerable or rare — these are listed in Table 12.4. For many of the EVCs that are endangered, vulnerable or rare as a result of depletion, the only occurrence outside conservation reserves is on private land. This reflects the historic demarcation between public land and the selection of arable lands for farming associated with private land.

Table 12.4: Endangered, Vulnerable and Rare Ecological Vegetation Classes in the Midlands and Otways FMAs

| Name | % of pre-1750 extent in Reserves | Criteria (see Table 12.3 above) |
|--|----------------------------------|---------------------------------|
| Damp Sands Herb-rich Woodland | 8.1% | R3, V1 |
| Sand Heathland | 75.0% | R2, R3 |
| Clay Heathland | 5.4% | R2, R3 |
| Estuarine Wetland | 8.9% | R2 |
| Riparian Scrub Complex | 29.4% | R3 |
| Riparian Shrubland | 19.6% | R2, V1 |
| Herb-rich Foothill Forest | 4.0% | V1, V2, V3 |
| Rocky Outcrop Shrubland | 0.0% | R1, R2, E1, E2, E3 |
| Damp Forest | 8.7% | R3, V3 |
| Cool Temperate Rainforest | 68.6% | E3 |
| Montane Grassy Woodland | 0.0% | R1, R2, R3 |
| Valley Grassy Forest | 3.1% | R3, V1 |
| Swamp Scrub | 0.8% | E2 |
| Plains Grassy Woodland | 0.4% | V3, E2 |
| Floodplain Riparian Woodland | 2.2% | V3, E2 |
| Box Ironbark Forest | 8.0% | R1, V1 |
| Rocky Chenopod Woodland | 21.4% | R1, R2 |
| Alluvial Terraces Herb-rich Woodland | 2.4% | R1, V1 |
| Creekline Grassy Woodland | 4.8% | V1 |
| Metamorphic Slopes Shrubby Woodland | 0.0% | R1, R2, V1 |
| Hillcrest Herb-rich Woodland | 22.2% | R1, R2 |
| Granitic Hills Woodland | 0.0% | R1, R2, E2 |
| Rocky Outcrop Shrubland/Herbland Mosaic | 52.7% | R1, R2 |
| Wetland Formation | 9.1% | R2, R3, V1, V2, V3 |
| Spring Soak Woodland | 0.0% | R2, E2 |
| Swampy Riparian Woodland | 0.1% | R1, R2, V1, V3 |
| Riparian Forest/Swampy Riparian Woodland/Riparian Shrubland/Riverine Escarpment Scrub/Disturbed Mosaic | 0.0% | R1, R2, R3, E2 |
| Broombush Mallee | 0.0% | R2, R3, V1 |
| Lignum Wetland | 0.6% | R1, R2, R3, V1, E3 |
| Plains Grassy Wetland | 0.2% | R2, E2, E3 |
| Swampy Riparian Complex | 0.0% | R2, E2 |
| Valley Heathy Forest | 0.8% | R1, R2, R3, E2 |
| Grassy Forest | 0.0% | V1, V2, V3 |
| Plains Grassland | 0.0% | V3, E2, E3 |
| Sand Forest | 0.0% | R2, R3, E3 |
| Sedge Wetland | 0.0% | R1, R2, R3 |
| Mangrove Shrubland | 47.5% | R1, R2, R3 |
| Alluvial Terraces Herb-rich Woodland/Plains Grassy Woodland Complex | 0.0% | R2, R3, V3, E2, E3 |
| Coastal Tussock Grassland | 63.2% | R2, R3 |
| Creekline Herb-rich Woodland | 7.3% | R3, V1 |
| Damp Heath Scrub | 5.1% | V2, E2 |
| Grassy Woodland | 0.3% | E2, E3 |
| Valley Slopes Dry Forest | 100.0% | R1, R2, R3 |
| Coast Gully Thicket | 50.4% | R1, R2, R3 |
| Seasonally Inundated Shrubby Woodland | 100.0% | R1, R2, R3 |
| Seasonally-inundated Sub-saline Herbland | 100.0% | R1, R2, R3 |
| Shallow Freshwater Marsh | 0.0% | R2, R3, V3 |
| Stoney Rises Woodland | 0.5% | E2, E3 |
| Gilgai Plain Woodland/Wetland Mosaic | 0.0% | R1, R2, E2, E3 |
| Valley Grassy Forest/Plains Grassy Woodland Complex | 0.0% | R2, E2, E3 |
| Valley Grassy Forest/Slopes Box Grassy Woodland Complex | 0.0% | R1, R2, E2, E3 |
| Grassy Woodland/Valley Grassy Forest Complex | 0.0% | R1, R2, E2, E3 |
| Shrubby Woodland | 100.0% | R1, R2 |
| Plains Sedgy Woodland | 0.0% | R2, E2, E3 |
| Cane Grass Wetland | 0.0% | R1, R2, R3, V1, E3 |
| Red Gum Wetland | 0.0% | R2, R3, V1, E3 |
| Reed Swamp | 85.7% | R1, R2 |

| Name | % of pre-1750 extent in Reserves | Criteria (see Table 12.3 above) |
|---|----------------------------------|---------------------------------|
| Grassy Dry Forest/Heathy Dry Forest Complex | 4.2% | R1, V3 |
| Rocky Outcrop Shrubland/Herbland/Grassy Dry Forest Complex | 47.9% | R1 |
| Creekline Sedgy Woodland | 0.0% | R2, R3, V1, V3 |
| Riparian Woodland | 0.9% | R2, R3, E2, E3 |
| Plains Sedgy Wetland | 0.4% | R2, R3, E2, E3 |
| Aquatic Herbland/Plains Sedgy Wetland Mosaic | 0.0% | R3, V1 |
| Mangrove Shrubland/Coastal Saltmarsh/Berm Grassy Shrubland/Coastal Tussock Grassland Mosaic | 0.0% | R1, R2, R3 |
| Damp Heath Scrub/Heathy Woodland Complex | 100.0% | R2, R3 |
| Calcarene Dune Woodland | 4.9% | R2, R3, V1, V3 |
| Montane Grassy Woodland/Rock Outcrop Shrubland/Herbland Mosaic | 0.0% | R1, R3 |
| Floodplain Reedbed | 0.0% | R2, R3 |
| Plains Brackish Sedge Wetland | 55.4% | R1, R2, R3 |
| Scoria Cone Woodland | 1.4% | V3, E2, E3 |
| Escarpment Shrubland | 0.0% | R2, R3, V1, V2 |
| Grassy Woodland/Heathy Dry Forest Complex | 0.0% | E2 |
| Cane Grass-Lignum Halophyllic Herbland | 64.6% | R1, R2, R3 |
| Plains Freshwater Sedge Wetland | 89.9% | R1, R2, R3 |

Notes:

¹ Per cent Reservation in Conservation Parks and Reserves is based on pre-1750 extent.

² Threatening processes and management will be described in the separate Biodiversity Assessment report. Further information on disturbances and management actions is provided in section 12.7.

12.5 FLORA SPECIES ASSESSMENT

The flora species assessment is currently being completed and will be reported in Volume 2 of the West Victoria Comprehensive Regional Assessment.

12.6 TERRESTRIAL FAUNA SPECIES ASSESSMENT

Introduction

The purpose of this terrestrial fauna assessment is to provide information to be used in addressing the biodiversity criteria for the West region.

The assessment of West region fauna has been handled separately for terrestrial and aquatic species (see section 12.8 for aquatic species assessment).

Priority Species Information

The assessment of terrestrial fauna is based largely on a subset of species found in the West region which are considered high priority because either their long-term survival is threatened in some way, or because they are considered to be good indicator species (i.e. species whose presence or absence is indicative of a particular habitat, community or set of environmental conditions). Those that are threatened may be considered to be threatened nationally, or just in Victoria. They are listed under the Commonwealth *Endangered Species Protection Act 1992* (ESP Act) and/or the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act) and/or the Threatened Fauna in Victoria list (NRE 1999). The indicator species were chosen to provide a broader assessment of fauna in the region and included species representative of taxa at risk from various management activities, and not necessarily forestry related. All of these species are shown in Table 12.5.

As well as showing the status (endangered, vulnerable etc) of each species under the FFG and ESP Acts, Table 12.5 also indicates whether an Action Statement and/or a Recovery Plan exists or is being prepared for that species.

Table 12.5: Terrestrial Fauna Species Included in the Assessment

| Species Name | Common Name | TFV 1999 | FFG Status | Action Statement (Vic) | ESP Status | Recovery Plan (C'wlth) | Secure in Other States |
|--|---------------------------|----------|------------|------------------------|------------|------------------------|------------------------|
| Mammals | | | | | | | |
| Priority species | | | | | | | |
| <i>Mastacomys fuscus</i> | Broad-toothed Rat | L | | | | | No |
| <i>Dasyurus maculatus</i> | Spot-tailed Quoll | E | L | Yes | V | No | No |
| <i>Miniopterus schreibersii oceanensis</i> | Eastern Bent-wing Bat | V | L | In prep | | | Yes |
| <i>Myotis macropus</i> | Southern Myotis | L | | | | | No |
| <i>Phascogale tapoatafa</i> | Brush-tailed Phascogale | V | L | In prep | | | No |
| <i>Petaurus norfolcensis</i> | Squirrel Glider | E | L | In prep | | | No |
| <i>Sminthopsis murina</i> | Common Dunnart | D | | | | | Yes |
| <i>Pseudomys fumeus</i> | Smoky Mouse | E | R | | | | No |
| <i>Pseudomys shortridgei</i> | Heath Mouse | L | L | In prep | E | No | No |
| <i>Antechinus minimus</i> | Swamp Antechinus | L | | | | | Yes |
| Indicator species | | | | | | | |
| <i>Potorous tridactylus</i> | Long-nosed Potoroo | | | | | | Yes |
| <i>Antechinus flavipes</i> | Yellow-footed Antechinus | | | | | | Yes |
| <i>Petaurus australis</i> | Yellow-bellied Glider | | | | | | No |
| <i>Sminthopsis leucopus</i> | White-footed Dunnart | | | | | | No |
| <i>Scotorepens balstoni</i> | Inland Broad-nosed Bat | | | | | | Yes |
| <i>Falsistrellus tasmaniensis</i> | Eastern False Pipistrelle | | | | | | Yes |
| Birds | | | | | | | |
| Priority species | | | | | | | |
| <i>Xanthomyza phrygia</i> | Regent Honeyeater | C | L | Yes | E | Yes | No |
| <i>Grantiella picta</i> | Painted Honeyeater | V | L | No | | | No |
| <i>Lathamus discolor</i> | Swift Parrot | E | L | In prep | V | Yes | No |
| <i>Calyptorhynchus banksii graptogyne</i> | Red-tailed Black-Cockatoo | E | L | Yes | E | Yes | No |
| <i>Dasyornis broadbenti</i> | Rufous Bristlebird | V | L | Yes | | | No |
| <i>Burhinus grallarius</i> | Bush Stone-curlew | V | L | In prep | | | No |
| <i>Pomatostomus temporalis</i> | Grey-crowned Babbler | E | L | Yes | | | No |
| <i>Lophoictinia isura</i> | Square-tailed Kite | E | | | | | No |
| <i>Accipiter novaehollandiae</i> | Grey Goshawk | L | | | | | No |
| <i>Haliaeetus leucogaster</i> | White-bellied Sea-eagle | E | L | Yes | | | No |
| <i>Ninox connivens</i> | Barking Owl | E | R | No | | | No |
| <i>Ninox strenua</i> | Powerful Owl | E | L | In prep | | | No |
| <i>Tyto novaehollandiae</i> | Masked Owl | E | L | In prep | | | No |
| <i>Hylacola pyrrhopygia</i> | Chestnut-rumped Heathwren | D | | | | | Yes |
| <i>Chthonicola sagittata</i> | Speckled Warbler | V | | | | | Yes |
| Indicator species | | | | | | | |
| <i>Alecedo azurea</i> | Azure Kingfisher | | | | | | No |
| <i>Melanodryas cucullata</i> | Hooded Robin | | | | | | Yes |
| <i>Pachycephala inornata</i> | Gilbert's Whistler | | | | | | No |
| <i>Chrysococcyx osculans</i> | Black-eared Cuckoo | | | | | | Yes |

| Species Name | Common Name | TFV 1999 | FFG Status | Action Statement (Vic) | ESP Status | Recovery Plan (C'wlth) | Secure in Other States |
|---------------------------------|--------------------------|----------|------------|------------------------|------------|------------------------|------------------------|
| Reptiles | | | | | | | |
| Priority species | | | | | | | |
| <i>Aprasia striolata</i> | Striped Worm-lizard | L | | | | | ? |
| <i>Varanus varius</i> | Lace Monitor | D | | | | | Yes |
| <i>Egernia coventryi</i> | Swamp Skink | V | | | | | Yes |
| <i>Ramphotyphlops proximus</i> | Woodland Blind Snake | V | | | | | Yes |
| <i>Tympanocryptis diemensis</i> | Anglesea Mountain Dragon | C | | | | | No |
| Indicator species | | | | | | | |
| <i>Pygopus lepidopodus</i> | Common Scaly-foot | | | | | | Yes |
| Amphibians | | | | | | | |
| Priority species | | | | | | | |
| <i>Litoria raniformis</i> | Warty Bell Frog | V | X | | | | Yes |

Notes: Threatened Fauna in Victoria - 1999 (NRE 1999) - C- Critically endangered, E- Endangered, V-Vulnerable, L-Lower risk near threatened, D-Data deficient

Flora and Fauna Guarantee Act 1988 (FFG Act): L-Listed, R-recommended for listing, X-rejected from listing
Commonwealth Endangered Species Protection Act (ESP): E = Endangered; V = Vulnerable.

More information on each of the species listed in Table 12.5 is provided in the Biodiversity Assessment Report and in the sections that follow.

Terrestrial invertebrates

The terrestrial invertebrate assessment is currently being completed and will be made available as part of a supplementary report to be published shortly.

Species Vulnerability Assessment

A vulnerability assessment was done for terrestrial vertebrate fauna to identify those species which are likely to be at higher risk of decline or extinction. The following characteristics of a species influence the likelihood of its decline or becoming extinct:

1. **Rarity** — based on the geographic range and abundance of populations, as well as how tightly they are restricted to specific habitat types. Species or populations most predisposed to extinction are those that have small geographic ranges, low abundance and narrow habitat specificity.
2. **Population dynamics** — whether a population is increasing, stable or decreasing.
3. **Spatial dynamics** — the way in which individual populations increase or decrease, and their ability to disperse and hence interact with other populations. Populations most predisposed to extinction are those with high population variability and low powers of dispersal.
4. **Life history parameters** — aspects of a species' biology that may make it susceptible to extinction. Reproductive output and longevity are considered most important. Species most predisposed to extinction are those which are long-lived and those with low reproductive outputs (e.g. small litter or clutch sizes).

The above biological characteristics which may predispose species or populations to decline or extinction have been rated for all priority terrestrial fauna species occurring in the West region (see Table 12.6). This information provides a basis for identifying and prioritising those species that are most in need of management actions to improve the prospects of their long-term survival. This assessment should also be considered in conjunction with the information relating to threatening processes discussed later.

Table 12.6: Summary of Life History and Population Dynamics Information for Fauna Species

| Species | Population trend in the last 10 years | Rarity Ratings | | | Spatial Dynamics Ratings | | Life History Parameter Ratings | |
|---------------------------|---------------------------------------|------------------|-----------|---------------------|--------------------------|---------------------|--------------------------------|-------------|
| | | Geographic Range | Abundance | Habitat Specificity | Population Variability | Powers of Dispersal | Reproductive Output | Longevity |
| Mammals | | | | | | | | |
| Broad-toothed Rat | *declined | small | low | medium | *low | unknown | medium | long-lived |
| Spot-tailed Quoll | declined | large | low | wide | low | *high | medium | unknown |
| Eastern Bent-wing Bat | *declined | medium | low | narrow | low | high | low | long-lived |
| Southern Myotis | unknown | large | low | narrow | low | unknown | low | long-lived |
| Brush-tailed Phascogale | declined | large | low | wide | high | high | high | short-lived |
| Squirrel Glider | *declined | small | low | wide | unknown | high | low | short-lived |
| Common Dunnart | *declined | large | low | narrow | unknown | unknown | high | short-lived |
| Smoky Mouse | declined | small | low | narrow | high | *low | medium | short-lived |
| Heath Mouse | *declined | small | low | narrow | high | unknown | medium | long-lived |
| Swamp Antechinus | unknown | medium | low | narrow | high | low | high | short-lived |
| Long-nosed Potoroo | declined | medium | low | wide | low | unknown | medium | long-lived |
| Yellow-footed Antechinus | *stable | medium | low | wide | high | unknown | high | short-lived |
| Yellow-bellied Glider | *declined | medium | low | wide | low | high | low | long-lived |
| White-footed Dunnart | declined | medium | unknown | wide | unknown | high | high | short-lived |
| Inland Broad-nosed Bat | unknown | medium | low | wide | low | high | low | long-lived |
| Eastern False Pipistrelle | unknown | large | low | narrow | low | high | low | long-lived |
| Birds | | | | | | | | |
| Regent Honeyeater | declined | large | low | narrow | high | high | low | unknown |
| Painted Honeyeater | *declined | medium | low | narrow | high | high | high | unknown |
| Swift Parrot | declined | large | low | narrow | high | high | high | *long-lived |
| Red-tailed Black-Cockatoo | *declined | small | low | narrow | high | high | low | long-lived |
| Rufous Bristlebird | declined | small | low | narrow | *low | low | low | unknown |
| Bush Stone-curlew | declined | large | low | narrow | low | *low | low | long-lived |
| Grey-crowned Babbler | declined | medium | low | wide | low | low | low | short-lived |
| Square-tailed Kite | unknown | medium | low | wide | unknown | high | low | *long-lived |
| Grey Goshawk | unknown | large | low | narrow | unknown | high | low | *long-lived |
| White-bellied Sea-eagle | unknown | large | low | wide | low | high | low | long-lived |
| Barking Owl | unknown | large | low | narrow | low | high | low | *long-lived |
| Powerful Owl | stable | large | low | wide | low | high | low | long-lived |
| Masked Owl | *declined | medium | low | medium | unknown | high | low | long-lived |
| Chestnut-rumped Heathwren | unknown | large | low | narrow | unknown | low | low | short-lived |
| Azure Kingfisher | declined | large | low | narrow | high | unknown | medium | *long-lived |
| Hooded Robin | declined | large | low | wide | *low | low | low | long-lived |
| Speckled Warbler | declined | medium | medium | wide | high | low | medium | short-lived |
| Gilbert's Whistler | declined | medium | low | wide | low | high | low | *long-lived |
| Black-eared Cuckoo | declined | large | low | medium | high | high | low | unknown |
| Reptiles | | | | | | | | |
| Striped Worm-lizard | unknown | medium | low | narrow | unknown | low | low | unknown |
| Lace Monitor | unknown | medium | medium | wide | unknown | unknown | low | *long-lived |
| Swamp Skink | unknown | large | low | narrow | unknown | low | low | *long-lived |
| Woodland Blind Snake | unknown | small | low | medium | unknown | low | low | unknown |
| Anglesea Mountain Dragon | *declined | small | low | narrow | unknown | low | low | unknown |
| Common Scaly-foot | unknown | small | low | medium | unknown | low | low | unknown |
| Amphibians | | | | | | | | |
| Warty Bell Frog | declined | large | unknown | wide | unknown | unknown | unknown | unknown |

* Unknown, but most likely classification.

Most of the species assessed have either medium or large geographic ranges within the West region. Species with a small geographic range (Broad-toothed Rat, Squirrel Glider, Smoky Mouse, Heath Mouse, Red-tailed Black-Cockatoo, Rufous Bristlebird, Woodland Blind Snake, Anglesea Mountain Dragon, Common Scaly-foot) are more vulnerable to regional extinction as a result of localised disturbance.

As expected for a group of species selected because there is some concern for their status, most species have a low abundance. Twelve of the threatened species with a low abundance, nevertheless have a large geographic range over the West region (based on small numbers of widely scattered records).

Many of the species covered by the review were rated as habitat specific. These species often depend on a combination of certain habitat components, e.g. for example, the Swamp Skink requires dense ground level vegetation and a humid micro-environment. Loss or reduction of a critical habitat component is likely to lead to population declines.

Five of the 42 species listed in Table 12.6, Smoky Mouse, Heath Mouse, Red-tailed Black-Cockatoo, Rufous Bristlebird and Anglesea Mountain Dragon, have a combination of small geographic range size, low abundance and narrow habitat specificity. Most of these species exist in small isolated populations, making them particularly vulnerable to disturbances, especially events such as wildfire which can cause local extinctions. Species in this group are more predisposed to the threat of decline or extinction within the West region and should be given particular consideration in developing priorities for management action.

The chances of discrete populations of a species collapsing are reduced if the species has a good ability to disperse and if the sizes of populations are not highly variable (see spatial dynamics ratings). West region species in this group include the Spot-tailed Quoll, Yellow-bellied Glider, the three bat species, White-bellied Sea-Eagle, most of the large forest owls and Gilbert's Whistler. At the other extreme are species whose spatial dynamics characteristics make them more vulnerable to extinction; these include the Swamp Antechinus, and Speckled Warbler. Both these species are also short-lived, increasing their risk of decline.

Population trends are the clearest indicators of a species' likelihood of decline or extinction. The majority of species are thought to have declined in abundance since European settlement, usually as a result of loss of habitat through clearing for agriculture and urban development. Of the species whose population trend in the past 10 years could be determined, the majority have decreased. Although Powerful Owl numbers are thought to have decreased since European settlement, they are thought to have stabilised over the past 10 years.

Unfortunately, the population trend in the past 10 years could not be determined for a range of species. This, together with other gaps in knowledge of species indicated in Table 12.6, highlights the need for further biological information on a large number of the species assessed.

Species Reservation Analysis

A reservation analysis has been undertaken to assess the extent to which terrestrial vertebrate species in the West region are protected in the reserve system.

Using data from the *Atlas of Victorian Wildlife*, both formal survey and incidental records were intersected with existing land tenure to calculate the total proportion of records for each species in each of the major land tenure categories — see Table 12.7. There are 12 species for which less than 20 per cent of records are in Reserves. Two of these species, the Red-tailed

Black-Cockatoo and the Striped Worm Lizard, have their major occurrence in the West region.

The results should be considered in conjunction with the information on threatening processes. Many threatening processes operate across reserve and off-reserve areas, and other measures are in place, in addition to reservation, to provide protection at the species level.

Table 12.7: Reservation Analysis of Priority Fauna Species Records in West Region

| SPECIES | Total | Conservation Parks & Reserves | | State Forest & Other Public Land | | Private Land | | Water Bodies | |
|---------------------------|-------|-------------------------------|-----|----------------------------------|-----|--------------|-----|--------------|-----|
| | | Number | % | Number | % | Number | % | Number | % |
| Mammals | | | | | | | | | |
| Broad-toothed Rat | 35 | 10 | 29% | 10 | 29% | 15 | 43% | | 0% |
| Spot-tailed Quoll | 102 | 10 | 10% | 13 | 13% | 79 | 77% | | 0% |
| Eastern Bent-wing Bat | 87 | 41 | 47% | 7 | 8% | 39 | 45% | | 0% |
| Southern Myotis | 34 | 6 | 18% | 0 | 0% | 14 | 41% | 14 | 41% |
| Brush-tailed Phascogale | 136 | 9 | 7% | 16 | 12% | 111 | 82% | | 0% |
| Squirrel Glider | 37 | 13 | 35% | 7 | 19% | 17 | 46% | | 0% |
| Common Dunnart | 46 | 17 | 37% | 5 | 11% | 24 | 52% | | 0% |
| Smoky Mouse | 17 | 16 | 94% | 0 | 0% | 1 | 6% | | 0% |
| Heath Mouse | 404 | 171 | 42% | 102 | 25% | 130 | 32% | 1 | 0% |
| Swamp Antechinus | 232 | 76 | 33% | 47 | 20% | 109 | 47% | | 0% |
| Birds | | | | | | | | | |
| Regent Honeyeater | 42 | 2 | 5% | 13 | 31% | 27 | 64% | | 0% |
| Painted Honeyeater | 51 | 15 | 29% | 10 | 20% | 26 | 51% | | 0% |
| Swift Parrot | 210 | 22 | 10% | 65 | 31% | 123 | 59% | | 0% |
| Red-tailed Black-Cockatoo | 1272 | 102 | 8% | 469 | 37% | 693 | 54% | 8 | 1% |
| Rufous Bristlebird | 333 | 155 | 47% | 25 | 8% | 146 | 44% | 7 | 2% |
| Bush Stone-curlew | 183 | 22 | 12% | 18 | 10% | 143 | 78% | | 0% |
| Grey-crowned Babbler | 67 | 15 | 22% | 5 | 7% | 47 | 70% | | 0% |
| Square-tailed Kite | 32 | 7 | 22% | 6 | 19% | 19 | 59% | | 0% |
| Grey Goshawk | 248 | 52 | 21% | 25 | 10% | 168 | 68% | 3 | 1% |
| White-bellied Sea-Eagle | 56 | 12 | 21% | 4 | 7% | 19 | 34% | 21 | 38% |
| Barking Owl | 85 | 16 | 19% | 15 | 18% | 53 | 62% | 1 | 1% |
| Powerful Owl | 470 | 122 | 26% | 214 | 46% | 131 | 28% | 3 | 1% |
| Masked Owl | 61 | 10 | 16% | 20 | 33% | 31 | 51% | | 0% |
| Chestnut-rumped Heathwren | 132 | 54 | 41% | 28 | 21% | 49 | 37% | 1 | 1% |
| Speckled Warbler | 273 | 58 | 21% | 41 | 15% | 169 | 62% | 5 | 2% |
| Reptiles | | | | | | | | | |
| Striped Worm-Lizard | 21 | 2 | 10% | 5 | 24% | 14 | 67% | | 0% |
| Lace Monitor | 50 | 9 | 18% | 7 | 14% | 33 | 66% | 1 | 2% |
| Swamp Skink | 45 | 27 | 60% | 14 | 31% | 4 | 9% | | 0% |
| Woodland Blind Snake | 9 | 1 | 11% | 0 | 0% | 7 | 78% | 1 | 11% |
| Amphibians | | | | | | | | | |
| Warty Bell Frog | 318 | 37 | 12% | 62 | 19% | 200 | 63% | 19 | 6% |

12.7 REVIEW OF DISTURBANCES AND IMPLICATIONS FOR FLORA AND FAUNA

Introduction

The decline of species can be largely attributed to the impacts of disturbances, both direct — on species, and indirect — on essential components of their habitat. In this review, disturbances are defined as activities or events with associated environmental impacts. The environmental impacts may constitute potentially threatening processes for particular taxa. Such potentially threatening processes, as defined under the *Flora and Fauna Guarantee Act 1988* (FFG Act), could pose a significant threat to the survival, abundance and evolutionary development of native species or ecological communities of flora or fauna.

A range of mechanisms is in place in the West region to ensure that threatening processes which affect individual species are addressed. These include:

- a conservation reserve system which includes a sample of habitats on public land;
- requirements under the FFG Act and the *Endangered Species Protection Act 1992*;
- a range of provisions in the Code of Forest Practices for Timber Production (NRE 1996b) and the Code of Practices for Fire Management on Public Land (CNR 1995b), which address many of the threatening processes operating in the region.

Additional protection is afforded by measures in the Otways and Midlands Forest Management Plans (DCE 1992, NRE 1996b) which include specific threatened species strategies and Special Protection Zones.

Methods

Disturbances, which impact on flora and fauna in the West region, were identified as part of an assessment of vulnerability, population parameters and life history attributes of 42 terrestrial vertebrates. These species were selected for analysis because they are either classified as rare or threatened in Victoria, or considered to be indicators, representative of a suite of species which may be vulnerable to the continued action of threatening processes. The 42 fauna species are listed in Table 12.8.

Each disturbance was evaluated to determine the extent of its occurrence within the West region, the potentially threatening processes which are associated with it, the overall significance of the threat to native flora and fauna in the region, species attributes which might predispose taxa to negative impacts, and examples of the animals that might therefore be susceptible to the disturbance. Management systems, including policies and processes, for the amelioration of the adverse biodiversity impacts of the disturbance were also summarised.

The significance of threats to fauna was assessed through reference to the current literature and consultation with recognised experts in the biology of the species. Threatening processes that potentially affect more than one component of a species' life cycle or habitat scored higher ratings than threats that affect fewer life cycle or habitat components.

For each disturbance identified, a score was assigned for each priority species being considered, indicating the level of threat.

Disturbances were scored for each species as follows:

- Effect unknown;
- 0 Processes not likely to be operating as a threat or there is no information to suggest that it is a threat;

- 1 Process is a minor threat, which by itself is unlikely to lead to broad scale decline of the species;
- 2 Process is a moderate threat, which is likely to lead to some decline of the species, especially if it operates in combination with other threatening processes; and
- 3 Process is a major threat, which if not checked poses a significant risk to the viability of the species in the West region.

The assessments were made recognising that practices on public land follow minimum prescriptions required under the Code of Forest Practices for Timber Production (NRE 1996b) and various State Acts and Regulations and that practices on private land are in accord with the *Planning and Environment Act 1987* and the *Catchment and Land Protection Act 1994*. However, the assessments do not take account of additional protection afforded in various Action Statements, Park management plans, nor any additional measure in the Otways and Midlands Forest Management Plans. The following discussion applies only to the West region.

Results and Discussion

The results of the fauna disturbance assessment are presented in Table 12.8.

The combined score for each threatening process can provide an indication of the relative importance of different threatening processes affecting taxa in the West region (as shown in Table 12.8). Overall, clearing of native vegetation was the highest scoring threat for fauna, followed by timber harvesting and grazing. Clearing of native vegetation was also identified as affecting the greatest number of fauna species.

An explanation of each threatening process follows, with a discussion of the key species affected in the West region, and management arrangements that are in place to mitigate these threats.

Clearing of Native Vegetation

Clearing of native vegetation in the West region occurs as part of development for agricultural, industrial, urban and utility purposes. Historically extensive open forests, woodlands and grasslands covered the inland plains of the region. These EVCs were particularly amenable to agriculture and were cleared or altered extensively and now persist largely as scattered remnants on or adjacent to private land, or as linear strips along roadsides and watercourses.

Many of the threatening processes indirectly associated with this disturbance result from loss of critical habitat elements, and fragmentation and isolation of habitat. The Woodland Blind Snake, Rufous Bristlebird, Squirrel Glider and Anglesea Mountain Dragon are particularly vulnerable to habitat isolation, and loss and fragmentation of habitat are significant threats to the large forest owls, Brush-tailed Phascogale and Lace Monitor. Remnant woodland habitats on fertile soils are important food sources for mobile bird species such as the Regent Honeyeater, Swift Parrot and Painted Honeyeater. Selective loss of these habitats may deplete a food resource at a critical time of year and contribute to local or regional population declines. All known nest sites of the Red-tailed Black-Cockatoo are on private land. This species is particularly vulnerable to loss of this critical habitat element. For species which utilise woodland habitats as well as other forest types, (e.g. Speckled Warbler, Chestnut-rumped Heathwren, Yellow-footed Antechinus) clearing for agriculture is considered a moderate threat.

Table 12.8: Impacts of Threatening Processes on Fauna Species in West Region

| SPECIES | Clearing of Native | Timber Harvesting | Fuel Reduction | Firewood Collection | Unplanned Fire | Introduced Species | Grazing/Trampling | Pest Control | Road Const/Maint | Mining/Quarrying | Tree Dieback | Recreation | Illegal Collect/Harve | Vandalism | Dams/Impound | Interspecific Competition | Pasture Improvement | Loss of Genetic | Mineshaft Collapse | Rock Harvesting | Ozone Depletion |
|---------------------------|--------------------|-------------------|----------------|---------------------|----------------|--------------------|-------------------|--------------|------------------|------------------|--------------|------------|-----------------------|-----------|--------------|---------------------------|---------------------|-----------------|--------------------|-----------------|-----------------|
| MAMMALS | | | | | | | | | | | | | | | | | | | | | |
| Broad-toothed Rat | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 0 | 1 | 0 | - | - | 0 | 0 | 2 | | | | | | |
| Spot-tailed Quoll | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | | | | | | |
| Eastern Bent-wing Bat | 1 | - | - | - | - | 2 | 0 | 2 | 0 | 2 | - | 3 | 1 | 2 | 0 | | | | 3 | | |
| Large-footed Myotis | 1 | 2 | - | - | - | 1 | 1 | 2 | 2 | - | - | 1 | 0 | 1 | 0 | | | | | | |
| Brush-tailed Phascogale | 3 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | | | | | | |
| Squirrel Glider | 3 | 1 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | | | 2 | | | |
| Common Dunnart | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | | | | | | |
| Smoky Mouse | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 0 | 1 | 0 | - | 1 | 0 | 0 | 1 | | | | | | |
| Heath Mouse | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | | | | | | |
| Swamp Antechinus | 3 | 1 | 2 | 1 | 2 | 3 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | | | | | | |
| Long-nosed Potoroo | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | | | | | | |
| Yellow-footed | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | | | | | | |
| Yellow-bellied Glider | 2 | 3 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | | | | | | |
| White-footed Dunnart | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | |
| Inland Broad-nosed Bat | 3 | 2 | - | 2 | - | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | | | | | | |
| Eastern False Pipistrelle | 1 | 2 | - | - | - | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | | | | | |
| BIRDS | | | | | | | | | | | | | | | | | | | | | |
| Regent Honeyeater | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 0 | 2 | 1 | 2 | 1 | 0 | - | 0 | 2 | | | | | |
| Painted Honeyeater | 3 | 2 | 1 | 2 | 2 | - | 2 | - | - | - | 2 | 0 | 0 | 0 | 0 | 2 | | | | | |
| Swift Parrot | 2 | 2 | - | 2 | - | 1 | 2 | - | 1 | 1 | 2 | - | - | - | 0 | - | | | | | |
| Red-tailed Black- | 3 | 3 | 3 | 3 | 3 | - | 2 | 0 | 2 | 2 | 2 | 0 | 3 | 1 | 0 | 2 | | | | | |
| Rufous Bristlebird | 3 | 1 | 3 | - | 3 | 3 | 2 | 0 | - | 0 | 0 | 1 | 0 | - | 0 | | | | | | |
| Bush Stone-Curlew | 3 | 1 | 1 | 3 | - | 3 | 2 | 2 | 2 | - | 1 | 0 | 1 | 1 | 0 | | 3 | | | | |
| Grey-crowned Babbler | 3 | 0 | 2 | 2 | - | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 3 | | | | |
| Square-tailed Kite | 2 | 2 | 2 | 1 | 2 | 0 | 1 | - | 1 | - | 1 | - | 2 | 2 | 0 | | | | | | |
| Grey Goshawk | 2 | 2 | 2 | 1 | 2 | 0 | 1 | 2 | 1 | - | 1 | - | - | 2 | 0 | | | | | | |
| White-bellied Sea-Eagle | 2 | 2 | - | 1 | - | 0 | - | 1 | 2 | 1 | 1 | 3 | - | 1 | 0 | - | | | | | |
| Barking Owl | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 1 | 2 | 0 | 0 | 0 | 0 | | | | | | |
| Powerful Owl | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | | | | | | |
| Masked Owl | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 1 | - | 2 | 0 | 0 | 0 | 0 | | | | | | |
| Chestnut-rumped | 2 | - | 2 | 2 | 2 | - | 1 | - | 0 | - | - | 0 | 0 | 0 | 0 | | | | | | |
| Azure Kingfisher | 2 | 1 | - | 0 | - | 2 | 1 | - | - | - | 0 | - | 0 | 0 | 2 | | | | | | |
| Hooded Robin | 2 | - | 2 | 2 | 2 | 3 | 2 | - | - | - | 2 | 0 | 0 | 0 | 0 | | | | | | |
| Speckled Warbler | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 0 | 0 | - | 1 | 0 | 0 | - | 0 | | | | | | |
| Gilbert's Whistler | 3 | 2 | 2 | 2 | 1 | - | 2 | - | - | 2 | 1 | - | 0 | 0 | 0 | | | | | | |
| Black-eared Cuckoo | 2 | 2 | 2 | 2 | 1 | 1 | 2 | - | - | 1 | 1 | 0 | 0 | 0 | 0 | | | | | | |
| REPTILES | | | | | | | | | | | | | | | | | | | | | |
| Striped Worm-lizard | 3 | - | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 1 | - | 1 | 0 | 0 | - | | | | | | |
| Common Scaly-foot | 3 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | - | 0 | 0 | 0 | 0 | | | | | 1 | |
| Lace Monitor | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | | | | | | |
| Swamp Skink | 3 | 2 | 1 | 0 | 1 | 2 | 2 | - | 1 | 1 | 1 | 1 | 0 | 0 | 2 | | | | | | |
| Anglesea Mountain | 3 | 3 | 2 | 1 | 3 | 3 | 1 | - | 2 | 2 | - | 1 | 1 | 0 | 0 | | | | | | |
| Woodland Blind Snake | 3 | 1 | 2 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | - | 0 | 0 | 0 | 0 | | | | | | |
| AMPHIBIANS | | | | | | | | | | | | | | | | | | | | | |
| Warty Bell Frog | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | - | - | - | 0 | 1 | - | - | | | | | | 2 |
| TOTAL SCORE | 101 | 72 | 62 | 63 | 63 | 67 | 68 | 35 | 36 | 27 | 38 | 18 | 10 | 11 | 9 | | | | | | |
| NO. OF SPECIES | | | | | | | | | | | | | | | | | | | | | |
| Major threat | 21 | 6 | 5 | 4 | 5 | 11 | 3 | 3 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | | | | | | |
| Moderate threat | 18 | 22 | 16 | 20 | 19 | 9 | 23 | 7 | 7 | 5 | 10 | 0 | 1 | 3 | 3 | | | | | | |
| Minor threat | 3 | 8 | 13 | 10 | 8 | 12 | 12 | 12 | 18 | 17 | 18 | 11 | 5 | 6 | 2 | | | | | | |
| Not a threat | 0 | 1 | 0 | 3 | 0 | 4 | 2 | 9 | 7 | 8 | 4 | 22 | 31 | 27 | 34 | | | | | | |
| Unknown threat | 0 | 4 | 7 | 4 | 9 | 4 | 1 | 10 | 8 | 11 | 9 | 6 | 3 | 5 | 2 | | | | | | |
| TOTAL NO. AFFECTED | 42 | 37 | 35 | 35 | 33 | 33 | 39 | 22 | 27 | 21 | 28 | 14 | 7 | 8 | 6 | | | | | | |

Further clearing of native vegetation is significantly mitigated by the implementation of native vegetation retention controls under the *Planning and Environment Act 1987*. Landholders and public authorities must apply for a permit to clear native vegetation from land greater than 0.4 ha. Permits to clear native vegetation are generally only granted for small areas with little significance or slightly larger areas of degraded native vegetation. Removal of protected flora associated with clearing requires authorisation under the FFG Act. The rate of clearing of private land is monitored by NRE through a database of clearing applications and satellite imagery that allows detailed comparison between current and past extent of tree clearance. Since the introduction of planning restrictions on the clearing of native vegetation on private land in 1989, the rate of vegetation loss has decreased tenfold in Victoria.

Clearing of native vegetation on public land requires Ministerial or Departmental approval, and major developments are usually the subject of Environment Effects Statements in which any impacts on native flora and fauna are considered.

Timber Harvesting

Timber harvesting methods used in the West region include seed tree, selection, shelterwood and clearfell systems. The seed tree system involves the felling of all except five to nine well spaced trees per hectare with regeneration achieved through the release of seed from these retained trees onto a prepared seed bed. Habitat trees are retained according to prescriptions and these can include some of the retained seed trees. The selection system involves the harvesting of small patches or single mature trees while retaining habitat trees and minimising damage to the remaining trees. The shelterwood system incorporates two commercial harvests. A proportion of the trees containing sawlogs remains after the first shelterwood harvest, and current practice is to harvest these after about 15 years. Clearfelling involves the removal of all standing timber except for designated habitat trees. The choice of harvesting system is largely determined by the forest type and the requirements of different eucalypt species for successful regeneration following harvesting.

Timber harvesting impacts upon a range of fauna species through its short-term effect of habitat removal and medium and longer-term effect of producing even-aged regrowth forests that are less suitable for some species than older forests. Threatening processes include the loss of hollow-bearing trees, the conversion of mature stands to young regrowth stands, and fragmentation. Ecologically mature or old-growth forests are generally more structurally and floristically diverse than regrowth forests. In the West region, timber harvesting is considered a major threat to the Spot-tailed Quoll, Yellow-bellied Glider, Powerful Owl, Red-tailed Black-Cockatoo, Anglesea Mountain Dragon and Lace Monitor. Many of these species forage over large areas and utilise hollow-bearing trees as nest, shelter or foraging sites, and a significant proportion of suitable habitat is found in State forest. As a result, threatening processes related to timber harvesting include the loss of hollow-bearing trees, the conversion of mature stands to young regrowth stands, and fragmentation of habitat.

Conversion of mature stands to young regrowth stands, canopy loss and habitat fragmentation resulting from timber harvesting are potentially threatening processes for the Regent Honeyeater, Painted Honeyeater, Swift Parrot, Grey Goshawk, and Square-tailed Kite. Loss of hollow-bearing trees, a reduction in foraging substrate or prey, and habitat fragmentation resulting from timber harvesting operations are potentially threatening processes for Brush-tailed Phascogale, Masked Owl and Barking Owl. Loss of hollows threatens Yellow-footed Antechinus, Inland Broad-nosed Bat and Eastern False Pipistrelle. Altered stream conditions as a result of timber harvesting operations may indirectly impact on the Southern Myotis and Azure Kingfisher that feed on aquatic insects and fish. Soil disturbance and loss of litter during timber harvesting operations is a potential threat to the Woodland Blind Snake, Common Scaly-foot and Speckled Warbler, while loss and disturbance of shrub and ground

layers are potential threats to Black-eared Cuckoo, Gilbert's Whistler, Chestnut-rumped Heathwren, White-footed Dunnart, Common Dunnart, Smoky Mouse and Heath Mouse. The availability of hypogaeal (underground fruiting) fungi, an important food of the Long-nosed Potoroo and Heath Mouse, may also be affected.

Timber harvesting and associated roading and burning activities are managed under the forest management planning process which includes the Code of Forest Practices for Timber Production (NRE 1996b), the Code of Practice for Fire Management on Public Land (CNR 1995b), the Otway and Midlands Forest Management Plans (DCE 1992, NRE 1996a), regional prescriptions and the annual Wood Utilisation Plans. The Code of Forest Practices and Forest Management Plans are subject to periodic review with formal public consultation, while regional prescriptions and Wood Utilisation Plans are prepared in consultation with regional flora and fauna staff and community input.

The Code of Forest Practices provides principles and guidelines and sets minimum standards for forest operations in State forests in Victoria. It aims to ensure that environmental values and water catchments are protected, by careful operation planning, reservation of appropriate areas and vegetation corridors. Such prescriptions particularly benefit certain forest ecosystems (such as riparian EVCs), and the flora and fauna associated with them.

Potentially threatening processes listed under the FFG Act which may be relevant to timber harvesting are: *Degradation of native riparian vegetation*, *Increase in sediment input into Victorian rivers and streams due to human activities*, *Loss of hollow-bearing trees in Victorian native forests*, and *The invasion of native vegetation by 'environmental weeds'*.

The West region encompasses the Otway, Midlands, Portland and approximately half of the Horsham Forest Management Areas (FMAs), and small parts of Central and Dandenong FMAs. Forest management plans are currently in place for the Otway and Midlands FMAs. Management strategies for species and threatening processes listed under the FFG Act are detailed in Action Statements and incorporated into forest management plans, where relevant. Direct and indirect taking of protected flora associated with timber harvesting requires authorisation under the FFG Act. In addition to the formal reserve system already in place, Special Protection Zones will be defined and managed for conservation with timber harvesting excluded. Current prescriptions set a minimum of 15 retained trees per 10 ha harvested for all forest types for conservation of wildlife habitat within the timber production forest.

Grazing

Domestic stock and feral and naturalised exotic animals, including rabbits, hares, deer, goats and brumbies, are the main agents of grazing or browsing and trampling of native vegetation within the West region. On public land, licensed grazing is practised in State forest, roadside reserves and water frontages. Browsing by native herbivores is not considered as a disturbance in this review.

Grazing, browsing or trampling can result in direct damage to or loss of plant, and reduced reproductive output. Less direct potentially threatening processes associated with grazing are habitat modification, reduction in the litter layer and soil disturbance, compaction or erosion. The ecological attributes, which predispose plants to threat from grazing, include palatability and occurrence in habitats that tend to be grazed more frequently or heavily, such as grassy habitats. The historical combination of alienation, grazing and clearing has resulted in a number of ecological vegetation classes being scarce on public land, and is now often present as degraded remnants on private land.

Lack of regeneration as a result of grazing of remnant patches of native vegetation is a significant threat to species such as the Painted Honeyeater, Regent Honeyeater, Swift Parrot, Bush Stone-curlew, Squirrel Glider, Grey-crowned Babbler, and Red-tailed Black-Cockatoo. Lack of regeneration resulting in loss of habitat in the long term may also have a significant impact on species that utilise forest farmland edges such as the Masked Owl and Barking Owl. Soil disturbance resulting from grazing is likely to adversely affect subterranean species such as the Woodland Blind Snake and Striped Worm-lizard. Elimination and simplification of understorey vegetation and trampling of litter accumulations as a result of grazing are threatening processes for a range of reptile species, particularly skinks, and ground-foraging birds and mammals. Grazing and trampling are likely to adversely affect habitat of the Warty Bell Frog. Ground nesting birds are vulnerable to loss of eggs and young from trampling.

Grazing on public land including State forest is permitted under licence subject to regulation under relevant legislation. For public roadsides managed by local government, development of roadside management plans which address issues such as grazing are critical to ensure habitat conservation for many species.

One of the major impacts of grazing is listed as a Potentially Threatening Process under the FFG Act. This is *The Degradation of native riparian vegetation along Victorian rivers and streams*.

Rabbits exert significant grazing pressure on native vegetation in parts of the West region. Coordinated public and private land rabbit control programs are ongoing.

Fuel Reduction Burning

The effects of fire on flora and fauna vary, depending on the scale, frequency, intensity and season of burns. Most fuel reduction burns are low intensity burns that aim to reduce the ground, understorey and bark fuel loadings. Fuel reduction burning is carried out in a wide range of forest types in the West region. It generally occurs in the vicinity of 3-7 years frequency for areas that require asset protection, and less frequently for other areas.

Fuel reduction burning in the West region is regarded as a major threat to the Spot-tailed Quoll, Red-tailed Black-Cockatoo, Rufous Bristlebird, Striped Worm-lizard and Common Scaly-foot, and a threat to a further 30 fauna species considered in the assessment. The development of optimum habitat for species such as the Heath Mouse, Swamp Skink and Common Dunnart may be retarded by inappropriate fire regimes. A potentially critical food source for young Red-tailed Black-Cockatoos, now found only on roadsides, is particularly vulnerable to fire prevention activities in these areas. Frequent low-intensity burns can simplify and eventually eliminate dense understorey, reducing shelter and foraging sites for Spot-tailed Quoll, Rufous Bristlebird, Swamp Antechinus and Yellow-footed Antechinus. The loss of shrub and litter layers threaten species dependent on these layers, including Black-eared Cuckoo, Gilbert's Whistler and White-footed Dunnart. Species that nest on or near the ground, including the Common Dunnart, Chestnut-rumped Heathwren and Rufous Bristlebird, may be impacted by the loss of these sites. Loss of litter and logs threatens species that are dependent upon these habitats such as the Striped Worm-lizard, Common Scaly-foot, Anglesea Mountain Dragon and Woodland Blind Snake. The effect of fire on hypogeal fungi is potentially severe for the Long-nosed Potoroo and Heath Mouse.

Fire management in the West region is guided by the Code of Practice for Fire Management on Public Land that outlines general principles and guidelines for fuel reduction burning and Regional Fire Protection Plans. Each fuel reduction burn undertaken on Public land must be the subject of an approved burn plan in accordance with the Code and Regional Fire Protection Plan. Such plans must take into account prescriptions developed for the protection of threatened species.

FFG Act Action Statements include fire management prescriptions for species that are threatened by this process. However, for the majority of species, the effect of fuel reduction burning, particularly the effect of burning frequencies, is largely unknown. NRE is undertaking long-term research on fuel reduction burns in the Wombat State Forest, in the Midlands FMA.

Unplanned Fire (Wildfire)

Fire is a fundamental element of the Australian environment and is the major natural disturbance maintaining the mosaic of floristic and structural diversity within native vegetation. Wildfire may have both positive and negative outcomes for flora and fauna populations.

Effects of fire on vegetation are dependent on the frequency, intensity and season of burn. They include changes in species composition, abundance, and physical and age structure. Low intensity fires generally leave more areas of un-burned vegetation, but high intensity fires can also be restricted or patchy in extent.

Adverse effects of wildfire on animal species are related to mortality, subsequent loss of shelter and nest sites, reduction in prey availability and foraging substrate, and increased risk of predation by introduced species. Small isolated populations are particularly vulnerable to stochastic catastrophic events such as wildfire. Wildfire is regarded as a major threat to the Spot-tailed Quoll, Smoky Mouse, Squirrel Glider, Red-tailed Black-Cockatoo, Rufous Bristlebird and Anglesea Mountain Dragon, and all species assessed were considered to be under some degree of threat from wildfire. The major food source of the Red-tailed Black-Cockatoo may be limited for up to five years following fires that burn the forest canopy. Populations of species such as the Squirrel Glider which relies on understorey *Acacia* species may be locally disadvantaged by a fire which destroys this winter food source, but fire may also stimulate germination of the seed bank benefiting the local glider population. However, populations of this species are small and isolated, and wildfire may cause localised extinction. Rufous Bristlebirds have a restricted distribution and suitable habitat is limited, making this species particularly vulnerable to wildfire. The small isolated Anglesea Mountain Dragon populations are also vulnerable to localised extinction from wildfire. Wildfire impacts the Spot-tailed Quoll by reducing foraging habitat and prey, and destroying den sites.

The Department of Natural Resources and Environment has the responsibility for prevention and suppression of fire in State forest, National Parks and reserves, and all protected public land. The Code of Practice for Fire Management on Public Land and regional fire protection plans include strategies for fire prevention, preparedness, fire suppression and recovery after wildfire. Significant and sensitive natural values can be taken into account by these plans.

Road Construction and Maintenance

Potentially threatening processes include direct damage or loss of plants by machinery, habitat loss and/or fragmentation, altered micro-climatic and light conditions, erosion, sedimentation, introduction of soil or gravel contaminated with weed seed or fungal spores, and the facilitation of weed spread due to continual disturbance of road margins.

Roadside vegetation provides important habitat for the Grey-crowned Babbler, Bush Stone-curlew, Regent Honeyeater, Swift Parrot, Red-tailed Black-Cockatoo and Squirrel Glider. Road widening and upgrading and installation of utilities degrade and can reduce habitat by removing and damaging mature trees, saplings and shrubs, and may also result in weed invasion. Roads can create barriers to movement and fragment habitat. Species with limited mobility, such as small mammals and skinks, are particularly vulnerable. The establishment of roads through undisturbed forest may allow introduced predators to colonise new areas.

Construction of roads and tracks can result in increased sedimentation of streams and alteration of riparian habitats. Increased sedimentation and turbidity of streams may indirectly affect the Southern Myotis through reduced prey availability.

All new roads and tracks used for timber production in State forests must be built to comply with the Code of Forest Practices for Timber Production (NRE 1996b). However, many roads and tracks were built prior to introduction of the Code and do not meet today's standards. Action is underway to prioritise improvements to existing roads, based on a recent condition assessment. In State forest, attention is paid to planning the road network to avoid threatened species habitat, minimise environmental damage and provide high standard stream crossings.

VicRoads (the Victorian Government agency responsible for main roads and highways throughout Victoria) has recently published an environmental strategy. Local municipalities are responsible for all other public roads (and roadsides), excluding those managed by NRE. Local Government Roadside Management Plans that incorporate guidelines for habitat management should assist in achieving conservation objectives for species dependent upon roadside vegetation in the agricultural landscape.

The following are listed as Potentially Threatening Processes under the FFG Act:

Degradation of native riparian vegetation along Victorian rivers and streams, Increase in sediment input into Victorian rivers and streams due to human activities and The invasion of native vegetation by environmental weeds.

Recreation

A wide range of recreational pursuits takes place in the West region, but the most significant, from a disturbance perspective, are vehicle-based activities, fishing, hunting, and camping. At stream crossing points, high levels of vehicle traffic can result in localised bank erosion and sedimentation. Vehicle use can also result in the transport of soil, potentially carrying plant diseases and weed propagules.

Within the West region, fauna species most vulnerable to threatening processes associated with recreational activities are those dependent on sensitive habitat types, and whose distributions are restricted to areas where recreational activities are concentrated. Recreational activity is considered a major threat to the Eastern Bent-wing Bat and White-bellied Sea-Eagle. For the majority of species, assessed recreation was either not considered a threat or was considered a minor threat.

Records of the White-bellied Sea-Eagle and a number of nest sites are concentrated near several large permanent water bodies. Protection of these sites from disturbance is recognised as a significant factor in the conservation of this species. Recreational cave exploration has the potential to rouse inhabitant Eastern Bent-wing Bats from energy-saving torpor; this may cause fatalities or roost abandonment, and is considered a major threat to this species.

Vehicle-based activities on public land are managed through the relevant management planning process (Forest Management Plan or Park Management Plans). Effort is generally made to encourage activities in appropriate zones where these activities are compatible with overall management objectives, or where impacts can be minimised.

Introduced Fauna Species

This disturbance relates to the impact of introduced fauna on native fauna, and covers predation and competition by introduced species.

The Broad-toothed Rat, Common Dunnart, Swamp Antechinus, Long-nosed Potoroo, Bush Stone-curlew, Rufous Bristlebird, Hooded Robin, Striped Worm-lizard and Anglesea

Mountain Dragon (all ground-dwelling or ground-nesting) are particularly at risk in the West region from predation by introduced carnivores. Bird species that nest on or near the ground, such as the Bush Stone-curlew, Hooded Robin, Rufous Bristlebird and Speckled Warbler, are vulnerable to predation by Foxes, Cats and Dogs, with both individuals and eggs taken. Eastern Bent-wing Bats are preyed upon by Cats as they leave their cave/mineshaft roosts.

Competition by introduced species for food and nest hollows is recognised as a major threat to the Spot-tailed Quoll, and a minor threat to the Lace Monitor, Barking Owl, Masked Owl, Swift Parrot and Regent Honeyeater. There appears to be some dietary overlap between Cats, Foxes and the Spot-tailed Quoll. Competition for prey items may potentially threaten the viability of this Quoll in the West region. Introduced species also impact on the Spot-tailed Quoll through spread of disease. Feral European Honey Bees are known to occupy hollow trees, and may compete for this resource and nectar with several native species, such as the Brush-tailed Phascogale, Regent Honeyeater and Swift Parrot. European Carp stir up water debris, increasing water turbidity, and may significantly impact on habitat quality for the Azure Kingfisher, which may have difficulty detecting prey in murky water.

Predation by both Foxes and Cats are listed as Potentially Threatening Processes under the FFG Act, with a published Action Statement for the Fox and an Action Statement currently under preparation for the Cat. Predation by the Cat and Fox are listed as key Threatening Processes under the *Endangered Species Protection Act 1992*, and Threat Abatement Plans have been prepared for each.

Pest animal control measures in the West region include programs coordinated with adjacent landowners (Good Neighbour Program) and, where feasible, targeted programs through the region. Management plans include strategies relating to pest animal control.

Pest Control

Control of pest species potentially impacts on native fauna through non-target and secondary poisoning, and food chain contamination by chemicals. This disturbance is a major threat to the Spot-tailed Quoll, Masked Owl and Warty Bell Frog, and a moderate threat to seven other species.

The Spot-tailed Quoll is especially at risk from non-target poisoning, as ingestion of 1080-poisoned baits meant for Foxes and Dogs can cause death of individual animals or local populations. Rabbits are probably a major prey item for the Masked Owl and reduction in Rabbit numbers due to control programs, such as poisoned-baiting and the Calicivirus, is considered a major threat to these species. The Barking Owl may also be affected by loss of Rabbit prey. There is also a risk of secondary poisoning from consuming poisoned Rabbits or Rats to the Spot-tailed Quoll and Grey Goshawk. The destruction of burrows and piles of logs and debris for Rabbit control are a potential threat for the Lace Monitor. There is the potential risk that some mammals such as the Long-nosed Potoroo may get caught in traps set for pest species. Pesticide poisoning and loss of prey are a potential threat to most of the bats in the West region and may affect insectivorous birds such as the Bush Stone-curlew. The use of herbicides and pesticides are likely to impact on Warty Bell Frog populations through direct poisoning as well as loss of invertebrate food, and have been implicated in the decline of the species.

Overall the ecological implications for native fauna of pesticide use is unknown but is potentially significant given the importance of insects and other invertebrates as prey; this issue requires investigation. It is important that pest control programs are closely monitored for any adverse impacts on native fauna and effectiveness on the target species.

Firewood Collection

In Victoria, firewood represents one of the highest volume forest products. In the West region most commercial cutters collect firewood as a by-product of harvesting operations, including thinning. Collection for domestic use is widespread, particularly in areas close to major population centres.

Logs, litter and debris are important microhabitats providing shelter, refuge, foraging, basking and breeding sites for many species such as the Woodland Blind Snake, Striped Worm-lizard, and Common Scaly-foot, Anglesea Mountain Dragon, Common Dunnart, Brush-tailed Phascogale, Spot-tailed Quoll, Yellow-footed Antechinus, Bush Stone-curlew, Grey-crowned Babbler, Chestnut-rumped Heathwren and Speckled Warbler. The loss of old trees from woodland remnants on private land is a particularly significant threat to species that utilise these habitats including Barking Owl, Masked Owl, Brush-tailed Phascogale, Regent Honeyeater, Swift Parrot, Painted Honeyeater and Squirrel Glider. The majority of Red-tailed Black-Cockatoo habitat is now restricted to remnant trees on private land. Loss of this critical habitat component is a major threat to this species.

On private land, harvesting of firewood for domestic use and the cutting of standing dead trees is exempt from the Native Vegetation Retention Controls. One of the major impacts of firewood collection, *The loss of hollow-bearing trees*, is listed as a Potentially Threatening Process under the FFG Act.

Firewood collection for domestic use on public land is controlled by the issue of licences that stipulate the location and amount of timber to be collected. Firewood collection along roadsides requires local government permission and a licence. Some Shires have roadside management plans, which may control firewood collection on roadsides, prohibiting removal of timber from certain high conservation value sites. The number of licences issued for commercial firewood operations on public land depends on an assessment of the amount of wood available in accordance with the Wood Utilisation Plan in each Forest Management Area. Commercial cutters must also hold a forest operator's licence and operate in accordance with the Code of Forest Practices and local prescriptions.

A large proportion of the firewood collected from within the West region is from woodland remnants on private land. The FFG Act, *Conservation, Forests and Lands Act 1987* and the *Planning and Environment Act 1987* provide some controls for firewood collection.

Illegal Collecting/Harvesting

This disturbance includes direct interference to plants and animals by humans in the form of collection or deliberate hunting, poisoning or trapping. Illegal collecting is considered a major threat to the Red-tailed Black-Cockatoo which may be captured for the live pet trade. Some reptile species may also be vulnerable to collection for the pet trade. Egg collection is a potentially significant threat to the Square-tailed Kite.

Removal of wildlife from the wild is prohibited under the *Wildlife Act 1975*, and the FFG Act requires a permit to take from the wild all listed species.

Dieback

Dieback describes the protracted decline of health and vigour of plants and, it is likely that many factors interact to lead to dieback. Possible contributing factors include insect defoliation, fungal diseases, drought, fire, altered water tables, increased salinity, nutrient imbalances as a result of applications of fertilisers, soil erosion and reduced soil aeration, land clearing, lack of regeneration and overgrazing.

The direct impact of dieback and related processes involves the damage or loss of plants. This can lead to changes in vegetation structure, composition and diversity, the alteration of microclimatic conditions and the loss or modification of habitat. Within the West region there have been numerous incidences of dieback in forest stands, generally associated with fungal pathogens. Outbreaks of *Phytophthora cinnamomi* have occurred in Angahook Forest Park in the Otways, several areas of the Midlands, including severe outbreaks in the Brisbane Ranges, the Horsham FMA, particularly the Grampians National Park, and in the south west of this FMA. Dieback associated with *Armillaria* spp has been recorded from two State forests in the Midlands FMA. Myrtle Wilt affects areas of rainforest in the Otways. To date there has been no incidence of fungal-induced dieback in the Portland FMA, although signs of declining tree health have been noted on the Dundas Tablelands.

Within the West region, dieback is considered a moderate threat to 10 fauna species. The majority of these species are at least partially dependent on remnant vegetation in agricultural land and have been recorded from forest blocks where fungal-induced dieback has been recorded. There are only four species covered by this review that are not considered to be affected by dieback.

The Code of Forest Practices, management plans and conditions of exploration licences address the threatening process, *Use of Phytophthora cinnamomi*-infected gravel in construction of roads, bridges and reservoirs, which is listed as a Potentially Threatening Process under the FFG Act.

Mining/Quarrying

Within the West region, gold is the most commonly mined mineral. Rock, gravel, clay, sand and soil are also extracted from a number of quarries. Although mining/quarrying has the potential to impact a large number of species, due to the small scale and number of operations in the West region, this disturbance is currently considered only a minor threat to the majority of species covered by this review. Mining is considered a moderate threat to Eastern Bent-wing Bat, Red-tailed Black-Cockatoo, Gilbert's Whistler, Common Scaly-foot and Anglesea Mountain Dragon.

Mining and quarrying involve direct loss of vegetation, habitat destruction, increased erosion and sedimentation, and alteration of soil drainage characteristics. Other issues associated with mining include tailings disposal and treatment, disposal of effluents or treatment wastes, and weed control and ineffective or inappropriate revegetation measures following surface works and developments. Species associated with riparian habitats such as the Southern Myotis and Swamp Skink may be impacted by increased sedimentation and degradation of habitat. The Eastern Bent-wing Bat may be impacted by reworking of old mines which now serve as roost sites. Mining in areas of Red-tailed Black-Cockatoo and Gilbert's Whistler habitat will remove and degrade important habitat components for these species. The Common Scaly-foot and Anglesea Dragon have highly restricted distributions in the West region, and may be significantly impacted by mining and quarrying.

Mineral exploration, mining and extractive industries are not permitted in Reference Areas, National, State or Wilderness Parks, except where a tenement or application pre-dates the Park and the Minister responsible for the National Parks consents. Mining and exploration operations require a licence and work plan approved by Minerals and Petroleum Victoria before exploration or mining works can be undertaken. Similarly, extractive industries require a work plan and a consent of the relevant Minister for extractive operations.

Vandalism

This disturbance includes direct interference to animals by humans in the form of deliberate shooting and disturbance at nest and roost sites. Vandalism is considered a moderate threat to

the Eastern Bent-wing Bat, Square-tailed Kite and Grey Goshawk, and a minor threat to Southern Myotis, Bush Stone-curlew, White-bellied Sea-Eagle, Red-tailed Black-Cockatoo and Lace Monitor. Deliberate disturbance of bats at roost is a potentially threatening process for these species. The White-bellied Sea-Eagle is particularly sensitive to human disturbance at the nest. The Grey Goshawk, Square-tailed Kite, White-bellied Sea-Eagle and Bush Stone-curlew may be threatened by illegal shooting. Reptile species may be targets of random acts of vandalism.

All wildlife are protected under the *Wildlife Act 1975*.

Dams/Impoundments

Potentially threatening processes associated with dam/impoundment construction and subsequent operation include increases in sediment input to rivers and streams, modifications to natural temperature fluctuations and flow rates. Degradation of adjacent native riparian vegetation, and loss and fragmentation of habitat is also a potentially threatening process associated with dams and impoundments.

Siltation, alteration of stream flow and degradation of riparian vegetation are moderate threats to the Azure Kingfisher, Swamp Skink and Broad-toothed Rat. The environmental impacts of dams/impoundments have been subject to numerous studies. Processes to minimise impacts include environmental flow allocations, construction of fish ladders and regulating the temperature flowing out of storages.

Other Disturbances

Pasture Improvement

Since the 1960s, there has been substantial development in improved pastures on private land which involves the replacement of native grasses with exotic pasture species. Pasture improvement was considered to be the principal cause of population declines of the Bush Stone-curlew in north eastern Victoria between 1985 and 1991. Education programs which inform land managers of the ecological effects of intensified land use practices, such as pasture improvement, is a management issue identified by the Bush Stone-curlew Action Statement. Pasture improvement is also considered a major threat to the Grey-crowned Babbler. A range of other actions undertaken through programs such as *Land for Wildlife* and Landcare in conjunction with land owners can also assist in mitigating impacts on native species.

Mineshaft Collapse

Mineshaft collapse and mineshaft entrances becoming overgrown are recognised as major threats to the Eastern Bent-wing Bat. This species is dependent on caves and mineshafts for roosting and breeding. Restricted access to and loss of breeding habitat due to these processes is likely to lead to a decline of population numbers in the West region.

Climate Change

The Enhanced Greenhouse Effect refers to the increase of greenhouse gases caused by human activities and the resultant warming of the atmosphere. Increases in ultraviolet radiation are known to cause death of frog eggs and larvae, and may have contributed to population declines of the Warty Bell Frog.

Loss of Genetic Diversity

Loss of genetic diversity is a threat to small, fragmented or isolated populations or less mobile species. It is considered to be a potential threat to the Squirrel Glider.

12.8 AQUATIC FAUNA SPECIES ASSESSMENT

Introduction

The quality of stream habitats, and their biota, can be greatly influenced by a wide range of activities within the catchment, including many that occur away from the stream system. The impact of these activities may also be felt far downstream from the actual site of disturbance, often outside the forest areas in which they occur. To reduce the impact of these activities, management prescriptions need to be based on accurate and adequate scientific information. This includes information on the distribution, biology and habitat requirements of individual species and communities, along with data on how successful ameliorative actions are at protecting those species and communities.

This section considers available information on fish and aquatic macroinvertebrates (crayfish, shrimps, large insects etc) occurring in the West region river systems, reviews the range of factors which are threats to the survival of important species and describes the management actions which are in place to mitigate those threats.

The West region encompasses the catchments south of the Great Dividing Range (GDR) in the western half of Victoria. Because of the position of the boundary, a number of small parts of north flowing streams are incorporated into the region: the Wimmera River upstream of Horsham, Richardson River upstream of the Wimmera Highway, Avoca River upstream of Avoca, Loddon River upstream of Cairn Curran Reservoir, Coliban River upstream of Upper Coliban Reservoir and the Goulburn River between Seymour and Lake Nagambie (including the Sunday Creek and Sugarloaf Creek tributaries).

Twenty-one native freshwater fish species have been recorded from the West region, and ten are known to migrate as part of their life cycle. The number of aquatic macroinvertebrate species in the region is unknown. While it is certain that the fragmented landscape of the Region would contribute to restricted distributions that would make a number of these species eligible for listing under the *Flora & Fauna Guarantee Act* 1988 (FFG Act), the lack of knowledge about these groups has contributed to there being only one species currently listed.

Data Review

As part of the assessment, a review was conducted of the number of sites surveyed for aquatic species in the West region, with information being taken from surveys dating back to 1963. Assessments were also made of the adequacy of the biological data obtained from sites during these surveys. This information can be used to identify priority areas and data gaps to be filled through additional survey work.

There is generally wide spatial coverage of sampling records across the region, though many sites fall into fairly restricted areas where survey intensity has been very high, due to intensive surveys for specific projects.

Intensive surveys of fish populations in the West region have primarily been conducted by the Department of Natural Resources and Environment (NRE). Other investigations that incidentally recorded fish species were conducted by other government agencies, universities and private individuals.

Records were obtained for 471 sites in the region where surveys have been conducted for freshwater fish, with 95 in the catchments located north of the divide and 376 in the catchments to the south. However only 219 of these are considered to be full surveys of species present with adequate data quality for distributional analyses. Of the 471 surveyed sites, 27.6 per cent were in areas set aside for conservation purposes, 20.4 per cent in State forest, and the remaining 52 per cent on private land and other public land (e.g. stream

frontages). The majority of sites in State forest have been sampled as part of a research to support the development of an RFA for the region.

Surveys of aquatic macroinvertebrates in the West region have primarily been conducted by a number of Government departments and agencies, and Monash and Deakin Universities. As part of the National Monitoring River Health Initiative (MRHI), 83 sites are currently being monitored in the West region. Additional sampling using the same methodology as the MRHI was undertaken at 22 sites as part of the recent RFA research project.

There are no significant gaps in fish distributional data from the West region following the recent RFA research and survey programs. However, significant data gaps exist on life history and population characteristics for all priority fish species. There is also limited data on spawning behaviour, cues for migration and the reactions of priority fish species to disturbances, particularly increased sedimentation and turbidity, and changes to temperature.

Of the aquatic macroinvertebrates occurring in the West region, the distribution of most is not well known, although recent RFA surveys have improved our understanding of the distribution of species within the region. With some minor exceptions (e.g. decapod crustacea, mayflies, stoneflies), the scientific classification and life histories of aquatic macroinvertebrates are poorly understood. In addition, impacts of disturbances on these taxa are similarly poorly understood.

Priority Species Information

Of the 21 native freshwater fish species recorded from the West region, 10 are listed as threatened fauna in Victoria (NRE 1999), including six which are listed under the FFG Act, and four of these are also listed under the Commonwealth ESP Act (Table 12.9).

Nine of the priority aquatic macroinvertebrate species known from the West region have been identified as threatened in Victoria (CNR 1995e), with one of them also being listed under the FFG Act.

Threatening Processes - Impacts and Management

This section reviews the current state of knowledge of threatening processes affecting aquatic species in the West region and the management actions that are in place to mitigate those threats. It aims to provide information to assist in management, research and future surveys. It is based on existing scientific literature and expert opinion. The review covers priority aquatic species in the West region, taken as being those species listed in Table 12.9.

Impacts

Based on studies conducted elsewhere, a number of activities have the potential for significant impacts on aquatic ecosystems, and therefore on aquatic species. A list of broad disturbance categories and their major impact on aquatic ecosystems is shown in Table 12.10.

By far the most common effect of most disturbances is the increase in sediment in rivers and streams. Increased levels of sediment can adversely affect all aspects of freshwater ecosystems by reducing water quality and degrading or destroying habitat. Increased turbidity can have adverse physical, physiological and behavioural effects on stream-dwelling plants and animals. Increased sedimentation of river is a listed Potentially Threatening Process under the FFG Act.

Dams represent a severe disturbance to aquatic systems, potentially affecting a number of priority aquatic species in the West region. Where low-level off-takes are used (many older dams), water temperature can be lowered substantially. Storage and release of water at

different times also changes the natural flow regimes. Dams can also present a barrier to migratory fish species. Altered temperature regimes, altered flow regimes of rivers and barriers to fish passage are all listed Potentially Threatening Process under the FFG Act.

Table 12.9: Priority Aquatic Fauna Species Occurring in the West Region.

| Species Name | Common Name | Conservation Status* | FFG/ESP Listing |
|------------------------------------|------------------------|----------------------|-----------------|
| Fish | | | |
| <i>Edelia obscura</i> | Yarra Pygmy Perch | Near threatened | FFG/ESP |
| <i>Gadopsis marmoratus</i> | River Blackfish | Data Deficient | |
| <i>Galaxias olidus</i> | Mountain Galaxias | Data Deficient | |
| <i>Galaxias rostratus</i> | Flat-headed Galaxias | Data Deficient | |
| <i>Galaxiella pusilla</i> | Dwarf Galaxias | Near threatened | FFG/ESP |
| <i>Macquaria ambigua</i> | Golden Perch | Vulnerable | |
| <i>Nannoperca variegata</i> | Variegated Pygmy Perch | Vulnerable | FFG/ESP |
| <i>Prototroctes maraena</i> | Australian Grayling | Vulnerable | FFG/ESP |
| <i>Tandanus tandanus</i> | Freshwater Catfish | Vulnerable | FFG |
| <i>Neochanna cleaveri</i> | Australian Mudfish | Endangered | FFG |
| Crayfish | | | |
| <i>Euastacus bispinosus</i> | Glenelg Spiny Cray | Ins. known | |
| <i>Euastacus armatus</i> | Murray Spiny Cray | Ins. known | |
| Other invertebrates | | | |
| <i>Hyridella glenelgensis</i> | Mollusca, Bivalvia | Rare | |
| <i>Plectrotarsus gravenhorstii</i> | Insecta, Trichoptera | Ins. known | |
| <i>Archeophylax canarus</i> | Insecta, Trichoptera | Rare | FFG |
| <i>Orphinotrichia justini</i> | Insecta, Trichoptera | Ins. known | |
| <i>Taskiria otwayensis</i> | Insecta, Trichoptera | Endangered | |
| <i>Boeckella nyoraensis</i> | Crustacea, Copepoda | Rare | |
| <i>Fibulacampus gracilior</i> | Crustacea, Copepoda | Ins. known | |

* Conservation status is based on *Threatened Fauna in Victoria - 1995*. **Ins. known** = Insufficiently known.

FFG = Flora and Fauna Guarantee Act 1988, **ESP** = Endangered Species Protection Act 1992.

Management

A range of conservation measures is currently in place or proposed for the protection of streams and catchments in the West region.

Following the Land Conservation Council's (LCC) Rivers and Streams Special Investigation (LCC 1991a) the corridors of the Goulburn (below Lake Eildon), Leredderg, Aire and Glenelg (below Dartmoor) Rivers in the West region were designated as Heritage River Areas under the *Heritage Rivers Act 1992* because of their significant natural, scenic, cultural heritage and recreational values. Draft management plans for these heritage rivers have been produced, and include strategies to protect significant environmental values in each river. The LCC did not recognise any catchments within the West region as Essentially Natural Catchments, indicating the widespread level of disturbance throughout the region.

General conservation measures to protect riparian and instream values are also key elements of the Code of Forest Practices for Timber Production and regional prescriptions. These contain a number of measures aimed at protecting water quality and instream values.

Under the provisions of the FFG Act and the ESP Act, and as part of Park and Forest Management Plans, conservation guidelines can be developed and implemented to protect individual species and their habitats from threatening processes. Where biological information is adequate, quite specific guidelines can be developed. Other priority aquatic species are afforded protection through the more general habitat protection measures of the Code of Forest Practices.

Recreational fish species are protected by a variety of fishing regulations, mainly bag and size limits, and closed seasons during breeding. Fishing regulations also exist for Spiny Crayfish species in Victoria.

Table 12.10: Broad Disturbance Category with Potentially Significant Impacts on Aquatic Ecosystems.

| Broad disturbance category | Potential impacts on aquatic ecosystems |
|----------------------------|---|
| Clearing | <ul style="list-style-type: none"> • Stream bed and bank degradation • Increased sedimentation and turbidity • Increased nutrient concentrations in water • Increased pesticide concentrations in water |
| Dams | <ul style="list-style-type: none"> • Changed flow regimes • Increased sedimentation and turbidity • Decreased water temperature • Barriers to fish passage |
| Fire | <ul style="list-style-type: none"> • Increased sedimentation and turbidity • Increased nutrient concentrations in water |
| Grazing | <ul style="list-style-type: none"> • Stream bed and bank degradation • Increased sedimentation and turbidity • Increased nutrient concentrations in water • Reduction of swamp/headwater habitat |
| Harvesting | <ul style="list-style-type: none"> • Reduction in population numbers |
| Introduced species | <ul style="list-style-type: none"> • Competition with native species • Predation on native species |
| Mining/Quarrying | <ul style="list-style-type: none"> • Increased sedimentation and turbidity • Increased toxic chemical concentrations in water |
| Pest control | <ul style="list-style-type: none"> • Increased pesticide concentrations |
| Recreation | <ul style="list-style-type: none"> • Stream bed and bank degradation • Increased sedimentation and turbidity |
| Roading | <ul style="list-style-type: none"> • Stream bed and bank degradation • Increased sedimentation and turbidity |
| Timber harvesting | <ul style="list-style-type: none"> • Increased sedimentation and turbidity • Increased nutrient concentrations in water |
| Waste disposal | <ul style="list-style-type: none"> • Increased nutrient concentrations in water • Increased toxic chemical concentrations in water |

13. NATIONAL ESTATE

13.1 INTRODUCTION

Background

The Register of the National Estate is a national register of places in Australia which have national estate heritage value. Heritage values are features which have cultural or natural significance to the national, regional or local community as defined in section 4 of the *Australian Heritage Commission Act 1975*.

Many forest areas are listed in the Register of the National Estate. The Commonwealth Government, in making decisions concerning forests, such as the granting of licences to export woodchips, must consider the possible effect of these decisions on the National Estate.

A regional assessment model for identifying the National Estate was developed in 1991/92 by the Australian Heritage Commission (AHC), in cooperation with the Western Australian Department of Conservation and Land Management (CALM), for the Southern Forest Region of south-west Western Australia, (AHC and CALM 1992). The model was refined and applied in the Victorian East Gippsland and the Central Highland Regional Forest Agreement (RFA) process. The RFA process is consistent with the statutory requirements of the *Australian Heritage Commission Act 1975*.

Initial historic research for the purposes National Estate assessment in the West commenced in 1996, with much of the field work for cultural and historic values being conducted in 1998 and 1999. This work is now being finalised. The assessment of natural values is currently under way.

The objectives of the national estate study are to:

- assess the representation of national estate values in the existing nature conservation reserve system and other protective land tenures where appropriate;
- identify those areas in the West which merit listing in the Register of the National Estate; and
- provide management guidelines on the protection and maintenance of national estate values.

The West National Estate report will be released for public comment later this year.

The methodology used for the national estate assessment essentially followed the methods developed and reviewed for the East Gippsland, Central Highlands, North East Victoria and Tasmanian RFAs. The methods are outlined in the reports:

Method Papers: Central Highlands National Estate Assessment , Volume One - Natural Values. (AHC and DCNR 1994);

Method Papers: East Gippsland and Central Highlands Joint Forest Projects; Volume Two - Cultural Values. (AHC and DCNR 1994);

Tasmania-Commonwealth Regional Forest Agreement, National Estate Report. Background Report Part H. (Tasmanian Public Land Use Commission 1997); and

National Estate Identification and Assessment in the North East Region of Victoria. (Joint Commonwealth and Victorian RFA Steering Committee 1999).

Approach to the National Estate Assessment

The national estate study involves distinct phases, the identification phase, the protection analysis phase and, the development of conservation principles.

The **identification** phase involves assessing the available information against the National Estate sub-criteria to determine areas of value and delineate indicative national estate places. Details on the AHC's criteria and sub-criteria will be outlined in the forthcoming National Estate report. The major components of this phase were: determining the appropriate methods; analysing existing data; undertaking further gap filling studies; applying the sub-criteria to the data available; and applying thresholds of significance.

The **protection analysis** phase involves an assessment of each national estate value and its sensitivity, resilience and/or robustness to various types of disturbance. Most cultural heritage places are sensitive to disturbance, although for many cultural places their significance is linked with continuing human interaction. In contrast, old-growth forest values are considered sensitive to disturbance such as harvesting, roading or wildfire.

The **conservation principles** phase involves consideration of the sensitivity to disturbance of each value, as well as current international 'best practice' in natural and cultural heritage conservation and the design of nature conservation reserves.

Management and protection of many national estate values are undertaken through a range of mechanisms which can be included in the Forest Management Plans for the Otway and Midlands Forest Management Areas (FMAs) and as set out in the Code of Forest Practices for Timber Production (NRE 1996b). Forest Management Plans address the conservation principles of many national estate values which will assist in their management. Statewide guidelines for the management of cultural heritage values in the forest, parks and reserves is to be prepared once all the Victorian RFAs are completed. Until such time as the statewide guidelines are completed, *Guidelines for the Management of Cultural Heritage Values in the Forests, Parks and Reserves of East Gippsland* (NRE 1997m) will function as an interim guide. Measures to guide Aboriginal heritage protection and management are being developed with the Aboriginal communities of the West region.

13.2 DATA REVIEW

Much of the data for national estate analysis is derived from extensive data sets assembled by NRE over many years. These are analysed and supplemented by consultancies, special projects, and input from the community. Where possible, one source of data is used to complement or confirm, another to ensure that the most robust data sets were compiled.

Eight broad types of data and information are used in the assessment:

- existing scientific (natural and cultural heritage) studies and reports;
- site-specific data obtained from field research;
- data collected from mapping, usually aerial photo interpretation;
- existing databases of cultural heritage places;
- information derived from models, using limited ground data;
- studies conducted by consultants;
- community information; and
- information from experts.

The data being used in the national estate study include:

- ecological vegetation class mapping;
- disturbance mapping from old-growth assessment;
- National Wilderness Inventory database;
- the NRE Flora Information System;
- the Atlas of Victorian Wildlife;
- the forest growth stage data set;
- the NRE Historic Places Section Database
- the NRE visual management system;
- the Register of the National Estate;
- Heritage Victoria Register;
- data assembled at heritage workshops conducted with local communities and major stakeholder groups;
- published and unpublished scientific data;
- specific historic thematic studies, including research and field surveys for sawmill and tramway sites, selected historic themes, and forest activity sites;
- aesthetic value assessment study ;
- social value assessment study; and
- geological and geomorphical data.

These data sources will be summarised in the forthcoming National Estate report.

13.3 CONSULTATION PROCESS FOR NATIONAL ESTATE ASSESSMENT

The main objectives of the consultation process are to:

- involve the community in the identification of its heritage;
- inform all sectors of the community about the national estate study (that is local people and organisations, recreation groups, industry groups, conservation organisations and unions);
- be open and transparent about process, methods and decisions;
- encourage a better understanding of heritage, the AHC's role and processes; and
- encourage a stronger understanding of management and conservation measures.

Key stakeholders

Peak conservation and industry groups were briefed on the national estate study as part of the public briefings, at the local community heritage workshops and at the stakeholders heritage workshop in Melbourne. Community heritage workshops were conducted at; Avoca, Apollo Bay, Rushworth, Daylesford, Heywood, Hamilton and Camperdown. Community heritage data compiled at the community heritage workshops was made available for review and comment. A further opportunity for comment will follow the release of the National Estate report.

Aboriginal communities

Aboriginal communities, through the organisations Ballarat and District Aboriginal Co-operative Ltd, Brambuk Incorporated, Framlingham Aboriginal Trust, Goolum-Goolum Aboriginal Co-operative Ltd, Kerrup-Jmara Elders Aboriginal Corporation and Wathaurong Aboriginal Corporation Ltd, have been involved in a round of workshops held in June 1999, as the first stage in developing an agreed Aboriginal heritage management system. Mirimbiak Nations Aboriginal Corporation has been contacted in order to inform all Native Title claimants in the region.

13.4 SUMMARY OF THE NATIONAL ESTATE ASSESSMENTS

The assessment of national estate natural and cultural values of the forests of the region will be summarised in the National Estate report.

More detailed information on cultural value assessments will also be available in the following consultants' reports:

- Marshall, B. and Jones, R. 1997 *Victorian Cultural Heritage Data Audit and Analysis for the RFA Regions: the West.*
- Graeme Butler & Associates 1997 *A Study of Places Relating to Selected Historic Forest Themes in the West Forest Region Victoria.*
- Context Pty Ltd 1997a *Identification and Assessment of Community Heritage Values in the West Forest Region, Victoria: Workshop Overview Report.*
- Context Pty Ltd 1997b *Identification and Assessment of Community Heritage Values in the West Forest Region, Victoria: Social Value Assessment Report.*
- Context Pty Ltd 1997c *Identification and Assessment of Community Heritage Values in the West Forest Region, Victoria: Inventory of Community Heritage Places.*
- Robin Crocker & Associates 1997 *Identification and Assessment of Aesthetic value in West Forest Region Victoria.*
- Bannear, D. 1997 *A Study of Historic Forest Activity Sites in the West Forest Region, Victoria.*
- Evans, P. 1997 *A Study of Historic Sawmill and Tramway Sites in the West Forest Region, Victoria.*

14. WILDERNESS

14.1 INTRODUCTION

Wilderness quality is essentially a measure of the extent to which a location is remote from and undisturbed by the influence of modern technological society. The National Reserve criteria (JANIS 1997) specify that 90 percent (or more if practicable) of the area of high quality wilderness that meets the minimum area requirements should be protected in reserves.

In 1988, the Victorian Land Conservation Council (LCC) commenced a statewide investigation of wilderness. An important input to this investigation was the 'Survey of Wilderness Quality in Victoria' undertaken by Preece and Lesslie (1987). This survey was jointly funded by the Victorian Government and the Australian Heritage Commission, and was the pilot study for the National Wilderness Inventory which has since been extended to other States. The survey mapped the variation in wilderness quality across the major natural areas of the State. The LCC used this information to identify a number of wilderness and remote and natural areas in the State. None of the wilderness areas identified by the LCC fall within the West RFA region, although three areas in the Grampians National Park were identified with remote and natural attributes (LCC 1991b).

As more recent and detailed disturbance information currently being compiled by NRE as part of the old growth survey will be available, a re-assessment of wilderness values in the Region will be undertaken.

14.2 METHODS

The National Wilderness Inventory (NWI) methodology (Lesslie and Maslen 1995) has been adopted as the standard approach to the assessment of wilderness in RFAs throughout Australia. This methodology will be applied to the assessment of wilderness quality for the West region national estate study.

The NWI methodology produces a database of 'wilderness quality' across the region. This is achieved by measuring the variation in wilderness quality across the landscape using wilderness quality 'indicators' that represent the two essential attributes of wilderness: remoteness and naturalness. The indicators are:

- **Remoteness from Settlement** — remoteness from places of permanent occupation;
- **Remoteness from Access** — remoteness from established access routes;
- **Apparent Naturalness** — the degree to which the landscape is free from the presence of permanent structures associated with modern technological society; and
- **Biophysical Naturalness** — the degree to which the natural environment is free from biophysical disturbance caused by the influence of modern technological society.

Each of the indicators is rated from 0 to 5 according to the assessed remoteness and naturalness. The index of wilderness quality derives from a summing of the component indices and is represented by a range from zero to 20. Wilderness areas are most commonly defined as being areas of high wilderness quality (12 and above) occupying at least 8000 ha (JANIS 1997, VicRAFSC 1996a).

14.3 OUTCOMES

The findings of this assessment will be published later this year in conjunction with the National Estate report for the West region and addressed in the RFA Directions report.

15. WORLD HERITAGE

15.1 METHODOLOGY

In accordance with the Commonwealth/Victoria Scoping Agreement and the Commonwealth's obligations under the World Heritage Convention, there is a commitment by both governments to identify and assess World Heritage values in the West region as part of the RFA.

Places on the World Heritage List are defined as those which have outstanding universal value. The methodology used to identify and assess places which may have this level of value is based on a thematic approach. This assesses significance by developing themes of outstanding universal value, and then testing places against these themes.

The methodology involves the use of an Expert Panel and provides a systematic means of identifying a list of places that meet the criteria and operational guidelines of the World Heritage Convention.

The first step (Step A) of the methodology involves the Expert Panel providing advice to Governments on themes of outstanding universal value relevant to Australia. These themes are then used in the second step (Step B) to develop a list of places that might include those that best represent the identified themes in a global context.

These potential places are then further examined against the Operational Guidelines for the World Heritage Convention to determine whether they have World Heritage value. They are tested using a series of sieves where the places identified at Step B are assessed for authenticity and integrity (Step C), and adequacy of management and legal protection (Step D), prior to formal assessment against the World Heritage criteria in the final step (Step E). Places that do not meet the tests are eliminated at each step of the assessment process.

Details of this methodology are included in the *East Gippsland Environment and Heritage Report* (VicRFASC 1996a).

15.2 ASSESSMENT

An Expert Panel was established to implement Step A and Step B of the methodology for Victoria. Members of the Expert Panel were drawn from amongst Australia's foremost specialists in disciplines relevant to the World Heritage natural and cultural criteria. The panel met in Melbourne on 13-14 June 1996.

Details of the membership of the panel and the formal record of its meeting are included in the *East Gippsland Environment and Heritage Report* (VicRFASC 1996a). A detailed overview of the relevant methodology may be found in *World Heritage Report—Record of the World Heritage Expert Panel Meeting: Western Australia, New South Wales and Queensland* (Commonwealth of Australia 1998). This report is accessible on the RFA Internet site.

Step A of the methodology required the Expert Panel to:

- provide advice on the identification of significant themes relating to World Heritage natural values (flora, fauna, geological and geomorphological) or cultural values (Aboriginal and European) for all terrestrial areas of Australia;

- assess these themes in their global context in order to provide advice to Governments on which themes are of outstanding universal value; and
- identify those outstanding universal themes which are relevant to forested areas in Australia.

The Expert Panel was then asked to undertake Step B of the methodology for places in Victoria and to:

- determine which, if any, of the outstanding universal themes for forested areas identified in Step A are relevant to Victoria, as well as to Australia as a whole; and
- provide advice on whether there are places in Victoria which best express the themes and which therefore need to be further investigated as part of the CRA process.

15.3 OUTCOMES

The outcomes of the Expert Panel's work are summarised in Table 15.1 below.

The panel identified five potential sub-themes in Victoria which warrant further investigation. Four of these sub-themes are potentially relevant to the West region. The relevant sub-themes are:

- areas with outstanding examples of *Eucalyptus*-dominated vegetation
- fossils, associated with sites such as the Otway Coast (Cape Otway); and
- records of past climates, for example, lakes with climatic sequences in their sediments, including a number of Western Victorian volcanic lakes.

The Expert Panel in its deliberations on Victoria made the following statement clarifying the nature of the *Eucalyptus* theme:

A strong nomination focussed on Eucalyptus evolution and diversity would include a wide variety of Eucalyptus types from a variety of environments. An excellent representative sample of these can be found in south east Australia, centred on East Gippsland, encompassing a range of habitats from the sea to the alpine herbland, and then to the inland plains. This sample would not be found in a single, contiguous area but would comprise several large areas, most of which could be expected to already have protected area status.

The expression of these sub-themes is not contained entirely within the West region as they extend to other Victorian RFA regions and areas beyond Victoria. Any assessment of potential World Heritage values (Steps C-E of the methodology) would need to be undertaken in this broader context. The Commonwealth and Victoria remain committed to carrying out such an assessment in this broader context in co-operation with all states involved.

Table 15.1: Summary of World Heritage Themes, Sub-themes and Places in Victoria Warranting Further Investigation

| STEP A | | STEP B |
|-----------------------|---------------------------|--------------------------|
| AUSTRALIA | | VICTORIA |
| All Terrestrial Areas | Australian Forested Areas | Victorian Forested Areas |

| Australian Themes of Outstanding Universal Value | Australian Sub-themes/ Exemplars | Explanatory Sentence | Australian Forest Sub-themes/ Exemplars | Potential Places in Victoria Warranting Further Investigation |
|--|----------------------------------|----------------------|---|---|
|--|----------------------------------|----------------------|---|---|

NATURAL

| | | | | |
|---|--------------------------------|---|------------------------------|---|
| Ancient records of life and landforms. | Ancient landforms and fossils. | Australia has outstanding examples of the earliest known records of life and early physiographic features. | | |
| Origin and development of biota and landforms as a result of Gondwana plate tectonics and more recent stability and long isolation. | Passive continental margins. | Marginal swells are characteristic of all passive continental margins. The Australian marginal swells are outstanding and exceptional in having volcanics to allow the process to be dated. | Passive continental margins. | Parts of the Australian marginal swells associated with the Eastern Highlands (only partly represented in Victoria). |
| | Paleoplains. | Australia has outstanding examples of ancient soil forms in its ancient laterites and duricrusts. | | |
| | Paleo-drainage systems. | Australia has outstanding examples of Mesozoic and older river systems extant in its landscapes. | | |
| | Fossils. | Cretaceous fossil sites in Victoria (particularly including fossil remnants of dinosaurs, fish and birds) are the best examples of southern high latitude Cretaceous faunas known. | Fossils. | Fossil sites at the Otway Coast (Cape Otway), Koonwarra (Leongatha region) and the Bunurong Marine Park (Inverloch region). |

| STEP A | | | | STEP B |
|--|--|---|--|--|
| Australian Themes of Outstanding Universal Value | Australian Sub-themes/ Exemplars | Explanatory Sentence | Australian Forest Sub-themes/ Exemplars | Potential Places in Victoria Warranting Further Investigation |
| | Refugia, Relicts. | Australia has outstanding examples of relict biota reflecting ancient Gondwana biota. | Refugia, Relicts. | |
| | Rainforest. | Australian rainforests are an outstanding example of ecosystems from which modern biota are derived. These rainforests are exceptionally rich in primitive and relictual species, many of which are similar to fossils from Gondwanaland. | Rainforest. | |
| Evolution of landforms, species and ecosystems under conditions of stress. | Scleromorphy. | The Australian flora includes outstanding examples of the evolution of a diverse range of scleromorphic characteristics in response to low nutrient soils and a highly variable climate. | Scleromorphy. | |
| | Arid landscapes and adaptations. | Australia, as the most arid, non-polar continent on earth, has outstanding examples of arid landforms and arid-adapted biota in its sandy deserts, including the longest longitudinal dune systems in the world. | | |
| | <i>Eucalyptus</i> -dominated vegetation. | <i>Eucalyptus</i> -dominated vegetation in Australia is an outstanding example on a continental scale of forest and woodland vegetation dominated by a single genus. This vegetation has evolved under stress, including conditions of high climatic variability, nutrient deficiency, and high fire frequency. | <i>Eucalyptus</i> -dominated vegetation. | |
| | | | | Areas with outstanding relevant examples of <i>Eucalyptus</i> -dominated vegetation associated with the Eastern Forests of Victoria. |

| STEP A | | | STEP B | |
|---|----------------------------------|---|---|---|
| Australian Themes of Outstanding Universal Value | Australian Sub-themes/ Exemplars | Explanatory Sentence | Australian Forest Sub-themes/ Exemplars | Potential Places in Victoria Warranting Further Investigation |
| (cont.) Evolution of landforms, species and ecosystems under conditions of stress. | Alpine. | Australia has outstanding examples of globally unusual vegetation that has developed in response to maritime conditions and poor soils. | | |
| Climate change and its impacts. | Records of past climates. | Australia has outstanding and globally significant records of past climates preserved in the sediments of a number of its lake systems. | Records of past climates. | Lakes with climatic sequences in their sediments, including a number of Western Victorian volcanic lakes. |

CULTURAL

| | | | |
|--|--|--|--|
| Traditional human settlement and land use. | Complex persistence of a hunting- and-gathering society on a single continent. | Australia provides the only example of where the hunting-and-gathering way of life has dominated an entire continent up until modern times. This way of life continues to play a significant role in the occupation of the continent, particularly in its northern and central sections. | Complex persistence of a hunting- and-gathering society on a single continent. |
| Artistic expression. | Rock art. | Australia has Aboriginal art sites that represent a unique artistic achievement, as well as providing an outstanding record of human interaction with the environment over tens of thousands of years. | Rock art. |
| Religious expression. | Dreaming sites. | Australia provides an outstanding example of where the religious system of hunting-and-gathering societies is embodied in the landscape. | Dreaming sites. |

16. ECOLOGICALLY SUSTAINABLE FOREST MANAGEMENT

This chapter has been prepared in two parts:

Part 1 Summary of the independent Statewide assessment of ecologically sustainable forest management (ESFM) in Victoria (VicRAFSC 1997b) and a statement on ecologically sustainable forest management for the West RFA Region.

Part 2 Response of the Commonwealth and Victoria to the Statewide ESFM assessment reported in the Central Highlands Directions Report (VicRAFSC 1997c).

PART 1 INDEPENDENT ESFM ASSESSMENT

The following is a summary of an independently assessed report on ecologically sustainable forest management in Victoria.

The report is only part of the overall assessment of ecologically sustainable forest management and, together with community input, provides a starting point for Commonwealth and State consideration and determination of sustainable forest management in Victorian Regional Forest Agreements.

The report examines and assesses the systems and processes underpinning the delivery of ecologically sustainable forest management in Victoria. The report adopts a 'systems' approach rather than seeking to catalogue specific on-ground practices. An analysis of the overall management system and the process elements was undertaken because there are no established performance indicators or benchmarks for ecologically sustainable forest management.

Given that the report is based on the findings of an independent panel which completed a review and assessment of ESFM in East Gippsland, and an assessment of Statewide practices which was independently peer reviewed, the views contained in this summary and the full report are not necessarily those of the joint Commonwealth and Victorian RFA Steering Committee (the RFA Steering Committee) or of the Commonwealth or Victorian Governments.

16.1 INTRODUCTION

Ecologically sustainable forest management is a key element of current forest policy and underpins the objectives articulated in the National Forest Policy Statement. ESFM can be operationally defined as the management of forest on all land tenures to maintain the overall capacity of forests to provide goods, protect biodiversity, and protect the full suite of forest values at the regional level (VicRAFSC 1996a).

The National Forest Policy Statement proposes to give effect to ecologically sustainable forest management through:

- Integrated planning processes and management systems.
- Codes of Practice and environmental prescriptions.
- Management plans incorporating sustainable yield harvesting practices.
- Management of native forests outside the reserve system complementing the objectives of nature conservation reserve management. (Commonwealth of Australia 1992b).

Following completion of the Independent Advisory Group's work on ESFM for East Gippsland, it was recognised that the information and assessments arising from that work related largely to management systems and processes that are relevant in a Statewide context, not just East Gippsland. Consequently, the Commonwealth and Victoria agreed to the development of a Statewide ESFM report and assessment, using as much of the information as possible from the East Gippsland work as a basis for the Statewide report, and to fill any gaps as required.

A brief description is provided below outlining:

- the methodology used in the Statewide assessment;
- a statement on ecologically sustainable forest management for the West RFA Region. The complete Statewide assessment report (VicRAFS1997b) was published at the same time as the Comprehensive Regional Assessments for Central Highlands;
- a description of the environmental management system framework used for the assessment;
- a summary of the outcomes of the assessment based on five environmental management system components in relation to the ecologically sustainable management criteria; and
- an overall appraisal of Victoria's forest management systems and processes.

The Commonwealth and Victoria have considered the Statewide ESFM assessment and the comments made by the Expert Advisory Group and Professor Ian Ferguson. Part 2 outlines the response of the Commonwealth and Victoria to the Statewide ESFM assessment, as well as the current status of actions in regards to the responses.

16.2 METHODOLOGY

Assessment of Statewide Forest Management Systems and Processes in Victoria

The assessment focuses on the effectiveness of management systems and processes in delivering ecologically sustainable forest management according to a set of principles and criteria (Table 16.1).

Preparation of the Statewide ESFM report was undertaken by a Project Management Group consisting of Commonwealth and Victorian officials under the guidance of the RFA Steering Committee. Descriptions and assessment of Statewide management systems and processes were either adapted from systems and processes described for East Gippsland having relevance to the whole State or, in the case of systems and processes not covered in the East Gippsland Report, prepared by the Project Management Group.

The final report was independently reviewed by Professor Ian Ferguson, the chair of the East Gippsland Ecologically Sustainable Forest Management Expert Advisory Group in accordance with the following terms of reference:

The consultant is required to review and report on a description and assessment of Ecologically Sustainable Forest Management systems and processes in Victoria in relation to ESFM principles and environmental management criteria with particular attention to:

1. *new descriptions and assessments of Statewide management systems and processes not covered in the East Gippsland Report;*
2. *whether the assessments of Statewide management systems and processes properly reflect the East Gippsland Report; and*
3. *an overall appraisal of the Statewide report and identification of the strengths and weaknesses of Victoria's forest management systems and processes.*

West Forest Management Systems and Processes

As part of the CRA for the West, the forest management systems applicable to that region were reviewed, against the Statewide ESFM report (VicRAFSC 1997b) to identify any issues or systems that are specific to the West. It is considered that the Statewide review of ESFM is applicable to the West.

The Statewide ESFM report indicates an intention to prepare a forest management plan for Portland and Horsham FMAs by the end of 2001 and notes that forest management plans for the Midlands and Otway FMAs are already in place. Where a forest management plan is not in place, such as in Portland and Horsham FMAs, State forest is managed according to approved LCC recommendations and NRE policy and guidelines. When prepared, the proposed Portland/Horsham Forest Management Plan will be released for public comment prior to its finalisation. It will be an integrated management plan developed with assistance from the community in the area. The plan will propose a framework for the future management of the State forests of Portland and Horsham, and will commit the Department of Natural Resources and Environment (NRE) to the completion of specific management actions to enhance the conservation and production roles of State forest. New forest management plans for the Otway and Midlands are due in 2002 and 2005 respectively.

Description of the Environmental Management System Framework used for the Assessment

The International Standards Organisation (ISO) 14004 (Standards Australia 1995) environmental management system framework provided guidance for developing the structure for the assessment of Victoria's forest management systems and processes (Table 16.2). The ISO 14000 series environmental management system operates at an organisation¹ level, and has the potential to contribute to an internationally acceptable system for certification of forest management and labeling of forest products in the future. Victoria's forest management systems and processes were classified into five components for the assessment of ecologically sustainable forest management.

Commitment and Policy Framework

The commitment of the Commonwealth and Victorian Governments, their Departments and relevant business units to ecologically sustainable forest management was assessed in terms of the development and application of appropriate legislation, policies, conventions and agreements which contribute to achieving ecologically sustainable forest management. The process for coordination of Commonwealth and State forest-related policies and legislative requirements was also treated under this heading.

Planning

A major focus of the assessment was whether management practices were supported by principles of environmental care, guidelines and minimum standards, and the basis (quantitative, qualitative, expert opinion) for application of guidelines and minimum standards within codes for specific management practices, and transparency of the planning process. Focus was also given to legal requirements, environmental aspects of forest management practices, allocation of values to particular planning zones, planning processes for minimising environmental impacts of management practices, and appropriateness of plans and their scale and scope in relation to environmental objectives and targets.

¹ An organisation can be Commonwealth and State Government organisations or statutory authorities, Governments, private or non-government organisations. For the purpose of the ecologically sustainable forest management assessment, Governments and their administrative structures have been assessed. Private organisations are not included in this assessment.

Implementation

The capacity and capabilities of governments and their agencies to deliver ecologically sustainable forest management through adequate accountability and responsibility, resourcing, operational controls, documentation, records keeping and reporting, communication, education and knowledge, and skills and training was assessed.

Forest information, monitoring and evaluation

The assessment considered Victoria's systems for monitoring and evaluating environmental performance of the implementation of forest management plans and the condition of the forest in relation to requirements for ecologically sustainable forest management.

The process for auditing components of the management system and corrective actions to determine system performance was also assessed. Assessment of audit processes was based on their objectivity and impartiality, and whether they were conducted by properly trained personnel (Standards Australia 1995).

Review and improvement

Processes for review which lead to continuous improvement of the management system and environmental performance were assessed. These included:

- processes for improvement of the management system which can lead to improved performance;
- application of review findings and research and development at policy, management and planning levels; and
- effectiveness of research and development processes.

Ecologically Sustainable Forest Management Assessment Criteria

Ecologically Sustainable Forest Management has been assessed against nine principles for ecologically sustainable forest management and the five environmental management system criteria namely: public transparency; monitoring; compliance; scientific and technical basis; and review (Table 16.1).

The nine principles have been developed for national application from the Montreal Process, Forest Stewardship Council Principles and Australian Forestry Council Principles for Environmental Care in Native Hardwood Logging.

Principle 1 Maintain the full suite of forest values for present and future generations

This principle addresses the issue of intergenerational equity, that is, that forests be managed to meet present needs without compromising the ability of future generations to meet their own needs (Young 1993). It provides the context in which principles 2-9 must be considered.

Principle 2 Maintain and enhance long-term multiple socio-economic benefits to meet the needs of societies

The basis of this principle is the promotion of forest-related economic activity which is consistent with the maintenance of the environment and satisfaction of the socio-economic requirements for income, employment, goods and services. Implicit in this principle is the optimum use of the forest economy's capital stock (human, man-made and natural resource capital) through management so as to maximise the long-term welfare or benefit of society in terms of goods and services it requires. The forest economy covers timber and other forest products and uses, water supply, minerals, grazing, recreation and tourism.

Principle 3 *Protect and maintain biodiversity*

The maintenance of biodiversity is fundamental to achieving ecologically sustainable forest use (ESDWG 1991, Commonwealth of Australia 1992b). Incorporated into the concept of biodiversity is variation at the ecosystem, species and genetic levels.

Principle 4 *Maintain the productive capacity and sustainability of forest ecosystems*

Sustained production of biomass by forest ecosystems is essential to the well-being of all living things. The productive capacity of a forest can be influenced through the silvicultural regime and other management activities. Implicit in the term sustainability is the understanding that irreversible damage through resource use is not imposed on the capacity of the forest to supply goods or services to present and future generations (Ferguson *et al* 1996).

Principle 5 *Maintain forest ecosystem health and vitality*

This principle reflects the concept of ecological integrity whereby the health and vitality of an ecosystem is maintained under changing environmental conditions. Structural and functional changes can occur in ecosystems as a result of threatening processes, such as land clearing, fire, pollution, pests and diseases. These can cause significant shifts in species composition, loss of key biological components, or the degradation of ecosystem processes. Consideration of ecological integrity means determining thresholds of environmental change whereby each threshold results in a reorganisation of the ecosystem to a different but appropriate level. The properties and processes of forest ecosystems over management periods become important considerations for maintaining ecological integrity over time.

Principle 6 *Protect soil and water resources*

Forests contribute significantly to the maintenance and conservation of the soil resource; they afford water catchment protection, and maintain the quality and quantity of water.

Principle 7 *Maintain forest contribution to global carbon cycles*

Carbon is stored in Australian forests as living plant and animal biomass and dead organic matter in the form of forest debris. As a general rule, carbon is accumulated and stored in forests that are growing and which, as a consequence, contribute positively to carbon storage. Forests in which carbon is accumulated through photosynthesis but offset by the loss of carbon resulting from biomass decomposition or death are carbon neutral. Generally, forests that make a negative contribution to carbon storage are those that are regularly burnt, harvested on short rotations, or subject to heavy soil disturbance.

Principle 8 *Maintain natural and cultural heritage values*

Heritage encompasses archaeological sites, historic places and customs (cultural heritage), and natural values or objects (natural heritage) that are of aesthetic and social value and passed down to the present generation from past generations.

Principle 9 *Utilise the precautionary principle for prevention of environmental degradation*

In applying the precautionary principle, public and private decisions should be guided by:

1. careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and
2. an assessment of the risk-weighted consequences of various options.

In interpreting this principle, particular attention was paid to processes based on 'risk assessment' and 'risk management' strategies. Such processes are important to minimise environmental impacts and avoid serious or irreversible damage to the environment.

A full description of the nine principles is provided in the Statewide ESFM assessment report (VicRAFSC 1997b).

16.3 SUMMARY OF ASSESSMENT

The following is a summary of the 1997 assessment of Victoria's forest management systems and processes in relation to the ecologically sustainable forest management principles and environmental management system criteria above. It should be noted that some action has been undertaken on these items and this is set out in Part 2.

Commitment and Policy Framework

Legislation and National and State policies for the forests of Victoria provide a comprehensive framework for ensuring that all forest values are considered, assessed and afforded protection. In general, all the principles of ecologically sustainable forest management are met. On public land, legislation requires strategic land-use planning at the State/regional level through to legally enforceable Codes of Practice at the operational level (e.g. Code of Forest Practices for Timber Production - the Code). On private land, the legislation requires regional level planning, adherence to the Code and control of, for example, the clearance of native vegetation. In a number of instances, these arrangements are reinforced by legislation designed to safeguard particular values (e.g. Flora and Fauna Guarantee Act).

The assessment report suggested that revision of Commonwealth Acts such as the *Australian Heritage Commission Act 1975* and the *Environment Protection (Impact of Proposals) Act 1974* should be considered in the light of current RFA processes to improve coordination of forest management, and especially to develop a jointly agreed approach to identifying and assessing heritage values that minimises the overlap and differences between Commonwealth and Victorian legislation. Duplication in the application of Commonwealth and State Acts relating to the protection of endangered flora and fauna should be addressed. Subsequently, Federal Parliament passed the Environment Protection and Biodiversity Conservation Bill (1999) in June 1999. When enacted the new legislation will amalgamate former legislation and will clarify the roles and responsibilities of Commonwealth and state/territory governments in the protection of the environment.

Statutory land-use planning and management processes for public land in Victoria involve a precautionary approach in determining the need, level and mechanisms for protecting important environmental values. On private land, environmental protection, including requirements for retention of native vegetation, is achieved through planning scheme provisions under the *Planning and Environment Act 1987* and is identified in Catchment Management Strategies under the *Catchment and Land Protection Act 1994*.

There is a legislative requirement to review sustainable sawlog yields every five years. The transparency of the review process could be improved. Yields are legislated and industry licence volumes are allocated on the basis of regional sustainable yield.

Some potential socio-economic benefits are currently being foregone in Victoria by lack of utilisation of residual logs as a result of Commonwealth restrictions on export of woodchips. Harvest and export of pulpwood throughout Victoria would also have benefits for silviculture and fire management provided environmental values are protected.

Legislation was passed by the Victorian Parliament in 1997 to replace the Land Conservation Council with a new body called the 'Environment Conservation Council' whose task will be to conduct investigations into the balanced use or development of public land within the State.

Planning

Principle 1 Maintain the full suite of forest values for present and future generations

The planning processes in Victoria span all the levels required for achieving ecologically sustainable forest management. Land Conservation Council (LCC) studies have collected and assessed available information thoroughly, provided significant opportunities for public input, and ensured a balanced allocation of forested public land between resource use and conservation on a broad regional scale. The allocation of public land achieved through Land Conservation Council processes addresses all assessment criteria and provides a sound basis for ecologically sustainable forest management.

Preparing effective strategic plans for ecologically sustainable forest management requires methods for dealing with the often complex trade-offs necessary between competing ecological and socio-economic values. There is a strong need for sophisticated modelling approaches and data for dealing with these trade-offs, and this is being addressed.

Forest Management Plans, the Code and associated prescriptions applied within the land-use framework established by the Land Conservation Council, provide a strong basis for achieving ecologically sustainable forest management. The plans specifically address parks and State forests but take account of all tenures in their attempt to balance resource use with other conservation and management requirements. Where forest management plans are not in place, the forest is managed according to approved LCC recommendations and the Department of Natural Resources and Environment (NRE) policy and guidelines. In such areas, the preparation of the Wood Utilisation Plan assumes a more important role. Wood Utilisation Plans are prepared by a multi-disciplinary team and must take account of all available information on timber, flora, fauna, catchment, land protection and cultural values. The monitoring of implementation of Wood Utilisation Plans occurs. However this is hampered by the lack of an adequate coupe recording and tracking system.

The Department of Natural Resources and Environment needs to develop a system for monitoring implementation of plans, commence reporting on plan implementation, and make the information publicly available, along with actions intended to address any identified deficiencies. For national parks, major issues include setting clear and strategic goals for the conservation of biodiversity (or other express purposes of reservation) that are realistic in relation to available resources and against which the success of management can be judged, and consideration of the collective contribution of individual parks to regional conservation (or other express purposes of reservation) in the planning processes.

The Native Vegetation Retention Controls, Flora and Fauna Guarantee and the Code provide mechanisms for protecting environmental and other values on private land. Strategic regional plans which address flora and fauna conservation issues are required to ensure their implementation is coordinated and directed towards clear conservation goals or other relevant goals. Catchment Management Strategies may fulfil this role but are not yet well-developed.

The environmental effects statements (EES) and planning processes for assessing exploration and mining applications provide opportunities for consideration of socio-economic, environmental and cultural values, and for public participation. The incorporation of the former Department of Minerals and Energy into NRE should facilitate communication between formerly separate agencies and help produce more timely and balanced outcomes. NRE is, however, still refining its internal processes for assessment of exploration and mining applications. Work Plans provide mechanisms for the setting of suitable licence conditions.

The local government planning process for assessment of mining applications is slow and often more adversarial than the EES process. The EES process is more objective and rigorous, providing better opportunities for consideration of scientific evidence and differing views on the relative merits of a proposal.

At the strategic planning level there are major opportunities for public input to forest management in Victoria. Public confidence in forest management planning could be increased by development of a more comprehensive set of performance indicators against which implementation of the plan can be assessed, and setting of some more explicit targets against which the effectiveness of plans can be measured.

Principle 2 Maintain and enhance long-term multiple socio-economic benefits to meet the needs of societies

The Flora and Fauna Guarantee Act and the Land Conservation Act have clear requirements for involvement of scientific experts, community consultation and consideration of socio-economic issues. These issues could be considered more thoroughly in preparing forest management plans where necessary. Current policy and programs are principally directed at improving and extending the plantation estate on private land, and the economic returns and environmental and social benefits provided by plantations and trees on farms.

There is a need for better links between forest management plans, local government planning and cross border regional planning for industry, tourism, recreation and catchment management. Significant changes in industry opportunity (e.g. value-adding, pulpwood utilisation, and tourism) should trigger re-examination of forest management plans.

Principle 3 Protect and maintain biodiversity

Planning for protection of biodiversity in Victoria involves a hierarchy of strategic and operational plans which assess the need for reservation or special management at all scales from region to coupe, and puts in place regional and local prescriptions designed to limit the impacts of timber harvesting and other activities on flora and fauna and other values. The reserve system established by the Land Conservation Council land-use planning process is supplemented by a complementary zoning scheme in State forests which provides special prescriptions for conservation of Ecological Vegetation Classes, old-growth forests, and threatened flora and fauna. Overall, these planning processes make a major contribution to meeting the requirements for protecting and maintaining biodiversity and complementary management of 'off-reserve' areas. Once the boundaries of the National Reserve System are determined, mechanisms need to be developed to accommodate long-term changes in landscape dynamics through removal, exchange, or addition of areas on or near the boundaries. These mechanisms for periodic changes should seek to maintain adherence to the reserve criteria and the level of the sustainable yield, but provide sufficient flexibility to accommodate new information.

The effectiveness of Action Statements and Recovery Plans for flora and fauna need to be better assessed, based on monitoring and research. While Action Statements and Recovery Plans have been completed for numerous species, they have not been completed for communities and threatening processes. Additionally the overarching Flora and Fauna Guarantee Strategy has yet to be completed. These elements of the Flora and Fauna Guarantee should be implemented to ensure a coordinated approach to flora and fauna conservation.

Strategic regional plans are required to ensure that mechanisms for protecting biodiversity on private land are coordinated and directed towards clear flora and fauna conservation goals.

Principle 4 Maintain the productive capacity and sustainability of forest ecosystems

The adequacy of the existing Statewide process for estimating sustainable yield in those areas with a forest management plan has been reviewed as part of the East Gippsland RFA process (VicRAFS 1996d). Procedures and data for achieving these estimates are coarse at present, but uncertainties are accounted for by making conservative estimates of sustainable yield.

The process should continue to be as transparent as possible within restrictions relating to commercial confidentiality. It should continue to seek input of the best available specialist expertise from within and outside the Department of Natural Resources and Environment, and include regular reviews as legislated in relation to monitoring indicators of ecological sustainability.

The fact that formal review of sustainable yield is a separate process to preparation of Forest Management Plans is seen by some community groups as a potential impediment to achieving ecologically sustainable forest management. It should be recognised, however, that the five-yearly review of sustainable yield takes account of changes in the land base for timber production to meet conservation needs. Greater explanation of the procedure for estimating sustainable yield and making the methodology and data used publicly available at an earlier stage than has occurred previously would raise public confidence in this process. Sustainable yield and actual hardwood sawlog supply levels should be routinely reported and be publicly available.

Principle 5 Maintain forest ecosystem health and vitality

Wildfires pose a significant threat to resources, property and forest values on both public and private lands. Potential losses are considered in planning. Clearly established planning guidelines under the Code of Practice for Management of Fire on Public Land and strategic and operational plans provide a sound basis for integrated and effective management and control of fire in Victoria. The current practice of ensuring that fauna and flora officers have input to fire management plans is an important part of minimising risks to biodiversity. On private lands, the processes and planning mechanisms adopted by the Country Fire Authority provide a logical and accountable basis for strategic and operational planning for prevention and control of wildfires. While most issues are appropriately dealt with through strategic and additional plans, the overall effectiveness of pest management is limited by the lack of strategic plans for pest plant and animal control that cover all tenures. Operational planning processes should provide continuing programs for training and updating field staff and access to support materials.

Principle 6 Protect soil and water resources

For State forests, the Code of Forest Practices and supporting local management prescriptions provide guidelines for protection of soil and water values. The guidelines given in the Code are designed as Statewide minimum standards and therefore cannot address regional variation. The development of regional prescriptions that build on the Code standards to take account of local factors such as soil types and climatic conditions is required and should continue, as should research into the development of indicators of soil damage caused by harvesting machinery.

Areas of high soil erosion risk are often excluded from harvesting and may be placed in the Special Protection Zone as part of a Forest Management Area plan. The management of these and other erosion-prone areas in reserves is based on exclusion or careful management of fire and other activities to maintain vegetation and litter cover. Inclusion of targets in forest management plans for soil and water quality should be considered.

Catchment Management Authorities have played an important role in analysing threats and beneficial uses and must continue to do so to provide appropriate strategies to protect soil and water at the sub-catchment level.

Principle 7 Maintain forest contribution to global carbon cycles

Victoria aims to progressively increase its total forest cover through programs such as Landcare and the Tree Victoria Action Plan. There is a judgement by forest managers that conversion of mature forest to regrowth will maintain carbon storage, and that management burning will have a neutral long-term effect on forest carbon budgets. Little information is available to test these judgements at a regional scale. The areas of greatest uncertainty are the pattern of carbon re-accumulation in forest biomass after harvesting, the effects of harvesting and fire regimes on changes in the soil carbon store, and the residence time of carbon in harvested forest products.

Principle 8 Maintain natural and cultural heritage values

A suite of legislation protects all archaeological sites (Aboriginal and historic), significant historic sites, and aesthetic values. They are recognised at the strategic forest management level and in a range of management plans. More detailed strategies for the identification and protection of cultural heritage values, including Aboriginal sites, are required.

Deficiencies at the operational planning level need to be addressed through improved liaison with Aboriginal Affairs Victoria to implement the Aboriginal and Archaeological Relics Act, and increased participation of Aboriginal communities in Aboriginal site identification and management. A systematic approach to Aboriginal site impact assessment through appropriate ongoing identification of values (through consultation with communities and field survey) is required.

Principle 9 Use the precautionary principle for prevention of environmental degradation

A precautionary approach to forest management is adopted through a range of planning processes including a conservation reserve and zoning system, reservation of Ecological Vegetation Classes based on rarity and other indicators of risk, application of management prescriptions to ameliorate threatening processes in forests managed for timber harvesting and in sustainable yield.

Areas for improvement include:

- recognition in Forest Management Plans of the contribution of all forest areas to regional conservation goals e.g. General Management Zone;
- development of a formal approach to risk assessment at the commencement of the planning process and at periodic reviews to give greater confidence in the measures taken to ameliorate risk and to better identify the need for research into new types of information; and
- development of flexible corridor networks to accommodate changes in habitat where necessary.

Implementation

The accountabilities and responsibilities for delivery of each element of ecologically sustainable forest management are clearly established. The high level of public ownership and land management by one Department provides a good basis for a coordinated approach to ecologically sustainable forest management and minimises overlap and duplication between government agencies. Service delivery is facilitated by a departmental structure with both centralised control and strong decentralised components. The creation of Parks Victoria as a

provider of park management services to NRE is new. It is unclear whether policy and regulatory functions can be clearly and effectively separated and maintained by the Parks Program within NRE, and whether the protocols and other planning measures concerning coordination across these and other bodies within NRE and Parks Victoria will be effective in fire and other management activities. These aspects merit review and continued improvement.

The program and budgeting process of NRE generally reflects National Forest Policy Statement initiatives to improve public forestry accounting systems. In this way, the performance of both commercial activities and community service obligations can be clearly evaluated. A strength of the business unit structure is that it should allow all costs and benefits relating to ecologically sustainable forest management to be fully identified. Uniform treatment of all business units and activities is acknowledged to be difficult and ongoing refinements are needed. Particular attention is needed to identify costs on a regional basis and to separate costs of commercial and non-commercial activities. The level of funding to an individual region should be linked to the requirements for effectively implementing the strategic and annual plans for ecologically sustainable forest management in that region. Maintenance of a strategic focus for research into ecologically sustainable forest management also needs a continuing commitment to funding. For sustainable fire management, it is important to ensure that levels of skilled staff for fire-planning and suppression activities are maintained at least at current levels.

The process for control of forest operations to achieve compliance with the Code of Forest Practices and Coupe Plans is transparent and accountable. There is clear responsibility for control for each stage of timber harvesting from supervision of the implementation of the Coupe Plan to the signing of a Coupe Completion certificate following satisfactory compliance with the plan, including draining of major snig tracks and rehabilitation of landings. A major strength in managing timber harvesting operations is the Forest Operator Licensing System. The indicator point system provides a strong basis for the regulation of harvesting activities conducted by independent contractors to ensure they conform with the Code of Forest Practices. The process of control to achieve compliance with the Code of Fire Management on Public Lands is transparent and accountable. Country Fire Authority requirements for supervision by trained staff of all fire prevention and control operations, and a permit system for prescribed burning by private landholders provides an accountable basis for control of fire operations on private land. Improvement is needed in the forthcoming reviews of Fire Protection Plans to ensure that specialist peer review is generally undertaken. The lack of auditing processes for other Departmental operations is a weakness which should be addressed. In particular, there is a need to audit the extent of compliance of strategic and operational plans. An area for improvement is the supervision of forest operations where protection of archaeological or heritage values is important.

Statewide guidelines and procedures for parks and reserves provide guidance and a consistent approach across the State for a variety of field operations and park management issues. Supervision of contractors by field staff, ranger patrols to ensure visitor compliance with regulations, and leases and licences provide further operational control.

Private landholders are responsible for controlling activities on their land. Native Vegetation Retention Controls, Flora and Fauna Guarantee and the Code provide mechanisms for protecting environmental values on private land. However, their implementation lacks coordination. It is important to ensure this is coordinated and directed towards clear flora and fauna conservation goals. Development of further practical guides, and other information material describing good forest practice, especially to assist small plantation owners, would be helpful. Greater consistency in the interpretation of the Native Vegetation Retention Controls for plantation development is required.

Timber Harvesting Plans which conform to the Code and the S13 amendment to the planning scheme must be lodged for timber harvesting operations on private land with the responsible authority. This is usually local government which is then responsible for ensuring compliance with the provisions of the plan. These can be enforced through formal enforcement orders and subsequent recourse to the Administrative Appeals Tribunal. Local government often does not have the expertise to implement Native Vegetation Retention Controls, to assess cultural and heritage values, or to monitor compliance with permit conditions. Continued improvement in this area is necessary. Expansion of the trial in Gippsland using accredited forestry personnel to ensure harvesting plans comply with the Code, if successful, should be encouraged.

For exploration and mining, the on-ground presence of NRE staff is designed to ensure that monitoring of compliance with licence conditions occurs and that progressive rehabilitation of mine sites is satisfactory. Rehabilitation bonds provide a further incentive for compliance.

Most documents comprising the environmental management system are published or are made publicly available. Greater attention should be paid to ensuring that up-to-date copies of key documents, e.g. management prescriptions, are readily available to staff and other relevant parties. There is a need for a computerised database system to record forest operations, in particular, timber harvesting. This is important to ensure that old-growth forest and forest resource inventory information is regularly updated. Archival material of particular interest to ecologically sustainable forest management including historical records of fire, storm, settlement, timber harvesting, is not properly catalogued and stored. There is a need for retaining and transmitting the corporate knowledge base. This requires documentation of procedures, regular training and effective induction.

While NRE and Parks Victoria have training programs in place, there is room for improvement in a number of areas. Effective operational planning depends on, for example, identification of critical values at the local (coupe) scale (e.g. habitat requirements in Special Management Zones and soil erodibility).

On-ground assessments are made by Forest Officers and Park Rangers, and a wide range of skills are required to make competent professional judgements. Current planning processes need to better emphasise the importance of adequate technical training of field staff and access to support materials.

Forest Information, Monitoring and Evaluation

The development of flora and fauna databases covering all land tenures and the development of data gathering programs directly linked to strategic planning requirements is a strength of NRE's planning process, and also provides a basis for strategic long term monitoring of forest change. There are parallel databases for natural and cultural heritage places in forests. The joint Australian Heritage Commission/Department of Natural Resources and Environment studies have utilised existing databases and established new databases for many layers of site-based values. The Department's operational planning systems could be improved significantly through access to and regular updating of data concerned with Aboriginal sites.

Areas for improvement in forest information include:

- gathering and storage of socio-economic data for consideration in strategic plans;
- development of a Statewide computerised site, site management and visitor statistics database in national parks to improve the management process;
- systematic surveys of plant pest location and density and the development of a specific strategic plant and animal pest protection plan (similar to the fire protection plan) identifying priority control zones;

- making the GIS available to staff in the more remote areas of the State as well as Melbourne and major regional centres; and
- implementation of the Integrated Forest Planning System as new data from SFRI becomes available electronically.

While recent strategic plans include mechanisms to monitor their implementation, this is a relatively new process and implementation reports are yet to become available. It is essential that NRE complete the system for monitoring implementation of park plans, commence reporting on plan implementation on all land tenures, and make the information publicly available, along with actions intended to address any identified deficiencies. Monitoring of implementation of Wood Utilisation Plans is hampered by the lack of an adequate coupe recording and tracking system. The Department's monitoring process provide a sound basis for ensuring forest regeneration. However, assessment of other sustainability indicators could be undertaken during regeneration assessments to monitor the effects of forest operations.

NRE has a large body of information on the forest environment and a number of specific monitoring programs. However, the development of sustainability indicators is essential to assess whether stated forest management objectives are being met. While many indicators are implicit in current management plans, specific indicators and programs are required for monitoring biodiversity, health and vitality of forest ecosystems, soil and water resources, and social and cultural heritage values. Monitoring is required to assess whether prescriptions, such as habitat tree retention, linear reserves and streamside buffers, achieve their desired objectives in the longer term. The monitoring of road and track condition on public land is inadequate, leading to risks to soil and water quality. This is especially the case for those pre-dating the Code of Forest Practices. Indicators need to be sensitive to, and representative of, ecological change at strategic and operational scales. The applicability of presently held data for this purpose will need to be assessed.

Reference Areas have the potential to be valuable for monitoring long-term changes in forest ecosystems. A detailed inventory of the Reference Area system is required, including an assessment of its representativeness, extent of replication and the degree to which it provides reliable examples of forests unaffected by humans.

There are no formal processes for routine and regular audit of compliance with some Departmental policies and plans. Periodic audits are recommended. Auditing for compliance of components of Victoria's management system with the Code and exploration and mining licences is internally based and appropriate. Auditing applies to coupe planning, timber harvesting operations, log grading, fire operations, exploration and mining, and record-keeping. A strength of the auditing system in State forests is that a summary of results is made public and that substantial penalties are possible for breaches. NRE's internal audit of timber harvesting and log grading operations is an appropriate and effective means for assessing compliance with the Code and prescriptions. The use of staff from outside the region subject to audit is a strength of the process. Consideration should be given to increasing the transparency of audits by making the results of audit processes publicly available along with measures taken to address deficiencies, and by increasing the independence of the audit teams. Log grade audit results should be published. Consideration should be given to independent log grading procedures, perhaps related to the audit of the Code outlined above. The number of coupes audited may be too small to adequately sample the full range of environmental conditions under which problems may occur. Code audits should cover both public and private land, including plantations.

Corrective actions result from reviews of operational prescriptions and procedures, audit findings and results of regeneration performance, reports on Annual Service Agreements, supervision of field operations, and enforcement patrols to detect unauthorised activities in

Parks or State forest. To improve transparency, NRE should better document corrective actions taken.

Review and Improvement

A process for reviewing the forest management system components has not been formally developed by NRE. A process with appropriate reporting mechanisms, such as a 'state of the forests report' is required to ensure continuous review and improvement of the management system. This would be in keeping with developments in forestry organisations throughout the world. The scientific basis of those parts of forest management which generate greatest environmental risk or are subject to contrary scientific interpretations, together with those where scientific knowledge is advancing rapidly, should be subject to more frequent peer review.

NRE's research program clearly links to providing information for improving strategic planning and reducing environmental risks in forest management. A stronger commitment to the timely completion, appropriate peer review and publication of scientific research would improve public confidence and the scientific basis of forest management. A well defined long-term research and development program in which critical areas for research and development are identified is needed.

16.4 OVERALL APPRAISAL

The appraisal below was prepared by Professor Ian Ferguson as part of his independent review of the Statewide ESFM report (terms of reference are given in 16.1). This appraisal was made in addition to a number of comments incorporated into the Statewide report, and it should be read in that context. Given that it was an independent peer review, the views contained in this appraisal are not necessarily those of the RFA Steering Committee or of the Commonwealth or Victorian Governments.

Victoria has all of the major elements in place for appropriate systems and processes for ecologically sustainable forest management. Having said that, however, there is still considerable scope for further improvement. Forest-related legislation needs review to bring some aspects up-to-date and to make it more comprehensible to the public. Land-use planning processes need refinement in the light of changes in bureaucratic structures and current needs. Closer attention needs to be paid to strategic planning of the integration of reserve and off-reserve management. The purchasers of stumpage need to recognise the importance of competition in determining the price of publicly-owned native timber, and the role of contestable but renewable and transferable rights to timber supply from that forest. More training is needed to ensure that staff are adequately prepared for planning and management under ecologically sustainable forest management. More research is needed to assist in the resolution of various issues.

These are not major or exceptional requirements: they are the measures required for continuing improvement in management systems. The extent and rapidity of adoption will be dictated by

- *the economic viability of the commercial activities and the capacity to fund improvements in forest management through productivity gains,*
- *the resources available for improvements in non-commercial management activities,*
- *the support that the public at large gives to the economic, environmental and social outcomes, and*
- *the commitment of Governments, the timber industry, and the bureaucracy to the process.'*

In an era when resources for non-commercial activities are becoming scarcer and more competitive, there are concerns about the capacity for the system to fund adequately the improvements needed for management of an extended National Reserve System and the better integration of reserve and off-reserve management for all forest values. The formation of Parks Victoria may provide a basis for improved productivity that will enable existing resources to stretch further but the division of responsibilities between it and the NRE is still unclear. The additional resources required should not be underestimated.

Victoria is in a good position to deal with these issues providing it remains adaptive and accepting that sustainable forest management is a goal to be pursued vigorously, not an antique to be admired.

PART 2 RESPONSE TO STATEWIDE ESFM MANAGEMENT

The Commonwealth and Victoria have considered the Statewide ESFM assessment and the comments made by the Expert Advisory Group and Professor Ferguson as summarised in Part 1 of this chapter. The discussion below outlines the response of the Commonwealth and Victoria to the Statewide ESFM assessment as reported in the Central Highlands Directions Report (VicRAFSC 1997c). It is important to note when reading this response that some of the improvements suggested by the Expert Advisory Group have already been addressed through commitments made in the East Gippsland and Central Highlands RFAs, while others are not considered sufficiently significant to justify an adjustment to the systems and processes already in place. Each of the issues (or suggested improvements) in the Statewide ESFM report are briefly described below with a page reference, together with a response from the Commonwealth and Victoria. The issues are grouped according to the five environmental management system components described in the Statewide ESFM report.

In addition, since the release of the Central Highlands Directions Report the following actions, as reported in the following discussion as planned actions, have been completed:

- review and amendment of Commonwealth legislation dealing with the environment (Environment Protection and Biodiversity Conservation Bill 1999);
- Parks Victoria has been established under the *Parks Victoria Act 1998* to provide management services to the State for parks, reserves and other Crown land;
- Forestry Victoria has been established to enable clearer environmental accountability and an improved commercial focus for logging activity in State forests;
- the East Gippsland Forest Management Plan Amendment (NRE 1997k) has been completed in accordance with the East Gippsland RFA;
- regional prescriptions for timber production have been completed;
- Biodiversity Strategy, previously referred to as the Flora and Fauna Guarantee strategy, has been published (NRE 1997l);
- the internal audit of the compliance with the Code of Forest Practices for Timber Production for 1998 has been published (NRE 1998f);
- Guidelines for the Management of Cultural Heritage Values in Forests, Parks and Reserves in East Gippsland (NRE 1997j) have been published and it is intended to prepare Statewide guidelines during 1999;
- completion of SFRI for the North East (Benalla-Mansfield, Wangaratta and Wodonga FMAs); and
- a pilot program in municipalities in the Gippsland region to trial the accreditation of forestry professionals relating to planning for forest operations on private land has been completed and a report is being prepared.

Commitment and Policy Framework

Issue: Review of the Victorian Forests Act. (p40)

Response: As a result of commitments given in the National Competition Policy Agreement and through the Victorian Legislative Review Committee, a review of the *Forests Act 1958* is scheduled to be completed by 1999.

Issue: Review of Commonwealth Acts dealing with the environment. (p40).

Response: The Commonwealth reviewed Commonwealth legislation dealing with the environment. Federal Parliament passed the Environment Protection and Biodiversity Conservation Bill (1999) with amendments June 1999. When enacted the new legislation will amalgamate former legislation and will clarify the roles and responsibilities of Commonwealth and state/territory governments in the protection of the environment.

Issue: The need to address the duplication of processes associated with the Commonwealth Endangered Species Protection Act and the Victorian Flora and Fauna Guarantee Act. (p40)

Response: This issue has been addressed through commitments agreed in the East Gippsland RFA.

Issue: The need to address the duplication in application of Commonwealth and State heritage legislation. (p40)

Response: Avoidance of duplication is being addressed through State-Commonwealth initiatives to standardise criteria and assessment processes. The review of Commonwealth environmental legislation may also address this issue in part.

Planning

Issue: Flexibility with respect to the boundaries of the CAR Reserve System is necessary to accommodate long-term changes. (p42)

Response: This issue is addressed in commitments made in the East Gippsland RFA and will be implemented according to the guidelines in the amendment to the East Gippsland Forest Management Plan. It is envisaged that similar provisions will also apply in future RFAs.

Issue: The need for more thorough treatment of socio-economic factors in forest management plans. (p47)

Response: This requirement would only be considered in the event that significant social and economic implications are likely to arise from a forest management plan. However, this is unlikely given the current RFA processes. Major changes to land use and consequently, potentially significant socio-economic implications have usually been addressed in Land Conservation Council investigations and these have been accompanied by detailed socio-economic studies.

Issue: The need for formal risk assessment at the commencement of planning processes and at periodic reviews to guide new research. (p47)

Response: A systematic identification and assessment of risk and threatening processes is already undertaken at the commencement of forest planning processes. Those risks that are of particular significance are given greatest attention. For example, the potential risk to a range of forest-dependent species such as large forest owls and the Long-footed Potoroo in East Gippsland was identified early in the planning process and resulted in the development of detailed strategies to ameliorate the potential risk. The process of risk assessment will be addressed at the time of reviews to identify changes in factors affecting risk management.

Issue: The contribution of all forest areas to regional conservation goals needs to be recognised. (p48)

Response: This concept is a fundamental component of the National Forest Reserve Criteria and will be taken into account in the development and design of the CAR Reserve System in each region.

Issue: The need for performance indicators to monitor forest management plan implementation. (p48)

Response: Management plans already include a set of specific actions against which implementation can be assessed. There is also a requirement for an annual report on the implementation of the plans and these will establish timelines for priority actions attached to the approved service agreement.

Issue: The need to include specific targets for soil and water quality in plans. (p48)

Response: There is already a commitment in the East Gippsland RFA to develop indicators of sustainability, including appropriate protection of soil and water values that are relevant to particular regions.

Issue: More detailed strategies are required to identify and protect cultural heritage values. (p48)

Response: This issue is being addressed through the development of cultural heritage guidelines and improved arrangements in relation to consultation with Aboriginal communities. It is envisaged that guidelines and provisions similar to those prepared for the East Gippsland Region will be prepared for the remainder of the State.

Issue: Better links between the range of forest management planning processes within and across regional boundaries and the requirement that significant changes in forest management or condition should provide a trigger to review plans. (p48)

Response: There are already considerable linkages between relevant planning processes which ensure that activities operating across tenures and regions are properly coordinated and planned, and the need for major improvement is not considered necessary at this time. Major changes in the planning area, such as wildfire or major changes in land use, have resulted in major reviews in the past and will continue to do so.

Issue: More research is required to strengthen the scientific basis of the Code of Forest Practices, especially soil protection, and monitoring to confirm the effectiveness of prescriptions as a basis for their improvement. Further work is required to develop regional prescriptions that build on the Code to take account of local factors such as soil types and climatic conditions. (p48)

Response: Further research to underpin the Code of Forest Practices (NRE 1996b) is underway including a program to develop ecologically sustainable development indicators for soil, and to develop and evaluate long term soil monitoring programs. A field guide is being developed to assist staff in dealing with soil erosion hazard and soil permeability, and potential for overland flow in accordance with the Code. Further information on research is contained in the Compendium of Forest Research (VicRAFSC 1998b) (see review and improvement section below). Work is also progressing such that regional prescriptions for all Forest Management Areas will be completed by the end of 1997.

Issue: Greater explanation of the procedure for estimating sustainable yield is required, as well as the need to make information on the methodology and data used available at an earlier stage. Sustainable yield and sawlog supply levels should be routinely reported and be publicly available. (p49)

Response: Victoria will continue to publish the methodology, including reviews and improvements of methods, and data sources used in estimating sustainable yield at the time of each review, and to make this publicly available as soon as possible, recognising that the Minister is required to seek parliamentary approval of sustainable yield levels in each Forest Management Area following the Review. Victoria already provides public reporting of sustainable yield levels through the *Forests Act 1958* (Schedule 3), while sawlog supply levels for Victoria are provided in the Department's annual reports.

Issue: There is a need to set clear and strategic goals for the conservation of biodiversity (or other express purposes of reservation) in parks and reserves that are realistic in relation to available resources and against which the success of management can be judged. This would involve a procedure for monitoring implementation of plans. The contribution of parks to regional conservation should also be considered. (p50)

Response: Recent park plans contain specific implementation actions with respect to biodiversity conservation and other express purposes for reservation against which plan implementation can be monitored. The specified actions are prioritised and must be included in relevant service agreements which identify funding levels associated with their implementation. Each park plan is prepared with the parks regional context in mind, including its contribution to the regional conservation goals and the recreational and tourism opportunities. The Commonwealth and Victoria consider that the new plan approach meets the suggested requirements outlined in the ESFM report. There is a commitment to complete all plans across the State by the end of 1998 and this approach will be adopted in these plans. Park managers, including Parks Victoria, are developing a complementary framework for monitoring the condition of the parks and reserves estate. This framework should be achieved by 1999. The contribution of all land tenures, including parks, is considered in determining the CAR Reserve System for RFAs.

Issue: Wider use should be made of Reference Areas for long-term comparative studies on the impacts of human disturbance in other forested areas. (p50)

Response: The Commonwealth and Victoria support the use of reference areas as baseline research sites as long as that use is consistent with the objectives of reference areas.

Issue: The implementation of processes to protect environmental values on private land require improved coordination, and the expertise of local government to implement the controls and to assess values or monitor compliance needs to be improved. (p53)

Response: Better coordination of actions on private land is a stated objective of the new Catchment Management Authorities through the implementation of strategic regional plans and the Native Vegetation Retention controls. The Commonwealth and Victoria agree that local government requires improved expertise in monitoring compliance with permit conditions and in assessing environmental values on private land. A pilot program is underway to identify accredited experts who can be utilised by local government to address these issues.

Issue: The implementation of consistent approaches to auditing of compliance with the Code of Forest Practices on both public and private land is needed, as is the development of further practical guides and other material describing good forest practice, especially to assist small

forest growers. Greater consistency is required in the interpretation of the Native Vegetation Retention Controls for plantation development. (p54)

Response: Victoria is not currently intending to require audits of compliance with the Code of Forest Practices on private land. It should be recognised that forest activity is the only private land use currently subject to a Code of Practice. Both the Commonwealth and Victoria are involved in the development of practical information and guidance relating to plantation establishment on private land. These initiatives will continue and funding arrangements are in place to promote private forest industry development over the next few years. Both the Commonwealth and Victoria consider that the issue of consistency in the interpretation of Native Vegetation Retention Controls will be facilitated by the information being collected as part of the RFA process, such as standard vegetation mapping across the State. Vegetation information should assist in identifying important vegetation types that are in particular need of protection in a regional context. Auditing of compliance with the Code of Forest Practices on public land is dealt with under 'Implementation' below.

Issue: There is a need to strengthen the scientific basis of fire management plans through research in order to better balance protection of life and property with conservation of biodiversity, soil and water. (p58)

Response: The Victorian Code of Fire Practice for Public Land requires that the Department undertake, participate in, or support research programs aimed at improving: firefighter safety; understanding of fire behaviour; prediction of threat of wildfire to life, assets and values; the effects and effectiveness of preparedness actions; and firefighting methods, including knowledge of their impact on environmental values. The East Gippsland RFA identifies further research on fire management as a high priority and in 1997-98 Victoria will spend more than \$300 000 on fire research which is directly related to strengthening the scientific underpinning of fire management. This research will include impacts on flora, invertebrates, bats and birds as well as investigating prescribed burning prescriptions for heathlands. This will facilitate the continued improvement of the scientific basis of fire management and protection measures.

Issue: While Action Statements under the Flora and Fauna Guarantee Act have been completed for numerous species, they have not been completed for communities and threatening processes. The Flora and Fauna Guarantee Strategy has yet to be completed. The effectiveness of Action Statements and Recovery Plans needs to be better assessed, based on monitoring and research. (p59)

Response: Victoria is committed to the completion of Action Statements for threatened communities and threatening processes, but it must be recognised that this work needs to be prioritised with other Action Statements required under the Flora and Fauna Guarantee Act. Action Statements are currently in preparation for several communities and threatening processes. Victoria is also committed to the completion of the Flora and Fauna Guarantee Strategy and this is scheduled to occur by the end of 1997. Action Statements already include provisions for monitoring and research, and a standardised method of monitoring their implementation is in place. An example of the process for developing and implementing Action Statements, including provision for monitoring, is provided by past and continuing work on Leadbeater's Possum. Victoria has committed in the East Gippsland RFA to a Quality Assurance Program (QAP). This will identify feedback loops between the components of the forest management system.

Issue: There is a need for a systematic approach to the ongoing identification of Aboriginal cultural values, collaboration with Aboriginal communities to facilitate and increase their participation in natural resource management, improved liaison between Aboriginal Affairs Victoria (AAV) and the Department of Natural Resources and Environment in implementing

the Aboriginal and Archaeological Relics Act, and improved consultation with local Aboriginal communities in the preparation of Wood Utilisation Plans (WUPs) and the proposed siting of forest operations. (p60)

Response: The assessment work completed as part of the RFA process has provided good information on sites of Aboriginal cultural significance and this information has been included in an existing database maintained by AAV. Victoria has committed in the East Gippsland RFA to manage Aboriginal cultural heritage in accordance with a set of guidelines agreed between the governments and the Aboriginal communities and this should facilitate better communication and participation in natural resource management. The guidelines include a strategy for targeted survey of archaeological sites and a procedure for checking existing site data bases for archaeological values as part of forest planning. Forest Management Plans and Park Management Plans also commit the Department to better communication with local Aboriginal communities and this is already occurring in East Gippsland, particularly in relation to the development of WUPs and other forest operations. Regular meetings of the local communities, Departmental staff and AAV staff have been established.

Issue: Local government planning processes for assessing mining applications is slow and often more adversarial than the Environmental Effects Statement (EES) process, which tends to be more objective and rigorous, providing better opportunities for consideration of scientific evidence and differing views on the relative merits of a proposal. (p63)

Response: While the governments do not necessarily agree with this view, it is noted that major proposals in Victoria usually require an EES before they can proceed. The East Gippsland RFA also requires that an EES must be completed prior to any mining activity in the CAR Reserve System. It is envisaged that similar provisions will also apply in future RFAs.

Issue: The overall effectiveness of pest management is limited by the lack of strategic plans for pest plant and animal control that cover all tenures. Operational planning should provide for ongoing training and updating of field staff, and access to support materials. (p64)

Response: Strategic programs for pest plant and animal control covering all land tenures currently exist. For example, strategic rabbit control plans for the release of rabbit calici-virus (RCD) and follow-up control works using other methods; Statewide Good Neighbour Programs which coordinate pest plant and animal control on private property and adjoining public land; and pest plant and animal control programs within parks are developed in a regional context and in accordance with parks procedures. In relation to staff training, the Department has a comprehensive and individually based training program for its staff, especially in key areas such as fire protection and suppression, forest and park operations pest, plants and animal control, and flora and fauna management. These programs will continue.

Implementation

Issue: The Expert Group was unclear about whether the policy and regulatory functions associated with the management of parks and reserves can be separated between the parks program in the Department and the new Parks Victoria entity. (p67)

Response: The Victorian Government has established Parks Victoria as a service agency for the provision of park management services in Victoria. New legislation which clearly establishes the separate roles and functions of that organisation and the Department is in preparation. Fire management responsibilities will also be clearly defined in the new legislation.

Issue: Particular attention is needed to identify costs on a regional basis and to separate the costs of commercial and non-commercial activities. A focus on research into ESFM requires an ongoing commitment to funding. (p68)

Response: Departmental budgets are already prepared on a regional basis taking into account regional priorities and needs. Further separation into commercial and non-commercial activities or projects is achieved through allocation of funds to the head office business units. The Department commits significant funding to support ongoing research into land management. As part of this, the Forests Service has developed a three year rolling program of research (with a budget of \$1.5 million for 1997-98) focussed on ESFM in order to provide stability for projects extending beyond one year.

Issue: Better supervision of forest operations where protection of archaeological or heritage values is important. (p71)

Response: The Commonwealth and Victoria do not consider there is sufficient evidence to warrant this conclusion. Provisions currently exist to audit compliance with the Code of Forest Practices in relation to the protection of cultural values, and audits have not shown any significant problems. Cultural heritage experts within the Department are also involved in the development of WUPs and the establishment of appropriate buffers to protect identified values. The development of Guidelines for the protection of Cultural Heritage values should also assist in overcoming communication issues associated with cultural site protection and help avoid damage to sensitive sites.

Issue: Improvement is needed in the forthcoming review of fire protection plans to ensure that specialist peer review is generally undertaken. (p71)

Response: The Code of Practice for Fire Management on Public Land specifies that when preparing each fire protection plan 'the Department must involve its specialists in flora, fauna, parks, forestry, land and water protection and fire management'.

Issue: The lack of auditing processes for other Departmental operations is a weakness which should be addressed. In particular, there is a need to audit the extent of compliance of strategic and operational plans. (p72)

Response: The Commonwealth and Victoria consider that the key activities on public land are already subject to audit processes. An audit of the Code of Fire Practices on Public Land (CNR 1995d) is to be introduced. The implementation of strategic and operational plans such as the forest and park plans is already subject to regular review and reporting.

Issue: Up-to-date copies of key documents, for example, management prescriptions should be readily available to staff and other relevant parties. There is a need for a computerised database system to record forest operations in particular, to enable maintenance and updating of important datasets. (p72)

Response: A range of documents, including reports and management plans are readily available to staff and others on the Department's site on the internet. Additional documentation is located at offices. Much of the information collected as part of the RFA process and the Statewide Forest Resources Inventory (SFRI) is stored in GIS format and can be readily used in future planning and management. The establishment of GIS systems in regional centres, which will enable forest records to be stored digitally and be spatially referenced, is occurring progressively as resources and data collection permit. The RFA and Forest Management Planning processes provide significant opportunities for this program to be accelerated.

Issue: Staff training, especially in key areas such as fire planning and suppression activities, and in the area of cultural heritage protection is important. Long-term training strategies for individual staff and the retention and transmittal of corporate knowledge through ongoing documentation of procedures are very important as available resources decline. (p73)

Response: Both the Commonwealth and Victoria agree that these are important issues and resources are being committed to them to ensure that valuable information and expertise is retained or can be purchased from the private sector. Minimum standards for staff competencies have been established in key areas such as fire management and there is a focus on the preparation of important documents containing critical procedures, such as regional prescriptions. See additional comments in the Planning section above regarding staff training.

Issue: There is a need to promote good forestry practice on private land. (p74)

Response: This issue is already addressed in the Planning section above.

Information, Monitoring and Evaluation

Issue: Data collection, storage and updating of forest information needs to be improved in specific areas. (p78)

Response: These issues are being addressed through the RFA and SFRI processes in particular, and further information will be derived from the development and monitoring of sustainability indicators. The issue of socio-economic information has been addressed above. A database of visitor statistics is currently available for parks and priority reserves, and it is intended to extend this program and its scope as time and resources permit. Systematic surveys of pest plants and animals are undertaken in priority areas across the State and these provide input to the development of regional control programs. Updating of datasets concerned with Aboriginal and National Estate values will occur as new information becomes available. The Commonwealth and Victoria are both committed to maintaining databases for which they have responsibility. The SFRI and IFPS programs are being progressively implemented across the State and are scheduled for completion by the year 2000. As indicated above, GIS capacity in regional centres is being introduced progressively as resources permit. The Governments have also agreed to the development of a Data Agreement which is intended to address storage and updating of datasets, and to maintain them in the corporate NRE library.

Issue: Monitoring of implementation of park plans should commence as soon as possible and should be publicly available, along with actions to address any identified deficiencies. The monitoring of implementation of WUPs is hampered by the lack of an adequate coupe recording and tracking system. (p79)

Response: Implementation of park plans is undertaken through the development of Regional Action Plans which are prepared annually by Parks Victoria and are maintained in Regional offices. These are reviewed annually to ensure that implementation is proceeding in accordance with the specified outcomes. Coupe recording and tracking systems currently vary across the State. The Department is currently pursuing the development of a tool for delineating coupes on a GIS and ensuring consistency across the State, with the intention of introducing it progressively across Victoria from 1998.

Issue: There is a need to develop sustainability indicators in order to assess whether stated forest management objectives are being met. A detailed inventory of the Reference Area system is required, including an assessment of its representativeness, extent of replication and the degree to which it provides reliable examples of forests unaffected by humans. (p80)

Response: Both the Commonwealth and Victoria are committed to the development and implementation of sustainability indicators for the forested regions of Victoria. This commitment was made in the East Gippsland RFA. Research into key aspects of the forest management system, including the efficacy of buffers on streams, is currently underway. An inventory of the Reference Area system was undertaken by the Land Conservation Council as part of its Statewide Review of Public Land Use (LCC 1988) which was completed in 1988. That report is publicly available and covers the issues raised by the Expert Group.

Issue: There are no formal processes for auditing of compliance with some Departmental policies and plans. Periodic audits are necessary for these. Consideration should be given to increasing the transparency of audits by making the results publicly available, along with measures to address deficiencies, and by increasing the independence of the audit teams. Log grade audits should be published and consideration should be given to independent log grading procedures. Code audits should cover both public and private land. (p82)

Response: The issue of further audits of Departmental processes is dealt with earlier, as has the issue of Code audits on private land. Victoria has committed to publish future reports of internal audits of compliance with the Code of Forest Practices for Timber Production (NRE 1996b) as part of the East Gippsland RFA. Audit teams are drawn from people who are actively involved in the day-to-day implementation of the Code and are stationed outside the Region being audited. The Department currently has in place several procedures to ensure the independence and accuracy of log grading, including spot checks of logs in the forest and at sawmills. Other mechanisms are also being considered.

Review and Improvement

Issue: A process for reviewing the forest management components has not been formally developed. A process with appropriate reporting mechanisms, such as the 'State of the Forests Report' is required to ensure continuous review and improvement of the management system. Key elements of the system should be subject to more frequent peer review. (p83)

Response: The Commonwealth and Victoria consider that review and improvement mechanisms do exist in some areas of the management system, e.g. the Code of Forest Practices for Timber Production which has just been independently reviewed and adjustments made in the light of new information. In addition, the ESFM assessment conducted in Victoria for the RFA process used an environmental management system approach against which to report. Victoria considers that this framework is a useful model for subsequent reporting when used in conjunction with sustainability indicators consistent with the Montreal criteria.

Issue: In relation to research, there is a need for a stronger commitment to timely completion, appropriate peer review and publication. External peer review of research should be routinely sought and funding should be based on assessment of environmental threats. Formal processes are required to ensure that the most recent relevant research is used to assist in management decisions. A well-defined long term research program is needed. The Expert Group outlined the most critical areas for research and development. (p85)

Response: The basis of this issue is related to comments made by some groups in the community that the Department is not publishing some of its research because it has implications for current management. In fact, most of the documents of concern to community groups have not been published because they were in draft form and had not been reviewed by appropriate experts, both within and outside the Department. External peer review of research in the Department is regularly undertaken in order to ensure that research methodology and interpretation of results is appropriate and scientifically based. It would be very difficult for the Department to ignore published research when making management decisions, especially if the Department had conducted the research. The Forests Service

within the Department develops a three-year rolling plan of research matched by appropriate funding in order to provide certainty for projects beyond the current financial year. The research program is developed with input from a range of experts and is geared toward the improvement of forest management, consistent with ESFM goals. The Commonwealth and Victorian Governments are committed to research in key areas as part of the East Gippsland RFA and the next three-year rolling research plan will reflect those commitments. The areas of research are also consistent with those outlined by the Expert Group. The details of the research plan is publicly available and is accessible on the Department's internet site.

Table 16.1: Management System Structure and Criteria for Assessment of Ecologically Sustainable Forest Management.

| ASSESSMENT CRITERIA | CRITERIA* DESCRIPTION |
|--|---|
| System design to meet national principles of ecologically sustainable forest management | <p>The planning and management of native forests should:</p> <ol style="list-style-type: none"> 1. Maintain the full suite of forest values for present and future generations. 2. Maintain and enhance long-term multiple socio-economic benefits to meet the needs of societies. 3. Protect and maintain biodiversity. 4. Maintain the productive capacity and sustainability of forest ecosystems. 5. Maintain forest ecosystem health and vitality. 6. Protect soil and water resources. 7. Maintain forest contribution to global carbon cycles. 8. Maintain natural and cultural heritage values. 9. Utilise the precautionary principle for prevention of environmental degradation. <p><u>Notes</u></p> <ol style="list-style-type: none"> 1. These principles should be interpreted and applied in the context of the National Forest Policy Statement and other existing policy documents. 2. Definitions contained in the National Forest Policy Statement apply to these principles. 3. Planning and management of plantations should be consistent with the Ministerial Council for Forest Fisheries and Aquaculture document: Forest Practices Related to Wood Production in Plantations: National Principles. <p>* These criteria need to be applied at the appropriate ecological scales.</p> |
| Public transparency | <p><u>Scrutiny:</u> Type and level of scrutiny — parliamentary, administrative.</p> <p><u>Consultation:</u> Opportunity for public comment, individual stakeholder and group submissions, advisory group involvement in the process, information exchange, provision for feedback in consultation process.</p> <p><u>Access to information:</u> Process for access to information.</p> <p><u>Public involvement:</u> Opportunity for individual stakeholder or community groups to be involved in the decision-making process.</p> <p><u>Reporting:</u> Mechanism for reporting of processes and outcomes for all system criteria.</p> |
| Monitoring | <p><u>Trend measurements:</u> Process for assessment of change.</p> <p><u>Monitoring regimes:</u> Process for regular monitoring of indicators.</p> <p><u>Standards:</u> Process for designation of quantifiable measures against which the quality or performance of a characteristic or attribute is assessed.</p> <p><u>Performance targets:</u> Process for designation of specified goals.</p> <p><u>Performance verification:</u> Process for ensuring achievement of standards and targets.</p> |
| Compliance | <u>Audit arrangements, penalties, incentives:</u> Processes that ensure compliance with stated goals or objectives. |
| Scientific and technical basis | <p><u>Mechanism</u> for assessing adequacy of information (for example scientific/peer review);</p> <p><u>Process</u> for incorporation of information into decision making process.</p> |
| Review | <u>Mechanism</u> for review, feedback and continual improvement, internal/external, periodicity. |

Table 16.2: Forest Management Systems and Processes in Victoria

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| <p>1. LEGISLATION AND POLICIES International Treaties, Conventions and Initiatives Commonwealth Government Legislation National Policies State Legislation State Policies</p> <p>2. PLANNING <i>Strategic Planning</i></p> <ul style="list-style-type: none"> • Regional Forest Agreements • Land-use Planning — Public land <p><i>Forest Management Planning — Public Land</i></p> <ul style="list-style-type: none"> • Forest Management Plans (State Forest) • Victorian Code of Forest Practices • Regional Prescriptions • Sustainable Yield • Wood Utilisation Plans • Forest Coupe Plans • Log Grading <p><i>Park Planning</i></p> <ul style="list-style-type: none"> • Park Plans <p><i>Private Land</i></p> <ul style="list-style-type: none"> • Land-use Plans • Education and Cooperative Programs • Native Vegetation Retention Controls • Code of Forest Practices for Private Land • Waters of Victoria State Environment Protection Policy • Flora and Fauna Guarantee • Plantation Management • Private forestry strategy <p><i>Fire Management Planning</i></p> <ul style="list-style-type: none"> • Code of Practice for Fire Management • Regional Fire Protection Plans <p><i>Flora and Fauna Planning</i></p> <ul style="list-style-type: none"> • Flora and Fauna Guarantee • Recovery Plans | <p>2. PLANNING (continued) <i>Cultural Values</i></p> <ul style="list-style-type: none"> • Aboriginal Places • Historic Places <p><i>Exploration and Mining</i></p> <ul style="list-style-type: none"> • Environmental Effects Statements • Planning Permits • Work Plans • Environmental Review Committees <p><i>Other Plans</i></p> <p>3. IMPLEMENTATION <i>Accountabilities and Responsibilities</i> <i>Resourcing of Implementation Programs</i> <i>Operational Controls over Implementation Programs</i></p> <ul style="list-style-type: none"> • Control of timber harvesting in State forests • Control of fire management operations • Control of other activities in State forest • Control of operations in National Parks • Control of other operations on public land • Control of activities on private land <p><i>Documentation and Records Keeping</i> <i>Communication and Education</i> <i>Knowledge, Skills and Training</i></p> <p>4. INFORMATION MONITORING AND EVALUATION <i>Forest Information</i> <i>Monitoring Implementation of Plans and Programs</i> <i>Monitoring and Evaluating Condition of the Forest Environment</i> <i>Auditing of Compliance with Regulations and Controls</i> <i>Corrective Action</i></p> <p>5. REVIEW AND IMPROVEMENT Review of the Environmental Management System Research and Development</p> |
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APPENDIX 1. KEY LEGISLATION

The following list describes major legislation relevant to the Regional Forest Agreement. It is not intended to be an exhaustive list. A full list of legislation and international conventions relating to the RFA process is contained in the Victoria statewide assessment of ecologically sustainable forest management (VicRAFSC 1997b).

COMMONWEALTH LEGISLATION

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

This Act has a 1987 amendment, which applies directly to Victoria. It stipulates that all places of significance to Aboriginal communities, including places covered by the Victorian Archaeological and Aboriginal Relics Preservation Act, are to be protected. Such places may only be damaged or destroyed with the express permission of the relevant local Aboriginal communities.

Australian Heritage Commission Act 1975

The Australian Heritage Commission has a statutory obligation under this Act to identify the National Estate. The Commonwealth has an obligation to take into account the effect of its actions on the National Estate.

Endangered Species Protection Act 1992

This Act provides a legislative basis for Commonwealth responsibilities with regard to the conservation of endangered and vulnerable species and endangered ecological communities, and the amelioration of the processes that threaten them.

Environment Protection (Impact of Proposals) Act 1974

All Governments in Australia have statutory requirements for environment impact assessments. This Act requires Commonwealth decision-makers to refer to the Minister for the Environment decisions or actions likely to affect the environment to a significant extent.

Export Control Act 1982

Regulations under this Act provide the Commonwealth with a mechanism with which to impose environmental conditions on harvesting operations for the export of unprocessed wood and woodchips. In addition, it allows for the assessment of the potential for domestic processing.

World Heritage Properties Conservation Act 1983

This Act provides for the protection and conservation of those properties in Australia and its external territories that are of outstanding universal natural or cultural value. Such properties are those which:

- are inscribed in the World Heritage List; or
- are nominated for inscription on the World Heritage List; or
- are subject to an inquiry established by a law of the Commonwealth whose purpose is to consider whether the property forms part of the natural or cultural heritage; or
- form part of the natural or cultural heritage, and are declared so by regulation.
- The Act authorises the Commonwealth to prevent the damage or destruction of a property through the prohibition by regulation of prescribed activities. It does not enable the Commonwealth Government to assume responsibility for the management of a property.

VICTORIAN LEGISLATION

Archaeological and Aboriginal Relics Preservation Act 1972

This Act requires that all Aboriginal, archaeological and historic sites are protected. It is administered by Aboriginal Affairs Victoria, which maintains a register of known sites within Victoria.

Catchment and Land Protection Act 1994

This Act establishes an administrative framework for advising Government on the integrated management and protection of catchments on all land tenures across the State. It establishes processes to encourage and support community participation in the management of land and water resources through the establishment of a State-wide Catchment and Land Protection Board, ten regional Catchment and Land Protection Boards, and a Pest Animal Advisory Committee. The Act consolidates functions relating to the identification, proclamation and management of water supply catchments previously performed under the Land Conservation Act and its predecessor, the *Soil Conservation and Land Utilisation Act 1958*.

Conservation, Forests and Lands Act 1987

This Act formally transferred the responsibilities of a number of former statutory bodies to the (then) new Department of Conservation, Forests and Lands resulting from machinery of Government changes. This single, integrated public land management agency (and its successors) is responsible for the management and protection of the State's public lands including State forests (both native and exotic), National Parks and reserves, wildlife (including commercial fisheries) and other public lands, in addition to private land catchment protection functions.

The Act provides legislative backing for Codes of Practice which govern activities on public and private lands, under which the Code of Forest Practices for Timber Production and Code of Practice for Fire Management on Public Land have been developed. It also provides for the establishment of 'conservation covenants' on private land titles in order to protect important environmental values.

Country Fire Authority Act 1958

This Act consolidates the law relating to the Country Fire Authority and confers on the Authority a responsibility to prevent and suppress fire on all land (urban and rural), other than unoccupied Crown Land, outside the Melbourne Metropolitan Fire District.

Crown Land (Reserves) Act 1978

This Act provides for the reservation of Crown land for a variety of public purposes including flora and fauna conservation.

Environment Conservation Council Act 1997

The *Environment Conservation Council Act 1997* came into operation on 1 July 1997. This Act established the new Environment Conservation Council (ECC) and replaced the *Land Conservation Act 1970* and the Land Conservation Council (LCC).

The role of the ECC is to advise the Government on public land use planning and the balanced use or development of public land or any flora, fauna or minerals on, above or under that land or water flowing over that land. The new Council has a wider role than the former LCC, being able to advise on all natural resource matters, taking into account relevant issues that may impact on use of resources.

Previous recommendations made by the Land Conservation Council, most of which were approved by government, continue to have effect under the new Act.

Environment Effects Act 1978

This Act provides for the assessment of potential environmental impacts of proposed developments on land of all tenures. Major instruments and control mechanisms are Environment Effects Statements and ministerial Assessment Reports.

Environment Protection Act 1970

This Act establishes the Environment Protection Authority as an independent statutory body and provides it with powers, duties and functions on lands of all tenures concerning the protection of receiving environments (air, land and water), control of noise and pollution.

Extractive Industries Development Act 1995

The aim of this Act is to facilitate and streamline the planning and approvals processes on public and private lands for the removal of extractive materials (eg stone). Specifically, the purpose of the Act includes providing for a coordinated assessment and approvals process for extractive industries, and ensuring that operations are carried out with safe operating standards and in a manner that ensures the rehabilitation of quarried land to a safe and stable landform.

Fisheries Act 1995

The *Fisheries Act 1995* was fully proclaimed on 1 April 1998 and repeals the 1968 Act. This Act covers the Commonwealth/State management of fisheries, fishery management plans, regulation of commercial and recreational fishing, aquaculture, protected aquatic biota, noxious aquatic species, fisheries reserves, fisheries co-management, enforcement and legal proceedings. Under this Act, a licence is required to fish in inland waters including within forested catchments; and all public authorities must have regard to fishery management plans.

Flora and Fauna Guarantee Act 1988

This Act provides a legislative basis for the conservation of Victoria's flora and fauna on all land tenures. Major instruments include the listing of threatened species and communities and threatening processes, the development of Action Statements, controls over the taking, trading and keeping of native species, and the use of Interim Conservation Orders for the urgent protection of areas facing immediate threats.

Forests Act 1958

This Act provides for the management of State forests, protection of these and other public and private lands from fire, development of working plans and the licensed sale of forest produce. Through its licensing provisions and regulations, the Act also provides for control of the use of State forest. Under its powers for the making of regulations, the Timber Harvesting Regulations and associated forest operator accreditation and licensing have been implemented. These regulations provide the legislative basis on which provisions in the Code of Forest Practices for Timber Production (NRE 1996b) are implemented. The Forests Act requires that proper and sufficient work be carried out for prevention and suppression of fire in State forest, national parks and protected public land.

Forests (Wood Pulp Agreement) Act 1996

This Act guarantees AMCOR Plantations Pty. Ltd. with a supply of pulpwood for its pulp and paper mill at Maryvale until 2030. Logs are drawn from State forest in a supply zone that falls within Central Gippsland, Dandenong and Central Forest Management Areas. The annual

supply level is well within the forecast yields of residual logs resulting from sustainable sawlog harvesting in these areas.

Heritage Act 1995

This Act aims to provide for the protection and conservation of places and objects of cultural heritage significance and the registration of such places and objects. The Act establishes a Heritage Council and Victorian Heritage Register. The main function of the Heritage Council is to advise the Minister for Planning and Local Government on the state of Victoria's cultural heritage resources and to determine which heritage places and objects are added to the Victorian Heritage Register. Only items of special significance to the history and development of Victoria are added to the Register.

The Act also establishes the Heritage Inventory, which is a listing of all known historical archaeological sites in Victoria regardless of their level of significance.

Heritage Rivers Act 1992

This Act establishes a number of Heritage Rivers and Natural Catchment Areas on public land, where significant nature conservation, recreation, scenic or cultural heritage values have been identified. The Act specifies activities that are not permitted in these areas and requires that a management plan be prepared for each area.

Land Act 1958

This Act governs the alienation and use of unreserved Crown land, other than State forest, including the issuing of licences and leases for occupational use.

Land Conservation (Vehicle Control) Act 1972

The Act controls the movement of private motor vehicles on public lands, to prevent soil erosion and other environmental damage.

Land Titles Validation Act 1994

The purpose of this Act is to validate, in accordance with the *Native Title Act 1993* of the Commonwealth, past acts that are invalidated because of the existence of native title. It also provides for compensation rights for the holders of native title, which have been affected by past acts attributable to the State and to confirm certain existing rights.

Mineral Resources Development Act 1990

This Act aims to encourage an economically viable Victorian mining industry which makes the best use of mineral resources in a way compatible with the State's economic, social and environmental objectives. It provides for the granting of licences to explore and extract minerals. Three categories of public land have varying levels of exemption from mining activity.

National Parks Act 1975

This Act provides for the declaration and protection of national, wilderness, State and other parks. Its objectives are to protect the natural and cultural values of the State's system of parks, and to provide the community with opportunities for enjoyment, recreation, education and research. It also provides administrative procedures for the licensing and control of activities in parks, the preparation of management plans and creates the statutory office of Director of National Parks.

Planning and Environment Act 1987

This Act establishes a framework for integrating policies and environmental considerations into planning decisions affecting private lands across the State. It establishes a system of planning schemes with local, regional and State sections into which appropriate controls for the use, development and protection of land can be incorporated through instruments such as planning permits and landowner agreements.

The objectives of the Act include provision for the protection of natural resources and the maintenance of ecological processes and genetic diversity, and to conserve places of scientific, aesthetic or special conservation value. It requires ‘responsible authorities’ to administer and enforce planning schemes, under which applications for planning permits may be referred to other relevant authorities to stipulate permit conditions or the grounds for permit refusal.

Reference Areas Act 1978

This Act provides for the setting aside and management of ‘Reference Areas’ on public land. These are areas of special ecological and scientific interest or significance, which could serve as a baseline for comparative assessment of impacts of land uses elsewhere. Their use is largely confined to scientific study. A Reference Areas Advisory Committee advises the Minister on how the areas should be protected, controlled and managed. The aim is to ensure that ecological processes within them continue unhindered.

Victorian Conservation Trust Act 1972

This Act establishes the Trust for Nature (Victoria) to encourage and assist the preservation of areas of private land, which are of significant conservation value, and to assist in flora and fauna conservation. It provides for the establishment of ‘conservation covenants’ on private land titles in order to protect important environmental values.

Victorian Plantations Corporation Act 1993

This Act confers operational and administrative powers on the Victorian Plantation Corporation, a statutory corporation established under the *State Owned Enterprises Act 1992*. The Corporation is responsible for the management and protection of State-owned plantation timber resources, both hardwood and softwood.

Water Act 1989

This Act (and amendments) establishes rights and obligations in relation to water resources, provides mechanisms for the allocation of water resources (including to the environment), governs the statutory powers and functions of water authorities outside the metropolitan area and provides for integrated management of water resources for environmental and consumer protection.

Wildlife Act 1975

This Act provides for the establishment and management of State wildlife and nature reserves, licences, research and management, wildlife management cooperative areas, prohibited areas and sanctuaries, declaration of noxious wildlife, offences, enforcement and legal proceedings.

APPENDIX 2. MEMBERSHIP OF COMMITTEES

JOINT COMMONWEALTH-VICTORIA STEERING COMMITTEE

Victoria

| | |
|---------------------------|---|
| Gerard O'Neill (co-chair) | Department of Natural Resources and Environment (NRE) |
| Ian Miles | NRE |
| Andrew Maclean | NRE |
| Athena Andriotis | Department of Premier and Cabinet |
| Michonne van Rees | NRE |

Commonwealth

| | |
|-----------------------------|---|
| Belinda Robinson (co-chair) | Department of Prime Minister and Cabinet (PM&C) |
| Rhondda Dickson | Environment Australia (EA) |
| Tom Aldred | Agriculture Fisheries and Forestry – Australia (AFFA) |
| Catharine Masters | PM&C |

JOINT COMMONWEALTH-VICTORIA TECHNICAL COMMITTEE

Victoria

| | |
|---------------------------|-----------------------------|
| Andrew Maclean (co-chair) | NRE, Forests Service |
| Kylie White | NRE, Forests Service |
| Rod Anderson | NRE, Parks, Flora and Fauna |
| Chris Ashe | NRE, Parks, Flora and Fauna |
| Alison Boak | NRE, North East Region |
| Daniel Catrice | NRE, Parks, Flora and Fauna |
| David Clarke | Aboriginal Affairs Victoria |
| Sue Houlden | NRE, Forests Service |
| David Parkes | NRE, Parks, Flora and Fauna |
| Phil Roberts | NRE, Minerals and Petroleum |
| Michael Sutton | NRE, Forests Service |

Commonwealth

| | |
|-----------------------------|-----------------------------------|
| Geoff Dyne (co-chair) | EA, Environment Forests Taskforce |
| Dougal Morrision (co-chair) | AFFA, Forest Assessment Branch |
| Catharine Masters | PM&C, Forests Taskforce |
| Steve Watts | PM&C, Forests Taskforce |
| Pam Robinson | AFFA, Community Coordinator |
| Peter Connell | AFFA, ABARE |
| Ray Spencer | AFFA, BRS Forestry |
| Vanessa Hill | AFFA, Forest Assessment Branch |
| Yanis Mieztis | IRS, AGSO |
| Felix Schlager | EA, Environment Forests Taskforce |
| Juliet Ramsey | EA, Environment Forests Taskforce |

APPENDIX 3. DEFINITION OF SAWLOG GRADES

In Victoria all hardwood sawlogs other than River Red Gum and box-ironbark species must be graded in accordance with hardwood sawlog grading instructions and interpretations. The Hardwood Sawlog Grading Card (Jeremiah and Roob 1992) defines sawlogs by grades (A to D) as described below, and allows for some variation between grades by relative changes between diameter, number of defective quarters and size of pipe defect.

DEFINITION OF SAWLOG:

A sawlog is defined as any length of a log of merchantable species which:

- is at least 2.7 m in length
- has a small end diameter (measured under bark) of 25 cm or greater
- does not have sweep or crook which exceeds one-fifth of the diameter along a 2.4 m straight edge
- is of grade D standard or better

DEFINITION OF SAWLOG GRADE:

A Grade

Any sawlog with a minimum small end diameter under bark of 50 cm which has no defective quarters and maximum defects on exposed ends of:

- one-quarter diameter lengths of all gum vein or gum pockets
- light stain

In addition:

- maximum angle of sloping grain of 1:10 along the length of the sawlog

B Grade

Any sawlog with a minimum small end diameter under bark of 35 cm which has maximum allowable defects on exposed ends of:

- one quarter diameter length of loose gum veins/pockets and shakes
- one diameter length of tight gum vein more than 3 mm in width
- two diameters length of tight gum vein less than 3 mm in width
- light stain

In addition:

- 1:10 angle of sloping grain along the sawlog axis
- a maximum of one defective quarter along the length of the sawlog
- a maximum of 105 cm squared of pipe in an exposed end.

C Grade

Any sawlog with a minimum small end diameter under bark of 30 cm which has maximum allowable defects on exposed ends of:

- one diameter length of loose gum veins/pockets and shakes
- seven diameters length of tight gum vein more than 3 mm width
- unlimited lengths of tight gum veins less than 3 mm width

- dark stain

In addition:

- maximum sloping grain angle of 1:8 along the length of the sawlog
- maximum of two defective quarters
- maximum of 112 cm square of pipe in an exposed end

D Grade

Any sawlog with a minimum small end diameter under bark of 25 cm which has maximum allowable defects on exposed ends of:

- two diameters length of loose gum veins/pockets or shakes
- 10 diameters length of tight gum vein more than 3 mm width
- unlimited length of tight gum vein less than 3 mm width
- dark stain

In addition:

- maximum sloping grain angle of 1:8 along the length of the sawlog
- maximum of three defective quarters
- maximum of 120 cm square of pipe on exposed ends

APPENDIX 4. GEOLOGICAL AND MINERALISING EVENTS

Table 1a: Glenelg Zone — Summary of Geological and Mineralising Events

Table 1b: Stawell, Bendigo-Ballarat and Melbourne Zones; Otway and Murray Basins — Summary of Geological and Mineralising Events

**APPENDIX 5. POTENTIAL MINERAL RESOURCES
ASSESSMENT SUMMARY DESCRIPTIONS**

| Deposit type | Summary description of mineral tracts |
|---|--|
| Heavy Mineral Sands | The tract is based on the distribution of the late Miocene to early Pliocene Loxton-Parilla Sands in the Murray Basin. The tract includes strandline type heavy mineral deposits (high potential) and for flat-lying fine-grained WIM150 style deposits (moderate potential). Including the part within the region is currently under intense exploration for strandline type deposits. Numerous strandline and WIM150 type of heavy mineral deposits are present in the region within the tract. |
| Slate belt gold | The tracts are based on the distribution of Cambrian and Ordovician turbidites (and their metamorphic equivalents) in metasedimentary rocks and Cambrian and Devonian granitoids (in places overlain by younger sediments). Structural features and known gold occurrences define areas with higher potential. The tract contains most of primary gold occurrences and the potential of rocks in the Stawell and Bendigo-Ballarat zones is higher than those in the Melbourne zone because the former Glenelg zone rocks are more intensely metamorphosed and did not see orogenies equivalent of those in the Lachlan Fold Belt. Granitoids in the Stawell are younger than the slate belt mineralisation hence they are not included in the tract. |
| Disseminated gold | The tract is based on the distribution of the same rock suites as for slate belt gold. These rocks are favourable for the potential to form haloes of disseminated and stockwork gold mineralisation around mineralised veins. |
| Epithermal gold and silver | The tracts are based on the distribution of subaerial intrusive/extrusive complexes, the presence of calderas/ring faults and associated propylitic, chloritic, sericitic and argillic alteration. The tracts include Early Devonian Rocklands Volcanics in the Mount Macedon Complex in the Ballarat Zone. |
| Porphyry copper-gold | The tract is based on the distribution of I and S-type, relatively magnetic and oxidised granitoids of Cambrian, Devonian and Tertiary wall-rock alteration, geochemical anomalies and the presence of mineral prospects having features similar to porphyry systems. Also included where the aeromagnetics suggest that magnetic granitoids are present at shallow depths. |
| Volcanic massive sulphide base metal and gold silver deposits | This tract of highest mineral potential delineate areas of Cambrian metabasalts, gabbro and sediments in the Stawell Belt. It includes volcaniclastics deposited in a marine environment west of the Stawell Belt and also east of the belt near the Melbourne zone. |
| Tin veins | These tracts include granitoids which are felsic, fractionated, non-magnetic, S-type or I-type, that may have associated tin mineralisation. Granite, Trawalla Granite and Rocklands Rhyolite. The Rocklands Rhyolite is included in the tract because these are similar to the Mexican tin deposits. |
| Brown and black coal | The tract of high potential overlies the extent of known economic brown coal at Anglesea. The tract of moderate potential includes Bacchus Marsh-Altona Basin, parts of the Eastern View Formation outside the Anglesea Formation, Lal Lal Basin and parts of the Bacchus Marsh-Altona Basin coalfield. The tract of moderate potential also includes the Eumeralla Formation throughout the region. Moderate potential for brown coal include the Demons Bluff Formation and the Dilwyn Formation. |

There is also potential for other deposit types as follows:

- alluvial gold deposits in Tertiary and Quaternary sediments, including gold bearing conglomerates in the Grampians, with potential for deep lead gold near primary slate belt and disseminated gold deposits;
- tungsten-molybdenum vein deposits in fractionated but relatively oxidised granitoids and adjoining sediments;
- dimension stone in various granitoids and other rock types in the region;
- deposits of limestone associated with Tertiary and Quaternary limestone units including the Jan Juc Formation, the Port Campbell Limestone and the Whalers Bluff Formation;
- silica sand deposits in the Tertiary units in the Otway Basin (Wiridjil Gravel, Moomowroong Sand and the Dilwyn Formation); the Tertiary Werribee Formation in the Bacchus Marsh area and the Malanganee Sand in the southwestern part of the region.
- residual kaolin deposits in weathered feldspar rich rocks and transported kaolin in areas of Tertiary and Quaternary sediments;
- construction materials where suitable rock materials occur within viable transport distances of population centres and transport routes.