

CENTRAL HIGHLANDS

COMPREHENSIVE REGIONAL ASSESSMENT REPORT

June 1997

**Prepared by officials to support the Central Highlands Regional Forest
Agreement process.**

FOREWORD

This report describes the Comprehensive Regional Assessment (CRA) that has been undertaken in Victoria's Central Highlands Regional Forest Agreement (RFA) region.

The CRA has examined the natural, cultural, social, resource and economic values in the forests of the Central Highlands. This involved detailed assessments of biodiversity, old-growth forest, national estate, wilderness, world heritage, social values, forest resources and the forest based industries and ecologically sustainable forest management.

Following the release of this CRA report, meetings with the local community and interest groups will be held to discuss the documentation and its implications, and to consider the issues that will need to be addressed in the RFA. Following consultation with the local community and interested groups, this assessment will provide a basis for the Victorian and Commonwealth Governments to develop a Regional Forest Agreement.

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

EXECUTIVE SUMMARY

The Comprehensive Regional Assessment (CRA) of the Central Highlands of Victoria brings together a wide range of studies conducted in recent years, as well as research conducted specifically for the CRA. It provides information required for the development of a Regional Forest Agreement (RFA).

The natural and cultural studies undertaken for the CRA are biodiversity, old-growth forest, wilderness, national estate and world heritage. The resource and economic studies focus upon forest management, timber production and other forest products, recreation and tourism, plantation potential, water and minerals. These studies are also underpinned by a social assessment.

The Region

The Central Highlands RFA Region lies immediately to the north and east of the Melbourne metropolitan area and extends to Seymour and Lake Eildon in the north, the Hume Freeway in the west and Baw Baw National Park and Moe in the east. Townships within the region include: Lilydale, Toolangi, Healesville, Marysville, Alexandra, Eildon, Kinglake, Whittlesea, Woods Point, Warburton, Powelltown, Noojee, Erica/Rawson, Neerim South and Warragul.

The region covers a little over one million hectares, about half of which is private land used mainly for agriculture. The other half is public land and, by contrast with private land, is mostly native forest. About one third of this public forest is in reserves of various types, and the remainder is mostly State forest.

Forest Management

The objective of forest management on public land is to conserve natural and cultural values whilst providing economic benefits for the community. Activities in State forest are undertaken consistent with State-wide, regional and local planning and regulatory mechanisms, including:

- the Code of Forest Practices for Timber Production and operator licensing arrangements;
- a forest management planning process which applies a zoning scheme to protect biodiversity and other forest values as well as the identification of areas where timber production is a high priority;
- Wood Utilisation and Coupe Harvesting Plans; and
- legislated regional sustainable yield.

The methodology for determining sustainable yield forecasts has been appraised and found to be satisfactory. Victoria is undertaking a Statewide Forest Resource Inventory for the region, the results of which will be available by the next review of sustainable yield in 2001. This will improve the level of knowledge about sustainable yield in the region.

Wood Based Industries

The Central Highlands represents a significant native hardwood resource for the wood based industries, accounting for 33 per cent of total sawlog production and 57 per cent of total pulplog production from Victorian State forests in 1995-96. The Central Highlands region contributed around \$11.9 million in log royalties in 1995-96, or 48 per cent of total log royalties received by the Victorian Government in that year.

The Central Highlands provides high quality hardwood resources which support a range of sawmilling and pulpwood processing industries which are located both within the region and beyond. These hardwood resources support an estimated 1537 direct jobs, including jobs associated with forest management, pulp and paper manufacturing, sawmilling and logging and haulage.

There are 41 sawmills and four major domestic pulpwood processors receiving hardwood resources from the Central Highlands. Hardwood sourced from the Central Highlands is estimated to account for around \$232 million in product output from the pulpwood processing industries, together with a further \$91 million in product output from the sawmilling industry.

The wood based industries receiving hardwood resources from the Central Highlands also contribute to further economic activity and jobs throughout Victoria. It is estimated that these wood based industries contribute 3830 direct and indirect jobs, and \$731 million in State output across the Victorian economy.

Plantations

Plantations can contribute significantly to the regions wood supply, particularly as an additional source of pulpwood and small sawlogs for industry. They can also contribute to regional economic development and provide substantial environmental and agricultural productivity benefits to landholders and the broader community.

The existing plantation estate in the region is 10 320 ha and the CRA has identified that there is potential for this estate to be expanded on private land although such decisions will be made by individual landholders.

Other Forest Products

State forests supply a range of produce and benefits in addition to sawlogs and pulplogs, tourism and recreation and water production, including:

- posts and poles, firewood and specialty timbers
- grazing
- apiculture
- tree-ferns

These activities are licensed and supervised by NRE.

Tourism and Recreation

Tourism activities are also an important part of the regional economy of the Central Highlands:

- in 1995 the region received approximately 764 600 day visitors and 1.8 million visitor nights;
- expenditure in the region by Australian and international visitors is estimated to have been about \$97 million in 1995; and
- sixty-three per cent of visitors to the Central Highlands in 1995 were visiting the region for pleasure or holiday.

Forests contribute significantly to regional tourism and recreation, providing a wide range of opportunities while conserving the natural environment. The region's State forests attract around 850 000 visitors each year and have some of the highest usage of any State forests within Victoria. In 1995-96, almost 3 million people visited the region's National and State parks. The Dandenong Ranges National Park has the third highest visitation rate of all national parks in the State.

Water

The catchments of the Central Highlands contribute all of the water supply for Melbourne and are a significant source rural and urban water supplies in the Goulburn, Latrobe, Yarra and West Gippsland regions. The streams and catchments of the Central Highlands also have significant ecological, heritage and tourism and recreation values.

Approximately fifty percent of Melbourne Water's catchments are covered with ash eucalypt species:

- several of the Melbourne Water Supply Catchments are included in the Yarra Ranges National Park where timber harvesting is not permitted;
- a range of uses such as water production, recreation and timber production are permitted under certain conditions in water supply catchments within State forest such as in the Yarra tributaries and in the Tarago and Thomson catchments; and
- water quality is generally high, and these catchments provide a reliable supply of safe, high quality drinking water that consistently meets national guidelines.

In State forest water quality is managed through a range of techniques that limit opportunities for soil or high energy water flows to directly enter drainage lines. Provisions in the Code of Forest Practices for Timber Production are designed to maintain catchment values, in particular water quality and quantity. Other provisions in the forest management plan also place limits on the timing and extent of timber harvesting in various water supply catchments to ensure that water quality and yield are maintained.

Minerals

The region is an important supplier of construction materials and other industrial mineral commodities, has a long history of mining and contains a number of known mineral deposits. There are 41 operating quarries in the region supplying a wide range of industrial, construction and agricultural uses.

The Central Highlands is part of a major gold province and is estimated to have produced about 11% of Victoria's gold production. The region is also prospective for a number of deposit types, including:

- high potential for slate-belt gold and some construction materials over most of the Central Highlands, with small tracts of high potential for brown coal in the southeast of the region, and
- moderate to high potential for disseminated gold, epithermal gold, nickel-copper, secondary deposits of kaolin, and higher value construction materials.

Social

The social assessment provides a social profile of the regions population of around 300,000 and its townships and communities. New research for the social assessment included a survey of 1100 people in the region, workshops with community and interest groups, case studies and demographic data analysis. The social assessment process has provided communities and other stakeholders the opportunity to present their views and opinions in an open and neutral forum. They are keen to have a voice in determining how forest resources are used and managed and their views will provide an important input to decisions about the Central Highlands RFA.

The assessment indicates that communities in the region are self-reliant and committed and also have a clear vision for their future. Social cohesion within the communities is also very high. The region is seen to afford a quality of life which is unattainable in urban areas. Residents value the safety of rural areas, the friendliness of the people and the beauty of the surrounding environment. Communities and other stakeholders consider a range of values to be important in relation to forest use.

Biodiversity

The biodiversity assessment is based on a study of forest ecosystems and communities (ecological vegetation classes), flora and fauna species and their habitats, the potential threats to these in the region and the management arrangements that are in place to address those threats.

The region is of significant interest because of the diversity and pattern in its vegetation and faunal communities. Forty ecological vegetation classes (EVCs) have been identified in the Central Highlands. An assessment of the pre-1750 distribution of forest EVCs shows that they are all currently represented in the reserve system. Twenty EVCs are now recognised as rare, endangered or vulnerable. This group includes a wide variety of types such as grasslands, rocky outcrop shrubland, valley heathy forest, box woodland, riverine forest and granitic hills woodland. For many, this status is connected with past land-use, in particular, clearing for agriculture and most occur largely on private land.

The biodiversity assessment also provides detailed information about 67 plants of conservation significance, including factors that may predispose them to decline or extinction, potential threats and management actions in place to mitigate those threats.

Information about 33 species of mammals, reptiles, birds and frogs and 15 flora species that are listed under Commonwealth or State legislation as being threatened is provided in the CRA Report. The Central Highlands contains the only known populations of Leadbeater's possum, an endangered species with complex habitat requirements. The Baw Baw frog is also confined to the Central Highlands, where it occupies a restricted range at higher elevations. The region also provides important habitat for a number of large forest owls.

Old-growth Forest

The 1939 wildfires killed large areas of ash forest in the Central Highlands. Consequently, old-growth forest occurs usually in small and scattered patches across the region. Of the 40 ecological vegetation classes identified in the Central Highlands, 16 contain old-growth forest. Old-growth forest covers about 26 000 hectares or about 4.5% of the 600,000 hectares of native vegetation in the study area and over 90% of it is protected.

Wilderness

A study of wilderness quality in the Eastern Victorian forests (east of the Hume Freeway) found that there is no area of high wilderness quality which meets the national reserve criteria in the Central Highlands region.

National Estate

The national estate assessment completed in 1993 has explored a wide range of natural and cultural heritage values. The 1939 fires in the Central Highlands have had a major influence on natural values and the cultural values of people currently living in the region. While there are no tangible historic features left from the fires, a number of fire disaster sites have a strong association with community memory and meaning. The 1939 fires burnt considerable areas of the region and natural landscapes identified in the study are largely confined to the Yarra Ranges National Park.

Other natural values identified included refuges from climatic change, relict species and remnant vegetation. There are a number of threatened species in the region, including Leadbeater's Possum and the Helmeted Honeyeater, the States faunal emblems.

A number of Aboriginal places were identified in the study, these have traditional and historic associations such as hunting and gathering places, missions and reserves, massacre sites and pastoral properties. The nature of the forest areas and their past remoteness and difficulty of access are highlighted in the national estate assessment. One of the most outstanding areas considered was the Rubicon Forest with its sawmills, including the innovative Clark and Pearce No. 1 mill. This typifies bush sawmilling in Victoria's mountains, with isolated and temporary sawmill settlements

deep in the forest, serviced by tramways which linked up to the Victorian railway system.

World Heritage

Two possible World Heritage themes have been identified as potentially represented in the Central Highlands - Australian marginal swells associated with the Eastern Highlands and areas with outstanding relevant examples of Eucalyptus-dominated vegetation. An assessment of the possible representation of these themes in the Central Highlands will be undertaken in a broader context which covers other parts of Victoria and other states.

ESFM

Ecologically Sustainable Forest Management (ESFM) is 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.

An Independent Advisory Group assessed the systems and processes for delivering ESFM in the East Gippsland RFA. Following its completion, 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. Consequently the Steering Committee agreed to a Statewide ESFM assessment, using as much information as possible from the East Gippsland work. The assessment was then independently peer reviewed by Professor Ian Ferguson of the University of Melbourne.

The report examines and assesses the systems and processes underpinning the delivery of ESFM in Victoria. The assessment 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 nationally agreed performance indicators or benchmarks for ESFM.

Given that the assessment is based on the findings of an independent panel and an assessment of Statewide practices which was independently peer reviewed, it does not necessarily reflect the views of the Steering Committee. The Steering Committee will consider the assessment in the development of the Central Highlands RFA.

CONTENTS

FOREWORD

EXECUTIVE SUMMARY

1	BACKGROUND TO THE RFA PROCESS	1
1.1	Introduction	1
1.2	Legislative and Policy Framework for the RFA Process	1
1.3	The RFA Process in Victoria	4
2	THE CENTRAL HIGHLANDS REGION	7
2.1	Location	7
2.2	Landscape and Climate	7
2.3	Size and Tenure	7
2.4	Population	8
2.5	Regional Economy of the Central Highlands Region	8
2.6	History of the Central Highlands Forests	11
2.7	Land Classification	14
2.8	Management Arrangements	15
3	FOREST MANAGEMENT AND RESOURCE UTILISATION	16
3.1	State Forest Management	20
3.2	Silviculture	23
3.3	Fire Planning and Management	24
3.4	Forest Research	24
3.5	Monitoring, Review and Reporting	24
4	MANAGING FOR TIMBER PRODUCTION	25
4.1	Forest Type, Extent and Merchantability	25
4.2	Legislative and Policy Framework for Sustainable Yield	27
4.3	Sustainable Yield in the Central Highlands	29
4.4	Appraisal of Sustainable Yield Methodology	33
4.5	Future Approach Using IFPS and SFRI	34
4.6	Residual Logs	36
5	TIMBER INDUSTRY CURRENT POSITION OUTLOOK	38
5.1	Structure and Value of the Hardwood Timber Based Industries	38
5.2	Sawmilling Industry Survey	47
5.3	The Hardwood Sawntimber Industry	47
5.4	The Pulpwood Processing Industry	51
5.5	International and Domestic Forest Product Market Outlook	54
5.6	Industry Development Opportunities	56
6	PLANTATIONS	59
6.1	Introduction	59
6.2	Policies, Programs and Initiatives	59
6.3	Current Resource	63
6.4	Plantation Potential	63

6.5	Plantation Options	65
7	OTHER FOREST PRODUCE	67
7.1	Management	67
7.2	Profile of Existing Supply, Usage and Demand	68
7.3	Outlook and Development Opportunities for Other Produce	71
8	TOURISM AND RECREATION	73
8.1	Introduction	73
8.2	Overview of Tourism And Recreation in the Central Highlands	74
8.3	Tourism and Recreation on Public Land in the Central Highlands	76
8.4	Economic Value of Tourism in National Parks and State Forest	79
8.5	Demand for Tourism and Recreation in Forests	80
9	WATER AND CATCHMENTS	81
9.1	Introduction	81
9.2	Water Resources in the Central Highlands	81
9.3	Water Usage from the Central Highlands	85
9.4	Legislative and Policy Framework	88
9.5	Issues for Water Management	96
10	MINERALS AND EXTRACTIVES	108
10.1	Introduction	108
10.2	Known and Potential Mineral and Extractive Resources	108
10.3	Current Exploration, Mining and Extraction Activities and Potential Economic Value	114
10.4	Legislation and Land Access	119
11	SOCIAL	124
11.1	Introduction	124
11.2	Stakeholder Views	126
11.3	Social and Economic Structure	127
11.4	Community Attitudes and Values	128
11.5	Community Case Studies	131
12	BIODIVERSITY	134
12.1	Introduction	134
12.2	Methods used in Biodiversity Assessment	135
12.3	Data Review for Terrestrial Species	137
12.4	Forest Ecosystem Assessment	139
12.5	Flora Species Assessment	150
12.6	Terrestrial Fauna Species Assessment	162
12.7	Aquatic Fauna Species Assessment	180

13	OLD GROWTH	185
13.1	Introduction	185
13.2	Vegetation Classes	187
13.3	Forest Age	187
13.4	Forest Disturbance	189
13.5	Analysis of Data and Results	191
14	WILDERNESS	196
14.1	Introduction	196
14.2	Data	196
14.3	Methods	196
14.4	Results	197
14.5	Conclusion	197
15	NATIONAL ESTATE	198
15.1	Introduction	198
15.2	Data Review	199
15.3	Consultation Process for National Estate Assessment	203
15.4	Summary of the National Estate Assessment	204
15.5	The Protection and Management of National Estate Values in the Central Highlands	207
15.6	Conclusion	209
16	WORLD HERITAGE	215
16.1	Methodology	215
16.2	Assessment	216
16.3	Outcomes	216
17	ECOLOGICALLY SUSTAINABLE FOREST MANAGEMENT	221
17.1	Introduction	221
17.2	Summary of Assessment	225
17.3	Overall Appraisal	233
	REFERENCES	237
APPENDICES		
Appendix 1	Key Legislation	246
Appendix 2	Membership of Committees	251
Appendix 3	Definition of Sawlog Grades	252
Appendix 4	Potential Mineral Resources Assessment Summary	254
Appendix 5	Summary of Geological and Mineralising Events	255

LIST OF TABLES

Table 2.1	Central Highlands and Victorian gross state product by major industry (1995-96 dollars)
Table 2.2	Number of residents employed in the Central Highlands and Victoria, by industry
Table 3.1	Extent of Forest Management Zones and other land categories in the Central Highlands
Table 3.2	Current and potentially available silvicultural treatments identified for the Central Highlands
Table 4.1	Net productive area for commercial forest types in the Central Highlands Region (ha)
Table 4.2	D+ net MAI ($\text{m}^3/\text{ha}/\text{yr}$) by Forest management area
Table 4.3	Legislated Sustainable Yields of Sawlogs (m^3/year)
Table 4.4	1990 Legislated Sustainable Yields of Sawlogs (m^3/year)
Table 4.5	C+ net MAI, by Forest Management Area ($\text{m}^3/\text{ha}/\text{year}$)
Table 5.1	Key economic features of the timber based industries drawing hardwood resources from the Central Highlands, 1995-96
Table 5.2	Total forestry and wood based industry employment resident in the Central Highlands RFA region, 1991
Table 5.3	Gross volume of logs received from Central Highlands region, 1995-96
Table 5.4	Royalties received from Central Highlands region, 1995-96
Table 5.5	D+ sawlog yield estimates for the Central Highlands, by forest type, 1997-2006
Table 5.6	Log harvesting and transport contractors operating in the Central Highlands region, 1995-96
Table 5.7	Key financial features of sawmills drawing hardwood resources from the Central Highlands, by category of sawmill product, 1995-96
Table 5.8	Intake for sawmills drawing hardwood resources from the Central Highlands, 1995-96
Table 5.9	Production of sawmills drawing hardwood resources from the Central Highlands, 1995-96
Table 5.10	Sawntimber production shares from D+ logs, by mill size, 1995-96
Table 5.11	Current and anticipated Central Highlands sawntimber production and major markets
Table 5.12	Uses of Central Highlands pulplogs and sawmill residues, 1995-96
Table 5.13	Hardwood availability in the Central Highlands ($'000 \text{ m}^3$ per year)
Table 7.1	Central Highlands other forest produce royalty revenues (1995-96 dollars)
Table 7.2	Central Highlands beekeeping production values, 1994
Table 8.1	Central Highlands visitor characteristics, 1995
Table 8.2	Visitor activities in the Central Highlands, 1995
Table 8.3	Visitors to major sites in the Central Highlands
Table 8.4	Parks in the Central Highlands managed under the National Parks Act 1975
Table 9.1	Mean annual streamflow of river basins
Table 9.2	Mean annual discharge, maximum and minimum monthly discharge for selected watercourses in the Central Highlands

Table 9.3	Major surface water storages within the Central Highlands
Table 9.4	Catchments within the Central Highlands region, shown as in Map 9.1
Table 9.5	Water use within the river basins (excluding Melbourne Water Supply system)
Table 9.6	Special Water Supply Catchment Areas in the Central Highlands
Table 10.1	Summary of potential mineral resources as at November 1996
Table 10.2	Total mineral exploration expenditure, Central Highlands
Table 10.3	Expenditure on mining licences in the Central Highlands
Table 10.4	Gross revenue and direct employment, Nagambie Gold Mine
Table 10.5	Land use categories as a proportion of total land area, Central Highlands
Table 11.1	Summary of issues raised by groups with economic dependency on forest use
Table 12.1	Proportion of flora sampling density classes for the Central Highlands region
Table 12.2	Terrestrial vertebrate fauna survey data by species group
Table 12.3	Representative conservation (percentage reservation status) of EVCs in the Central Highlands region based on pre-1750 vegetation mapping
Table 12.4	Geographic Representation Units in the Central Highlands region
Table 12.5	Representative conservation (percentage reservation status) of EVCs in the Central Highlands region by Geographic Representation Unit
Table 12.6	Extent and level of protection for different forest growth stages and disturbance categories in the Central Highlands region
Table 12.7	The National Forest Reserve (JANIS) criteria used to assess the conservation status of EVCs
Table 12.8	Endangered, vulnerable and rare Ecological Vegetation Classes in the Central Highlands, their percent reservation in the region, threatening processes, and current management actions to address threats
Table 12.9	Current management responses for threatening processes that affect forest ecosystems
Table 12.10	Central Highlands plant species listed under the FFG Act and/or ESP Act
Table 12.11	Plant groupings of conservation significance in the Central Highlands
Table 12.12	Summary of life history and population dynamics information for species occurring in the Central Highlands which are listed under the FFG Act and/or ESP Act
Table 12.13	Tenure categories of the largest and next largest proportion of population for Central Highlands plant species listed under the FFG Act and/or the ESP Act
Table 12.14	Threatening processes affecting flora, potential impacts and regional significance
Table 12.15	Terrestrial fauna species included in the assessment
Table 12.16	Summary of life history and population dynamics information
Table 12.17	Proportions of species records in reserves, non-reserve areas and partially reserved areas
Table 12.18	Impacts of threatening processes on priority fauna species
Table 12.19	Aquatic fauna species occurring in the Central Highlands and

	listed under the Victorian <i>Flora and Fauna Guarantee Act 1988</i> and/or the Commonwealth <i>Endangered Species Protection Act 1992</i> and/or on the Threatened Fauna of Victoria list
Table 12.20	Broad disturbance category with potentially significant impacts on aquatic ecosystems
Table 13.1	Assignment of old-growth forest status
Table 13.2	Representation of old-growth in conservation reserves and forest management zones
Table 13.3	Area and protection of old-growth in geographic representation units
Table 14.1	Summary of protection of areas of high wilderness quality within the eastern Victorian forests
Table 16.1	Summary of World Heritage themes, subthemes and places in Victoria warranting further investigation
Table 17.1	Management System Structure and Criteria for Assessment of Ecologically Sustainable Forest Management
Table 17.2	Forest management systems and processes in Victoria

LIST OF FIGURES

Figure 1.1	The RFA Development Process
Figure 2.1	Proportion of public land in forest management zones and conservation reserves
Figure 5.1	Central Highlands forest resource and mill locations
Figure 5.2	Current structure of the forest industry in the Central Highlands
Figure 5.3	Distribution of employment in sawmills receiving logs from the Central Highlands, by processing capacity
Figure 6.1	Plantation options: Scale and Purpose
Figure 9.1	Relationship between forest age and water yield in Ash forests of the Central Highlands
Figure 10.1	Construction materials, quarries, occurrences and interest areas
Figure 10.2	Land tenure and exploration licences
Figure 10.3	Relationship between levels of resource potential and levels of certainty
Figure 13.1	Relationship between the typical eucalypt growth stages described by Jacobs and those considered by the Central Highlands old-growth study

LIST OF MAPS

Map 1	Land Tenure and Forest Management Zones
Map 1A	Land Tenure and Forest Management Zones (A3 format)
Map 2	Ecological Vegetation Classes - Current Extent
Map 3	Pre-1750 Extent - Ecological Vegetation Classes
Map 4	Old-growth Forest
Map 5	National Estate Values
Map 6	Commercial Forest Types
Map 9.1	Water Supply Catchments
Map 10.1	Surface Geology
Map 10.2	Mineral Occurrences
Map 10.3	Composite Mineral Potential
Map 10.4	Cumulative Mineral Potential
Map 11.1	Location of the five regional sectors

- Map 11.2** 'The area in which I live is very dependent on the timber and logging industry'
- Map 11.3** 'I sometimes feel torn between the need for jobs and the need to preserve native forest areas in Victoria'
- Map 11.4** 'During the last year have you or your family visited areas of native forest in Victoria?'
- Map 11.5** 'Would you like to see new industries develop in your area?'
- Map 12.1** Environmental Stratification

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 a long term solution to this issue.

The NFPS sets out the process for undertaking joint Commonwealth and State Comprehensive Regional Assessments of natural, cultural, economic, and social values of Australia's forests. These assessments will form the basis for the negotiation of Regional Forest Agreements between the Commonwealth Government and the State Governments. Regional Forest Agreements will encompass:

- the establishment and management of a forest reserve system which is comprehensive, adequate and representative,
- ecologically sustainable management of the forest estate, and
- development of an efficient, internationally competitive timber industry.

RFAs are agreements between the States/Territories and the Commonwealth and recognise the range of economic and environmental obligations which each tier of government has regarding the long term management and protection of forest values in specific regions. 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 and wilderness through a CAR reserve system and complementary off-reserve management.

A central aim in the RFA process is to recognise and consider the full range of forest values when making forest resource use decisions. This reflects the need to consider both benefits and costs when making policy or resource use decisions.

The detailed information required to negotiate each RFA is drawn together through a CRA of the full range of forest values of a region. CRAs are conducted on a regional basis, with the regions being agreed by the Commonwealth and each State respectively. East Gippsland was the first region within Australia to have a completed CRA and RFA. The major steps in the RFA process are shown in Figure 1.1, and are described in more detail in the next section.

1.2 LEGISLATIVE AND POLICY FRAMEWORK FOR THE RFA PROCESS

There is a range of legislative obligations and policies at the Commonwealth and State level that form the framework for the RFA process. RFAs are intended to recognise and meet the legislative obligations and policies of both Governments.

The National Forest Policy Statement (NFPS)

The NFPS defines the policies of State and Commonwealth Governments in relation to the RFA process and its objectives. 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 the following:

- 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; and
- research and development; and international responsibilities.

National Reserve Criteria

Following signing of the NFPS, an intergovernmental Technical Working Group on Reserve Criteria was established in 1993 to draft the national criteria required by the NFPS, under the Joint Australian and New Zealand Environment and Conservation Council (ANZECC)/Ministerial Council on Forestry, Fisheries and Aquaculture (MCFFA) NFPS Implementation Sub-committee (JANIS). The Technical Working Group comprised representatives from state forestry and conservation agencies and the CSIRO.

A report by JANIS, *Proposed Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia*, was released in mid- 1996 and public submissions invited. Following consideration of these submissions by JANIS, the criteria were finalised and ministers from ANZECC and MCFFA have now endorsed these criteria.

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* which regulates the export of woodchips and unprocessed wood. In assessing applications for export licences under this Act, the relevant Minister is required to ensure that a range of Commonwealth obligations are met. The major legislation includes:

- *Endangered Species Protection Act 1992*
- *World Heritage Properties Conservation Act 1983*
- *Export Control Act 1982*
- *Australian Heritage Commission Act 1975*
- *Environment Protection (Impact of Proposals) Act 1974.*

Victorian Legislation

The NFPS recognises that State and Territory governments have constitutional responsibility for land use decisions and primary responsibility for forest management. To fulfil this responsibility the States and Territories have enacted legislation that allocates forest land tenures and specifies the administrative framework and policies within which public and private forests are managed. The major Victorian legislation includes:

- *Forests Act 1958*
- *Land Act 1958*
- *Land Conservation Act 1970*
- *Environment Protection Act 1970*

- *Archaeological and Aboriginal Relics Preservation Act 1972*
- *Land Conservation (Vehicle Control) Act 1972*
- *Victorian Conservation Trust Act 1972*
- *National Parks Act 1975*
- *Wildlife Act 1975*
- *Environment Effects Act 1978*
- *Reference Areas Act 1978*
- *Crown Land (Reserves) Act 1978*
- *Conservation, Forests and Lands Act 1987*
- *Planning and Environment Act 1987*
- *Flora and Fauna Guarantee Act 1988*
- *Water Act 1989*
- *Mineral Resources Development Act 1990*
- *Heritage Rivers Act 1992*
- *Victorian Plantations Corporation Act 1993*
- *Catchment and Land Protection Act 1994*
- *Extractive Industries Development Act 1995*
- *Heritage Act 1995.*

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 Central Highlands 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

An objective of Regional Forest Agreements is that, to the maximum extent possible, existing data sets and processes used in the assessments be accredited.

The framework for accrediting data sets and processes is set out in the Intergovernmental Agreement on the Environment (IGAE) (Commonwealth of Australia 1992a). Accreditation, as outlined in the IGAE, refers to the Commonwealth or a State endorsing a process used by the other jurisdiction(s) as having accommodated part or all of the interests of the accrediting government.

The data sets and processes considered in the assessments described in this report have been accredited for use in the Central Highlands RFA. Key data information will be provided in a separate report and available upon request.

1.3 THE RFA PROCESS IN VICTORIA

Background

During 1995, the Commonwealth and the States of Victoria, Tasmania, New South Wales and Western Australia undertook a process of identifying Interim (or Deferred) Forest Areas in order to provide interim protection for forests that may be required for a CAR reserve system while RFAs are being completed.

An Interim Forest Agreement (IFA) between the Commonwealth and Victoria was signed in January 1996. At the same time, the Prime Minister and Premier also signed a Scoping Agreement setting out administrative and operational arrangements for undertaking CRAs and developing RFAs, as well as committing Governments to establishing processes and timetables for the completion of the RFA process.

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,
- Gippsland,
- North East, and
- West.

The RFA for the East Gippsland region was signed by the Prime Minister and the Premier of Victoria on 3 February 1997. The Central Highlands is the second region in Victoria in which an RFA is to be developed.

Stages in the RFA process

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

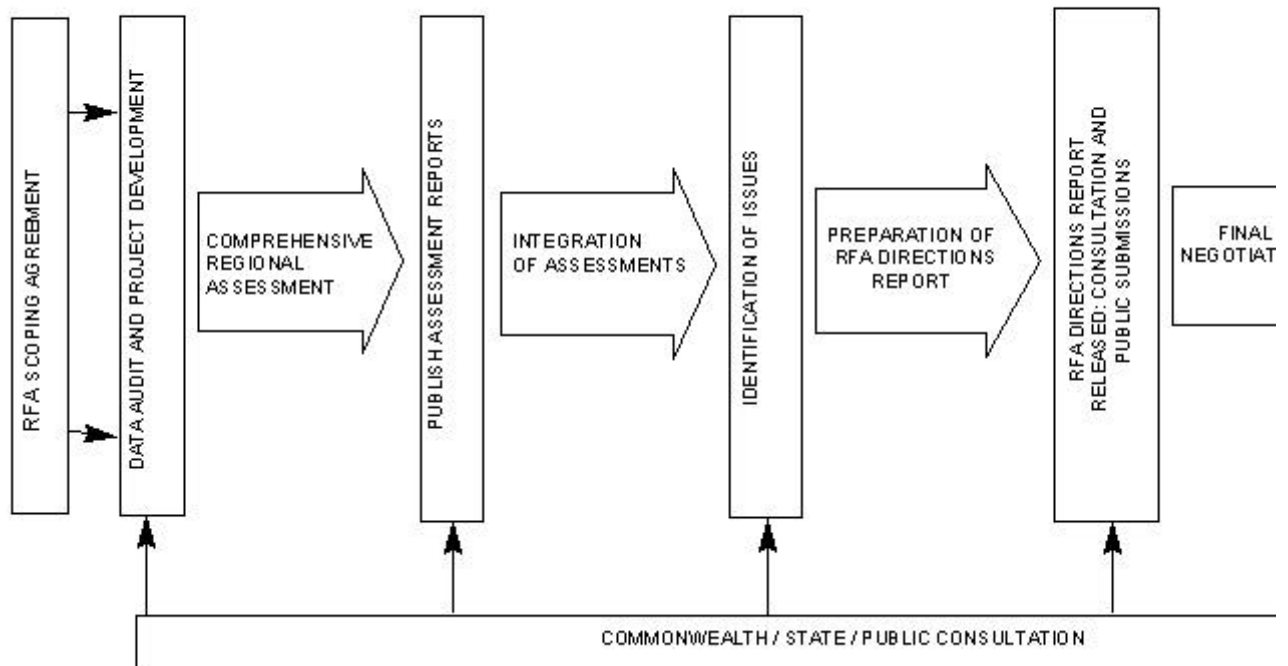
Comprehensive Regional Assessment (CRA)

The CRA that has been undertaken for the Central Highlands region is described in this report. It consists of the following assessments:

- | | |
|---------------------|------------------|
| • biodiversity | • world heritage |
| • old-growth forest | • social |
| • wilderness | • resource |
| • national estate | • economics |

Figure 1.1 Major Stages in the RFA Process

THE RFA DEVELOPMENT PROCESS



The CRA brings together a wide range of studies conducted in recent years. References to any relevant technical papers are provided in each chapter.

The CRA provides a synthesis of the information on which the RFA can be developed and agreed between the Victorian and Commonwealth Governments. It does not make judgements or interpretations of information where that 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 paper

The CRA assessment reports are a precursor to the integration phase of the RFA process. During the integration phase, information from the assessments and public consultation will be used to identify and analyse issues that need to be addressed in the RFA. This analysis will include consideration of:

- biodiversity,
- wilderness,
- old-growth,
- ecologically sustainable forest management,
- forest production, and
- community and forest based industries needs.

A description of these issues and results of the analysis will be provided in a Central Highlands RFA Directions Report which will be released in mid-1997.

Opportunities for consultation with the community and stakeholder groups will be provided both during the development of the Directions Report and following its release. With this in mind, a series of workshops will be held in Central Highlands and Melbourne over the next few months. The consultation process is designed to focus discussions 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 integration phase, the Directions Report will be released for an eight week public comment period. This phase is an important component of the consultation process in developing an RFA for the Central Highlands. The Directions Report will discuss the issues identified during the integration phase, and outline how they might best be resolved in the RFA, this will provide a basis for detailed discussion with stakeholders. Following this phase, the Commonwealth and State Governments will negotiate the Regional Forest Agreement. The RFA is scheduled to be completed in late 1997.

2. CENTRAL HIGHLANDS REGION

2.1 LOCATION

The Central Highlands RFA Region has the same boundaries as those used for the Proposed Central Highlands Forest Management Plan; it comprises the Shires of Murrindindi, Baw Baw and Yarra Ranges and parts of the Shires of Mitchell, Delatite, Cardinia, Nillumbik and the City of Whittlesea (see Map 1). The Region lies immediately to the north and east of the Melbourne metropolitan area and extends to Seymour and Lake Eildon in the north, the Hume Freeway in the west and Baw Baw National Park and Moe in the east.

Townships within the region include: Lilydale, Toolangi, Healesville, Marysville, Alexandra, Eildon, Kinglake, Whittlesea, Woods Point, Warburton, Powelltown, Noojee, Erica/Rawson, Neerim South and Warragul.

2.2 LANDSCAPE AND CLIMATE

The Dividing Range is the dominant landform feature. It runs east-west, thus dividing the north of the region from the south. Weather patterns and fire conditions are influenced by the Dividing Range which creates a rainshadow effect with the higher ridges producing drier environments in the north of the region. As a result, mixed-species forests and woodlands are more common north of the Great Divide.

The dominant influences on the weather in the Central Highlands are landscape and latitude. The climate is induced by anticyclones and depressions, generally moving from west to east creating hot dry summers (Luke and McArthur 1978), interspersed with shallow cool fronts that may produce rain activity. Localised afternoon stormcells containing electrical activity are also common. Low pressure systems are prevalent in winter, bringing moist air from Bass Strait to the western and southern reaches of the elevated ranges from Mt Baw Baw to Mt Disappointment resulting in high rainfall reaching up to 1700 mm per annum (Luke and McArthur 1978). These areas of high rainfall and moderate climate provide optimal conditions for the tall moist ash forests.

2.3 SIZE AND TENURE

The Central Highlands RFA Region covers approximately 1.1 million hectares. Private land comprises some 502,800 ha, or 44 per cent of the region, and is mostly cleared and used for a range of agricultural pursuits.

Public land comprises about 600,000 ha, or 56 per cent of the area. The public land is covered mostly by native forest. The region is renowned for its beauty, diverse range of flora and fauna, timber resources, recreational opportunities and the high quality of water in its rivers and streams (NRE 1996b).

State forest occupies about 389,800 ha, or 62 per cent of the public land and conservation reserves (National Parks and Flora and Fauna Reserves) occupy 29 per cent of the public land, or about 179,700 ha. The remaining public land in the Central Highlands, as shown in Figure 1, includes other reserves, other public land and water bodies.

2.4 POPULATION

The Central Highlands RFA Region had a population of approximately 280,000 in 1991 (ABS 1991). With a forecast annual population growth rate of around 1.4 percent, the population in 1997 would be expected to be around 300,000.

There are no major cities in the Central Highlands Region. Warragul is the largest township with a population of approximately 9100 persons (ABS 1991 in Henshall Hansen Associates *et al* 1992). There are numerous small towns in the region with populations of less than 1000 people (eg Noojee: 100 people; Erica: 228 people; Rawson: 312 people; Kinglake: 584 people; Marysville: 662 people).

More detailed demographic information is provided in the section on the Social Assessment.

2.5 REGIONAL ECONOMY OF THE CENTRAL HIGHLANDS REGION

The regional economy of the Central Highlands makes a significant contribution to economic activity and employment in Victoria. In 1994-95, for example, economic businesses operating in the Central Highlands region are estimated to have accounted for over 9 per cent or \$10 billion (in 1995-96 dollars) of Victorian gross state product (GSP). In addition, the Central Highlands is estimated to have accounted for 9.4 per cent of Victorian employment in 1994-95 (Table 2.1).

Within the Central Highlands region, the forestry and hardwood processing, mining, recreation and tourism, and minor forest product industries (for example, craftwood and beekeeping) rely to a varying extent on the public forest resource.

In 1994-95, it is estimated that the agriculture, forestry and fishing; mining; accommodation, cafes and restaurants; and cultural and recreational service industries jointly accounted for \$830 million (or 8.3 per cent) of total Central Highlands GSP (Table 2.1).

Public native forests in the Central Highlands region contribute to further economic and employment generating activities outside the Central Highlands region. An important example includes wood processing activities that are located outside the Central Highlands region. The Maryvale pulp and paper mill, for example, is located outside the Central Highlands but receives around 58 per cent of its eucalypt wood resources from within the Central Highlands RFA region, and directly employs 930 persons. The economic significance of wood processing industries linked to the native forest hardwood resources from the Central Highlands RFA region are discussed in more detail elsewhere in this report.

The native forest based industries also contribute to direct and indirect employment within the Central Highlands region. For those people residing in the Central Highlands region in 1990-91, the forestry and logging; wood and paper product; and mining industries directly accounted for 2.3 per cent of total employment (Table 2.2). The cultural, recreational and accommodation industries accounted for 3.8 per cent of regional employment in 1990-91 (Table 2.2).

**Table 2.1: Central Highlands and Victorian gross state product by major industry
(1995-96 dollars)**

	Central Highlands a)			Victoria		
	1990-91 b) (\$m)	1994-95 c) (\$m)	Share d) (%)	1990-91 (\$m)	1994-95 (\$m)	Share e) (%)
Agriculture, forestry and fishing	223	227	2.3	2 796	2 854	2.7
Mining	271	231	2.3	3 970	3 380	3.1
Manufacturing	1 888	2 042	20.4	18 151	19 635	18.3
Electricity, gas and water	629	596	6.0	4 059	3 846	3.6
Construction	734	658	6.6	6 983	6 265	5.8
Wholesale trade	509	514	5.1	6 756	6 834	6.4
Retail trade	553	611	6.1	7 223	7 972	7.4
Accommodation, cafes and restaurants	124	152	1.5	1 620	1 978	1.8
Transport and storage	368	431	4.3	4 546	5 330	5.0
Communication	328	409	4.1	2 900	3 612	3.4
Finance and insurance	212	301	3.0	3 062	4 344	4.0
Property and business services	680	703	7.0	9 730	10 047	9.3
Government administration and defence	375	376	3.8	3 620	3 626	3.4
Education	475	531	5.3	5 091	5 694	5.3
Health and community services	600	684	6.8	6 156	7 015	6.5
Cultural and recreational services	153	220	2.2	1 331	1 919	1.8
Personal and other services	222	243	2.4	1 737	1 898	1.8
Ownership of dwellings	938	915	9.1	9 680	9 451	8.8
General government	163	164	1.6	1 826	1 832	1.7
Total	9 445	10 008	100	101 238	107 531	100
Share of Victorian GSP (%)	9.33	9.31				

a) Estimates from ABS statistics based on statistical local areas (SLAs). Parts of some SLAs included here do not lie completely within the Central Highlands RFA boundary. b) Assuming real GDP/employment for the Central Highlands is same as for Victoria. c) Assuming the industry output shares of Central Highlands in Victoria are the same in 1994-95 as in 1990-91 and assuming the Central Highlands proportion of Victorian employment is the same in 1994-95 as in 1990-91. d) Share of Central Highlands contribution to Victorian GSP. e) Share of Victorian GSP. Source: ABS (1996a).

Table 2.2: Number of residents employed in the Central Highlands and Victoria, by industry

	Central Highlands			Victoria		
	1990-91 ^{a)} (no.)	1994-95 ^{b)} (no.)	Share ^{c)} (%)	1990-91 ^{d)} (no.)	1994-95 ^{d)} (no.)	Share ^{e)} (%)
Agriculture, forestry and fishing	6 500	5 588	2.9	101 900	87 600	4.3
<i>Forestry and logging</i> ^{f)}	195	na		na	na	
Mining	490	943	0.5	4 000	7 700	0.4
Manufacturing	35 673	35 161	18.2	362 200	357 000	17.3
<i>Wood and paper products</i> ^{f)}	3 549	na		na	na	
Construction	13 002	13 879	7.2	124 500	132 900	6.5
Wholesale and retail trade	36 797	39 972	20.7	402 200	436 900	21.2
Transport and storage	6 940	6 679	3.5	95 700	92 100	4.5
Finance, property and business	18 785	24 315	12.6	223 500	289 300	14.1
Community services	41 118	44 760	23.2	362 400	394 500	20.3
Personal, recreational and other	9 361	9 787	5.1	136 100	142 300	6.9
<i>Cultural, recreational and accommodation</i> ^{f)}	6 963	na		na	na	
Not stated or classifiable	16 629	11 735	6.1	167 500	118 200	5.7
Total	185 295	192 819	100	1 980 000	2 058 500	100
Share of Victorian employment (%)	9.36	9.37				

^{a)} Estimates from 1991 census data based on statistical local areas (SLAs). Parts of some SLAs included here do not lie completely within the Central Highlands RFA boundary. ^{b)} Assuming industry employment shares of Central Highlands in Victoria are the same in 1994-95 as in 1990-91. ^{c)} Share of estimated Central Highlands employment. ^{d)} As at May 1991 and 1995 respectively. ^{e)} Share of Victorian employment. ^{f)} Subcategory of major category above (major category estimate includes subcategory).

Source: ABS (1996b).

2.6 HISTORY OF THE CENTRAL HIGHLANDS FORESTS

The forests of the Central Highlands region have been occupied by Aboriginal communities for thousands of years. The region covers areas inhabited by the *Woiworung* (also known as *Wurundjeri*) and *Taungurong* peoples. Their cultures were based on an intimate and dynamic relationship with the environment through activities such as gathering, hunting and burning and through the association of place with religious beliefs and obligations.

By the early 1800s, while there had been little physical contact with Europeans, the introduction of new diseases had already started to seriously affect local Aboriginal populations and to threaten their traditional social and subsistence base. European settlement from the mid-1830s signified the beginning of the 'Frontier' - a period of European settlement that would have the most significant effects on Aboriginal people in the Central Highlands and elsewhere.

Pastoral settlement in Victoria proceeded to rapidly dispossess Aboriginal people of their land. This occurred to such an extent that by 1851 there was little land untouched, other than heavily forested areas. Initially, forested mountainous country in the Central Highlands provided a refuge from the encroachment of the settlers. The gold rush of the 1850s, however, brought more intensive settlement. During this period, the effects of land dispossession, disease, general erosion of culture, and frequent violent conflict, forced Aboriginal people into a relationship of economic dependency with the settlers.

Aboriginal people were enlisted in the establishment of pastoral runs and farms, working at clearing and timber-getting. From as early as the 1840s, they were engaged in wattle-bark stripping in the study area. Later still, when mills started operating in the area, mill work provided many Aboriginal people with the means to support their families. Aboriginal people have continued to work in the timber industry up until the present day.

From the 1860s, missions and reserves were created to provide permanent places of residence, through the formation of the Central Board appointed to watch over the interests of the Aborigines in the Colony of Victoria. Stations and reserves, such as Coranderrk (at Healesville) and Acheron, were established in well-timbered areas remote from the centres of white settlement. The surrounding forests continued as important refuges and hunting grounds where people could camp and escape the constraints of the imposed culture. Many of these places are still remembered by Aboriginal people living in the area.

The Aborigines Protection Act of 1886 required Aboriginal people of mixed descent to leave the stations and assimilate with the European community. By the early 1900s, only small numbers of Aboriginal people were left living on stations in Victoria, such as Coranderrk. In 1917 the Government recommended that, for economic reasons, all remaining Aboriginal people on stations should move to Lake Tyers in Gippsland. Coranderrk station was closed down during 1923 and 1924.

The history of this period, and its ramifications for Aboriginal people today in the Central Highlands area is brought alive for the general public through the Galeena Beek Living Cultural Centre located at Healesville.

By the late 1840s, much of the Central Highlands plains and open valleys were occupied by squatters. The land was divided into runs and the production of fine wool for Merino sheep was the main economic activity. Few towns were proclaimed before the mid-1850s.

One of the first discoveries of gold in Victoria was in 1851, at Andersons Creek (Warrandyte) east of Melbourne. The Emerald field was opened up in 1858 and short-lived rushes developed along the Little Yarra and Upper Yarra Rivers. Despite a small rush near the Jamieson flat in 1854, it was not until 1857 that the miners returned to explore the Big River and discover gold at Enochs Point - the first gateway to the Upper Goulburn field. The Yarra Forests experienced a number of smaller gold rushes, and during the 1860s and 1870s a great deal of mining was carried out in the Upper Yarra fields.

The major goldfield in the region (often known as the Jordan) stretched along a three-mile wide belt of auriferous land from Jamieson to Walhalla. Its discovery in the 1860s led to Victoria's major gold rush of that period. The steep mountain gullies and plentiful water shaped a particular technology, as a result of which water wheels and tramways became characteristics of the field. The Jordan goldfield boasted Walhalla, which for 50 years was one of Victoria's outstanding mining districts, and the Woods Point field was opened up from the north in 1861. Mining continued on the Jordan goldfield until the 1920s and 1930s; but only two mines continued to operate after the 1930s: the A1 at Gaffneys Creek and the Morning Star at Woods Point.

The Yarra Track, the famous route to the Woods Point-Jordan goldfields, had the greatest impact of any gold era track on the long term development of the Yarra Forest region. The track not only led to the creation of new towns, but also gave a large boost to the development of many existing towns within the region. It was popular with walkers before the 1939 fires.

Timber cutting in the north intensified during the goldmining period of the 1850s and 1860s. Forests surrounding Walhalla and Jericho were intensively cut as miners sought timber for mine supports, heavy construction and fuel, leaving many hillsides denuded and susceptible to erosion. The 1870s and 1880s were prosperous years, and secondary industries developed in most towns. Mining gradually gave way to sawmilling in the mountains surrounding Alexandra, Mansfield, Yea and Broadford.

Sawmills were established as early as the 1850s, and some developed directly from mining. A new, large scale era of sawmilling was initiated in the eastern forests by the extension of the Victorian Railways system to towns such as Wandong and Nar Nar Goon (in the 1870s), Yea (1883), Healesville (1889), Fern Tree Gully (1890), Gembrook (1898), Warburton (1901), Alexandra (1909), Erica and Walhalla (1910). During the period from 1885 to 1950, sawmilling developed a common and relatively stable pattern. The establishment of railways enabled the cartage of timber to the Melbourne market.

With the opening of the railways, the region became popular with visitors. The Dandenongs, Marysville, Narbethong and Healesville have been major resorts since the 1880s and are still popular tourist attractions in the region. National Parks were popular destinations for Melbourne's day trippers. In the 1950s growing interest in downhill skiing eventually led to the establishment by 1966 of the alpine resort at Mt Baw Baw. Lake Mountain is a major cross country skiing destination in Victoria, because it is near to Melbourne.

Development of water supply facilities in the Central Highlands began in the 1850s, with the completion of the Yan Yean reservoir in 1857, the Maroondah scheme in 1891, and numerous developments in the twentieth century including the Upper Yarra Dam and the Thomson Dam.

Throughout the 1880s and 1890s, the distance between the Government rail line and the timber resource was a constraint for sawmillers. As a result, an extensive network of

tramlines was developed as a means of conveying timber to the rail lines. This allowed the removal of timber from a greater area.

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 were enacted. The destruction of many forest areas associated with the mining boom led to the reservation of large tracts of forest. 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 of 1918* - it established the Forests Commission of Victoria, which proceeded to survey and reserve valuable forested land. The development of forest management coincided with the early years of intensive commercial sawmilling in the eastern forests.

Sawmilling activity in the Central Highlands region peaked in the 1920s and again immediately after World War II with fire salvage work. In the 1920s the sawmilling industry was taking off further east. As gold-mining declined in the Walhalla district, timber took over as the major source of employment. Mills sprang up in the forests from Moondarra and Erica across the ranges to the Upper Tanjil Valley and Mount Baw Baw. Erica took over as the major district centre. By the early 1930s, millers were entering the 'virgin bush' country around Matlock and in the Tanjil catchment.

Both before and after the war, the Forests Commission aimed at diversifying the range of forest products. The development of the kiln seasoning and reconditioning process in the early 1920s replaced the slow air-drying of timber for joinery, and enhanced the competitiveness of Australian timber. By 1931 the Commission was noticing an increased use of local kiln-seasoned hardwoods. Also, from the early years of the Forests Commission, encouragement was given to the production of paper pulp from mountain ash. In 1936, the Government, the Commission, and Australian Paper Manufacturers Limited (APM, now AMCOR) reached an agreement that led to the establishment of a pulp and paper plant at Maryvale in Gippsland. The facility commenced production in October 1939 and for several years drew its wood supply from the fire killed ash forests destroyed by bushfires in 1939. This mill is now the largest producer of quality paper in Australia, and the initial agreement with APM was ratified by an Act of parliament in 1996,. Though located outside the Central Highlands, the mill is a major user of residual wood from the region.

Widespread bushfires in 1939 destroyed large areas of mountain forests, along with many tramways, mills and settlements. The Government initiated a scheme which directed the timber industry to concentrate operations in fire-killed and damaged stands. Milling operations were accelerated to minimise timber losses, reaching a peak during 1945-1950. The salvage operations declined in the early 1950s as much of the remaining timber had degraded. Salvage operations were terminated in 1952 to avoid damaging the regenerating forest.

The Royal Commission, which followed the fire, directed that sawmills should no longer be sited in the bush. 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 World War II, encouraged the increased mechanization of forestry operations.

In 1983 the Ash Wednesday wildfires burnt significant areas of forest (43,500 ha, mainly in the Warburton district), including large areas of ash forest. Of this area, 4,200 ha were severely burnt, requiring a salvage operation. Regeneration from the 1939 fire events forms the basis for native timber supply in the Central Highlands.

Since the initial reservation of forest in 1873 more blocks were added to the forest estate, and the Forests Commission of Victoria was formed to control forestry operations on both reserved forestland unoccupied Crown land throughout Victoria. In the 1970s to 1990s the Land Conservation Council conducted a number of public land use reviews which lead to the creation of new and enlarged National, State, and Regional Parks and other reserves and the identification of forests that would be available for timber production and other land uses.

2.7 LAND CLASSIFICATION

Conservation Reserves

The Central Highlands 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 and tourism. The reserve system occupies approximately 180,000 ha, or 29 per cent of the public land in the region. Information on the reserve system and the values which it contains is provided in the biodiversity, old-growth and national estate assessments. The location of the reserve system is shown on Map 1.

State Forest Zoning System

Within State forest provision is made for:

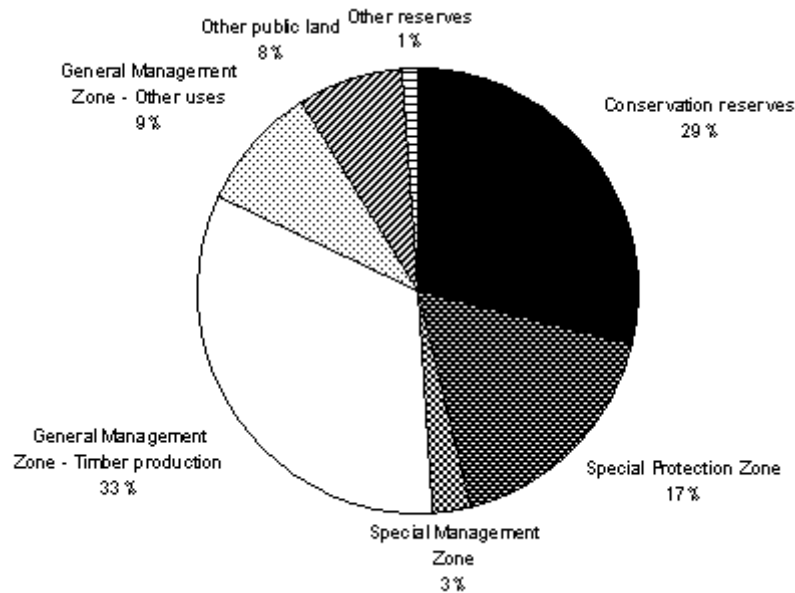
- water supply;
- catchment and stream protection;
- hardwood timber production;
- conservation of natural and cultural values;
- recreation and tourism;
- mineral exploration and mining; and
- other forest uses, such as honey production and grazing.

The Proposed Central Highlands Forest Management Plan (NRE 1996b) proposes a strategic landuse framework in State forest and is based on three 'management zones' which set priorities and specify permitted activities for different parts of the forest. The three management zones are proposed as follows.

- 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 proposed SPZs account for 109,200 ha or 17 per cent of the public land in the region.
- The **Special Management Zone (SMZ)** - managed to conserve specific features where timber harvesting is still permitted under certain conditions. The proposed SMZs account for 17,100 ha or 3 per cent of the public land in the region.
- The **General Management Zone (GMZ)** - managed for a number of uses where timber production is the main priority. The proposed GMZs account for 263,500 ha or 42 per cent of the public land in the region.

Figure 2.1 illustrates the proportion of public land in forest management zones, conservation reserves and other public land in the region. Of the 389,800 ha of State forest, the net productive area for timber harvesting is approximately 222,400 ha which includes the SMZ and GMZ - timber production. The remainder is either SPZ or GMZ - other uses (unproductive forest or unavailable for harvesting due to steep slopes).

Figure 2.1: Proportion of public land in forest management zones and conservation reserves



Source: NRE (1996b).

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

Objectives for forest management on public land are based on the conservation of natural and cultural values whilst providing resources for the community's economic benefit.

This chapter briefly outlines State forest planning and management in the Central Highlands region. Further information about the forest management planning process is provided in the Ecologically Sustainable Forest Management (ESFM) reports (VicRFASC 1996b and VicRFASC 1997a), the Proposed Central Highlands Forest Management Plan (NRE 1996b), and the Statements of Resources, Uses and Values (McHugh 1991, Jeremiah and Roob 1992, Abbot *et al* 1993).

3.1 STATE FOREST MANAGEMENT

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

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

Planning for forest management in Victoria is guided by 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*. Management is also guided by Government and Departmental policies. The process of forest management planning in Victoria is described in the East Gippsland ESFM report (VicRFASC 1996b) and the Victorian ESFM Report (VicRFASC 1997a), and the reader is referred to these documents for particular details. Content of plans is established in the Code of Forest Practices Revision No. 2 (NRE 1996a).

Harvesting and road construction in State forest is undertaken consistent with a series of State-wide, regional and local planning and regulation mechanisms, including:

- the Code of Forest Practices for Timber Production which contains goals and guidelines for the conduct of all commercial timber production activities in Victoria;
- Forest Management Plans which address the management of environmental, cultural and resource values in Forest Management Areas;
- Forest Management Area prescriptions for the control of timber harvesting in native forests;
- Wood Utilisation Plans which 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 area to be harvested and a schedule which incorporates the specifications and conditions under which the operation is to be administered and controlled; and
- Forest Operator Licensing which requires that logging operators be licenced, having first received environmental training and accreditation. Operators can be suspended from the forest for breaches of environmental protectional provisions.

Guidelines and Codes of Conduct for recreational uses such four wheel driving and rock climbing have also been developed in Victoria in consultation with the relevant user groups.

Forest Management Plans

The Timber Industry Strategy divided Victoria into 15 Forest Management Areas (FMAs). Management plans are to be prepared for each FMA to direct the use and care of forests for planning periods of ten years, with provision for review if circumstances warrant. The planning process provides opportunities for public consultation and participation in resource use and protection.

The Central Highlands RFA region covers portions of three FMAs: the majority of the Dandenong and Central FMAs, and a western portion of Central Gippsland FMA. Resource documents, 'Statements of Resources, Uses and Values' (SRUVs), have been produced for each of these FMAs. In the past, Forest Management Plans have been produced for individual FMAs. However, the area of the recently produced Proposed Central Highlands Forest Management Plan (NRE 1996b) corresponds with the Central Highlands RFA area.

The Proposed Central Highlands Forest Management Plan includes:

- protection measures for botanical, zoological, historical and geological values,
- areas of special landscape value, and outlines of the measures for their protection,
- measures to protect streams and water catchment values,
- guidelines for management of particular recreation activities (eg horseriding, bushwalking, deer hunting) and of recreation sites,
- a process to determine the road network to be maintained by NRE,
- sawlog yield estimates for the planning period,
- guidelines for other uses of State forest, and
- priorities for pest, plant and animal control programs.

The final plan will be published after the Central Highlands Regional Forest Agreement is finalised.

Land use and forest management zoning

The Central Highlands RFA area covers 1 129 900 ha, of which 35 per cent is State forest, 16 per cent parks and other conservation reserves, five per cent other public land, and the balance (44 per cent) private land, as shown in Table 3.1. The area of State forest in the Central Highlands has been determined following detailed land use studies by the Land Conservation Council which involve community input. The most recent LCC review was completed in 1994.

Within State forest, the Proposed Central Highlands Forest Management Plan (NRE 1996b), identifies three forest management zones which set management priorities and specify permitted activities for different parts of the forest. The Special Protection Zone (SPZ) is managed for conservation purposes, and timber harvesting is excluded. The Special Management Zone (SMZ) is managed to conserve specific features, while catering for timber production under certain conditions. The General Management Zone (GMZ) is managed for a range of uses with timber production a priority.

Combined with scheduled parks under the National Parks Act and other conservation reserves, the forest management zones provide an integrated conservation reserve network and a framework for sustainable forest use. The Proposed Central Highlands Forest Management Plan provides a process for review of the zoning scheme when a change to forest management zones is proved warranted eg after a major wildfire or if a zone is found not to contain the values for which it was identified. Proposed changes to the zoning scheme will be assessed according to a range of factors including whether they adequately conserve the values listed in the zoning scheme register (there should be no net deterioration in the

standard of protection of values in the Special Protection Zone). The impact on the productive capacity of the forest can also be considered.

The proposed management plan states that significant changes to forest management zones will be made available for public comment and, following consideration of comments received and relevant specialist advice, approval will be sought from the Secretary of NRE for adoption of the revised zones.

For resource management purposes and coupe harvesting recording, State forest in the Region is divided into forest blocks of about 10 000 hectares. Blocks are subdivided into compartments of some 300 to 700 hectares, and this is the smallest permanent forest planning unit. In the past, timber resource data was collated on a compartment basis for strategic planning purposes. Compartments are further divided into coupes, the smallest management unit, with a maximum area of 40 hectares. Coupe boundaries are marked, although boundaries may be determined by natural features such as ridges or other prominent features. Contiguous coupes must not exceed 120 hectares. All coupes, compartments and blocks are individually numbered and identified so that they can be readily identified for management purposes.

Table 3.1: Extent of Forest Management Zones and other land categories in the Central Highlands.

	Area (ha)	Proportion of all land (%)	Proportion of public land (%)	Proportion of State forest (%)
STATE FOREST				
Special Protection Zone	109 200	10	17	28
Special Management Zone	17 100	2	3	4
General Management Zone	263 500	23	42	68
Timber production a)	207 700	(18)	(33)	(53)
Other uses	55 800	(5)	(9)	(15)
State forest sub-totals	389 800	35	62	100
OTHER PUBLIC LAND				
Conservation reserves b)	179 700	16	29	
Other reserves c)	4 000		1	
Other public land d)	39 800	4	6	
Water bodies	13 800	1	2	
Other public land sub-totals	237 300	21	38	
Public land total	627 100	56	100	
PRIVATE LAND	502 800	44		
Total Public and private Land for the Central Highlands	1 129 900	100		

a) This is the estimated net productive area of forest both available and suitable for sawlog production in the GMZ. Streamside reserves are included in the SPZ. Unproductive areas and steep slopes are included in the GMZ 'other uses' category. **b)** Although not subject to this Plan, these areas, which include parks, were taken into account in formulating management strategies for State forest. **c)** The LCC's Final Recommendations for the Melbourne Area District 2 Review identified a number of regional parks and historic and cultural features reserves. These reserves are set aside primarily for recreation or historic purposes but in which other uses, such as timber harvesting, are permitted. They include the Rubicon Valley, Comet Sawmill, Mississippi No. 1 Mill settlement, Ada River sawmills, Kirchubel's Tramway and Mill and Coopers Creek Copper Mine Historic and Cultural Features Reserves, and Kurth Kiln and Tyers Regional Parks. **d)** 'Other public land' includes land managed by the Victorian Plantations Corporation and water-supply authorities. *Sources:* Proposed Central Highlands Forest Management Plan (NRE 1996b)

The total area of State forest within the Central Highlands is 389 800 ha. The gross area available for harvesting in the GMZ and SMZ, which is 280 600 ha. However, not all of the gross available area can be harvested. The GMZ totals 263 500 ha and is divided into two subzones: the 'Timber production' subzone of 207 700 ha, and the 'Other uses' subzone of 55 800 ha. The latter subzone is not suitable for harvesting due to steep slopes or its low productivity (generally less than 28m in height). This information is shown in Table 3.1. All of the area within the SMZ is considered available for harvesting, but to take account of the constraints on timber harvesting within the SMZ, sustainable yield estimates have assumed that only 50 per cent of the volume will be available. The net productive area available for timber harvesting is 222 400 ha.

Other areas of public land, as shown in Table 3.1, include water bodies which store water for rural and urban water supply, and plantations managed by the Victorian Plantations Corporation (VPC). Discussion of water and plantations is provided in Chapters 9 and 6 respectively.

Code of Forest Practices for Timber Production

The Victorian Parliament ratified the Code of Forest Practices for Timber Production in May 1989 in accordance with section 55 of the *Conservation, Forests and Lands Act 1987*. The Code was immediately implemented on public land through amendments to the conditions of all commercial forest produce licences, and through the introduction of a system of licensing individual forest operators. The operator licensing system is similar to vehicle licences with points being allocated to licencees for breaches of the Code. Licence suspension and licence cancellation are also provided under this system.

The Code on public land is augmented by regional prescriptions that consider the local conditions such as climate, forest type, topography, elevation, soil type, land ownership, and various management objectives. In addition to the Code and prescriptions, Wood Utilisation Plans and Forest Coupe Plans provide a framework for operational planning to regulate the harvesting of timber from native forests.

Amendment S13 under the *Planning and Environment Act 1987* in 1993 provided for the amendment of all Victorian municipal planning schemes. The outcome of the amendment is that the Code also applied to operations on private land.

The Code lays down Statewide goals, guidelines and minimum standards that apply for timber harvesting, timber extraction roading, regeneration and reforestation in native forests. Provisions of the Code are designed to ensure that:

- the forest is adequately regenerated and managed following timber harvesting;
- reforestation is achieved efficiently and with environmental care;
- environmental values (including landscape, flora, fauna, archaeological, historic and cultural values) are conserved, and water supply catchments are protected; and
- opportunities are provided for recreation, scientific study and education.

Several reviews of aspects of the Code have been undertaken (Victoria Auditor-General 1993, CNR 1995a; CNR 1995b; CNR 1995c; O'Shaughnessy 1995). A second version of the Code was developed by NRE using a process of scientific review and community consultation, and was ratified by Parliament in 1996.

3.2 SILVICULTURE

A review of the theory and practice of silviculture was provided in the East Gippsland Resource and Economics Report (VicRFASC 1996d). Further detail on silviculture is available in Florence (1996) and the Proposed Central Highlands Forest Management Plan (NRE 1996b). A summary is provided here.

Silviculture is concerned with the treatment of forest stands to achieve identified management aims. Treatment can include harvesting, regeneration and tending operations such as thinning and fertilising. Combined, such treatments form a system designed to manage the structure, composition and growth of a forest stand.

The Central Highlands RFA region is dominated by ash type eucalypt forest and mixed species eucalypt forests. These two forest types differ in their ecological responses to disturbance, particularly in relation to their mode of regeneration. Ash type forests are killed by all but low intensity fires, whereas the mixed species stands can withstand higher intensity fires. The development of silvicultural systems has been guided by the ecological characteristics of forests, with consideration to environmental, economic and social factors. The following discussion is given as background specific to the Central Highlands before providing a synopsis of current NRE policy, management practices and research in silviculture.

Ash Forests

Ash forests in the Central Highlands are dominated by *E. regnans* (Mountain Ash), *E. nitens* (Shining Gum) and *E. delegatensis* (Alpine Ash). These species are normally found in pure stands at altitudes ranging between 150 and 1100m for *E. regnans*, and 900 and 1500m for *E. delegatensis* (LCC 1991).

Regeneration systems

The ash species are intolerant of shade. They require direct sunlight for successful regeneration: less than 95 per cent full sunlight is inadequate. Through operational experience, regeneration systems have been developed which are consistently able to provide for adequate regeneration and optimal growth. These incorporate clearfelling, burning debris remaining after harvest and artificial sowing. Burning produces a high quality seedbed, which assists in early regeneration. Where burning is not appropriate, or conditions have resulted 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; however, when seed availability is restricted, or seed has failed to germinate, seedlings are planted.

The seed tree system is a modification of clearfelling and is used where seed crops or standing trees are considered sufficient to meet specified seedfall targets and the seedtree can be harvested in a second cut.

Regrowth management

Eucalypt forests are by nature self-thinning as they mature. Clearfelling and high intensity wildfire often result in dense regeneration leading to competition for light and nutrients between individual stems. The result is that some stems become dominant and grow strongly, while others are suppressed.

Thinning of dense, suppressed or malformed *E. regnans* regrowth has been shown to lead to increased diameter and basal area (and thus, volume) in the retained trees, thereby contributing to increased sawlog production (Webb 1966, in Jeremiah and Roob 1992).

Mixed Species Forests

Mixed species forests in the Central Highlands include *E. obliqua* (Messmate), *E. cypellocarpa* (Mountain Grey Gum), *E. radiata* (Narrow-leaved Peppermint), *E. dives* (Broad-leaved Peppermint) and a variety of stringybark species.

Regeneration systems

Species in these mixed stands can regenerate by seed, coppice or lignotuber, and therefore present a greater range of silvicultural options for regeneration. Fire can be used to stimulate seedfall, and to create a receptive seedbed. The mixed species forests do not have the same requirements for direct sunlight in the regeneration phase. As a result, the Seed Tree system is more commonly used in these forests, although clearfelling (on higher quality sites) or group selection techniques may also be used. In practice the regeneration process is strongly influenced by the method of harvesting, which varies with site quality. On higher quality sites, clearfelling in a manner similar to that used in the ash forests is often used whereas on the lower quality sites, group selection techniques are sometimes used.

Regeneration systems that incorporate non-clearfelling practices in Ash and Mixed Species forests are being investigated in the Central Highlands and East Gippsland.

Regrowth management

Thinning of stands can also be undertaken in mixed species forest to increase wood yield by concentrating growth on retained stems. Suitable stands of mixed species forest will be thinned, where appropriate, to lead to increase productivity and stand quality. Such operations will follow the NRE Guideline on Thinning (NRE 1997a).

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 in the Central Highlands is contained in the Proposed Central Highlands Forest Management Plan and the Code of Forest Practices for Timber Production. They are implemented through the regional prescriptions, Wood Utilisation Plans, and Coupe Harvesting Plans.

The Code of Forest Practices for Timber Production (NRE 1996a) provides a series of goals and guidelines for the establishment and tending of timber stands on public lands which include:

- Regeneration,
- Reforestation,
- Tree species and seed sources,
- Stocking and early growth,
- Tending, and
- Forest Health.

Harvesting and regeneration systems in the Central Highlands are managed to:

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

In the Central Highlands, guidelines have been proposed to achieve a balanced age structure in the longer term, while maintaining a non-declining yield of sawlogs through:

- harvesting ash forest and high quality mixed species forest using clearfelling or seed tree systems on a nominal 80-year rotation;
- harvesting low quality mixed species forest on a nominal 120-year rotation;
- increasing the level of harvesting from mixed-species stands;
- implementing thinning and early-spacing regimes to accelerate the production of sawlogs; and
- Timber Stand Improvement (TSI) operations to improve productivity of mixed species stands.

The Proposed Forest Management Plan identifies several silvicultural systems that are currently used or potentially available for the Central Highlands (Table 3.2).

Table 3.2: Current and potentially available silvicultural treatments identified for the Central Highlands

Silvicultural Treatment	Ash type forest		Mixed Species forest	
	Currently used	Potentially available a)	Currently used	Potentially available a)
Harvesting /regeneration				
Clear-felling	✓		✓	
Shelterwood		✓ b)		✓
Seed Tree	✓		✓	
Retained overwood		✓ c)		
Group selection			✓	
Regrowth Management				
Thinning	✓		✓	
Early Spacing	✓			✓
Reforestation	✓			✓
TSI			✓	

a) Potentially available treatments are aimed at catering for fauna / landscape values when these are significant. b) Availability is subject to continued current research and development to address safety, costs and productivity. c) Availability is subject to operational development to address costs, productivity and retained tree survival. *Sources: NRE (1996b)*

Silviculture Research

The Victorian Government has undertaken a long-term research program known as the Silvicultural Systems Project (SSP) to investigate alternatives to clearfelling in the Ash forests (Squire *et al* 1987). 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 raised.

The SSP compared ash forest clearfelling 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. The effects of an uneven aged structure were considered in terms of sustained yield. A second phase of the study will involve an evaluation of the ecological, operational and social aspects of the selected alternatives.

The SSP reports thus far have indicated that systems other than clearfelling and seed tree systems can also produce adequate regeneration of *E. regnans*. 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 system will continue to be used to harvest and regenerate *E. regnans* (Campbell 1997)

Departmental and CSIRO research into thinning of ash eucalypt has occurred over many years, and the reported results indicate that, given suitable machinery and sites with low levels of old log debris, thinning can be commercially viable and will benefit the forests in the longer term (Webb 1966, Kerruish and Rawlins 1991). A collaborative program involving CSIRO, University of Melbourne and the Australian Logging Council - the Forest Technology Program - is setting out to investigate ways of minimising site soil disturbance in Victorian and Tasmanian forests using appropriate machine technology and integrated harvesting and site preparation.

From the research the silvicultural systems listed in Table 3.2 have been identified as currently and potentially suitable for application in the State forests of the Central Highlands.

3.3 FIRE PLANNING AND MANAGEMENT

The Department of Natural Resources and Environment has the responsibility for prevention and suppression of fire in every State forest and national park, and all protected public land in accordance with the *Forests Act 1975*. In addition, the *National Parks Act 1975* requires that the Parks scheduled under that Act be protected from injury by fire. The Department also has fire prevention responsibilities on other land within 1.5 km of State forest, National Park, and protected Public Land, unless such land is excised from those responsibilities. When combined this area of fire protection responsibility is known as the Fire Protected Area.

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

The Code of Practice for Fire Management on Public Land (CNR 1995d) provides a framework for fire management on Public land in Victoria. In addition to this Statewide Code, regional fire protection plans are prepared and provide a strategy for prevention, preparedness, suppression and recovery after wildfire. Regional fire protection plans covering the Central Highlands RFA region are the Dandenong Region, Central Gippsland Region and draft Alexandra Region Fire Protection Plans. Forest and park management plans also include strategies pertaining to fire management.

The Regional Fire Protection Plans are developed and implemented in coordination with municipal fire prevention committees. Consultation and liaison with both levels of committees in the development and review of plans for public land is undertaken (McHugh 1991).

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: asset protection (especially adjacent to private property) (zone 1), strategic fuel reduced corridors (zone 2), specific flora and fauna management (zone 3) and exclusion of prescribed burning (zone 4). 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 which can be damaged by fire are generally located in Zone 5 in which 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 fuel management strategy zoning takes into account the natural values and principles of environmental care. Similarly, fire suppression follows consideration of factors including values at risk from the wildfire or suppression activities.

The frequency of burning will depend on the priority for fuel reduction, the rate of fine fuel accumulation and biological values in accordance with the priority zones (CNR 1995d). Research into fuel accumulation in dry sclerophyll forests in Victoria by Tolhurst (1996) has found surface litter fuels to reaccumulate to pre-burn levels in two to four years. Elevated fuel were found to be slower to recover and may take ten years or more to return to pre-burn conditions. Course fuels were unaffected by a single low intensity fuel reduction burn, whilst the bark on trees will take an estimated 15-25 years to recover to pre-burn conditions. The results from Tolhurst's (1996) research provided the foundations of NRE's fire protection works. Fire protection works are now based on a measure of total fire hazard not just the litter fuel load levels.

The Central Highlands Proposed Forest Management Plan (NRE 1996b) specifically provides for a review of fuel reduction burning operations in areas containing fire sensitive biological values when the Regional Fire Protection Plans are revised.

Rehabilitation is undertaken after a fire event. Where necessary, NRE prepares a rehabilitation plan which details activities considered necessary to assist the recovery of infra-structure, other assets and environmental values from the impact of wildfire and fire suppression, as required under the Code.

3.4 FOREST RESEARCH

Much research has been undertaken in the forests of Victoria and the Central Highlands. The Compendium of Forest Research (VicRFASC 1997b) contains an annotated bibliography of research and other scientific literature, and a synopsis of research in progress. The Compendium is available on request.

3.5 MONITORING, REVIEW AND REPORTING

The key features of monitoring and review of the forest management systems are outlined in the Proposed Central Highlands Forest Management Plan (NRE 1996b). The Proposed Plan also specifies the arrangements for regular reporting on the implementation of the Plan.

These processes are considered further in the Statewide ESFM assessment (VicRFASC 1997a).

4. MANAGING FOR TIMBER PRODUCTION

This section describes and evaluates the past, present and future arrangements used by NRE for inventory, data handling and yield forecasting for sawlogs and residual logs in the Central Highlands 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 in the Central Highlands are considered to be commercial if potential stand height exceeds 28m.

For timber production purposes, the commercial forests of the Central Highlands have been classified into three forest types:

- Ash,
- High quality mixed species, and
- Low quality mixed species.

The Ash forest type consists of stands dominated by either Mountain Ash (*E. regnans*) or Alpine Ash (*E. delegatensis*) with associated understories (these sub-categories are used in Table 4.1). The High quality mixed species forest type generally describes the mixed species forest that occupies the higher elevation slopes and includes Mountain Ash, Alpine Ash, Shining Gum (*E. nitens* and *E. denticulata*), Messmate (*E. obliqua*) and Mountain Grey Gum (*E. cypellocarpa*). Low quality mixed species forest generally occurs in the lower elevation foothills and can include Messmate, Narrow-leaf Peppermint, Mountain Grey Gum and Manna Gum as characteristic species.

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 accordance with the recommendations of the LCC (LCC 1994) no pre-1900 ash type forest is harvested in the Central Highlands. Harvesting in the Central Highlands is therefore confined to ash forest regenerated since 1900, and the mixed species forest types.

Map 6 describes the spatial location and extent of the commercial forest types in Central Highlands.

**Table 4.1: Net productive area for commercial forest types in the
Central Highlands Region (ha)**

Forest Type	Dandenong FMA			Central FMA			Central Gippsland FMA within C/H		
	M/OM	Regrowth	Unstocked	MOM	Regrowth	Unstocked	M/OM	Regrowth	Unstocked
Alpine Ash	6	238	NA	895	14879	NA	60	6935	NA
Mountain Ash and Shining Gum	487	13428	1836	992	20455	659	506	25157	5776
High Quality Mixed Species	4368	959	NA	12691	4077	NA	5448	6180	37
Low Quality Mixed Species	11064	2857	NA	26359	23349	NA	24383	9933	1002
Total Area 225 216	15925	17482	1836	40937	62760	659	30397	48205	7015

Source: Proposed Central Highlands FMP Appendix R(NRE 1996b)

Sawlog Classification

Sawlogs are graded according to their quality, and sometimes by their 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 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 yield predictions is changing from C+ sawlogs to D+ sawlogs to align the standards used for licensed sawlog allocations with the legislation. Logs not meeting the D Grade requirements are termed residual logs.

Residual Log Classification

Victorian Government policy for native forest timber production is geared towards sawlog production and value-adding. Residual logs are those that are either too small or too defective to meet current sawlog specifications, but may be salvaged mainly for non-sawlog end-uses such as firewood, craftwood or wood-fibre products. Residual logs are produced as a byproduct of harvesting for sawlogs, or from silvicultural activities such as thinning or overwood removal which are designed to enhance future sawlog production.

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

Timber Resource

As indicated earlier, timber harvesting in Ash forest is restricted to stands that have regenerated since 1900. Consequently the timber resource and information related to the resource description is mainly concerned with regrowth Ash forest. Approximately 20 per cent of the timber volume currently available to industry is derived from mature and overmature mixed species forests.

Regrowth

Regrowth forest accounts for about 68 per cent of the net productive area of the Central Highlands. Data for regrowth growth rates is therefore very important. Growth data used in the forecast of sustainable yield are usually derived from surveys or inventories of forest

plots in representative forest types. These data are then used to predict growth rates across the entire area in question. Data pertaining to ash type forests were derived from the Forest Inventory Reports (FCV 1980a, 1980b, 1981; CFL 1985a, 1985b). The mixed species forests have not been surveyed as thoroughly, and the data pertaining to them are considered to be inferior to that of the ash forests, however the impact on sustainable yield of any errors that might be associated with these estimates should be relatively small, given the low growth rates applied.

The growth rates for D+ sawlog yield, detailed in table 4.2, have been derived from STANDSIM (Opie 1972, Campbell *et al.* 1979) and have been validated using data from the inventories described above.

Table 4.2. D+ net MAI (m³/ha/yr) by Forest Management Area.

Forest Type	Central FMA	Central Gippsland FMA	Dandenong FMA
Alpine Ash	3.98	3.59	-
Mountain Ash and Shining Gum	4.34	3.53	3.55
High Quality Mixed Species	1.52	1.52	1.52
Low Quality Mixed Species	1.01	1.01	1.01

Standing Timber Volumes Mature/Over Mature Resource

Data for forest type by area and age class is contained in the Hardwood Area Resource Information System (HARIS), which is a special purpose database. The HARIS database was described and appraised by the University of Melbourne for the East Gippsland CRA Report (VicRFASC 1996d).

For the Central Highlands, HARIS provides a standing volume for sawlog and residual roundwood for the Mature and Overmature (M/OM) forest types. The broad forest age class strata contained in HARIS in the Central Highlands are:

- Pre 1900 (Mature and Over-Mature, or M/OM);
- Decades after 1900 to 1991 (Regrowth, Advanced Regrowth and Mature).

HARIS is not used to provide data for standing volumes of regrowth ash, as this can be forecast using growth estimates, age class and area statements. HARIS is used, however for estimating standing volumes of Mixed Species. The data on mixed species forest types currently contained in HARIS are of variable age and quality, and consequently do not carry a high level of confidence. As described in table 4.1, M/OM mixed species forest types comprises approximately 37 per cent of the net harvestable area in the three FMA's. Table 5.13 shows that mature and overmature Mixed Species accounts for approximately 20 per cent of current sawlog licence allocations across the region.

4.2 LEGISLATIVE, POLICY AND PLANNING FRAMEWORK FOR SUSTAINABLE YIELD

'Sustainable yield', as it applies in Victoria, is the rate of sawlog harvesting that can be maintained from the forest, without impairing the long-term productivity of the land, taking into account the present structure and condition of the forest (NRE 1996b).

Sustainable yield is forecast on the basis of sawlog production, as timber harvesting in Victoria is sawlog-driven with residual logs produced as a byproduct 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 can be implemented and waste is 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 (FMA) must equal - or be within two per cent of - the sustainable yield rate forecast over a 15 year supply period, referred to as the 'long-term hardwood supply level'. The short-term (annual) sawlog supply level is more flexible to allow for the consideration of 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* also specifies that the sustainable yield rates for the harvesting of hardwood sawlogs from native State forest are to be reviewed in each five year period from 1 July 1991. The Minister is required to consider a formal review of Sustainable Yield outside the specified five yearly timetable if the 'Minister thinks there has been a significant variation in the hardwood sawlog resources in any State forest available to be exploited commercially' or 'if he or she thinks is appropriate to do so.' (Sections 52d. (2,3)). On completion of the review, the Minister may decide that sustainable yield rates should remain the same, or may recommend to the Governor in Council new sustainable yield rates, given significant changes in the available sawlog resource, for all or any of the State's 15 designated forest management areas.

The major objectives set by the Department for meeting the legislated requirements for sustainable yield in Central Highlands are to:

- provide a non-declining supply of grade D+ (previously C+) sawlogs;
- provide the highest yield available (on a sustainable basis) at any given point in time; and
- eventually reach the long term potential productivity of the forest which will result from a balanced age class distribution throughout the forest (NRE, 1996a).

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

- net productive area of mature/overmature forest;
- standing volume of grade D+ (previously C+) 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; and
- allowances for known risks (for example wildfire) or other factors.

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

The current legislated Sustainable Yields for the Central, Dandenong and Central Gippsland FMA's are provided in Table 4.3.

Table 4.3: Legislated Sustainable Yields of Sawlogs (m³/year)

Forest management Area	Volume (D+m³/yr)
Dandenong FMA	46 000
Central FMA	144 000
Central Gippsland FMA	225 000
Total	415 000

Source: Forests Act 1958

It should be noted that only 24 per cent of the Central Gippsland FMA occurs within the Central Highlands region discussed in this report, and therefore the forecast for the Central Highlands region is proportionally smaller. Actual figures for the region are not available, although licenced volumes are given in Table 5.13.

The information and processes used to forecast sustainable yield for the Central, Dandenong and Central Gippsland FMA's are briefly discussed below.

4.3 SUSTAINABLE YIELD IN CENTRAL HIGHLANDS

The following discussion outlines the major factors that have influenced the development of the sustainable yield forecasts that apply to the Forest Management Areas (FMAs) within the Central Highlands.

1984/85 Inquiry into the Timber Industry

The data and processes used to forecast sustainable yield in Central Highlands stem from the Timber Industry Inquiry (Ferguson 1985). This inquiry was established by the Victorian Government 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 assumptions and the prevailing management strategies and included a conservative approach 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 factor 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 Chairman, Professor Ferguson, concluded at the time the forecasts were adequate but recommended that more advanced planning methods and forecasting be used in future (Ferguson 1985).

Since the Timber Industry Inquiry, various factors have resulted in changes to timber resource availability in the region. The following is a brief synopsis of these changes and the relative implications for sustainable yield forecasts.

1986 Timber Industry Strategy

The Timber Industry Strategy (TIS) (Victoria Government 1986) established the basis for the application of regional sustainable yield to the harvesting of sawlogs from State forest in Victoria in response to the Timber Industry Inquiry. The regions established for this purpose

are called Forest Management Areas (FMAs) and are based on areas of native forest supplying sawlogs, the location of major conversion centres and consolidation of supply commitments to individual sawmills. Sustainable sawlog yield rates for each FMA were determined based on available resource data, management plans and existing sawlog utilisation standards.

Sustainable Yield forecasts for Central, Dandenong and Central Gippsland FMA's, determined for the Timber Industry Inquiry were adopted (Table 4.4).

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

Forest management Area	Volume (C+m ³ /yr)
Dandenong FMA	41 000
Central FMA	115 000
Central Gippsland FMA	183 000
Total	339 000

Source: Proposed Central Highlands FMP (NRE 1996b)

Forecast estimates were made to 2016. On the basis of the available information and the net productive area of State forest, it was expected that as the Ash resource matured in the Central Highlands, sustainable yield levels would increase. Assuming no other changes, sustainable yields were estimated to increase from the 1985 levels by 32 per cent for the Central FMA, 58 per cent for the Dandenong FMA and 14 per cent for the Central Gippsland FMA (Victoria Government 1986). Growth rates used to estimate the forecasts are given below (Table 4.5).

Table 4.5: C+ net MAI, by Forest Management Area (m³/ha/yr)

Forest Type	Central FMA	Central Gippsland FMA	Dandenong FMA
Alpine Ash	2.50	2.26	-
Mountain Ash and Shining Gum	3.00	3.26	3.00
Mountain Mixed Species	2.00	1.41	2.00
Foothill Mixed Species	1.50	1.15	1.50

1988 Uniform Log Grading Rules

New State-wide 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 Red Gum, Box and Ironbark, which are termed durable species.

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 Central Highlands, 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 Central Highlands 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. 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 long term licences were set in accordance with the Sustainable Yield forecasts for Central and Dandenong FMA's (Table 4.4). Licences for the Central Gippsland FMA however were set at approximately 66 per cent of the estimated sustainable yield forecast in recognition of the level of uncertainty of data for standing timber volumes and growth rates in mixed species forests. This reduction was in addition to the 25 per cent reduction factor applied to the net available area across the region in forecasting the yield estimate in 1985.

Negotiation on the renewal of these licences will commence from 1998/99.

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 Central Highlands.

1990 Sustainable Yield Legislation

In 1990, as part of the implementation of the TIS, the Forests Act 1958 was amended to provide for a legislated sustainable yield rate for each FMA. The forecasts are specified in a schedule to the Act and are periodically reviewed according to legislative requirements.

The 1990 legislation adopted the sustainable yield rates for Central, Dandenong and Central Gippsland FMA's that were established in the Timber Industry Strategy of 1986. The assumptions and the methodologies used to forecast the sustainable yield in Central Gippsland FMA were described in Pearson and Featherston (1992).

1993 Transfer of Strzelecki Ranges Hardwood Plantations to the Victorian Plantations Corporation

Following the formation of the Victorian Plantations Corporation (VPC) in 1993, some 10,718 ha of hardwood plantations across the State including 7,416 ha in the Strzelecki Ranges (principally 20-30 year old Mountain Ash) were transferred to the Corporation. The Strzelecki hardwood plantations accounted for approximately 10 per cent of the sustainable yield in Central Gippsland FMA and, prior to this decision, were to be available for sawlog harvesting, and contribute to the sustainable yield from about 2020.

Given that the forecast sustainable yield in the Central Gippsland FMA was estimated to increase by approximately 14 per cent, it was considered that the estimated 10 per cent loss

could be offset and therefore a change to the legislated sustainable yield rate was not warranted.

1994 Land Conservation Council Melbourne District 2 Review

Acceptance by the Victorian Government of the Land Conservation Council (LCC 1994) recommendations for additions to National Parks in the Central Highlands resulted in a reduction of 3,413 ha of net productive area and the prohibition of logging in all stands of pre-1900 Ash forest. This resulted in an estimated reduction of about 5100m³ of C+ sawlogs per annum from the three FMA's. The Council recommended that any change to sustainable yield rates should not be made until after 2001, at which time the estimated reduction could be offset by predicted increases associated with the maturing ash resource. The impact of the recommendations was estimated to be a reduction of 2.6 per cent, 12.5 per cent and 1 per cent in the Central, Dandenong and Central Gippsland FMA's, respectively. This reduction is well within the estimated increases in the Timber Industry Strategy (1986).

1994/95 State-wide Forest Resources Inventory (SFRI)

The State-wide Forest Resources Inventory (SFRI) commenced in Victoria in 1994/95 (NRE 1996b). The SFRI will map around about 3.5 million hectares of State forest, with sampling of productive mature and over-mature forests to determine the volume of D+ sawlog. The five year 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 M/OM and regrowth stands. Specifically the new inventory will:

- update the State's timber resource data, replacing data collected primarily in the 1960s and 1970s,
- 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.

Data from the SFRI for the FMA's located in the Central Highlands RFA region will start to become available from mid-1998. Further discussion of the SFRI is given below.

1996 Statewide Review of Sustainable Yield

The *Forest 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. Therefore, the first review was conducted in 1996.

At the time of the review the SFRI project had commenced in the Central Highlands, however data were not available to update existing information. In addition, with a number of planning processes underway, including the development of the Proposed Central Highlands Forest Management Plan and the CRA/RFA about to commence, it was decided that a full reconciliation of the changes would occur prior to the next sustainable yield review, due in 2001. Improved timber resource information derived from the SFRI program will also be available at this time. Consequently the changes in assumptions since 1985, including the impact of removing the Strzelecki Ranges hardwood plantations from the available resource, were not formally considered in the 1996 Review. However, given the above synopsis, NRE

considered that the conservatism of the original forecast, and magnitude of the subsequent changes could be accommodated without changes to the Sustainable yield forecasts.

One change that was made as part of the 1996 review was the conversion of sustainable yield rates from C+ to D+, 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 1996 yield rates, corrected for D+ sawlogs, in terms of MAI were given in Table 4.2 above.

1996 Proposed Forest Management Plan

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 input from the community. 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. The proposed Central Highlands Forest Management Plan (FMP) was released in December 1996 (NRE 1996a).

Following the development of the zoning scheme in the proposed plan, an analysis of the implications for timber resource availability was conducted by NRE. The analysis was based on the net productive area available for harvesting (table 4.1), revised growth rates for D+ sawlogs (Table 4.3) and also included an adjustment for the potential resource losses due to wildfire equivalent to 0.5 per cent per annum.

As discussed earlier, the sustainable yield rates legislated in 1990 included a general reduction factor (25 per cent) which accounted for areas of low productivity, steep slopes, leadbeaters possum habitat and rainforest. These areas have now been mapped in detail in the Central Highlands and, as their area is more accurately known, a reduction factor for these features was not included in the analysis. However, the analysis conducted for the proposed Plan did include a reduction factor of 15 per cent to account for the uncertainty in resource estimates, in particular the mixed species resource.

In preparing the proposed Plan, the Standsim growth model (Opie 1972) was used to simulate the growth of an intensive network of inventory plots to produce yield estimates for ash-eucalypt forests. The yield estimates for the mixed species forests were based on limited sampling and expected harvest volumes. The SFRI program is collecting additional yield information in both the ash-eucalypt and mixed species forests.

As reported by NRE (1996a) the analysis provided an indication that current legislated volumes can still be achieved were the Plan to be adopted.

4.4 APPRAISAL OF SUSTAINABLE YIELD METHODOLOGY

As documented in the previous sections, the process and methodology used to make the forecast of sustainable yield in the Central Highlands is largely derived from the submissions made to the Timber Industry Inquiry (Ferguson 1995) for the Central, Dandenong and Central Gippsland FMA's. The sustainable yield forecasts, which were subsequently adopted in the Timber Industry Strategy (1986) and incorporated into legislation in 1990, have not been

altered except in terms of sawlog classification, and have been accepted by the Victorian Parliament as the basis for the 1996 Statewide review of sustainable yield.

Since the initial legislated sustainable yield was forecast, a number of changes have occurred, including:

- a decrease of 5,100m³ C+ per year arising from the LCC recommendations;
- the loss of 7,416ha of hardwood plantations in the Strzeleckis (part of Central Gippsland FMA);
- an increase in net productive area due to more accurate definition of allowances required for Leadbeater's Possum habitat and rainforest;
- an overall increase, due to validation of MAIs (increasing in the regrowth ash and decreasing in the mixed species).

In considering these changes, the 1996 statewide review of sustainable yield by NRE (NRE, 1996a) determined that the levels would not be changed, other than to convert C+ to D+ sawlogs, due to the high level of conservatism in the original estimates (incorporating a 25 per cent reduction factor in available area) and the licencing arrangements (set at 67 per cent of forecast estimates in Central Gippsland), and the ability to offset any unforeseen shortfall by the anticipated increases in resource availability, expected to occur from 2002 (Victoria Government 1986).

The analysis undertaken as part of the development of the Proposed Central Highlands Forest Management Plan also provides a validation measure against the legislated forecast yields, although it was not formally used in the 1996 statewide review. The analysis represents the most up-to-date and complete review of timber resource availability for the Central Highlands since 1985 as it used SYSS (described below) linked to GIS (1:25000 area statement with proposed Forest Management Zoning), improved D+ growth curves for regrowth forest, an allowance for resource loss following wildfire and uncertainty in some resource estimates (a reduction factor of 15 per cent). As reported by NRE (1996a) the analysis provided an indication that current legislated volumes can still be achieved were the Plan to be adopted.

NRE has indicated that improved data and modelling systems will be available using SFRI and IFPS (described below) before the next legislated review in 2001. The availability of the SFRI data will allow a formal reconciliation arising from any divergence from the current forecast yield level, and improved forecast estimates. Sustainable yield levels in the Central Highlands are dominated by regrowth ash (both in area and growth rates). Reliable information on growth rates and net productive area exists for these forests. Future wood availability is likely to increase as the ash resource matures, and as alternative silvicultural options to further enhance timber yields are implemented. On this basis, it is likely that any correction that may be required to current sustainable yield forecasts could be offset by potential increases in sustainable yield through the long term resource capacity of the region.

Nevertheless, there is some potential to improve the confidence in the current forecasts through formal documentation of the methodology used to determine resource availability for the preparation of the proposed Plan, including stated assumptions, and exposure to risk using sensitivity analysis, as well as formal documentation of actual versus predicted yields.

4.5 FUTURE APPROACH USING IFPS AND SFRI

Inventory

The forecast of sustainable yield for the 2001 review will be based on new inventory data provided from the Statewide Forest Resource Inventory (SFRI) (Penny, 1996). The SFRI will provide new and more accurate estimates of standing volume, and data will be spatially referenced. The information will be held in a GIS database from aerial photographs and plot assessments. The SFRI GIS database will provide an area statement in the same format as that from HARIS, though regrowth is redefined as 'age classes, by decade from 1920'. Any age-class before this will be classed as M/OM. Under the SFRI proposed timeline for the Central

Highlands, aerial photography will be completed in 1997, the plot inventory work is scheduled for the summer of 1997-98, with all the reporting on SFRI due in September 1998.

SFRI data will update and improve NRE knowledge for the Ash stands, and greatly improve the level of data for the mixed species stands. As well, a new forest planning system, the Integrated Forest Planning System (IFPS), will be used. This, together with the improved quality data, will allow a more accurate forecast of sustainable yield. It will also aid the prediction of the ecological impacts of harvesting. The most important features of the SFRI/IFPS system are discussed in the following sections.

Area

In the past, the State forest area in the HARIS database was classified in terms of total, gross productive and net productive area. The total area refers to the total area of the stand, and includes areas that are unsuitable for harvesting due to factors such as low site quality, steep slopes, and poor access. The gross productive area is the area of the stand that is capable of producing merchantable timber under current utilisation procedures, and includes productive forest in reserves that will not be harvested. The net available area is the actual area from which sawlogs are harvested under current management prescriptions as defined by the Code of Forest Practices (NRE, 1996a) and the Proposed Forest Management Plan (NRE, 1996b). This area therefore excludes productive forest located in reserves and steep slopes. Areas which are deemed to be unmerchantable due to accessibility constraints are also excluded.

Tools

The analysis methodology applied to sustainable yield forecasts has progressed from a manual spreadsheet approach through various stages of computerised spreadsheets, culminating in the current version of Sustainable Yield Spreadsheet (SYSS). SYSS is a specialised Microsoft Excel spreadsheet which uses summarised information (such as from HARIS or GIS), calculates the availability of timber, and provides a summary of results. Using SYSS is an iterative process, whereby the resource is heuristically scheduled to be harvested according to its age and productivity (Pearson and Featherston, 1992). An allowance for fire and error can also be made using the SYSS system. The latest version of SYSS now forms a component of the Integrated Forest Planning System.

The Integrated Forest Planning System (IFPS), which will be used to forecast sustainable yield, is a Linear Programming (LP) optimisation package composed of SYSS, FORPLAN (Johnson *et al.*, 1986) and SPECTRUM (Camenson *et al.*, 1996). The user specifies a minimum and maximum harvesting age for each forest type, and the package optimises wood flow according to these and any additional constraints that may be added - for example, constrained harvesting regimes in catchments to ensure a specific water flow level, or more complicated thinning regimes.

The LP packages optimise wood flow whilst ensuring a non-declining yield. Data are entered into FORPLAN/SPECTRUM as a list of analysis areas derived from a GIS, each with attributes such as area and volume by forest type by age class, each with associated yield curves and silvicultural regimes. To each of the analysis areas, attributes such as water yields can be attached, and it is also possible to specify constraints on harvesting for a particular area if it is within a Special Management Zone. FORPLAN has a limit of 1,000 analysis areas, compared with 72 (ie 6 forest types times 12 age classes) in SYSS. SPECTRUM has no limit on analysis areas, and does not constrain the user to schedule harvesting at constant time periods. Using IFPS enables the construction of a more detailed harvesting prescription, but one which is also more complicated to programme and to check. However, SYSS is used to make a coarse estimate of the sustainable yield and develop the silvicultural strategy, while

the linear programming packages provide a detailed break-up of harvesting to the block level, which can be output to a map base.

The Midlands sustainable yield review (CNR, 1995c) is an example of the use of an LP tool to incorporate detailed harvesting prescriptions for specific areas. To forecast sustainable yield for the Midlands, yield curves were used which were specific to the district and sometimes to the block level for each forest type.

Monitoring and Auditing

NRE is in the process of producing a report on 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. The report will be used as an internal accounting procedure, and will also be considered as a component of the 1996 review of sustainable yield. This will ensure that the legislated sustainable yield rate is consistent with the previous five years' harvesting, and that the licence levels remain within two per cent of the sustainable yield, as required by the legislation.

Information on area and volume harvested, by forest type and age-class, will be received from the regions on a yearly basis. This information will enable NRE to monitor the area and volume harvested and in comparing these to the sustainable yield forecast, pinpoint discrepancies in the area statements, standing volume estimates and yield projections for each FMA.

Review of SFRI and IFPS

The SFRI system was reviewed in 1996 and Brack and Turner, 1996). In the opinion of the reviewers, the proposed Inventory and Yield Data collection and analysis is an effective and useful methodology that should result in statistically valid and unbiased estimate of volume and yield appropriate for strategic level planning. Brack and Turner 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.

One of the major inadequacies of the old HARIS based data in the Central Highlands, is the poor quality of data (standing volume and growth) for the mixed species resource. Because of the time constraints involved, repeat measurements from permanent growth plots established with the SFRI will not be available by the 2001 review. The proposed use of stem analysis to develop growth and yield models was found to be methodologically sound by the consultants, and should allow development of appropriate models.

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

The IFPS methodology was reviewed and approved by an external consultant, Brian Turner (CNR, 1995c) for its application in the Midlands FMA. The use of this methodology in conjunction with good quality GIS-based inventory data was found to be consistent with best international practices. The introduction and greater flexibility of the FORPLAN update, SPECTRUM modelling software in the IFPS system should provide further improvements.

4.6 RESIDUAL LOGS

Residual logs are those that are either too small or too defective to meet current sawlog specifications (Appendix 3). The Timber Industry Strategy (Victoria Government, 1986) sets

the context for Departmental policy regarding the production of residual logs. Native forest timber production in Victoria is geared towards sawlog production and value-adding. Residual logs are produced both as a byproduct of harvesting for sawlogs, and from silvicultural activities such as thinning or overwood removal which are designed to enhance future sawlog production.

Currently, about 600 000 m³ of residual logs become available in Central Highlands each year as a byproduct of normal sawlog harvesting operations. Forecasts indicate that residual log availability is expected to remain relatively constant, at least until the year 2020. Improved estimates will be available through the SFRI.

The estimated volumes of residual logs in the Central Highlands were derived using STANDSIM for the ash forests and from inventory work in the case of the mixed species resource.

5. TIMBER INDUSTRY - CURRENT POSITION AND OUTLOOK

5.1 STRUCTURE AND VALUE OF THE HARDWOOD TIMBER BASED INDUSTRIES

The native wood based industries are an important component of the economy of the Central Highlands and surrounding regions. Taking into account the proportion of native hardwood from the Central Highlands region that is utilised by the sawmilling and pulpwood processing based industries (including facilities located both within and outside the region), these wood resources presently provide for an estimated 1537 direct jobs, and an estimated gross value of turnover of \$323 million. This includes a turnover value of \$91 million for the sawmilling industry and \$232 million for the pulpwood processing industries (Table 5.1). Estimates of gross value and employment from the sawmilling and pulpwood processing industries were calculated on a pro-rata basis, by multiplying the percentage of total wood intake that is sourced from the Central Highlands region for these industries by the relevant total employment or gross value of production figures.

The flow-on effects to the state economy from the forest based industries using wood sourced from the Central Highlands RFA area may be broadly estimated using appropriate input-output and employment multipliers. Drawing on available multipliers for the forest based industries in the Victorian economy, it is estimated that the value of turnover from the sawmilling and pulpwood processing industries receiving hardwood resources from the Central Highlands contribute \$170 million and \$496 million respectively to state output. These estimates are based on a state output multiplier of 1.87 for the sawmilling sector and 2.14 for the paper products sector (National Institute of Economic and Industry Research 1985).

In addition, the value of gross receipts of logging and haulage contractors from the Central Highlands was estimated at \$32 million in 1995-96 (refer Table 5.6). Using a state output multiplier of 2.04 for the forestry sector, it is estimated that the logging and haulage industries contribute \$65 million to state output.

The total value of turnover attributable to hardwood resources from the Central Highlands region from the logging and haulage, sawmilling and pulpwood processing based industries is therefore estimated to contribute \$731 million to state output.

The sawmilling and pulpwood processing industries receiving hardwood resources from the Central Highlands contribute 1564 and 1445 jobs respectively to the Victorian economy. These estimates are based on a state employment multiplier of 2.3 for the sawmilling sector (with 680 direct jobs) and 3.1 for the paper products sector (with 466 direct jobs). It is also estimated that the forest management sector (with 130 direct jobs) and logging and haulage sectors (with 261 direct jobs) from the Central Highlands region contribute an additional 821 indirect jobs to the Victorian economy, using a state employment multiplier of 2.1 for the forestry sector.

In addition, the value of log royalties received by the Victorian Government from the Central Highlands RFA region was \$11.92 million in 1995-96, with a further \$1.08 million received by the Victorian Government in sawmill licence fees. In addition, \$5.1 million roading charges were collected from the Central Highlands.

It should also be acknowledged that a proportion of revenues received by the wood based industries and other sectors of the regional economy are transferred to governments through the payment of relevant taxes. For example, applying a company tax rate of 36 per cent to estimated operating profit, the value of company taxes paid on sawmilling income from wood resources sourced from the Central Highlands region may be as high as \$5.8 million. However, this figure is likely to over estimate the actual value of company taxes paid, since no account of allowable depreciation items has been included.

Significance of the Eucalypt Ash Timber Resource

Eucalypt ash species form the basis of high quality domestic hardwoods for the Victorian wood processing and manufacturing industries. Eucalypt ash species referred to here include mountain ash, alpine ash and shining gum. This group of ash species have proven the most suitable local species for drying and subsequent further processing into higher value products (LCC 1991).

Table 5.1: Key economic features of the timber based industries drawing hardwood resources from the Central Highlands, 1995-96

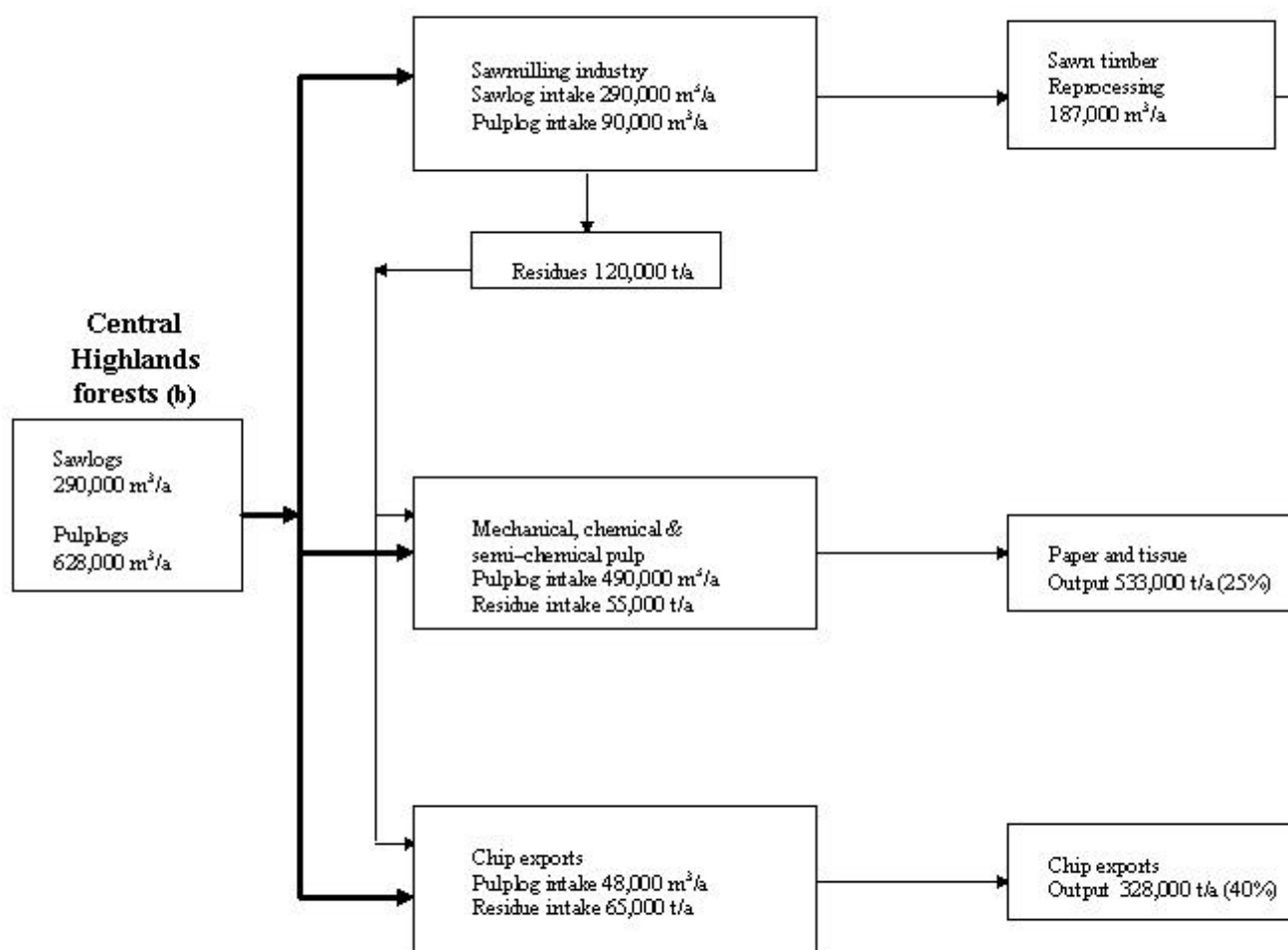
Gross value of wood based industries (product value)	\$ million
Pulpwood based industries	232 a)
Sawmilling industry	91
Total product value	323
Forestry and wood based industry employment	no. persons
Forest management	130 b)
Pulpwood based industry	466 a)
Sawmilling industry	680
Logging and haulage	261
Total employment	1 537
Log volumes produced	m³
Sawlogs produced	279 100
Residual log produced	579 800
Total volume	858 900
State forest royalties received	\$ million
Sawlog royalties received	8.77
Residual log royalties received	3.15
Sawmill licence fees received	1.08
Total royalties	13.00

a) Calculated by multiplying the percentage of total intake sourced from the Central Highlands by the relevant total employment, production or gross value of production figures. Most of these facilities are not located in the Central Highlands. b) K. Wareing, Victorian Association of Forest Industries, personal communication, October 1996.

High value uses of these timbers include furniture, flooring, doors, panelling and mouldings. The high value use of ash species is exemplified by its being the most common group of species used by furniture manufacturers in the eastern mainland States. Investment by firms in capital to enable further processing of ash timbers has been taking place in the Central Highlands region, and is described further in this chapter. Some 70 per cent of the further processing capacity in Victoria is associated with the Central Highlands ash resource.

Figure 5.2:

Figure 5.2: Current structure of the forest industry in the Central Highlands (a)



Figures in brackets are the percentage of total fi Highlands

a Estimates based on sawmill survey.

There are 41 hardwood sawmills and four major pulpwood processors receiving wood from State forest within the region. The location of State forests in the Central Highlands region and mills (both sawmills and pulpwood processors) receiving hardwood resources from the region is shown in Figure 5.1 (enclosed in sleeve at back of report). All of the pulp and paper making facilities receiving wood resources from the Central Highlands are located outside the region, together with a number of sawmills.

The 41 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 41 hardwood sawmills also include one specialist recovery mill which produces a high proportion of sawn product (such as palings and pallets) from residual logs.

The pulpwood processing activities include the use of State forest logs at the large integrated pulp and paper making facilities located at Maryvale; pulp production activities at Myrtleford (which is further processed in Melbourne to produce tissue paper); integrated pulp and tissue production activities in Millicent (South Australia); and woodchip export activities located in Geelong. The current structure of the Central Highlands hardwood based industry is illustrated in Figure 5.2.

Table 5.2: Total forestry and wood based industry employment resident in the Central Highlands RFA region, 1991

Industry	Employees
Forestry and logging	110
Forestry and service to forestry	60
Logging	135
Total forestry and logging	195
Wood and paper products manufacturing	
Log sawmilling	222
Resawn and dressed timber	75
Veneers, manufactured boards of wood	23
Wooden doors	29
Wood structural fittings, joinery NEC	472
Wooden containers	21
Hardwood woodchips	0
Wood products NEC	121
Furniture	1 414
Wood, wood products, furniture undefined	10
Wood, wood products undefined	87
Paper, paper products undefined	135
Pulp, paper and paperboard	294
Paper bags (including textile bags)	50
Solid fibreboard containers	126
Corrugated fibreboard containers	145
Paper products NEC	325
Total wood and paper products	3 549
Total forestry and wood based industries	3 744

Source: ABS (1996b).

In Table 5.2, estimates are provided for employment by major industry category for people who were resident in the Statistical Local Areas comprising the Central Highlands RFA region. Based on these figures, the wood based industries accounted for 3744 direct jobs, or around two per cent of total regional employment in 1990-91. It is important to note, however, that these figures are based on residents within the Central Highlands region, and do not take account of wood based industry jobs that are linked to hardwood resources sourced from the Central Highlands RFA region which are located outside the RFA boundary.

Total sawmilling and pulpwood processing employment that is attributed to hardwood resources received from the Central Highlands is given in Table 5.1, which includes employment both within and outside the region. These estimates include, for example, employment at the Maryvale pulp and paper mill, and sawmilling employment located in towns such as Powelltown and Heyfield. The Maryvale pulp and paper mill receives approximately 58 per cent of eucalypt wood resources from the Central Highlands region and employs 930 persons. On a pro rata basis, some 320 jobs at Maryvale are dependent on hardwood timber resources from the Central Highlands.

In addition to direct sawmilling and pulpwood processing employment, native hardwood resources from the Central Highlands region also contribute to a range of further solid wood manufacturing based activities, such as furniture manufacturing, joinery and craft wood industries. In 1991, for example, there were 2134 persons employed in the furniture and joinery based industries (which included the categories: resawn and dressed timber; furniture; wooden doors; veneers and manufactured boards of wood; wooden structural fittings and joinery; and miscellaneous wood products) who were resident in the Statistical Local Areas comprising the Central Highlands RFA region (Table 5.2). It is important to note, however, that these manufacturing activities are likely to have been based on wood resources sourced from hardwood native forests, plantation softwood forests and imports. There are also a range of other manufacturing facilities located outside the Central Highlands region which receive semi-processed wood products from the Central Highlands for further processing.

State Forest Log Production and Value

The Central Highlands region represents a significant native hardwood resource for the wood based industries, accounting in 1995-96 for around 33 per cent of total state sawlog production and 57 per cent of total state residual log production (Table 5.3). In 1995-96, the region produced around 279 000 cubic metres of sawlog, and 580 000 cubic metres of residual log.

The Central Highlands region contributed around \$11.9 million in log royalties in 1995-96, or around 48 per cent of total state forest log royalties received in that year (Table 5.4). These royalties stemmed from a combination of high production volumes as well as a relatively high proportion of higher grade sawlogs, which attract a higher log royalty. In 1995-96, total sawlog royalties received from the region were \$8.8 million, while total residual log royalties were \$3.1 million.

The native eucalypt ash forests of the Central Highlands region have a high commercial value, because of their relatively rapid rates of growth and their characteristic long straight bole which makes them highly suitable for milling into sawntimber products. Although the eucalypt ash forests (comprising mountain ash, alpine ash and shining gum) account for only a small proportion of the total forest area in the region, they provide a substantial share of higher grade sawlogs.

Pulpwood material sourced from eucalypt ash forests is also regarded as a cost effective input into the manufacture of pulp and paper products, because of the lower quantity of black tannins produced during the paper manufacturing process. This makes ash eucalypt less costly compared with other sources of pulpwood supply which contain higher quantities of black tannins, such as the mixed species hardwood forests.

Table 5.3: Gross volume of logs received from Central Highlands region, 1995-96 a)

(1) Volume of Non-ash species, by log grade b)								
	A m ³	B m ³	C m ³	D m ³	D+ m ³	R m ³	Other m ³	Total m ³
Central Gippsland	—	1 000	5 502	2 610	9 112	49 871	14	58 997
Central	—	3 868	8 086	4 342	16 296	21 519	—	37 815
Dandenong	—	773	3 908	2 378	7 059	24 965	—	32 024
Central Highlands	—	5 641	17 496	9 330	32 467	96 355	14	128 836
Total Victoria	532	33 768	297 168	141 002	472 470	478 292	13 717	964 479
Central Highlands c) (%)		16.7	5.9	6.6	6.9	20.1	0.1	13.4
(2) Volume of Ash species, by log grade b)								
	A m ³	B m ³	C m ³	D m ³	D+ m ³	R m ³	Total ash and non-ash m ³	
Central Gippsland	187	34 634	59 232	16 344	110 397	260 391	370 788	429 785
Central	63	43 273	44 757	18 100	106 193	123 750	229 943	267 758
Dandenong	32	10 769	15 657	3 582	30 040	99 347	129 387	161 411
Central Highlands	282	88 676	119 646	38 026	246 630	483 488	730 118	858 954
Total Victoria	2 106	114 786	186 842	60 743	364 477	532 974	897 451	1 861 930
Central Highlands c) (%)	13.4	77.3	64.0	62.6	67.8	90.7	81.4	46.1
(3) Total ash and non-ash species								
	A m ³	B m ³	C m ³	D m ³	D+ m ³	R m ³	Other m ³	Total
Central Highlands	282	94 317	137 142	47 356	279 097	579 843	14	858 954
Total Victoria	2 638	148 554	484 010	201 745	836 947	1 011 266	13 717	1 861 930
Central Highlands c) (%)	10.7	63.5	28.3	23.5	33.3	57.3	0.1	46.1

a) The Central Highlands RFA region includes all state forest areas in the Central and Dandenong FMAs but does not include all of the State forest in the Central Gippsland FMA. Only that part of the Central Gippsland FMA within the RFA boundary has been included. b) Log grades A to D represent sawlogs of diminishing log quality respectively. Log grade R represents residual or pulplog. Other grades include firewood. c) Central Highlands share of Victorian total. *Source:* NRE (1997b).

The Central Highlands RFA region represents a significant source of ash eucalypt logs for the domestic sawmilling and pulp and paper based industries, accounting for around 81 per cent of total eucalypt ash type logs produced from Victorian state forests in 1995-96. The region produced 246 630 cubic metres of eucalypt ash type sawlog in 1995-96, with a total royalty

value of approximately \$8.1 million, and around 483 500 cubic metres of ash type residual log in 1995-96, with a total royalty value of around \$2.7 million.

Table 5.4: Royalties received from Central Highlands region, 1995-96 a) ('000 1995-96 dollars)

Non-ash species								
Log grade b)	A	B	C	D	Total D+	R	Other	Total
Central Gippsland	—	32 118	143 050	19 662	194 790	202 511	909	398 250
Central	—	117 213	194 729	33 021	344 963	87 212	—	432 175
Dandenong	—	27 697	116 538	20 471	164 706	114 254	—	278 960
Central Highlands	—	177 028	454 317	73 154	704 499	403 977	909	1 109 385
Victoria	27 067	1 145 253	6 408 670	1 035 713	8 616 703	1 814 323	520 457	10 951 483
Central Highlands c) (%)		15.5	7.1	7.1	8.2	22.3	0.2	10.1
Ash species								
Log grade b)	A	B	C	D	Total D+	R	Total	Total ash and non-ash
Central Gipps.	11 667	1 548 569	1 903 958	193 654	3 657 848	1 685 551	5 343 399	5 741 649
Central	3 872	1 726 001	1 341 342	235 002	3 306 217	420 927	3 727 144	4 159 319
Dandenong	2 328	510 772	541 148	51 059	1 105 257	634 792	1 740 099	2 019 059
Central H'lands	17867	3 785 342	3 786 448	479 715	8 069 372	2 741 270	10 810 642	11 920 027
Victoria	121 721	4 777 803	5 459 729	647 716	11 006 969	2 906 861	13 913 830	24 865 313
Central H'lands c) (%)	14.7	79.2	69.4	74.6	73.3	94.3	77.7	47.9
Total ash and non-ash								
Log grade b)	A	B	C	D	Total D+	R	Other	Total
Central H'lands	17867	3 962 370	4 240 765	552 869	8 773 871	3 145 247	909	11 920 027
Victoria	148 788	5 923 056	11 868 399	1 683 429	19 623 672	4 721 184	520 457	24 865 313
Central H'lands c) (%)	12.0	66.9	35.7	32.8	44.7	66.6	0.2	47.9

a) The Central Highlands RFA region includes all state forest areas in the Central and Dandenong FMAs but does not include all of the State forest in the Central Gippsland FMA. Only that part of the Central Gippsland FMA within the RFA boundary has been included. Royalties include the Timber Promotion Council Levy but exclude roading charges and sawmill licence fees. **b)** Log grades A to D represent sawlogs of diminishing log quality respectively. Log grade R represents residual or pulplog. Other grades include firewood etc. **c)** Central Highlands share of Victorian total.

Sources: NRE (1997b).

The region produced around 32 500 cubic metres of non-ash type hardwood sawlog in 1995-96 which had a total royalty value of \$704 500. Over the same period, around 96 500 cubic metres of non-ash type hardwood residual log, with a total royalty value of \$404 000, was extracted. The Central Highlands accounted for 13 per cent of Victoria's total non-ash log production in 1995-96 but almost 75 per cent of the logs were residual logs of low quality and value. As such, the region only accounted for around 10 per cent of the royalties received in Victoria for non-ash logs.

In addition to royalty payments, in 1995–96 sawmill licence fees for the Central Highlands RFA region were around \$1.1 million and roading charges were \$5.1 million.

Log Pricing and Allocation Arrangements

Central Highlands hardwood sawlogs are classified using a system of log grades in diminishing order of sawlog quality from A through to D. Presently, B and C grade sawlogs account for the bulk of ash species sawlogs produced from the Central Highlands. Pulpwood logs (or residual roundwood logs) taken from the Central Highlands are used as a fibre input for the production of pulp and paper products. A proportion of the better quality logs below D grade sawlog are converted to sawn products, in particular pallets and fencing material.

Fifteen year sawlog licences were introduced in 1987 and these specify the volumes, species group and grades of sawlogs to be supplied. Sawlogs sourced from state forests in the Central Highlands RFA region are currently sold at the stump. That is, royalties are charged on the sawlog before any processing occurs. Licences include the right to harvest and buy timber. Sawmillers pay private contractors to harvest and transport sawlogs from the forest to the mill, however licence conditions provide for the Department of Natural Resources and Environment to do this if necessary.

The majority of sawlog licence allocations are measured in gross volume terms, which includes the proportion of defect material in the log which is unsuitable for sawmilling. On the other hand, sustainable yield forecasts are in net volume terms, which exclude such defect material.

Licensees can receive logs up to 30 per cent above or below their annual allocation, thus allowing for fluctuations in market conditions. Allocations must be averaged over the licence period, with no more than 110 per cent of the annual allocation being used in any five year period. Table 5.5 shows the forecast sawlog yields by forest type, for the period 1997–2006 for the three FMAs comprising the Central Highlands RFA region. This provides a broad estimate of wood availability for timber production purposes over this period (NRE 1996b).

Table 5.5: D+ sawlog yield estimates for the Central Highlands, by forest type, 1997-2006 (m³ per year) a)

Forest type	Dandenong	Central	Central Gippsland
Alpine ash		50 000	50 000
Mountain ash and shining gum	37 500	70 000	157 000
High quality mixed species	4 000	16 000	10 000
Low quality mixed species	4 500	8 000	8 000
Total	46 000	144 000	225 000

a) This includes the three FMAs in their entirety. Source: NRE (1996b). Note: The sawlog yield estimate for Central Gippsland FMA is based on harvesting 150 ha/yr in the Thompson Reservoir catchment.

The proportion of sawlog grades which are allocated to licencees are negotiated on the basis of the degree of value adding being undertaken. If licencees are engaging in value adding, they have been allocated a higher proportion of higher grade logs. However, the total allocation of D+ logs does not vary through this process.

Log Harvesting and Transport

At present, sawmillers hire contractors to harvest and transport logs from the forest to the mill. There are about 96 log harvesting and transport contracting operators within the Central Highlands RFA region. These contractors operate in a number of different Forest Management Areas (FMAs) across the region (Table 5.6), and employ around 260 persons between them. Management arrangements are such that logging and harvesting operations are

Table 5.6: Log harvesting and transport contractors operating in the Central Highlands region, 1995-96

	Dandenong	Central	Central Gippsland	Total
Number of contracting operators				
Logging only	2	12	na	14
Transport only	10	22	18a)	50
Integrated logging and transport	5	na	27	32
Total contractors	17	34	45	96
Employment				
Logging	32	50	81	163
Transport	19	33	36	88
Administration	2	4	4	10
Total employment	53	87	121	261
Average number of employees per logging contractor	4.6	4.0	3.0	na
Log volumes d)				
Total volumes handled (m ³ /year)	124 000	298 000	550 000b)	972 000
Average volumes handled per logging contractor (m ³ /year)	17 700	27 000	20 000	na
Proportion of total volumes handled from public native forests in Central Highlands (%)	100	100	90b)	na
Capital investment and receipts				
Total capital value of all related plant and equipment (\$ million)	5.5	11.8	25.0	42.3
Average level of capital invested (\$ million)				
– per logging contractor	0.485	0.550	0.770c)	na
– per transport contractor	0.110	0.240	0.220a)	na
Total value of receipts received by contractors (\$ million)	3.9	11.0	17.1	32.0

a) Refers to eighteen subcontractor operators. b) Does not include additional private volumes handled on a part time basis by 5–6 operators. c) Refers to integrated logging and transport contractors. d) Includes both sawlogs and residual logs. na Not applicable. Source: Broad estimates supplied by the respective logging and hauling syndicates for the three FMAs comprising the Central Highlands RFA region.

scheduled through a logging and hauling syndicate within each of the three FMAs comprising the Central Highlands RFA region. There is one logging and harvesting syndicate each for the Dandenong, Central and Central Gippsland FMAs. The total current value of all plant and equipment (for example, harvesting gear and trucks) invested in the log harvesting and transport sectors across the region has been estimated at around \$42 million.

Recipients of logs from Central Highlands State forests pay a roading charge to the Department of Natural Resources and Environment. This is used to build and maintain

Departmental roads required for timber extraction. In 1995-96 roading charges collected from the Dandenong, Central and Central Gippsland FMAs were \$0.9 million, \$1.7 million and \$2.5 million respectively.

5.2 SAWMILLING INDUSTRY SURVEY

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 Central Highlands region was conducted as part of the CRA process.

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 one week in December 1996, by face to face interviews with sawmill owners or managers. All

Deriving total estimates for sawmills drawing hardwood resources from the Central Highlands

Eighty per cent (33 out of 41) of hardwood sawmills receiving logs from the Central Highlands RFA responded to the survey.

The sawmill population of the Central Highlands was grouped into four classes based on the size of their total log intake for 1995-96. The size classes were:

Log intake	Central Highlands population	Survey responses
Under 5000 m ³	17	10
5000–10000 m ³	8	8
10000–30000 m ³	11	10
Over 30000 m ³	5	5

Total estimates for the Central Highlands sawmilling industry were derived by weighting the survey respondents. Weights were based on both the sawmill population and estimated log intake class of the sawmills.

In some instances, the sawmillers only supplied partial responses to the questionnaires. For omitted data, estimates calculated from average costs, prices and returns were used.

Total estimates for the Central Highlands are supplied with a 'relative standard error' (RSE). These errors are the standard errors of the estimates expressed as a percentage of the survey estimates. There is roughly a two in three chance that the survey estimate is within one standard error of the value that would have been obtained from the total population.

sawmill owners/managers were contacted as part of the economic survey. Questionnaires were completed for 33 of the 41 hardwood sawmills receiving state forest logs from the Central Highlands RFA region. In log intake terms, the survey responses accounted for about 95 per cent of total state forest logs received by the Central Highlands sawmilling industry in 1995-96. The method used to derive estimates for the Central Highlands sawmill industry is outlined in the box.

5.3 THE HARDWOOD SAWNTIMBER INDUSTRY

In 1995-96, there were 41 hardwood sawmills receiving logs from State forests located in the Central Highlands RFA region. The following financial and physical information presented

on the hardwood sawmilling industry relates to the 1995-96 financial year, as this was the latest year for which complete records were available.

Total sawntimber production in Victoria in 1995-96 was around 882 300 cubic metres. Total hardwood sawntimber production from sawmills dependent on the Central Highlands resource for the same period is estimated at 187 000 cubic metres, or 21 per cent of total Victorian sawntimber production (including both softwood and hardwood sawntimber). Total hardwood sawntimber production from sawmills dependent on the Central Highlands resource was 46 per cent of total Victorian hardwood sawntimber production in 1995-96. Some of the other key financial features of the hardwood sawmilling industry in the Central Highlands region are presented in Table 5.7.

The total value of turnover (or gross receipts) for sawmills receiving hardwood resources from the Central Highlands is estimated at about \$91 million in 1995-96, with total operating costs estimated at about \$75 million. As such, the total net value of production (or net profits earned) for 1995-96 for sawmills receiving hardwood resources from the Central Highlands is estimated at around \$16 million. It is estimated that labour costs for the sawmilling industry were \$17.7 million in 1995-96, or almost a quarter of the estimated total operating cost.

Table 5.7: Key financial features of sawmills drawing hardwood resources from the Central Highlands, by category of sawmill product, 1995-96 a)

	Total	Sawmills producing:			
		Seasoned timber		Unseasoned timber	
	\$m	\$m	%	\$m	%
Gross receipts from sawntimber and products	85.9 (1)	66.3	77.2	19.6	22.8
Gross receipts from sawmill residues (woodchips etc.)	4.8 (2)	2.8	58.0	2.0	42.0
Gross value of production	90.7 (1)	69.1	76.2	21.6	23.8
Labour costs (wages and salaries paid)	17.7 (2)	13.9	78.5	3.8	21.5
Total operating costs b)	74.6 (1)	54.2	72.7	20.4	27.3
Capital investment by sawmills in 1995-96	9.4 (4)	7.5	79.8	1.9	20.2
Net value of production c)	16.1 (1)	14.9	92.5	1.2	7.5
Replacement value of fixed capital	76.9 (1)	57.4	74.6	19.5	25.4

a) Preliminary estimates for industry based on sawmill survey. Figures in parentheses are RSEs for the estimates. b) Operating costs include labour costs, wood purchasing and delivery costs, repairs and maintenance, depreciation and interest payments. c) Net value of production is the gross value of production minus total operating costs.

Most capital investment in the Central Highlands sawntimber industry would appear to be in mills which produce seasoned timbers. In 1995-96, 75 per cent of the replacement value of fixed capital for sawmills receiving logs from the Central Highlands was accounted for by mills producing seasoned timber (Table 5.7). In addition, these mills accounted for 80 per cent of capital investment in 1995-96 by sawmills receiving logs from the Central Highlands.

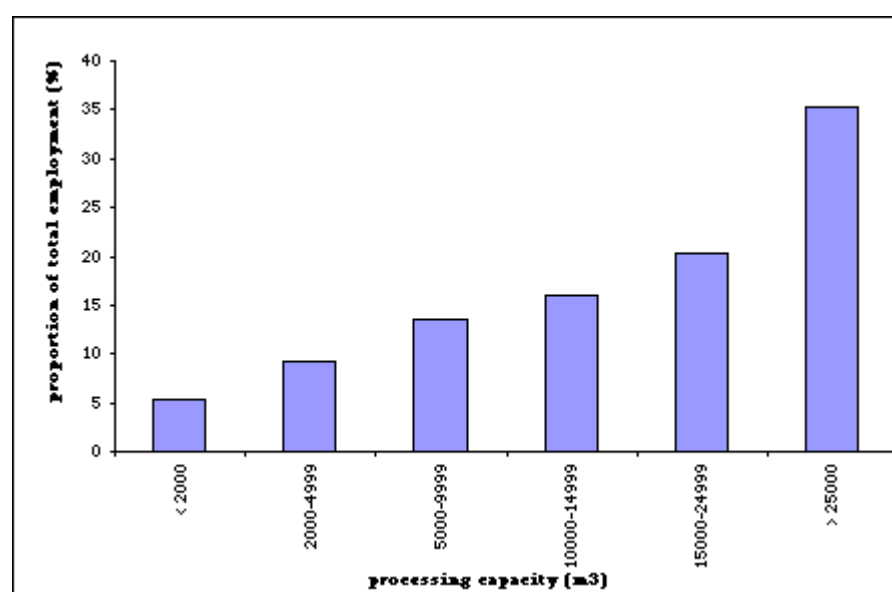
Sawmills producing seasoned timber accounted for about 93 per cent of the total net value of production in 1995-96.

Table 5.8: Intake for sawmills drawing hardwood resources from the Central Highlands, 1995-96 a)

	Intake m ³		Share of total intake%
Central Highlands state forests	372 500	(1)	82.0
Central Highlands private forest	10 000	(25)	2.2
Other than Central Highlands RFA	5 000	(17)	1.2
Total log intake	387 500	(1)	85.4
Raw wood material intake	66 500b)	(4)	14.6
Total intake by sawmills	454 000	(1)	100

a) Preliminary estimates for industry based on sawmill survey. Log intake includes sawlogs and residual logs processed by sawmills and specialist recovery mills. Figures in parentheses are RSEs for the estimates. b) Includes sawn and semi-processed wood from other Central Highlands sawmills.

Figure 5.3: Distribution of employment in sawmills receiving logs from the Central Highlands, by processing capacity



For the 41 sawmills, it is estimated that about 96 per cent of their total log intake came from State forests located within the Central Highlands RFA region in 1995-96. The remaining sawlogs received were sourced from private forests or forests located outside the Central Highlands RFA region (Table 5.8). Furthermore, sawmills receiving logs from the Central Highlands also received about 66 000 cubic metres of sawn wood material from other sawmills, both within and outside the Central Highlands RFA. As such, the total intake of these sawmills was 15 per cent greater than their intake of logs from the region.

Based on the survey of sawmills receiving logs from the Central Highlands, it is estimated that they employ a total of 680 people. About 93 per cent of these employees are full time

workers. Employment varies from mills with only one employee to almost 100 workers per mill. From Figure 5.3, it is apparent that the majority of sawmill industry employment is concentrated in sawmills with a large processing capacity.

Major Sawntimber Products and Markets

Total production in 1995-96 from sawmills drawing hardwood resources from the Central Highlands region is presented in Table 5.11. These production figures include the processing of D+ sawlogs and some residual logs by a specialist recovery mill. In terms of total sawntimber production, about 62 per cent of the 187 000 cubic metres of hardwood sawntimber in 1995-96 was sold as unseasoned timber such as scantling, palings and pallets (Table 5.9). The remaining 38 per cent was sold as appearance grade or seasoned structural timber.

Table 5.9: Production of sawmills drawing hardwood resources from the Central Highlands, 1995-96 ^{a)}

	Total		Proportion
	m3		%
Seasoned sawntimber			
Appearance – select	11 153	(9)	2.8
Appearance – standard	8 565	(2)	2.2
Structural	37 361	(3)	9.4
Further processed	13 130	(12)	3.3
Unseasoned timber			
Scantling	39 735	(5)	10.0
Palings and pallets b)	47 295	(2)	11.9
Other sawn	29 764	(9)	7.5
Total sawntimber	187 003	(1)	47.0
Woodchips	119 824	(1)	30.1
Other residues	90 918	(9)	22.9
Total residues	210 742	(1)	53.0
Total sawn and residue	397 745	(1)	100.0

^{a)} Preliminary estimates for industry based on sawmill survey. Figures in parentheses are the RSEs for the estimates. ^{b)} A large specialist recovery producer accounts for around 45 per cent of this estimate.

However, when the processing of D+ sawlogs is considered separately from sawmilling activities to residual grade logs, the proportion of seasoned sawntimber production increases (Table 5.10). Approximately 56 per cent of D+ sawlogs processed by sawmills receiving hardwood resources from the Central Highlands in 1995-96 was sold as unseasoned timber such as scantling, palings and pallets. The remaining 44 per cent was sold as appearance grade or seasoned structural timber.

Sawntimber production shares from sawlogs (A to D grade logs) by sawmill size is shown in Table 5.11. The large scale sawmills, with log intake of more than 15 000 cubic metres produced almost 50 per cent of the total sawntimber in 1995-96 but accounted for around 60 per cent of seasoned timber sales. In general, the smaller sawmills produced higher proportions of unseasoned timber. Mills with log intakes of less than 15 000 cubic metres

accounted for 50 per cent of total sawmill output, however, they accounted for 58 per cent of unseasoned timber production.

Table 5.10: Sawntimber production shares from D+ logs, by mill size, 1995-96 a)

	Sawmill to tal log intake			
	Proportion of total	< 5000m ³	5000–15000m ³	> 15000m ³
	%	%	%	%
Seasoned sawntimber				
Appearance – select	7.2	17.3	15.5	67.2
Appearance – standard	5.5	3.1	32.2	64.7
Structural	23.2	17.4	37.3	45.3
Further processed	8.1	8.3	0.6	91.1
Total seasoned	44.0	13.9	26.4	59.7
Unseasoned timber				
Scantling	25.4	16.7	41.3	42.0
Palings and pallets	11.6	20.2	54.8	25.0
Other sawn	19.0	8.6	38.4	53.0
Total unseasoned	56.0	14.7	43.1	42.4
Total sawntimber	100	14.4	35.8	49.8

a) Preliminary estimates for industry based on sawmill survey. Totals may not add due to rounding.

Table 5.13 shows the proportion of sawntimber products sold by sawmills drawing hardwood resources from the Central Highlands in 1995-96 and also the sawmills' anticipated production split up in 2005-06. Around 56 per cent of sawntimber production in 1995-96 consisted of unseasoned timber, palings and pallets. However, Central Highlands sawmillers anticipate that by 2005-06 this product share would drop to approximately 38 per cent. The sawmillers anticipated a large increase in the production of seasoned structural grade timber and further increases in the production of appearance grade and processed timber to replace the selling of unseasoned products.

The major markets for each product were also identified. The unseasoned timber products were mainly distributed to Melbourne and other Victorian cities such as Bendigo, while the markets for the seasoned products were in the Australian capital cities and in Japan.

Table 5.11: Current and anticipated Central Highlands sawntimber production and major markets a)

Product	Production share		Major market in 1995-96
	1995-96 %	2005-06 b) %	
Unseasoned sawntimber	44.0	33.2	Melbourne and other Victoria
Palings and pallets	11.6	4.5	Melbourne and other Victoria
Dried structural grade	23.6	38.2	Melbourne, Brisbane and other Victoria
Appearance grade – standard	5.4	6.6	Melbourne, Brisbane, Sydney and Japan
Appearance grade – select	7.1	9.1	Melbourne, Brisbane, Sydney and Japan
Other	8.3	8.4	Melbourne, Japan, Brisbane and Adelaide
Total	100.0	100.0	

a) Preliminary estimates for industry based on sawmill survey. These estimates exclude specialist recovery mills. **b)** Anticipated production share.

5.4 THE PULPWOOD PROCESSING INDUSTRY

Pulplogs (or residual logs) and sawmill residues sourced from the Central Highlands are used in a number of major downstream processing operations. The most significant of these involve the production of paper, tissue, pulp and woodchips. In Table 5.12 the total wood fibre intakes of major downstream processors that are sourced from the Central Highlands are shown. In addition, employment, product output and gross value of production attributable to wood fibre resources from the Central Highlands are estimated. It is important to note that the estimates of employment, product output and gross value of production presented in Table 5.12 reflect the proportion of total fibre input that is sourced from the Central Highlands. Interpreting these figures as an indication of the implications of wood supply changes from the Central Highlands is potentially misleading. For example, as all paper grades produced at Australian Paper's Maryvale mill contain eucalypt, a change in wood supply from the Central Highlands will affect the profitability of all paper grades.

Table 5.12: Uses of Central Highlands pulplogs and sawmill residues, 1995-96

		Paper and tissue	Export woodchips	Total
Intake from Central Highlands				
Pulplogs	(m ³)	488 649	47 609	536 258
Residues	(m ³)	53 461	64 269	117 730
Total intake	(m³)	542 110	111 878	653 988
Employment a w.f.	(no.)	458	8	466
Production	(t)	148 770 a, b)	108 344 c)	na
Gross value of production b(\$m)		-	-	232

a) Calculated by multiplying the percentage of total intake sourced from the Central Highlands by the relevant total employment, production or gross value of production figures. **b)** Production in 1995-96 was lower than normal because of a mill shut down while two paper machines were upgraded. **c)** Estimate based on recovery rates. **na** Not applicable.

A description of the major downstream processing operations using pulpwood from the Central Highlands is provided below.

Australian Paper

Australian Paper's Maryvale mill is the largest pulp and paper making complex in Australia, employing 930 people. There are currently four paper making machines installed which produce around 400 000 tonnes of paper products a year. These products include high quality copy paper, strong brown paper and cardboard stock. The paper produced at Maryvale is sold mostly on domestic markets and a small proportion is exported.

The Maryvale mill uses both eucalypt and pine in the production of various pulps. About 60 per cent of the wood used in the production of pulp at Maryvale is eucalypt, and all paper grades produced at Maryvale contain eucalypt. Pulp produced at Maryvale, imported pulp and recycled fibre are used as inputs in the production of paper at the mill.

Of the eucalypt used at the Maryvale mill, approximately 58 per cent (around 475 000 m³) is sourced from the Central Highlands. Under the *Forests (Wood Pulp Agreement) Act 1996*, Amcor Plantations Pty Ltd has a legislated supply of residual logs from State forests. The supply levels are:

- 500 000 m³ from 1996-97 to 2003-04;
- 450 000 m³ from 2004-05 to 2006-07;
- 400 000 m³ from 2007-08 to 2009-10; and
- 350 000 m³ from 2010-11 to 2029-30.

Much of this will be sourced from the State forests of the Central Highlands region, to be used as fibre for the integrated pulp and paper making activities at Maryvale.

Carter Holt Harvey

Carter Holt Harvey operates a pulp mill at Myrtleford which supplies a tissue mill in Melbourne. The Myrtleford pulp mill employs 30 full time staff and has a capacity of 15 000 air dried tonnes of eucalypt pulp a year and 20 000 air dried tonnes of softwood pulp. Of the eucalypt resource pulped at Myrtleford, approximately 70 per cent is sourced from the Central Highlands.

Production at the tissue mill in Melbourne is around 63 000 tonnes of tissue a year and 645 people are employed (including some interstate). Approximately 8 per cent of tissue production is attributable to hardwood sourced from the Central Highlands.

Kimberly Clark

Kimberly Clark operates a pulp and paper plant at Millicent in South Australia which employs 650 full time staff. The Millicent plant has a production capacity of 100 000 tonnes a year of tissue and output is sold on the Australian market with some tissue exported to New Zealand.

Total fibre input into the mill is around 475 000 tonnes, consisting of 375 000 tonnes of softwood and 100 000 tonnes of hardwood. Around 55 per cent of hardwood fibre input into the Millicent mill is sourced from the Central Highlands, via an independent residual log processing facility which is located in Marysville. This resource is being utilised by Kimberly Clark until its plantation eucalypt resource becomes available in 2000.

Midway Wood Products

Midway Wood Products operates an export oriented woodchip facility in Geelong. Eucalypt pulplogs, sawmill residues and softwood are chipped at this facility. The mill has a production capacity of around 500 000 tonnes a year. Twenty full time staff are employed at the mill handling the eucalypt resources received (additional staff are employed in plantation operations and handling the softwood received).

Of the eucalypt resources received, approximately 40 per cent (or 115 000 tonnes) are sourced from the Central Highlands. Approximately 57 per cent of eucalypt resources received from the Central Highlands are provided as sawmill residues, with the remainder provided as residual logs.

5.5 INTERNATIONAL AND DOMESTIC FOREST PRODUCT MARKET OUTLOOK

The domestic market outlook for wood based industries is strongly influenced by international market conditions for forest products, due to the fact that Australia is a large net importer of most forest products (with the exception of woodchips). Because Australian trade in most forest products (such as sawntimber) is small in comparison with world trade, domestic prices for forest products are largely determined by the landed or import parity price of imports. Consequently, the extent to which the domestic hardwood sawntimber industry can maintain or increase profitability depends strongly on the cost competitiveness of local products compared with imported substitute products.

The discussion below presents a broad overview of the factors influencing the market outlook for Australian hardwood forest product industries. 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.

Outlook for Forest Products 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 such as Japan, South Korea and Taiwan has resulted in an increase in per capita consumption of wood products, particularly paper products. Because of its proximity and its potential for significant increases in consumption, 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 led to 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 and Malaysia, moves to promote value added domestic processing, and increased domestic demand for wood products in traditional tropical wood supplying countries.

Sawntimber

Global production of sawn hardwood increased from 110 million cubic metres in 1980 to 130 million cubic metres in 1991, but has since declined slightly. The production of sawn hardwood in Asia is expected to continue to decline, because of the decreasing availability of tropical hardwood logs. However, the Asia Pacific forest products sector has the potential to meet projected consumer demand and as a result, significant price increases are not expected. Demand could be met through a combination of efficient use of existing Pacific Rim timber resources and the establishment of new manufacturing capacity to produce non-traditional products such as medium density fibreboard, oriented strand board and other reconstituted panels (Johnson, 1997). These predicted changes to traditional trading patterns present a range of opportunities for future development and growth in the Australian timber industry.

Australian production of sawn hardwood has declined from a peak of 2.6 million cubic metres in 1964-65 to 1.4 million cubic metres in 1995-96, 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. By the first decade of the next century, Australia is likely to have a small export surplus of softwood sawntimber available (ABARE 1997).

Hardwood sawntimber production in Australia has traditionally been consumed as structural timber. Competition from domestically produced and imported softwood sawntimber has contributed to a decline in total hardwood consumption and market share in traditional hardwood markets such as house framing, and more recently in exterior applications through the development of preservation and lamination technologies for softwoods. Increasingly the focus is likely to be on the production of appearance grades of timber used in furniture and joinery, as these grades have the greatest export potential. Despite the limited potential for price increases, an expected tightening in supply of hardwood sawntimber in the Pacific Rim may provide opportunities for the export of high grade hardwoods, for appearance applications and engineered panels.

Wood Based Panels

Wood based panels are used mainly in the construction and furniture industries. Total world consumption of wood based panels has increased from 25 million cubic metres in 1960 to around 125 million cubic metres in 1995. The most important panel produced in the Asia Pacific region in volume terms is plywood, accounting for over 70 per cent of total panel production of around 30 million cubic metres in 1995. However, in line with decreasing availability of veneer logs, production in the region is expected to decline and investment into other panel product processing capacity is currently increasing.

Of the wood based panel products currently available, medium density fibreboard (MDF) has recorded the strongest market growth over the past decade. Rapid growth in the consumption of MDF since the early 1990s in domestic and international markets is attributed to the widespread application and growing acceptance by consumers of MDF products in building and furniture uses. Additional capacity is planned to be developed in the region in the short term.

Before 1995-96, Australia was a net importer of wood based panel products. Australian veneer producers who target the high value decorative veneer market continue to be competitive against imports. The main factors influencing their ability to expand their market base is the future availability and quality of the resource and the price competitiveness of substitute products such as MDF. Limited marketing opportunities exist for new panel producers in supplying the Australian market. Any new producer would need to rely on the expanding export markets in the Asia Pacific region.

Pulp and Paper

Growth in world paper consumption closely follows changes in economic activity. As a consequence, growth in consumption of paper products is expected to be particularly strong in the Asian region. World paper and paperboard consumption is forecast to increase from the current level of about 280 million tonnes a year to around 420 million tonnes a year by 2010 (Margules Poyry 1997). The projected annual rate of growth in world paper consumption to 2010 of around 3 per cent a year is well above forecast world population growth rates of around 1.5 per cent a year. This reflects the growing urbanisation and 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 be slightly slower, reflecting a slowdown in economic growth rates in the developing countries.

An analysis of world market supplies of pulpwood indicates a gradual tightening of pulpwood supplies after 2010 (Cameron 1997). Upward pressure on paper and paperboard prices, and hence pulp prices, will be moderated, however, by increased use of recovered/waste paper, particularly in the production of lower quality paper products. Nevertheless, real world pulp prices may increase over the medium term. This expected real price increase together with access to a large domestic forest resource, particularly from plantations, may encourage expansion of Australia's pulp and paper industry. Australia has been a significant importer of paper products and pulp, allowing for the possibility of an expansion of the domestic industry to replace imports to some degree.

Woodchips

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 1995-96. There has been little growth in Australia's woodchip exports in recent years, with shipments averaging 3.15 million tonnes over the five years to 1995-96. In line with an expected increase in paper consumption and production in Asia, woodchip demand is projected to increase to 2020.

5.6 INDUSTRY DEVELOPMENT OPPORTUNITIES

As part of the economic assessment underlying the future development of a Central Highlands RFA, an examination of broad industry development opportunities was undertaken. This assessment included a number of industry workshops to investigate the feasibility of possible future development of the Central Highlands native wood based industries, as well as detailed analysis of global industry and market conditions. This section outlines some of the main findings of this investigation, taking into account forest product markets, and the availability and quality of the hardwood resource. The development opportunities outlined here assume:

- competitive energy markets in the region;
- internationally competitive port facilities;
- internationally comparable wood royalties, road tolls, fuel and other taxes;
- no import duties, import quotas or other direct or indirect barriers to imports of forest products by Australia; and
- long term security of wood supply.

Hardwood Availability

The availability and quality of hardwood resources from the Central Highlands will have a bearing on development opportunities. As shown in Table 5.13 the quantity of hardwood sawlogs and residual logs available for harvesting from the region is not expected to change significantly over the next twenty years, although the proportion of hardwood timber being sourced from mature mixed species forests will decline substantially. The figures provided in Table 5.13 are for the Central Highlands region. They differ from the sustainable yield forecast described in Chapter 4 which are based on the three FMAs in their entirety. However, only a portion of the Central Gippsland FMA is included in the Central Highlands RFA region.

Table 5.13: Hardwood availability in the Central Highlands('000 m³ per year) a)

	Licenced volumes 1996/97		Estimated availability			
			2010		2020	
	Mature Regrowth		Mature Regrowth		MatureRegrowth	
Sawlog (D+)						
Ash	0	190	0	271	0	271
Mixed species	90	0	68	0	13	69
Recovery sawn	3	12	6	7	1	10
<i>Total sawlog</i>	<i>93</i>	<i>202</i>	<i>74</i>	<i>278</i>	<i>14</i>	<i>350</i>
Total sawlog (mature and regrowth)		295		352		364
Residual log						
Pulpwood	94	472	266	296	50	423
Sawmill residue b)	8	60	22	83	4	105
<i>Total residue</i>	<i>102</i>	<i>532</i>	<i>288</i>	<i>379</i>	<i>54</i>	<i>528</i>
Total residue (mature and regrowth)		634		667		582

a) Estimates of resource availability have been made based on the forest area and forest type within each FMA or portion thereof. Some degree of error may exist in the figures due to the resource figures not conforming with existing management boundaries. The availability figures for the Central Highlands provided here are smaller than the sawlog yield estimates presented in Table 5.5 as those estimates incorporate the whole FMAs. Sawlog is D+ and nett of defect for commercial production purposes. b) Sawmill residue is included as a component of the total pulpwood resource. This comprises around 25 per cent of the total available roundwood sawlog volume. Source: Unpublished Department of Natural Resources and Environment and industry data.

Current licensed volumes of around 295 000 cubic metres (mature and regrowth) is below the forecast hardwood availability due to uncertainty in the reliability of mature mixed species resource estimates in the Central Gippsland FMA. The SFRI program will enable a more accurate forecast of sustainable yield in the next review period and this may result in additional volumes of sawlog to be available under licence. Minor variations in sawlog availability over time are due to the fact that the mixed species resource in the Central Gippsland FMA is not evenly distributed across the FMA and, as indicated above, only the western portion of the FMA is included in the Central Highlands RFA region.

Sawlog availability, including recovery sawn material, is not expected to change significantly and will remain at about 350 000 to 360 000 cubic metres (mature and regrowth D+ net). Increasing amounts of regrowth material will become available and will contribute 96 per cent of the available volume by 2020.

Sawnwood

The existing industry within the region appears to be well placed to expand to more fully utilise the available hardwood sawlog resource over the next two decades. It is expected that the number of hardwood sawmills in the region will decrease as production is concentrated in fewer, larger plants than currently. Development of the hardwood sawnwood sector is expected to concentrate on value added products for expanding Asian markets. As a result,

more kiln drying investment and development of technologies to recover higher value products from the resource are likely to be undertaken.

Wood Based Panel Products

It is likely that a medium density fibreboard (MDF) plant in the Central Highlands could be competitive in supplying the Japanese market, although lower transport costs mean that total delivered costs for Indonesian and Malaysian producers may be slightly lower. The expanding market for MDF in Asia and cost competitive position of the industry in Victoria indicates that MDF would be a viable option for development. The establishment of an MDF plant using approximately 250 000 tonnes a year of pulpwood is possible by 2010.

In contrast, it is likely that particleboard production in the Central Highlands would be at a competitive disadvantage to other suppliers. As a result, it is not anticipated that particleboard production will be developed in the region.

Opportunities exist for the establishment of a plywood plant given an expected downturn in availability of mixed tropical hardwood peeler logs from traditional suppliers such as Indonesia and Malaysia. The establishment of a plywood plant would require further work to be undertaken in assessing the characteristics of the ash and mixed species forests to determine their suitability for plywood production.

Pulp and Paper Industry Development

Given the large current and planned level of capital investment at the existing Maryvale mill, it is likely that the main developments in the region's pulp and paper industry to the year 2010 are likely to centre around expansion of the existing facilities. This will involve the startup of a new printing and writing paper machine by 1998 which has already been announced. One possible scenario for further development to the year 2010 could be the expansion or rebuild of this machine to 250 000 tonnes a year capacity, expansion or rebuild of another machine at the site to 150 000 tonnes a year of coated paper grades, as well as expansion or rebuild of the existing bleached eucalypt kraft pulp mill to 250 000 tonnes a year.

Australian Paper has indicated that, with planned mill developments and the increased availability of its eucalypt plantation wood (from the Gippsland region), it will reduce the requirement for eucalypt from the Central Highlands RFA by the year 2010.

Kimberly Clark has indicated that within a few years, it will not require the 60 000 tonnes a year of pulpwood that it currently sources from the Central Highlands as supplies closer to the mill in South Australia will be available. Also, Carter Holt Harvey, which operates a Bleached Chemi-Mechanical Pulp (BCMP) mill in Myrtleford, has not announced any long term plans for this facility. The mill currently processes about 20 000 tonnes a year of hardwood pulpwood from the region. A possible scenario is that this may continue to 2010, but not to 2020.

The volume of pulpwood available (including pulpwood roundwood and sawmill residues) to 2010 and 2020 gives rise to a number of potential development options for the Central Highlands. As discussed above, by 2010 the estimated pulpwood resource could supply a new MDF mill in the region. By 2020, however, it is likely that the facilities at Maryvale will be outdated and less competitive. The construction of a new 600 000 ADt/a BHKP mill in the region, utilising not only the pulpwood available in the Central Highlands, but also that from the East Gippsland and Gippsland RFA regions, is possible.

In order for a potential MDF mill to remain viable, the new BHKP mill could use around 400 000 tonnes a year of softwood fibre input (sourced from the Central Highlands, Gippsland and East Gippsland RFA regions).

6. PLANTATIONS

6.1 INTRODUCTION

Plantations can contribute significantly to our wood supply, providing an additional resource, particularly of pulpwood and small diameter sawlogs for industry. Consequently they can contribute to regional economic development, especially if they are linked to downstream processing industries. In addition, plantation development on farms has the potential to provide environmental, landcare and agricultural productivity benefits to landholders and to the broader community.

Plantations in South-Eastern Australia are typically of native species (predominantly *Eucalyptus* spp.), referred to as ‘hardwood’, or exotic Radiata Pine (*Pinus radiata*) referred to as ‘softwood’. To date, hardwood plantations in Australia have mainly been managed to produce short rotation pulpwood for paper manufacturing; however it is anticipated that improved technology will eventually enable economic sawlog production from hardwoods, as is currently possible for softwoods.

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

The Victorian Scoping Agreement specifies that the focus of RFAs is on public native forests, and where necessary private native forests. It is important to note that the use and management of cleared private land is not covered by RFAs. However, the scoping agreement requires an analysis of a region’s potential for plantation expansion to inform considerations on potential industry development and infrastructure options. This section draws from an analysis of the potential for plantation development undertaken for the Central Highlands (BRS 1997b).

6.2 POLICIES, PROGRAMS AND INITIATIVES

State and Commonwealth Governments have developed a number of policy and program initiatives to allow for plantation development and management in the context of economic efficiency, social considerations, and environment and heritage issues. However, it should be noted that it is a policy position of the Victorian and Commonwealth Governments in the National Forest Policy Statement (NFPS) (Commonwealth of Australia 1992b) 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 1995b).

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 cleared agricultural land, to improve water quality, and to meet other environmental, economic or aesthetic objectives.

Objectives in relation to Australia's plantation resource, as stated within the NFPS are:

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

Governments also agreed, through the NFPS:

- 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.
- 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. The WAPIS is a Commonwealth Government initiative to encourage investment, value adding, and jobs growth in forest related industries. Notable features of WAPIS include: removal of impediments to plantation development in areas such as taxation; planning and access to information; review of pricing policies and export controls; and promotion of plantation research and development.

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 Practice for Timber Production and associated procedures.

The Victorian Private Forestry Program and National Farm Forestry Program are implementing initiatives addressing the NFPS. In addition, Commonwealth and Victorian legislation pertaining to plantation development has been reviewed. Victorian forestry rights were approved by Parliament in 1996 under the *Forestry Rights Act 1996*, providing for agreements between landowners and tree growers that give legal title for trees separate from the land. Under the provisions of the *Planning and Environment Act 1987* forestry plantations can be established in some areas without requiring a planning permit.

The Victorian Plantations Corporation (VPC) was established under the *Victorian Plantations Corporations Act 1993* to act as an independent State business corporation under the *State Owned Enterprises Act 1992* (VPC 1996). The Corporation is responsible for the management and protection of State-owned plantation timber resources, both hardwood and softwood. Approximately 120,000 ha of plantations on public land are vested with the VPC. The Victorian Government has commenced processes aimed at converting lands vested with the VPC to freehold title, thus enhancing the commercial viability of the VPC.

Plantations 2020 Vision

In 1996, the Ministerial Council on Forestry, Fisheries and Aquaculture agreed to a national goal of trebling Australia's forest plantations estate by the year 2020. The Standing Committee on Forestry (SCF) and industry representatives have since started to formulate an implementation plan for the Plantation 2020 Vision.

The Victorian Government has established a taskforce to develop a strategy for private forestry in Victoria, aimed at increasing plantation development in Victoria in line with the national target of trebling the plantation estate by the year 2020. The taskforce is expected to report to the Victorian Government within the next few months.

Private Forestry Program

The Department of Natural Resources and Environment's Private Forestry Program facilitates development of the commercial private forestry sector. The program is run in conjunction with the Commonwealth's Farm Forestry Program, an initiative funded under the NFPS and the WAPIS.

Through WAPIS, the Commonwealth Government has provided around \$17 million nationally for more than 50 projects under the Farm Forestry Program over the period 1996 to 2000, including nearly \$5 million for projects in Victoria.

In total, at least \$10 million of Commonwealth-State funding will be used to support extension, demonstration, education and training, information gathering and dissemination, planning and coordination, and practical research and development activities aimed at enhancing the uptake of farm forestry.

Under WAPIS financial support is being provided to enable regional plantation committees to promote plantation and farm forestry development more effectively in their regions, including by addressing planning, infrastructure and coordination issues, undertaking feasibility studies, developing regional plantation and farm forestry strategies and formulating related marketing, investment and woodflow plans. In some regions it is expected the committees will also play a role in overseeing the coordination of regional farm forestry projects. These bodies provide an opportunity for farmers, industry and governments to effectively communicate with each other and collaboratively address issues of mutual concern.

Under the Natural Heritage Trust the Commonwealth intends to expand and enhance the Farm Forestry Program over the period 1997-98 to 2001-02. In addition, resources will be invested in the program from the National Vegetation Initiative to provide support for activities in lower rainfall regions, including the development and promotion of wood and non-wood products, especially where these activities give priority to biodiversity and land degradation issues.

Social and Environmental Implications of Plantations

In the past, land purchase by governments and corporations for plantation establishment has led to concern by landholders and some rural communities about:

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

To address this issue, the Victorian Government initiated a State Plantations Impact Study (SPIS). The study made 41 recommendations relating to plantation development and management on cleared agricultural lands. The recommendations covered:

- 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 (SPIS 1990).

Many of these recommendations have been subsequently addressed either directly or indirectly through the reforms to administrative and operational procedures stemming from the NFPS, as discussed above and below.

In agricultural landscapes many benefits can come from plantation development, such as:

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

The policy framework described in the NFPS and the Victorian Timber Industry Strategy were inclusive of the environmental issues associated with plantations. The Victorian Government has developed and implemented a Code of Forest Practices for Timber Production Revision No. 2 (NRE 1996a) that directs plantation development and harvesting in a manner consistent with the principles of environmental care.

Plantation Management

Plantation management on public and private lands in Victoria must comply with the Code of Forest Practices Revision No.2 (NRE 1996a). The Code provides Statewide establishment and management goals and guidelines for plantation management on public and private lands. The Code also contains a number of Statewide minimum standards (such as set back reservations along streamsides).

On public lands these goals and guidelines are implemented through local prescriptions, Forest Management Plans and Forest Coupe Plans. Compliance with the Code on public lands is required under the *Conservation, Forests and Lands Act 1987*, and *Forests Act 1958*, and are supervised by authorised officers.

Compliance with the Code on private lands and public land vested with the VPC is required through Planning Schemes administered under the *Planning and Environment Act 1987*. Operations on these lands are monitored by local municipalities through their planning scheme provisions.

As noted above, the Victorian Code and associated controls have been accredited by the Commonwealth Government as the basis for removal of export controls on plantation products.

6.3 CURRENT RESOURCE

The National Plantation Inventory (BRS 1997a) has identified 15 national plantation regions. The Central Highlands RFA region falls into parts of the Murray Valley and Central Gippsland plantation regions. The Murray Valley Plantation Region, extending from Melbourne to the southern New South Wales softwood district of Tumut, contains a total of 161 010 ha of plantations which are predominantly softwood (mainly *Pinus radiata*) and less than 100 ha of hardwood species (BRS 1997a). The Central Gippsland Plantation Region, located between Melbourne and Bairnsdale, and including the Strzelecki Ranges, contains 81 330 ha of plantations, with 67 470 ha of softwoods (mainly *Pinus radiata*) and 13 840 ha of hardwoods (eg *E. globulus*, *E. nitens*) (BRS 1997a).

The resources of the Murray Valley and the Central Gippsland regions are quite substantial and support a major regional industry with the resource held by VPC, AMCOR and a number of smaller investors.

The existing plantation estate in the Central Highlands RFA region is 10 320 ha, 2389 ha of private plantation, and 7931 ha held by the VPC (BRS 1997c). Softwood plantation products from the Central Highlands region include sawlog, veneer and pulp and paper products.

6.4 PLANTATION POTENTIAL

Approximately 500 000 ha of the Central Highlands is privately owned. Of this, 388 000 ha is classed as 'not forested' (BRS 1997c). Such lands can be considered to have potential for plantations of a variety of species, both hardwood and softwood. Private forested land may have plantation potential, but clearance of native vegetation for plantations must be in accordance with Victorian Native Vegetation Clearance Controls under the provisions of the *Planning and Environment Act 1987*. Forest operations in private plantations are also governed by the Code of Forest Practices for Timber Production (NRE 1996a).

Although the region has the physical capability to support a variety of species, only a few would be appropriate for large scale plantation establishment. This is due to the availability of markets, the resource composition of existing plantations in the region, and processor preferences for a narrow range of species. The species most likely to have plantation potential are *E. globulus*, *E. nitens*, *E. regnans* and *P. radiata* (BRS 1997b). Some other species could be considered for minor or niche markets (eg *Acacia melanoxylon*).

Land Capability

Plantation capability assessment identifies areas biophysically capable of supporting particular tree species - that is, locations where the growth requirements of the species under consideration are satisfied. To a large extent, land capability can be determined by analysis of rainfall and soils, provided that other climatic variables, such as temperature and light intensity, are within the correct range. In general, within the Central Highlands, the following parameters can be used for determining potential for plantations:

- Rainfall > 550 mm / annum (*E. globulus*, *P. radiata*);
- Rainfall > 750 mm / annum (*E. nitens*, *E. regnans*);
- Higher rainfall increases capability;
- Deeper, more fertile soil increases capability;
- Minimum temperature
- Drought
- Slope less than 30° (and less than 20° on erosion-susceptible soils).

Land capability has been assessed for a selected range of species including *E. globulus* (Blue Gum), *E. nitens* (Shining Gum), *E. regnans* (Mountain Ash), *P. radiata* (Radiata Pine) and *Acacia Melanoxylon* (Blackwood) (BRS 1997b).

Land capability for the species selected was generally high. For the relatively hardy species, *E. globulus* and *P. radiata*, 'gross capable area' was found to be above 80 per cent of the cleared, non-forested land base. For the more sensitive species, *E. regnans* and *A. melanoxylon*, gross capable area was found to be lower - 66 per cent and 64 per cent, respectively.

Net capable area is estimated at around 80 per cent of gross. Comparison of the capability of the Central Highlands with the capability of existing plantation areas in the rest of south eastern Australia revealed that the area is comparable with the better existing locations, especially for radiata pine and the temperate eucalypt species. The area also has good capability for supporting blackwood plantations, though the best sites are restricted to more fertile locations with very high moisture availability.

Suitability

Land suitability is defined as the overall ability of land to support plantations, considering economic and social factors as well as capability factors. There are many socio-economic variables that contribute to the suitability of land for plantation establishment, for example:

- cost of land per unit area;
- method of purchase (lease, purchase of unimproved land and purchase of land with improvements);
- availability of woodprocessor(s) and/or market(s);
- distance to processors and markets;
- parcel size (logistically, larger is better due to economies of scale);
- road access;
- local government zoning;
- opportunity costs of alternative land uses (eg agriculture);
- returns from plantation products;
- land prices; and
- social impacts and associated costs.

Land in the Central Highlands currently supports industries such as dairying and horticulture. To the south, near Melbourne, land is in demand for housing, due to urban expansion and rural/residential holdings. Together, these factors result in relatively high land prices in this part of the region.

A broad assessment of the suitability of land in the Central Highlands for plantations has been undertaken, using parcel size and price as an indicator of suitability (BRS 1997b). Given the assumption that land would be leased or bought unimproved, and that the price of land reflects its value for other uses such as agriculture, properties smaller than 10 ha are, on the whole, too expensive, and probably unsuited to large scale forestry, if the property is to be purchased outright.

On the other hand, larger properties (50 ha and greater) are probably better suited to industrial forestry activities (taking into consideration their lower cost per unit area, and the logistic advantage and economy of scale that comes from their size). Estimates based on the assessment indicate that several thousand hectares of capable, suitable land exist, and that the current plantation estate could potentially be expanded by a factor of two or more, depending on markets, infrastructure and the other suitability factors.

It should be noted that actual investment is a matter for commercial decision by companies and individuals, and more detailed resource and economic assessments would need to be undertaken to more precisely quantify the scope for plantation expansion.

The potential for expansion of farm forestry or agroforestry is probably less dependent on the price and area of properties, and is presumably quite high. Owners may be keen to 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.

It is difficult to gauge the suitability of the Central Highlands for this type of plantation forestry, but its popularity is likely to increase, especially if international prices for wood-based products rise in future.

6.5 PLANTATION OPTIONS

There are many options for establishing plantations in the Central Highlands. At one end of the spectrum, plantations could be established as large scale commercial investment, whilst at the other, farm-forestry, agroforestry and land protection are feasible options. Figure 6.1 shows these possibilities as a continuum. Examples of some of the options represented in Figure 6.1 are given below:

Industrial or off-farm investor plantation options:

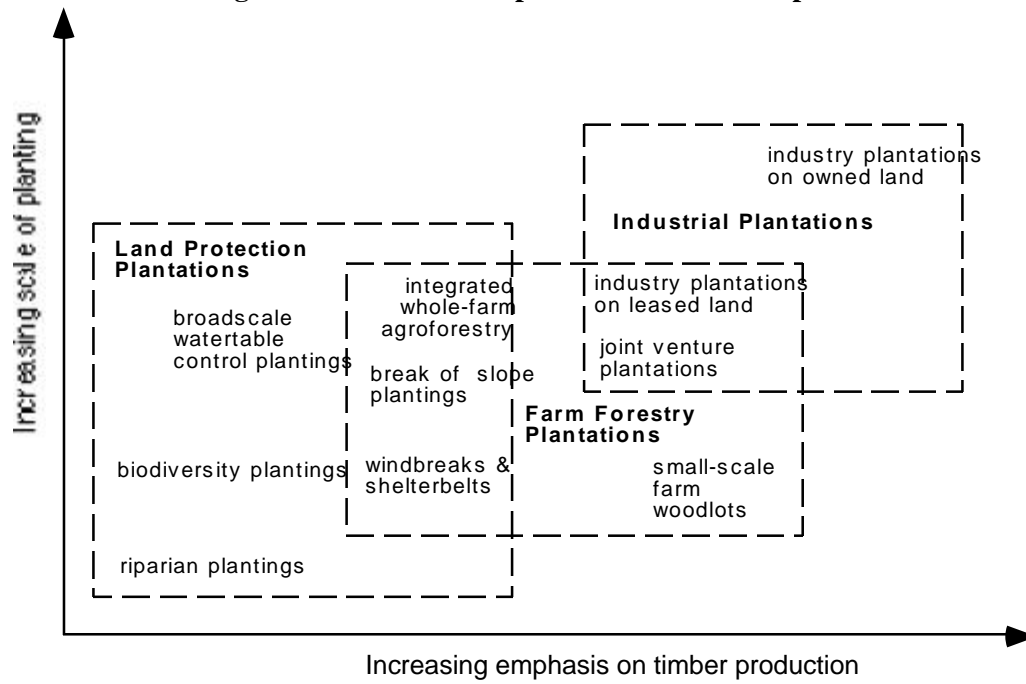
- Sawlog-driven pine plantation - close spacing, 2-3 thinnings and clearfelling at 30+ years;
- Clearwood-driven pruning operations, thinning for faster, increased diameter growth; and
- Eucalypt pulpwood plantation, close spacing, short (10-20 year) rotation.

Farm forestry / agroforestry options:

- Timberbelts - managed for timber, while providing shelter for agricultural land;
- Wide spaced tree 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.

Figure 6.1: Plantation Options: Scale and Purpose



7. OTHER FOREST PRODUCE

The State forests of the Central Highlands supply a range of produce and benefits other than sawlogs and pulplogs:

- minor forest produce including posts and poles, other hewn timber, firewood, wood chop blocks and specialty timbers
- grazing
- apiculture
- tree-ferns.

The current economic values arising from these activities are described in this section.

Other forest uses include:

- recreation,
- tourism,
- mineral exploration and mining (including extractive industries such as gravel and stone),
- water production

These uses are discussed separately in this report.

7.1 MANAGEMENT

Like larger scale sawlog and residual log production, management of other forest produce is aimed at both sustainability of supply and minimisation or avoidance of adverse impacts on the environment. The nature and level of the activity determines the intensity of management planning and control required.

Licensing and supervision arrangements reflect the level of production activity and, hence, the likely scale of impact. Currently firewood collection is managed by permit or short term licences, and is collected either from firewood production areas or from sawlog harvesting residues within State forest General Management Zones. Trees may not be felled unless authorised by a Forest Officer.

Management planning and supervision increases in relation to the nature and potential impact of the production activity. For example, commercial firewood collection in State forest is more closely regulated than domestic firewood operations in the Central Highlands. The costs associated with the supervision of some minor forest operations can outweigh the revenue raised from those operations.

Other forest produce, such as tree-ferns and specialty timbers, may be derived as by-products or in salvage operations. Grazing and honey production activities are also managed taking into account the long term productive capacity of the land.

7.2 PROFILE OF EXISTING SUPPLY, USAGE AND DEMAND

Minor Forest Produce

The level of minor forest produce harvesting in the Central Highlands is relatively high for some produce, due to the size and close proximity of the Melbourne market and the number of towns in the region. While 12-month licences are issued to commercial cutters for the production of fencing material (posts, poles, rails) and firewood, much of the harvest is undertaken under short-term, small quantity licences, issued to individuals for private and small scale commercial use.

Wherever possible, harvesting of this produce is integrated with other forest operations, such as sawlog harvesting and road construction.

Total royalties received by NRE for commercial activities related to other forest produce in the Central Highlands was \$52,725 in 1994-95 and \$68,133 in 1995-96 (Table 7.1).

Table 7.1: Central Highlands other forest produce royalty revenues
(1995-96 dollars)

Product	1994-95	1995-96
Firewood	31 213	40 660
Posts and poles	3 879	4 631
Wood chop blocks	1 718	7 208
Specialty timbers	10 995	166
Grazing licences	1 928	2 070
Apiary licences	994	1 040
Tree ferns	1 266	7 466
Seed capsules	6	4 113
Myrtle beech fronds a)	570	642
Xanthorea seed heads	n/a	70
Tea tree stakes	156	67
Total revenue	52 725	68 133

a) Harvesting to be phased out by June 1997 (NRE 1996b). *Sources:* Department of Natural Resources and Environment, November 1996.

Firewood

Durable timbers are often preferred by firewood collectors. Firewood must be collected from material on the ground, and this material is more readily available in logging coupes. Ash species are generally not considered to be a desirable firewood due to their fast burning nature, which is related to the low density of the timber.

The Yarra Forests and the Broadford Forest have the greatest demand for firewood collection from the outer northern and eastern suburbs of Melbourne and from outlying urban areas. State forest around Alexandra and Marysville is mainly utilised for firewood by people from

these two towns, whereas people from the major towns of the La Trobe Valley generally collect firewood from State forest outside the Central Highlands (mostly Boola Boola State Forest).

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:

- site clearing prior to reforestation operations,
- residual material remaining after normal timber-harvesting operations,
- salvage operations,
- thinning operations,
- timber stand improvement works,,
- scavenger operations, and roadside clearing works.

The ability to carry out regeneration burns in areas available for firewood collection is an important consideration. Sometimes those areas open to the public in autumn cannot be burnt and must wait to be regenerated in the following year. Mechanical seed bed preparation, usually a more expensive operation, may then be required. Where feasible, supply of firewood from timber stand improvement operations in the lower elevation areas in autumn is preferred, because the timber is often more suitable for fuel and gathering the wood is less likely to affect other operations (NRE 1996b).

Firewood collection requires considerable management 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, safety, and licence and fee collection.

Licences totalling between 5,000 and 7,000 cubic metres of firewood are sold annually in the Central Highlands, and are considered to be within the productive capacity of the forest.

Posts, Poles and Other Hewn Timbers

While a few commercial cutters supply posts and other hewn timbers to the local market, many land-owners have traditionally met their own requirements under licences issued over nearby forest. This small market is reflected in the relatively low royalty figures outlined in Table 7.1. The existing level of demand for posts and other hewn timbers is mostly supplied from coupes scheduled as part of normal harvesting operations.

Wood chop Blocks

The Department of Natural Resources and Environment supplies the organisers of wood chopping events, such as the one held at the Royal Melbourne Show, with wood chop blocks from the Central Highlands. These are usually ash species timbers in a uniform size. The market for this product is not likely to increase substantially in the future.

Specialty Timbers

Species such as Blackwood (*Acacia melanoxylon*), Silver Wattle (*A. dealbata*), Myrtle Beech (*Nothofagus cunninghamii*) and Southern Sassafras (*Atherosperma moschatum*) produce timber with attractive colour and figure, making them sought after for use in furniture manufacturing and for wood turning. Burls from trees cut in logging coupes are also produced from normal sawlog operations and are used by some wood turners.

These specialty timbers become available in small quantities during sawlog harvesting and road construction. They are considered as a by-product of sawlog harvesting, and specialty timber/craftwood licences are issued accordingly.

Interest in specialty timbers has been increasing in recent years. A feature of reafforestation works in Central Highlands Ash Forests has been the large volume of silver wattle that is largely unutilised due to it not being taken up by markets. The generally pure stands of wattle are windrowed and subsequently burnt in autumn before the site is re-established with eucalypts over winter. Silver wattle has great potential as an appearance grade product, generally being used for cupboards, lining boards and furniture.

Grazing

Grazing in the State forests of the Central Highlands is regulated through the issue of grazing licences or leases. Most of the Central Highlands region is unsuitable for grazing as it has dense forest cover. Grazing licences occupy 114 hectares, or 0.03 per cent of State forest within the Central Highlands, with a further 127 hectares under grazing licence within Bunyip State Park.

Two types of grazing licence have been issued within the Central Highlands region:

- agistment permits allowing grazing for a fixed, but usually short, period; and
- grazing permits allowing all-year grazing in certain areas.

Apiculture

Foothill forests containing stringybark species are traditional areas for honey production in the Central Highlands. Ash forests are not generally preferred for apiculture due to the irregularity and small quantity of flowers.

The various species of flora of importance to honey production flower at different times of the year and produce differing quantities and qualities of nectar and pollen. The honey produced from individual species also varies widely in colour, flavour, density and tendency to candy. In some cases, different species may flower consecutively and hives may be kept at the one site for many months. More usually though, as flowering declines, hives are moved to sites where flowering is at its peak during the honey producing season. In 1995-96, there were nine apiary sites licensed in State forests and ten sites in Eildon State Park within the Central Highlands.

Apiary sites can be either temporary or permanent. Permanent sites are usually held by one apiarist for many years. This does not mean, however, that they are permanently occupied. On the contrary, they are typically occupied for only two or three months each year. Temporary sites are typically used less regularly, although a particular site may be used on a recurring basis. A large proportion of State forest in the region is unused by beekeepers, primarily due to poor access, inappropriate site conditions or unsuitable honey flora.

Access to bee-keeping activities in State forests of the Central Highlands is controlled by NRE bee-keeping licences. In 1995-96, NRE received \$1040 in royalties from the issue of beekeeping licences in Central Highlands State forests (Table 7.2). These royalties represent only part of the economic value derived from beekeeping activities. In 1994, the honey produced from residents located within the Central Highlands region had an estimated market value of \$97 356 or 1.5 per cent of total Victorian honey production as shown in Table 7.2. It is estimated that in favourable seasons, approximately 400 tonnes of honey could be produced from the Central Highlands with an approximate value of \$0.5 million. Although honey is the major product of the Victorian industry, of which approximately half is exported, other produce include beeswax, pollen and royal jelly. In addition, the value of pollination of agricultural crops by bees has been estimated at \$70 million for the Central Highlands (LCC 1991). Because data on the costs of honey production are not presently

available, it has not been possible to estimate the total net economic value of honey production from the Central Highlands.

Table 7.2: Central Highlands beekeeping production values, 1994

	Value of total honey produced (1995-96 dollars)	Number of hives
Central Highlands	97 356	2 296
Victoria	6 577 110	88 742

Source: ABS (1996a).

Tree-ferns

Harvesting of tree-ferns from public land has not generally been permitted in Victoria, although exceptions have been made where specific plants faced permanent destruction, for example, by road clearing. The species most suitable for harvesting is the Soft Tree-fern (*Dicksonia antarctica*) which is common in timber production areas in the region. Harvesting from road construction is expected to be the major source of tree-ferns over the next few years.

A proposed method of harvesting of tree-ferns from logging coupes was trialed during the 1995/96 harvesting season in the Central Gippsland FMA. Further evaluation of proposed methods for tree fern harvesting is required.

Other Produce

Presently there is low demand for forest produce such as understorey species, cut flowers and live plant specimens. Protected flora species can only be taken from public land when covered by a permit under the Flora and Fauna Guarantee Act. A permit for harvesting of minor forest produce and payment of a royalty fee is usually required.

The NRE employs contractors to collect seed for regeneration of logging coupes. In addition, seed is collected by private companies and other organisations under permit and a royalty is paid by capsule weight. The most sought after species from the forests of the Central Highlands is Shining Gum (*Eucalyptus nitens*) for plantation establishment.

7.3 OUTLOOK AND DEVELOPMENT OPPORTUNITIES FOR OTHER PRODUCE

Minor Forest Produce

Due to the close proximity and size of the potential market for minor forest produce (Melbourne's outer eastern suburbs and towns spread throughout the Central Highlands), the demand for this produce could increase significantly in the future. The produce with the most potential include firewood, specialty timbers and tree-ferns.

Firewood

Steady growth in demand is expected with the increasing number of domestic wood burning stoves and heaters being installed in homes in Melbourne. While the long-term demand for fuel wood is linked with the price of major energy sources such as natural gas, the demand for fire wood is expected to continue to increase with expanding housing development outside the Melbourne metropolitan area.

Considerable opportunity exists for commercial operators to harvest firewood from the Central Highlands State forests for sale to local and Melbourne markets. At present, residue from various forest harvesting operations is not utilised to its potential. Firewood collection operations may also benefit silvicultural operations by reducing harvesting residue or for use in thinning stands.

Specialty Timbers

At present, only a small proportion of specialty species available through normal forest operations are harvested from the Central Highlands. Specialty species such as Silver Wattle, Myrtle Beech and Blackwood frequently become available in small quantities during logging operations and can produce excellent feature grade timbers. With forecast increases in population growth and economic activity, it is likely that market opportunities for specialty grade timbers, which become available in small quantities in harvesting operations, will increase, particularly around the Melbourne metropolitan area.

Tree-ferns

A considerable number of tree-ferns that occur in logging coupes or on newly constructed road lines are not presently utilised. They could therefore provide a potential source of State forest revenue as nursery plants for consumers. Considerable markets exist both within Australia and overseas for tree-ferns, and these markets may expand in the future depending upon preferences for Australian native species.

Grazing

Grazing of domestic stock in State forest provides direct agricultural benefits to producers. In the Central Highlands grazing is likely to continue on a small scale, reflecting the large proportion of dense forest cover which is generally unsuitable for grazing activity.

Apiculture

Roads developed for timber production potentially increase access to areas of State forest for beekeeping, and the NRE fire protection program provides a level of security for hives and other equipment used in the industry. Due to the preference for particular forest tree species and access to suitable apiary locations, it is expected that current levels of demand are likely to continue.

8. TOURISM AND RECREATION

8.1 INTRODUCTION

The Central Highlands region has long attracted visitors seeking to enjoy its many natural and cultural features, and forms an important component of Victoria's tourism and recreation resource.

The densely forested public land in the region provides a diverse recreation venue which complements the cultural attractions of the neighboring towns and the rural landscapes and features on private land. Together they combine to offer a high quality recreation and tourism resource easily accessible to Melbourne and the Latrobe Valley for day visits and weekend trips.

The main attractions of the Central Highlands include National and State Parks, lakes and other water features such as Lake Eildon, Healesville Sanctuary, snow fields, wineries, indigenous cultural centres, Puffing Billy vintage railway, guest houses, antique shops and art galleries, scenic rural and forested countryside and small villages and townships (Henshall Hansen and Associates and Read Sturgess and Associates et al. 1992).

Many of the region's public land attractions centre on its forests, rivers and ranges, and contribute several of the region's competitive tourism strengths, such as the old growth ash forests of the Yarra Ranges, the public gardens and forests of the Dandenongs, and opportunities to view wildlife.

In 1995-96 tourism (calculated as cultural and recreational services and accommodation, restaurants and cafes at factor cost) contributed about 4 per cent (\$3.7 billion) of Victoria's gross state product (ABS, 1995). In 1991 the Victorian tourism and recreation industry accounted for approximately 6.1 per cent (111 780 jobs) of the State's employment (ABS, 1996b). While the Central Highlands region accounted for 5.1 per cent of visitors to Victoria in 1995 it also received some 1.5 million day trippers (Tourism Victoria, 1996a).

Tourism Victoria is preparing Regional Tourism Development Plans for each of the State's thirteen tourism product regions; a strategy is being prepared for the Yarra Valley, Dandenongs and Ranges tourism region which covers the majority of the Central Highlands RFA region and is expected to be completed in the near future.

Tourism Victoria (1996a) defines a 'visitor' as an Australian resident or international visitor undertaking a trip within Victoria. A 'trip' is a tourism journey within Victoria. A 'visit' is a stay of one or more nights to a place during a trip. A 'day trip' is defined as travel away from the home within Victoria of at least 50 km by a Victorian resident. A 'day tripper' is a Victorian resident undertaking a day trip within Victoria.

8.2 OVERVIEW OF TOURISM AND RECREATION IN THE CENTRAL HIGHLANDS

Henshall Hansen and Associates and Read Sturgess and Associates et al. (1992) in a socio-economic study of the Central Highlands area of the Land Conservation Council's Melbourne Area District II, found that apart from attractions in Melbourne, the Central Highlands tourist attractions have some of the highest visitor numbers in Victoria. Based on the Victorian regional travel and tourism survey regions (as described in Tourism Victoria, 1996a), public land in the Yarra Valley, Dandenongs and the Ranges tourism region within the Central Highlands has the second highest visitation levels of any public land in Victoria, receiving over 2.5 million visits in 1994-95 (Albone pers comm.). This has been attributed to the region's spectacular landscapes and forests, as well as its proximity to Melbourne.

Tourism activities are an important part of the regional economy of the Central Highlands. It is estimated that expenditure in the region by Australian and international visitors was \$97.8 million in 1995 (Tourism Victoria 1996a).

Results from the Victorian regional travel and tourism survey found that the Central Highlands received approximately 764 600 visitors in 1995. The region also received 1.8 million visitor nights or 4 per cent of visitor nights spent in Victoria in 1995 (Tourism Victoria, 1996a). Characteristics of visitors to the Central Highlands are shown in Table 8.1.

Table 8.1: Central Highlands visitor characteristics, 1995

Visitor Origin	%
Intrastate	75
Interstate	14
International	11
Average length of visit	nights
	2.4
Average expenditure	\$/day
Overnight visitors	54
Day trippers	18

Source: Tourism Victoria (1996a)

The majority of visitors to the Central Highlands in 1995 (63 per cent) were visiting the region for pleasure or holiday (Tourism Victoria, 1996a). Due to the close proximity to Melbourne, a high proportion of visitation to the Central Highlands is by day visitors, in particular in the southern areas of the region near Melbourne. Table 8.2 shows the most popular visitor activities in the Central Highlands, including the activities of the day trippers.

Visitation of major tourism and recreation sites in the Central Highlands, as identified by Henshall Hansen and Associates and Read Sturgess and Associates et al. (1992) is listed in Table 8.3.

General economic conditions should be noted when reviewing the recreation and tourism information contained within this report.

Table 8.2: Visitor activities in the Central Highlands, 1995

Activity	Visitors (% participating)	Day trippers (% participating)
Drive to sightsee/pleasure	50.4	48.7
Restaurants/dining out	37.2	9.9
Bushwalking	35.5	8.4
Visiting national park/forest	30.3	15.1
Visiting friends and relatives	30.2	23.5
Shopping	23.6	8.0
Visit an art gallery/craft centre	18.0	4.3
Visit a park or garden	11.7	6.4
Visit animal/wildlife park/zoo	10.7	22.0
Fishing	10.4	2.3
Picnic BBQ	-	29.0
Visit a museum or historic site	3.8	1.9
Attend a Festival/Event	5.8	3.9
Visit a winery	7.4	4.4
Water Skiing/Snow Skiing	9.6	1.4
Organised tour/Group activity	8.6	3.1
Swimming/surfing/diving	9.4	0.3
Sailing/boating	8.0	0.3
Playing sport	2.1	4.0

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

Table 8.3: Visitors to major sites in the Central Highlands

	Visitors 1990/91 [#]	Visitors 1995/96 [*]
Parks and forests		
National and State Parks	1 850 500	2 908 600
State Forests	n/a	850 000
Snowfields		
Lake Mountain	170 000	160 000
Mt Baw Baw	36 000	42 000
Reservoir Parks		
Cardinia and Aura Vale	609 000	373 700
Reservoirs		
Maroondah	242 000	212 100
Fernshaw	232 000	87 900
Sugarloaf	191 000	118 900
Coranderk	163 000	n/a
Upper Yarra	149 000	61 600
Thomson	53 000	54 400
Donnellys	7 000	29 200 d)
Other Attractions		
Puffing Billy railway	220 000	219 800 ^c
Emerald Lake Park	400 000	n/a
National Rhododendron Gardens	65 000	14 000
Healesville Sanctuary	349 000	319 500 c)

a) Increase in visitors to national parks may be due to more parks being included in the count. b) Figures are for 1994-95. c) figures are for the year ended 31st December 1995. d) Now part of Yarra Ranges National Park. n/a data is not available. Sources: # Henshall Hansen and Associates and Read Sturgess and Associates et al (1992). * Alpine Resorts Commission, (personal communication), Parks Victoria (personal communication), Tourism Victoria (1996b), Read Sturgess and Associates (1995).

8.3 TOURISM AND RECREATION ON PUBLIC LAND IN THE CENTRAL HIGHLANDS

As noted above, the Central Highlands forests contribute significantly to the region's tourism and recreation. In managing public land, and particularly forests within the Central Highlands, NRE aims to provide a wide range of tourism and recreational opportunities while conserving the natural environment (McHugh, 1991). Both State forests and parks and reserves are popular and complement each other as visitor destinations.

As indicated in Tables 8.3 and 8.4 examples of the many attractions found on public land in the region include:

- The Yarra Ranges with their mountain ash forests, popular picnic localities and scenic drives;
- Kinglake National Park;
- the gardens and mountain ash forests of the Dandenongs, and Puffing Billy;
- Healesville Sanctuary and the Toolangi Forest Discovery Centre;
- The snowfields of Mount Baw Baw, the Baw Baw Plateau, Mount Donna Buang and Lake Mountain;
- Lake Eildon and the rivers and streams of the region, popular for fishing and camping (eg the Big River);
- Opportunities in State forest for deer hunting, particularly in the east of the region;
- four-wheel driving along the many roads and tracks through the area;
- historic features such as the tramways and sawmill sites in the State forest between Warburton and Powelltown.

Tourism has been widely advocated as a potential area for regional economic growth due to the diversity of natural resources in the Central Highlands. Both National Parks and State forests contribute to the overall attractiveness of the area as a potential tourist destination. However, there are some differences in recreation opportunities available in National Parks compared with State forests. The type of activity which occurs in individual parks and forests is largely governed by regulations, which vary with tenure, and the management plans which accompany the park, reserve or forest. There are generally tighter constraints placed on recreation and tourism in National and State Parks than those in State forests.

NRE and Parks Victoria have a role to play in the development and promotion of the Central Highlands area, particularly in some of the towns such as Marysville, Healesville and Warburton adjacent to forests. Regional Tourism Boards coordinate tourism promotion, including the distribution of promotional material. Their membership is drawn from local tourist operators, business and local and State Government representatives. Parks Victoria on behalf of NRE has membership on some of these Boards and liaises with them, local tourism associations, municipalities, and Tourism Victoria to promote attractions in the Central Highlands as required. In addition, information about NRE facilities and recreational opportunities is made available to the Regional Tourism Boards for inclusion in tourism promotion activities. (NRE, 1996b).

Tourism and Recreation in National Parks

Land classified under the *National Parks Act 1975* is managed to preserve flora, fauna and other natural features and to provide appropriate opportunities for enjoyment by visitors. Within the Central Highlands there are five National Parks, five State Parks and various other parks and reserves such as Lysterfield Lake Park designated under the *National Parks Act 1975*. Visit-day numbers to parks are shown in Table 8.4. 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 8.4: Parks in the Central Highlands managed under the National Parks Act 1975

Park/ Reserve	Area as of 30 June 1995 (ha)	Visit-days (1995-96)
Dandenong Ranges National Park	1 920	1 107 267
Yarra Ranges National Park	76 000	784 000
Kinglake National Park	21 600	224 004
Lysterfield Lake Park	1 276	164 279
Warrandyte State Park	586	143 658
Eildon State Park	24 000	103 416
Baw Baw National Park	13 300	96 600
Cathedral Range State Park	3 577	85 008
Fraser National Park	3 750	73 665
Bunyip State Park	13 900	43 599
Moondarra State Park	6 292	na
Totals	168 851	2 908 564

Source: NRE (1996a)

Land managed under the *National Parks Act 1975* in Victoria received an estimated 12 966 160 visit days in 1995-96. Of these visits approximately 22 per cent were to National and State parks within the Central Highlands.

The most popular parks were the Dandenong Ranges National Park, Yarra Ranges National Park, Kinglake National Park and the Lysterfield Lake Park. These parks accounted for approximately 78 per cent of all visits to National and State Parks in the region. The Dandenong Ranges National Park received the third highest number of visits to National Parks in Victoria in 1995-96.

In order to preserve the natural environment in parks and reserves, recreation activities are managed with the general aim of minimising impacts on the natural environment. Parks regulations and management plans specify which activities are permitted in Parks. General restrictions in National Parks include the prohibition of firearms and pets such as cats and dogs.

Parks, as with State forests, include management zones and overlays based on different management objectives. Examples of zones include conservation, conservation and recreation, recreation development and education zones. This zoning system is designed to reduce conflicts between various types of visitor use and protection of other park values.

Recreation in Parks in the Central Highlands includes activities such as picnicking, camping, fishing, bushwalking, horse riding, rock climbing and abseiling, canoeing, cycling and pleasure driving. Cross-country skiing is also a popular activity in two parks (Yarra Ranges National Park, Baw Baw National Park). In some cases and under special conditions, car and motor bike rallies, orienteering and rogaining, and training exercises may be permitted in some areas. Deer hunting by stalking is legally permitted in parts of two parks (Eildon State Park and Baw Baw National Park).

Tourism and Recreation in State forest

State forests of the Central Highlands are estimated to attract around 850 000 visitor days each year (NRE, 1996b). Due to their close proximity to Melbourne, the Central Highlands State forests have some of the highest usage of any State forests within Victoria. Read Sturgess and Associates (1995) found that State forests close to Melbourne had a more constant use throughout the year than those State forests further away. The main recreation areas include the Marysville, Toolangi, Mount Disappointment and Yarra State forests.

State forests complement the park and reserves system by providing additional recreational activities to those offered in parks and reserves (Jeremiah and Roob, 1992). Read Sturgess and Associates (1995) found that the most popular activities within the Central Highlands State forests include picnics, nature observation, trail bike riding, horse riding, forest drives, four wheel driving, walking and hunting. Other activities include camping, fishing, mountain-bike riding, car rallies, rogaining and orienteering, canoeing and rafting, rock climbing, fossicking and prospecting.

Although National Parks often have a higher profile than State forests, Read Sturgess and Associates (1995) found that visitor levels in some State forests increased as visitor levels to nearby National Parks increased. The recent declaration of the Yarra Ranges National Park is expected to increase the profile of the Central Highlands as a tourist destination and may lead to increased use of the surrounding State forest.

The Proposed Central Highlands Forest Management Plan (NRE, 1996b) includes the following aims for tourism and recreation management.

- To provide for a wide range of recreational activities in State forest which complement those available in parks and reserves.

- To facilitate the participation of the private sector in the provision of tourism and visitor services.
- To participate in and integrate tourism planning and promotion with peak tourism bodies and local government.
- To minimise the environmental damage caused by recreational activities.
- To educate and inform visitors about native forests and their management.

In managing public land, NRE aims to provide a wide range of recreational opportunities while conserving the natural environment. To assist in recreation planning, the State forests have been segmented into four recreation management zones. Activity and visitor use in Zone 1 is high and concentrated, and infrastructure may be well developed; in Zone 4, activity and visitor use is dispersed and infrastructure may be minimal to non-existent. The zones take into account recreational activities and facilities available in nearby parks and reserves.

Within each of the zones NRE provides opportunities for suitable recreational activities. In intensively-used areas, such as around Marysville and Warburton (Zone 1), where State forest is an important part of the area's tourism attraction, day walks, picnics and scenic drives with appropriately developed facilities are encouraged. However, as many independent, self-sufficient visitors seek access to more remote recreational opportunities, such as camping and four-wheel-driving along the Big River (Zone 4), access to and information on these areas is of a lower standard, and facilities are more limited (NRE, 1996b).

Community interest in the management and protection of the natural environment, particularly native forests, is growing. In order to encourage an understanding of forest management practices in the Central Highlands Area, a number of environmental study sites have been identified, and many community groups visit them. Education and interpretation facilities include Toolangi Forest Discovery Centre, Healesville Sanctuary and other facilities managed by other organisations. In addition to these environmental study sites, NRE produces a wide range of information, such as brochures, maps, posters and pamphlets for both school groups and the general public.

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. Commercial tours are becoming a popular means for tourists to enjoy forest areas. Types of tours include horse-riding, wildlife spotlighting and forest tours. These commercial activities are regulated through NRE's Commercial Tours Permit System which operates across all public land.

There are about 79 commercial tour operators on public land in the Central Highlands. This represents about 28 per cent of all Victorian tour operators licensed by NRE. While most operate within National Parks, some also operate within State forests such as the Toolangi and Yarra State Forests.

The main activities of the Commercial Tour Permits issued for public land in the Central Highlands (with the number of operators in brackets) include: bushwalking (24); 4WD tours (20); horseriding (18); rafting/canoeing/kayaking (16); rockclimbing/abseiling (12); coach, bus and boat tours (7); and bicycle riding (6). Other commercial tour operations within Central Highlands forests include fishing, camping, cross country skiing, bird watching, vehicle based sight seeing and trail bike tours.

8.4 ECONOMIC VALUE OF TOURISM IN NATIONAL PARKS AND STATE FOREST

Read Sturgess and Associates (1995) study suggests that the net economic value of recreation in Victorian State forests is within the range of \$6-\$18 per visitor day.

In 1995-96, there were about 850 000 visit days to the Central Highlands State forests and approximately 2 908 600 visit days to Central Highlands parks. Using the Read Sturgess and Associates (1995) estimates and extending them to include expenditure in National Parks, this equates to a total net economic value of at least \$22.5 million per year for tourism and recreation in Central Highlands forests.

In addition, the study suggests that a range of between \$20 and \$50 per visitor day be used as a guide to calculate the stimulus of tourism and recreation in State forests on the regional economy through flow on effects. Extending these estimates again to include National Parks, this equates to tourism and recreation in Central Highlands forests contributing between \$75.1 million and \$187.9 million per year to the regional economy.

These estimates suggest that tourism and recreation is an important part of the economic values derived from Central Highlands forests.

Employment

Henshall Hansen and Associates et al (1992) undertook a study of the Central Highlands area within the Land Conservation Council's Melbourne District 2. Based on a total visitation of 1.5 million annually to parks and alpine resorts within the area, the study estimated that visitors to public land in the region support potentially 210 jobs directly. In addition, through a multiplier effect, the study estimated day visits to the region would support a further 100 jobs indirectly, of which possibly half would be local. This implies that tourism and recreation in Central Highlands forests supported a total of approximately 260 jobs within the region in 1992.

8.5 DEMAND FOR TOURISM AND RECREATION IN FORESTS

The Tourism Forecasting Council predicts that domestic visitor nights in Victoria will increase by 24 per cent between 1994 and 2005 and that international visitor nights in Australia will increase on average by 8.9 per cent between 1995 and 2005 (Tourism Forecasting Council 1996a, 1996b). With visitors to Victoria and Australia predicted to increase, and given the geographical location of the Central Highlands, it can be projected that the region will receive an increase in visitors in coming years.

The trend towards nature based tourism over recent years suggests an increase in tourism and recreation in Central Highlands forests in the years to come. In the international arena, nature based tourism (ie tourism activities occurring in natural areas) is an important component of global tourism.

Read Sturgess and Associates (1995) found that the growth in visitor numbers to national parks in Victoria averaged 3.4 per cent per annum in the 5 years to 1993-94 and expected this growth to continue. The study concluded that growth in visitor numbers to State forests had been similar and that a 3 percent to 5 per cent growth rate can be expected to the end of the decade.

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:

- 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 a large, but mainly unrealised interest in four wheel driving, canoeing, learning about aboriginal culture/history, white water rafting, scuba diving, cross country skiing, hang gliding and working as volunteers in parks.

It would seem that public land in the Central Highlands is well suited to appeal to much of the population as it provides for a number of these activities and facilities. For example, the region provides opportunities for family activities and enjoying the great outdoors relatively close to Melbourne. In addition the Toolangi Forest Centre and Healesville Sanctuary provide educational opportunities for visitors and there are opportunities for adventure activities such as rock climbing; cross country skiing; canoeing and four wheel driving; and opportunities to undertake picnic and short bushwalks.

9. WATER AND CATCHMENTS

9.1 INTRODUCTION

A supply of water in sufficient quantity and appropriate quality is essential for maintaining natural environments, and for recreational, agricultural, industrial and domestic uses. Water is an important resource that can be harvested from forested catchments. In the Central Highlands these are used for a range of uses including recreation, conservation, timber production and water supply.

The relationship of water, forests and forest use is complex, and based on many variables including climate and geology, lithology and vegetation. Linkages exist between the properties of the soils, the forest structure, and the impacts of land use (including both the area and spatial distribution of uses) on water quality and quantity in the Central Highlands and these complexities present significant policy and management challenges to government.

Large scale timber harvesting in the Central Highlands has the potential to affect water quality and quantity. The significance of these affects relates to soil properties, forest water demand, water allocation and forestry practices. This chapter describes the policy and planning framework that governs water management in Victoria and examines water resources and production in the context of the current land uses of the Central Highlands. These descriptions include a brief review of relevant research underpinning management and references are provided in the bibliography.

A major consideration of the RFA process is the implementation of ecologically sustainable forest management (ESFM) and a review of the Statewide systems for ESFM is described in a separate CRA report (VicRFASC 1997a)

9.2 WATER RESOURCES IN THE CENTRAL HIGHLANDS

Water resources can broadly be classified as surface water or ground water. The configuration and nature of the water resources in a region depend on a number of elements of the water cycle. In brief terms, 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 will usually infiltrate until saturation occurs, and then run off as surface flow. Overland flow contributes to short term river flow following a rainfall event, and infiltration contributes to underground water (aquifer) reserves which may be discharged into rivers and streams.

Infiltration is a function of soil porosity and storing capacity. Sands and loamy soils will absorb more water more quickly than clays or rock. Where the soil becomes saturated, or rain falls more quickly than it can infiltrate, overland flow can lead to erosion. Vegetation serves to disperse the energy of water before it hits the ground and runs off, and has the capacity to hold soil and stabilise slopes. Vegetation also uses water for maintenance of physiological functions. Water use by forests will vary with forest type and age, for example a very young forest uses less than a mature forest, but the greatest demands for water use are usually associated with vigorously growing, even-aged juvenile forests.

Human impacts can also affect water values at two levels. Firstly, the land use regime and distribution within a region will determine vegetation cover and broad levels of disturbance or influence on water quality and quantity. At a more detailed level, the management

arrangements and practices implemented at the local level will influence water characteristics downstream. The relationships between land use and catchment and water values at the local level are well documented and these are considered as part of management issues. However, it is worth describing the land use arrangements at the broad level as part of the discussion of the water resources of the Region.

Catchments located in developed or developing areas in the Central Highlands have undergone complex landuse/management change including:

- land cover modification;
- resource production/extraction activities;
- construction/modification of waterways;
- application of fertilisers, herbicides, pesticides and other chemicals;
- road construction, maintenance and use;
- various forms of recreation; and
- urban or rural residential development.

Although the CRA is concerned largely with public lands, the information provided below demonstrates that some water storages draw water from other tenures including private property (Lake Eildon and Blue Rock Lake). Land uses on private property in the Central Highlands includes agriculture, residential and industrial activities. Within forests, recreation, tourism, extractive (e.g. gravel) and other production activities may also impact on water quality.

Details of public land tenures by area are provided in Chapter 1. Map 9.1 and Table 9.4 indicate tenure by catchment. Public lands account for 627 100 ha or 56 per cent (NRE 1996a) of the Central Highlands region and virtually all of this area is forested. The remaining 44 per cent or 502 800 ha of private land (NRE 1996a) includes around 388,400 ha cleared land and around 114,400ha forest (BRS 1997c) used for a range of uses including agriculture, industry and residential uses.

In general, public land in the region is concentrated on the Dividing Range coinciding with the upper portions of the five drainage basins described below, although some water supply reservoirs draw from catchments containing areas of freehold, non-forested land eg. Moondarra Reservoir, Blue Rock Lake and Lake Eildon. Map 1 shows the land tenures of the region, as well as the major river basins and Map 9.1 indicates the major catchments with respect to water storages within or drawing from the region.

The eastern and southern portions of the region are substantially freehold and contain the most arable lands, associated with foothills and valleys falling from the divide. Land uses include urban/rural residential, industrial, agricultural/horticultural, and some plantations.

Surface Water Resources

The Australian Water Resources Commission (AWRC) has divided Australia into twelve Drainage Divisions which are sub-divided into basins. The Central Highland region is within the Murray-Darling Division and South East Coast Division and extend across parts of five basins:

The southern portion of the **Goulburn River Basin** (#5 AWRC) - including the Goulburn, Yea, Murrindindi, Acheron, Taggerty, Royston, Rubicon, Taponga, and Big Rivers and their tributaries;

The western portion of the **Thomson River Basin** (#25 AWRC) - including the Thomson and Aberfeldy Rivers and their tributaries;

The north western section of the **Latrobe River Basin** (#26 AWRC) - including the Latrobe, Tanjil, Tyers and Moe Rivers and their tributaries;

The north-eastern portion of the **Bunyip River Basin** (#28 AWRC) - including the Patterson's, Bunyip and Tarago Rivers and their tributaries; and

The majority (except for an area in the south-west) of the **Yarra River Basin** (#29 AWRC) - including the Yarra, Merri, Darebin, Plenty, Watts, Little Yarra and O'Shannassy Rivers and their tributaries. (DWR, 1989).

Estimates of the area, mean annual streamflow and the divertible and developed surface water resource of each of these basins is provided in Table 9.1.

Table 9.1 Mean annual streamflow of river basins

Basin	Area (ha)	Mean annual streamflow (ML)	Divertible resource (ML)	Developed resource (ML)
Goulburn	1,619,158	3,040,000	1,930,000	1,780,000
Thomson	596,947	1,215,000	805,000	512,000
Latrobe	521,386	980,000	525,000	457,000
Yarra	409,562	1,100,000	575,000	442,000
Bunyip	389,033	355,000	120,000	49,000

Australian rivers and streams are highly variable (Table 9.2) with much of the variability being a function of seasonality, and this is the case with the Central Highlands. Most streams carry the greater proportion of their annual flow in winter and spring. Water storages in the Central Highlands, such as Lake Eildon and those within the Yarra catchment can modify and regulate streamflow in these catchments. This modification of seasonality can have effects on riverine ecosystems, however, controlled releases of water from water storages can assist in the maintenance of environmental values.

Allocations for the use of water are required to take into account ecological values of the water resources. Minimum flows, also known as passing flows or environmental flows, are provided along rivers in the Central Highlands (e.g. Thomson, Yarra, Latrobe, Goulburn) for maintaining aquatic ecosystems.

Table 9.2: Mean annual discharge, maximum and minimum monthly discharge for selected watercourses in the Central Highlands

Watercourse	Gauging station	Mean annual discharge (ML)	Max monthly discharge (ML)	Min monthly discharge (ML)
Goulburn catchment				
Acheron River	Tagerty	337,000	112,000	1,220
Big River	Jamieson	330,000	153,000	1,460
Goulburn River	Eildon	1,650,000	907,000	235
Goulburn River	Seymour	2,650,000	1,070,000	20,400
Thomson catchment				
Thomson River	Cooper Ck	353,000	172,000	1,720
Thomson River	Narrows	241,000	88,500	1,570
La Trobe catchment				
La Trobe River	Noojee	112,000	27,100	1,860
La Trobe River	Willow Grove	226,000	77,200	2,330
Bunyip catchment				
Bunyip River	Iona	106,000	51,900	97
Bunyip River	Bunyip	153,000	93,600	1,800
Yarra catchment				
Blue Jacket Ck	Coranderrk Weir	372	83	5
Yarra River	Mill Grove	171,000	93,700	1,300
Yarra River	Warrandyte	751,000	459,000	1,560

Source: State Rivers and Water Supply Commission 1984 in LCC 1991

Ground Water Resources

The Central Highlands lies predominantly within the Highlands groundwater province and a small area of the Gippsland groundwater province. It covers an extensive shallow aquifer system (less than 150m below the surface) throughout the region, and a deep aquifer system in the south-eastern area of the region. Fractured rock aquifers and alluvial valley aquifers which occur within the Central Highlands include:

- shallow Quaternary alluvial aquifer systems along major river valleys including the Acheron, Thomson and the Latrobe River and lower reaches of their tributaries;
- shallow aquifers of the 'Haunted Hills' gravels to the north of the La Trobe River;
- aquifers of the La Trobe Valley Group deep aquifers of the Moe Swamp Basin and La Trobe Valley;
- aquifers of the Upper Cretaceous basalts in the western area;
- Palaeozoic and Mesozoic fractured rock aquifers in the highlands. (Heislars 1993, DWR 1989)

Groundwater quality in the Central Highlands is generally fresh (salinity <500 mg/L), however water quality declines to marginal (salinity 500-1500 mg/L) in the western area of the region near Melbourne, the northern area of the region and near the Latrobe River.

Groundwater yield and use varies throughout the region. High yielding and excellent quality aquifers which are located in the Kinglake area and Monbulk and Silvan-Wandin districts, in the Siluro-Devonian sediments and older volcanics, are principally used for irrigation and stock and domestic supply (Heislars 1993).

Aquifers of the highlands provide baseflow for many upland streams which enables some major rivers to continue flowing throughout the year (Heislars 1993).

9.3 WATER USAGE FROM THE CENTRAL HIGHLANDS

The catchments of the Central Highlands contribute all of the water supply for Melbourne, a large portion of the water used in the Goulburn-Murray Irrigation District to the north, the MaCalister Irrigation District to the south, and numerous other rural/urban water supplies both inside and outside the region. The streams and catchments of the Central Highlands also have significant ecological, heritage and tourism and recreation values.

Water resources of the Central Highlands are primarily used, both within and outside the region, for water supply for domestic, industrial and agricultural purposes, for recreation and for maintaining stream environments. The major water storages constructed in the forested catchments of the Central Highlands for water supply are listed in Table 9.3.

Table 9.3: Major surface water storages within the Central Highlands

Basin	Storage	Capacity (ML)	Primary Purpose	River
Goulburn	Lake Eildon	3,390,000	Irrigation	Goulburn
Thomson	Thomson Reservoir	1,123,000	Urban	Thomson
Latrobe	Blue Rock Lake	200,000	Urban, industrial	Tanjil
	Moondarra Reservoir	30,000	Urban, industrial	Tyers
Yarra	Yan Yean Reservoir	30,000	Urban	Off river
	Maroondah Reservoir	22,000	Urban	Watts
	Silvan Reservoir	40,000	Urban	Off river
	O'Shannassy Reservoir	4,000	Urban	O'Shannassy
	Upper Yarra Reservoir	200,000	Urban	Yarra
	Sugarloaf Reservoir	95,000	Urban	Off river
Bunyip	Tarago	37,600	Urban	Tarago
	Cardinia Reservoir	287,000	Urban	Off river

Source: DWR 1989, LCC 1991

Table 9.4 provides a list of the catchments within the Central Highlands as shown on Map 9.1. Most of the catchments are either National Park, State forest or other Crown land, except for the catchments supplying Moondarra, Blue Rock, Tarago and Eildon. As indicated in table 9.3, Yan Yean, Silvan, Sugarloaf and Cardinia water storages are not located directly on one stream or river.

Table 9.4: Catchments within the Central Highlands Region, shown in Map 9.1.

Catchment Number	Catchment Name
1	Armstrong Creek
2	Britannia Creek
3	Bunyip River
4	Cardinia
5	Cement Creek
6	Coranderrk Creek
7	Drouin
8	Healesville
9	Kilmore / Sunday Creek
10	Lake Eildon environs
11	Maroondah
12	McCraes Creek
13	McMahons Creek
14	Micks Creek
15	O'Shannassy
16	Plenty River
17	Running Creek
18	Silvan
19	Starvation Creek
20	Sugarloaf
21	Tanjil River
22	Tarago River
23	Thomson River (Stage 3)
24	Thomson River (Stages 1, 1A, 2)
25	Tomahawk Creek
26	Tyers River
27	Upper Goulburn
28	Upper Yarra
29	Wallaby Creek
30	Yan Yean

An indication of the relative use of water resources within the River basins, excluding water used for the Melbourne Water Supply System, is provided in Table 9.5. Water used for urban and industrial purposes within the Melbourne Metropolitan Area is primarily delivered from water storages of the Yarra River basin, the Thomson Reservoir and the Cardinia Reservoir (DWR 1989).

Table 9.5: Water use within the river basins (excluding Melbourne Water Supply system)

Basin	Urban and Industrial (ML)	Rural (ML)	Irrigation (ML)	Total Use (ML)
Goulburn	14,920	26,760	739,020	780,700 a)
Thomson	13,780	8,780	182,000	204,560
Latrobe	106,980	2,510	55,860	165,350 b)
Bunyip	2,600	9,560	18,280	30,440
Yarra	1,040	2,170	8,500	11,710

a) 6,000ML imported from the Murray River. b) 25% imported from the Thomson and Bunyip Basins' surface waters.

Source: DWR 1989

Irrigation is a major use of water resources of the river basins, in particular, the Goulburn and Thomson River basins. With the exception of the Bunyip River basin, which has a good supply of groundwater, surface water is the main source of water for irrigation. Lake Eildon, the Goulburn River basin's major water storage, which is located partly in the Central Highlands, supplies more than half the water used in the Goulburn-Murray Irrigation District (DWR, 1989). The water resources of the Thomson Reservoir are utilised for irrigation within this basin, and provide water for Melbourne and the Mornington Peninsula.

In contrast, within the Latrobe River Basin, the water resources are mainly used for industrial purposes. The electricity generation and pulp and paper production industries, which utilise both high and low quality water, are major industrial water users within the Basin. Blue Rock Lake and Moondarra Reservoir, as well as groundwater resources, are a source of water for these industries, which operate outside the Central Highlands.

Commercial aquaculture and hydro-electric power stations are also major commercial and industrial users of water in the Central Highlands. Hydro-electric power stations operate on several rivers including the Rubicon, Royston, Eildon and Thomson Rivers. Fish farms in the Upper Yarra catchment, and at Noojee near the headwaters of the Latrobe River, are also major users of water (EPA 1995a, EPA 1995b).

Many of the forested catchments of the Central Highlands provide for a diverse range of water-based and water-enhanced recreational activities in State forest and parks and reserves. Popular water based recreational activities include: fishing, canoeing/rafting, boating, water skiing and swimming, as well as associated activities such as camping and nature observation. (There is restricted access in several of Melbourne's water supply catchments.)

Areas which are particularly favoured for recreational fishing include parts of the Yarra, Tyers, Acheron, Rubicon, Big, Upper Goulburn, Thomson and Aberfeldy rivers. Rivers used for canoeing and rafting include sections of the Yarra, Tyers, Acheron, Big, Goulburn, Yea, Taponga, Thomson and Aberfeldy rivers and King Parrot Creek. Water storages such as Lake Eildon are very popular sites for a range of recreational activities.

The use and value of tourism and recreation in the Central Highlands is discussed in tourism and recreation assessment section.

Melbourne Water Supply

Melbourne water supplies are drawn from a number of catchments in the Central Highlands as shown on Map 9.1. The Upper Yarra, O'Shannassy and Maroondah water supply catchments, and the supply reservoirs in these catchments, are entirely contained within the Yarra Ranges National Park. Wallaby Creek and Plenty River water supply catchments, which are entirely contained within the Kinglake National Park, supply water to the Yan Yean Reservoir.

Other catchments supplying Melbourne include the Armstrong Creek, Cement Creek, Starvation Creek, McMahon's Creek and the Thomson catchments. The tenures of these catchments are public land, being either national park or State forest (see Map 9.1 and Table 9.4).

Water quality from these catchments is generally high. Melbourne Water Corporation, which supplies water to metropolitan Melbourne, indicates that the Corporation provides reliable supply of safe, high quality drinking water that consistently meets *1987 National Health and Medical Research Council* health guidelines (MWC 1996).

Melbourne Water supply water storages have a capacity of approximately 1826 gegalitres (MWRR 1992a). In recent years the average annual water consumption by the Melbourne population has generally been less than 450 gegalitres per annum. For the 90 years prior to the 1980s, Melbourne's water demand grew at a relatively steady rate of 2.9 per cent each year. Since the early 1980s Melbourne's water demand growth has slowed significantly as a result of demand management programs introduced. Since 1990 water consumption per household has been on a par with the lowest on record and peak demands have not grown, despite an increase in population. This reflects the success of the demand management program. (MWC 1997) This review was completed prior to the significant slowing in water demand that has occurred recently.

Reductions in water demand can postpone the timing of future augmentations. The Melbourne Water Resources Review, which reviewed the management of Melbourne's water to the year 2020, indicated that major augmentation of Melbourne's water supply can be deferred well beyond 2020. The review believed that an integrated Demand Management Strategy would make it possible to defer augmentation of the water supply beyond 2020 and that improved yields from existing catchments and "non-traditional" sources of supply will be able to defer augmentation further (NRE 1996b).

Water resources of several water supply catchments are also used for other purposes such as recreation. However, access in water supply catchments in the Kinglake National Park and Yarra Ranges National Park is restricted. Management arrangements in water supply catchments is discussed in later sections of this chapter.

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. The 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.

Also included under the framework is the adoption of an integrated catchment management approach to water resource management.

It is intended that the State and Territory Governments will have implemented the framework by 2001 with property rights in place (including environmental allocations) and water trading occurring no later than 1998. Implementation will be progressively measured by determining whether or not milestones (still being determined) 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 implementing the framework. This has been assisted by the work of the Agriculture and Resource Management Council of Australia (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* (1996).

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 co-operative development of guidelines. The 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
- co-ordination of all the agencies, levels of government and interest groups within the catchment
- 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; 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. 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 proposed 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).

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, some of which are detailed below:

- *Water Act, 1989*;
- *Catchment and Land Protection Act 1994*;
- State Environment Protection Policies declared under *the Environment Protection Act, 1970*;
- *Land Conservation Act (1970)*;
- Management Planning, Code of Forest Practices and Regional Prescriptions enacted under the provisions of the *Forests Act (1958)*; and the *Conservation, Forests and Lands Act (1987)*
- Management Planning under the provisions of the *National Parks Act 1978*.

Provisions of the Water Act 1989 (Vic)

Waterway Authorities and River management Authorities (RMA) have been appointed for catchments under the provisions of the *Water Act 1989*. The general objectives of RMA's are:

- to protect and enhance environmental, economic, recreational and aesthetic values of rivers; and
- to protect public and private assets from damage by rivers and streams.

The Water Act establishes a system of allocating the available water resource outside the Melbourne Metropolitan Area and provides for the integrated 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 amongst water authorities.

The Act provides for entitlements, known as 'bulk entitlements', to be granted to water authorities, other public bodies and the environment. Furthermore, it provides for the rights which are allocated from the bulk entitlement to an authority to be passed on to private individuals or the environment. These allocations for example may be a licence to take and use water from a waterway or groundwater.

Bulk water entitlements are currently being established within the Central Highlands. 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 a 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).

The Catchment and Land Protection Act (1994)

The *Catchment and Land Protection Act* (1994) provided for the establishment of Catchment and Land Protection (CALP) Boards across catchments to prepare regional strategies, which identify objectives and priorities for the quality of land and water resources across the regions. Parts of the West Gippsland, Port Phillip and Goulburn-Broken strategies cover the Central Highlands. See Port Phillip Catchment and Land Protection Board 1996 (PPCALP 1996), Goulburn Broken Catchment and Land Protection Board 1996 (GBCALP 1996), West Gippsland Region and Catchment Protection Board 1997 (WGRCPB 1997).

The Act requires that a regional catchment strategy:

- assess the land and water resources of the catchments in the region and how they are used;
- assess the nature, causes, extent and severity of land degradation of the catchments in the region and identify areas for priority attention; and
- identify objectives for the quality of the land and water resources of the catchments in the region; and
- set a program of measures to promote improved use of land and water resources and to treat land degradation.

Land managers are required to have regard to any regional catchment strategy applying to the land.

These documents provide a strategic framework designed to protect and improve the health and prosperity of these regions (PPCALP, 1996). Regional issues are identified and prioritised against the goals of the Regional Catchment Strategy which, in terms of catchment hydrology, include:

- The maintenance and improvement of water quality in rivers and streams;
- The coordination and monitoring of all catchment and land protection activities.

The sorts of initiatives that are proposed include:

- Reviews of the State environment protection policies for major catchments;
- Formulate and implement stormwater management agreements between authorities to address all catchment impacts which affect the targets of the State environment protection policies;
- Determine standards and codes of practice or management guidelines for water quality improvement and develop partnership agreements for implementation; and
- Identify and locate the main diffuse and point sources of nutrient, sediment and bacterial input to waterways, and develop site specific actions to meet the requirements of revised SEPPs and the Victorian Nutrient Management Strategy.

Areas within catchments warranting particular attention, such as areas required for water supply, can be declared Special Areas under the *Catchment and Land Protection Act 1994* (Vic). Within the Central Highlands Region there are 17 Special Areas classified as Special Water Supply Catchment Areas (Table 9.6).

Table 9.6: Special Water Supply Catchment Areas in the Central Highlands

Name of Catchment	Area (km ²)	For the protection of:	Special Area Plan	Slope (°)	Seasonal Closure	Stream Buffers	Filter Strips
Upper Goulburn (a)	3535	Irrigation		30	-	20 m	5 m
Lake Eildon Environs (a)	868	Irrigation	Yes	30	-	20 m	5 m
Tyers River	317	Town Water	Yes	30	1 June - 31 Oct.	20 m	5 m
Kilmore	5	Town Water	Yes				
Bunyip River	39	Town Water	Yes	25 30	1 May - 30 Nov.(b) 1 June - 31 Oct.(c)	20 m	5 m
Healesville	3	Town Water	Special Area Plan no longer in effect				
McCraes Creek	5	Town Water	Yes				
Drouin	14	Town Water		30	1 July - 30 Sept.	20 m	5 m
Tarago River	114	Town Water	Yes	30	1 May - 31 Oct.	20 m	5 m
Micks Creek	5	Town Water	Special Area Plan no longer in effect				
Thomson River (Stages 1,1A,2)	332	Town Water	Special Area Plan no longer in effect	30	1 May - 31 Oct.	40 m (e)	5 m
Thomson River (Stage 3)	158	Town Water		30	1 May - 31 Oct.	40 m (e)	5 m
Running Creek (Hurstbridge)	20	Town Water					
Tanjil	509	Irrigation/ Industrial/ Town Water	Yes	30	1 June - 31 Oct.	20 m	5 m
Britannia Creek	18	Town Water	Yes	25	1 July - 30 Sept.	20 m	5 m
Tomakaw Creek (Gembrook)	3	Town Water					
Sunday Creek (Broadford-Kilmore) (d)	20	Town Water	Yes	30	-	20 m	5 m

a) Only part of special area is within Central Highland region b) Dandenong FMA c) Central Gippsland FMA d) A maximum of 25 ha harvested per year. e) Major streams only. Source: LCC (1994), NRE (1996a) and *Catchment and Land Protection Act 1994* (Vic).

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. The Code of Forest Practices for Timber Production (Code) requires that water quality and yield are protected in water supply catchments.

Under the Act, Special Area Plans, which can be prepared for declared areas, must 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 Central Highlands place specific requirements on forest management including, for example, seasonal restrictions on harvesting in particular areas and restrictions on the level, type and location of recreation activities. The Thomson catchment provides an example of this form of management arrangement, and is discussed further below.

Government Approved Land Conservation Council Recommendations

Under the *Land Conservation Act 1970* (Vic), the Land Conservation Council may carry out investigations and make recommendations with respect to the use of public land in order to provide for the balanced use of land in Victoria. The LCC's Melbourne Area, District 2 Review (LCC, 1994) of public land use of the Central Highlands region was completed in 1994, and a statewide Special Investigation into Rivers and Streams was completed in 1991.

The LCC recommended that a range of public land tenures, namely State forest, National Parks and State Parks, within the Central Highlands also be used for water supply and to protect stream and water catchments

In recognising the diverse values of streams and water catchments within the Central Highlands, the LCC made specific recommendations (LCC, 1994) for the use of Natural Feature Reserves (that is, Water Frontage Reserves passing through freehold and public land Streamside Reserves), Heritage Rivers and River Zones in State forests.

Heritage Rivers were identified in the LCC's Statewide investigation into Rivers and Streams (LCC, 1991) in which 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. Timber harvesting is not permitted in the river corridors of the Big and Thomson Heritage Rivers but is permitted in the remainder of the Thomson and the Big River Valley, subject to application of the Visual management System;
- 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.

Subsequently, within the area of the Central Highlands, the corridors of the Big, Thomson, Yarra and Goulburn (below Lake Eildon) have been designated as Heritage Rivers and are protected under the *Heritage Rivers Act, 1992*, which provides the formal protection in accordance with the recommendations above. The O'Shannassy Natural Catchment, located mainly in the Yarra Ranges National Park, was further listed as an essentially natural catchment.

The Big Heritage River is fully within State forest, whereas the Thomson Heritage River is within State forest and the Baw Baw National Park. The Aberfeldy Heritage River is fully within Baw Baw National Park. The Yarra and Goulburn Heritage Rivers within the Central Highlands predominantly pass through freehold land.

Furthermore, 'River Zones' have been recommended by the LCC (LCC 1994) along other rivers and streams in the Central Highlands which contain significant natural, scenic or recreational values. These are the Upper Goulburn, Murrindindi, Acheron, Latrobe and Toorong Rivers and Snobs Creek. The corridor to be protected along these rivers and streams varies according to local conditions, but generally extends between 100m and 300m from each bank. The primary aims of management of 'River Zones' are the protection of

natural and scenic values, the provision of recreation facilities and interpretative aids, and that timber harvesting and gravel extraction not be permitted in these zones

In State forest all River Zones and Heritage River corridors have been included in the forest management Special Protection Zone (SPZ) (NRE 1996b).

State Environment Protection Policy - *Environment Protection Act 1970 (Vic)*

The Environment Protection Act 1970 (Vic) 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 Central Highlands include:

- SEPP (Waters of Victoria) 1988, including the Central Gippsland Schedule F5;
- SEPP (Waters of Port Phillip Bay) 1975;
- SEPP (Waters of the Yarra River and Tributaries) 1984; and
- Draft SEPP (Groundwaters of Victoria).

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.

The SEPP (Waters of Victoria) 1988 applies to surface waters throughout the State except when varied by separate SEPP's for specific areas, such as the Central Gippsland Schedule F5 which applies to the Latrobe and Thomson River Basins. The SEPP for the Waters of the Yarra River and Tributaries, that provides supplementary provisions to the SEPP (Waters of Victoria), is currently under review - the SEPP (Waters of Victoria) draft schedule for the Waters of the Yarra Catchment (EPA, 1995b) was released for public comment in 1995. The main beneficial uses to be protected in the Latrobe and Thomson River Basins and Yarra catchments include potable and agricultural water supply, recreation and maintenance of natural aquatic ecosystems. In addition, industrial water supply and aquifer recharge are protected beneficial uses in the Latrobe and Thomson River Basins.

Controls enacted under the *Forests Act 1958 (Vic)*

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 are considered below. These include provisions of the Code of Practices for Timber Harvesting, Proposed Central Highlands Forest Management Plan and local harvesting prescriptions.

Provisions of the National Parks Act 1975 (Vic.)

National Parks and State Parks are managed in accordance with the National Parks Act 1975 (Vic.). In 1995 the Act was amended through the National Parks (Yarra Ranges and Other Amendments) Act 1995, to create the Yarra Ranges national park and an extension to the Kinglake national park.

Of the 87,000 hectares of National Park created under this Act, 75,000 hectares is classified as Designated water Supply Catchments. These catchments (Wallaby Creek, Maroondah, O'Shannassy, Upper Yarra and parts of Armstrong and Cement Creek Catchments) form a major component of Melbourne's water supply system. In accordance with Victorian Government Water Policy these catchments continue to be managed as closed catchments thus providing Melbourne with high quality water which requires minimal treatment.

Specific provisions in the Act designed to protect water values in these catchments include the following:

- maintenance of water quality and protection of water resources is a paramount consideration in exercising powers and performing functions in these areas;
- restriction of human activity to protect water quality and water resources is an objective of the Act;
- it is the function of Melbourne Water Corporation to determine the policy necessary to protect these areas for the purpose of water supply, protect water quality and water resources, and restrict human activity; and
- provision for the Director of National Parks and Melbourne Water to enter into an agreement for management of these areas.

In accordance with the intentions of the Act, a Catchment Management Agreement was entered into between the Director of National Parks and Melbourne Water Corporation prior to the proclamation of these parks in December 1995. The Agreement details the respective responsibilities of Melbourne Water Corporation and National Parks Service for management of activities in these catchments.

Victorian Water Quality Monitoring

There are two major Statewide environmental water quality monitoring programs in Victoria. These are:

- The Victorian Water Quality Monitoring Network (VWQMN), managed by the Department of Natural Resources and Environment.
- A network of fixed sites run and funded by the Environment Protection Authority (EPA).

These networks complement their physico-chemical water quality monitoring programs with biological assessment of the health of waterbodies. (CALPC *et al* 1996)

Extensive and intensive regional water quality monitoring programs are also conducted Melbourne Water, which monitors streams in several streams and catchments focusing on urban water quality issues, and the Murray Darling Basin Commission (MDBC) which monitors section of the Murray River and its major tributaries.

9.5 ISSUES FOR WATER MANAGEMENT

The major issues for water management are related to the quality and quantity of water. As identified earlier, many water quality issues are related to land tenure, as this is a major determinant of the condition and level of disturbance of the land, as well as the usage of the land which largely determines the access and management arrangements applicable to an area. As many of the water storage catchments of the Central Highlands are almost exclusively public forested land and the discussion below is therefore directed towards public land management issues.

Given the predominance of public forested land catchments in the region, and the use of a number of these for the Melbourne water supply, there has been much research based in the forested catchments of the region. This section reviews the research, discusses the issues of quality and quantity and examines the management arrangements for addressing these issues.

Water Quality

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 retain high water quality while, in contrast, agricultural and urban environments have lower water quality. As a result, some domestic water supplies in the Central Highlands require treatment to ensure that water quality is suitable for domestic consumption. Land use practices resulting in erosion and the transport of nutrients, urban runoff or point source discharges of pollutants are major causes of poor water quality in stream networks. Water quality issues in some areas of the Central Highlands include nutrient enrichment, suspended solids and turbidity of surface waters. Increasing salinity of streams in the forested catchments of the Goulburn River Basin and acidity of waterways in south-eastern Australia are also occurring, in river basins in which the Central Highlands lie, however the cause of these trends are not yet fully known. Nevertheless, water quality in relation to catchment conditions is good within the forested areas of the Central Highlands (DWR 1989). The trend throughout the catchments of the central Highlands however is for water quality to deteriorate in the lower catchments in response to non-forest land uses (DWR 1989).

Recreational activities can adversely affect water quality where the activity, such as camping and recreational vehicle use, results in significant soil compaction, erosion or bacteriological contamination of surface water. Erosion of roads and tracks from forestry and recreational vehicle use has been identified within some areas in the Central Highlands, though this is currently not widespread across the region.

Research on water quality and yield

As described earlier, the major Melbourne water supply catchments are predominantly forested public land. As a result of the importance of the Central Highlands to Melbourne's water supply there has been a major research effort into the forested catchments of the region. 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 70-80 per cent of Melbourne's water and, therefore, most catchment research has concentrated on the ash forests.

In the Central Highlands, catchment experiments have been established in both mature growth and regrowth dominated catchments. Water yield studies have included the processes

of fog drip, canopy interception, soil moisture depletion, transpiration and plant water relations in mountain ash. This research has investigated the effects on water yield of:

- the conversion of old forest to regrowth condition, through both wildfire and clearfelling;
- the selective cutting of mature stands;
- thinning in regrowth stands; and
- initial stand density 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 maintenance procedures on silt production from unsurfaced roads (O'Shaughnessy and Jayasuriya 1987).

The effects of a best practice forest harvesting and regeneration operation 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 the selectively felled catchment has had less of a decline in water yields than the clearfelled area but the more intensive road network of the selectively felled catchment has seen water quality affected for ten years, compared with 5 years for the clearfelled catchment (Langford et al 1982).

The hydrology of 1939 regrowth ash forests has been studied using fifteen 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 streamflows 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, 2000 and 20000 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 ~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 the well supervised timber harvesting on water quality is small. Grayson noted that the suspension of logging during wet weather, the protection of runoff producing areas with buffer strips, and the management of runoff from roads, snig tracks and log landings, eliminated intrusion of contaminated runoff into streams. O'Shaughnessy (NRE 1996a) noted that roads and tracks may present a greater hazard with regard to sedimentation of streams than do timber-harvesting operations. The research by Grayson et al. (1993) and work by Haydon et al. (1991) suggests a positive relationship between the frequency of road use and the production of *coarse* sediment and total sediment. 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).

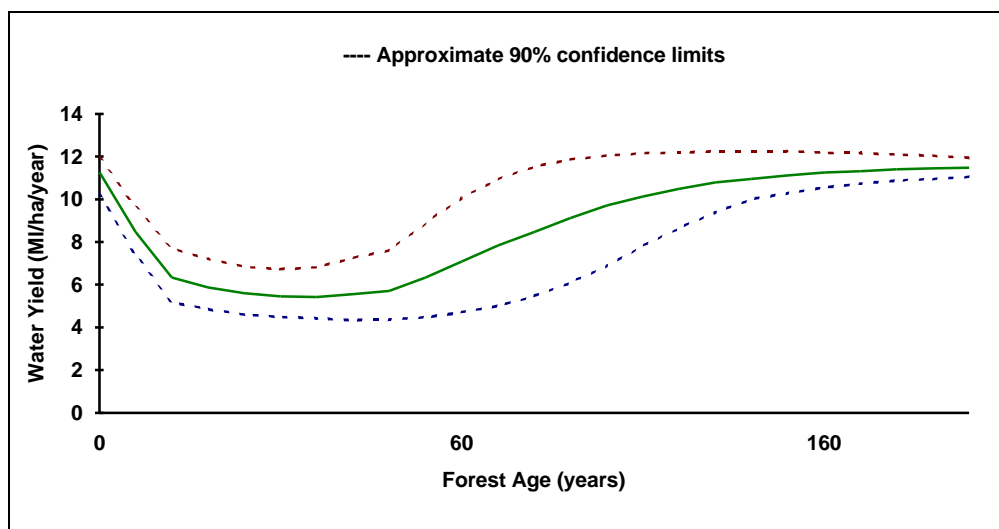
Dargavel et al. (1995) also discuss the impact of timber harvesting and roads on water quality. Based on local and overseas studies, it was concluded that avoiding direct stream disturbance by these activities and preventing turbid inflows will provide a high level of protection. Dargavel highlighted the importance of the standard, application and monitoring of forest management practices. The application of codes to road construction and maintenance was also stressed.

The literature identifies that there may be advantages and disadvantages of alternative silvicultural systems that may increase/maintain water yield and quality within the harvesting areas but result in greater impact of associated infrastructure and roading requirements. In clearfelling operations, for example, much of the road network can be closed and revegetated until the next rotation harvest time, but the alternative silvicultural selection systems might require more regular access and hence the need to maintain the road network (O'Shaughnessy and Jayasuriya 1987). In this sense, alternative silvicultural systems may generate higher sediment losses than occur with clear felling systems.

Water yield can be affected by catchment management and land use. Hydrological research in the Central Highlands indicates that large-scale regeneration or reforestation activities following timber harvesting or wildfire may result in a decrease in long term water yields in Ash forests (Kuczera 1985). A significant reduction in water yield has the potential to adversely affect aquatic values and may also necessitate additional water storage capacity to maintain water supply.

Kuczera (1985), in a study of water yields in areas of regenerating Ash forests following the 1939 bushfires, 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 run-off and groundwater. 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 clear fell activities, which can be considered as a silvicultural replication of wildfire disturbance. Kuczera also showed that for every one per cent of mature forest converted to regrowth forest from wildfire similar to 1939, a decline of 6 mm in annual water yield could be expected some 30 years later. The model has wide confidence limits and Kuczera (1985) indicated that another 30-40 years of data are required for validation of the model.

Figure 9.1: Relationship between forest age and water yield in Ash forests of the Central Highlands



Source: Abbott *et al.* 1993

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 fifty per cent of pre-treatment level has been recorded in response to eighty per cent clearfelling and regeneration.

The effects of timber harvesting and wildfire on water yields of mixed species forests of Central Highlands is less well understood. Read Sturgess and Associates (1994) in a study of the Thomson catchment noted that water yields from mixed species forests is much lower than Ash primarily due to mixed species forests growing in areas with lower rainfall and because they have higher evaporation rates. Mixed-species forests are generally found in the exposed lower elevation areas, and on northern and western slopes at higher elevations, where fire generally occurs more frequently, and at less intensity than in Ash. Consequently, mixed species forests tend to be dominated by fire resistant eucalypts, such as the stringybarks and peppermints. Unlike Ash, mature trees in mixed species forests are capable of recovering from low and medium intensity fire disturbance. Consequently the forest canopy in mixed-species forests is capable of recovering and after a given disturbance event, there may be fewer areas of actual re-growth forest created (Kuczera 1985). Accordingly, fire may not have as significant an effect on the water yield in these forests as in ash type forests. Dargavel *et al.* (1995) indicates that there are no recent long term catchment results available for mixed species forests on the eastern seaboard indicating effects of clear felling and regeneration on streamflows. Following clearfelling of mixed species in the Reefton experiment in the Central Highlands, Nandakumar and Mein (1993) estimated that when ten per cent of a catchment was cleared, there was a corresponding 33 mm increase in runoff, and that water yields peaked 2-3 years after clearing and then declined to pre-treatment levels after 5-8 years. However the results at this stage should be regarded as preliminary.

Other research which addresses this issue has produced variable results. The yields from mixed species 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 one Victorian mixed species

forest, the Lerderderg, there was no statistical long term effect on water yield, after logging sixteen 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 that expected in 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 in the investigation of hydrological responses in mixed species forests.

Implications of the research

Kuzcera's model of the relationship between the condition and management of forested catchments and water yield, requires consideration in catchments which supply both water and timber. Melbourne Water and the former Department of Conservation and Natural Resources jointly commissioned two studies of the relative economic values of timber and water production in the Thomson catchment. These studies, Read Sturgess and Associates *et al.* (1992) and Read Sturgess and Associates (1994), modelled timber yields and resulting water yields, for various timber harvesting options including no timber harvesting and harvesting at various ages or thinning. A range of estimates of wood and water yields over a 200 year period were developed by varying the rotation length and the use of thinning.

In the 1992 study, the price of standing timber was estimated using information from auction prices for timber licences and the price of water 'in the stream' was estimated using the residual price approach. Estimating the residual price involved estimating consumers' willingness to pay for water and then subtracting water distribution costs.

It was concluded that the loss of timber resulting from a longer rotation is more than compensated for by increased water yields. The no-logging option and options involving thinning with long rotation periods were preferred.

The 1994 study differed from the original by valuing water using the opportunity cost method (after criticisms of the residual price approach used in the 1992 study) and by considering a larger range of silvicultural options. The opportunity cost method accounts for the fact that if stream flows are reduced as a result of logging, then augmentation to water storage capacity would be undertaken sooner than it otherwise would. The opportunity cost of using water to support logging is the cost of bringing forward these investments (Dargavel *et al.* 1995). In the 1994 study, the economic and financial analysis indicated that strip thinning at age 50 combined with a 200 year rotation would produce the greatest increase in total value of the catchment outputs and the highest Net Present Value of cash flows. Other options included clear-felling on a 200-year rotation, strip thinning at 50 years with a 120-year rotation, and the no-timber harvesting option. In their conclusions, however, the consultants stated that there remained uncertainty about many issues central to the economic analysis. Wood and water valuations were sensitive to factors including: discount rate, rate of growth in water consumption, water yield from mixed species forests, whether or not full treatment of water would be required by short rotations, and the level of augmentation costs (Read Sturgess *et al* 1994).

The Read Sturgess *et al* (1994) projections of future augmentations, for each timber harvesting option, indicated that the timing of the first two augmentations are the same for the status quo and no timber harvesting options. The third augmentation for status quo option was four years earlier than no timber harvesting option. The third augmentation was projected to be 16 years after the first augmentation. Read Sturgess *et al* (1994) projected the first augmentation at 2016, however since this study a 'user pay' system of water pricing has been introduced in Melbourne which can influence water demand. Continued reduction in water demand would postpone the timing of future augmentations.

Ferguson (1985) criticises both the Read Sturgess and Associates *et al.* (1992) and Read Sturgess and Associates (1994) studies. Ferguson's major criticism of the 1994 study centres around the way in which water is valued at the catchment. Ferguson makes the point that the scarcity price of water should be used and that the scarcity price will vary according to the catchment (or augmentation) concerned. The scarcity price is the difference between the marginal cost of water supply from new sources (including capital costs) and the marginal cost of supply from current sources. If the marginal cost of supply from new sources is higher than current sources then the scarcity price is positive, if new supplies have lower marginal costs than current supplies then the scarcity price it is zero.

As the marginal cost (including capital cost) of the first two augmentations is estimated to be less than that of the Thomson Dam, the scarcity price of water in the Thomson Dam is zero and joint production of timber and water is optimal. It was found that until the use of the Lower Yarra augmentation (in around the year 2032), joint production is optimal, despite a positive scarcity price.

Ferguson also concluded that joint production was not optimal during the Lower Yarra augmentation (from around 2032 to 2039) but that for subsequent augmentations joint production is optimal as the scarcity price of water in the Thomson Dam falls.

Dargavel *et al.* (1995) have criticised the Read Sturgess *et al.* (1992) and Read Sturgess *et al.* (1994) studies on other grounds. They argue that both studies deal only with timber values and the value of water to Melbourne consumers and that if the impacts of logging on other values (such as ecological, non-timber forest products, non-urban water uses and recreational values) were taken into account, results are likely to favour long rotations or no logging options even more strongly. It is important to note that the Read Sturgess *et al.* studies were only required to consider wood and water values. It is also possible that under some scenarios, such as the adoption of a closed catchment policy for the Thompson, significant costs would be incurred in foregone recreation activities. These further issues were not considered by Dargavel *et al.* (1995).

Clearly the overall results of the studies are inconclusive and depend heavily on the assumptions underlying the analyses, and the quality of the underlying data. They can, however, provide one input into a decision making process, such as the development of Forest Management Plans, that seeks to provide for a range of forest uses. Such planning processes should consider the implications of the studies and can use the results to model indicative outcomes of different management strategies. DNRE has begun to incorporate these issues through its work on IFPS, discussed later in this section.

Management Arrangements

Water quality protection measures

On State forest water quality is managed by a range of techniques limiting the opportunity for soil or high energy water flow from directly entering drainage lines. Forest operations in Central Highlands are regulated in accordance with the Code of Forest Practices for Timber Production (NRE 1996a) and regional prescriptions which provide for the protection of filter strips and buffers on drainage lines and streams, and limitations on timber harvesting operations in steep terrain. Also, design and construction standards of roads consider soil and management principles to protect water quality and, timber harvesting and road use is timed seasonally and in response to weather through the application of road closures and harvesting limitations.

The Code provides the basis for detailed harvesting prescriptions and individual coupe plan preparation, taking into account 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 optimise environmental protection through local prescriptions in Coupe Plans. Forest operations in the region are conducted in accordance with a set of local timber harvesting prescriptions (CNR 1995a, 1995b, 1995c) and roading prescriptions for timber harvesting (DCE 1991).

A broad description of some of the key features and provisions of the Code for minimising soil erosion and protecting water quality in forest areas is provided in the box below. It is emphasised that the full Code and local prescriptions are detailed documents and this description provides an indication of the mechanisms that are employed to protect water quality and aquatic habitat.

As noted earlier, a potential source of water pollution in forested catchments is road construction and maintenance. The road and track network in forests is managed by NRE, local municipalities and the Roads Corporation (VicRoads). The majority of roads in State forest were built prior to the introduction of the Code of Forest Practices for Timber Production through which there has been a progressive improvement in the standard of road construction and maintenance. Some of the road network, established prior to the Code, does not meet current standards and there is potential for erosion from this network of older tracks. 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 are now used for vehicle based recreation. The use of these roads and tracks during wet conditions can be unsafe and can cause serious damage to the tracks and environmental values. Restrictions on the use of roads occurs in some water supply catchments.

The proposed Central Highlands Forest Management Plan (NRE 1996a) indicates that some parts of network need to be extended, upgraded and rationalised. The management plan proposes to identify and maintain a road network in State forest that meets the public and NRE needs. Following the identification of the road network to be maintained, some roads and tracks may be seasonally, temporarily, or permanently closed. The plan proposes that priority areas should include catchments containing threatened flora or fauna susceptible to increases in stream sedimentation and catchments used for domestic water supply purposes (NRE 1996a).

Increased stream sedimentation is regarded as a threat to species such as the Spotted Tree Frog and Barred Galaxias which are listed as Endangered in Victoria. Management prescriptions, including special requirements concerning stream buffers, roads and stream crossing in catchments containing these species, are incorporated in the Central Highlands forest management plan.

The effect of timber harvesting and regeneration on water quantity and quality can also be managed by spatially (size of an area) and temporally (over time) limiting the amount of timber harvesting in a catchment area. In the Central Highlands these techniques are used in several water supply catchments, including some of those which provide water for Melbourne domestic use. These techniques are discussed under water quantity, below.

Overview of Code of Practice (NRE, 1996a) Relating Specifically to Water Quantity and Quality Issues

(As noted in the text, it is emphasised that the full Code and local prescriptions are detailed documents and this description provides an indication of the mechanisms that are employed to protect water quality and aquatic habitat.)

WATER QUANTITY	<p>CODE OF PRACTICE</p> <p>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.</p> <p>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.</p>
WATER QUALITY AND AQUATIC HABITAT	<p>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.</p>
Slope limitations	<p>Harvesting operations should be excluded from slopes $>30^\circ$, or on lesser slopes of unstable soil where erosion risk is high. 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.</p>
Log landings and dumps	<p>Located, constructed and maintained to minimise soil disturbance and water quality deterioration. Stockpiling of topsoil should occur, where appropriate, later use during rehabilitation. Rehabilitation required when no longer used. Must not be located parallel to drainage lines.</p>
Snig tracks and forwarding tracks	<p>Crossing of filter strips is to be limited.</p>
Fuel dumps and machinery servicing	<p>Located to minimise pollution of streams and wetlands.</p>
Wet weather restrictions	<p>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.</p>

ROADING	
Design	Roads must accommodate anticipated frequency, type and speed of traffic, soil and subgrade conditions, road drainage and water quality requirements.
Location	<p>Roads must be located to minimise the number of stream crossings and interference with natural drainage.</p> <p>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.</p> <p>Avoid steep and unstable slopes, and any disturbance to streams, buffer strips, riparian vegetation and rainforest in areas not associated with approved crossings.</p> <p>Avoid entry of sidecast material into streams or drainage lines.</p> <p>Road surface runoff to be discharged away from streams and drainage lines, as far as practicable.</p>
Construction	Undertaken when climatic and site conditions minimise impact on water quality.
Culverts and drains	<p>Must be installed concurrently with road construction.</p> <p>Draining by cross drains or outsloping required if construction is to be left over winter or an extended period.</p>
Partially built roads	Closed to traffic until completed. Temporary stabilization 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	<p>Fill positioned to minimise sediments being transported into streams.</p> <p>Earth embankments revegetated or surfaced, or retaining walls constructed.</p>
Maintenance	Road drainage must be maintained to minimise discharge of turbid water into streams

Water quantity management arrangements

Water supply catchments which cover areas of Ash forests include Melbourne Water Supply catchments in the Yarra River Basin and the Tarago and Thomson water supply catchments. Approximately fifty percent of Melbourne Water's catchments are covered with ash eucalypt species. Timber harvesting is not permitted within the Melbourne Water Supply Catchments (Upper Yarra, Maroondah and O'Shannassy catchments, and parts of Cement Creek and Armstrong Creek catchments) which are located within the Yarra Ranges National Park.

Timber harvesting occurs in State forest in the Yarra tributaries (Starvation Creek, McMahon's Creek, Cement Creek and Armstrong Creek catchments) by agreement with Melbourne Water and in the Tarago and Thomson catchments. The Yarra tributaries are managed so that timber harvesting occurs in only one of the four catchments in any one year and that a maximum of 30 percent of each of the catchments is harvested over a ten year period. Water from the catchment being harvested for timber is not diverted into the water supply system during timber harvesting operations. The water supply system does not have the facility to store any additional water yield from the Yarra tributaries. Water yield is a

consideration of forest management in water supply catchments, including these catchments and the Tanjil and Tyers water supply catchments which also contain areas of Ash forest.

Victorian government policy regarding the use of water supply catchments such as the Thomson provides for a range of compatible uses such as water production, recreation and timber production. Each of these activities are permitted in the Thomson catchment. Timber harvesting is restricted to an average of 150 ha per year for the period 1987 to 2002 to meet current sawlog licence commitments and this will not result in a long term reduction in water yield (NRE 1996a).

The Land Conservation Council in its review of the use of public land in the Central Highlands (LCC 1994) noted that, given the sensitivity of the Read Sturgess and Associates et al. analyses to several factors, and the absence of assessment of the environmental implications of strip thinning, the findings of the economic study do not provide a clear basis for immediate change to management within the catchment. The LCC recommended further works be undertaken to validate the outcomes and technical applicability of each timber harvesting option (LCC 1994). Strip thinning is not undertaken within the Thomson catchment primarily due to costs of implementation, lack of suitable sites and problems associated with safety (NRE 1996a).

NRE and Melbourne Water are developing a long-term timber and water harvesting strategy for the Thomson Reservoir catchment which will provide Melbourne Water with an expected water yield increase from the catchment and NRE with an expected timber yield from the catchment. The Integrated Forest Planning System (IFPS) is being used to provide water and timber yields for various timber harvesting options.

The IFPS is a decision support tool which is used to evaluate scenarios and develop options for the management of a range of forest values. These values can include timber, water, recreation, habitat management and biodiversity. Use of the IFPS involves the construction of a mathematical model of the region under study, through the collation of data for the values being studied. The key data elements are its spatial location, quantitative value and how the value changes over time. Validation is required of the spatial integrity of the data used. Extensive analyses are undertaken for each model to explore and define the feasible range of options being examined. The IFPS has been reviewed, and is discussed further in Chapter 4.

For the Central Highlands five IFPS models have been constructed to date. The major values studied in these models have been wood, water and arboreal habitat. In excess of 600 analyses were undertaken to evaluate scenarios associated with the Proposed Forest Management Plan, Thomson wood/water study and the development of reservation and production options. These, and other IFPS models will be refined as new information becomes available on wood and water issues in the Thomson Catchment and will provide input into decisions on the long term timber and water harvesting strategy.

All options under consideration provide for non-declining yields of water from the Thomson Reservoir catchment and non-declining yields of timber from the Central Gippsland Forest Management Area (NRE 1996a). Information from the State Forest Resources Inventory, which should be available in 1998, will be considered in developing the strategy.

Proposed Central Highlands Forest Management Plan

The Proposed Central Highlands Forest Management Plan, which complements the Code, has been developed in accordance with the requirements of:

- the *Forests Act 1958*;
- the *Flora and Fauna Guarantee Act, 1988* and Associated Statements; and
- the *Catchment and Land Protection Act, 1994*.

The aims of the Proposed Management Plan, in relation to streams and catchments, include: to maintain biological values associated with rivers and streams; to ensure water quality is suitable for current and likely future use; and to maintain of at least current water yields from catchments used for domestic and irrigation supply. To achieve these aims, the Proposed Forest Management Plan establishes strategies for forest management through a series of actions and management guidelines for prevention of soil erosion and stream sedimentation.

Management Actions commit NRE to implementing a number of actions which further enhance the management of State forest. Proposed management actions relating to soil erosion and water quality include:

- Prepare field guides which classify soil type, to facilitate assessment of maximum allowable slopes and buffer/filter strip widths;
- Prepare management prescriptions for roads other than those used for timber extraction; and
- Manage timber harvesting and road construction and maintenance operations in accordance with the Code, the Management Guideline outlined below, the timber harvesting prescriptions and the Roding Prescriptions for Timber Production in the Central Highlands.
- Complete negotiations with Melbourne Water regarding a long term timber and water harvesting strategy for the Thomson Reservoir catchment.

Management Guidelines are intended to give direction to forest managers to facilitate protection and management of specific values or uses. The management guideline relating to the prevention of soil erosion and stream sedimentation propose that construction and maintenance of roads and other large scale forest operations should be evaluated during planning stages to determine appropriate techniques for preventing soil erosion and stream sedimentation. The proposed Plan states that the following factors should be considered:

- *soil type* - soils developed on granite are more erodible than those developed on shales and siltstones;
- *annual rainfall*- soils in areas of lower annual rainfall have a lower organic component and a greater erosion risk than corresponding soils in higher rainfall areas;
- *seasonal rainfall* - erosion hazard and sediment runoff will be increased if operations are carried out during or shortly after wet weather. Harvesting should be timed to minimise the possibility of operations coinciding with extended periods of wet weather.;
- *slope* - steeper and longer slopes create a greater hazard than flatter and shorter slopes;

- *logging technology* - use of rubber-tyred skidders, flexible tracked machines or cable logging systems reduce soil disturbance and compaction compared to older-style tracked machines used to drag logs to landings;
- *coupe planning and design* - management and location of landings, grade and location of snig tracks, widths of streamside reserves and filter strips, the proportion of trees retained on a coupe, and the nature of regeneration operations should be varied to minimise erosion risks; and
- *roads* - location, design and maintenance of permanent and coupe access roads.

Monitoring

The management arrangements in place for the protection of water values are not static, and are subject to review through Victoria's management systems, which are considered further in the ESFM assessment. However, the major processes and actions relevant to monitoring and reporting of hydrology related issues outlined in the Proposed Central Highlands Forest Management Plan (NRE 1996b): include:

- regular audits of timber harvesting operations against the Code and Prescriptions;
- regular monitoring of water quality in State forest streams through the Victorian Water Quality Monitoring Network. Data from this is used to detect trends in water quality and yield in forest catchments.

The Proposed Plan also specifies the arrangements for regular reporting on the implementation of the Plan.

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 resources in forested land,
- current and potential uses of forested land,
- economic value of 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 report 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. The report considers identified mineral deposits that border the region where such deposits signify the potential for the discovery of similar deposits in the region. A technical report detailing this assessment is available on request.

Supply of construction materials to Melbourne is currently the most significant extractive activity in the Central Highlands. The region was a major gold producer last century, and many old deposits have recently attracted exploration interest. In addition to current mining and exploration activities, the Central Highlands contains a few undeveloped mineral deposits (though currently production is planned only at the Morning Star deposit). 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 MINERAL AND EXTRACTIVE RESOURCES

The Central Highland area covers parts of two major geological provinces:

- **The Melbourne Zone**, which is bounded by the Heathcote Fault zone (Map 10.2) in the west and the Mount Wellington Fault zone in the east (Vanden Berg and Gray 1988). Overall, this zone is 150 km wide and extends north-south for approximately 180 km. The sedimentary sequence consists of Cambrian greenstones, Middle to Late Ordovician black slates conformably overlain by Silurian to Middle Devonian quartz turbidites

(sediments deposited by turbidity currents)(O'Shea *et al* 1992). The sequence is intruded by Late Devonian granitoids, and overlain, in part, by caldera volcanics which are derived from the same parent magma as the granitoids.

- **The Gippsland Basin.** The northwestern portion of the Gippsland Basin lies within the Central Highlands area. The main sedimentary sequences within the area are the Strzelecki Group (Cretaceous) and the Moe Swamp Basin (Tertiary) (Map 10.2). Tertiary sediments deposited in the Latrobe Valley Depression, which are partly continuous with the Moe Swamp Basin sediments, lie to the south of the Central Highlands. The brown coal mining operations within the Latrobe Valley Depression, at Yallourn and Morwell, are located near the southern boundary of the Central Highlands.

The regional geological setting is shown on Maps 10.1 and 10.2, and the main geological and mineralising events are summarised in Appendix 5.

Identified Mineral and Extractive Occurrences and Resources

Map 10.2 shows 88 mineral occurrences, old mines and deposits are located in the Central Highlands region and adjacent areas. The actual number of occurrences is much larger, and many of these are gold occurrences within the various old goldfields which are also shown on the map. For example, over 100 gold mines have operated in the Woods Point-Walhalla sub-province alone.

Industrial and construction quarrying is the major extraction activity in the region. There are 41 quarries currently in operation (Figure 10.1) with another six applications being considered in the region.

Gold

Eleven percent of Victoria's total hard rock gold production has been from the Melbourne geological zone, most of which is in the Central Highlands (O'Shea *et al* 1992). Assuming that a similar proportion of Victoria's alluvial gold production also came from the Central Highlands, the total gold production in the Central Highlands could have been of the order of 275 tonnes (VicRFASC 1997c).

Apart from the Woods Point-Walhalla gold sub-province, 33 minor goldfields (Map 10.2) have been identified in and adjacent to the Central Highlands. Some lie under the suburbs of Melbourne, including the small Ringwood and North Balwyn goldfields. Just to the northeast of the Central Highlands, low grade disseminated gold occurs in the Merton and Tallangalook goldfields. Current indicated and inferred resources at Golden Mountain, in the Tallangalook goldfield, are estimated at 1.3 million tonnes of ore at a gold grade of 1.5 grams/tonne (Duketon Goldfields 1996).

Underground exploration of the Morning Star mine area has delineated a total resource of 234 000 ounces, comprising of 1.47 million tonnes surficial ore at 1.9 grams per tonne gold and 0.712 million tonnes underground ore at 6.3 grams per tonne gold (Goodz and Associates 1997)

Base metals, cobalt and manganese

The Thomson River copper deposit, just outside the southeast corner of the Central Highlands, is hosted by a gabbroic or pyroxenitic dyke thought to be part of the Woods Point (Walhalla) dyke swarm (Keays and Kirkland 1972). Mining was intermittent from 1864 and total production from the deposit was 92.5 tonnes copper, 7.5 tonnes nickel, 3.75 kg gold, 5.75 kg platinum, 9.5 kg palladium and 32 kg silver. Remaining resources were reported as 62.5 tonnes copper, 2.25 kg gold, 4.25 kg platinum, 11 kg palladium and 19 kg silver

(Ramsay and Willman 1988). The dyke swarm extends into the Central Highlands, and deposits similar to the Thomson River deposit may be present in the region.

Minor amounts of copper, lead, zinc and silver commonly occur with gold mineralisation in the Woods Point-Walhalla gold sub-province. Cobalt and manganese occur at Spotted Dog Creek (Tanjil) in the southeast of the Central Highlands.

Platinum group metals

Platinum group metals are associated with widespread non-economic copper-nickel sulphide mineralisation in the Woods Point-Walhalla gold sub-province (O'Shea *et al* 1992). At least ten dykes are mineralised and for each 1% of copper there is 1 gram/tonne gold, 1 gram/tonne palladium and probably 1 gram/tonne platinum (Keays and Green 1974). Such mineralisation is known at the Shamrock, New Loch Fyne and Hunts mines. At East Walhalla Mine (just outside the southeast boundary), small amounts of ore were produced from three small open pits and a shallow shaft. No production data is available but samples taken around 1917 assayed up to 0.6% copper, 2.93 grams/tonne platinum, 1.02 grams/tonne gold, and 5.23 grams/tonne silver.

Antimony

Stibnite (antimony sulphide mineral) is found in most of the gold occurrences in the western half of the Central Highlands. About 500 kg of concentrate was produced at the Big River mine in the northern part of the Woods Point-Walhalla gold sub-province (Bell 1964). Ore samples taken at the Big River mine in 1964 assayed 43% - 53% antimony.

Tin, tungsten, molybdenum and bismuth

Tin has been sluice mined at a small group of tin fields in the central south of the region. Tin also occurs at Maindample, just to the north of the region. Tungsten has been mined on a minor scale at Britannia Creek and Wilks Creek in the center of the region.

Tin-tungsten occurs at Tin Creek in a small field in the central north of the region. Molybdenum, bismuth and tungsten occur at Monkey Gully, near the northern boundary of the region.

Construction materials

Hard rock is quarried from a number of sites around Melbourne (Figure 10.1). The main types of rock used are basalt, granite, acid volcanics, hornfels, schist and sedimentary rock for road aggregate and other uses. Colluvial deposits (scree) and softer rocks such as sandstone and shale are used extensively for road making. Other land uses severely constrain the development of new quarries within 60 km of Melbourne (McHaffie and Buckley 1995). Hard rock resources are sufficient to supply the Melbourne area for 25 years (McHaffie 1991).

Construction sand resources are found in Tertiary floodplain and piedmont fluvial sand deposits as well as in smaller, but similar, deposit types of Quaternary age. Large resources of coastal dune sands exist to the south of the Central Highlands, but their finer and more uniform grainsize restricts their use.

There are major Tertiary sands producers, south of the region (Figure 10.1 enclosed in sleeve at back of report); however resources of good quality concrete sand are diminishing rapidly (McHaffie and Buckley 1995). New supplies of construction sand will need to be available in the future. Major potential resource areas in the Central Highlands lie to the north of Trafalgar, and overlie the brown coal basins in the Latrobe Valley, in the southeast corner of the region.

Significant deposits of **clay and clay shale** formed from deep weathering of Palaeozoic rocks in late Cretaceous, early Tertiary and mid-Tertiary times. Residual clays, derived from granites at Hallam and Mesozoic sedimentary rocks south of Drouin, are found south of the Central Highlands. Erosion of the Cretaceous/Tertiary clays formed alluvial clay deposits later in the Tertiary and Quaternary ages.

Resources of red firing clays are sufficient for at least 20 years, but white firing types will require the development of more distant resources to the south-east of Melbourne (McHaffie and Buckley 1995).

Limestone/dolomite

Limestone occurs in Devonian sedimentary rock sequences known to be widespread in the Central Highlands and is quarried at Lilydale (about 35 km east of Melbourne). The Lower Devonian Lilydale Limestone Member is the only known economic source of hard Paleozoic age limestone within 100 km of Melbourne. Overburden thickness and urban encroachment impose severe limits on quarry extension, but resources are sufficient for the long term (McHaffie and Buckley 1995).

Dolomite and dolomitic limestone is quarried as part of a major operation at Lilydale. The dolomitic material occurs as interbeds in the Lower Devonian Lilydale Limestone Member and is ground for agricultural use. Thicker dolomite beds (up to 30 metres thick) are known to occur beneath the quarry (McHaffie and Buckley 1995).

Brown coal

A large part of the brown coal bearing Moe Swamp Basin (sub basin of the Gippsland Basin) encroaches on the southeast corner of the Central Highlands. Total resources for the Moe Swamp Basin, which lies mostly within the southeast portion of Central Highlands, are estimated at 773 million tonnes. No production has been recorded from the Moe Swamp Basin coals given the larger, more accessible brown coal deposits elsewhere in the Latrobe Valley.

Total reserves for the Gippsland Basin have been estimated at 96 300 million tonnes, while total resources have been calculated at over 172,874 million tonnes (Gloe and Holdgate 1991). The production for 1923-1995 from mines in the Gippsland Basin totals 1 115 million tonnes (Barton *et al* 1992; BRS estimate 1997).

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 which 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 Central Highlands 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, Kropschot and Dickinson (1984), Taylor and Steven (1983), and Dewitt *et al* (1986).

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 10.3).

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.

Figure 10.3: Relationship between levels of resource potential and levels of certainty

Mineral potential in the Central Highlands

Mineral potential tracts were identified for eleven mineral and three extractive deposit types. Potential mineral resources are summarised in Table 10.1 and described below. Only the

deposit types judged to be most likely to constitute significant resources in the region have been assessed in detail. Construction materials such as hard rock, gravel, sand and clay were included in the assessment because of the region's importance as a current and future source of these materials. Extraction sites for low unit value construction materials are often dictated by other land uses (such as real estate developments) and by cost of transport. Areas from which construction materials may be extracted in future are shown on Figure 10.1 as 'interest areas'.

Table 10.1: Summary of Potential Mineral Resources as at November 1996

Deposit type	Probability of occurrence	Certainty level	Area of tract (sq km)	Tract % of region	% of tract in existing reserves
Coal	High	B	330	2.9	4.9
Slate belt gold	High	B	6340	56.1	14.9
Construction materials	High	B	67	0.6	0.1
	Moderate-high	B	534	4.7	1.7
Disseminated gold	Moderate-high	B	6340	56.1	14.9
Epithermal gold-silver	Moderate-high	B	1254	11.1	36.3
Kaolin	Moderate-high	B	2170	19.2	5.4
Nickel-copper deposits	Moderate-high	B	790	7.0	24.8
Alluvial gold	Moderate	B	2119	18.8	5.6
Skarn scheelite	Moderate	B	1823	16.1	11.7
Sandstone uranium	Moderate	C	361	3.2	5.9
Tin veins	Low-moderate	B	5235	46.3	17.4
Tungsten-molybdenum veins	Low-moderate	B	5235	46.3	17.4
Limestone	Low-moderate	C	4217	37.3	17.1
Bauxite	Low	C	310	2.7	0.3

The favourable geological tracts for slate-belt gold and disseminated gold , epithermal gold , brown coal , kaolin, nickel-copper and high and low value construction materials are described in Appendix 4.

There is also potential for other deposit types in the following tracts:

- skarn scheelite deposits for tungsten in calcareous sediments near granitoids;
- tin veins and tungsten/molybdenum vein deposits in granitoids and adjoining sediments;
- sandstone uranium deposits at the base of the Moe Swamp Basin;
- bauxite deposits on deeply weathered Tertiary volcanics which include tholeiitic and minor alkaline basalts. Similar rocks also occur at the Watkins and Paynes bauxite deposits, just outside the region. (McHaffie and Buckley 1995);
- alluvial gold deposits in Tertiary and Quaternary sediments with potential for deep lead gold near primary slate belt and disseminated gold deposits.

The tracts of mineral potential for various types of mineral deposits have been combined and summarised in Maps 10.3 and 10.4. Parts of the tracts for construction materials, which are in the interest areas in Figure 10.1 are also included in Maps 10.3 and 10.4.

Map 10.3 is a composite of mineral potential tracts over the Central Highlands and shows the highest level of mineral potential assessed (in December 1996) for any particular area in the region. Most of the Central Highlands is covered by a tract of high potential for deposits of slate-belt gold, with smaller tracts of high potential for brown coal confined to the southeast part of the region. In this approach, tracts of lower mineral potential are obscured by the tract having the highest level of mineral potential in any particular area. For example, tracts of low to moderate potential for limestone deposits are obscured by tracts of high potential for slate bed gold.

It should be noted that Map 10.3 is a composite of mineral potential tracts for different mineral deposits that do not have equal economic value. For example, a tract with moderate to high potential for epithermal gold may be considered to have a higher economic value than a tract with high potential for coal.

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. Scores of overlapping tracts were then added to derive a 'cumulative mineral potential' score. Areas with high cumulative scores indicate potential for more than one type of deposit.

The cumulative mineral potential scores highlight the diversity of potential resources in the northeast of the Central Highlands where there are overlapping tracts of potential for deposits of slate-belt and disseminated gold, nickel-copper and limestone/dolomite. Areas around granitoids are highlighted to show overlapping potential for deposits of slate-belt and disseminated gold, tungsten skarns, tin veins, tungsten-molybdenum veins and limestone/dolomite. The granitoids themselves have the lowest scores as the potential in these rocks is restricted to tracts of low to moderate potential for deposits of tin veins and for tungsten-molybdenum veins.

Areas with overlapping tracts highlighted by Map 10.4 are not necessarily more prospective than a single tract of high potential, such as slate-belt gold. Note that of the construction material tracts, only the construction material 'interest areas' (Figure 10.1) are superimposed on Map 10.4.

Maps 10.3 and 10.4 only provide an indication of the physical potential for minerals of different areas of the Central Highlands. The relative economic significance of tracts for different types of mineral deposits is influenced by factors such as perceptions of prospectivity, future market conditions, land access and technological developments.

10.3 CURRENT EXPLORATION, MINING AND EXTRACTION ACTIVITIES AND POTENTIAL ECONOMIC VALUE

The potential economic value of the region's mineral resources is affected by a number of factors including: mineral prospectivity; timing of discoveries; future metal prices and mining costs; and rules and regulations governing exploration and mining. Ideally, an economic assessment of a region's known and potential mineral resources would involve an estimation of the value of the right to explore and mine. Unfortunately, due to data limitations, this has

not been possible. However the major factors affecting potential economic value are outlined, and some indicators of that value are examined.

The mineral resource assessment provides an indication of which land is likely to be prospective for 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.

Exploration

While there are presently no significant operating metallic mineral mines in the Central Highlands, expenditure on exploration and mining licences was \$1.8 million in 1995-96. Commodities being explored for were gold, base metals and antimony.

The Woods Point-Walhalla region was prospected intensively from the early 1860s and intermittently into the late 1890s during several mining booms. However, except for the work conducted by Government geologists, most early prospecting results were never recorded.

An Exploration Licence system was introduced in the mid-1960s which allowed exploration of large areas. Since 1965, about 220 exploration licences, over the Central Highlands and adjacent areas have been applied for. To date, none have led to a profitable mine being established.

Exploration in some areas has been hampered by rugged topography, difficult access and at times severe weather. Drilling in the area is difficult and some geochemical samples taken for analysis have subsequently been found to be either invalid or unreliable. Hence, at least some exploration in the region has been ineffective. Significant mineral deposits may remain undetected, and many quite prospective areas remain, to a large degree, untested.

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 explored for include gold, silver, base metals, platinoids, antimony, mercury, uranium, tungsten and phosphate.

Gold has been the major exploration target in the region and exploration activity is currently focused on the search for primary gold mineralisation in Devonian dykes (slate belt gold type as at Woods Point) and to a minor extent, base metals (particularly copper, lead, zinc-nickel) covering the Cambrian greenstones and the dyke swarms in the eastern portion of the region, particularly between Walhalla and Jamieson. Exploration for gold is also focused around the Devonian Cerberean volcanic in the central part of the region.

Current and historical exploration expenditures provide some indication of the potential value of the undiscovered mineral resources of the Central Highlands. This is because exploration expenditure will tend to be higher in areas of higher perceived mineral potential. However, because of the uncertainty and dynamics of exploration, different risk attitudes of companies and difficulty of exploration, expenditure only provides an approximation of true prospectivity. Perceptions of sovereign risk (the risk of policy changes affecting returns to investment after an investment has been made) also affect exploration expenditure.

At the time of this assessment, there were 34 active exploration licences in the Central Highlands region (Figure 10.2 enclosed in sleeve at back of report), distributed among 20 companies. In 1995-96 exploration expenditure in the Central Highlands was about \$1.8 million (Minerals and Petroleum Victoria 1997), which represented around five per cent of expenditure in that year on exploration for base metals and gold on Victorian exploration expenditure in that year (Table 10.2).

Table 10.2: Total mineral exploration expenditure, Central Highlands

Year	Central Highlands exploration expenditure (\$)	Victorian exploration expenditure MRD Act (\$ million)	Central Highlands exploration, as a percentage of Victorian exploration expenditure
1991-92	462 362	10.0	4.6
1992-93	633 178	14.7	4.3
1993-94	1 982 268	18.7	10.6
1994-95	2 490 854	41.1	6.1
1995-96	1 813 581	35.1	5.2
Totals	7 382 243	119.6	6.2

Note: Figures include private mineral exploration expenditure on Exploration and Mining Licences, as derived from Mineral and Petroleum Victoria records.

Of the 34 exploration licences in the region, there are many prospects where resources have been identified and exploration has proceeded to more advanced stages.

Jericho

The Jericho Project is in the Walhalla–Woods Point–Gaffney’s Creek–Jamieson gold belt (Figure 10.2). Previous mining activities in the project area, mostly conducted between 1861 and 1940, recovered substantial quantities of alluvial gold from numerous rivers in addition to gold from quartz reefs at several locations. In the three years since an exploration licence was granted for the Jericho prospect, Osprey Gold NL has spent \$280 000 on exploration and has budgeted \$450 000 for 1997-98 (GH Fethers, Osprey Gold NL, *pers. comm.*, 14 February 1997).

Mining and Extraction

Recent production has come from deposits in the Gaffney’s Creek area mined from 1968 to 1989 and the A1 Mine between (also near Gaffney’s Creek) 1989 and 1992 (O’Shea *et al* 1992). Currently two small scale hard rock gold mines are the only operating metallic mines in the region.

While no substantial mining activity currently is being undertaken in the Central Highlands there has been significant expenditure on mining licences (Table 10.3). Most of this expenditure occurs on mining licences which overlie historical workings and where production is anticipated to occur at some stage. Exploration being undertaken on such mining licences is generally at an advanced stage, involving detailed assessment of a resource (K. Weston, Minerals and Petroleum Victoria, *pers. comm.*, March 1997).

Table 10.3: Expenditure on Mining Licences in the Central Highlands

Year	Mining licence exploration expenditure	Mining licence other expenditure	Total expenditure mining licences	Number of mining licences
1991-92	328 658	73 714	402 372	23
1992-93	286 678	4 851 064	5 137 742	26
1993-94	1 358 629	1 224 040	2 562 669	28
1994-95	563 126	1 838 980	2 402 106	33
1995-96	518 924	1 501 091	2 020 015	31
Totals	3 056 015	9 488 889	12 544 904	

Note: Figures derived from Mineral and Petroleum records. Mining licence exploration expenditure included in Table 10.2.

Of the mining licences within the area, only at the Morning Star project (Figure 10.2) have sufficient resources been identified to proceed toward a mining feasibility study - which is currently being undertaken. The Morning Star deposit has produced over 883 000 ounces of gold since 1862 at an average grade of 24.5 grams per tonne (Wilkinson 1996), although most of this gold was produced in the last century.

Around \$3.5 million has been spent on exploration of the Morning Star deposit, including mine dewatering and refurbishment of the old mine shaft. With current resource estimates, it is likely that future mining of the opencut and underground resource would occur over a period of four to five years (R. Bird, Mount Conqueror Minerals NL, *per. comm.*, February 1997).

Potential future economic benefits of the Morning Star project have not been estimated. However, if the current resource of 234 000 ounces was extracted over five years, this would equate to annual gross revenues of around \$23 million. Using the 1995 average industry gross margin (Australian spot price, less industry average total cost) it is found that such production, were it to start today, would have a present value of about \$16 million, using a 5 per cent discount rate.

This figure gives an order-of-magnitude estimate of the potential direct benefits from the project. To estimate the actual potential net economic benefits of the project it would be necessary to gather project-specific cost and production data. In addition, it is likely that such a large project would produce indirect benefits that would not be reflected in producer returns alone. Examples of such indirect benefits are reduced unemployment and stimulated production in other markets.

It is estimated that, in the first half of 1996, around 3.5 million tonnes of construction material was quarried in the area at a gross value of some \$41.1 million. Henshall Hansen and Associates and Read Sturgess and Associates et al. (1992) estimated that 186 people were directly employed in the 31 quarries within the Central Highlands in 1991, of which 19 people were employed in the three quarries on public land (although the area used in their study was slightly larger than the boundary used for this report). The main industrial mineral resources produced in the Central Highlands are sand, hard rock, clay and limestone. Construction materials and other industrial mineral commodities are particularly significant as the Central Highlands is close to Melbourne.

As most titles for the extraction of construction materials in the Central Highlands are situated on private land (Figure 10.1), they are unlikely to be affected by the outcomes of the Regional Forest Agreement. Quarries are often located on private land in Victoria because

construction materials are owned by the land owner, and not (as in the case of minerals) exclusively by the Crown. This provides an incentive for quarry operators to develop operations on private land.

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 Central Highlands. 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 163 Victorian slate bed gold deposits surveyed by Bowen (1974), 85 per cent had total production of between 1000 and 6228 kilograms. The Nagambie gold mine (just outside the study area) recently closed after production of 4185 kilograms. The case history of the Nagambie operation provides a useful insight to the effect that a mine lying within this range could have on local towns and regional economies, if found in the Central Highlands.

The Nagambie gold deposit was discovered in 1985 and in 1987 a resource of 7 million tonnes at a 1.2 grams per tonne gold grade was delineated by the Perseverance Corporation Ltd (Hughes 1990). The mine operated from July 1989 until December 1996 and minor amounts of gold are still being extracted from leach residues. 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.

In addition to the net economic benefits associated with the rents from production (not calculated in this report), the Nagambie gold 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 employment multiplier effects;
- Perseverance spent \$465 000 upgrading local infrastructure including the electricity relay station and road improvements which enabled a \$1.5 million mushroom farming business to be established, creating eight new jobs (in addition to the multiplier effects above)
- the mine brought new workers into the region (31 mine employees were new residents), increasing the diversity and level of skill in the Nagambie region's occupational structure, population growth in the region over the period 1989–91 was around 4.5 per cent, thus reversing the previous trend of population decline in the area.

Table 10.4: Gross Revenue and Direct Employment, Nagambie Gold Mine

Year	Gross revenue (\$1996)	Direct employment
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, *pers. comm.*, February 1997.

Although mines like Nagambie may be temporary (3–10 years life in many cases); in addition to bringing economic benefits to the local and wider economies during their operating life such projects also provide infrastructure and demographic benefits to smaller communities, which can have lasting effects.

Outlook for Mineral Production

Future levels of supply and demand in world metals markets will affect future exploration activities (and, hence, on mining) in the Central Highlands. Base metals (copper, lead and zinc) and gold are the focus of current exploration activity in the Central Highlands and the outlook for these markets is discussed below. Detailed market outlook assessments for the medium term are given in Haine and Roarty (1997) and Middleton and Allen (1997) for base metals and gold, respectively.

Base metals

Overall, world consumption of base metals increased by 1.5 per cent in 1996 and is forecast to grow by a further 3.1 per cent in 1997. Consumption is projected to increase at around 2.0–2.5 per cent a year over the medium term, easing gradually over the longer term. World mine supply of the three base metals is forecast to rise in 1997. World refined copper production is forecast to increase particularly strongly, with more modest increases forecast for refined zinc and lead production.

Over the longer term, continuing technological developments can be expected to place downward pressure on costs. Together with projected demand growth, the long term downward trend in real prices for each of the base metals is expected to continue.

Gold

World gold consumption is projected to increase at around 3.5 per cent a year, largely as a result of expected further growth in demand for jewellery in developing countries. Further liberalisation of gold trade policies in a number of Asian developing countries may also contribute to increased world demand for gold over the medium to long term.

Continued growth in world gold consumption is expected to be largely met by increased gold production from emerging producers and further sales of official sector reserves. The development of high quality gold deposits in the emerging gold producing regions and adoption of new technologies in traditional producing regions are expected to place downward pressure on costs. Over the medium to longer term, real gold prices are expected to remain relatively flat and may possibly decline slightly.

10.4 LEGISLATION AND LAND ACCESS

Access to land is an important issue for exploration and mining. At this stage the implications of the RFA for exploration and mining are not known.

It is important to note that no area can ever be classified as unprospective 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 implications of these can change over time. There are also dynamic aspects to market information that will affect perceptions of a region’s prospectivity; for example, 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 on 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. Other relevant legislation includes the Mineral Resources (Titles) Regulations, 1991.

All exploration and mining activities are subject to 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 work plan and other approvals being obtained: and
- site visits and monitoring of environmental management activities by government officers.

Under the MRDA there are four main land types:

- private land,
- exempt Crown land,
- restricted Crown land, and
- unrestricted Crown land.

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 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 15 per cent of the land in the Central Highlands CRA 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 three per cent of the region.

Table 10.5: Land Use Categories as a Proportion of Total Land Area, Central Highlands

Land use category	Area ('000 ha)	Proportion of Central Highlands (%)
Private land	503	44
Exempt Crown land	164	15
Restricted Crown land	31	3
Unrestricted Crown land	431	38
Total Central Highlands	1129	100

Source: Minerals Victoria

The Nature of Exploration and Mining

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.

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.

Because of incomplete geological knowledge, the discovery rate in Australia is roughly of the order of one mine per thousand exploration programs. Thus areas are often repeatedly explored before a mineral deposit is found.

Although discovery and delineation are the primary reasons for exploration, lack of discovery from an exploration program does not imply that the effort yielded no benefit. Information gained from exploration will usually increase the understanding of a region's geology. There are many cases where information gained from both successful and unsuccessful exploration programs was later used to locate mineral deposits that were either overlooked by, or were not the target of, past exploration (eg in highly prospective areas such as Kanowna Belle in Yilgarn, of WA and Century in the Mount Isa Inlier in Queensland or in areas not previously known to be of very high potential (eg Olympic Dam on Stuart Shelf, SA).

Because exploration is primarily an information-gathering process it is necessarily dynamic, so that most regions can never be regarded as having been explored. Many recent Australian discoveries have occurred in known mineral provinces that have been explored for over 100 years. There are many reasons for exploration to have continued in such areas. For example, technology and scientific understanding of geological processes continue to develop with time; such advances not only encourage exploration in areas where prospectivity was previously considered low, they also lower the costs and increase the efficiency of exploration. Also, changing economic conditions (for example, changes in metal prices or

the costs of extraction) affect the expected returns from exploration and can have a significant impact on 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 (for example, drilling), unless special steps are taken to reduce such impacts.

Exploration methods used in the Central Highlands are as follows:

- **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; 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. Followup-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 are able to 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 or is 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 ten metres square.

Rehabilitation of areas disturbed by exploration is required in Victoria.

In contrast to 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 uses.

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 is a routine aspect of mining approvals. Such assessments may include impacts on flora and fauna, water supply, catchment management and public safety.

Many potential environmental effects of mining activities can be eliminated or mitigated, though at a cost to the mining company. Given the relatively limited areas of land disturbed by the operation of a mine, water pollution often represents the major potential threat to the environment from mining. 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 vegetation or assisting its re-establishment of vegetation and reducing the potential for pollution from the former mine site.

11.0 SOCIAL ASSESSMENT

11.1 INTRODUCTION

The purpose of social impact assessment is to develop a profile of current conditions in a region as a basis from which 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).

The social assessment describes the current situation in the region and provides a socio-economic 'snapshot' of the people and communities which may be affected by planning and policy decisions about the forest. Social assessment methodology is used to highlight values relating to a particular issue, increase public involvement and determine the nature and significance of potential social impacts.

Over the past decade there has been an increasing awareness by government, industry and the community of the importance of considering the social impact of decisions. There are many definitions of social impacts; however it is commonly agreed (Armour 1990) that social impacts are 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).

Within the Central Highlands changes in both Federal and State government policies have required some readjustment of the management of forest resources. The continual updating of information concerning production, conservation, recreation, water, historic and cultural heritage and social values relating to the forest resource, and the need to balance the provision of these uses and values in management, has provided the impetus for policy change.

A review of previous social assessment studies in Victoria reveals that there have been a number of decisions which have affected some local communities, though within the Central Highlands region the negative impacts relating to decisions about forests have been minimal. Changes in access or management of the State forest resource have largely come about through both State and Regional strategy and policy decisions. In Victoria, such policy developments have included:

- The Timber Industry Strategy (1986),
- The Code of Forest Practices (1989),
- The State Plantations Impact Study (1990), and
- The National Forest Policy Statement (Commonwealth of Australia 1992b).
- The implementation of the Land Conservation Council's (LCC) recommendations for the use of public land. The Council completed studies of the region in 1977 and 1994, which incorporated some social assessment work.

This social assessment of Central Highlands has shown that the community is keen to have a voice in determining how future forest resources are used and managed. The process has provided communities and other stakeholders the opportunity to present their views and opinions in an open and neutral forum. These views will provide an important input to decisions about the Central Highlands RFA.

It is evident that a range of values exist in relation to forest use. It is important to recognise that the experience of an individual or a community shape the way that specific events are perceived. In this way, what is important to a member of a community, or the community as a whole, may not be important to someone outside that community. It is therefore important to acknowledge and consider the values, social dynamics and beliefs of those immediately affected by changes in order to minimise any consequent social disruption and to maximise the positive community potential within the region.

As a result of this process, this report contains the views of many people in the Central Highlands region or those with an interest in the forests of the region. They do not necessarily reflect the views of the Steering Committee or the Commonwealth or Victorian Governments.

Data has been collected to provide information on: employment and labour force characteristics, socio-demographic structure, provision of community infrastructure, community vitality, social well-being, historical response to change, community visions and aspirations and community attitudes towards forest use. This information has been obtained at regional, local government and community levels.

Social assessment has three distinct phases:

- assessment and prediction
- mitigation and monitoring
- audit and analysis

The assessment phase is the focus of this report as it provides information essential to the determination of potential impacts of change before any change has taken place. This phase involves two key activities: scoping and profiling.

Scoping involves identifying and documenting the important issues relating to a proposed change. Profiling involves documenting the social conditions for a particular region to develop a better understanding of social and cultural values and their relationship to the proposed change.

A variety of data collection methods and data sources was used to strengthen the study design and validate the results. The methods included survey, interview, participation observation, networking, focus group and workshop techniques.

Groups involved in forest-use activities such as logging, transport, apiary, seed collecting, tourism and other forest uses were asked to complete written surveys. In addition, a random telephone survey was undertaken of almost 1100 households within the Central Highlands region as a way of obtaining the views of the wider community in relation to forest issues.

More detailed assessment work was undertaken in a series of case studies covering six communities across the region. These communities differed in terms of their population size, industry dependency, diversity of the local economy and geographic location. Communities such as Alexandra, Noojee, and Erica/Rawson were seen as more dependent upon forest-related industries while others, such as Healesville had a more diverse economic base. The case study areas selected were intended to represent the social and economic diversity of the Central Highlands region. Interviews, focus groups and community workshops were conducted in each of these case study communities and representatives from a range of community sectors, local organisations and the general public were invited to attend.

11.2 STAKEHOLDER VIEWS

Public involvement is an integral part of the social assessment process. Through the Forest Community Coordinator in Victoria, a range of stakeholders at a State, regional and local level have participated in the social assessment process. These stakeholder interests may be categorised as follows:

- timber industry;
- tourism and recreation;
- conservation;
- other forest users (apiarists, seed collectors, firewood collectors, craftwood and specialty timber artisans);
- mineral exploration;
- landholders;
- local government;
- Aboriginal communities; and
- general community.

Issues raised by industry groups included uncertainty of future resource supply and subsequent employment, and the desire to see more investment and value adding in the region.

Those involved in tourism and recreational activities were concerned about the maintenance of landscape values and access to forest areas. They requested involvement in the development of forest management plans. Further education about forestry activities was also sought.

Conservation groups within the region were largely concerned about the management of forests for short-term economic gain. Many felt isolated in their respective communities and excluded from formal decision making processes. Concern was also expressed over the loss of old growth forests, wilderness and biodiversity values and soil erosion and water quality decline. The desire was expressed for further involvement in forest management and an increase in the number of areas to be set aside in reserves.

Other forest users within the region wanted to see better working relationships established between themselves and harvesting contractors. Greater access to forest resources and an examination of certain forest practices and their compatibility with other forest values were requested.

Mineral interest groups also expressed a desire for greater involvement in forest management, and were concerned that areas with mineral potential may be placed in reserves restricting future access. There was a strong desire for multiple use of forested areas and issues relating to fire management were raised.

Landholders in the region also raised a number of issues. These included the desire to see an expansion of plantations of native species on both public and private land, and the further development of farm forestry initiatives. However, concerns were raised about the impact of weeds, fence maintenance, fire and wildlife on private land arising from adjoining forest areas. Consistent with the views of tourist operators, landholders believed there was a need for buffer zones to minimise the visibility of forestry activities and were also concerned about damage to local roads from heavy usage by log trucks. Landholders believed that there should be a shared use of forest areas by timber and tourism/recreation industries and that water quality was an important issue. Again, a desire to participate in the RFA process was evident.

Local government within the Central Highlands region raised a number of issues. These included: maintenance and upgrading of physical infrastructure within their respective shires; improved relationships with industry within the region; and capitalising on the economic benefits of industry development. Water quality, environmental and aesthetic concerns in relation to forest areas were also raised.

There was a strong desire by Aboriginal people to be involved in the development of forest management plans and to have areas of cultural significance protected and valued. Concern about water quality deterioration arising from harvesting was expressed. Aboriginal communities believed they have the right to access forests for cultural purposes, and want to see improved training of Aboriginal people for employment in forest management. They saw their interests as separate from other assessments currently being undertaken and believed that further discussion is required. The potential for the further development of Aboriginal cultural tourism within the region was also identified.

In relation to the general community within the region, respondents indicated that they benefit significantly from recreational activities in forested areas. There was a recognition of the importance of the timber industry within the region, coupled with a belief that forests should also be preserved for future generations. Consideration of aesthetic values was also highlighted, including the need for sufficient buffer zones in State forest areas between logging coupes and tourist areas.

It was also stated that many communities were experiencing a degree of instability and uncertainty due to the current socio-economic climate, resulting in social disharmony, financial and social stress, loss of services and reduced community participation. Respondents believed that there was a need for increased education about forest management and use and that an increase in plantation development and other industry initiatives would enhance community stability.

11.3 SOCIAL AND ECONOMIC STRUCTURE

The Central Highlands region has a traditional economic reliance upon its natural resource base. Community services, wholesale and retail trade and manufacturing are the sectors with the highest employment, reflecting the influence of urban areas located in the Yarra Ranges Shire. In 1991, forest based industries provided approximately 3,744 direct jobs in the region, most of which are involved in forestry and logging and wood and paper products manufacturing (ABS 1996b).

The Central Highlands region had a population of about 280,000 people in 1991 (ABS, 1991). Approximately 190,000 people reside within the Shires of Murrindindi, Baw Baw and Yarra Ranges with about 0.4 per cent of the population being of Aboriginal and Torres Strait Islander descent. This figure is comparable to the proportion of Aboriginal people living in Victoria.

Between 1986 and 1991, population growth increased by 1.18 per cent, and with a forecast annual population growth rate of around 1.4 per cent, the population in 1997 would be expected to be above 300 000 persons. The region has a relatively young population, with 22.5 per cent of people aged between 5 to 24 years and 22.1 per cent in the 25-34 year age group. These figures exceed the State averages for these age groups.

The region has approximately 58,000 households, about half of which are privately owned. A total of 39% of households in the Shires of Murrindindi and Baw Baw have average

incomes of below \$25,000, while in the Shire of Yarra Ranges 36% of households have incomes of less than \$30,000 per annum. Two-parent families are predominant and only a small proportion of the population hold graduate or postgraduate qualifications.

11.4 COMMUNITY ATTITUDES AND VALUES

Within the region, attitudes of self-reliance and commitment are common. Individuals identify strongly with their communities and have a clear vision for their future. Employment for the youth of the community was perceived as a major priority. The decline of young people in some areas, due to a lack of employment opportunities, is resulting in an ageing population in some communities. Furthermore, the restructuring and regionalisation of community infrastructure is also a major concern due to the limited services that currently exist in rural areas.

Despite these problems, the rural environment is seen to afford a quality of life which is unattainable in urban areas. Residents value the safety of rural areas, the friendliness of the people and the beauty of the surrounding environment. Social cohesion within the communities is also very high.

Communities are investing time and energy in exploring new economic development options, and this is occurring at both local community level as well as in the larger regional forums. This is reflected in Shire reports within the region. The Shire of Yarra Ranges has just completed a research project which considers future Warburton business prospects. Many of the proposed ideas look at encouraging development of timber and wood products. Other projects within the region are encouraging tourist attractions such as local festivals and events, and the potential of value added wood products is receiving greater consideration throughout the region.

Tourism and recreation are important activities within the region and there is a strong focus on nature based experiences which revolve around forests and waterways. There are strong links between the tourist industry and other industries, in particular, the wine growing and gourmet food sectors. In addition, two of Victoria's alpine resorts fall within the region. Other recreational activities in the region include: 4 wheel driving, fishing, forest drives, trail bike riding, horse riding, bushwalking, nature observation, hunting and swimming. Use of State forest areas within the region is high and National and State parks within the region hold particular attraction to those involved in bushwalking, cross country skiing, rock climbing and water based activities.

Telephone Survey of Community Attitudes

A telephone survey of almost 1,100 households showed considerable variation in attitudes towards the use and management of native forests across the Central Highlands. Map 11.1 indicates the sub-regional sectors from which respondents were sampled. A consistent theme evident in the survey was the concern¹ expressed by the population in relation to the use and management of native forests. For instance, 88 per cent of the sample indicated that they were concerned about the management of native forests in Victoria, with 82% believing that laws to protect the use of native forests should be improved. Sixty per cent of the sample believed that forest industries should have more say in how native forests are managed, and only 25% believed that private landholders should be able to manage and use their native forests in any way they wished.

¹The term concern is a technical term used in the social assessment of environmental values and should not be interpreted as reflecting either a positive or negative evaluation of the environment or environmental issues.

The survey also provided an indication of the use of native forests in Victoria by the population in the Central Highlands, with 80% of respondents indicating they had visited native forests in Victoria within the last year. Passive recreation, including bushwalking, picnicking, sightseeing and camping, were the most common reasons given for visiting native forests (Map 11.2).

Within the Central Highlands survey sample, 33 per cent of respondents indicated that the area in which they lived was very dependent on the timber industry (Map 11.3). However, there was significant variation across sectors. For example, fewer respondents in the Central Inner sector and the Western sector considered their area dependent on the timber industry than respondents in the Central Outer and Northern sectors. Major townships which respondents considered highly dependent on the timber industry included: Alexandra, Eildon, Eltham, Epping, Greensborough, Kinglake West, Launching Place, Seymour, Warburton, Woori Yallock and Yarra Junction.

Ninety-one per cent of respondents indicated that neither they nor family members in their household were employed in any business or industry that uses land in native forest areas and 11 per cent of respondents considered themselves to be dependent on the timber industry (to the extent that if the industries did not exist in their area they would have to live somewhere else). Twelve per cent of respondents believed that further reservation of native forest areas would threaten their current employment. This belief was found to be highest amongst the population within the Northern and Southern sectors of the region, where approximately 20 per cent of respondents were seen to hold this belief. However, in many areas people appear torn between the need to protect native forests and the need for employment within their respective communities (Map 11.4).

Forty-five percent of respondents said that they would like to see new industry development in their area (Map 11.5). Across all sectors, tourism was seen as the preferred new industry, with agriculture also mentioned in the Central Inner sector. In addition, a large percentage of respondents within the Southern and Northern sectors saw manufacturing as a preferred new industry. New industry development was largely seen to provide employment opportunities and 10% of the sample also indicated the need for light and small industry development in the region.

When asked to indicate what would be the effect on the community of a decrease in the future activity of the forest industry in their area, it was apparent that significant regional variations existed. Fewer respondents in the Southern (44 per cent), Central Inner (33 per cent) and Western (16 per cent) sectors indicated that a decreased forestry activity in the future would affect their community, compared with the Central Outer (78 per cent) and Northern (71 per cent) sectors. Respondents indicated that an increase in unemployment was the most significant change to the community likely to result from a decrease in future forestry activity (66 per cent of respondents). A smaller proportion of people (eight per cent) believed that surroundings would be improved as a result of a reduction in forestry activity in their area.

In general, respondents outlined that the main issues that need to be considered when areas are recommended to be set aside as protected areas are issues such as: flora and fauna (21.8 per cent agreement), diversity and abundance of wildlife (16.9 per cent agreement), affect on the community (9.9 per cent agreement), access to areas for public use, tourism and recreation (7.5 per cent agreement).

As part of the social assessment process individuals in a number of groups which have an economic dependence upon forest use were asked to complete a written survey. These groups range from harvesting and haulage contractors and other forest workers to apiarists, seed collectors, mineral exploration companies, tree fern collectors and tourist operators. Despite their varying dependence upon forest resources, the activities of these groups within forest areas are important and require consideration. Groups expressed sometimes similar and sometimes contrasting issues in relation to the future use and management of forest resources in the Central Highlands region (Table 11.1).

Table 11.1: Summary of issues raised by groups with economic dependency on forest use.

Group	Issues
Contractors	<ul style="list-style-type: none"> • Insecurity of employment • Insecurity in investment • Desire for a sustainable timber industry • Better representation of timber industry in the media
Forest Workers	<ul style="list-style-type: none"> • Insecurity of employment • Industry stability essential for investment • Desire for decisions to be based on fact • Better representation of timber industry in the media • Polarisation in the debate creates community division
District Forest Employees	<ul style="list-style-type: none"> • Desire for sustainable forest management • Concern about current forestry practices • Development of plantation forestry • Value adding has been an essential development • Science disregarded in politically polarised arguments
Tourist Operators	<ul style="list-style-type: none"> • Controlled logging compatible with tourism/recreation • Impact of visible logging on tourism/recreation due to adverse aesthetic, environmental, safety and noise concerns • Recognition that forestry and recreation/tourism are essential to community

Table 11.1 continued

Group	Issues
Other Forest Use	<ul style="list-style-type: none"> • Forest management for timber not necessarily compatible with other uses (Specialty timber craftsman (sic)) • Coordination with other forest users would assist compatability of uses (Specialty timber craftsman (sic)) • Short forestry seasons limit employment opportunities (Roading contractors) • Access to forest areas (Apiarists)

People employed in the timber industry, especially contractors, had strong family ties within their respective areas and had been working in the industry for considerable lengths of time. In addition, a high percentage of contractors have family members also employed in the contracting business. This was true to some extent with forest workers also. Tourist operators, in contrast, were more mobile and had often chosen to live within a particular locality for lifestyle or business reasons.

11.5 COMMUNITY CASE STUDIES

Six case study communities were selected which represented the economic and social diversity of the region. At a community level, dependence upon the timber industry varied according to geographic location and population size. For example, the township of Noojee located north of Warragul is a small town with a reliance on only one industry, timber. Noojee's history reflects the early development of the timber industry and the establishment of small sawmills. The township identifies strongly with the timber industry and each year holds the 'Festival of the Forest'. Workshop participants indicated a strong attachment to the town and spoke openly about the loss of important services from the community over time. Visions for Noojee included investment in value adding opportunities to provide employment and skills training for youth and enhanced income security. Such investment was perceived to be a way of increasing community confidence. Some residents believed that Noojee had the potential to develop in other areas such as tourism.

The townships of Erica/Rawson also have a relatively high presence of forest-related industry within their townships. In recent times, the Erica/Rawson area had a total of three sawmills, but now only one is operational. The townships, like Noojee, have experienced a continual loss of services and there are many houses standing empty. Workshop participants indicated that local people wanted to see an end to the uncertainty in the forest industry through the development of a sustainable timber industry, in balance with tourism. It was envisaged that both industries would provide the jobs needed to keep young people in the town, to fill the 'empty houses' and support and maintain the level of services and facilities within the township.

The township of Alexandra, while having a strong timber industry presence, with the Gould's sawmill located on the outskirts of the town and a Department of Natural Resources and Environment office, also identified strongly with the tourism industry. Alexandra is a relatively well serviced community with a number of active community groups. One of the main issues raised in this area was concern over the loss of youth from the community. While investment and expansion of the timber industry would provide further employment, participants believed that there were opportunities for both tourism and timber industry development and that in relation to the use of timber, all forest values should be considered.

The townships of Marysville and Kinglake identify more strongly with tourism possibly due to their proximity to the Yarra Ranges National Park and the Kinglake National Park. While both townships have an association with the timber industry, both areas outlined their visions in regard to tourism development and the attainment of additional community services. Residents of both areas believed that greater participation by community members could contribute to the achievement of these visions, and community vitality in both areas appeared strong.

The township of Healesville, possibly due to its prominence as a main rural centre in the region, expressed slightly different issues from the other townships. Although situated in a rural area, the proximity of Healesville to Melbourne and its dependence upon the outer suburbs of the city has led to uncertainty regarding community identity. Residents spoke of division between traditional families and new residents to the area and believed that this influenced the sense of community within the township. However there was a strong desire for Healesville to remain autonomous and maintain its own identity. Other problems such as increased crime rates in recent years and a high degree of poverty were also outlined. In relation to community visions, tourism was raised as a viable economic development option due to the presence of the wine industry and main attractions such as the Yarra Ranges National Park, the Healesville Sanctuary, Maroondah Park and the newly opened Galeena Beek Cultural Centre.

Within all the case study areas outlined, there are many groups which have the potential to be strongly affected by change due to their reliance on particular community services. For example, women with young children often rely more heavily on pre-primary and primary school educational facilities, adequate health care and voluntary organisations such as Nursing Mothers. The elderly are far more dependent upon adequate transport, medical and ambulance services, police services and community services such as the community bus or library van. Unemployed people within an area are reliant upon services such as youth resource centres and programs which attempt to facilitate their entry into the workforce, and public transport.

In areas where populations are declining, these types of services are often more difficult to justify and thus have the potential to be withdrawn or downgraded. It is also often the case that such groups are given little opportunity to participate actively in decision making, yet often bring quite different perspectives on issues. As a result, focus groups were conducted to obtain the views of these groups within the region. In regards to visions for their community, while senior citizens perceived the need for more community interest by youth, greater community participation and tourism development. Young mothers outlined the need to encourage new people to the area and diversify industry and business within the township e.g. alternative health specialists. The unemployed wanted to see improved recreational facilities and a reduction in crime. When asked about the importance of forest issues, there was a desire by groups for sustainable management of forests and better education. All groups recognised the need for employment and recreation and believed that a balance could be achieved.

Interviews were also conducted with representatives from Camp Jungai and the Coranderrk Aboriginal Cooperative to consider the issues of importance to Aboriginal communities within the region. A main issue raised by the groups included the desire for adequate consultation in relation to land use decision making and an acknowledgment and consideration of the land rights of Aboriginal people. When asked about sites of cultural significance, the groups outlined that many sites fall within reserved areas within the region.

More detailed information is provided in the Social Assessment Technical Report (VicRFASC 1997d) which is available on request. Further information and communication in relation to social assessment work is continuing with the community of the Central Highlands 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 1996), 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% 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% 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 Central Highlands 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 Comprehensive Regional Assessment Central Highlands: Biodiversity Assessment report (VicRFASC 1997e). 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 Central Highlands region, which species were targeted, and whether survey sites are reasonably distributed to detect most species in most geographic or environmental components. The results of these analyses were used to highlight gaps in information and identify those areas which may require further survey work.

Ecosystem Assessment

Ecological Vegetation Classes (EVCs) have been used as the basis of the forest ecosystem diversity assessment for the Central Highlands. 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 (Comprehensive Regional Assessment East Gippsland: Environment and Heritage Report - ref VicRFASC 1996a). The first part of the assessment involved determining and mapping the types of forest communities occurring in the Central Highlands 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.

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, 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*.

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 are also important in determining the risk of decline or extinction. Vulnerability assessments were conducted for several Central Highlands flora and fauna species of conservation significance. This information assists in identifying and prioritising those species which are most in need of management actions to improve the prospects for their long-term survival.

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 dedicated and informal reserves (eg national parks, Special Protection Zones) 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 have been conducted for flora, fauna and EVCs.

Threatening Processes (Disturbances)

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 have negative effects (direct or indirect) on a species are referred to as threatening processes. This assessment describes threatening processes

relevant to the Central Highlands and the management arrangements currently in place to address these.

12.3 DATA REVIEW FOR TERRESTRIAL SPECIES

Introduction

The primary aim of the data review process is to ascertain the adequacy of existing site-based biological data for determining the distribution of flora and fauna species, and relating this to their habitat requirements. Outcomes from the review can also be used to identify data gaps and priority areas for additional survey work. The methods described here were used for terrestrial flora and fauna only - the data review for aquatic species is discussed in section 7.2.

The first stage of the data review involves selecting only those survey data which meet required standards of accuracy, precision and reliability. This allows a degree of confidence when analysing the distribution of species.

The next stage involves assessing the extent to which the site records for flora and fauna are representative of the environmental and geographic variation within the region. This was achieved by dividing the region into units or “strata” which exhibit similar environmental characteristics based on a series of factors or variables. Although there are many variables to choose from (for example, temperature, rainfall, elevation and slope), those which are considered to most influence the distribution of species in a region are selected to create the stratification. Each stratum may be represented by several discrete areas (or substrata) within a region.

These strata and substrata are then analysed to determine the intensity of survey for flora and fauna. That is, the density of survey sites is determined for each (such as number of survey sites per 10,000 ha). Calculations are also made for each stratum of the probability of encountering species that have not previously been recorded in surveys there.

Methods

Analyses of the variation in annual rainfall, temperature extremes and rock types across the region were used to classify the major types of environments occurring in the Central Highlands. The analysis identified 68 different strata for the region, each characterised by a particular combination of rainfall, temperature and rock type. It is important to note that only forested areas were considered.

The 68 strata for the Central Highlands region ranged in area from 4 ha to more than 100,000 ha each, with the largest of these comprising 1,668 components or substrata (see Map 12.1). This environmental stratification was subsequently used for the analyses of flora and fauna databases presented below.

Flora

The dataset used for the assessment of the Central Highlands flora was derived from the Flora Information System of Victoria (CNR 1993), and the Victorian Rare or Threatened Plant Population database. It comprises all available data from vegetation surveys and studies of the region undertaken during the period from 1979 to 1997, and includes more than 4,300 site records.

The distribution and density of site records were used to evaluate the intensity of sampling of the environmental variation in the region. The results are summarised in Table 12.1. Very small strata classes (less than 100 ha) were not considered in the evaluation. The 56 environmental strata (>100 ha) on which the table is based represent 99.96% of the total area of the region.

Table 12.1: Proportion of flora sampling density classes for the Central Highlands region

Density class	Sampling density for flora (no. of sites/10,000 ha)	Number of strata	Total area (ha)	% of Central Highlands region
very high	>100	11	72,489	10.12%
high	40-100	15	331,157	46.25%
moderate	10-40	15	257,778	36.00%
low	1-10	3	46,639	6.51%
zero sites	0	12	7,572	1.06%

The Central Highlands flora dataset provides good coverage of the spatial and geographic variation of the region. More than 60% of the environmental strata have been sampled at moderate or better densities; this represents approximately 73% of the strata that are greater than 100 ha in size. In terms of area, an estimated 92% of the region has been sampled at moderate or better densities, and more than half of the region has been sampled at high or very high densities. Strata without flora survey sites occupy only about 1% of the total area. These comprise 12 strata that are generally small and scattered and tend to be located in areas of lower rainfall, or in parts of the landscape that have been fragmented due to land use activities.

The spatial distribution of sampling within each stratum has been mapped and assessed. The results of this work show a sampling bias, with many sample sites clustered in timber production areas. In general, the distribution of flora sites, whilst highly clustered in timber production areas, is representative of the variation across the region, although additional survey effort in less sampled environments would improve the database. The most significant areas of relatively low sampling density are in the north-east and include the Matlock and Big River districts and areas at the junction between private and public lands in the Alexandra, Broadford, Neerim and Erica districts (Alexandra, Disappointment and La Trobe geographic representation units) refer to Map 1 and Table 12.4.

In general, the level of flora survey in the Central Highlands is high compared to other forested regions in Australia.

Fauna

In Victoria, much of the existing site data for fauna has come from incidental records, rather than systematic survey. Thus, a lack of surveyed sites in certain strata does not necessarily mean that the strata have not been sampled; it simply means that the information was not appropriate for use in this analysis.

The site-based biological data sets used in the fauna assessment were drawn from the Atlas of Victorian Wildlife. Survey data was analysed for each of the species groups indicated in Table 12.2. Survey data on invertebrates was insufficient to enable such analysis.

As was done for flora, the distribution and density of survey site records were used to evaluate the adequacy of sampling of the environmental variation in the region. The probability of the next species recorded for a particular stratum being new (i.e. not previously recorded in surveys for that fauna group in that stratum) was used as an indication of the adequacy of sampling effort. For example, the probability of the next species being new would be 100% in stratum that had not previously been surveyed, whereas it would be small (possibly <5%) in strata that had been extensively surveyed because most species occurring there would have been already detected in earlier surveys. The analysis was confined to the 20 most extensive strata which range from 15% to 0.8% of the area (totalling 93% of the area). A summary of results for these strata is given in Table 12.2.

Table 12.2: Terrestrial vertebrate fauna survey data by species group

Faunal group	Arboreal Mamm.	Large Mamm.	Small Ground Mamm.	Bats	Diurnal Birds	Nocturnal Birds	Large Forest Owls	Reptiles	Amphibians
Number of sites surveyed	1,371	251	1,995	738	933	1,119	733	943	957
Number of the 68 strata with survey sites	41	26	36	31	33	38	36	29	29
Number of the 20 largest strata with survey sites	19	18	19	17	17	19	19	17	17
Number of the 20 largest strata with low probability ($\leq 5\%$) of new species in next survey	13	4	16	16	13	9	8	6	4

Of the 20 largest strata generated by the stratification of the Central Highlands region, between 17 and 19 contained surveyed sites for each of the fauna groups considered. Bats and small ground mammals are the groups most comprehensively surveyed across the region, given that they have the most strata with low probabilities of new species being detected. Future surveys for reptiles, amphibians and large mammals are most likely to detect species not previously recorded in surveys. The analysis shows that while survey intensities are adequate for many of the strata and fauna groups, a number of survey gaps have been identified at substrata level in different parts of the region. Further detail on these gaps are contained in the Technical Report.

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 Central Highlands.

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 (for example, 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 (EVC Methodology Paper, Appendix G, Comprehensive Regional Assessment East Gippsland: Environment and Heritage Report - ref VicRFASC 1996a. A detailed description of the EVC concept can also be found in that report.

A total of 40 EVCs have been identified as currently occurring in the Central Highlands. These EVCs have been mapped across all land in the region at a scale of 1:100,000. The Central Highlands EVCs are listed in Table 12.3. A detailed description of each EVC is available in the Central Highlands CRA Technical Report for Biodiversity.

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 in the Central Highlands region 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.

The approximate distribution of each EVC in the region prior to 1750 has been mapped (no EVCs have disappeared from the region). An analysis of the reliability of the pre-1750 mapping shows that, in general, predicted distributions of EVCs north of the Yarra River have a high reliability, EVCs south of the Yarra River and on the Yea spur are of moderate reliability due to poor access or little remaining native vegetation, and EVC mapping in small areas associated with reservoirs, and areas near Neerim South and near Labertouche are of lower reliability due to poor access and little available information.

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 Central Highlands. The extent of representation of EVCs in conservation reserves and in parts of the State forest Special Protection Zone (SPZ) has been used as the basis for evaluating the current reservation status of forest ecosystems in the region.

Table 12.3 shows the distribution of EVC's across all land tenures in the Central Highlands. 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.

Special Protection Zone: managed specifically for the protection of conservation values and timber harvesting is excluded. The SPZ is comprised of the following four categories:

- (a) Large and contiguous areas;

- (b) A network of connecting areas (200-400m wide) based around riparian zones (including Heritage River corridors) but also including wildlife corridors on ridges and crossings between catchments;
- (c) Linear reserves of less than 200 m width and small areas less than 5 ha; and
- (d) Areas protected by the Code of Forest Practices for Timber Production. This category includes all permanent streams and all rainforest stands and an adjoining buffer of non-rainforest vegetation of at least 40 metres.

Special Management Zone (SMZ): areas included in this zone are managed to conserve specific features, while catering for timber production under certain circumstances.

General Management Zone (GMZ): areas included in this zone will be managed for a range of uses, but timber production will have a high priority.

Other Parks and Reserves: this category includes regional parks and historic and cultural features reserves, where timber harvesting may be permitted.

Other Public Land: includes land managed by the Victorian Plantations Corporation and water supply authorities, such as Melbourne Water.

Table 12.3.

Table 12.3: Representative conservation (percentage reservation status) of EVCs in

Ecological Vegetation Class	Area (ha)		Percent remaining	Conservation	
	Pre 1750	Current			a
Clay Heathland	27	27	99.2		
Lowland Forest	78,992	42,805	54.2	13.6	1.4
Riparian Scrub Complex	9,992	2,695	27.0	0.8	0.0
Riparian Forest	43,059	31,801	73.9	15.5	9.8
Heathy Dry Forest	15,025	14,436	96.1	26.6	32.9
Grassy Dry Forest	73,892	41,579	56.3	19.2	4.0
Herb-rich Foothill Forest	168,346	123,049	73.1	11.6	8.8
Rocky Outcrop Scrub	311	227	73.1	62.9	
Rocky Outcrop Shrubland	19	5	28.0		
Damp Forest	198,726	162,307	81.7	16.6	7.3
Wet Forest	123,752	120,068	97.0	28.7	8.3
Cool Temperate Rainforest (ii)	12,984	12,970	99.9	43.8	22.5
Montane Dry Woodland	7,087	7,050	99.5	3.2	48.5
Montane Damp Forest	20,506	20,150	98.3	7.7	13.7
Montane Wet Forest	50,319	49,678	98.7	33.6	7.7
Montane Riparian Thicket	3,056	3,056	100.0	33.3	7.3
Sub Alpine Woodland	7,262	7,259	100.0	78.9	6.3
Treeless Sub Alpine Complex	1,855	1,825	98.4	84.9	0.2
Shrubby Foothill Forest	50,296	35,482	70.5	22.4	3.6
Valley Grassy Forest	64,452	7,201	11.2	1.6	0.0
Heathy Woodland	17,876	6,684	37.4	21.4	1.7
Wet/Swamp Heathland	6,250	3,779	60.5	47.1	
Swamp Scrub	5,655	429	7.6		
Box Woodland	25,339	328	1.3	0.2	
Plains Grassy Woodland	44,369	1,474	3.3	0.2	0.0
Floodplain Riparian Woodland (iii)	18,016	2,463	13.7	4.7	0.1
Riparian Thicket	1,726	1,006	58.3	4.1	0.3
Box Ironbark Forest	1,449	711	49.1	1.8	
Granitic Hills Woodland	1,258	215	17.1		
Riverine Escarpment Scrub	765	241	31.5		
Swampy Riparian Woodland	2,530	964	38.1	15.5	
Grassland	7,982	15	0.2		
Gray Clay Drainage Line Complex (iv)	560	0	0.0		
Plains Grassy Wetland	354	4	1.2		
Swampy Riparian Complex	50,889	5,945	11.7	0.8	0.0
Valley Heathy Forest	4,155	347	8.4		
Grassy Forest	10,059	2,682	26.7	0.3	
Swamp Formation	12	1	10.7		
Damp Sands Herb-rich Woodland	162	46	28.4		
Riverine Forest	210	4	1.9		
Rock	23	23	98.4	37.2	
Cleared Land		405,145			
Water Bodies	4	13,776			
Total	1,129,953	1,129,953			

i) The percentages of each EVC shown in the various land tenures comprise proportions of their pre-1750 extent. The area on p under "Current Extent". ii) All Cool Temperate Rainforest and an adjoining buffer of non-rainforest vegetation is protected in the s in the other public land category is contained within the Goulburn Heritage River corridor. iv) The remaining occurrence of this E v) Categories of SPZ are described in Section 12.4 of the Biodiversity Chapter.

The data in Table 12.3 has also been used to ascertain the rarity and threatened status of EVCs within the region. A comparison of the tenure distribution of EVCs in the Central Highlands based on their pre-1750 extent shows that the majority of forested EVCs on public land are well represented in the reserve system. However, some EVCs, such as Grassy Forest, Plains Grassy Woodland, Box Woodland, Valley Grassy Forest, Swampy Riparian Complex and Riparian Scrub Complex are not well represented primarily because they occur largely on arable land and have been subject to selection in the past for agriculture or related land uses.

Sub-regional reservation of Ecological Vegetation Classes

The Central Highlands region has been divided into 11 Geographic Representation Units (GRUs) based on variation in land form, geology, vegetation and climate across the region (Table 12.4). The GRUs reflect environmental change in the region at a landscape scale. These GRUs are shown on Map 1.

Table 12.4: Geographic Representation Units in the Central Highlands region

Geographic Representation Unit (GRU)	Description (a)
1. Aberfeldy	Steeply dissected ranges in a rainshadow from the Baw Baw Massif
2. Acheron	The southern portion of the Blue Range consisting of high rainfall and steeply dissected areas south of the Great Divide
3. Alexandra	Moderate to low rainfall foothills and ranges to the north of the Great Divide
4. Big River	Steeply dissected ranges north of the Great Divide, in low rainfall areas
5. Bunyip	Rolling hills and small ranges in moderate to high rainfall zones south of the Great Divide
6. Disappointment	The moderate to high rainfall areas of the Hume Range, Mt. Disappointment and the surrounding foothills
7. Latrobe	Foothill country of moderate to high rainfall south of the Great Divide on the margins of the Latrobe Valley
8. Marysville	The northern portions of the Blue Range and all of the Royston Range straddling the Great Divide under moderate to high rainfall regimes. This GRU has small areas of sub-alpine country
9. Matlock	Steeply dissected ranges south of the Great Divide, in low to moderate rainfall areas
10. Thomson	Very high rainfall areas of the Baw Baw Range. Steeply dissected mountains south of the Great Divide reaching sub-alpine elevations in places.
11. Yarra	Low elevation rolling hills and river plains of the Yarra and its tributaries south of the Great Divide

a) Rainfall is classified as low (<700mm), moderate (700-1000mm), high (1000-1200mm) or very high (>1200mm); the table does not include geological attributes of each GRU.

An analysis of the percent reservation of pre-1750 EVCs within each GRU can assist in evaluating the extent to which the reserve system encompasses regional variation in forest ecosystems (Table 12.5).

Table 12.5. Representative conservation (percentage reservation status) of EVCs in the Central Highlands region by Geographic Representation Unit.

Table 12.5: Representative conservation (percentage reservation status) of pr									
Ecological Vegetation Classes	Pre 1750 Area (ha)	ABERFELDY (iii)		ACHERON		ALEXANDRA		BIG RIVER	
		Area (ha)	% Prot	Area (ha)	Prot %	Area (ha)	Prot %	Area (ha)	Prot %
Clay Heathland	27								
Lowland Forest	78,992			5,365	4				
Riparian Scrub Complex	9,992			833	0				
Riparian Forest	43,059	6	0	5,938	42	2,049	18	2,510	45
Heathy Dry Forest	15,025	212	71	42	0	22	0	741	57
Grassy Dry Forest	73,892					19,383	26	13,109	63
Herb-rich Foothill Forest	168,346	584	77	3,898	27	26,330	13	21,342	52
Rocky Outcrop Scrub	311			9	100				
Rocky Outcrop Shrubland	19								
Damp Forest	198,726	1,040	66	31,921	26	1,379	23	8,542	26
Wet Forest	123,752			46,602	55			1,192	16
Cool Temperate Rainforest (ii)	12,984			6,406	90			73	57
Montane Dry Woodland	7,087	4	26					1,277	56
Montane Damp Forest	20,506			148	52			1,122	53
Montane Wet Forest	50,319			7,383	87			1,031	23
Montane Riparian Thicket	3,056			18	100			24	85
Sub-alpine Woodland	7,262			13	60			316	94
Treeless Sub-alpine Complex	1,855							3	100
Shrubby Foothill Forest	50,296	437	48	6,312	15				
Valley Grassy Forest	64,452			274	0	20,369	2	241	1
Heathy Woodland	17,876			1,317	1				
Wet/Swamp Heathland	6,250			378	0				
Swamp Scrub	5,655								
Box Woodland	25,339					13,542	1		
Plains Grassy Woodland	44,721					16,689	0	134	1
Floodplain Riparian Woodland	18,016			373	0	9,999	7	65	44
Riparian Thicket	1,726			505	18				
Box Ironbark Forest	1,449								
Granitic Hills Woodland	1,258								
Riverine Escarpment Scrub	765								
Swampy Riparian Woodland	2,530			40	11				
Grassland	7,982								
Gray Clay Drainage Line Complex	560								
Plains Grassy Wetland	354					10	0		
Swampy Riparian Complex	50,889			1,538	1	3,645	0		
Valley Heathy Forest	4,155								
Grassy Forest	10,059			38	0				
Swamp Formation	12								
Damp Sands Herb-rich Woodland	162								
Riverine Forest	210								
Water Bodies	4							4	
Total Area	1,129,959								

i) This table shows the pre-1750 extent of each EVC within each of the eleven Geographic Representation Units across the Central Highlands which is currently within a conservation reserve and the first two categories of the Special Protection Zone in State Forest as defined in the Forest Act 1978. Private land have been cleared. ii) All Cool Temperate Rainforest and an adjoining buffer of non-rainforest vegetation is protected in the Thomson Reservoir and occurs on the eastern margin of the Thomson Reservoir.

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 also been assessed. This analysis also assists in evaluating the extent to which the reserve system encompasses regional variation in forest ecosystems. A total of 73 floristic communities were identified for the 40 EVCs described as currently represented in the region. The majority of EVCs included only one floristic community, although 11 EVCs included two or more such communities. Only two of the floristic communities were found to be unrepresented in reserves; these included the Heathy Dry Forest floristic community which occurs on poorer sites north of the Great Divide in the Matlock GRU, and the Grassy Dry Forest floristic community that is currently found in the Yarra GRU (Yarra Valley) but was once more common on private land in urban areas of Melbourne.

Reservation status of Ecological Vegetation Class growth stages

Forest disturbance categories have been used to represent the major growth stages that characterise the dynamics of forests in the region. The growth stage/disturbance categories used have been derived from Woodgate *et al.* (1994), and include:

1. Old-growth Forest - a definition may be found in the old-growth chapter of this report;
2. Negligibly Disturbed Forest - forest which has less than 10% of the oldest (senescent) growth stage and less than 10% of the youngest (regrowth) growth stage contributing to the upper canopy layers, and where the effects of disturbance are negligible;
3. Significantly Disturbed Forest - forest which has greater than 10% of the youngest (regrowth) growth stage in the upper canopy layer, and has been subject to natural disturbance, for example, wildfire; and
4. Other Forest - includes forest which has greater than 10% of regrowth forest in the upper stratum originating from unnatural disturbances (timber harvesting etc.) and other forest where the type and level of disturbance is unknown.

The reservation status of EVCs in the region has been assessed for each of the above forest disturbance categories (Table 12.6).

The extent of reservation of the old-growth forest growth stage is between 71% and 100% for the EVCs examined (Table 12.6). Negligibly-disturbed forest also had a high level of protection, with all but seven of the EVCs examined having above 50% reservation.

Threatened Forest Ecosystems

The conservation status of EVCs in the Central Highlands has been assessed using the criteria derived from the National Forest Reserve Criteria (JANIS 1996) (see Table 12.7).

Table 12.6: Extent and level of protection for different forest growth stages and disturbance categories in the Highlands region (i).

Ecological Vegetation Classes	Total Area	Old-growth Forest		Negligibly Disturbed		Significantly Disturbed	
	ha	ha	% Prot (ii)	ha	% Prot (ii)	ha	% Prot (ii)
Lowland Forest	26858	22	100	11812	38	14723	52
Riparian Forest	27375	130	100	7974	67	16958	56
Heathy Dry Forest	13871	9214	77	3080	48	1531	38
Grassy Dry Forest	22625	7	100	16136	74	6417	70
Herb-rich Foothill Forest	94776	77	85	29629	60	64841	25
Rocky Outcrop Scrub	195			135	100	60	100
Damp Forest	143126	547	99	55658	47	86506	27
Wet Forest	113281	5083	99	37321	61	70677	31
Cool Temperate Rainforest	12918	1690	100	7722	74	3493	66
Montane Dry Woodland	7072	4040	71	1940	31	1091	25
Montane Damp Forest	20130	75	100	10237	25	9813	19
Montane Wet Forest	49677	940	100	22290	58	26448	29
Montane Riparian Thicket	3056	10	94	1677	63	1369	33
Sub-alpine Woodland	7254	3	100	3007	88	4240	84
Shrubby Foothill Forest	27983	32	100	13652	65	14094	26
Valley Grassy Forest	1136	696	71	430	72	8	100
Heathy Woodland	5137	3427	89	1491	51	193	42
Wet/Swamp Heathland	3095			2920	96	163	82
Box Woodland	33			30	100		
Plains Grassy Woodland	271			259	14	13	
Floodplain Riparian Woodland	1472			19	24	157	65
Riparian Thicket	524			299	100	225	100
Sub-alpine Complex	1825			838	94	986	93
Total	583690	25993	92	228556	63	324006	53

i) This table excludes private land, EVCs occurring entirely on private land and those for which it is not possible to determine the growth stage.

ii) Percent of area protected is based on area in conservation reserves and SPZ categories a and b as defined in Section 12.4.

Table 12.7: 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 20 EVCs from the Central Highlands have been classified as endangered, vulnerable or rare - these are listed in Table 12.8.

Table 12.8: Endangered, vulnerable and rare Ecological Vegetation Classes in the Central Highlands, their percent reservation in the region, threatening processes, and current management actions to address threats.

EVC	Criteria	% Reser v (a)	Threatening Processes	Management Action
Swamp Scrub	E2, E3	0	<ul style="list-style-type: none"> • habitat loss and fragmentation from agricultural clearing • weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> • Native Vegetation Retention controls (NVR)
Box Woodland	E2, E3	0.2	<ul style="list-style-type: none"> • habitat loss and fragmentation from agricultural clearing • weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> • NVR • intensive reserve management, minimisation of disturbance, monitoring fire regimes
Plains Grassy Woodland	E2, E3	0.2	<ul style="list-style-type: none"> • habitat loss and fragmentation from agricultural clearing • weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> • NVR • Land for Wildlife • intensive reserve management, minimisation of disturbance, monitoring fire regimes

Grassland (b)	E1, E2, E3	0	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> · NVR · Land for wildlife
Grey Clay Drainage Line Complex (b)	E1, E2, E3	0	<ul style="list-style-type: none"> · altered drainage · weed invasion · habitat loss and fragmentation from agricultural clearing 	
Plains Grassy Wetland	E1, E2, E3, R3	0	<ul style="list-style-type: none"> · altered drainage · grazing · weed invasion 	
Valley Heathy Forest	E2, E3	0	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> · NVR
Grassy Forest	E3, V1, V2	0.3	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> · NVR
Riverine Forest	E1, E2, E3	0	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through fragmentation from agricultural clearing and grazing · altered flooding regimes 	<ul style="list-style-type: none"> · NVR · intensive reserve management, minimisation of disturbance, monitoring fire regimes
Valley Grassy Forest	E3, V1, V2	1.6	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> · NVR · Land for wildlife
Damp Sands Herb-rich Woodland	E3, V1, V2	0	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> · NVR
Granitic Hills Woodland	E3, V1, V2	0	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through fragmentation from agricultural clearing 	<ul style="list-style-type: none"> · NVR

Swampy Riparian Complex	E3, V1, V2	0.8	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through catchment disturbance and recreation access 	<ul style="list-style-type: none"> · NVR
Floodplain Riparian Woodland including Wetland formation	E2, E3, V1, V2, R3	4.8	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through fragmentation from agricultural clearing and grazing · altered flooding regimes · wetland drainage for agricultural development 	<ul style="list-style-type: none"> · NVR · Land for wildlife
Riparian Scrub Complex	V1	0.8	<ul style="list-style-type: none"> · habitat loss and fragmentation from agricultural clearing · weed invasion through grazing 	<ul style="list-style-type: none"> · NVR
Rocky Outcrop Shrubland	V1, R3	0 (b)		<ul style="list-style-type: none"> · NVR
Riverine Escarpment Scrub	V1, R3	0	<ul style="list-style-type: none"> · weed invasion through catchment disturbance 	<ul style="list-style-type: none"> · NVR
Rocky Outcrop Scrub	R3	62.9	<ul style="list-style-type: none"> · denudation through recreation use 	<ul style="list-style-type: none"> · NVR
Clay Heathland	R3	0	<ul style="list-style-type: none"> · Cinnamon Fungus 	<ul style="list-style-type: none"> · NVR
Cool Temperate Rainforest	R3	73.5	<ul style="list-style-type: none"> · Myrtle Wilt disease through disturbance associated with forest activities · Permanent edge effects associated with roading along and across rainforest stands 	<ul style="list-style-type: none"> · Reservation of all stands · Excluded from timber harvesting through forest management zoning · Seminar and field training days in rainforest protection for regional staff.

a) Based on pre-1750 extent. b) The remaining extent of the EVC is entirely on private land.

Management of Threats

Threatening processes identified as likely to affect forest ecosystems in the Central Highlands region are summarised in Table 12.9, together with a brief summary of major responses to each threat. A more detailed discussion of responses is available in the Comprehensive Regional Assessment Central Highlands: Biodiversity Assessment (VicRFASC 1997e).

Table 12.9: Current management responses for threatening processes that affect forest ecosystems.

Threatening Process	Management Responses
Clearing native vegetation	<ul style="list-style-type: none"> government approval; planning permits; environmental impact assessments authorisation under the <i>Flora and Fauna Guarantee Act 1988</i> (FFG Act) for taking of protected flora Native Vegetation Retention controls
Timber harvesting	<ul style="list-style-type: none"> Code of Forest Practices for Timber Production; Forest Management Plans; regional prescriptions; Wood Utilisation Plans authorisation under the FFG Act for removal of protected flora
Planned fire	<ul style="list-style-type: none"> Code of Fire Practices; Regional Fire Management Plans; regional prescriptions; management plans Action Statements for species, communities, sites
Grazing	<ul style="list-style-type: none"> grazing licences; control of pests, including permits for native species removal
Road construction and maintenance	<ul style="list-style-type: none"> Vicroads environmental strategy; local municipality strategies for roadside conservation Code of Forest Practices for Timber Production applies in State forests
Recreation	<ul style="list-style-type: none"> planning processes including Forest Management Plans, Park Management Plans control of skiing and resort development by Alpine Resorts Commission
Environmental weed invasion	<ul style="list-style-type: none"> weed control under the <i>Catchment and Land Protection Act 1992</i> investigation by the Environment and Natural Resources Committee listed as potentially threatening processes under the FFG Act National Weeds Strategy

Rainforest, mixed forest

Cool Temperate Rainforest is the only rainforest EVC in the Central Highlands. Most stands of rainforest occur in gullies and river valleys in the region. Protection of rainforest is achieved both through reservation and by exclusion from timber harvesting under the Code of Forest Practices for Timber Production (the Code) (NRE 1996a). A recent review of the Code by CSIRO recommended revisions to improve rainforest protection; these include expansion of buffer zones and inclusion of rainforest management strategies in Forest Management Plans. The revised Code, which was ratified by the Victorian Parliament in 1997, incorporates these recommendations.

Mixed forest characteristically includes a *Eucalyptus*-dominated overstorey with rainforest species in the understorey. This vegetation type is represented in the Central Highlands by Cool Temperate Mixed Forest. Although widely-distributed, mixed forest is uncommon in the Central Highlands. The largest areas of this EVC in the region are protected in the Yarra Ranges National Park.

Refugia

Refugia are areas in which flora and fauna species are able to survive despite the impacts of major threatening processes; for example, those associated with environmental or ecological change. Threatening processes may include short- and medium-term change due to factors such as drought, fire or flooding, and long-term change due to global climate change.

An analysis of refugia in the Central Highlands, undertaken as part of the National Estate assessment, identified 11 refuge areas. These ranged from small patches of cool temperate rainforest (typically fire refugia) to larger aggregations of EVCs associated with subalpine areas and montane plateaux (providing habitat for cold-dependent species). The total refugial area for flora in the region was estimated to be 52,344 hectares.

12.5 FLORA SPECIES ASSESSMENT

Introduction

Assessment of the Central Highlands flora has involved analysing the distribution and viability of individual plant species and their populations in the region. The purpose of this assessment is to assist in determining whether:

- viable populations of all terrestrial and aquatic plant species are maintained throughout their natural range in the region;
- representative populations of each species are included in the reserve system; and
- populations and their habitats both within and outside the reserve system are subject to management appropriate for their long-term maintenance.

Priority Species Information

A total of approximately 2,000 species of vascular plants have been recorded for the Central Highlands region, including 67 species of conservation significance and 500 exotic species. However, the amount and quality of information on particular species is highly variable. Fifteen species of conservation significance are listed as Threatened in Victoria under Schedule 2 of the *Flora and Fauna Guarantee Act 1988* (FFG Act) and/or listed as nationally Endangered or Vulnerable under Schedule 1 of the Commonwealth *Endangered Species Protection Act 1992* (ESP Act) (see Table 12.10).

Both the ESP Act and the FFG Act include provisions for the preparation of Recovery Plans or Action Statements for listed taxa. Action Statements and Recovery Plans outline the actions necessary to maximise the long-term chances of species surviving in the wild. It should be noted that the implementation of management actions is dependent on available funding and identification of priorities within and between species. Table 12.10 summarises the current status of plans for priority species listed under the ESP Act and/or the FFG Act.

Table 12.10: Central Highlands plant species listed under the FFG Act and/or ESP Act

Species Name	Common Name	Conservation Status	FFG/ESP Listing	Action Statement (FFG), Recovery Plan (ESP) status
<i>Amphibromus pithogastrus</i>	Swollen Swamp Wallaby-grass	Threatened	FFG	in preparation
<i>Astelia australiana</i>	Tall Astelia	Threatened, Vulnerable	FFG, ESP	published & implemented, Research Plan
<i>Bracteata</i> sp. aff. <i>subundulata</i>	Swamp Everlasting	Threatened	FFG	in preparation
<i>Caladenia concolor</i>	Maroon Spider Orchid	Threatened	FFG	-
<i>Caladenia rosella</i>	Rosella Spider Orchid	Threatened, Endangered	FFG, ESP	in preparation, yes a)
<i>Carex tasmanica</i>	Curly Sedge	Threatened	FFG	in preparation
<i>Cyathea cunninghamii</i>	Prickly Tree-fern	Threatened	FFG	in preparation

<i>Cullen tenax</i>	Tough Psoralea	Threatened	FFG	-
<i>Eucalyptus crenulata</i>	Buxton Gum	Threatened, Endangered	FFG, ESP	published & implemented, -
<i>Grevillea barklyana</i> ssp. <i>barklyana</i>	Gully Grevillea	Threatened	FFG	in preparation
<i>Lepidium hyssopifolium</i>	Small Pepper-cress	Threatened, Endangered	FFG, ESP	in preparation, -
<i>Phebalium wilsonii</i>	Shiny Phebalium	Threatened	FFG	in preparation
<i>Senecio laticostatus</i>		Vulnerable	ESP	
<i>Senecio macrocarpus</i>	Large-fruit Groundsel	Threatened, Vulnerable	FFG, ESP	published, -
<i>Thismia rodwayi</i>	Fairy Lanterns	Threatened	FFG	-

a) Although Recovery Plans have been prepared for some ESP listed species, none have yet been formally approved by the Environment Minister.

The distribution of plants of conservation significance is often associated with particular habitats or other environmental factors. Some groupings have been identified for plants of conservation significance based on their abundance, distribution and habitats (Table 12.11).

Table 12.11: Plant groupings of conservation significance in the Central Highlands.

Plant Grouping	Species of conservation significance
Plants of sub-alpine habitats which have a localised distribution	Sub-alpine habitats are restricted to Baw Baw Plateau, Lake Mountain, Mt Bullfight and Mt Torbreck. Rare species of these habitats include: <i>Richea victoriana</i> , <i>Tasmannia vickeriana</i> , <i>Monotoca oreophila</i> , <i>Coprosma moorei</i> , <i>Coprosma perpusilla</i> var <i>perpusilla</i> , <i>Brachyscome obovata</i> , <i>Erigeron pappocromus</i> var <i>oblongata</i> , <i>Epacris glacialis</i> , <i>Epacris coriacea</i> , <i>Lycopodium scariosum</i> , <i>Juncus antarcticus</i> , <i>Mitrasacme montana</i> .
Endemic plants of moist forests which may be locally common	Endemic species of moist forests that tend to be locally common in the region include: <i>Persoonia arborea</i> , <i>Wittsteinia vacciniacea</i> , <i>Carex alsophila</i> , <i>Oxalis magellanica</i> , <i>Lastreopsis hispida</i> .
Uncommon plants which are widespread in the region	Species with narrow habitat requirements; include significant species of fern gullies, rainforests such as <i>Tmesipteris</i> species, <i>Huperzia varia</i> , <i>Cyathea cunninghamii</i> , <i>Thismia rodwayi</i> , <i>Gahnia grandis</i> ; and species of dry forest habitats such as <i>Ozothamnus rogersianus</i> , <i>Lindsaea microphylla</i> , <i>Acacia howittii</i> , <i>Eucalyptus neglecta</i> , <i>Eucalyptus alligatrix</i> , <i>Pteris comans</i>
Endemic plants of moist forests confined to few populations	Endemic species of moist forests that are confined to few populations in the region include: <i>Eucalyptus crenulata</i> , <i>Astelia australiana</i> , <i>Grevillea barklyana</i> ssp. <i>barklyana</i> , <i>Phebalium wilsonii</i>
Plants of marginal habitats in the Central Highlands	Marginal habitats in the region include: natural grasslands, grassy woodlands, riverine plains. Significant species of these habitats include: <i>Senecio macrocarpus</i> , <i>Senecio laticostatus</i> , <i>Hypsela tridens</i> , <i>Carex tasmanica</i> , <i>Cullen tenax</i> , <i>Amphibromus fluitans</i>
Plants of depleted habitats in the Central Highlands	Habitats that have been depleted, largely due to clearing in the region, include the valleys of the Yarra River, Goulburn River and La Trobe River. Significant species of these depleted habitats include: <i>Eucalyptus yarraensis</i> , <i>Eucalyptus strzelecki</i> , <i>Epilobium pallidiflorum</i> , <i>Pultenaea weindorferi</i> , <i>Burnettia cuneata</i>

Species Vulnerability Assessment

A vulnerability assessment was undertaken for all plant species of conservation significance in the Central Highlands. The purpose of the assessment was to identify plant species of conservation significance that are likely to be at higher risk of decline or extinction. Assessment of risk took into account the proportion of each species' geographic range within the Central Highlands, narrowness of habitat requirements, current estimated population sizes, and susceptibility to threatening processes or natural catastrophic events. Species which have low overall number of records in the region, few records from elsewhere in

Australia, narrow habitat requirements and most of their records from outside the reserve system were regarded as most likely to be of concern. Further details of the analysis, including a table of results for all 67 species of conservation significance in the region, may be found in the Central Highlands Biodiversity Technical Report. The vulnerability analysis indicated that many of the 67 species of conservation significance may be subject to increased risk due to particular aspects of their distribution or ecology. For example, *Amphibromus pithogastrus*, *Caladenia concolor*, *Caladenia rosella*, *Lepidium hyssopifolium*, *Lindsaea microphylla*, *Lomandra longifolia* ssp. *exilis*, *Prasophyllum lindleyanum*, *Thismia rodwayi* and *Tmesipteris elongata* ssp. *elongata* may have an increased vulnerability due to small population size. Another 48 species may have an increased risk due to low numbers of sub-populations in the region. Some species may also be at increased risk due to the size of their populations changing markedly in response to fire or other environmental factors; these include *Lepidium hyssopifolium* and *Pultenaea weindorferi*. A total of 41 of the species also show localised distribution patterns and narrow habitat ranges which are both associated with increased vulnerability.

The following species show confirmed or suspected decline of both population size and distribution in the region: *Amphibromus pithogastrus*, *Caladenia rosella*, *Carex tasmanica*, *Cyathea cunninghamii*, *Eucalyptus crenulata*, *Lepidium hyssopifolium* and *Pultenaea weindorferi*. Other species showing decline in their distribution in the region include: *Bracteantha* sp. aff. *subundulata*, *Caladenia concolor*, *Caladenia flavovirens*, *Caladenia lindleyana* and *Cullen tenax*. Additional species showing decline in population size in the region include: *Epilobium pallidiflorum*, *Gahnia grandis* and *Senecio macrocarpus*. Reproductive output is low in *Astelia australiana*, *Cyathea cunninghamii* and *Persoonia arborea*.

A summary of life history characteristics and population information used for the vulnerability assessment for the priority species listed under the FFG Act and/or the ESP Act is included below in Table 12.12.

Table 12.12: Summary of life history and population dynamics information for species occurring in the Central Highlands which are listed under the FFG Act and/or ESP Act

Priority species	distrib- ution pattern	distrib- ution trend	habitat breadth	No. of sub popula- tions	No. of individ- uals	Population trend	Population variability	Longevity (years)	Repro- ductive output
<i>Amphibromus pithogastrus</i>	localised	suspected decline	narrow	<10	<10	suspected decline	unknown	unknown	unknown
<i>Astelia australiana</i>	localised	stable	narrow	10 to 100	1000-10000	stable	low	10-50	low
<i>Bracteantha</i> sp. aff. <i>subundulata</i>	localised	suspected decline	narrow	<10	100-1000	unknown	unknown	unknown	unknown
<i>Caladenia concolor</i>	localised	suspected decline	narrow	<10	<10	unknown	unknown	unknown	unknown
<i>Caladenia rosella</i>	localised	suspected decline	narrow	<10	<100	suspected decline	unknown	unknown	unknown
<i>Carex tasmanica</i>	localised	suspected decline	narrow	<10	unknown	suspected decline	unknown	5-10	high
<i>Cullen tenax</i>	localised	suspected decline	wide	<10	unknown	unknown	unknown	5-10	high
<i>Cyathea cunninghamii</i>	localised	demonst. decline	narrow	<10	10-100	suspected decline	low	>50	low

<i>Eucalyptus crenulata</i>	localised	demonst.d ecline	narrow	<10	1000- 10000	demonst. decline	low	>50	high
<i>Grevillea barklyana</i> ssp. <i>barklyana</i>	localised	stable	narrow	10-100	100-1000	stable	low	>50	high
<i>Lepidium hyssopifolium</i>	localised	demonst. decline	narrow	<10	<10	demonst. decline	high	1-5	high
<i>Phebalium wilsonii</i>	localised	unknown	narrow	<10	100-1000	unknown	unknown	>50	high
<i>Senecio laticostatus</i>	localised	unknown	unknown	<10	unknown	unknown	unknown	unknown	high
<i>Senecio macrocarpus</i>	localised	unknown	narrow	<10	unknown	suspected decline	unknown	unknown	high
<i>Thismia rodwayi</i>	localised	unknown	unknown	<10	<10	unknown	unknown	unknown	unknown

Species listed under the FFG Act and/or ESP Act that appear to have both a higher vulnerability and the majority of their recorded individuals in the region from outside the reserve system include *Astelia australiana*, *Bracteantha* sp. aff. *subundulata*, *Amphibromus pithogastrus*, *Caladenia rosella* and *Senecio laticostatus*. These species are likely to be of greatest concern in terms of their potential vulnerability in the Central Highlands.

Species Reservation Analysis

A reservation analysis has been undertaken to assess the extent to which plant species of conservation significance in the Central Highlands are protected in the reserve system. In this analysis the reserve system only includes dedicated reserves. The assessment involved a qualitative evaluation of the tenure of the largest number and the second largest number of individuals in the region for each species of conservation significance. The assessment was based on a combination of expert opinion and site records and other information available in NRE databases and the scientific literature. Only records that have been confirmed within the last 10 years were used for the evaluation.

Many of the species of conservation significance in the Central Highlands have the majority of their recorded individuals in reserves. For example, 36 of the 67 species of conservation significance had their largest or second largest number of recorded individuals in reserves; these included 22 species with their largest number of records, and 14 species with their second largest number of individuals, from the reserve system. Thirty species had their largest number of individuals from other public land, and an additional 15 species had the majority of their individuals from private land.

Eighteen of the species of conservation significance have most (>50%) of their geographic range within the Central Highlands, and 15 of these species have their largest or second largest number of recorded individuals in the region within the reserve system. An estimated 41% (20 species) of the remaining 49 species with the majority of their geographic range outside the Central Highlands also have their largest or second largest number of recorded individuals in conservation reserves.

Table 12.13 summarises the tenure categories of recorded individuals for priority species listed under the FFG Act and/or the ESP Act. The table also includes estimates of population size and distribution for each of these species based on a combination of expert opinion, available data, and published information.

Table 12.13: Tenure categories of the largest and next largest proportion of population for Central Highlands plant species listed under the FFG Act and/or the ESP Act.

Priority Species	Total of Vic records	Total of CH records	% of Aust range in CH	Tenure of largest proportion of population	Tenure of next largest proportion of population
<i>Amphibromus pithogastrus</i>	3	1	50-75	private land	-
<i>Astelia australiana</i>	45	37	75-100	other public land	-
<i>Bracteantha</i> sp. aff. <i>subundulata</i>	11	2	25-50	other public land	-
<i>Caladenia concolor</i>	11	3	0-25	private land	-
<i>Caladenia rosella</i>	7	3	25-50	private land	conservation reserve
<i>Carex tasmanica</i>	20	11	0-25	private land	-
<i>Cyathea cunninghamii</i>	175	28	0-25	other public land	-
<i>Cullen tenax</i>	15	4	0-25	private land	-
<i>Eucalyptus crenulata</i>	34	33	75-100	conservation reserve	private land
<i>Grevillea barklyana</i> ssp. <i>barklyana</i>	37	37	75-100	other public land	conservation reserve
<i>Lepidium hyssopifolium</i>	32	6	0-25	other public land	-
<i>Phebalium wilsonii</i>	12	12	75-100	conservation reserve	-
<i>Senecio laticostatus</i>	3	3	50-75	private land	-
<i>Senecio macrocarpus</i>	34	3	0-25	other public land	-
<i>Thismia rodwayi</i>	1	1	0-25	conservation reserve	-

Six of the priority listed species have more than 50% of their Australia-wide distribution in the Central Highlands region. Two of these, *Eucalyptus crenulata* and *Phebalium wilsonii*, have the majority of their regional records from conservation reserves. Another species, *Grevillea barklyana* ssp. *barklyana*, has its second largest number of confirmed regional records from conservation reserves. The remaining three species with more than 50% of their distribution in the region (*Amphibromus pithogastrus*, *Astelia australiana* and *Senecio laticostatus*) have the majority of their individuals on private land, or on other public land. Even though *Astelia australiana* is not represented in dedicated conservation reserves, the Proposed Central Highlands Forest Management Plan includes specific management prescriptions for the species based on its FFG Action Statement. This includes sub-catchment protection for the most significant occurrences and these are included in the Special Protection Zone (SPZ).

Priority listed species with 25-50% of their national distribution in the Central Highlands region include *Caladenia rosella* and *Bracteantha* sp. aff. *subundulata*. The remaining seven priority listed species have less than 25% of their Australia-wide distribution in the Central Highlands. One of these species, *Thismia rodwayi*, has the majority of its regional records from conservation reserves (Table 12.13).

Threatening Processes - Impacts and Management

A review of current knowledge of both natural and human-induced threatening processes and their potential impacts on the flora of the Central Highlands has been undertaken. Each threatening process has been evaluated in relation to the following factors:

- the extent of its occurrence in the Central Highlands;
- any other potentially threatening processes associated with it;
- the strength of association between threatening processes;
- the significance of the threats posed;
- attributes of species that might predispose them to negative impacts from the threat (for example, due to their ecology, life history or life form);
- species likely to suffer negative impacts due to the threat;
- management, including policies and processes, to reduce impacts of the threat.

The major threatening processes associated with human-induced disturbances or with other disturbance factors, together with their potential impacts, likely significance for the Central Highlands flora, and management to reduce impacts, are discussed below and summarised in Table 12.14.

Clearing of native vegetation

Clearing of native vegetation in the Central Highlands is associated with agriculture, industry, urban development, utility or tourism developments, mining and other extractive land uses. In most parts of the region, clearing of native vegetation is not occurring at a significant rate, although it may be locally significant for some areas of private land on the outskirts of Melbourne. The overall rate of loss of native vegetation on private land due to clearing is estimated to have decreased tenfold in the region since planning restrictions were introduced in 1989.

Potentially threatening processes that result from clearing of native vegetation include loss or severe modification of habitat, and loss of or damage to native plants or animals. Historic clearing has resulted in significant impacts on some native flora and fauna in the region. The impacts of recent clearing that have resulted in habitat removal are regarded as moderate for the region, although they may be higher for some areas given the localised nature of clearing (Table 12.14).

Most native plant species are susceptible to the impacts of clearing, although some species can survive and some may even reproduce more vigorously following clearing activities. The overall impact of clearing of native vegetation in terms of loss or damage to individual plants and animals are considered low for the region (Table 12.14).

Clearing of native vegetation on public land requires Ministerial or Departmental approval, and may also require planning permission. Major developments require Environmental Effects Statements that assess any impacts on native species. Removal of protected species requires authorisation under the *Flora and Fauna Guarantee Act 1988*. Clearing of native vegetation on private land requires local planning authority approval, and Departmental approval is also required for areas greater than 10 ha.

Timber harvesting

Harvesting of native forest for timber occurs on the public land (36% of which is suitable and available for timber harvesting) in the Central Highlands region, and also takes place in some areas on private land. Clearfelling is the most common system used for timber harvesting in the region. Clearfelling involves felling of trees, snigging, loading and removal of logs, and subsequent preparation of the logged area (coupe) by burning or by mechanical disturbance to promote regeneration.

Potentially threatening processes associated with timber harvesting which result from direct impacts of activities such as felling, snigging and loading are of moderate significance in the region. Impacts include loss or damage to individual plants and animals associated with machinery use or falling trees, soil disturbance including compaction, and loss or disturbance of soil seed stores. Species that depend on soil-stored seed or on vegetative (non-seed) parts for their regeneration are at greatest risk from these impacts.

Potentially threatening processes associated with indirect impacts of timber harvesting are due to loss or modification of habitat. It has been suggested that clearfelling may be similar to naturally-occurring wildfire in at least some of its impacts on forest flora and fauna; however, the extent to which this may be so remains unresolved. Loss of forest canopy layers results in significant changes in light and temperature conditions on the forest floor.

Removal of habitat trees, logs and forest litter characteristic of mature or senescent forest has an impact on flora and fauna dependent on these. Increased erosion and sedimentation of streams as a result of soil disturbance during harvesting is another indirect effect; impacts vary from site to site, but its overall significance is low. Plant diseases may also be spread by spores carried in soil on vehicles and other equipment used in timber harvesting operations.

There are also potentially threatening processes associated with cycles of timber harvesting (eg 60-120 year cycles). In harvested areas, impacts may include elimination of mature and old-growth stages from forests which have natural replacement cycles of several centuries or more. Longer-term or cumulative impacts of harvesting cycles may also be associated with gradual changes to soil structure and composition. Threatening processes, potential impacts on flora, and significance of impacts associated with timber harvesting are summarised in Table 12.14.

The Code of Forest Practices for Timber Production (the Code) provides principles and guidelines and sets minimum standards for forest operations in State forests in Victoria. The forest management planning process, which includes prescriptions set out in the Code, the Proposed Forest Management Plan, regional prescriptions, and the annual Wood Utilisation Plans, is used to control timber harvesting, roading and burning activities in State forests. There is no harvesting of old-growth Ash forests in the Central Highlands, and very limited old-growth harvesting in other forest types. Indirect taking of protected flora during harvesting requires authorisation under the *Flora and Fauna Guarantee Act 1988*.

Planned fire and the planned absence of fire

The use (and non-use) of fire for forest management purposes in the Central Highlands includes ecological burning, fuel reduction burning and regeneration burning. Ecological burning is the use of planned fire to produce particular ecological outcomes such as reduction in particular dominant species, creation of gaps, and stimulation of growth or reproduction of target species. Ecological burning is used only rarely in the Central Highlands region and tends to be confined to very small areas. The potential impacts of ecological burning and their significance for flora of the region are summarised in Table 12.14.

Fuel reduction burning is based on the use of a planned fire to reduce or remove plant litter (fuel) from the forest floor and therefore to lower the rate of spread or intensity of a wildfire. The use of fuel reduction burning is widespread in the drier forested parts of the Central Highlands region. It is also used as a fire-prevention control measure in the vicinity of towns, power lines, plantations and fire-sensitive forest types. Potential impacts of fuel reduction burning and their regional significance are summarised below in Table 12.14.

Regeneration burning involves the burning of windrowed or heaped debris remaining after timber harvesting. The primary purpose of regeneration burning is to create conditions appropriate for natural germination of eucalypt seed using high-intensity fire. Regeneration burning is used throughout forested areas of the Central Highlands where clearfall harvesting occurs. The potential impacts due to regeneration burning and the regional significance of these are outlined in Table 12.14.

There is also evidence to suggest that the frequency of wildfire has probably increased since European settlement, mainly due to an increase in human-induced ignition factors. This change, either alone or combined with other disturbances, has the potential to cause changes combined with other disturbances, has the potential to cause changes in the floristic composition and structure of native vegetation.

Management to exclude fire is implemented for significant areas of forest in the Central Highlands, including those associated with outer urban areas. The main purpose of deliberate fire exclusion is to protect property and other assets from the effects of wildfire. Vegetation types that are adapted to fire as a recurrent ecological factor are the most prone to deleterious changes due to the absence of fire; these vegetation types include some dry forests and non-forest vegetation such as heathlands and grasslands. Table 12.14 summarises the significance of the potential impacts due to long-term exclusion of fire.

Prescriptions for management activities associated with fuel reduction and regeneration burning are included in the Department of Natural Resources and Environment Code of Fire Practices, Regional Fire Management Plans and Regional Prescriptions. Specifications for ecological burning are set out in management plans or Actions Statements for species, communities or sites that are particularly sensitive.

Grazing or browsing

Grazing or browsing of native vegetation occurs in many parts of the Central Highlands and can be the result of domestic stock, feral or naturalised exotic animals, or some native species. Grazing of native vegetation by domestic stock, particularly cattle, is largely confined to private land, although some small areas of public land are grazed under licence and road verges are used for stock movement.

Grazing and browsing by exotic animals is widespread throughout the Central Highlands. Naturalised populations of exotic animals occur in areas of the region, including pest species such as rabbits, pigs and goats, game animals such as deer, and abandoned domestic animals including horses.

Browsing of forest vegetation by native species is a natural ecological process. However, it can become a threatening process when populations of native browsers increase in size or become concentrated in isolated remnant areas to the point where they exceed the carrying capacity of the native vegetation. This situation is unlikely to arise in extensive forested areas; it tends to be confined to smaller public land blocks and to private land, particularly in the northern parts of the region.

The potential impacts of grazing and browsing of native vegetation and their significance for the region's flora are summarised in Table 12.14. The overall regional significance is moderate, but the local significance may be higher in some habitats, particularly those associated with the following EVCs: Plains Grassland; Plains Grassy Woodland; Box Woodland; Floodplain Riparian Woodland; Grassy Dry Forest; Valley Forest; and associated wetlands. These EVCs tend to be less common on public land and are often present as degraded remnants on private land.

Domestic stock grazing on public land takes place under licence. Licence conditions are subject to periodic review. Active management is undertaken to control or eradicate populations of pest animals in areas of higher impact, often adjacent to agricultural lands. Targeted pest management may also be included in Action Statements or Recovery Plans for priority native species. Permits are required to reduce populations of native browsing animals in situations where overbrowsing occurs.

Road construction and maintenance

Roads and tracks are constructed and maintained throughout the Central Highlands region, including State forest and conservation reserves. The roads on public land provide access for timber harvesting, fire management, catchment management and recreation. Road

construction and maintenance activities include clearing of vegetation, earthworks, and construction of bridges, culverts and drains.

Threatening processes associated with road construction and maintenance include direct damage or loss of individual plants by machinery and modification or loss of habitat due to movement and earthworks. Indirect effects include habitat modification or loss due to fragmentation by roads, increased erosion and stream sedimentation, altered environmental conditions of light, temperature and moisture, and introduction of pathogens and weeds.

The impacts of these threatening processes tend to be greatest in the steeper, mountainous and high rainfall parts of the region, particularly in areas associated with gullies. Species of wet gullies, including *Astelia australiana* and *Phebalium wilsonii*, and species sensitive to increased exposure, including ferns, are most susceptible. The threatening processes, together with their potential impacts and significance for the flora of the region are summarised in Table 12.14.

Vicroads (a Victorian Government agency) manages highways throughout the State. Objectives and commitments for the conservation of native flora associated with road construction, maintenance and use are included in the environmental strategy recently published by Vicroads. Roads other than highways are constructed and maintained by local municipalities or by other land managers where appropriate, including the Department of Natural Resources and Environment, organisations responsible for utilities on public land and private landholders. Road construction and maintenance in State forests and conservation reserves is planned and implemented as part of coordinated management plans. Standards and guidelines for road construction in State forests are specified in the Code of Forest Practices for Timber Production (NRE 1996a) and particular emphasis is given to the protection of riparian environments and associated vegetation.

Recreation

The Central Highlands region is used for a wide range of recreation. Vehicle-based activities including fishing, hunting, camping and tourism are widespread and represent the most significant form of recreation in the region. Skiing (down-hill and cross-country) is also an important recreational activity, but is confined to a few higher altitude areas.

Potentially threatening processes associated with recreational activities include habitat loss or degradation, introduction of environmental weeds and plant pathogens, and pollution or increased nutrient levels (eutrophication) of wetlands and streams, particularly in subalpine regions (see Table 12.14). The impacts of vehicle-based recreation can include habitat disturbance, particularly in localities used for camping and sightseeing, localised erosion and sedimentation due to heavy use of stream crossings, and transport of soil that may contain weeds and diseases. These impacts are greatest in localised areas of the river valleys of the region where they are often confined to areas near rivers and streams.

Snow sports (including down-hill and cross-country skiing and snow-play) and associated development of facilities and other infrastructure, including ski runs, cross-country trails, buildings and car parks can have impacts including clearing and fragmentation of native vegetation, pollution, particularly from sewerage systems, and introduction of environmental weeds. These impacts tend to be localised. Snow sport and associated resort development are confined to the Mt Baw Baw Alpine Resort (the only down-hill resort in the Central Highlands), Baw Baw Plateau, Mt St Gwinear, Lake Mountain and Mt Donna Buang.

Vehicle-based recreation on public land in the region is managed through planning processes set out in Forest Management Plans and Park Management Plans. These attempt to

encourage recreational activities in areas where impacts can be minimised. Skiing and ski resort development is managed by the Alpine Resorts Commission in cooperation with the Department of Natural Resources and Environment.

Environmental weed invasion

Environmental weed invasion includes the introduction and spread of exotic species, and naturalisation of populations of these species. It also includes the extension of the distribution of some native species beyond the natural limits of their range or habitat. Environmental weeds are widespread in all habitats throughout all parts of the Central Highlands region.

Potentially threatening processes associated with environmental weed invasion include competition and habitat modification. Species typical of habitats prone to weed invasion are at greatest risk; these habitats include areas along rivers or streams, areas of higher soil fertility, and fragmented habitats in close proximity to sites of weed infestation such as waste areas and agricultural lands. The potential impacts due to environmental weeds and their significance for the flora of the region are summarised in Table 12.14.

Important environmental weed species in the Central Highlands include Blackberry (*Rubus fruticosus* spp. agg.), St John's Wort (*Hypericum perforatum*), Blue Periwinkle (*Vinca major*), Quaking Grasses (*Briza* spp.), Japanese Honeysuckle (*Lonicera japonica*), Himalayan Honeysuckle (*Leycesteria formosa*), Holly (*Ilex aquifolium*), English Ivy (*Hedera helix*), English Broom (*Cytisus scoparius*), Cotoneaster (*Cotoneaster* spp.), Yorkshire Fog (*Holcus lanatus*) and Canary Grasses (*Phalaris* spp.). Native species that have extended beyond their natural range and are of concern include Sweet Pittosporum (*Pittosporum undulatum*) and Cootamundra Wattle (*Acacia baileyana*).

The National Weeds Strategy considers environmental weed invasion in an Australia-wide context. Environmental weed invasion has been listed as a potentially threatening process in Victoria under the *Flora and Fauna Guarantee Act 1988*. Environmental weeds can be listed as State Prohibited, Regionally Prohibited, or Regionally Controlled weed species under the Victorian *Catchment and Land Protection Act 1992*. Regional priorities for management of environmental weeds are identified in relevant Park or forest management plans. Management of environmental weed invasions is the responsibility of land managers and landholders for public and private lands.

Plant pathogens

The introduction and spread of plant pathogens which has occurred in the Central Highlands is often associated with other forms of disturbance. The most important plant pathogens in the region are Cinnamon Fungus (*Phytophthora cinnamomi*) which is responsible for dieback disease, and *Chalara australis* which causes Myrtle Wilt, a disease of the rainforest tree Myrtle Beech (*Nothofagus cunninghamii*).

Although Cinnamon Fungus is widespread throughout the Central Highlands, dieback disease caused by the pathogen is localised to areas with susceptible species and appropriate conditions of higher soil moisture. Threatening processes due to Cinnamon Fungus are associated with loss of individual plants and damage or loss of habitat. Dieback disease results from infection and death of parts of the root system of susceptible species. Loss of the root system eventually results in 'dieback' of the canopy and subsequent death of infected plants. The expression of the disease may vary from loss of a few susceptible individuals in a forest community to decimation of entire populations of susceptible species from an area. Management to control dieback disease includes quarantine of disease-affected areas, and

hygiene procedures to prevent spread of the disease. A National Threat Abatement Plan for *Phytophthora* is being prepared by Governments.

Myrtle Wilt results from infection by the pathogen *Chalara australis*, usually via wounds or natural root grafts, and results in death of infected Myrtle Beech trees. In many cases, the disease appears to occur naturally at low levels of infection and in equilibrium. However, disturbance of rainforest stands has been shown to elevate the incidence of the disease. The most significant threat associated with elevated incidence of Myrtle Wilt is habitat modification in the form of the creation of gaps in the rainforest canopy. In combination with fire and permanent roading, this may lead to a significant contraction and fragmentation of rainforest stands. The species at greatest risk from this process are those dependent on rainforest habitats. The potential impacts of the pathogens Cinnamon Fungus and Myrtle Wilt and their significance for the flora of the region are summarised in Table 12.14.

The Code of Forest Practices for Timber Production (NRE 1996a) requires additional buffering of rainforest stands where Myrtle Beech comprises more than 20% of the canopy, and any road construction adjacent to rainforest areas is to be avoided wherever possible. Management of Myrtle Wilt on public land also involves monitoring incidence of the disease and the nature of the regeneration in gaps created by the disease.

Other disturbances

Other disturbances that may affect flora in the Central Highlands region include pollution, genetic pollution and deliberate collection of plant species. These other disturbances are currently regarded as having only a minor effect on native flora of the region. However, the impacts of genetic pollution from genetically-modified species, or from provenances from outside the region, may be potentially significant although major impacts have not been revealed by research to date. Deliberate collecting may also have significant impacts on a small number of species, particularly native orchids.

Table 12.14: Threatening processes affecting flora, potential impacts and regional significance

Threatening Process	Potential impacts on flora	Significance of impacts
Clearing of native vegetation	total loss or severe modification of habitat	moderate, but high in some environments
	direct damage or loss of individuals	low
Timber Harvesting	direct damage or loss	moderate
	habitat modification	moderate
	soil compaction	moderate
	failure to reproduce	high
Planned Fire	damage or loss	low
	failure to reproduce due to type and timing of burning	low
	absence of suitable conditions for plant establishment	low
	competition from fire-adapted species	low

<i>Fuel reduction burning</i>	damage or loss	low, but high for fire-sensitive species
	failure to reproduce due to type and timing of burning	moderate; can be locally high
	absence of suitable conditions for plant establishment	low; can be locally high
	competition from fire-adapted species	high
<i>Regeneration burning</i>	damage or loss	low, but high for fire-sensitive species
	failure to reproduce due to type and timing of burning	low, but high for carry-over coupes
	absence of suitable conditions for plant establishment	low
	competition from fire-adapted species	low; can be locally high
<i>Exclusion of fire</i>	failure to reproduce due to type and timing of burning	high for some veg types
	absence of suitable conditions for plant establishment	high for some veg types
	competition from fire-adapted species	high for some veg types
Grazing, browsing	direct damage or loss	low
	reduced reproduction	moderate
	habitat modification, soil erosion	moderate
	weed invasion	moderate
Road construction, road maintenance	direct damage or loss	low; can be locally high
	habitat loss or fragmentation	low
	habitat modification - erosion, sedimentation	moderate
	habitat modification - altered microclimate	moderate
	introduction of weeds, disease	high
Recreation	ongoing facilitation of weed spread	moderate
	habitat loss or degradation	locally high?
	erosion, sedimentation	locally high?
	introduction and spread of weeds, diseases	locally moderate?

Table 12.14 cont.

<i>Skiing infrastructure</i>	habitat loss or degradation	locally moderate
	introduction of weeds	locally high
	introduction of disease	locally high
	pollution of wetlands (eutrophication)	locally low
Environmental weeds	competition between native and exotic species	high
	modification of native habitat	high
Pathogens	direct damage or loss	high in some veg types
	modification of native habitat	high in some veg types
	competition from disease-resistant species	moderate

Management review

An assessment of past and current monitoring activities for plant species of conservation significance in the region has indicated that three of the priority listed species, *Astelia australiana*, *Caladenia rosella* and *Eucalyptus crenulata*, are subject to regular monitoring of population change and the impact of threats. Other species, including *Phebalium wilsonii*, *Grevillea barklyana* ssp *barklyana*, *Cyathea cunninghamii* and *Pultenaea weindorferi* are subject to other monitoring by professionals or amateurs.

Current management activities that address the needs of species of conservation significance in the region include environmental weed control, exclusion of predators or browsers, and controlled burning to benefit the species. These activities tend to be focussed on situations of degraded habitat or to reduce the impacts of threats. Species of conservation significance currently subject to active management in the Central Highlands include *Astelia australiana*, *Caladenia rosella*, *Eucalyptus crenulata* and *Cyathea cunninghamii* - each of these species has an Action Statement and/or Recovery Plan completed or in preparation (see Table 12.10).

12.6 TERRESTRIAL FAUNA SPECIES ASSESSMENT**Introduction**

The purpose of this terrestrial fauna assessment is similar to that described earlier for flora. It provides information to be used in addressing the biodiversity criteria for the Central Highlands region.

The assessment of Central Highlands fauna has been handled separately for terrestrial and aquatic species (see section 7 for aquatic species assessment).

Priority Species Information

The assessment of terrestrial fauna is based largely on a subset of species found in the Central Highlands which are considered high priority because their long-term survival is threatened in some way. They may be considered to be threatened nationally, or just in Victoria. The list of species considered are those listed under the Commonwealth *Endangered Species Protection Act 1992* (ESP Act), the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act) and the Threatened Fauna of Victoria list (CNR 1995e). These species are shown in Table 12.15.

As well as showing the status (endangered, vulnerable etc) of each species under the FFG and ESP Acts, Table 12.15 also indicates whether an Action Statement and/or a Recovery Plan exists or is being prepared for that species.

Table 12.15: Terrestrial fauna species included in the assessment

TFV = Threatened Fauna of Victoria List: E = endangered, K = insufficiently known, RC = restricted colonial breeding or roosting, R = rare, V = vulnerable;

FFG = Flora and Fauna Guarantee Act 1988: L = listed, R = recommended for listing;

ESP = Commonwealth Endangered Species Protection Act 1992: E = endangered, V = vulnerable.

Species Name	Common Name	TFV	FFG Status	Action State-ment (Vic)	ESP Status	Recovery Plan (C'wlth)	Secure in Other States
Mammals							
<i>Gymnobelideus leadbeateri</i>	Leadbeater's Possum	E	L	Yes	E	In prep	N/A
<i>Dasyurus maculatus</i>	Spot-tailed Quoll	V	L	Yes			No
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	L	In prep			No
<i>Mastacomys fuscus</i>	Broad-toothed Rat	R					No
<i>Pseudomys fumeus</i>	Smoky Mouse	V					No
<i>Antechinus minimus</i>	Swamp Antechinus	R					No
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	R	L	In prep			No
<i>Sminthopsis murina</i>	Common Dunnart	R					Yes
<i>Canis familiaris dingo</i>	Dingo	K					Yes
<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	RC	L	No			Yes
<i>Myotis macropus</i>	Large-footed Myotis	R					No
<i>Miniopterus schreibersii blepotis</i>	Common Bent-wing Bat	RC	L	In prep			Yes
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	RC					Yes
Birds							
<i>Lathamus discolor</i>	Swift Parrot	E	L	In prep	V	Yes*	No
<i>Lichenostomus melanops cassidix</i>	Helmeted Honeyeater	E	L	Yes	E	Yes*	No
<i>Grantiella picta</i>	Painted Honeyeater	R	L	No			No
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E	L	Yes	E	Yes*	No
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	E	L	Yes			No
<i>Burhinus grallarius</i>	Bush Stone-curlew	V	L	In prep			No
<i>Lophoictinia isura</i>	Square-tailed Kite	V					No
<i>Accipiter novaehollandiae</i>	Grey Goshawk	R					No
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	R	L	Yes			No
<i>Ninox connivens</i>	Barking Owl	R	R				No
<i>Ninox strenua</i>	Powerful Owl	R	L	In prep			No
<i>Tyto novaehollandiae</i>	Masked Owl	R	L	In prep			No
<i>Tyto tenebricosa</i>	Sooty Owl	R	L	In prep			No
Reptiles							
<i>Pseudemoia cryodroma</i>	Alpine Bog Skink	V	R				No
<i>Egernia coventryi</i>	Swamp Skink	R					No
<i>Pseudemoia rawlinsoni</i>	Glossy Grass Skink	K					No
Frogs							
<i>Litoria spenceri</i>	Spotted Tree Frog	E	L	Yes	E	In prep	No
<i>Philoria frosti</i>	Baw Baw Frog	E	L	Yes	V	Yes a)	No
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	L	Yes			No
<i>Litoria verreauxii alpina</i>	Alpine Tree Frog	K					No

a) Although Recovery Plans have been prepared for some ESP listed species, none have yet been formally approved by the Environment Minister.

More information on each of the species listed in Table 12.15 is provided in the Biodiversity Technical Report and in the sections which follow. Leadbeater's Possum, Baw Baw Frog and Spotted Tree Frog are listed as nationally endangered or vulnerable (ESP Act) and are frequently referred to later, particularly in the discussion of threatening processes. Some background on these species is provided here.

Leadbeater's Possum

Leadbeater's Possum is a small possum found only in the Central Highlands of Victoria. Previously thought to be extinct, it was rediscovered in 1961 and is considered nationally endangered. It is currently found mainly in mountain forests dominated by Mountain Ash, Alpine Ash and Shining Gum and has recently been recorded in Snow Gum woodland at Lake Mountain. A small population also exists in Yellingbo State Nature Reserve, in lowland swamp forest.

Wildfires in 1939 burnt approximately 84% of the Central Highlands ash-eucalypt forests. A wattle understorey provides important feeding habit for Leadbeater's Possum and the fire-killed remnants of mature forest and resultant regrowth from the 1939 fires has provided abundant feeding and nesting habitat for the species during the past 30 years. However, as the fire-killed nest trees decay and fall, the extent of this type of habitat is diminishing.

Even if timber harvesting were excluded from the regrowth ash forests, they will not be capable of providing suitable nest sites for a further 150 years - assuming that Ash trees must be about 200 years old before they can provide suitable nest sites. It therefore follows that the existing older-aged forest must continue to provide habitat for at least another 150 years.

Baw Baw Frog

Until recently the Baw Baw Frog was believed to be confined to the Baw Baw Plateau, within an area of 80 km², which is primarily within the Baw Baw National Park. The species has recently been recorded at lower elevations (1100-1300 m) in forest areas currently available for timber harvesting. A decline in Baw Baw Frog numbers on the Plateau has meant that conservation of these lower-elevation populations is important to the survival of the species. Adults of this species are known to use habitat adjacent to and some distance from breeding sites. Very little is known of movements of juveniles and sub-adults.

Spotted Tree Frog

The Spotted Tree Frog is known to occur in only thirteen discrete populations - eleven in Victoria and two in New South Wales. These are mainly on the north-west side of the Great Dividing Range between the Central Highlands in Victoria and Mt Kosciuszko in New South Wales. Survey results suggest the species has suffered a significant decline during the past 20 years. Tadpole development occurs in upland streams, with adjacent stream-side vegetation being used by adults for sheltering and basking.

Other important species

There are several other vertebrate fauna species which, while not formally listed as threatened, are considered by some researchers to require monitoring. These include:

Yellow-bellied Glider (*Petaurus australis*),
Greater Glider (*Petauroides volans*)
Mountain Brushtail Possum (*Trichosurus caninus*)
Dusky Antechinus (*Antechinus swainsonii*)
Peregrine Falcon (*Falco peregrinus*)

Gang Gang Cockatoo (*Callocephalon fimbriatum*)
 Yellow-tailed Black Cockatoo (*Calyptrorhynchus funereus*)
 Wonga Pigeon (*Leucosarcia melanolcuca*)
 Azure Kingfisher (*Alcedo azurea*)
 Tree Goanna (*Varanus varius*)

Terrestrial invertebrates

Although terrestrial invertebrates make up the majority of species in the region, the intensity of survey for this group is low. A number of insect species have been recorded as occurring in the Central Highlands and nowhere else. However, in some cases this could be a result of low sampling effort.

Among notable non-insect invertebrates are at least two species of Onychophora (velvet-worms). *Ooperipatus centunculus* is known only from the Mt Donna Buang-Warburton area and *O. pulchellus* appears to be restricted to Mt Baw Baw. A number of earthworm species are also recorded from the region. Some of these have not been seen since they were originally described last century. At least four species of land-snail are known to have distributions largely restricted to the Central Highlands region - the conservation status of these species is uncertain.

Experience elsewhere suggests that many invertebrate species are likely to have localised distributions and/or be vulnerable to a range of disturbances including those which are likely to affect the maintenance of microclimates on which many depend (such as rotting logs and ground litter).

Species Vulnerability Assessment

A vulnerability assessment was undertaken for all terrestrial fauna species of conservation significance in the Central Highlands. As for a similar assessment described earlier for plants, the purpose was 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 which 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 (eg 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 Central Highlands (see Table 12.16). This information provides a basis for identifying and prioritising those species which 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 12.16: Summary of life history and population dynamics information

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								
Leadbeater’s Possum	*stable/declined	medium	medium	narrow	low	high	low	short
Spot-tailed Quoll	unknown	medium	low	wide	low	high	high	unknown
Squirrel Glider	*declined	small	low	narrow	unknown	high	low	long
Broad-toothed Rat	unknown	medium	low	narrow	*low	low	low	*long
Smoky Mouse	unknown	medium	low	narrow	high	*low	high	short
Swamp Antechinus	unknown	small	low	narrow	high	low	high	short
Brush-tailed Phascogale	declined	medium	low	narrow	high	high	high	short
Common Dunnart	unknown	small	low	narrow	high	low	high	short
Dingo	unknown	unknown	*low	wide	low	high	low	long
Eastern Horseshoe Bat	declined	small	low	narrow	low	low	low	long
Large-footed Myotis	unknown	medium	low	narrow	low	unknown	low	long
Common Bent-wing Bat	declined	medium	medium	narrow	low	high	low	long
Grey-headed Flying-fox	increased	small	low	narrow	high	high	low	long
Birds								
Swift Parrot	declined	small	low	narrow	high	high	high	*long
Helmeted Honeyeater	increased	small	low	narrow	low	low	high	long
Painted Honeyeater	unknown	small	low	narrow	high	high	high	unknown
Regent Honeyeater	declined	*large	low	wide	high	high	low	unknown
Grey-crowned Babbler	declined	small	low	narrow	low	low	high	long
Bush Stone-curlew	declined	small	low	narrow	low	unknown	low	long
Square-tailed Kite	unknown	large	low	wide	unknown	high	low	long
Grey Goshawk	unknown	medium	low	wide	unknown	high	low	unknown
White-bellied Sea-Eagle	unknown	*large	low	wide	low	high	low	long
Barking Owl	unknown	medium	low	narrow	low	*high	low	*long
Powerful Owl	stable	large	low	wide	low	high	low	long
Masked Owl	unknown	small	low	unknown	unknown	high	low	long
Sooty Owl	unknown	large	low	narrow	low	high	low	long

Reptiles								
Alpine Bog Skink	*declined	small	low	narrow	low	low	low	unknown
Swamp Skink	*stable	small	low	narrow	low	low	low	*long
Glossy Grass Skink	*stable	small	low	narrow	low	low	low	unknown
Frogs								
Giant Burrowing Frog	unknown	unknown	low	*wide	unknown	high	high	unknown
Spotted Tree Frog	declined	small	low	narrow	high	low	low	long
Alpine Tree Frog	declined	small	low	narrow	unknown	low	low	unknown
Baw Baw Frog	declined	small	low	narrow	high	unknown	low	long

* Unknown, but most likely classification.

Most of the species assessed had small geographic ranges in the Central Highlands. Exceptions to this included the Powerful and Sooty Owls, with the Central Highlands being a stronghold of the Sooty Owl.

As expected for a group of species selected because there is some concern for their status, most species had low abundance. Only the Common Bent-winged Bat and Leadbeater's Possum were classified as having medium abundance. Although Leadbeater's Possum is mainly confined to the montane ash forests of the Central Highlands where its distribution is patchy, it can be locally common in areas of suitable habitat.

Most of the species were rated as habitat specific with the exception of the Spot-tailed Quoll, Dingo, Regent Honeyeater, Square-tailed Kite, Grey Goshawk, White-bellied Sea-Eagle and Powerful Owl. Most of these species are highly mobile and/or occupy large home ranges.

Sixteen of the 33 species listed in Table 12.16 have a combination of small geographic range size, low abundance and narrow habitat specificity. Based on these rarity ratings, these species should be given particular consideration in developing priorities for management action. It should however be noted that the Squirrel Glider, Grey-headed Flying Fox, Swift Parrot, Painted Honeyeater and Bush Stone-curlew are on the edge of a more extensive distribution outside the Central Highlands region.

The chances of discrete populations of a species collapsing are reduced if the size of populations are not highly variable and if the species has a good ability to disperse (see spatial dynamics ratings). Central Highlands species in this group include Leadbeater's Possum, Spot-tailed Quoll and most of the large forest owls. At the other extreme are species whose spatial dynamics characteristics make them more vulnerable to extinction - these include Smoky Mouse, Swamp Antechinus and Common Dunnart (both marsupial mice), and Spotted Tree Frog.

The Swift Parrot, Helmeted Honeyeater and Grey-crowned Babbler have a high reproductive output and longevity, making them less predisposed to decline or extinction. In contrast, Leadbeater's Possum is the only species known to have a low reproductive output and longevity.

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. Exceptions to this are the Grey-headed Flying-fox which has benefited from an increase in cultivated fruit trees in the Central Highlands, and the Helmeted Honeyeater which has been aided by an intensive recovery program for the species. Although the Powerful Owl, Swamp Skink and Glossy Grass Skink populations 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 12.16 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 Central Highlands 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 land tenure category - see Table 12.17. Categories used were Reserve, Non-Reserve and Partially Reserved areas (see table footnote for explanation). Table 12.17 also indicates whether the majority (>50%) of the species' known range is within the Central Highlands.

The results will tend to underestimate the level of protection provided to species by the reserve system because the reserve system has had fewer formal surveys than State Forest areas. 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 12.17: Proportions of species records in reserves, non-reserve areas and partially reserved areas

Group/Species	No. d), e)	Res a)	% Res	Non-Res c)	% Non-Res	Part Res b)	% Part Res	Most Range in CH
Mammals								
Leadbeater's Possum	277	153	55	113	41	11	4	Yes
Spot-tailed Quoll	8	3	38	4	50	1	13	No
Squirrel Glider	1	0	0	1	100	0	0	No
Broad-toothed Rat	47	31	66	15	32	1	2	Yes
Smoky Mouse	26	14	54	9	35	3	12	No
Swamp Antechinus	3	3	100	0	0	0	0	No
Brush-tailed Phascogale	80	14	18	66	83	0	0	No
Common Dunnart	23	1	4	22	96	0	0	No
Dingo	2	1	50	1	50	0	0	No
Eastern Horseshoe-bat	13	6	46	7	54	0	0	No
Large-footed Myotis	20	13	65	7	35	0	0	No
Common Bent-wing Bat	48	21	44	27	56	0	0	No
Grey-headed Flying-fox	0	0		0		0		No
Birds								
Swift Parrot	33	0	0	33	100	0	0	No
Helmeted Honeyeater	16	5	31	11	69	0	0	Yes
Painted Honeyeater	3	1	33	2	67	0	0	No
Regent Honeyeater	29	2	7	27	93	0	0	No
Grey-crowned Babbler	0	0		0		0		No
Bush Stone-curlew	1	0	0	1	100	0	0	No
Square-tailed Kite	6	1	17	5	83	0	0	No
Grey Goshawk	12	1	8	11	92	0	0	No
White-bellied Sea-eagle	10	1	10	9	90	0	0	No
Barking Owl	43	7	16	36	84	0	0	No
Powerful Owl	159	74	47	83	52	2	1	No
Masked Owl	12	3	25	9	75	0	0	No
Sooty Owl	164	124	76	29	18	11	7	No

Footnotes over page.

Table 12.17: cont.

Reptiles								
Alpine Bog Skink	3	2	67	1	33	0	0	Yes
Swamp Skink	10	5	50	5	50	0	0	No
Glossy Grass Skink	18	2	11	16	89	0	0	Yes
Amphibians								
Spotted Tree Frog	17	16	94	1	6	0	0	Yes
Baw Baw Frog	108	86	80	20	19	2	2	Yes
Giant Burrowing Frog	0	0		0		0		No
Alpine Tree Frog	14	10	71	3	21	1	7	No

a) Reserves include National Parks and Special Protection Zone categories a, b and c as defined in Section 12.4 of this Chapter.

b) Partially Reserved areas include Special Management Zones and Code of Forest Practice exclusion areas. c) Most records from within the Non-Reserve category are from private land. d) Only records post 1970 and with an accuracy of one minute or better were used in this analysis. e) Records of individuals over water bodies (mostly birds and bats) have been omitted.

Threatening Processes - Impacts and Management

This section reviews the current knowledge of both natural and human-induced threatening processes and their impacts on the terrestrial fauna of the Central Highlands. Threatening processes can impact both directly on species and indirectly on essential components of their habitat.

For each of the threatening process identified, a score has been assigned for each priority species being considered, indicating whether the threat on the species is unknown, insignificant, minor, moderate or major (see Table 12.18). The ratings apply to the Central Highlands only and are made assuming no specific management actions are in place. Threatening processes which potentially affect more than one component of a species life cycle or habitat scored a higher rating than another threat which affects fewer life cycle or habitat components.

A range of mechanisms has been implemented to ensure that threatening processes which affect individual species in the Central Highlands are addressed. These include:

- an extensive conservation reserve system covering the range of habitats on public land;
- specific protection afforded by threatened species strategies in the Proposed Central Highlands Forest Management Plan (NRE 1996b);
- requirements under the *Flora and Fauna Guarantee Act 1988* and the *Endangered Species Protection Act 1992*; and
- a range of provisions in the Code of Forest Practices for Timber Production (NRE 1996a) and the Code of Fire Practices (CNR 1995d) which address many of the threatening processes operating in the region.

Other potentially threatening processes on private land in the region are addressed under the provisions of the *Planning and Environment Act 1987* and the *Catchment and Land Protection Act 1994*.

Threatening processes, 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 Central Highlands.

The combined score for each threatening process can provide an indication of the relative importance of different threatening processes affecting fauna in the Central Highlands. Overall, unplanned fire was the highest scoring threat, followed by timber harvesting and introduced species. Timber harvesting was identified as a major threat to the greatest number of species. Overall, non-forestry clearing affected the greatest number of species, followed by timber harvesting and unplanned fire.

In this context considerable resources are committed to the prevention and suppression of unplanned fires and that a key element of forest management in the region is the development and implementation of threatened species strategies and detailed provisions to mitigate the effects of threatening processes operating in forests. As noted earlier the ratings in the table above, and in the discussion below do not take account of these arrangements.

An explanation of each threatening process follows, with a discussion of the key species affected in the Central Highlands and management arrangements that are in place to mitigate these threats.

Fire (planned)

This category includes the effects of fire prevention activities such as fuel reduction burning within forested areas and ploughing, slashing and burning along roadsides, as well as regeneration burning following timber harvesting. Fuel reduction burns are largely carried out in foothill mixed species forests in the Central Highlands, not in wet forests and alpine areas.

The effects of fire on fauna vary depending on the fire regime, including the frequency, intensity and season of burns. Inappropriate burning regimes, such as too frequent or too infrequent burning, can alter vegetation characteristics and may affect the habitat suitability for some species of fauna. Within the Central Highlands, planned fire is recognised as a moderate threat to Leadbeater's Possum, Squirrel Glider, Smoky Mouse, Alpine Bog Skink, Giant Burrowing Frog and Spotted Tree Frog.

The Smoky Mouse appears to rely on understorey vegetation components strongly influenced by the frequency and intensity of fire. Although the Alpine Bog Skink occurs in subalpine to alpine heathlands, areas which are not subjected to fuel reduction burning, a number of records of the species are close to areas where such burning may be undertaken.

Table 12.18: Impacts of threatening processes on priority fauna species.

This table must be read in conjunction with the following text. The ratings provided in this table assume that no specific management arrangements are in place to address threatening processes. The ratings shown are relevant to the Central Highlands region only.

SPECIES	THREATENING PROCESS															
	Fire (planned)	Fire (unplanned)	Timber Harvesting	Predation/competition by introduced species	Pest Control	Grazing	Disease	Harvesting of fauna by humans	Clearing for agric. & development	Mining/Quarrying	Roading	Recreation	Vandalism/Disturbance by Humans	Interspecific Competition	Climate Change	Firewood Collection
MAMMALS																
Leadbeater's Possum	2	3	3	1	0	0	0	0	0	0	1	0	0		2	
Spot-tailed Quoll	1	2	3	2	2	-	0	0	1	-	1	0	0			
Squirrel Glider	2	1	0	2	0	2	-	0	2	0	2	0	0			
Broad-toothed Rat	1	1	1	3	2	2	0	0	1	0	0	0	0			
Smoky Mouse	2	2	1	1	0	0	-	0	1	-	1	1	0			
Swamp Antechinus	1	3	0	2	0	1	-	0	0	0	0	2	0			
Brush-tailed Phascogale	1	2	1	3	1	1	1	0	3	1	1	0	0			
Common Dunnart	1	2	0	1	1	2	-	0	2	0	1	1	0			
Dingo	1	1	1	2	2	1	-	0	0	0	0	0	0			
Eastern Horseshoe Bat	-	-	-	2	2	0	0	0	0	2	0	0	3			3
Large-footed Myotis	1	1	2	1	2	0	-	0	1	2	2	1	1			
Common Bent-wing Bat	-	-	-	2	2	0	0	0	1	2	0	0	3			3
Grey-headed Flying-fox	0	0	0	0	1	0	-	0	1	0	0	0	0			
BIRDS																
Swift Parrot	-	-	1	-	-	-	-	0	1	-	-	0	-		1	1
Helmeted Honeyeater	0	3	1	1	0	1	2	0	1	0	0	1	1	3	2	2
Painted Honeyeater	-	-	1	-	-	1	-	-	1	-	-	-	-	1		1
Regent Honeyeater	-	1	1	-	-	1	-	0	2	-	1	-	-	2	2	1
Grey-crowned Babbler	1	1	1	1	-	1	-	-	1	-	1	-	1		1	1
Bush Stone-curlew	-	-	1	1	1	1	-	1	1	-	-	-	1		1	
Square-tailed Kite	1	2	1	0	0	1	-	1	1	-	1	0	1			
Grey Goshawk	1	1	2	0	2	-	-	-	1	-	1	1	1			
White-bellied Sea-Eagle	-	-	1	0	1	-	-	0	1	-	-	1	2	-		
Barking Owl	-	-	-	0	1	2	-	0	2	-	-	-	-			
Powerful Owl	1	2	3	1	0	1	1	0	3	1	-	0	1			
Masked Owl	1	1	2	3	2	1	-	0	3	1	-	0	1			
Sooty Owl	1	2	3	0	1	0	-	0	1	1	1	0	1		2	
REPTILES																
Alpine Bog Skink	2	3	0	1	0	3	-	0	2	0	3	3	0		3	
Swamp Skink	1	1	1	1	0	1	-	0	1	-	1	0	0		2	
Glossy Grass Skink	1	1	1	1	0	2	-	0	2	-	1	0	0		2	1
FROGS																
Giant Burrowing Frog	2	2	2	1	1	0	0	0	-	-	1	1	0			
Spotted Tree Frog	2	2	3	3	2	1	-	0	0	2	3	2	1		3	3
Alpine Tree Frog	-	-	-	-	0	2	0	0	2	0	-	2	0		3	1
Baw Baw Frog	0	3	3	1	0	2	1	0	2	0	1	2	0		3	
TOTAL SCORE	27	43	40	37	26	30	5	2	41	12	24	18	18			
NO. OF SPECIES AFFECTED																
Major threat	0	5	6	4	0	1	0	0	3	0	2	1	2			
Moderate threat	6	9	4	6	9	7	1	0	8	4	2	4	1			
Minor threat	15	10	14	13	8	13	3	2	16	4	14	7	10			
Not a threat	3	1	5	6	12	8	7	28	5	11	7	16	16			
Unknown threat	9	7	4	4	4	4	22	3	1	14	8	5	4			
Total no. affected	21	24	24	23	17	21	4	2	27	8	18	12	13			

High intensity burning of the debris left following timber harvesting is a management practice used to remove fuel, reduce fire hazards, and is the preferred technique for seedbed preparation in the Central Highlands Ash forests. Of the trees retained on coupes as wildlife habitat, dead trees (stags) generally collapse following regeneration burns, and live trees are often killed (and may also collapse before the next rotation). This process is identified as a moderate threat to Leadbeater's Possum and a minor threat to the Sooty Owl. Current Leadbeater's Possum management strategies address the loss of retained hollow-bearing trees during regeneration burns. The survival of retained trees and their subsequent use by wildlife requires monitoring to assess how effective management techniques are at providing wildlife habitat, and over what time period.

As discussed earlier in this report, fire management in the Central Highlands is guided by the Code of Practice for Fire Management on Public Land (CNR 1995d), which outlines general principles and guidelines for fuel reduction burning, and Regional Fire Protection Plans. Each fire protection plan includes a fuel management strategy, based on a zoning system. This may exclude prescribed burning from areas containing significant biological, cultural or economic values. Before fuel reduction burning is undertaken on public land, each burn must be the subject of an approved burn plan. This plan details ecological issues including the known or likely presence of rare or threatened fauna in or near the area to be burned, and particular habitats needing protection. Such plans must take into account prescriptions developed for the protection of threatened species. The Proposed Central Highlands Forest Management Plan (NRE 1996b) provides for a review of fuel reduction burn operations in areas containing fire sensitive biological values when the Regional Fire Protection Plans are revised.

Fire (unplanned)

Wildfire is an integral part of the ecology of forests and can have a significant effect on vegetation and the distribution and abundance of fauna. The steepness and heavily forested nature of some of the Central Highlands makes it highly vulnerable to wildfire, as shown by the fires of 1939 which burnt large areas of Mountain Ash forest within the region. Fire can cause direct mortalities of animals, and may eliminate critical habitat components and entire populations. Mortalities may also result from food shortages and predation following fire. Species occurring in small populations, populations that are isolated from others, or species with narrow habitat requirements, are particularly vulnerable to wildfire.

In the Central Highlands, severe wildfire is considered a major threat to Leadbeater's Possum, Swamp Antechinus, Helmeted Honeyeater, Alpine Bog Skink and the Baw Baw Frog (see Table 12.18). The 1983 Ash Wednesday wildfires are thought to have caused extinction of local populations of the Helmeted Honeyeater. The Swamp Antechinus is only known to occur in one State park within the Central Highlands; a wildfire in this park could result in elimination of the species from the region. Although wildfire is unlikely on the Baw Baw Plateau, the current low numbers of the Baw Baw Frog means that wildfire is a major threat to the species, particularly at those times of year when frogs are sheltering amongst vegetation and litter.

The DNRE has the responsibility for prevention and suppression of fire in State Forest, National Park, and all protected public land. The Code of Practice for Fire Management on Public Land (CNR 1995d) and regional fire protection plans include detailed strategies for fire prevention, preparedness, fire suppression and recovery after wildfire. These strategies give consideration to natural values (including fauna values) and principles of environmental care.

Timber harvesting

Timber harvesting is a threat to a range of fauna species through its short-term effect of habitat removal, and more importantly, by its medium and longer-term effect of producing even-aged regrowth forests that are less suitable for some species than older forest. Ecologically mature or old-growth forests are generally more structurally diverse than regrowth forests and are able to support higher populations and diversity of bird species. Many species, including arboreal mammals and forest birds, require trees with hollows for roosting or nesting. The 1939 fires significantly reduced the availability of hollow bearing trees and old growth forests in the Central Highlands. Timber harvesting in Ash forests is therefore confined to regrowth stands to ensure protection of remaining mature and old-growth forest. In mixed species forests no harvesting of old-growth is permitted in the Central Highlands. It is important to note that only 36% of the public native forest in the region is available for timber harvesting.

In the Central Highlands, timber harvesting is considered a major threat to Leadbeater's Possum, Spot-tailed Quoll, Powerful Owl, Sooty Owl, Spotted Tree Frog and Baw Baw Frog. It is also at least a moderate or minor threat to most of the other species considered in this assessment.

The Code of Forest Practices for Timber Production aims to ensure that environmental values are protected by careful operational planning, reservation of appropriate areas and vegetation corridors. Vegetation must be retained within at least 20 m of a permanent stream and at least 10 m either side of temporary streams and drainage lines. Trees must not be felled within such areas and timber extraction roading is planned to minimise impacts on catchment values. Such prescriptions will benefit species associated with stream habitats including Large-footed Myotis and Broad-toothed Rat. The Code and the Proposed Central Highlands Forest Management Plan provide for retention of wildlife habitat. Prescriptions are proposed to link major reserves via wildlife corridors, to retain habitat trees, to retain and protect biologically significant habitats, to control coupe characteristics such as size and shape and to modify harvesting in particular circumstances.

The Leadbeater's Possum Action Statement and Draft Recovery Plan provide guidelines and actions required for the conservation of this species, particularly in relation to timber harvesting. These are reflected in the specific measures proposed in the Central Highlands Proposed Forest Management Plan. These prescriptions are based on a zoning system determined by the density of trees with hollows, whether the trees are alive or dead, and the density of wattles in the understorey. Areas of critical habitat (Zone 1A), including virtually all of the older-aged forest in the Central Highlands, are protected against timber harvesting in either the Yarra Ranges National Park or in Special Protection Zones in State forest. Timber harvesting is to be excluded from Zone 1B habitat in State forest, largely comprising 1939 regrowth areas, while it contains specified tree hollow and wattle density levels. The areas occupied by the species have been divided into 21 Leadbeater's Possum Management Units, with a target of maintaining viable populations in each of these units by retaining patches of suitable habitat.

The management prescriptions for Powerful, Sooty and Masked Owls outlined in the Proposed Central Highlands Forest Management Plan aim to protect suitable habitat for at least 60% of the species' estimated populations occurring across the region. Both conservation reserves and State forest contribute to the conservation of owl habitat.

Timber harvesting may affect species which rely on streams such as for breeding or feeding. This can occur through siltation, changes to stream flow patterns and increased water temperature. Timber harvesting is considered a major threat to the Spotted Tree Frog, given that it may affect the viability of eggs and the survival of tadpoles as a result of disturbance. In addition to the provisions of the Code, the Proposed Central Highlands Forest Management Plan provides for a 300 m Special Protection Zone either side of streams with confirmed or potential Spotted Tree Frog localities.

Timber harvesting activities have the potential to affect some populations of the Baw Baw Frog. Until recently the Baw Baw Frog was believed to be primarily within the Baw Baw National Park. The species has recently been recorded at lower elevations (1100-1300 m) in State Forest. Until the results of recent survey work in State forest on the Baw Baw escarpment become available, the Proposed Central Highlands Forest Management Plan excludes timber harvesting from areas containing potential habitat for the Baw Baw Frog in Montane Wet Forest above an altitude of 1100 m.

Loss and fragmentation of habitat as a result of timber harvesting, particularly clearfell logging, is potentially a major threat to the Spot-tailed Quoll. The Proposed Central Highlands Forest Management Plan provides management prescriptions specifically for this and other species, as well as guidelines to be applied more generally for the broader protection of fauna and other biodiversity values.

Predation and competition by introduced species

This category covers predation by introduced species (eg. feral Cat, Fox, Trout) as well as competition by introduced species for resources such as food or shelter. It does not include predation or competition by native species.

Foxes and Cats are widespread throughout Victoria, occurring in most habitat types. Predation by introduced animals is recognised as a major threat to two species. Broad-toothed Rats occur in highly localised, disjunct populations in the Central Highlands and are therefore particularly susceptible to population declines from predation. Predation of the eggs and tadpoles of Spotted Tree Frogs by Trout represents a major threat to this species in the region. Predation by introduced species is considered a moderate threat to five species and a minor threat to 11 species in the Central Highlands.

There is some degree of dietary overlap between Cats, Foxes, feral Dogs and Spot-tailed Quolls, although the effect of these introduced predators on Spot-tailed Quoll populations is unknown. When prey is scarce, there may be increased competition between Dingoes and Foxes. Foxes may also compete with Masked Owls for rabbit prey. The feral European Honey Bee is known to occupy hollow trees, and may compete for this resource with several native species which use hollows, including the Brush-tailed Phascogale.

Current predator control programs within the Central Highlands are mainly limited to trapping, shooting and baiting for wild Dogs. Pest animal control programs within the region include programs coordinated with adjacent landowners (Good Neighbour Program) and, where feasible, targeted programs throughout the Central Highlands.

Pest control

This category includes mortality of native species from feeding on poison baits (non-target poisoning) and secondary poisoning as a result of ingestion of poisoned prey. It also includes the potential impact of loss of significant food sources following control programs for introduced species such as Rabbits. Spraying of herbicides for weed control, pesticides for insect control, and food chain contamination by heavy metals are also included within this category. Pest control is recognised as a moderate threat to nine species and a minor threat to eight species in the Central Highlands.

Trapping, shooting and baiting of wild Dogs and Foxes in the Central Highlands represents a moderate threat to Dingoes and Spot-tailed Quolls. The effect on the Central Highlands Dingo population is unknown but studies from other areas indicate potentially significant impacts. Although there are very few records of the Spot-tailed Quoll in the Central Highlands, non-target poisoning could potentially result in the death of individuals or local populations. Burying baits has been used as a remedial measure to reduce the incidence of non-target poisoning of such species, although further monitoring and research is needed. Within State forest in the Central Highlands region it is proposed that no threatening poisons are to be used within 1 km of Spot-tailed Quoll records less than five years old.

The secondary impacts of pest control is also considered. For example, there is potential for Spot-tailed Quolls to ingest poisoned Rabbits and Rabbit control programs could impact on the availability of prey for Masked Owls, although the proportion of Rabbit prey in the diet of this species is unknown. Some birds of prey and insectivorous bats may be susceptible to poisoning through accumulation of pesticides. Pesticides and herbicides may drain into streams, impacting on species such as the Spotted Tree Frog.

Management guidelines in the Proposed Central Highlands Forest Management Plan specify that pest control programs should take into account the potential impact on the conservation of rare or endangered fauna, and programs should be monitored to ascertain effects on non-target species.

Grazing

Grazing can alter the structure and floristics of vegetation, affecting its value as habitat for fauna. This occurs through its impact on plant regeneration, caused partly by trampling of vegetation, soil compaction and the spread of weeds. Grazing is considered a major threat to the Alpine Bog Skink and a moderate or minor threat to 20 other species considered in this assessment.

The Alpine Bog Skink has a limited, disjunct distribution and its habitat is particularly susceptible to reduction and modification caused by erosion arising from grazing and trampling. The Broad-toothed Rat exhibits a disjunct and localised distribution and loss of its habitat as a result of grazing and trampling is considered a moderate threat; however the species security has probably increased in recent years through protection of riparian forest sites and exclusion of cattle from alpine sites. Trampling of breeding sites has the potential to cause declines of the Alpine Tree Frog, however, the impact is unknown. Similarly, impacts on the Baw Baw Frog and its habitat are largely unknown.

Grazing of stock on Crown land is prohibited in alpine areas in the region, although a small and increasing number of feral cattle are present on the Baw Baw Plateau, as are Sambar Deer. Elsewhere, small areas in State forest and Bunyip State Park are held under grazing licences - there is provision for depasturing of stock and phasing out of grazing in the Park. Control of feral cattle from the Baw Baw National Park is being addressed as part of the management plan priorities for the Park.

Disease

The significance of disease is largely unknown for most species. The extreme vulnerability of the Helmeted Honeyeater makes it susceptible to any such events. Similarly, the extremely restricted distribution of the Baw Baw Frog makes it potentially vulnerable to the impacts of disease.

Harvesting of fauna by humans

This category covers direct interference to animals by humans in the form of collection or deliberate hunting, poisoning, or trapping. Overall, it is considered as a minor threat to the Bush Stone-curlew and Square-tailed Kite in the Central Highlands.

Clearing for agriculture or development

Extensive clearing of native vegetation for agriculture and settlement has been a significant factor in the decline of many species. Clearing affects species directly through loss of habitat and indirectly through fragmentation and isolation of habitat. As a result, local populations are more vulnerable to extinction from catastrophic events such as wildfire and more susceptible to threatening processes such as predation. Such clearing is now confined to relatively small areas on private land and may include clearing for plantations. If suitable habitat for particular species is largely restricted to private land, then loss of habitat may be considered significant.

Clearing is classified as a major threat to Brush-tailed Phascogale, Powerful Owl and Masked Owl. It is a moderate threat to the Alpine Bog Skink and Baw Baw Frog, species whose habitats may coincide with alpine resort developments. The Squirrel Glider, Common Dunnart, Regent Honeyeater, Barking Owl, Glossy Grass Skink and Alpine Tree Frog are other species for which non-forestry clearing is a moderate threat.

This threat is significantly mitigated by the implementation of native vegetation retention controls under the *Planning and Environment Act 1987*. Permits are required from local municipalities to clear native vegetation.

Mining/quarrying

Although mining is considered a threatening process, past mining activities would have had greater impact on species than modern mining activities which are regulated through a range of mechanisms. Mining within the Central Highlands in the past has been mainly for gold, with minor associated metals. Several products including rock, gravel, sand, clay, and soil have also been quarried from surface and river deposits.

Mining/quarrying is potentially a moderate threat to the Eastern Horseshoe Bat, Common Bent-wing Bat, Large-footed Myotis and the Spotted Tree Frog and a minor threat to three of the other species considered in this assessment.

Past mining has most likely caused deterioration of riparian habitats. Impacts, such as increased stream turbidity, may also extend some distance downstream. Eductor dredging is now illegal in Victoria. However, most of the rivers in the Central Highlands with road access are believed to have been dredged in the past. Disappearances and declines of Spotted Tree Frog populations may have been linked to past eductor dredging activities. Species which are dependent on streams, such as the Large-footed Myotis, may also be affected by mining and extraction activities adjacent to streams if these activities affect water quality with subsequent effects on instream fauna on which this species depends for food.

It is likely that the creation of mines in the Central Highlands region in the past led to an expansion in the distribution of the Eastern Horseshoe Bat and Common Bent-wing Bat. However, renewed interest in reworking old mines represents a potential threat to bats which rely on such sites. It is therefore proposed that known colonies of Eastern Horseshoe Bat are to be protected within the Central Highlands region by a 100 m buffer (NRE 1996b).

In order to mitigate the effects of current mineral exploration, mining and extractive industries these activities are not permitted in Reference Areas and some other specific areas, nor in National and State Parks except where a tenement or application pre-dates the Park. The Proposed Central Highlands Forest Management Plan specifies that no new extraction activity will be permitted within the Special Protection Zone (SPZ) unless it will make a significant contribution to the regional economy, and unless the values within the SPZ can be maintained or provided elsewhere. Approvals for mineral exploration, mining and extraction in other areas generally require work plans which can address environmental considerations.

Roading

This category includes habitat destruction and alteration of hydrological regimes by roading. Roading can directly destroy habitat, create barriers to movement, increase the potential of erosion and weed invasion, and increase water turbidity and siltation if associated with creek crossings. There is evidence that introduced predators such as Foxes utilise tracks as pathways.

The principal sources of sedimentation are likely to be associated with unsealed roads and tracks. Of greatest concern are roads and tracks that are close to streams, and poorly constructed or maintained tracks on erodible soils, especially at stream crossings. All new roads and tracks used for timber production must be built to standards outlined in the Code of Forest Practices for Timber Production. However, many roads and tracks were built prior to introduction of the Code and do not meet today's standards. Extra attention is now paid to planning road and track networks to avoid threatened species habitat, minimise environmental damage and provide high standard stream crossings.

Roading is considered a major threat to the Alpine Bog Skink and Spotted Tree Frog, a moderate threat to the Squirrel Glider and Large-footed Myotis, and a minor threat to a further 14 species.

The Proposed Central Highlands Forest Management Plan includes management guidelines for the determination of the road network to be maintained in State forest. Priority areas include catchments containing threatened fauna that are susceptible to increases in stream sedimentation. Catchments known to contain the Spotted Tree Frog are highlighted.

Recreation

This category relates to a range of recreational activities which can potentially damage or destroy habitat or disturb fauna. It includes vehicular use such as 4-wheel driving and trail bike riding, cross country skiing, hiking, fishing, horse riding and camping. Such activities and the provision of related infrastructure can directly remove or trample vegetation, cause soil compaction, pollution and sedimentation of streams, erosion and the spread of weeds. Recreation activity is considered a major threat to the Alpine Bog Skink, a moderate threat to the Swamp Antechinus, Spotted Tree Frog, Alpine Tree Frog and Baw Baw Frog, and a minor threat to seven species. The majority of species covered by the review are not considered threatened by recreation.

The habitat of the Alpine Bog Skink includes subalpine heath and sphagnum bog communities. These communities are easily damaged and take a long time to recover due to the brief growing season and harsh climate of alpine areas. Recreation activities including vehicular use, snow sports, slope grooming and lift construction and trampling by humans can cause loss and degradation of the habitat of the Alpine Bog Skink.

The Alpine Tree Frog is restricted to montane subalpine and alpine environments. The development of snow sport facilities in areas occupied by this species is likely to adversely affect the species through modification of habitat. Alterations to drainage patterns caused by bushwalking tracks and cross-country ski trails on the Baw Baw Plateau, and down-hill ski runs and cross-country trails in the Mt Baw Baw Alpine Resort, may affect breeding of the Baw Baw Frog. Implementation of management actions for the Baw Baw Frog outlined in the Baw Baw National Park Management Plan and the Action Statement for the species should also benefit populations of the Alpine Bog Skink and Alpine Tree Frog. The Proposed Central Highlands Forest Management Plan proposes to close and rehabilitate the Taponga River camping ground which is adjacent to a known population of the Spotted Tree Frog.

Vandalism/disturbance by humans

This category includes direct human disturbance of fauna. It is a major threat to the Common Bent-wing Bat and Eastern Horseshoe Bat, a moderate threat to the White-bellied Sea-Eagle and a minor threat to a further 10 species.

Human disturbance of roost sites of the Common Bent-wing Bat and Eastern Horseshoe Bat may cause the bats to abandon the site. Similarly, the White-bellied Sea-Eagle is vulnerable to disturbance and birds may desert nests if disturbed by humans. Current management strategies include discouraging visitors from known nest and roost sites and keeping the location of such sites confidential.

Other

This category includes a number of threats that were identified by experts as being relevant to particular species that are not covered by any of the above categories. They include the following:

Interspecific Competition

This refers to competition for resources such as food and shelter with other native species which may be exacerbated by loss of high quality sites and fragmentation. This has been recognised as a threat to honeyeater species within the Central Highlands, particularly the Helmeted Honeyeater. Appropriate management actions have been identified in the Recovery Plan and Action Statement for the Helmeted Honeyeater.

Climate Change

Major components of greenhouse-related climate change are warming of the atmosphere and increased ultraviolet radiation. Species which are potentially most at risk from this phenomenon, possibly by undergoing reductions in range, are the Spotted Tree Frog, Alpine Tree Frog, Baw Baw Frog and Alpine Bog Skink. Long-term and global strategies are needed to address this form of threat.

Firewood Collection

Firewood collection is a threat to species whose habitat is limited to small remnants and can result in the loss of important habitat components, including older trees and tree hollows. This is especially so in rural areas where roadside reserves are important fauna corridors. Firewood collection can lead to simplification of the ground layer, reducing habitat diversity for both vertebrates and invertebrates.

The cutting of timber in public forests, which subsequently may be available for firewood collection, is undertaken by licensed operators that are required to comply with the Code of Forest Practices for Timber Production (Code) and relevant timber harvesting operating prescriptions. The Code specifies that one of the approaches which should be considered for the conservation of flora and fauna is the retention of habitat trees and old-age understorey elements in appropriate numbers and configurations. A permit is required for the collection of firewood for domestic purposes from public land. The permit system provides for consideration of biodiversity values and sensitive fauna habitats are avoided.

Eucalypt Dieback

A number of factors including altered drainage patterns, increased salinity, increased leaf nutrients, insect attack and soil compaction are thought to contribute to eucalypt dieback. Woodland remnants, particularly those used for grazing, are particularly susceptible to dieback resulting from increased leaf nutrient levels, which can lead to an increase in leaf-eating insects. Dieback may result in deterioration of Helmeted Honeyeater habitat through lowered invertebrate prey and deteriorating health of affected trees. Research into the causes of eucalypt dieback within this species' range is an objective of the Helmeted Honeyeater Recovery Plan.

Dams/Impoundments/Hydroelectric Facilities

Water diversions, impoundments and water storage maintenance activities can result in alteration of stream flow regimes and water temperature. These can have a significant adverse effect on stream-dependent species such as the Spotted Tree Frog by reducing or eliminating breeding opportunities or survival of eggs and tadpoles.

Mineshaft Collapse/Overgrown Entrances

Mineshaft collapse and mineshaft entrances becoming overgrown are recognised as major threats to the Eastern Horseshoe Bat and the Common Bent-wing Bat, reducing available habitat and inhibiting bat access. These species are dependent on caves and mineshafts for roosting and breeding. The National Estate Values of the Central Highlands (AHC & CNR 1994a) recognise all mines used by colonial breeding or roosting bats as key fauna habitat which should be maintained across the project area. Known colonies of Eastern Horseshoe Bat in State forest are to be protected by a 100 m buffer (NRE 1996b).

12.7 AQUATIC FAUNA SPECIES ASSESSMENT

Introduction

This section considers the information on fish and aquatic invertebrates (crayfish, prawns, insects etc) occurring in the Central Highlands 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 region is bisected by the Great Dividing Range which splits the aquatic habitat into northern-flowing streams (draining into the Murray River) and southern-flowing (coastal) streams, with 11 and 16 naturally occurring native species of fish in each area respectively. At least 11 of the 23 species are known to be migratory.

The number of aquatic invertebrate species in the region is unknown and adequate distributional information exists for only a few of these.

Data Review

As part of the assessment, a review was conducted of the number of sites surveyed for aquatic species in the Central Highlands, with information being taken from surveys dating back to 1973. 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.

No coordinated effort has been made to systematically survey the aquatic habitats and associated fauna of this region, and apart from intensive surveys for specific projects, much of the region has not been adequately sampled.

Intensive surveys of fish populations in the Central Highlands region have primarily been conducted by the Department of Natural Resources and Environment. Other investigations which incidentally recorded fish species were conducted by other government agencies, universities and private individuals.

Records were obtained for 572 sites in the region where surveys have been conducted for freshwater fish, with 400 of these considered to be full surveys of species present with adequate data quality. Of the 572 surveyed sites, 16.1% were in areas set aside for conservation purposes, 42.5% in State forest, and the remaining 41.4% in private land and other public land.

Surveys of aquatic invertebrates in the Central Highlands have primarily been conducted by a number of Government departments and Monash University. Of the region's five catchments (Goulburn, Thomson, Latrobe, Bunyip, Yarra), the Yarra has been the most extensively surveyed (45 of 131 sites sampled prior to 1990). As part of the national Monitoring River Health Initiative, 40 sites are currently being monitored in the Central Highlands region. Because of often differing sampling methods, data comparisons between surveys need to be treated with caution.

The most crucial gaps in fish data from the Central Highlands region lie in the number of areas from which limited data are available, and the lack of information about fish populations. Significant data gaps exist on life history and population characteristics for all priority fish species. There is also limited data on the reactions of priority fish species to disturbances, particularly increased sedimentation and turbidity.

Of the priority aquatic invertebrates occurring in the Central Highlands, the distribution of most is not well known. With some minor exceptions, the same generally applies to their scientific classification and life histories.

Priority Species Information

Of the 23 native freshwater fish species recorded from the Central Highlands, 12 are listed as threatened fauna in Victoria (CNR 1995e), including six which are listed under the *Flora and Fauna Guarantee Act 1988*, and two of these are also listed under the Commonwealth *Endangered Species Protection Act 1992* (Table 12.19).

Fifteen of the aquatic invertebrate species known from the Central Highlands have been identified as threatened in Victoria, with seven of them also being listed (or recommended for listing) under the *Flora and Fauna Guarantee Act 1988*, including two species of crayfish.

Threatening processes - Impacts and Management

This section reviews the current state of knowledge of threatening processes affecting important aquatic species in the Central Highlands and the management actions which 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 Central Highlands, taken as being those species listed in Table 12.19.

Table 12.19: Aquatic fauna species occurring in the Central Highlands and listed under the Victorian *Flora and Fauna Guarantee Act 1988* and/or the Commonwealth *Endangered Species Protection Act 1992* and/or on the Threatened Fauna of Victoria list.

Species Name	Common Name	Conservation Status	FFG/ESP Listing
Fish			
<i>Geotria australis</i>	Pouched Lamprey	Rare	
<i>Prototroctes maraena</i>	Australian Grayling	Vulnerable	FFG, ESP
<i>Galaxias cleaveri</i>	Australian Mudfish	Vulnerable	FFG
<i>Galaxias fuscus</i>	Barred Galaxias	Endangered	FFG, ESP
<i>Galaxias olidus</i>	Mountain Galaxias	Ins. known	
<i>Galaxias rostratus</i>	Flat-headed Galaxias	Rare	
<i>Galaxias truttaceus</i>	Spotted Galaxias	Rare	
<i>Galaxiella pusilla</i>	Dwarf Galaxias	Vulnerable	FFG
<i>Maccullochella peelii peelii</i>	Murray Cod	Vulnerable	FFG
<i>Macquaria ambigua</i>	Golden Perch	Rare	
<i>Macquaria australasica</i>	Macquarie Perch	Vulnerable	FFG
<i>Gadopsis marmoratus</i>	River Blackfish	Ins. known	
Crayfish			
<i>Engaeus phyllocerus</i>	Narracan Burrowing Cray	Rare	FFG
<i>Engaeus sternalis</i>	Warragul Burrowing Cray	Endangered	FFG
<i>Euastacus armatus</i>	Murray Spiny Cray	Ins. known	
Other invertebrates			
<i>Hemiphysalis mirabilis</i>	Damselfly	Vulnerable	FFG
<i>Archeophylax canarus</i>	Caddisfly	Rare	FFG
<i>Plectrotarsus gravenhorsti</i>	Caddisfly	Ins. known	
<i>Riekoperla darlingtoni</i>	Mt Donna Buang Wingless Stonefly	Vulnerable	FFG
<i>Tanjistomella verna</i>	Caddisfly	Vulnerable	
<i>Thaumatoperla robusta</i>	Stonefly	Rare	
<i>Austrogammarus australis</i>	Dandenong Freshwater Amphipod	Ins. known	FFG
<i>Austrogammarus haasei</i>	Amphipod	Ins. known	FFG
<i>Boekella nyoraensis</i>	Copepod	Rare	
<i>Canthocampus dedeckeri</i>	Copepod	Ins. known	
<i>Canthocampus mammillifurca</i>	Copepod	Ins. known	
<i>Canthocampus sublaevis</i>	Copepod	Ins. known	

Ins. known = Insufficiently known, **FFG** = *Flora and Fauna Guarantee Act 1988*, **ESP** = *Endangered Species Protection Act 1992*

Impacts

Based on studies conducted elsewhere, a number of activities have either been shown to have, or have the potential to have 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 12.20.

Table 12.20: 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 pesticide concentrations • Increased nutrient concentrations in water
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
Water storages and instream barriers	<ul style="list-style-type: none"> • Changed flow regimes • Increased sedimentation and turbidity • Decreased water temperature • Barriers to fish passage

By far the most common effect of most disturbances is the increase in sediment in rivers and streams over and above normal inputs. 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. In the Central Highlands, most of the priority fish species lay eggs which settle on the stream bed and could therefore be affected by increased sedimentation which altered the substrate of egg deposition sites. Research in the region indicates that most of the priority stream-dwelling invertebrates would also suffer from increased levels of sedimentation and turbidity.

Dams represent a severe disturbance to aquatic systems, potentially affecting a number of priority aquatic species in the Central Highlands. Storage and release of water at different times also changes the natural flow regimes, most affecting those species such as the Murray Cod and Golden Perch which are known to require floods to trigger spawning. Dams and other barriers would also hinder the movement of the large proportion of migratory fish species found in the region.

Management

Following the Land Conservation Council's (LCC) Rivers and Streams Special Investigation (LCC 1991a), the Victorian Parliament legislated to protect the corridors of the Yarra, Goulburn (below Lake Eildon), Big, Aberfeldy and Thomson Rivers as Heritage Rivers because of their natural, scenic, cultural heritage and recreational values. Timber harvesting is excluded from the Heritage River corridors within this planning area. In State forest, these corridors are included in the Special Protection Zone (SPZ).

The LCC has also identified a 'River Zone' along other rivers and streams in the Central Highlands which contain significant natural, scenic or recreational value. These are the upper Goulburn, Murrindindi, Acheron, Latrobe and Toorongo Rivers and Snobs Creek. The corridor to be protected along these rivers and streams varies according to local circumstances but generally extends between 100 m and 300 m from each bank. These areas are also included in the SPZ.

Management strategies to protect riparian and instream values are also key elements of the Code of Forest Practices for Timber Production and the Proposed Central Highlands Forest Management Plan. The Code contains a number of measures aimed at protecting water quality and therefore instream values. Linear reserves in SPZs, extending 200 m from each bank of the watercourse have been established in the Proposed Central Highlands Forest Management Plan along most major streams. Within the SPZ, construction of new roads within linear reserves is to be avoided wherever possible.

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. This has been done for the Barred Galaxias. Other priority aquatic species are afforded protection through the more general habitat protection measures of the Code of Forest Practices, and the Proposed Forest Management Plan.

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.

13. OLD-GROWTH FOREST

13.1 INTRODUCTION

Under the 1992 National Forest Policy Statement (NFPS) the Commonwealth and State Governments agreed to a strategy to conserve and manage areas of old-growth forest across Australia as part of a comprehensive, adequate and representative forest reserve system. To clarify its objectives, national criteria have been established for the conservation of old-growth forests (JANIS, 1996, section 1.1.4). This chapter includes an assessment of the extent of old-growth forest in the Central Highlands and the application of the nationally agreed reserve criteria.

The first comprehensive regional assessment of old-growth forest in Australia was completed in East Gippsland by Woodgate *et al.* (1994), it has become the benchmark for a series of regional old-growth forest studies in Victoria. The Woodgate study developed working definitions of old-growth forest and a standard methodology for assessing and mapping forest of different age classes and 'ecological vegetation classes'. Ecological vegetation classes are part of a hierarchy of floristic vegetation descriptions as, for example, Box Woodland and Damp Forest. The term 'vegetation class' is interchangeable with ecological vegetation class.

As part of the Central Highlands Comprehensive Regional Assessment (CRA) that is required to complete a Regional Forest Agreement (RFA), the Commonwealth and Victorian Governments agreed to jointly undertake an assessment of the extent of old-growth forest in the Central Highlands of Victoria. This chapter describes the extent and characteristics of old-growth forest in the Central Highlands, it is based on a technical report *Study of old-growth forests in Victoria's Central Highlands, 1996* which provides greater detail and is available from the Department of Natural Resources and Environment.

The Characteristics of Old-growth Forest

Old-growth forests are significant to the Australian community because of their high nature conservation value, aesthetic and cultural values, and lack of disturbance. The attributes of old-growth forest include:

- the presence of relatively large trees and other associated understorey species in the wetter forest types to stunted and gnarled trees in drier forest types;
- relatively old trees and other plants in terms of development stage;
- the presence of large crown gaps (in some forest types);
- presence of tree hollows and/or fallen trees;
- characteristic biotic composition;
- presence of certain growth forms eg epiphytes in some forest types;
- stable nutrient cycles and high litter levels (in some vegetation classes); and
- low rates of change in species, forest structure and ecosystem functioning.

Old-growth Forest Definitions

The old-growth forest study of East Gippsland (Woodgate *et al.*, 1994) analysed a range of old-growth attributes and found that these forests were characterised by having the oldest possible growth stage and are negligibly disturbed. The Department of Natural Resources and Environment (NRE) for the purpose of its technical study of Central Highlands old-growth forest (NRE, 1996a) used the definition:

Old-growth forest is forest which contains significant amounts of its oldest growth stage - usually senescing trees - in the upper stratum and has been subject to any disturbance, the effect of which is now negligible.

This definition is consistent with the nationally agreed operational definition of old-growth forest for application in the RFA process, which is:

Old-growth forest is ecologically mature forest where the effects of disturbances are now negligible (JANIS, 1996).

In applying this interpretation to a forest ecosystem within a region, the following principles will apply:

- ecological maturity is defined by the characteristics of the older growth stages,
- if data are available on the structural, floristic, and functional qualities that would be expected to characterise an ecologically mature forest ecosystem, these data should be used in the assessment of the significance of disturbance effects, and
- negligible disturbance effects will be evident in most forests by a significant proportion of trees with age-related features and a species composition characteristic of the ecologically mature forest ecosystem.

Old-growth National Reserve Criteria

The following National Reserve Criteria have been established for the conservation of old-growth forests (JANIS, 1996).

Where old-growth forest is rare or depleted (generally less than 10 per cent of extant distribution) within a forest ecosystem, all viable examples should be protected, wherever possible. In practice, this would mean that most of the rare or depleted old-growth forest would be protected. Protection should be afforded through the range of mechanisms outlined in the National Reserve Criteria.

For other forest ecosystems, 60 per cent of the old-growth forest identified at the time of assessment would be protected, consistent with a flexible approach where appropriate, increasing to the levels of protection necessary to achieve the following objectives:

- the representation of old-growth forest across the geographic range of the forest ecosystem;
- the protection of high quality habitat for species identified under the biodiversity criterion;
- appropriate reserve design;
- protection of the largest and least fragmented areas of old-growth; and
- specific community needs for recreation and tourism.

Assessment Methodology

The old-growth forest survey methodology for the Central Highlands essentially followed that developed by Woodgate *et al.*, (1994) for East Gippsland. This methodology was independently assessed by a joint Commonwealth/State Scientific Advisory Group which considered that it is an appropriate and effective means of identifying old-growth stands in eucalypt forests. The characteristics and extent of old-growth forest in the Central Highlands were gathered using the following methods:

- mapping current forest cover from satellite images;
- assessing forest age from aerial photographs and field observation;
- analysing historical data within archival records;
- mapping and assessing the nature and degree of disturbance since European settlement;
- describing the natural and cultural values of all forests in the study area using digital spatial analysis techniques; and
- creating a digital database for information on aspects such as logging, fire history, forest type, floristic vegetation, land systems, land tenure, and land use.

Results of the old-growth analysis are reported only for public land. This is because freehold forest was assessed for old-growth characteristics, but none qualified as old-growth forest due to high levels of disturbance.

13.2 VEGETATION CLASSES

Vegetation in the study area was classified using a system of ecological vegetation classes. Of the total 24 forest vegetation classes identified for the study area, 17 were classified as eucalypt-dominated forest (ranging in total extent from 30 ha for Box Woodland to 143 130 ha for Damp Forest).

13.3 FOREST AGE

Introduction

For a particular site and vegetation class, old-growth forests are deemed to have attained their oldest, naturally achievable growth stage. Growth stage refers to the developmental stage of the tree based on its physical form. Distinctive features of tree crowns at different growth stages allow key growth stages to be identified from aerial photographs. The oldest growth stage is usually the senescing growth stage and to qualify as old-growth forest, this stage must be present as a component of the stand (Figure 13.1).

The Eucalypt forests, which are the dominant forest type in the Central Highlands, were assessed for the presence of senescing growth stages using aerial photo-interpretation supported by field validation. Crown form characteristics of trees were used to establish growth stage categories for forest stands, and this enabled interpreters to estimate the age of forest stands.

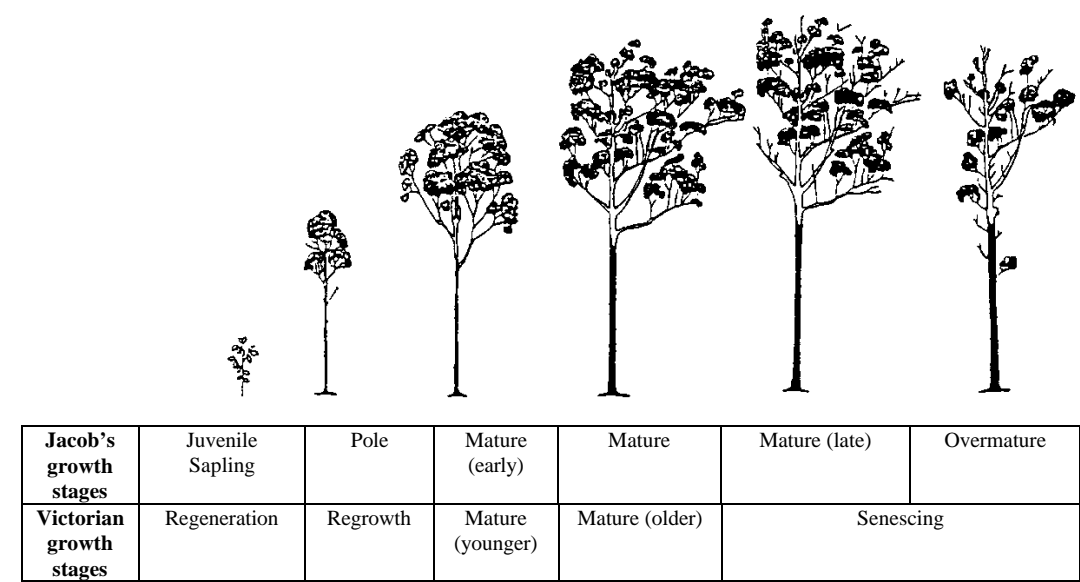
Crown Form, Growth Stage and Crown Cover Projection

The Central Highlands old-growth assessment considers that all eucalypt forests must pass through four critical growth stages:

- regeneration,
- regrowth,
- mature, and
- senescing.

These growth stages correspond to particular tree growth forms based on descriptions by Jacobs (1955), who described the different crown forms, or growth stages, characterised by trees at different stages of their development (Figure 13.1). Crown form (size, shape and composition) was mapped from aerial photographs for the Central Highlands and the growth stage for a given tree species was then inferred from this crown-form mapping.

Figure 13.1. Relationship between the typical eucalypt growth stages described by Jacobs (1955) and those considered by the Central Highlands Old-Growth Study



In the majority of vegetation classes identified in the Central Highlands, and particularly on high environmental quality sites (fertile sites), typical crown forms were consistent with the growth stages described by Jacobs, and could be readily mapped from aerial photos.

However, for eucalypt-dominated vegetation on poorer-quality sites, and for non-eucalypt vegetation types, field inspection showed that trees senesce and die without exhibiting the classic morphology of the Jacobs overmature growth form. For these forest types additional indicators such as relative crown size, regularity of crown gap and crown form distribution, and tree heights were used to infer growth stage. This permitted senescing growth stages to be distinguished from younger growth stages in most cases. Where no differentiation was possible, a precautionary approach was adopted whereby the mature component of the stand was considered to be equivalent to the senescing stage.

Many forest stands contained more than one growth stage in the canopy and, in these cases, the relative proportion of each growth stage was assessed. For this purpose, five categories of relative abundance of different growth stages were used:

- absent,
- sparse,
- sub-dominant,
- co-dominant, and
- dominant.

When applied to each of the four growth stages, 38 growth-stage combinations were mapped.

Tree Ageing

Limited investigations were conducted to determine the ages of forest growth stages by using dating techniques on two Mountain Ash trees. Interpretation of data suggested:

- an 'immature' growth stage for Mountain Ash of about 80 years,
- a 'mature' phase of about 270 years,
- a 'senescing' phase of about 100 years, and, finally,
- a 'stag' phase of about 50 years.

13.4 FOREST DISTURBANCE

Introduction

Forest disturbance mapping was undertaken to identify the presence and scale of disturbance in the Central Highlands forests, and whether or not the effect of past and present disturbance events is now negligible.

The current distribution and condition of the native vegetation in the study area reflects the impacts of European settlement. Most clearing of the natural vegetation on the plains and foothills has been for agriculture, but some has also been cleared for urban and industrial purposes, roads, recreation and other uses. The landscape of private land is predominantly agricultural. Public land has generally retained a cover of native vegetation which has been disturbed to a greater or lesser extent.

Disturbance is a primary characteristic which diminishes, or detracts from, old-growth forest status. Significant disturbance renders a forest ineligible as old-growth. The many disturbances known to alter the primary attributes (eg floristics, structure or growth stage) of the forests in the study area were investigated and quantified. Disturbances were described according to their cause – either natural (eg wildfires), or unnatural (that is, human induced, eg agricultural clearing, timber harvesting). Disturbances by Indigenous people before European settlement were also regarded as being natural.

Research covering historical and contemporary records was undertaken to delineate and map the extent and severity of these disturbances. Whilst the classification recognises the origin or frequency of the disturbance (whether natural or human induced) it was considered that, from an ecological perspective, there should be no arbitrary distinction between natural or human induced disturbances.

The effect of disturbance varied from one vegetation class to another. The significance of each disturbance was classified according to the following three levels.

- Areas with no record or evidence of disturbance history were described as ‘undisturbed’.
- ‘Negligible’ disturbance was defined as a disturbance for which there is an authentic record, but which is unlikely to have altered the structure or the usual composition of species for that vegetation class; or, if a disturbance did occur in the past, its effect is no longer significant.
- ‘Significant’ disturbance was defined as a disturbance regime for which there is an authentic record and which is likely to have altered the growth stage ratios, crown cover projection or the usual floristic composition of that vegetation class, and which is detectable at the time of the survey.

Agricultural Selection

Farming was closely linked to the early history of the Central Highlands and dramatically altered its landscape. Information about those areas of agricultural clearing within the study area that are now classified as State forest was extracted from archival files. Information on the location, extent and approximate period of clearing for each selection was entered into a geographic information system (GIS) database.

Grazing

Historical and current data on the location and extent of grazing licences were researched as part of the old-growth forest study and entered as one of the layers in the GIS database.

The impact of grazing obviously varies for each vegetation class. It is unlikely to have an appreciable effect on classes with vegetation unpalatable to livestock, which tended only to be grazed during periods of severe drought. However, grazing in areas that contained ‘palatable’ vegetation classes was considered to be a significant disturbance. Palatable vegetation classes identified were Box Woodland, Dry Sub-alpine Shrubland, Floodplain Riparian Woodland, Grassy Dry Forest, Herb-rich Foothill Forest, Plains Grassy Woodland, Sub-alpine Woodland, and Valley Forest.

Wildfire

Eucalypt forests are extremely fire-prone and major bushfires are a feature of the Central Highlands. The most critical of these were in 1926 and 1939 with most of the forests in the study area destroyed or severely damaged. These fires burnt almost 85% of the total of 175 000 ha of mountain forest (ash type) in the study area.

No adequate large-scale maps of the area burnt by the 1939 fires were located. The outer boundaries of the 1939 fires, and those of most of the wildfires for the last three decades were extracted from wildfire history records and re-drafted as a standard map layer for entry in the GIS database. Where aerial photograph interpretation confirmed significant disturbance to the growth stage or canopy within these areas, this was classified as ‘significant natural’ disturbance for the purposes of mapping old-growth forest.

Fuel Reduction Burning

Fuel reduction burning of forest has been routinely conducted in the drier forests of the Central Highlands since the 1960s. Boundary information is recorded on maps and supported by field reports and aerial observation of the proportion of the proposed area which had actually been burnt. In areas where crown-cover and growth-stage mapping from aerial photos revealed no damage, fuel reduction burning was classified as ‘negligible unnatural’ disturbance.

Mining

The location and extent of mining sites, tracks and other disturbances associated with mining (and those areas of forest which were cleared for fuel and mining timbers, and which have subsequently revegetated) were identified from archival records and aerial photographs, and entered into the GIS database for subsequent analysis. Areas cleared for fuel and mining timbers were recorded as 'significant disturbance'.

Timber Harvesting

Detailed information on the geographic extent of timber harvesting was obtained from historical records and maps and, for more recent harvesting, from aerial photographs. Significant areas of timber harvesting following the 1939 fires were mapped from aerial photographs taken between 1944 and 1954. Both clearfelled and selectively harvested areas were mapped and incorporated in the GIS database together with all former forest-based sawmill sites and the tramway network. When these mapped sources of disturbances were confirmed by the crown cover or growth stage mapping, the disturbance level was classified as 'significant unnatural'.

Other Disturbances

Native forest and other vegetation cleared or otherwise disturbed for the establishment of softwood plantations was identified and mapped from plantation map records. Other disturbances were recorded in the category of historic/cultural/utility features and included sawmill sites, mining sites and settlements together with timber, mining and construction-work, tramways and railways. Such areas were not included in the initial GIS analysis to identify old-growth forest. Rather, they were used to cross reference with identified old-growth forest and provided the focus for field checking. Such areas were usually classified as being 'significantly disturbed'.

13.5 ANALYSIS OF DATA AND RESULTS

Introduction

The objective of this stage was to identify old-growth forest using the information gathered from the assessment of growth stage, the collection of disturbance data, field assessment and expert knowledge.

Old-growth Database

Each forest stand was assessed and ranked for old-growth status. Crown cover projection, crown form, vegetation classes and disturbances were all compiled in map form and entered into the GIS old-growth database.

Assignment of Old-growth Forest Status

Using the forest growth-stage layer derived from crown-form mapping, and the disturbances assigned to stands for each disturbance regime, old-growth forest status was identified for each vegetation class according to the old-growth forest definition. That is, old-growth forest was identified as forest which:

- contains senescing trees present in the upper canopy (at least 10% of total crown cover for the stand),
- has regrowth present in sparse proportion (less than 10% of crown cover), and
- has negligible or no disturbances identified.

Younger forest dominated by mature growth stages with a lower proportion of old-growth forest structural characteristics, but which had negligible evidence of disturbance, was recognised as a separate class – ‘negligibly disturbed’ forest.

Table 13.1. Assignment of Old-growth forest status

Growth Stage			Disturbance Class		
Senescent	Mature	Regrowth	Undisturbed	Negligible	Significant
Dominant		> 10%	-	-	-
		< 10%	Old growth	Old growth	-
Co-dominant		> 10%	-	-	-
		< 10%	Old growth	Old growth	-
Sub-dominant		> 10%	-	-	-
		< 10%	Old growth	Old growth	-
Sparse/Absent		> 10%	-	-	-
		< 10%	Old growth	Old growth	-
Mature	Dominant	> 10%	-	-	-
		< 10%	Negligibly disturbed forest	Negligibly disturbed forest	-
Regrowth		> 10%	-	-	-

(Note: **dominant** - >50% of crown cover; **co-dominant** - 30-50% of crown cover; **sub-dominant** - 11-30% of crown cover; **sparse/absent** - <10% of crown cover)

Extent of Old-growth Forest

Old-growth forest occurs throughout the Central Highlands region, usually in small and scattered patches (see Map 4). On public land it was identified in 16 vegetation classes (see Table 13.2), which totalled some 25 993 hectares, representing approximately 4.4% of all extant vegetation in the region.

The analysis indicated that 83.6% of the total area of old-growth forest in the Central Highlands occurs in four vegetation classes:

- Heathy Dry Forest (35.4%),
- Wet Forest (19.5%),
- Montane Dry Woodland (15.5%), and
- Heathy Woodland (13.2%).

The largest areas of old-growth forest are found in the dry vegetation classes, located predominantly in the Thomson, Matlock and Big River Geographic Representation Units (GRUs). An aggregation of relatively small stands occurs in the Yarra, Bunyip and Latrobe River GRUs.

The Wet Forest old-growth stands are largely contained within the Yarra Ranges National Park (Melbourne Water closed catchment areas) in the Acheron GRU. Damp Forest old-growth occurs in small stands with the largest found in the O'Shannassy and Upper Yarra catchments within the Yarra Ranges National Park in the Acheron GRU, and the Big River catchment in State forest in the Matlock GRU.

Information on the area of negligibly and significantly disturbed forest is provided in Chapter 12.

Old-growth Reservation Levels

Table 13.2 provides information on the reservation status of the old-growth forest in each ecological vegetation class. This table shows the amount of old-growth protected in legislated parks and reserves (conservation reserves), larger areas of Special Protection Zones (SPZs) and by prescription (such as streamside buffers).

The Special Protection Zone is managed specifically for the protection of conservation values and timber harvesting is excluded. The SPZ is comprised of the following four categories:

- (a) Large and contiguous areas;
- (b) A network of connecting areas (200-400m wide) based around riparian zones (including Heritage River corridors) but also including wildlife corridors on ridges and crossings between catchments;
- (c) Linear reserves of less than 200 m width and small areas less than 5 ha; and
- (d) Areas protected by the Code of Forest Practices for Timber Production. This category includes all permanent streams and all rainforest stands and an adjoining buffer of non-rainforest vegetation of at least 40 metres.

Table 13.3 sets out the area and protection of old-growth forest in each of the Geographic Representation Units (GRUs). The 'area' figures in this table represent the total area of old-growth for each vegetation class in each GRU. The corresponding 'percent protection' figure refers to the proportion of that area in dedicated conservation reserves and in components 'a' and 'b' of the SPZ.

Table 13.2

Table 13.2: Representation of Old Growth in conservation

Ecological Vegetation Classes (i)	Area EVC (ha) (ii)	Percent of EVC as Old Growth (iii)	Area OG (iv)	Conservation	
				Reserves	a
Lowland Forest	42,805	<1	22	61.5	38.5
Riparian Forest	31,801	<1	130	17.7	80.6
Heathy Dry Forest	14,436	64	9214	32.7	44.7
Grassy Dry Forest	41,579	<1	7	0.0	99.9
Herb-rich Foothill Forest	123,049	<1	77	1.0	83.7
Damp Forest	162,307	<1	547	47.0	52.1
Wet Forest	120,068	4	5083	95.1	3.9
Cool Temperate Rainforest	12,970	13	1690	96.8	3.0
Montane Dry Woodland	7,050	57	4040	1.7	67.5
Montane Damp Forest	20,150	<1	75	40.5	59.5
Montane Wet Forest	49,678	2	940	96.4	2.2
Montane Riparian Thicket	3,056	<1	10	82.3	0.0
Sub-alpine Woodland	7,259	<1	3	100.0	0.0
Shrubby Foothill Forest	35,482	<1	32	89.6	10.4
Valley Grassy Forest	7,201	10	696	70.8	0.0
Heathy Woodland	6,684	51	3427	80.5	8.8

Notes for interpretation of this Table.

- (i) Only those EVCs that contain Old Growth are shown in the Table.
- (ii) The total area of each EVC is derived from the pre-1750 analysis and includes extant forest on both public and private land shown in the proposed Central Highlands Forest Management Plan which only reported on public land. The Table shows that while the proposed Plan did not include information on Cool Temperate Rainforest and Montane Riparian Thicket.
- (iii) The proportion of Old Growth in each EVC has been derived using the total area of extant forest on both public and private land.
- (iv) The total area of Old Growth in the Table above differs from the total provided in the Central Highlands Old Growth Analysis as these studies used slightly different boundaries to that of the Central Highlands RFA region.
- (v) A description of the categories, within the SPZ, used for this analysis is included in section 12.4.
- (vi) For the Old Growth analysis in the Central Highlands it was considered that Old Growth only occurs on public land.

Table 13.3

Table 13.3: Area and protection of Old Growth										
Ecological Vegetation Classes	ABERFELDY		ACHERON		ALEXANDRA		BIG RIVER		BUNYIP	
	Area (ha)	Prot %	Area (ha)	Prot %	Area (ha)	Prot %	Area (ha)	Prot %	Area (ha)	Prot %
Lowland Forest									14	100
Riparian Forest			23	100						
Heathy Dry Forest	198	68			8	0	441	69		
Grassy Dry Forest					7	100				
Herb-rich Foothill Forest					6	100	6	100	12	0
Damp Forest			156	100			5	100	5	100
Wet Forest			4392	100					10	100
Cool Temperate Rainforest			1530	100						
Montane Dry Woodland	3	41					770	64		
Montane Damp Forest			10	100						
Montane Wet Forest			893	100						
Montane Riparian Thicket										
Sub-alpine Woodland										
Shrubby Foothill Forest									4	100
Valley Grassy Forest										
Heathy Woodland									2437	92

- (i) This table shows the area of old growth in each EVC within each of the eleven Geographic Representation Units across that Unit which is currently within a conservation reserve and the first two categories of the Special Protection Zone in
- (ii) Also see notes from Table 13.2.

14. WILDERNESS

14.1 INTRODUCTION

The assessment of wilderness in the Central Highlands has been undertaken in the wider regional context of the forests of Eastern Victoria, given their broad similarity. The report *Wilderness Assessment of the Eastern Victorian Forests* (VicRFASC 1996f) analyses wilderness across four CRA regions, namely Central Highlands, East Gippsland, North East and Gippsland. Reference should be made to this report if further detail is required.

14.2 DATA

The data used in the analysis was that used in the NWI and comes from many sources. The distance related indicators (settlement, access and apparent naturalness) are essentially current AUSLIG digital mapping data updates with additional information in the detailed study areas. The disturbance information, that provides the base data for the biophysical naturalness indicator, is of variable quality and lineage across the region studied in this project.

In East Gippsland and the Central Highlands the disturbance information is that used in the detailed old-growth surveys of the region with a currency of April 1993 and December 1993 respectively. For the remainder of the region, the best available systematic disturbance information was most recently updated in 1986. Although this represents the best available information, its currency should be taken into consideration when interpreting the results of the analysis.

14.3 METHODS

The concept of wilderness embraces measures of remoteness, naturalness and lack of disturbance. The National Forest Policy Statement. A New Focus for Australia's Forests (Commonwealth of Australia 1992b) states on page 11 that 'forested wilderness areas will be protected by means of reserves developed in the broader context of protecting wilderness values of all lands.' Consistent with this, non-forest vegetation types have been included where they form a mosaic within largely forested wilderness identified in this current assessment.

The approach taken in this assessment has been to first identify and delineate areas of high wilderness quality, and then calculate the percentage of these areas within the existing reserve system.

The NWI methodology developed by Lesslie and Maslen (1995), produces a database of 'wilderness quality' across the region. This is achieved by measuring the variation in wilderness quality across the landscape using four wilderness quality 'indicators' that represent the two essential attributes of wilderness: remoteness and naturalness. (See *Wilderness Assessment of the Eastern Victorian Forests* (VicRFASC 1996f)).

To identify areas with high wilderness quality, the criteria used in this assessment were areas with a NWI wilderness quality of at least 12 and an area larger than 8000 hectares. In the East Gippsland and Central Highlands analyses, thresholds also applied on the four wilderness quality indicators.

Boundaries were delineated around areas that satisfied these criteria. Wherever possible, the boundaries which were adopted followed catchment divides or other, topographic features. Where such features did not prove suitable, boundaries were drawn that reflected the influence of nearby features affecting wilderness quality, such as roads.

14.4 RESULTS

This assessment of the Eastern Victorian forests identified 18 areas that meet the threshold requirements (see Table 14.1). None of these areas is within the Central Highlands RFA region. Both the total area and the area included within the existing legislated reserve system were calculated and are presented in Table 14.1. Those areas included within the existing legislated dedicated reserve system were considered to be protected.

14.5 CONCLUSION

No areas of high wilderness quality have been delineated within the Central Highlands RFA region. However, in the Eastern Victorian forests region 95% of the total area delineated as significant for high wilderness quality is protected in the existing reserve system. The proposed National Reserve criteria (JANIS 1996) specify that 90% (or more, if practicable) of the area of high quality wilderness that meets the minimum area requirements should be protected in reserves.

Table 14.1: Summary of Protection of Areas of High Wilderness Quality within the Eastern Victorian forests

Area	Total Hectares	Reserve Status	Hectares Reserved
Cape Howe	7,120	Full	7,120
Sandpatch	28,540	Part	17,150
Petrel	10,960	Full	10,960
Tamboon	5,000	Full	5,000
Coopracambra	28,050	Part	25,460
Upper-Brodribb	5,310	Part	4,850
Tingaringy	25,250	Part	25,060
Snowy	54,560	Full	54,560
Buchan	12,580	Full	12,580
Avon	39,650	Full	39,650
Mt Darling/Snowy Bluff	40,400	Full	40,400
Razor/Viking	15,700	Full	15,700
Wabba	19,700	Full	19,700
Indi Addition to Pilot and Davies Plain	24,300	Full	24,300
MacAlister	33,300	Full	33,300
Yarrarabulla Creek a)	13,000	Full	13,000
Dartmouth	26,950	Part	20,370
Wilsons Promontory	33,228	Full	33,228
Totals	423,688		402,388

a) Yarrarabulla Creek Area. Part of this area is not included in a legislated reserve but is covered by an Order in Council requiring its protection as a Remote and Natural Area.

15. NATIONAL ESTATE

15.1 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 co-operation 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). In Victoria, regional assessments of National Estate values have been completed for East Gippsland and the Central Highlands. The regional assessment process is consistent with the statutory requirements of the *Australian Heritage Commission Act 1975*.

The Central Highlands national estate assessment was undertaken in 1993-1994. It was coordinated by a steering committee consisting of Victorian Department of Conservation and Natural Resources (DCNR) (now Department of Natural Resources and Environment - NRE), Melbourne Water and AHC staff., with observers from the Land Conservation Council (LCC) and Aboriginal Affairs Victoria (AAV).

The 1993 Central Highlands national estate assessment study area differs slightly from the RFA region. The northern and eastern boundaries of the RFA region exclude some land covered by the national estate study. Information and tables in this chapter relate to the RFA region and not the 1993 national estate study area. The values identified that fall outside the Central Highlands RFA region will be considered as part of the adjacent Gippsland and North East RFA processes.

The objectives of the national estate study were to:

- assess the representation of national estate values in the existing nature conservation reserve system and other protective land tenures;
- identify those areas in the Central Highlands which merit listing in the Register of the National Estate; and
- provide management guidelines on the protection and maintenance of national estate values.

This chapter is based on the findings of the Central Highlands national estate study. The draft National Estate report entitled *National Estate Values in the Central Highlands of Victoria: draft project report* (AHC and CNR 1994a) was released for public comment in June 1994. Over 20 submissions were received from a variety of sources. The submissions ranged from short letters to detailed technical submissions. Many of these comments have

been incorporated in this report and will be considered in the documentation of places proposed for listing in the Register of the National Estate.

Details of the national estate study methodology can be found in:

- Method Papers: Central Highlands National Estate Assessment. Volume One - Natural Values (AHC and CNR 1994b); and
- Method Papers: East Gippsland and Central Highlands Joint Forest Projects. Volume Two - Cultural Values (AHC and CNR 1994c).

Approach to the National Estate Assessment

The national estate study involved distinct phases outlined below.

The **identification phase** involved assessing the available information against the National Estate sub-criteria to determine areas of value and delineate national estate places. Details on the AHC's criteria and sub-criteria can be found in the draft National Estate report (AHC and CNR 1994a). 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** involved 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. The richness of a cultural landscape is directly related to a long and diverse history of human interaction. In contrast, old-growth forest values are considered sensitive to disturbance such as harvesting, roading or wildfire.

Conservation principles were developed by considering 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 including the Proposed Central Highlands Forest Management Plan (NRE 1996b) and the Code of Forest Practices for Timber Production (Rev No 2) (NRE 1996a). The Proposed Central Highlands Forest Management Plan addresses the conservation principles of many national estate values which will assist in their management after adoption of the plan.

15.2 DATA REVIEW

Much of the data came from extensive data sets assembled by NRE over many years. These were analysed and supplemented by consultancies, special projects and community involvement. Where possible, one source of data was used to complement or confirm another to ensure that the most robust data sets were compiled.

Seven broad types of data and information were used in the assessment:

- existing scientific 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 sets used in the national estate study included:

- ecological vegetation class mapping;
- disturbance mapping from old-growth assessment;
- the NRE Flora Information System;
- the Atlas of Victorian Wildlife;
- the forest growth stage data set;
- the NRE Historic Places Section Database
- the AHC Register of the National Estate;
- specific cultural thematic studies including:
 - sawmill and tramway sites,
 - routes of human movement,
 - forest activity sites,
 - Melbourne Water historic places,
 - pastoral and grazing sites,
 - guest houses, tourism and recreation sites,
 - fire history sites, and
 - alluvial mining sites;
- aesthetic value data compilation;
- community sources, primarily from the heritage workshops, and field surveys (Johnston *et al* 1993);
- the Aboriginal Affairs Victoria site register database;
- the Aboriginal Affairs Victoria Aboriginal historical places database;
- geological and geomorphological values; and
- AHC's National Wilderness Inventory.

Ecological Vegetation Classes

A full description of the methodology used to derive ecological vegetation classes (EVCs) and their suitability for biodiversity assessment is described in Appendix G of the CRA East Gippsland Environment and Heritage Report (VicRFASC 1996a).

Any vegetation mapping exercise has limitations and EVCs are no exception. EVCs were recognised as the best available mapping units at the time of the assessment and compare favourably with other approaches to vegetation classification.

Disturbance Data Sets

A full description of the methodology used to derive disturbance data sets is described in Chapter 13 of this report, which deals with the Central Highlands old-growth assessment.

Validation of some disturbance information was required and undertaken during the period of the national estate assessment. Of particular note were the discrepancies between some cadastral based information (especially vegetation clearance) and more recent air-photo interpretation.

The information contained in the disturbance data sets was also used as baseline information for the assessment of historical values.

Flora Information System

The NRE Flora Information System (FIS) is a botanical database containing floristic data across Victoria. These include locations and species lists derived from a variety of surveys

conducted within the Central Highlands region. Records from formal survey quadrats (usually 30m), plus incidental site records, were used in the national estate study.

Although there is a comprehensive data set for the Central Highlands, there is a sampling bias toward State forest areas, where data collection has been undertaken during pre-logging surveys. Information is also stored at varying levels of accuracy. Non-quadrat information was not accurate enough to include in most of the analyses undertaken. To redress the sampling bias, additional information from scientific reports was incorporated where possible.

Atlas of Victorian Wildlife

The Atlas of Victorian Wildlife is a database of incidental and survey records of Victorian fauna. Information is available for mammals, birds, reptiles and amphibians, threatened freshwater fish and a small number of threatened invertebrates. There are over 1.5 million records across Victoria from a range of sources, including: NRE fauna surveys and incidental records; museums; field naturalist clubs; natural history journals and the public. The Atlas includes records from the many fauna surveys undertaken in the Central Highlands.

Data on the Atlas comes from individual sightings as well as formal surveys. The Atlas is not comprehensive, in that, for example, fish and invertebrate records are limited. Modelling was undertaken to address important fauna related values in recognition of other biases in the Atlas. For instance, a geographic bias exists in the data due to differential survey intensity across the region.

As with the Flora Information System, the Atlas stores information of variable accuracy. For this reason, only post-1970 records with precise locational information were used in the national estate assessment. The fauna data are again not uniformly spread, with more information being available for State Forests due to extensive pre-logging surveys.

Forest Growth Stage Data Set

A description of the data set and methodology used to derive growth stages for the Central Highlands old-growth assessment is described in Study of Old Growth Forest in Victoria's Central Highlands (NRE 1996c). This data set was used for the national estate assessment.

Historic Places Database

The Historic Places Section of NRE maintains a database of historic places on public land, grouped according to historical themes. Most of the Central Highlands historic places on this register had been recorded as part of the review of public land use by the LCC (Supple *et al* 1989). This was added to by the collation of disturbance history in the old-growth study (Woodgate *et al* 1994). A register of State significant places is also maintained by Heritage Victoria.

Victorian registers of historic places within the Central Highlands were reviewed to determine the adequacy of data for assessment, and to identify gaps where additional studies would need to be undertaken.

Aesthetic Value Data Compilation

Information relevant to assessing aesthetic values was not available in a readily accessible form. NRE utilises a Visual Management System which provides a scenic quality classification for State forest areas. This data was used to assist in corroborating the aesthetic values determined from other sources and to assist in delineating the boundaries of

areas of aesthetic value. A description of the method developed for aesthetic value assessment, which included community workshops data, tourism data, an art and literature survey, and direct consultation with forest officers, is available in the cultural methods papers (AHC and CNR 1994c).

The Register of the National Estate

The Australian Heritage Commission compiles the Register of the National Estate (RNE). It is a national inventory of heritage places, which lists nearly 12000 natural and cultural places throughout Australia. These places include all aspects of Australia's culture, history and natural environment, including Indigenous places. A national estate place can be a site, area or region, a building or other structure and its contents.

RNE historic places within the Central Highlands were also reviewed to determine the adequacy of data for assessment, and to identify gaps where additional studies would need to be undertaken.

Community Sources Including Heritage Workshops

Communities hold a wealth of knowledge about their heritage, which has not been extensively used in previous studies. Communities and interest groups also have strong opinions about heritage significance and its conservation.

Heritage workshops were designed to obtain data on national estate values within the region, particularly those places of social and aesthetic value to communities. Workshops were held in Alexandra, Healesville, Rawson and Melbourne. Following the workshops, field recording of selected places was undertaken to collect further data for assessment. Information was compiled and returned to communities for comment and verification. Values identified by the community and assessed to be above the threshold for inclusion in the Register of the National Estate have since been entered onto a Geographic Information System (GIS). Details of the methods are available in the cultural methods papers (AHC and CNR 1994c).

Aboriginal Affairs Victoria Database

Aboriginal Affairs Victoria (AAV) maintains a register of Aboriginal sites and places which includes archaeological, traditional, historic and contemporary places. The data is derived from a variety of sources, but primarily from field survey and literature. The locations of the sites are generally treated as confidential information.

At the commencement of the Central Highlands assessment there were 291 records of Aboriginal archaeological sites in the AAV register. Most of these were on the fringe of the metropolitan area where previous survey work had been concentrated. A further study was undertaken to provide better coverage of the forested uplands.

Aboriginal Historical Places

AAV undertook a consultancy, the Central Highlands Aboriginal Historical Places Project (Goulding 1993), to document Aboriginal associations to places within the Central Highlands forest areas. These associations were drawn from historical records and oral histories given by Aboriginal people with contemporary associations with the Central Highlands. The results of the study were presented to the relevant Aboriginal communities at the end of the project.

Assessment of Aboriginal cultural values in the Central Highlands has not been completed as the Aboriginal communities do not support providing additional community based information that is essential to determine the national estate significance of these values.

Geological and Geomorphological Values

Geological and geomorphological values were assessed by consultants and the methodology and results of the studies are presented in the draft National Estate report (AHC and CNR 1994a) and natural method papers (AHC and CNR 1994b).

National Wilderness Inventory

The National Wilderness Inventory (NWI):

- identifies wilderness quality (remote and natural values) across Australia; and
- provides wilderness resource information and tools to assist wilderness conservation and management planning in all States and Territories where the program has been conducted on a cooperative basis with the AHC.

15.3 CONSULTATION PROCESS FOR NATIONAL ESTATE ASSESSMENT

The main objectives of the consultation process were 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, 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.

Elements of the consultation process are discussed below.

Technical Advisory Committee

A Technical Advisory Committee was established for the national estate assessment. The Committee included independent experts to provide feedback and advice on the methodology and implications for the assessment process. The membership of the committee is listed in the draft National Estate report (AHC and CNR 1994a).

Peer Review

A peer review of technical procedures was deemed necessary to validate new methods and discuss specific issues. This was undertaken through a series of technical workshops which helped clarify some specific issues such as: the assessment of diversity for national estate purposes, and the identification and assessment of 'representative' fauna. These workshops were held in Canberra and Melbourne, and a series of experts from a number of universities, consultant firms and Commonwealth and State agencies attended. The results of the workshops were published as individual technical papers.

The workshops covered the following topics (see the draft National Estate report (AHC and CNR 1994a) for detailed references):

- identifying Aboriginal archaeological places;
- Aboriginal archival and oral history;
- identifying and assessing aesthetic value;
- assessing diversity in natural heritage;
- identifying places containing fauna values;
- identifying natural heritage places which demonstrate the principal characteristics of their vegetation class; and
- identifying and assessing social value for communities.

Key Stakeholders

Peak conservation and industry groups were briefed on the national estate study on six occasions in 1993 and 1994. Other opportunities for comment included the call for public submissions when the draft National Estate report was released in June 1994 (AHC and CNR 1994a).

Information and Media

A newsletter was published regularly and distributed throughout the region between May 1993 and June 1994.

Further information about the national estate study was provided in a number of articles in the regional press and a range of stories on local and regional radio.

Aboriginal Communities

Five individual Aboriginal community organisations were identified as having responsibilities in the Central Highlands Regional Assessment area. These are Camp Jungai Cooperative Ltd, Coranderrk Koori Cooperative Ltd, West Gippsland Aboriginal Cooperative Ltd, Wurundjeri Tribe Land Compensation and Cultural Heritage Council Inc and Central Gippsland Aboriginal Health and Housing Cooperative Ltd. A series of meetings was held with these groups during 1993/94.

Discussions are continuing with these groups on reviewing the assessment work undertaken during 1993/94 in order to further the process of assessing Aboriginal values.

15.4 SUMMARY OF THE NATIONAL ESTATE ASSESSMENT

The assessment of national estate included a wide range of values addressing aspects of both the natural and cultural heritage of the forests of the region. A full list of values identified is included in the draft National Estate report (AHC and CNR 1994a).

The following section is a summary of the assessments undertaken and introduces the broad themes assessed.

Extensive Natural Values

The Central Highlands is essentially a disturbed landscape. The 1939 fires burnt considerable areas of the region and timber harvesting, both pre-1939 and post-1939, has occurred across much of the region. Mining activity has also had a major influence in the region's forests. Additionally, the proximity of the region to Melbourne has exerted considerable recreation pressure on the Central Highlands.

Landscapes that are essentially undisturbed by European activity are rare in the Australian environment. The natural landscapes identified in the national estate assessment are substantial areas that have not been significantly disturbed by European activity. The largest areas in the Central Highlands, where essentially natural processes dominate the landscape and disturbance has been minimal, are in the Melbourne Water closed catchments in the Yarra Ranges National Park that largely escaped the wildfires of 1939. It is these areas that contain the majority of the areas of extensive natural value.

A wilderness quality survey of the region undertaken using the AHC's National Wilderness Inventory found no areas of high wilderness quality, because of the region's long history of

European occupation and its proximity to Melbourne. The Upper Yarra catchment within the Yarra Ranges National Park was identified as the most remote and natural area in the region.

Old-growth occurs throughout the Central Highlands region in generally small but numerous patches, with larger aggregations in the Yarra Ranges National Park.

Areas important in exhibiting vegetation succession were also identified within the region.

Flora

The flora values identified in the region include areas of refuge significance, areas containing relict species, areas exhibiting the principle characteristics of vegetation classes, old-growth, areas of species richness and those areas exhibiting primary and secondary successional characteristics.

Ecological Vegetation Classes (EVCs) in the Central Highlands region vary greatly in total area. Consequently other natural environment values related to EVCs vary similarly in extensiveness.

Four remnant EVCs were identified: Box Woodland; Floodplain Riparian Woodland; Plains Grassland; and Plains Grassy Woodland. The main distribution of all these EVCs is outside the Central Highlands. They are especially vulnerable to degradation from disturbance which affects their species composition or which introduces pests or pathogens.

Three EVCs and selected examples of a fourth EVC were identified as important for relictual flora: Cool Temperate Rainforest; Subalpine Complex; Wet/Swamp Heathland; and examples of Wet Forest within identified refugial areas.

Only one EVC in the region, Plains Grassland, was identified as nationally rare - Plains Grassland, occurs almost entirely on private land in the Central Highlands.

A number of attributes related to individual species of significance have also been considered including: rare and threatened species, species at the limit of their range, endemic species and those whose Central Highlands population is disjunct from the main population of the species.

Fauna

The fauna values of the region are of particular interest. Both of the State's faunal emblems (Leadbeater's Possum and the Helmeted Honeyeater) are believed to be confined to the region. A number of other threatened species are also found within the region. In many cases there is a relationship between threatened fauna and threatened vegetation communities. For example, the western edge of the Central Highlands includes remnants of the Melbourne Plains vegetation communities. The extent of these communities has been substantially diminished through the establishment and continued development of Melbourne. A number of threatened species, dependent on these vegetation communities, were identified in the analysis.

Due to the disturbance history of the region and the large number of species dependent on forest ecosystems, the analysis included the development of a fauna habitat model to address a number of the national estate criteria. These included areas of species richness and key fauna habitats for a wide range of species.

Additionally a number of values relating to individual species attributes and endemism were also identified.

Other Natural Values

Places important as refuges from climatic change, as refuges from drought and frequent fire, as research, teaching or type localities, and as sites of geological or geomorphological significance were also assessed.

Two types of refuges from climatic change were identified:

- high altitude areas which provide a suitable environment for cold-dependent species and communities (subalpine and montane plateaux); and
- south to south-east facing valleys, which provide a suitable climate for wetter forest types, including Cool Temperate Rainforest, Wet Forest and Damp Forest.

Places important as refuges from drought and frequent fire are strongly associated with higher altitudes, rivers and streams (riparian and rainforest EVCs), and older growth classes of Wet Forest and Montane Wet Forest.

Places important as research, teaching or type localities included:

- Teaching sites where teaching is occurring or had taken place, where the primary aim of that teaching was to increase understanding about Australian natural history;
- Type Localities - Biological, where the locations of type specimens are internationally recognised and are important for taxonomic reference; and
- Type Localities - Geological localities for fossils and stratigraphic sections.

The majority of geological sites were small features such as cuttings or quarries. However, in some cases an entire geological formation was identified. The Baw Baw Plateau is the most notable example. Four geomorphological sites, all large-scale features, were identified.

Cultural Values

Cultural values include social, aesthetic, historic and Aboriginal values. The most extensive cultural value identified in the Central Highlands comprises areas with high aesthetic values. Most of them are well-known national parks (eg Baw Baw, Kinglake and the Dandenongs), state parks and scenic reserves, comprising landscapes of forest, waterfalls, mountains and major river corridors. Many of the other places of aesthetic value identified were comparatively small in area and included waterfalls, walks, lookouts and scenic drives.

More than 200 significant historic places were identified, reflecting the richness and complexity of the region's history. Some forest areas are particularly rich, in that they contain remains from different periods of history or extensive remains, and so are important cultural landscapes. Three examples follow:

- Significant mining landscapes such as the Jordan Valley result from a gold mining boom of the 1860s which was responsible for the series of tracks which opened up the region for settlement.
- The Yarra track provided a direct route from Melbourne to the Jordan Valley and was the origin of the road from Healesville, through Marysville to Matlock and Woods Point. The road is renowned for providing a scenic route through the forested landscape, particularly at Blacks Spur.
- The sawmills of the Rubicon forest, such as the innovative Clark and Pearce No. 1 mill, typified bush sawmilling in Victoria's mountains, with isolated and temporary sawmill settlements deep in the forest, serviced by tramways which linked up to the Victorian railway system.

The region also contains significant early engineering works and features of aqueducts, weirs and tunnels that comprise part of Melbourne's water supply system. Little known forest history is reflected in the WWII internment camps, such as the Kinglake West POW camp. More recent history is represented by the Bend of Islands Environmental Living Zone, a significant 1950s experimental community settlement that was the first of its kind in Australia.

A particular cultural theme of the Central Highlands region is 'forest fire'. The cataclysmic fires of 1939 have been engraved in local community memory and a number of fire disaster sites were identified from community and history sources. The Fitzpatrick Mill Tragedy Site where fifteen people perished and the Toolangi Fire Origin site are examples of these places. There are no tangible historic features left from the fires, but the areas have a very strong association with community memory and meaning.

The active participation of local Aboriginal communities is regarded as an essential part of the identification and assessment process for Aboriginal places, especially in relation to verification of levels of significance. Local Aboriginal communities are currently being consulted regarding the values identified through the assessment undertaken during 1993/94. A number of Aboriginal places with traditional and historic associations were identified, such as hunting and gathering places, missions and reserves, massacre sites and pastoral properties.

15.5 THE PROTECTION AND MANAGEMENT OF NATIONAL ESTATE VALUES IN THE CENTRAL HIGHLANDS

One of the objectives of the national estate assessment was to assess the protection of all national estate values within the region. The effectiveness of the protection depends on the nature of the value. For example, the conservation of historic mining sites can be undertaken through sympathetic management in timber production areas, while conservation of natural landscapes is best ensured through their inclusion in the dedicated reserve system.

The first step in assessing the protection of national estate values was to determine which values were sensitive or potentially sensitive to a range of disturbances, as described below. The second step was to determine which reserve types provided protection for these values (see the draft National Estate report (AHC and CNR 1994a). The third step was to determine the current reservation status of these values. The final step was to determine which legislative mechanisms provide additional protection for these values.

Sensitivity of National Estate Values to Disturbance

In many instances, disturbance of one type or another has been integral to the application of the threshold for various national estate values, for example, natural landscapes and principle characteristics of class.

While the focus for the assessment is timber harvesting, various other types of disturbance occur in the region which affect national estate values. Many of the EVCs which occur in the region do not contain timbers which are harvested for sawlogs, but some may be subject to removal of trees for fence posts and poles or may have been disturbed through past mining or grazing activities. In some areas intensive recreation uses have also impacted on identified national estate values.

Reserve Analysis

This analysis identifies the extent to which a particular value occurs within the conservation reserve system. Values of a local nature, such as localities for rare fauna, have not been included. The reason for this is that sensitivity to disturbance varies depending on the species, and that the proportion of known locations in reserves is not necessarily a good indication of the conservation status of the value. Tables 15.1-15.2 indicate the reserve status of natural values in the Central Highlands RFA region.

Off Reserve Protection Mechanisms

A number of State and Commonwealth legislative and other administrative mechanisms also provide protection of natural and/or cultural national estate values. These mechanisms are frequently referred to as 'off reserve mechanisms' or practices that contribute to ecologically sustainable forest management.

The following mechanisms provide the framework for the protection of various natural and/or cultural values:

- Proposed Forest Management Plan Central Highlands 1996;
- Code of Forest Practices for Timber Production (Rev No 2) 1996;
- *Flora and Fauna Guarantee Act 1988*;
- *Endangered Species Protection Act 1992*;
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*;
- *Aboriginal and Archaeological Relics Preservation Act 1972*; and
- *Heritage Act 1995*.

An important component of the protection of cultural values includes the guidelines to be developed, in consultation with AAV and Aboriginal community representatives, for the management of cultural heritage values in the forests, parks and reserves of Central Highlands with input from regional forest officers and Parks Victoria rangers. Cultural heritage management guidelines were developed for the protection of cultural values identified in the national estate study, as part of the CRA process in East Gippsland (draft *Guidelines for the Management of Cultural Heritage Values in the forests, parks and reserves of East Gippsland*, Commonwealth of Australia and NRE, unpublished). The guidelines outline processes to be followed by NRE Forest and Parks Officers in managing cultural sites. It is envisaged that similar guidelines will be developed for the Central Highlands.

Summary of Protection of National Estate Values

Table 15.1 summarises the existing reservation status of identified national estate values across the region. Table 15.2 identifies those values by Geographic Representation Unit. As noted above, the levels of reservation in combination with other protection mechanisms contribute to the overall protection of national estate values, including those that are sensitive to disturbance.

Map 5 shows the areas identified as having national estate value. The map outlines:

- areas that contain extensive natural values; and
- areas or locations of cultural or restricted natural values.

Data and time limitations precluded assessment of all National Estate values on private land. Mapped areas on private land depicted as having significance for certain National Estate values are indicative only and more intensive work involving local councils, State authorities and the community would be necessary before their National Estate significance can be confirmed.

15.6 CONCLUSION

This national estate assessment has produced five main outcomes:

- a regional approach to identification of National Estate values, assessing both natural and cultural heritage values across the Central Highlands forests;
- a comprehensive information base for a wide range of national estate values on public land within the region;
- a firm basis on which to incorporate the national estate values into the assessment process for the Central Highlands RFA;
- an analysis of protection mechanisms for national estate values in the region; and
- the integration of cultural assessments with those of the natural environment. The forests of the Central Highlands have both cultural and natural heritage significance and these are strongly inter-related.

The results of this national estate assessment will be used during the integration phase prior to development of the RFA.

Places endorsed by the Australian Heritage Commission will be entered on the National Estate interim list; they will then be advertised and be subject to the statutory period of three months allowed for public comment. It is anticipated that interim listing of places identified through this process will occur after the Central Highlands Regional Forest Agreement is signed later this year. No listing action will be undertaken on private lands without additional work in consultation with landowners and this would not be done prior to the signing of the RFA.

Areas identified in the draft National Estate report (AHC and CNR 1994a) as having potential National Estate value are indicative only. They are not the delineated forest areas that will be listed in the Register of the National Estate. The draft National Estate report documents the values that need to be taken into account in determining National Estate places; the data in the draft National Estate report will form the basis of that determination. The data layers and indicative places will remain indicative until they have been considered by the Australian Heritage Commission.

Places already in the Register of the National Estate and those on the interim list will be updated in the context of information gathered during the national estate study.

Table 15.1: Reservation of National Estate values in the Central Highlands

Please refer to footnotes at the end of the 3rd page of this table for explanation.

National Estate Value (i)	Total ha (Public land only)	Reserves (ii)	SPZ Non code (iii)	Area in existing or proposed reserves	% in reserves	SPZ Code
Endemic Fauna (A1)	7,093	5,214	395	5,609	79.1	277
Refuges from Drought and frequent Fire (A2)	57,810	27,367	14,564	41,931	72.5	3,983
Key Fauna Habitats (A2) *	25,592	12,746	3,936	16,682	62.6	1,252
Modelled and observed Fauna Richness (A3)	88,329	21,983	16,649	38,632	43.7	4,078
Habitats of Rare or Threatened Species (B1) *	73,347	36,991	8,729	45,720	49.5	2,633
Rare and Uncommon Fauna Habitats (B1) *	45,694	23,766	6,681	30,447	64.2	2,322
Rare Fauna Habitats *	4,983	2,476	1,179	3,655	71.7	76

Uncommon Fauna Habitats *	40,712	21,290	5,502	26,792	63.3	2,246
Relictual EVCs (A1) *	38,557	23,132	6,515	29,647	75.3	1,585
Cool Temperate Rainforest (iv) *	11,890	5,676	3,710	9,386	78.6	1,010
Wet Forest *	21,776	12,951	2,669	15,620	69.7	538
Subalpine complex *	1,795	1,574	128	1,702	94.8	29
Wet and Swamp Heathland *	3,096	2,931	8	2,939	91.4	0
Endemic Flora (A1)	16,308	10,873	1,086	11,959	73.3	374
Limit of Range Flora (A1) *	41,327	19,528	4,244	23,772	54.0	1,528
Disjunct Flora (A1)	6,846	5,011	373	5,384	78.6	140
Remnant EVCs (A2) *	1,292	592	91	683	24.3	11
Box Woodland *	33	33	0	33	100.0	0
Plains Grassy Woodland *	271	35	0	35	12.5	0
Floodplain Riparian Woodland *	988	524	91	615	38.3	11
Plains Grassland *	0	0	0	0	0.0	0
Places Important for Succession (A2)	20,325	18,298	1,272	19,570	96.3	196
Modelled Flora Richness (A3)	26,724	6,470	5,932	12,402	46.4	2,750
Remote and Natural Areas (B1)	12,295	12,295	0	12,295	100.0	0
Natural Landscapes (B1) *	98,526	72,369	9,852	82,221	83.4	1,642
Old Growth Forest (B1) *	24,176	14,074	6,542	20,616	85.1	1,776
Montane Wet and Wet Forest *	6,024	5,769	242	6,011	99.2	38
Damp Forest *	475	257	213	470	98.9	72
Dry Forest EVCs *	1,934	1,705	217	1,922	99.4	20
Other Forest Types *	15,743	6,343	5,870	12,213	77.6	1,646

Table 15.1: (cont.)

National Estate Value (i)	Total ha (Public land only)	Reserves (ii)	SPZ Non code (iii)	Area in existing or proposed reserves	% in reserves	SPZ Code
Representative EVCs (D1)	124,233	86,216	13,302	99,518	80.1	2,956
Montane Dry Woodland	2,377	141	1,535	1,676	70.5	44
Montane Damp Forest	2,984	1,064	576	1,640	55.0	40
Montane Wet Forest	8,924	7,898	149	8,047	90.2	55
Montane Riparian Thicket	1,451	759	283	1,042	71.8	235
Cool Temperate Rainforest (iv)	3,153	2,821	183	3,004	95.3	89
Wet Forest	21,508	19,682	299	19,981	92.9	282
Damp Forest	21,666	15,177	1,959	17,136	79.1	677
Riparian Forest	4,356	2,450	1,222	3,672	84.3	328
Herb-rich Forest	19,032	8,255	3,684	11,939	62.7	563
Valley Forest	1,129	807	0	807	71.5	0
Heathy Dry Forest	5,269	2,873	1,640	4,513	85.7	416
Grassy Dry Forest	9,507	6,052	703	6,755	71.1	55
Rocky Outcrop Scrub	195	195	0	195	100.0	0
Subalpine Complex	831	785	3	788	94.8	11
Subalpine Woodland	3,140	2,499	306	2,805	89.3	9
Heathy Woodland	4,036	3,184	88	3,272	81.1	80
Wet and Swamp Heathland	2,806	2,759	0	2,759	98.3	0
Box Woodland	33	33	0	33	100.0	0
Plains Grassy Woodland	271	35	0	35	12.9	0

Floodplain Riparian Woodland	20	5	0	5	25.0	0
Shrubby Foothill Forest	7,875	6,470	62	6,532	82.9	30
Heathy Foothill Forest	3,146	2,247	111	2,358	75.0	42
Riparian thicket	524	25	499	524	100.0	0

Table 15.1: (cont.)

National Estate Value (i)	Total ha (Public land only)	Reserves (ii)	SPZ Non code (iii)	Area in existing or proposed reserves	% in reserves	SPZ Code	SM
Geology							
Geological evolution etc. (A1)	0	0	0	0	0.0	0	
Geological Processes (A2)	0	0	0	0	0.0	0	
Geological Diversity (A3)	0	0	0	0	0.0	0	
Uncommon/Rare Geology (B1)	0	0	0	0	0.0	0	
Research and Teaching Sites (C1)	42	22	1	23	54.8	1	
Principle Characteristics of Class (D1)	0	0	0	0	0.0	0	
Geomorphology							
Landform Evolution (A1)	13,487	8,146	861	9,007	66.8	453	6
Landscape Processes (A2)	11,974	6,692	861	7,553	63.1	442	6
Landform or Geomorphic Diversity (A3)	11,918	6,677	861	7,538	63.2	433	6
Uncommon/Rare Geomorphology (B1)	56	15	0	15	26.8	9	
Research and Teaching Sites (C1)	13,760	8,146	861	9,007	65.5	499	6
Principle Characteristics of Class (D1)	13,940	8,146	861	9,460	67.9	453	6
Cultural Values							
Places of aesthetic value (E1)	48,173	39,693	3,668	43,361	90.0	400	1
Natural History							
Type Localities and Research Areas etc. (C1)	40,728	32,773	1,801	34,574	84.9	472	7

i) Only area based National Estate values have been analysed, linear and point features are not included in this analysis. The 1993 National Estate values for the RFA region - while area statements in this table relate to the RFA area some reanalysis of values has been undertaken using the most recent pre-1750 analysis. This means that values are not directly comparable between this table and Tables 12.3, 12.5, 13.2 and 13.3. ii) The reserves and other nature conservation reserves. iii) The Special Protection Zone includes categories a, b and c as defined in Section 12.4 of the IEP. The process used by the study tends to exaggerate the true extent of linear EVCs, sometimes by as much as an order of magnitude. Figures

* These values have been assessed across all land tenures.

16. WORLD HERITAGE

16.1 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 Central Highlands 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 are the most outstanding of their kind in the world 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 required criteria 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).

16.2 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).

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 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..

16.3 OUTCOMES

The outcomes of the Expert Panel's work are summarised in table 16.1 below.

The panel identified five potential 'places' in Victoria which warrant further investigation.

Two of these places are potentially relevant to the Central Highlands, namely:

- parts of the Australian marginal swells associated with the Eastern Highlands; and
- areas with outstanding examples of *Eucalyptus*-dominated vegetation associated with the Eastern Forests of Victoria.

Neither of these places is contained entirely within the Central Highlands. Each includes parts of other Victorian RFA regions and areas beyond Victoria. Any assessment of potential World Heritage values in these places (Steps C-E of the methodology) needs to be undertaken in this broader context. For this reason, it will not be feasible to carry out an assessment of World Heritage values in these places in the Central Highlands RFA.

The Commonwealth and Victoria remain committed to carrying out such an assessment in this broader context in co-operation with all states involved after these states have carried out Step A and Step B of the methodology.

Table 16.1: Summary of World Heritage themes, subthemes 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 Subthemes/ Exemplars	Explanatory Sentence	Australian Forest Subthemes/ Exemplars	Potential places in Victoria warranting further investigation
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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 Subthemes/ Exemplars	Explanatory Sentence	Australian Forest Subthemes/ 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 Subthemes/ Exemplars	Explanatory Sentence	Australian Forest Subthemes/ 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

STEP A				STEP B
Australian Themes of Outstanding Universal Value	Australian Subthemes/ Exemplars	Explanatory Sentence	Australian Forest Subthemes/ Exemplars	Potential places in Victoria warranting further investigation
Encounter between cultures		Australia provides examples of the encounter between hunting-and-gathering societies and nineteenth century European societies.		
European expansion of the eighteenth and nineteenth centuries	Forced migration - a major way in which the expansion took place	Convict transportation to Australia is an outstanding example of how European powers initiated the occupation of an entire continent.	Forced migration - a major way in which the expansion took place	
	Integration of an economic system and the resources of a continent into the global economy	The Australian goldrushes are an outstanding example of the global migrations associated with the nineteenth century goldrushes.	Integration of an economic system and the resources of a continent into the global economy	Goldrush sites associated with the Central Goldfields of Victoria
Masterpiece of human creative genius				
Outstanding example of a type of building/ technological ensemble or landscape				

17. ECOLOGICALLY SUSTAINABLE FOREST MANAGEMENT

The following is a summary of an independently assessed report on ecologically sustainable forest management in Victoria. The full report is available on request.

The report is only part of the overall assessment of ecologically sustainable forest management and together with community input, it will provide a starting point for Commonwealth and State consideration and determination of sustainable forest management in subsequent 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 Victorian RFA Steering Committee or of the Commonwealth or Victorian Governments.

17.1 INTRODUCTION

Ecologically sustainable 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 (EGRFA, 1996b).

The National Forest Policy Statement proposes to give effect to ecologically sustainable forest management through:

1. Integrated planning processes and management systems.
2. Codes of Practice and environmental prescriptions.
3. Management plans incorporating sustainable yield harvesting practices.
4. Management of native forests outside the reserve system complementing the objectives of nature conservation reserve management. (Commonwealth of Australia 1992b, p.12).

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:

1. the methodology used in the Statewide assessment;

2. a statement on ecologically sustainable forest management for the Central Highlands RFA Region. The complete Statewide assessment report is published as part of the Comprehensive Regional Assessments for Central Highlands (VicRFASC, 1997a);
3. a summary of the outcomes of the assessment based on five environmental management system components in relation to the ecologically sustainable management criteria; and
4. an overall appraisal of Victoria's forest management systems and processes.

Method of 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 17.1).

Preparation of the Statewide report was undertaken by a Project Management Group consisting of Commonwealth and Victorian officials under the guidance of the Victorian 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 state-wide 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.*

Central Highlands Forest Management Systems and Processes

As part of the CRA for the Central Highlands a consideration of the forest management systems applicable to that region was undertaken, against the Statewide review of ESFM (VicRFASC 1997a) to identify any issues or systems that are specific to the Central Highlands. It is considered that the Statewide review of ESFM is applicable to the Central Highlands, with only limited exceptions or additions.

A proposed Central Highlands Forest Management Plan has been released for public comment prior to its finalisation. It is an integrated regional plan developed with assistance from Forest Management Area Advisory Committees from the three Forest Management Areas included in the region. The Plan proposes a framework for the future management of the forests of Central Highlands 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.

In addition to the planning arrangements which comply with Statewide processes, extra measures are applied for the protection of the Melbourne water supply. Amendments to the

National Parks Act for protection of the quality of the Melbourne water supply are discussed in detail in the Chapter 9. Special Water Supply Catchment Areas, such as the LaTrobe and Thomson River Basins and Yarra catchments, have been identified in the Region. Special Area Plans place specific requirements on forest management for the protection and maintenance of these catchments.

Description of the Environmental Management System Framework used for the Assessment

The 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 17.2). The ISO 14000 series environmental management system operates at an organisation² level and has the potential to contribute to an internationally acceptable system for certification of forest management and labelling 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.

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

²An 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.

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 17.1).

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.

17.2 SUMMARY OF ASSESSMENT

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). On private land, the legislation requires regional level planning, adherence to the Code of Practice for Timber Production 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).

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.

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.

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 has recently been passed by the Victorian Parliament 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 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 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, 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 (VicRFASC 1996b). 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 State-wide minimum standards and therefore cannot address regional variation. The development of regional prescriptions that build on 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;
- 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, for example, 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, 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 State-wide 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;
- 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.

17.3 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 17.1). 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 Victoria 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.’

Table 17.1: Management System Structure and Criteria for Assessment of Ecologically Sustainable Forest Management.

Criteria for assessment of management system elements and sub elements	
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>Scrutiny: Type and level of scrutiny - parliamentary, administrative.</p> <p>Consultation: 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>Access to information: Process for access to information.</p> <p>Public involvement: Opportunity for individual stakeholder or community groups to be involved in the decision-making process.</p> <p>Reporting: Mechanism for reporting of processes and outcomes for all system criteria.</p>
Monitoring	<p>Trend measurements: Process for assessment of change.</p> <p>Monitoring regimes: Process for regular monitoring of indicators.</p> <p>Standards: Process for designation of quantifiable measures against which the quality or performance of a characteristic or attribute is assessed.</p> <p>Performance targets: Process for designation of specified goals.</p> <p>Performance verification: Process for ensuring achievement of standards and targets</p>
Compliance	<p>Audit arrangements, penalties, incentives: Processes that ensure compliance with stated goals or objectives.</p>
Scientific and technical basis	<p>Mechanism for assessing adequacy of information (eg scientific/peer review); Process for incorporation of information into decision making process.</p>
Review	<p>Mechanism for review, feedback and continual improvement, internal/external, periodicity.</p>

Table 17.2: Forest Management Systems and Processes in Victoria

<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> Regional Forest Agreements Land Use Planning - Public land <i>Forest management planning - public land</i> Forest Management Plans (State forest) Victorian Code of Forest Practices Regional prescriptions Sustainable Yield Wood Utilisation plans Forest coupe plans Log grading <i>Park planning</i> Park Plans <i>Private land</i> 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 <i>Fire management planning</i> Code of Practice for Fire Management Regional Fire Protection Plans <i>Flora and Fauna planning</i> Flora and Fauna Guarantee Recovery Plans</p>	<p>2. PLANNING (continued) <i>Cultural values</i> Aboriginal places Historic places <i>Exploration and Mining</i> Environmental Effects Statements Planning Permits Work Plans Environmental Review Committees <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> 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 <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 *East Gippsland Independent Advisory Group Report on Ecologically Sustainable Forest Management, Systems and Processes*.

COMMONWEALTH LEGISLATION

Aboriginal and Torres Strait Islander 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 on unprocessed wood Regulations

These regulations provide the Commonwealth with a mechanism with which to impose environmental conditions on harvesting operations for the export of unprocessed wood. 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.

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.

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.

Environmental 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 co-ordinated 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 1968

This Act covers the Commonwealth/State management of fisheries, commercial and amateur licences, fish culture, noxious fish research and development, enforcement and legal proceedings. A licence is required to fish in inland waters under this Act, including within forested catchments. The *Fisheries Act 1995* has also recently been passed, but is yet to be fully proclaimed. In the interim, the provisions of the original Act continue to apply.

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 1996a) 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 which 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 Act 1970

The Land Conservation Act 1970 established the Land Conservation Council as an autonomous body to carry out investigations and make recommendations to Government on, 'the use of public land which provides for the balanced use of all land in Victoria'. In so doing, the Council must have regard to the present and future needs of the community for preservation of areas of conservation and recreation value, and take into account the social and economic implications of its recommendations.

An Environment Conservation Council Bill, currently with the Victorian Parliament, proposes to repeal the Land Conservation Act and establish an Environment Conservation Council to conduct investigations into the use or development of public land within Victoria. The Bill proposes that the repeal of the Land Conservation Act would not affect the continuing operation of any recommendation made under that Act. Current LCC investigations, such as the Box-Ironbark investigation, will be referred to the Environment Conservation Council.

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.

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.

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.

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 co-operative 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

Richard Rawson (co-chair)	Department of Natural Resources and Environment (NRE)
Janice Stanford	Department of Premier and Cabinet
Ian Miles	NRE, Forests Service
Gerard O'Neill	NRE, Forest Service

Commonwealth

Conall O'Connell (co-chair)	Department of Prime Minister and Cabinet (PM&C)
Anne-Marie Delahunt	Environment Australia (EA)
Allen Grant	Department of Primary Industries and Energy (DPIE)
Tom Aldred	PM&C

JOINT COMMONWEALTH-VICTORIA TECHNICAL COMMITTEE

Victoria

Ian Miles (co-chair)	NRE, Forests Service
Rod Anderson	NRE, Parks, Flora and Fauna
Daniel Catrice	NRE, Parks, Flora and Fauna
David Clarke	Aboriginal Affairs Victoria
Doug Hooley	NRE, Parks, Flora and Fauna
Sue Houlden	NRE, Forests Service
Bruce Kilgour	NRE, Forest Service
Adrian Moorees	NRE, Parks, Flora and Fauna
Ross Potter	NRE, Forests Service
Phil Roberts	NRE, Minerals and Petroleum
Brian Thompson	NRE, Forest Service
Kylie White	NRE - Gippsland Region

Commonwealth

Michael Stephens (co-chair)	DPIE
Terence Uren (co-chair)	EA
Tom Aldred	PM&C Forest Taskforce
Sheridan Coakes	DPIE
Maria Cofinas	EA
Geoff Dyne	EA
Peter Gooday	DPIE, Australian Bureau of Agriculture and Economics
Roger Hall	EA
Keith Lamb	DPIE, Bureau of Resource Sciences (BRS)
Yannis Miezitis	DPIE, BRS
Tracy Pateman	PM&C Forest Taskforce
Pam Robinson	DPIE, Community Coordinator
Katie Saxby	EA
Felix Schlager	EA
Phil Tickle	DPIE, BRS
David Woods	PM&C Forest 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

(NRE 1996d)

APPENDIX 4. POTENTIAL MINERAL RESOURCES ASSESSMENT SUMMARY

Deposit type	Summary description of mineral tracts
Slate belt gold	The tract is based on the distribution of Ordovician, Silurian, Siluro-Devonian and Devonian turbidites and their metamorphic equivalents. These rocks are favourable for hosting slate-belt vein gold mineralisation. The tract also contains known slate-belt vein deposits and the known occurrences of disseminated gold deposits.
Disseminated gold	The tract is based on the distribution of the same rock suites as for slate belt gold. These rocks are favourable for hosting slate-belt vein gold mineralisation with a potential to form haloes of disseminated and stockwork gold mineralisation around mineralised veins.
Epithermal gold and silver	The tract contains intrusive, volcanic and volcanoclastic rocks favourable for generating epithermal systems. More importantly the tracts have favourable structures, characteristic of several well-known mineralised epithermal systems. However no large scale hydrothermal alterations typical of epithermal systems have been reported. Similarly, no mineral occurrences of epithermal gold-silver mineralisation are recorded. The Barkley River Greenstone belt may underlie the Central Highlands region at depth. The potential of epithermal mineralisation in such greenstones is unknown. The tract for epithermal gold-silver deposits has an unknown potential for porphyry copper deposits.
Coal	The tract has been delineated by the boundary of the Moe Swamp Basin, about two thirds of which lies in the Central Highlands, and the Latrobe Valley Depression, just outside the Central Highlands. It contains large areas of Late Tertiary and Quaternary sediments overlying extensive coal seams. Known resources for the Moe Swamp Basin are very large. Drilling in the Yarragon Formation has confirmed the presence of the coal seams at depth over a wide area and has identified some resources of economic interest. It is possible that structures at depth that are not recognised at the surface, such as the Moe Monocline, could cause thickening of the coal seams which would improve their economic viability.
Limestone	The presence of Siluro-Devonian undifferentiated marine sediments and Early Devonian marine sediments delineates the tract. Known deposits occur along, and just outside, the eastern boundary of the Central Highlands. The Lilydale limestone deposit contains some dolomitic horizons.
Kaolin	The kaolin tract is delineated on the distribution of Tertiary and Quaternary sediments in which secondary clay deposits may occur. Lack of information at the scale of this assessment precludes the delineation of remaining primary Tertiary kaolin deposits. All known deposits of kaolin are outside the Central Highlands. Secondary kaolinitic clay deposits are known below brown coal seams in the Morwell and Yallourn open cut mines (McHaffie & Buckley, 1995). Similar clay seams are likely to be present in the Central Highlands as part of the brown coal bearing Moe Swamp Basin.
Nickel-copper	The Woods Point dyke swarm has the potential to host small nickel-copper deposits wherever thickenings in the dykes occur. The dykes contain mineralisation characteristic of this model type, hence the outcrop area of the Woods Point Dyke Swarm is assessed as having moderate to high potential.
Construction materials	Most of the Central Highlands rock types have high potential for lower grade/value construction materials in their fresh or weathered state and soil, sand and gravel are widespread. Suitable materials include: rippable sandstone, shale, schist and other rock, volcanic scoria and tuff, sand and gravel and soil and calcrete. The potential for economic deposits of higher value construction materials is delineated by areas of granite, basalt, acid to intermediate volcanics and hornfels rocks which provide potential for crushed hard rock. Basalt and granitic rock areas have potential for dimension stone, depending on the availability of high quality material within a particular rock body. Potential for suitable bodies of construction sand, clay and clay shale lie within Tertiary and Quaternary age sediments. Extensive alluvial clay deposits are associated with brown coal at Morwell just outside the region and may extend into the Central Highlands as do the brown coal basins.

PALAEOZOIC

Geological timescale		Age (Ma)	Sedimentation and associated volcanics	Magmatism	Major geological events	Main Metallic
PALAEOZOIC	Permian	251			erosion of	
		298			landsurface	
	Carboniferous	354	Mansfield Group		Kanimblan deformation	
			red beds	caldera volcanics		Slate belt
	Devonian		sandstone, siltstone, limestone	granitoid intrusion		gold
		410		Woods Point dyke swarm	Tabberabberan deformation	Dissem. & Epithermal gold
					Mount Wellington Fault Zone	Cu -Ni (Thompson)
	Silurian	434	siltstone, sandstone		Heathcote Fault Zone	
	Ordovician	490	Eastern area - sandstone mudstone, shale. Western area - mainly black shale			
	Cambrian	545	'Greenstones' chert volcaniclastics mafic volcanics			Epithermal gold Chromite Copper in basic
Precambrian						

(Ma) Million years ago

Mesozoic Era and Cainozoic Era (Gippsland Basin)

		Geological timescale	Age (Ma)	Sedimentation and associated volcanics	Magmatism	Major geological events	Metal
CAINOZOIC		Quaternary	1.78	Haunted Hills Fm			
		Tertiary	65	Yarragon Fm coal, clay, sand, basalt Thorpdale Volc's Childers Fm: brown coal, sands, clays & gravels	Thorpdale Volcanics - basalt	Gippsland Basin Moe Swamp Basin	Sandstone uranium
MESOZOIC		Cretaceous	141	Strzelecki Group sst, mdst, congl.		faulting, uplift, erosion of landsurface Gippsland Basin Strzelecki Group	Sandstone uranium
		Jurassic	205			erosion of landsurface	
		Triassic	251				

(Ma) Million years ago