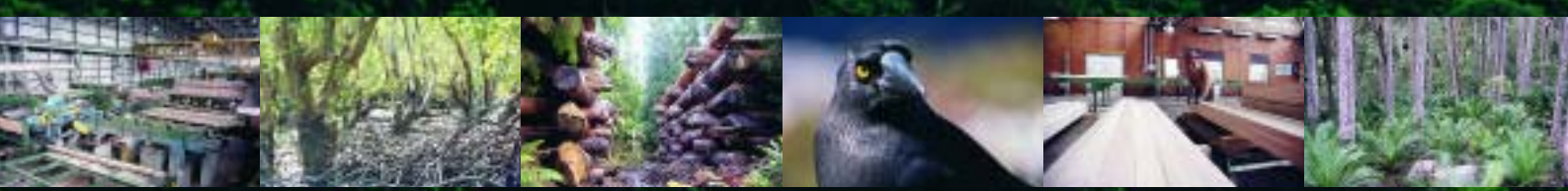
# Australia's State of the Forests Report 1998



# Australia's State of the Forests Report 1998

National Forest Inventory

Bureau of Rural Sciences

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Bureau of Rural Sciences
PO Box E11
Kingston ACT 2604

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The Bureau of Rural Sciences is a professionally independent scientific bureau within Agriculture, Fisheries and Forestry - Australia (AFFA). Its mission is to provide first-class scientific assessments, analysis and advice to enable AFFA to achieve its vision — rising national prosperity and quality of life through competitive and sustainable agricultural, fisheries and forestry industries.

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# *Foreword*

Forest issues remain high on the public agenda. Concerns range across economic, social, cultural, and conservation matters. Sound decisions as well as soundly based opinions depend upon access to factual information. Australia's first national *State of the Forests Report* aims to provide factual information at the State, Territory and national levels for a wide range of forest values. I believe that it will make an important contribution to identifying and implementing the national interest in whole-of-forest management.

The national *State of the Forests Report* was called for in the *Ecologically Sustainable Development Strategy* (1992) and the *National Forest Policy Statement* (1992). It is to be a report to the public, published every 5 years. The present report was compiled by the Management Team of the National Forest Inventory, which is based in the Bureau of Rural Sciences. The National Forest Inventory represents the forestry and conservation agencies of the Commonwealth Government as well as all the States and Territories. Together, these agencies have compiled the most comprehensive factual information about forests currently available, and presented it in a form that can be used primarily by the general public, but by specialists as well.

For the first time in the public arena, this Report covers all of the forests of Australia. All previous summaries have tended to focus on forests or forested regions from which timber was harvested for commercial operations. Other forests, some have been called 'woodlands', have generally been ignored in forest reports. Now, following the definition of forest agreed upon in the *National Forest Policy Statement*, the full extent of forested lands is formally recognised. This view will make it easier for land managers, and others interested in the Australian landscape, to appreciate fully the extent and diversity of forested lands in this country.

Compiling this Report has not been easy. Much of the information contained here has not been reported on comprehensively before or was not available in standard formats. During the preparation of the report, many significant gaps in our information base about Australian forests were exposed. Many of these gaps are noted within the text of this document. Also, extensive new information that was gathered during the currently ongoing comprehensive regional assessments of forests has not been included here. This information will be analysed and presented in the next *State of the Forests Report*.

This *State of the Forests Report* will be of value to general readers with an interest in forests as well as many others with professional needs for a broad overview of our forests. It will provide a base line against which to evaluate changes in forests, how we use forests, and how much we know about forests.

PETER O'BRIEN
Executive Director
Bureau of Rural Sciences

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# *Acronyms*

| | |
|---|---|
| ABARE | Australian Bureau of Agricultural and Resource Economics |
| ABS | Australian Bureau of Statistics |
| ANCA | Australian Nature Conservation Agency |
| ANM | Australian Newsprint Mills |
| ANZECC | Australian and New Zealand Environment and Conservation Council |
| APEC | Asia–Pacific Economic Cooperation (forum) |
| AUSLIG | Australian Surveying & Land Information Group |
| CAR | Comprehensive and adequate reserve (system) |
| $CO_2$ | Carbon dioxide |
| CRA | Comprehensive regional assessment |
| CRC | Co-operative research centre |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| EMS | Environmental management system |
| ESOCLIM | Computer program that models climate |
| IBRA | Interim Biogeographic Regionalisation of Australia |
| IUCN | International Union for the Conservation of Nature and Natural Resources |
| NEFBS | North East Forests Biodiversity Study (Report) |
| NFI | National Forest Inventory |
| NFPS | National Forest Policy Statement |
| NGGI | National Greenhouse Gas Inventory |
| NP | National park |
| NWI | National Wilderness Inventory |
| RFA | Regional forest agreement |
| ROTAP | Rare or threatened Australian plants |
| TAFE | Technical and Further Education |

# Glossary

| | |
|---|---|
| Biodiversity | A concept encompassing the diversity of species and communities occurring in a given region. It includes 'genetic diversity', which reflects the diversity within each species; 'species diversity', which is the variety of species; and 'ecosystem diversity', which is the diversity of different communities formed by living organisms and the relations between them. Biological diversity is the variety of all life forms - the plants, animals and micro-organisms - the genes they constitute, and the ecosystems they inhabit. |
| Biogeography | The study of the distribution of living things |
| Biological diversity | See biodiversity |
| C+ log grades | Classification unit of native forest sawlog quality |
| Category 1/category 3 | Classification unit of native forest sawlog quality |
| Closed forest | Forest in which the tree crowns cover 81–100 per cent of the land area when viewed from above |
| Code of forest practice | A set of principles and standards that specify minimum acceptable practices in harvesting and associated forest management operations |
| Community | See plant community |
| Crown cover | Area of ground covered by tree canopies, ignoring overlaps and gaps within individual canopies |
| Crown cover density | See crown cover |
| Ecologically sustainable forest management | A complex concept with many definitions relating to the management of forests for a wide range of values for very long periods of time. |
| Ecosystem diversity | See biodiversity |
| Edge effect | In relation to forests, it refers to the extent of effects which non-forest environmental influences have upon the forest along the edges where forest meets non-forested land |
| Endangered species and communities | Species in danger of extinction and whose survival is unlikely if the factors causing population decline continue operating. |
| Farm forest plantings | Deliberate establishment of trees on cleared farm land for environmental or commercial reasons |
| Forest | An area, incorporating all living and non-living components, that is dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding 2 metres and with existing or potential crown cover of overstorey strata about equal to or greater than 20 per cent. This definition includes Australia's diverse native forests and plantations, regardless of age. It is also sufficiently broad to encompass areas of trees that are sometimes described as woodlands. |
| Genetic diversity | See biodiversity |
| Geodiversity | The variety of different kinds of rocks, landforms and soils found in the natural world |

| | |
|---|---|
| Geographic information system | A computer-based system for spatially relating geographic data for analysis, presentation and storage. |
| Global carbon cycles | The movement of carbon between different parts of the Earth, including the storage of carbon in those parts |
| Greenhouse gases | Gases that affect the temperature of the Earth's surface and have a large bearing on the Earth's climate. They include water vapour, ozone, chlorofluorocarbons, carbon dioxide, methane and nitrous oxide. The 'enhanced greenhouse effect' refers to changes in the Earth's climate as a result of increasing levels of greenhouse gases in the atmosphere due to human activity. |
| High forest | A term previously used widely that refers to forest usually greater than 20 metres high at maturity and capable of producing commercial timber |
| Intergenerational equity in natural capital | Ensuring that future generations will have access to natural resources of the same health, diversity and productivity as those available to current generations |
| Lignotuber | Woody swelling at the base of the plant stem carrying buds by which the plant can regenerate |
| Low forest | Dominated by trees capable of a mature height ranging between 2 metres and 10 metres |
| Medium forest | Dominated by trees capable of a mature height ranging between 11 metres and 30 metres) |
| Montreal Process | The informal agreement by the Montreal Process Group of countries (currently 12) to work towards the implementation of a comprehensive set of criteria and indicators for forest conservation and sustainable management |
| Old-growth forest | Ecologically mature forest where the effects of disturbances are now negligible. |
| Open forest | Forest in which the tree crowns cover 51–80 per cent of the land area when viewed from above |
| Plant community | Recognisable association of a number of plant species |
| Plantation | Intensively managed stands of trees of either native or exotic species created by the regular placement of seedlings or seeds. |
| Precautionary principle | Where there is a threat of serious or irreversible environmental damage, lack of full scientific certainty of that damage occurring should not be used as a reason for postponing measures to prevent it |
| Recruitment | Immature plants of the next generation |
| Regional forest agreement | An agreement about the long-term management and use of forests in a particular region between the Commonwealth and a State or Territory government. |
| Remotely sensed data | Data which is obtained with a sensor which is physically separated from the object. Such sensors rely upon the detection of energy emitted from or reflected by the object |
| Shannon contagion | A measure of an entire region that focuses on the texture created by the distribution of forest and non-forest patches. Fine texture refers to many small patches across the landscape while course texture refers to patches which are large and clumped |

| | |
|---|---|
| Species diversity | See biodiversity |
| Structure/forest structure | Refers to the characteristic of forests to have layers of canopies with the uppermost being formed by the tallest trees. There may be none, or one to several understorey layers. The character of the ground surface (amount of litter, presence of dead fallen wood, stoniness) and the presence of vines also contribute to forest structure. Structure is usually very important to the creation of habitat for a wide range of species |
| Suite of forest values | A group of related values |
| Sustainable yield | The amount of forest produce which is believed can be harvested in perpetuity |
| Tall forest | Dominated by tree species capable of a mature height greater than 30 metres |
| Tenure | Title to land as controlled by legislation |
| Vulnerable species and communities | Species believed likely to move into the 'endangered[' category in the near future if the factors causing population decline continue operating |
| Wilderness | Land that, together with its plant and animal communities, is in a state that has not been substantially modified by, and is remote from, the influences of European settlement or is capable of being restored to such a state; is of sufficient size to make its maintenance in such a state feasible; and is capable of providing opportunities for solitude and self-reliant recreation) |
| Woodland | Forest in which the tree crowns cover 20–50 per cent of the land area when viewed from above |

# Summary

This is the first national State of the Forests Report for Australia. It has two purposes: to describe, at a national level, the broad characteristics, location, extent and ownership of Australia's forests; and to provide baseline information indicating the status of these forests and the range of uses to which they are put.

This report uses a definition of forest based on the one contained in the 1992 National Forest Policy Statement, signed by all State and Territory governments and the Commonwealth. It is:

> *An area, incorporating all living and non-living components, that is dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding two metres and with existing or potential crown cover of overstorey strata about equal to or greater than 20 per cent. This definition includes Australia's diverse native forests and plantations, regardless of age. It is also sufficiently broad to encompass areas of trees that are sometimes described as woodlands.*

This definition is different from some previous widely used definitions in several important ways. In particular, it now encompasses woodland (20-50 per cent crown cover) and forest-forming mallees. These differences mean that Australia's view of its forests moves closer to the internationally accepted definition of forest. It now includes the major timber producing areas as well as those areas of trees that occur in largely agricultural and pastoral landscapes. The estimated forest area is now recognised as being close to 157 million hectares. This figure is expected to change when detailed work across the tropics is completed in about 2001.

This report has demonstrated that reasonable information is available for forests with multiple-use tenure, but is scarce for other tenures. Data on timber extraction could be collated nationally (mainly for multiple-use forests), but national-level information on other forest uses and services is largely unavailable. In addition, few data are available for use in this report to document the contemporary relationship between the forest and Indigenous peoples. This State of the Forests Report has demonstrated a good capacity to report on many issues relevant to forests, and has shown major gaps in capacities to report in other areas.

## History

Australian forests have a distinctive ecology determined largely over the course of geological time. What became the Australian continent broke from the land mass of Gondwana about 135 million years ago. Since then, changes in climate have influenced the evolution of Australia's forests, as have other events such as the rise and fall of seas and the eventual separation of New Guinea and Tasmania from the mainland 10-15 thousand years ago.

The arrival of humans in Australia at least 40 000 and perhaps over 100 000 years ago appears to have coincided with a significant increase in the incidence of fire on the continent. This has also affected Australia's forest ecology.

The colonisation and settlement of Australia by non-Indigenous cultures, primarily the British, altered the state of the forests significantly. Forests were cleared to make way for settlement, for agriculture and for pastoralism. Timber was harvested to meet the demands of colonial society, and the condition of the forest resource was also affected by activities such as the gold rushes of the mid-to-late 1800s.

From the middle decades of the nineteenth century through to the first quarter of the twentieth century, States enacted major legislation to conserve forests in perpetuity. They protected both conservation and production forests, thus protecting them from clearing for other land uses and ensuring their active management. In the last quarter of the twentieth century, extensive areas of primarily public forest were added to the forest conservation estate.

The economic boom that followed World War II created an intense demand for construction timber that was met largely from native hardwood forests. In addition, a pulp and paper industry grew rapidly, based on native species such as *Eucalyptus regnans* and *E. delegatensis* and a growing resource of plantation softwoods, particularly *Pinus radiata*.

In the 1970s a woodchip export trade from Australia's forests commenced with the

construction of large woodchip mills in southern New South Wales, Tasmania and Western Australia. Other woodchip operations started elsewhere later.

An environmental movement expanded rapidly in Australia from the 1960s. It criticised forest harvesting and clearing for their impacts on biodiversity and other forest values, including wilderness and old-growth. The movement also called for an end to harvesting in rainforests and an expansion of the national park system. Public controversies about the nature, extent and intensity of timber harvesting, particularly in public forests, continue to the present.

## The present extent of forest

Of the 910 plant communities generally recognised as occurring in Australia, 457 were considered to be forest communities for this report. These were grouped into eight broad native forest types: eucalypt, acacia, melaleuca, rainforest, casuarina, mangrove, callitris and 'other'. Plantation forests were treated in two additional categories: hardwood and softwood. Table A shows the total land area on which each of these forest types occurs.

Australia has a total forest area of close to 157 million hectares, made up of almost 156 million hectares of native forests and just over 1 million hectares of plantations. With a land area of almost 769 million hectares, this means that about 20 per cent of the continent is forested.

The biodiversity of Australia's forests is known to be high, even though many areas are yet to be carefully documented. There are 1239 vertebrate species and 13 622 higher plant species known from forested areas of the continent (Table B). There are no comprehensive lists of rare or threatened species available for forests as the habitat of species known to be rare or threatened has not been systematically recorded.

Australia's native forests can be categorised by their crown cover, which is determined by estimating or measuring the area of ground covered by tree canopies. In this report, three classes of crown cover are recognised: closed forest (81-100 per cent crown cover); open forest (51-80 per cent crown cover); and woodland (20-50 per cent crown cover). Table C shows the area of native forest in each of these classes, by State and Territory.

Five tenure categories are recognised in this report: conservation reserves; multiple-use forests; leasehold land; other crown land; and private forests. Table D shows the area of native forest in each of these tenure categories, by State and Territory.

Taking private and leasehold forests together, almost 70 per cent of native forests are on land managed by the private sector, while the rest are managed by government agencies, local governments or other instrumentalities.

Nearly 15 million hectares of eucalypt forest occur in conservation reserves and about 10.7 million hectares are classified as multiple-use. About two-thirds of all eucalypt forests, over 90 per cent of acacia forests, virtually all casuarina forests and more than half of all mangrove and callitris forests occur on private or leasehold land. Just over half of all rainforests are found on land designated as conservation reserve or multiple-use, and about 40 per cent occur on private or leasehold land.

Of the plantation estate, more than two-thirds is publicly owned and the remainder is private. The majority of softwood plantations are publicly owned, but more hardwood plantations are on private land than on publicly owned land. New South Wales, Victoria and Queensland contain the most plantations.

## Uses and disturbances

This report describes and quantifies, where possible, the uses to which we put forests and the disturbances imposed upon them by people.

Such uses may be cultural. Indigenous peoples have lived in and used forested areas for thousands of years as hunting grounds, places for ceremony and learning, and as a source of bush tucker, medicines and raw materials. In recent times, the forests have formed an important economic resource for Indigenous and non-Indigenous peoples, as well as a source of cultural meaning.

The extent of forest has changed since settlement by Europeans. Estimates have some inherent uncertainties, but it seems likely that about 36 per cent of Australia's forests were converted to agricultural land between the time of settlement and 1980. Forest cover has since increased in some regions, either through plantation establishment or through a reduction in pressures such as grazing, and decreased in others. Contemporary trends in forest cover change are not fully documented for all States and Territories: a current joint project between the Commonwealth and State

and Territory governments to develop a national land clearance database should yield results by the end of 1998.

Forests are naturally fragmented, but clearing has contributed to the fragmentation of the forest resource. This report estimates that about 76 per cent of Australia's native forest occurs in patches greater than 100 000 hectares, but there are also many very small patches. Forest patches are mostly clumped in the coastal forested regions, while they become smaller and more dispersed towards the interior of the continent.

Forests in the higher rainfall zones of Australia make important contributions to the nation's streamflows. For example, the forested mountains of the upper Murray River comprise only 2 per cent of the total Murray-Darling catchment area yet provide 25 per cent of its streamflow. The woodlands and mallee forests of relatively dry inland areas are much less important in terms of streamflow. However, their high water use characteristics help maintain a low water table and thus aid the prevention of dryland salinity.

Forest conservation is an important forest use. Its general aim is to ensure that forest ecosystems and the natural processes that sustain them remain intact for their own sake and for the benefit and enjoyment of future generations of people. To varying extents, this is undertaken across most tenures.

Individual States and Territories have developed reserve systems based on a range of conservation principles. In 1992 the National Forest Policy Statement advocated the development of a comprehensive, adequate and representative reserve system for forests occurring in regions where commercial forestry predominates. A nationally agreed set of criteria for such a system has been developed and is currently being applied to designated forests, but the results were not available for inclusion in this report.

This report documents timber production in the nation's multiple-use forests. An average of 0.8 per cent (110 000 hectares) of the gross area of forest in this tenure category (13.3 million hectares) is harvested for timber in any one year; this is about 1.5 per cent of the net multiple-use forest area available (7.3 million hectares) (net area excludes forest not available for harvesting, for example, buffers and steep land). Note that harvested areas include a wide range of silvicultural systems, from clear cut to light selective logging. Few data are available for the area of harvestable native forest in private forests, or on other crown lands or leasehold lands.

Table E shows the forecast sustainable yield of sawlogs in the multiple-use native forests for 1994–95 compared to actual harvested volume. Sustainable yield estimates do not appear to form part of management of forests in other tenure categories. Data are provided on the volume of timber harvested from forests with multiple-use or private tenure over the period 1969–70 – 1993–94, subdivided by hardwood and softwood, and by sawlog and pulplog.

Livestock grazing is a predominant form of land use in leasehold and privately owned forests, which together comprise in excess of 108 million hectares. It is also practised widely on other crown land and in multiple-use forests in Queensland and northern New South Wales. However, in this report it was not possible to fully document this forest use.

Australia's forests are subject to a range of other uses, including tourism and recreation, mining and the extraction of non-wood products. The whole of the wet tropical rainforests of north Queensland provided an estimated $750 million to the region in 1997. Similar information on the economic value of forest tourism does not appear to be available for other parts of the country. There is as yet no standard method for reporting visitor use of forested areas, although some data are presented in this report. Nor are nationally collated data available on the area of forest subject to mining or quarrying, or to the extraction of non-wood forest products such as firewood, honey, bush foods and wildflowers.

Carbon storage is increasingly recognised as an important forest use. Australian forests are estimated to store 13.1 billion tonnes of carbon. Changes in land use, primarily the permanent clearing of forest, were the source of most of the 75 million tonnes of $CO_2$ and $CO_2$ equivalents that were estimated to have been released annually by this sector. Multiple-use forests were thought to be a carbon sink in 1997, absorbing a net amount of about 19.5 million tonnes of $CO_2$ or $CO_2$ equivalents.

Fire is a natural part of many Australian forests, but it exhibits great spatial and temporal variability. The ecological effects of a given fire regime are also variable and depend on intensity, frequency and the season of burn. Indigenous occupation increased the frequency of fire as Indigenous peoples used fire as a tool to assist with hunting and other activities.

Deliberate burning appears to have been highly selective – frequent in some areas and absent in others. European settlement altered existing fire regimes, traditionally by limiting or attempting to exclude fire, but most recently by burning to reduce the risk of bushfire and to achieve forest management objectives. There are no consistent continental-scale data on the amount of forest burned annually by either bushfire or prescribed burning.

Australia's native forests are affected by a range of pests and pathogens: some are indigenous and some have been introduced since the time of European settlement. Currently, there are no quantitative national data on the extent to which such pests and pathogens affect forest health. This report presents the occurrence and significance of over 50 animal pests, more than 40 weeds and a small set of pathogens as examples of a much longer list of pathogens, based on responses from State and Territory conservation and production forest agencies. The extent to which pesticides, herbicides and fungicides are used in forests by State and Territory agencies is also documented qualitatively.

## Policy and management

The management of forests is largely the responsibility of the States and Territories. This report lists the various Acts of Parliament most relevant to forest management and shows the institutional evolution of agencies in each State and Territory with responsibility for forest management. Recent initiatives related to forests that have been implemented at the State and Territory level are described.

In recent years the Commonwealth and some State governments have been engaged in joint forest planning exercises known as comprehensive regional assessments (CRAs) across parts of the forest estate, leading to the negotiation of regional forest agreements (RFAs). These set out how the forests of the region under assessment are to be managed and used over a period of up to 20 years. All current RFAs should be completed by the end of the year 2000. While this exercise has yielded significant new information about forests, it has generally not been possible to include such information in this report, but it is expected to inform the next State of the Forests Report.

The Commonwealth is responsible for ensuring that Australia's international obligations are met and that provisions of Commonwealth legislation are satisfied.

Australia is engaged in the Montreal Process, a non-legally binding agreement between 12 countries with significant areas of temperate and/or boreal forests. The Montreal Process has enabled the development of criteria and indicators for the sustainable management of temperate and boreal forests, which provide a common understanding of what is meant by sustainable forest management. These criteria and indicators will form the basis of national-level reporting of Australia's forests in future State of the Forests reports.

By far the most information on forest management activities is available for forests with multiple-use tenure; the report presents information on the silvicultural systems employed for various forest groups and the area of multiple-use forests and conservation reserves subject to management plans. It also summarises the content of codes of forest practice applied to multiple-use forests and, in some instances, to forestry on private lands. However, there is very little national-level information available to illuminate the management regimes imposed in forests with leasehold, private or other crown land tenure.

## Forest industries

Information on forest industries presented in this report relates to the three principal wood-based industries: forestry and logging; wood manufacturing; and paper production. Collectively, these had a gross industrial product of more than $4.3 billion in 1989-90. They contributed 1.1 per cent to the national gross operating surplus in the same year and paid $2.2 billion in wages and salaries.

The three principal wood-based industries employed about 84 200 people in 1995, representing 1.02 per cent of the total Australian workforce. Of these, 11 000 were employed in forestry and logging, 19 900 in log sawmilling and timber dressing, 30 000 in other wood product manufacturing, and 23 000 in paper and paper product manufacturing. In 1996 nearly 6900 business establishments were engaged in wood-related forest industries.

Australia exported about 7 per cent of domestically manufactured wood-based products in 1993–94; the rest were sold domestically. About 27 per cent of wood-based forest products consumed domestically in that year were imported.

Sawnwood consumption has remained relatively constant at around 4 million cubic

metres per year for the last 20 years. The proportions of hardwood and softwood have changed significantly over this period, from about two-thirds hardwood in 1975–76 to about one-third hardwood in 1996–97. Australia is a net importer of wood-based forest products in terms of value, but is a net exporter in terms of volume. The annual deficit in the terms of trade in this sector was $1.4 billion in 1996–97.

This report provides information on the productivity of the wood-based forest industries. Price indices for hardwoods, imported paper products and woodchips are also presented, as are revenues earned from the sale of wood from publicly owned native and plantation forests for the period 1991–95.

## Social dimensions

A measure of the extent to which communities are financially dependent on forests is the number of people employed in forest-related industries as a proportion of the total working population. In Australia, 186 towns have a forest dependency above 5 per cent. Of these, 104 towns have a dependency in the range of 5–10 per cent; just 5 towns have a dependency of more than 50 per cent. In 35 towns, more than 20 per cent of the workforce is employed in forest industries; all are relatively small communities.

Communities may also depend on forests in non-financial ways, for example, for food, raw materials and cultural ties. Information of this kind is not available.

Improving occupational health and safety standards have contributed to making the forest, the sawmill and the paper mill safer places in which to work. Nevertheless, the wood-based forest industries remain risky. For example, in the period 1991-92, forest loggers suffered 386 fatalities per 100 000 person-years, compared to 70 per 100 000 person-years in mining and quarrying and 143 in fishing. The figure for sawmill workers was 30 fatalities per 100 000 person-years.

This report documents available information on current forest research efforts, education in the forest sector and nationally significant awards in fields relevant to Australian forests.

## The state of knowledge

Much of our knowledge of forests is centred on the publicly owned, timber producing forests, which constitute a relatively small proportion of the total national forest estate. Less is known about forests of lower commercial quality, forests in conservation reserves and forests on private and leasehold estates.

In this report the state of the knowledge base is discussed under the seven headings that form the basis of the Montreal Process criteria for sustainable forest management. In addition, issues of concern to the Australian community are listed, to serve as a reference point for future reports about the issues considered nationally important in 1997.

### Table A: Forest area, by forest type

| Forest type | Area ('000 ha) |
|---|---|
| Eucalypt | 124 463 |
| Acacia | 12 298 |
| Melaleuca | 4 093 |
| Rainforest | 3 583 |
| Casuarina | 1 052 |
| Mangrove | 1 045 |
| Callitris | 867 |
| Other | 8 435 |
| **Total native forest** | **155 835** |
| Plantation softwood | 884 |
| Plantation hardwood | 159 |
| **Total plantations** | **1 042** |
| **Total forest** | **156 877** |

### Table B: Biodiversity of Australian forests—number of species known to occur in forests

| | |
|---|---|
| Mammals | 317 |
| Birds | 561 |
| Reptiles | 219 |
| Amphibians | 126 |
| Fish | 16 |
| Higher plants | 13 622 |
| Rare or threatened vertebrates | 81 |

## Table C: Native forest area, by crown cover, by State and Territory ('000 ha)*

| Crown cover | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | Australia |
|---|---|---|---|---|---|---|---|---|---|
| Closed forest | 0 | 217 | 693 | 2 964 | 20 | 545 | 8 | 180 | 4 627 |
| Open forest | 102 | 8 364 | 7 020 | 9 989 | 2 309 | 2 359 | 6 029 | 3 003 | 39 175 |
| Woodland | 17 | 12 206 | 27 671 | 36 102 | 3 170 | 0 | 1 248 | 31 617 | 112 033 |
| **Total** | **135** | **21 057** | **35 389** | **49 226** | **5 602** | **3 038** | **7 501** | **34 930** | **156 877** |

* Note: Column or row total may not add up due to rounding.

## Table D: Area of native forest in each tenure category, by State and Territory ('000 ha)*

| Tenure | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | Australia |
|---|---|---|---|---|---|---|---|---|---|
| Conservation reserves | 93 | 3 060 | 2 709 | 2 870 | 1 252 | 523 | 2 710 | 4 364 | 17 580 |
| Multiple-use forests | 5 | 3 095 | 0 | 3 983 | 27 | 1 285 | 3 346 | 1 612 | 13 351 |
| Leasehold land | 13 | 5 966 | 20 236 | 23 996 | 1 866 | 0 | 0 | 14 025 | 66 103 |
| Other crown land | 2 | 605 | 258 | 1 051 | 12 | 296 | 165 | 13 206 | 15 597 |
| Private forests | 7 | 8 046 | 11 187 | 17 111 | 2 327 | 801 | 1 038 | 1 502 | 42 018 |
| **Total** | **135** | **21 057** | **35 389** | **49 226** | **5 602** | **3 038** | **7 501** | **34 930** | **156 877** |

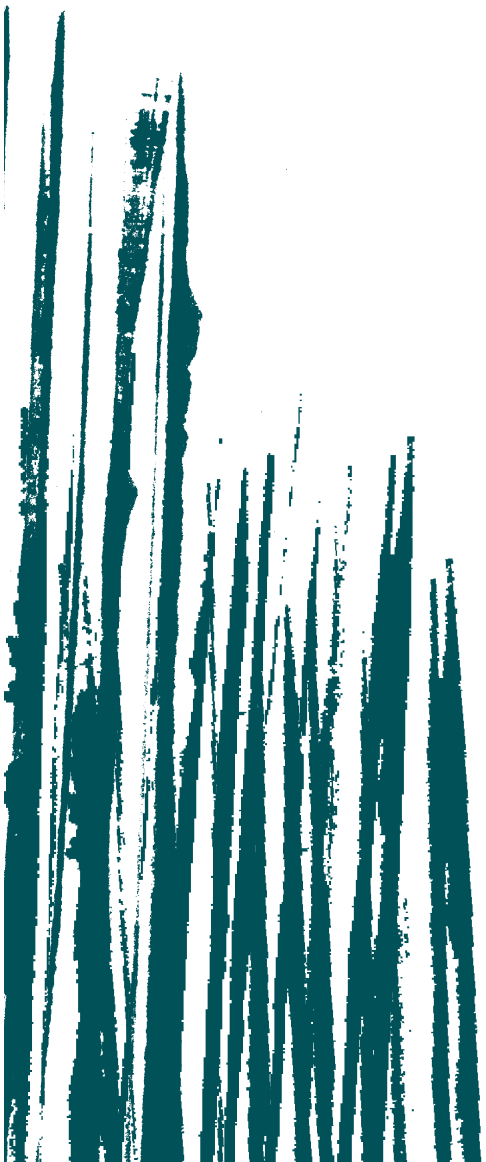
* Note: Column or row total may not add up due to rounding.

## Table E: Calculated sustainable yield and actual harvest of native forest sawlogs ('000 $m^3$) from multiple-use forests, 1994-95

| State | Sustainable yield | Harvested volume |
|---|---|---|
| ACT | N/A | N/A |
| NSW | 801 | 781 |
| NT | N/A | N/A |
| Qld | 112 | 111 |
| SA | N/A | N/A |
| Tas | 300 | 309 |
| Vic | 743 | 664 |
| WA | 758 | 689 |
| **Total** | **2714** | **2663** |

Note: N/A = not applicable (commercial harvesting of native forest does not occur).

# 1 *Introduction*



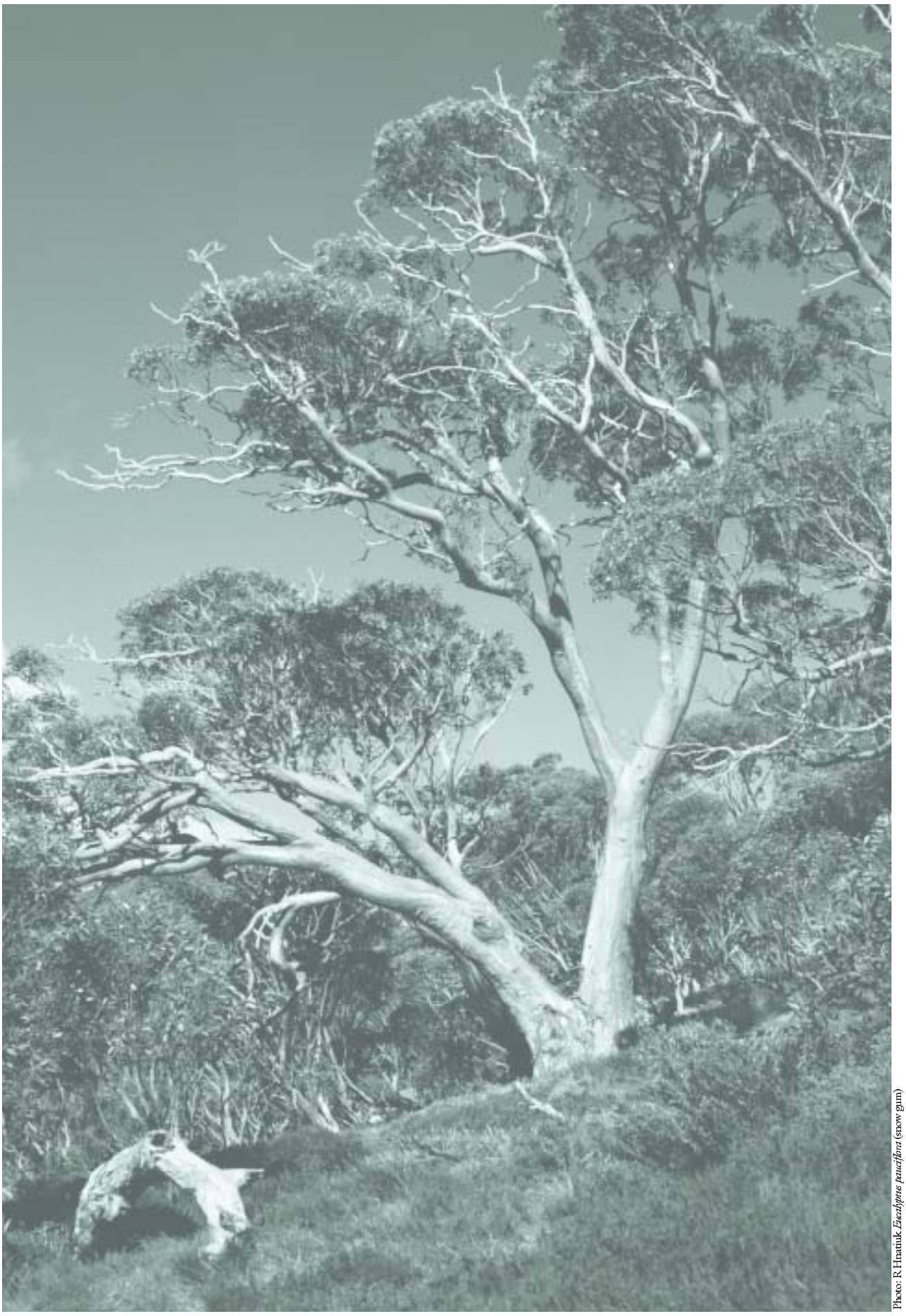


Photo: R Hnatiuk *Eucalyptus pauciflora* (snow gum)

# *Introduction*

This is the first national State of the Forests Report for Australia. It has two purposes: to describe, at a national level, the broad characteristics, location, extent and ownership of Australia's forests; and to provide baseline information indicating the status of these forests and the range of uses to which they are put. The report's origins lie in the National Strategy for Ecologically Sustainable Development and the National Forest Policy Statement, both of which were produced in 1992. They required the production of a five-yearly State of the Forests Report to the public.

Preparation of this report commenced in late 1994. The process of gathering, verifying and cross-checking information has been slow: it competed for the time of agencies that were also involved in the regional forest agreement process, a key initiative of governments. In addition, for many of the items reported on there was no previous national set of statistics. The regional forest agreement process has involved the gathering of new information about a significant part of Australia's forest estate. Some of this information has been included in this report, but there is much more that must be analysed before it can be fully incorporated into national-level reporting.

The contents of this report were developed by referring to the Tasmanian State of the Forests Report, the Canadian State of the Forests Report (Canada was the only other country known to have completed a national report), and to relevant chapters of State of the Environment Reports produced by individual States and Territories. This report also aimed to expand the coverage of forests given by the Australian State of the Environment Report, published in 1996.

The Montreal Process criteria and indicators of sustainable forest management, developed by an international working group of which Australia is a member, were also used to guide the development of this report. Since work on the report began, the Montreal Process has advanced: it published its First Approximation Report for Australia in 1997, based substantially on the information gathered for this State of the Forests Report. Subsequent State of the Forests Reports may focus more sharply on the Montreal Process criteria and indicators than has been done in this first edition.

## How the data were obtained

The National Forest Inventory sent questionnaires to relevant Commonwealth, State and Territory forest and conservation agencies requesting information on a wide range of forest-related issues. Responses were collated by the National Forest Inventory project team. Where the questionnaires were incomplete, other sources such as annual reports were gleaned, and other non-forest-related agencies such as the Australian Bureau of Statistics, the Australian Bureau of Agricultural and Resource Economics and the Australian Taxation Office were consulted. The report also used data from the 1997 report of the National Plantation Inventory. Most of the data in the current report predate information specifically gathered through the regional forest agreement process. It has not been possible to analyse and update databases with the new regional information.

The process of producing this report has served to identify a number of deficiencies in our ability to report on the state of the forests. Rectifying this situation will become part of preparations for subsequent State of the Forests Reports.

In particular, the relationship of the forests to the Indigenous peoples of Australia is an important element in the consideration of forests. The ways in which this relationship can be reported are the subject of specific research programs of the Montreal Process. However, there are no existing sources of information that could be used for this first edition. Issues are raised within the body of the report, but the detail provided is low.

## Forest cover inventory

An inventory of the national forest cover, undertaken for this report, was completed in 1997 using more than 100 data sets (Map 1). Many of these were created from extensive new vegetation mapping by State or Territory government agencies or from mapping specifically undertaken by the National Forest Inventory. Much of the data was compiled from aerial photographs and satellite imagery. The most recent imagery used is from 1994 and the majority is from 1991: the data sets produced from them vary widely in their level of detail.

A geographic information system was used to combine these data sets to generate national maps at a level of precision that has not been possible before. Nevertheless, the accuracy of these maps is dependent on the reliability and scale of the data that underlie them: as mapping at a finer scale continues, further revisions of forest area estimates may be expected.

# Defining a forest

Central to reporting on the state of Australia's forests is a consistent definition of what constitutes a forest. This report uses a definition that differs significantly from some previous definitions. As a result, the estimate of forest area given in this report is dramatically different to some earlier estimates, but similar to others.

## The current definition

The 1992 National Forest Policy Statement, signed by all Australian State and Territory governments and the Commonwealth, provided a clear biological definition of forest but contained uncertainty relating to crown cover and height. To remove this uncertainty, the National Forest Inventory reworded the definition slightly. Thus the definition of forest used in this report is:

> *An area, incorporating all living and non-living components, that is dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding 2 metres and with existing or potential crown cover of overstorey strata about equal to or greater than 20 per cent. This definition includes Australia's diverse native forests and plantations, regardless of age. It is also sufficiently broad to encompass areas of trees that are sometimes described as woodlands.*

This is similar but not identical to the single internationally accepted definition of forest used by the United Nations Food and Agriculture Organization, which is:

> *Land with tree crown cover (or equivalent stocking level) of more than 10 per cent and area of more than 0.5 hectares. The trees should be able to reach a minimum height of 5 m at maturity in situ. May consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground; or of open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 per cent.*

## The effect of changing the definition

The current Australian definition is different from some previous widely used Australian definitions in several important ways. First, the minimum potential crown cover to qualify an area of trees as forest is now 20 per cent, which puts into effect the National Forest Policy Statement requirements that 'forest' is to include what has sometimes been called 'woodland'. This contributes about 112 million hectares of woodland to Australia's total forest estate. Second, the definition refers to 'trees having usually a single stem' and sets the lower tree height limit at 2 metres. This allows the inclusion of the forest-forming mallees and adds about 11.8 million hectares to the total forest area. The full definition, which requires the vegetation to be of tree formation, excludes shrublands, even if they are higher than 2 metres. Finally, the previous widely used definition for reporting forest statistics was specifically designed to capture those forests that were potentially commercially exploitable: that is, greater than 20 metres high except for white cypress-pine forests, which were included irrespective of height. The current definition is biologically based rather than focused on a particular use of the forest.

The current definition embraces large areas of woodland not previously defined as forest,

making a much broader examination of forest uses, disturbances, policy and management appropriate. However, there is disparity between the amount of information available for the open forests and woodlands of northern Australia, south-east Western Australia, South Australia and western parts of New South Wales and southern Queensland – the 'new' parts of the forest estate – and that available for the commercial forest types of Tasmania, the east coast and south-west Western Australia. The quality and quantity of information available for the latter regions have been further enhanced through the regional forest agreement process. This State of the Forests Report reflects the disparities of data quality and availability between these regions.

## Defining a plantation

The definition of plantations used in this report is the same as that given in the National Forest Policy Statement. Thus, plantations are:

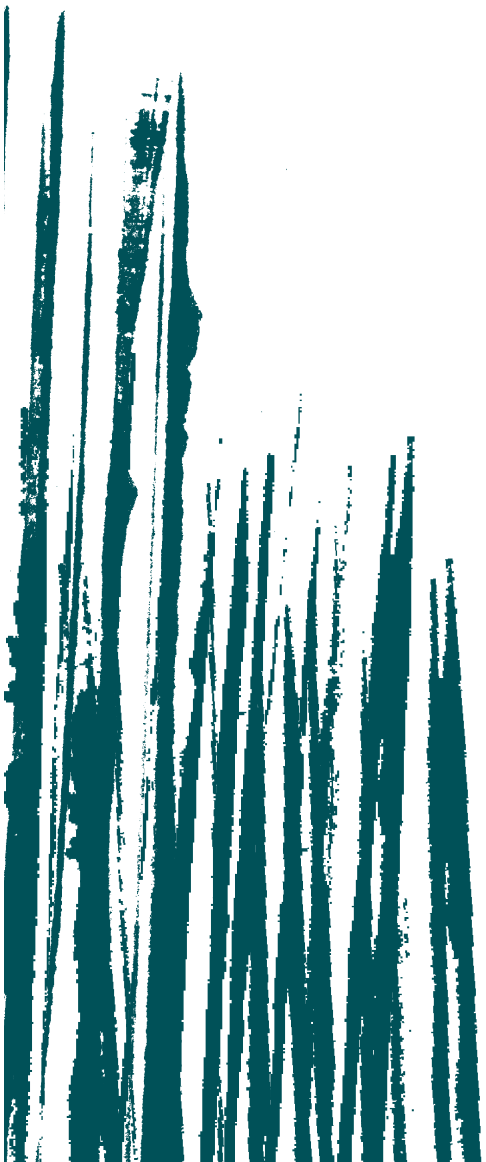
> *intensively managed stands of trees of either native or exotic species created by the regular placement of seedlings or seeds.*

Primarily large commercial plantations are reported. With a few exceptions, small areas of farm forest plantings generally less than about 1000 hectares in size are not reported here. They will be the focus of new work aimed specifically at documenting the location and size of this resource.

## Implications of continued forest mapping

The information on the area of forest is the best available now but there remain significant deficiencies in our knowledge. For example, the National Forest Inventory has begun a program to map in detail the large area of forest across northern Australia. Based on the information that will be gained from this exercise, it is expected that the total area of forest reported here will decline. There will also be changes in forest area that occur through the permanent clearing of forests, the extension of plantations onto previously unforested sites, natural regeneration of abandoned pasture lands, and revegetation programs. There will also be changes to the area of forest reported through improvements in the recording of forests against nationally accepted criteria. For example, not all records have been updated from the previous system of reporting areas of commercially valuable forest. In a number of the major commercial forest types, the forests were previously reported as 'open forest' when, in fact, they are woodlands or even open woodlands. When this information becomes available, it will show changes against the statistics reported here.

# 2 *A Short History of the Forests*



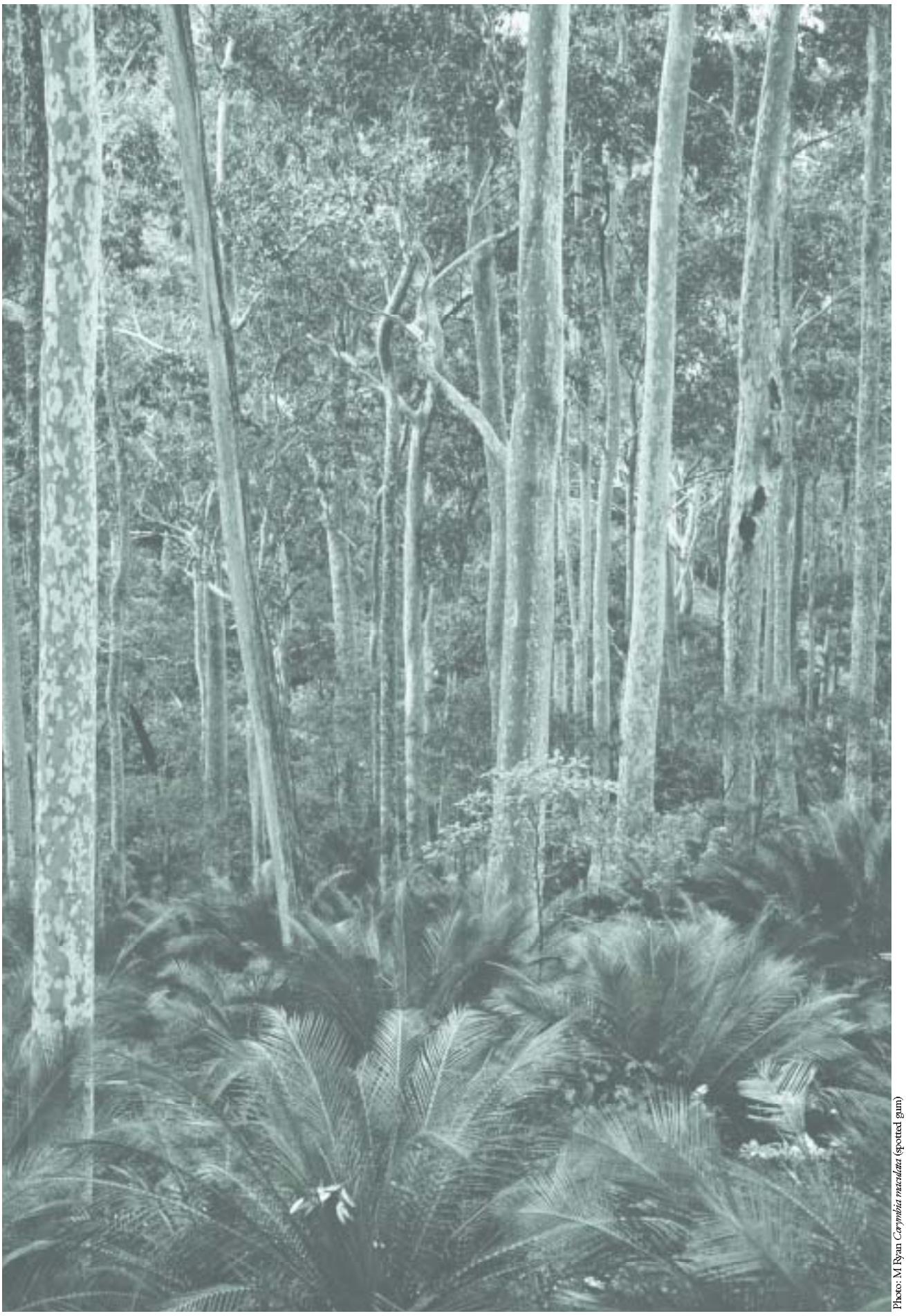


Photo: M Ryan *Corymbia maculata* (spotted gum)

# *A Short History of the Forests*

Australia's forests have ancient origins that determined their nature, affected how they could be used and influence how they are valued today. Their distinctive ecology evolved with the drift of what became the Australian continent breaking from the land mass of Gondwana about 135 million years ago, the great changes to the climate, the rise and fall of the seas, and the eventual separation of New Guinea and Tasmania from the mainland 10–15 thousand years ago.

## From Pangaea via Gondwana to Great Southern Land

Current scientific opinion holds that the first trees on earth probably developed in the Devonian period, more than 400 million years ago. Trees we would recognise today started to develop much later, in the Cretaceous period, which began about 144 million years ago.

The Cretaceous period was a long and comparatively stable period of about 80 million years. A rich variety of plant and animal life developed and spread across the single world continent, Pangaea, as it slowly separated into two continents, Laurasia and Gondwana. Dinosaurs dominated animal life, and conifers – non-flowering plants – dominated the forests. On the Gondwanan part of the continent, the conifers were largely podocarps, araucarias and taxodiums.

Angiosperms, the flowering plants, evolved during the Cretaceous period. Before Pangaea broke fully apart, the families of flowering plants we know today had spread widely, as can be seen from the similarity and common ancestry of flowering plants on now-separate continents. By the end of the Cretaceous period, Australia was breaking away from Gondwana; flowering trees capable of competing with the dominant conifers were becoming more widespread, as were mammals. The polar ice-caps of today had not yet developed, so sea levels were high and there was an inland sea on what was to become central Australia. Moist, closed-canopy forests dominated much of the land; fossil evidence indicates that they were rich in plant and animal life.

The last million years or so of the Cretaceous period were marked by the mass extinction of numerous species of plants and animals, including dinosaurs. (The Wollemi pine, *Wollemia nobilis*, discovered recently in the Blue Mountains skirting Sydney, is believed to be a survivor of this era.)

About 38 million years ago, the Australian continental plate finally separated completely from Gondwana and moved northward, colliding with Asia about 13 million years later, coincidentally forming the mountain backbone of New Guinea as the land buckled. Australia's climate became warmer and drier as the continent drifted away from the South Polar Region.

But climate change was gradual, ameliorated by new ocean and atmospheric circulation patterns caused by the separation of Australia from Gondwana and a general cooling of the world's climate. It was gradual enough to avoid mass extinctions of plant and animal life but, inevitably, the progressive drying of the continent disadvantaged the conifers and allowed new species to dominate the landscape. Cool and warm rainforests were gradually replaced by sclerophyllous vegetation, including eucalypts and acacias. The tough-leaved sclerophyll forests, both 'wet' and 'dry', developed the characteristic colour and texture we associate with most Australian forests today. In addition, the gradual collision of the Australian and Asian continents created opportunities for some species to move between these long-separated land masses, contributing to the richness of our current forest vegetation.

From the end of the Cretaceous period until the present, the Australian continent has been geologically stable. Throughout the intervening 65 million years, the surface of the

land has been subjected to continuous weathering and erosion, but not to the intense glaciation (except in Tasmania) that occurred in the northern hemisphere. There has been little recent volcanic activity (which, geologically speaking, means for the past 10 000 years or so), and so few new rocks or soils have been formed to replace those weathered away. For these reasons, Australia is often referred to as the oldest continent on earth.

## Australia's Gondwanan remnants

Most of the Gondwanan forests were gone by 2 million years ago, but there remain some isolated remnants.

These include the cool temperate rainforests of eastern Australia, from Tasmania to the high mountains of New South Wales and Queensland. Remnants of forests from warmer, but still Gondwanan, times are found in the wet tropical rainforests of north-eastern Queensland, in isolated areas of the Northern Territory and in the Kimberley region of Western Australia. The dry rainforests, or 'scrub' forests, of northern Australia, with biogeographic links to similar habitats of Africa and southern Asia, are also remnants of this period.

## Climate change and fire

Since the Cretaceous period, Australia's climate has been drying, with the forests dying or retreating to favourable niches. It has not been a steady retreat: the forests have advanced and retreated as the climate has fluctuated, but there has been a net loss of forest over the last few million years.

The geological record shows that for most of the past 2 million years the Australian continent was subject to periodic fires, facilitated by the general drying of the continent. Recently (geologically speaking), there was a sudden, significant increase in fire incidence. Given that Indigenous peoples used fire extensively, some researchers consider that the sudden increase in fire occurrence marks the arrival of humans in Australia.

# Populating the continent

## The first Australians

The people who arrived in Australia at least 40 000 and perhaps over 100 000 years ago developed the means to live on the continent during periods when its climate, the levels of its inland waters and seas, and the distribution of its ecosystems were slowly changing. By the start of the current climatic period, 10 000–15 000 years ago, the population – probably somewhere between 415 000 and 1.5 million – occupied all the land, with the exception of the Bass Strait islands. The material cultures and means of livelihood they developed were individually adapted to each ecosystem.

The open canopy of most forests enabled fire to be used extensively as a management tool in some forest types, modifying the condition of the ground and understorey vegetation to suit the browsing animals that could be hunted and for ease of travelling. Burning in some areas had the dual effect of promoting eucalypts over rainforest and limiting the extension of rainforest into eucalypt-dominated forest.

The forest management practices used by Indigenous peoples were – and in some forests still are – set within a system of spiritual beliefs about the origins of landscape features, people, animals and plants in the actions of the creation beings of the Dreamtime. These beliefs are accompanied by profound senses of spiritual identity with sites that remain sacred and of personal responsibility for stewardship of the country according to traditional custom.

## Colonisation and settlement

The colonisation and settlement of Australia by non-Indigenous cultures, primarily the British, drastically altered the state of the forests from that under Indigenous management. All land became the property of the crown, some of which was then allocated as freehold or leasehold to the colonists for agriculture, grazing or urban use. Many areas were not so allocated, leaving the 46.6 million hectares currently remaining as State forests, timber reserves, nature conservation reserves or

other crown land. In 1993, the High Court found that Indigenous, or native title, rights to land had not been completely extinguished in some areas, although their extent over crown and leasehold forest areas is still uncertain.

When the colonies federated in 1901 to become the States of the Commonwealth of Australia, the States retained their powers over the allocation and control of land, including forests. These powers were exercised differently so that the state of the forests today differs by State and Territory as well as by ecosystem and type of use. This short history can give only a national overview of some of the major influences that still affect the forests.

## Pastoralism

Grazing became the most important factor affecting extensive areas of Australia's forests. The naturally open canopy and management under Indigenous fire management regimes, which had created a 'park-like' landscape in certain types of forests, enabled the number of introduced sheep and cattle to increase rapidly (Figure 1). The economic benefits were substantial: Australia, it was said, 'rode on the sheep's back'. Where grazing was intense, it changed the state of the forests, both intentionally and inadvertently, by four salient processes. The settlers changed the pattern of fire intensity and frequency, which affected forest composition and structure. The hard-hoofed sheep and cattle compacted the soil more than did the marsupials. The runs, fully stocked in good seasons, were overgrazed in droughts and eaten out by plagues of rabbits. And to encourage grass, the settlers felled and ringbarked as many trees as they could.

The consequences of pastoralism vary with the type of forest and the time it takes for changes to become apparent. In the open forests and woodlands, the most widespread effect is the lack of effective regeneration. Although in temperate Australia there are still many large old trees standing in the pastoral areas, there are few younger ones to replace them when they die. Moreover, evidence of their poor health and shortened life expectancy is clear, with trees commonly exhibiting 'dieback' symptoms due to soil compaction, stock abrasion, fires and increased insect attacks. The once park-like landscape appears to be in the process of becoming virtually treeless.

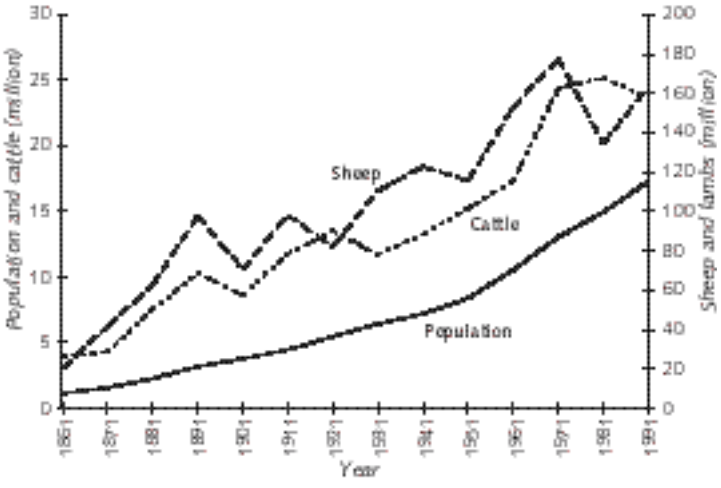
Some forests show remarkable persistence. In the acacia and callitris forests, the change from Indigenous fire management, coinciding with particularly favourable seasons, commonly stimulated a dense regrowth of seedlings and sucker shoots that turned into almost impenetrable thickets. In other areas, temporary release from grazing pressure enabled regeneration to take hold and the forests to recover. However, from the 1950s, mechanical clearing and the application of chemical herbicides reversed the natural recuperation of many such forests.

## Agriculture

While the effects of pastoralism were extensive and gradual, those of agriculture were intensive and immediate. To grow crops, the best land had to be found and the trees removed as completely as possible. Farmland was developed where the topography, climate and soils appeared suitable, which often meant that agricultural land took the place of tall eucalypt forests and rainforests. Initially, land on the highly productive valley floors was selected but, as agriculture expanded, as new markets were developed and as technology changed, other types of forest were also selected.

From the 1870s, lowland rainforests in Queensland and northern New South Wales were so extensively cleared for dairying and to

**Figure 1: Population and livestock numbers, 1861 to 1991**




Source: Year Book Australia (1997).

grow sugar cane that now only remnant patches remain. Some of the best tall forests, even on steep slopes, were also cleared in the 1880s up to the 1920s for dairying. In part, this was encouraged by schemes for closer settlement and, after World War I, for soldier settlement. Most of Australia's largest continuous tract of sub-tropical rainforest in the Big Scrub on the Richmond River in New South Wales was cleared, as was much of the tall eucalypt forests and rainforests of the Dorrigo Plateau. In Victoria, most of the tall eucalypt forests dominated by *Eucalyptus regnans* (mountain ash) in the Strzelecki Ranges were cleared, while some similar sites were cleared in Tasmania. Areas of tall *E. marginata* (jarrah) and *E. diversicolor* (karri) forest were cleared under a group settlement scheme to encourage migrants to Western Australia. Many of the farms created by these schemes subsequently failed.

The medium height and some low height open forests and woodlands were cleared on a vast scale throughout what are now the wheatbelt regions of South Australia, Victoria and New South Wales. Much of this clearing was completed by the 1920s, but the development of hardier varieties of wheat, the discovery of trace element deficiencies in the soils, the use of cropping systems with legumes, and the availability of bulldozers led to extensive areas of low woodlands being cleared from the 1950s in Western Australia and Victoria. A scheme to clear mallee in Victoria's Little Desert region provoked protests over both its economic feasibility and its environmental consequences. Its abandonment in 1970 was seen as an expression of the public's increasing recognition of forest values.

Every type of Australian forest has been cleared for agricultural crops to some extent, but it has only been since the 1980s that the full consequences of deforestation have come to be evaluated with those of pastoralism and other forms of forest use on a regional or catchment scale. For example, irrigated agriculture required some areas of forest to be cleared to grow crops such as fruit, cotton and rice, but had wider consequences. The forests in the catchments upstream had to be managed to limit the rate of siltation in the dams, while the health and growth of riverine forests downstream were affected by alterations to river flow and flood patterns.

The history of deforestation from agriculture, forest burning and grazing shows that environmental consequences may be long delayed. This is apparent not only in the loss of trees across the pastoral and agricultural landscapes, and the associated loss of biodiversity, but in the problems of dryland salinity and increasing salinity of water supplies.

## Coastal development

Some coastal and estuarine land was deforested by the creation and expansion of the major port cities and by the urbanisation that increased markedly from the 1960s. Within these areas, some mangrove forests were cleared in projects to create dry land for docks and airports, to permit canal estate and resort developments, and to provide effluent ponds. Many smaller local developments also contributed to the reduction in mangrove area. For example, the once continuous 20-kilometre strip of mangrove forest along the Parramatta River has been reduced to one short stretch and a few small patches. Industrial and urban pollution and the practice of spraying insecticides near urban areas have further degraded the condition of mangrove remnants.

## Mining

Some of the earliest extensive effects of mining on the forests were caused by the gold rushes of the nineteenth century, most notably to the central Victorian goldfields in the 1850s and to the Kalgoorlie goldfields in the 1890s, but also to many other smaller fields. There were urgent demands for timber for mining-related activities, poles and sawn timber for shelter and for wood to fuel the steam engines as mining moved deeper underground. The surrounding forests were rapidly denuded of their standing trees. This process continued until either the particular field was exhausted or until wood was replaced by diesel oil as the major fuel. The two largest areas affected were the tall eucalypt forests of the Victorian goldfields and the low to medium height open eucalypt forests and woodlands of the Western Australian goldfields, where 25–30 million tonnes of fuel wood were produced by clear-felling about 3.4 million hectares of forest between 1893 and 1965. Of these, some were

taken up for agriculture and some were left to regenerate and are now maturing again.

Mining can have a profound local effect on forests. For example, a large area of rainforest on the west coast of Tasmania was cut to fuel the smelters at the Mt Lyell copper mine. Subsequently, the forested mountains downwind of the smelters were denuded of all vegetation by acid rain.

## Sawmilling

All the timber required for houses, boats, bridges, carts, warehouses, barracks and all the other uses of wood in colonial society was produced manually by pit-sawing, hewing and splitting in the most accessible forests. Highly prized species such as *Toona australis* (red cedar) and *Lagarostrobos franklinii* (huon pine) were cut further afield, but the quantities and overall impacts on the forests were relatively small. The situation changed from the mid-1850s as demand for timber increased sharply, stimulated primarily by the gold rushes, pastoralism and population increases. The demands were met by increasing and mechanising domestic production in sawmills, and by importing softwood timber from the Baltic, the west coast of North America and, from the 1880s, New Zealand.

## Opening up the commercial timber producing forests, 1850s to 1940s

The number of sawmills steadily increased, but during the nineteenth century most were small, locally owned affairs. The cost of transporting timber to the main capital city markets governed where timber was cut. Water was cheapest for long-distance transport, so an inter-colonial trade flourished from coastal forests. Thus, Tasmanian forests supplied Adelaide, and Queensland and northern New South Wales forests supplied Sydney. Sawmills also followed the gradual extension of railways that enabled more of the inland forests to be opened up. For example, sawmills built in some of the callitris forests were able to send their softwood timber to compete with imports in the Sydney market from the 1880s, and both river boats and rail were used to open up the *E. camaldulensis* (river red gum) forests along the Murray River.

Sawmilling and the continued manual production of poles and hewn and split timbers were concentrated in the tall and medium height eucalypt forests and the rainforests, with some cutting for purely local use occurring in all other forest types. Although about 20 per cent of the total forest area was potentially suitable for commercial timber production, the area that was practically and economically accessible was considerably less. Sawmilling had to rely on bullock wagons or tramway systems to bring logs to the mills and to take sawn timber to rail or water. Although these systems became increasingly ingenious and were supplemented by steam winches, and although roads and trucks started to replace bullocks and tramways from the 1920s, the industry did not enter remote mountainous forests. Moreover, felling remained a manual and selective process in which only the best and accessible trees were felled.

The *E. marginata* (jarrah) and *E. diversicolor* (karri) forests of Western Australia were opened up later than those on the east coast, and on a much larger scale by far larger sawmills. These sawmills mainly served an export trade – at its height between the mid-1890s and World War I – in railway sleepers, mine and other heavy construction timbers, and paving blocks, where their durable qualities were needed. Part of the trade was supplied by hewing, as this was often preferred for sleepers. An extensive railway and tramway system was developed to link the forests, mills and ports. Clear-felling was the norm until the 1920s, when the Forests Department introduced selective systems.

The state of the commercial timber producing forests at the end of World War II was one in which all those on the east coast, apart from remote mountainous areas, were honeycombed with the tramways, tracks and cutting areas of many small sawmills. Selective felling had left many standing trees and untouched patches in gullies and similar places. Many standing trees were also left through the jarrah and karri forests of the west coast.

## 1940s to the present

The intense demand for timber during the boom following World War II was met largely from the hardwood forests, supplemented, as

discussed later, by increasing quantities of softwood sawlogs from the plantations. By 1960, total production had doubled, to reach a plateau. Since then, sawn timber has been progressively replaced by concrete, metals, plastics and wood panel products, so that the total demand has remained roughly constant despite population increases. Wood imports remained mostly in the long-established 25–35 per cent range of consumption.

The expansion of sawlog production in eastern Australia was achieved in three main ways: roads were constructed into remote mountain forests; bulldozers equipped with winches extracted logs from steep slopes and the patches previously bypassed; and areas previously logged were cut over again, sometimes repeatedly, taking increasingly poorer quality logs. The repeated selective logging of particular lower elevation tall and medium height open eucalypt forest types resulted in insufficient time for regenerating timber to mature and thus the diminution of their productive capacity.

The state of the commercial timber producing forests in this post-World War II period has been affected by six further factors, discussed in the remainder of this chapter: the declaration and management of State forests; the establishment of plantations; the expansion of the pulp and paper industry; the export of woodchips; the recent move to add value to wood products; and increased concern over environmental consequences.

## State forestry

The devastation of the goldfields forests, wasteful felling and hewing, widespread fire damage and the clearing of fine timber for farms led, from the 1860s, to calls for some of the commercial timber producing forests to be reserved from agricultural selection. Colonial and State governments were urged to follow the model adopted throughout the British Empire of selecting, or 'demarcating', some of the best forests, permanently reserving them as State forests (a term equivalent to 'multiple-use forests', used as a tenure category later in this report), and making their protection and management the responsibility of a specific agency staffed with professionally trained foresters. Against opposition from agricultural interests, each government was eventually persuaded to pass appropriate forestry legislation between 1870 (New South Wales) and 1920 (Tasmania).

The new forest services faced considerable difficulties: the sawmillers had to be regulated and fires controlled; the forests had to be mapped and their resources assessed; silvicultural systems had to be devised to regenerate the forests; and plans had to be prepared to sustain future yields. Some of the classical forestry principles developed elsewhere in the world proved unworkable in forest types with periodic severe fires and there was never enough money to fully regenerate all the areas selectively cut over. Moreover, there were considerable difficulties in having crown land transferred from the control of lands departments and reserved as State forest. For example, even though the national target to have 25 million acres (10 million hectares) reserved as State forest was adopted by the Interstate Forestry Conference and endorsed by the State premiers in 1920, it took over 40 years to reach this target.

The State forest services were sufficiently well established before World War II to expand rapidly and become far more effective in managing the State forests thereafter. They made many advances, of which only four are mentioned here. First was the way in which they opened up the previously inaccessible, remote and mountainous forests of the east coast. This was partly to facilitate the expansion of sawlog production, mentioned earlier, and partly to provide access for fire control. Second was the detailed mapping and resource assessment of the forests that informed the expansion of sawlog production and later informed its reduction to a more sustainable level. Third were the silvicultural methods developed to regenerate some of the forests, particularly the high-value ash-type forests. Fourth was the establishment of softwood plantations, which successfully offset the reduction in hardwood log production.

Grazing persisted in many open forests and woodlands and in those callitris forests that were declared as State forests, and was allowed in some plantations. Stock reduced the fire hazard but ate the tree seedlings and shoots, even when grass was abundant, and damaged pole stands. Control proved difficult, especially

when grazing was left for many years in the hands of lands departments, or during periods of drought. On some crown tenures, denudation of vegetation and accelerated soil erosion led to grazing being stopped. The most notable example of this was the elimination of grazing in the catchments of the Snowy Mountains Hydro-electric Scheme in the 1960s; this was subsequently extended to other sub-alpine forests and to national parks generally. A body of professional foresters was built up by overseas recruitment, overseas training and, increasingly, by training in Australia, forming a professional institute in 1935. The Victorian School of Forestry trained small numbers from 1910. It later expanded and sent some of its graduates to Melbourne University, into which it was eventually incorporated. An Australian Forestry School, started in 1926 in Adelaide, soon moved to Canberra and was incorporated into The Australian National University in 1965.

### Identification of forest and forestry

For most of the twentieth century, forest policy and forestry have been identified mainly with the concerns of State forestry, primarily those related to timber production (the obverse of this was a lack of attention to the state of private forests). This identification was largely the result of the long struggle to reserve State forests, establish effective forest management agencies and build a close-knit cadre of foresters. However, the protection of water catchments on public land had also been part of the rationale for declaring State forests and this was given increasing attention from the 1920s. For example, New South Wales legislated in 1935 that the purposes of some of its forest reserves were to protect watersheds, develop recreation and conserve wildlife, as well as to produce timber and allow grazing. In Victoria, the Forests Commission formalised its relations with water trusts in the 1950s and issued special prescriptions covering logging within them: these prescriptions were the forerunners of today's codes of forest practice. In Queensland, the Forestry Department managed the national parks as well as the State forests until 1975.

### Timber from private forests

Private forests were an important source of sawlogs, although this varied between States. Some hardwood sawlogs were salvaged from land being cleared for agriculture, others were selectively cut from areas left as forest, but the total quantity gradually decreased from the mid-1960s (Figure 19). The state of most of the commercial timber producing forests on private land was little affected by the concepts of forestry practised in State forests. Their productive capacity probably generally deteriorated under the grazing, burning and felling regimes of many landowners, but changes to the overall resource were not monitored.

## Plantation establishment

Plantations were established from the 1870s onwards to offset Australia's limited natural endowment of softwoods. South Australia took the lead and was eventually able to establish sawmills, pulp and paper mills and panel board factories based on them. Aided by Commonwealth loan funds, all States increased their rate of planting in the 1960s when the inevitable future decline in sawlog supplies from the native forests was realised. Some of the pulp and paper companies also started plantations to provide softwood pulpwood. These and plantations established by the larger timber companies gradually supplied increasing quantities of sawlogs as well as pulpwood. The establishment of eucalypt plantations has increased significantly in the last decade or so.

Various schemes to encourage smaller scale, or 'woodlot', planting on farms and other private land were undertaken from the 1920s. The rate of planting on farms increased in the 1990s, aided by schemes described later. So far they have made only a small contribution to wood supplies.

## Pulp and paper

After World War I, Australia's drive to replace imports, promote manufacturing and add more value to its primary products led the Commonwealth to establish the research laboratories that became CSIRO. The organisation worked closely with industry,

with research for the forest sector concentrated on the eucalypts, successfully finding ways to kiln-dry sawn timber and to make pulp for paper-making.

Between 1936 and 1941 three pulp and paper mills were built in Tasmania and Victoria to use eucalypts, and one in South Australia to use wood from pine plantations. The Tasmanian Government provided exclusive, long-term concessions over large areas of State forests, while the Victorian Government provided rights to the pulpwood only, because sawlogs from its forests were already allocated to sawmillers. The new mills demanded the pale, relatively long-fibred ash-type eucalypts, *E. regnans* (mountain ash or swamp gum) and *E. delegatensis* (alpine ash). The world's tallest hardwood forest, the *E. regnans* of the Florentine Valley, was included in a Tasmanian concession. A large area of the Victorian resource was burnt in the disastrous 1939 bushfires, but the pulp mill was able to salvage its wood for many years.

The existing pulp mills expanded rapidly and new ones were built during the 1950s and 1960s. They were supplied with softwood from the pine plantations, and with hardwood from new areas, and a wider range of eucalypt species which further research had found ways to use.

The increasing demand for pulpwood altered the state of those forests within economic reach of the pulp mills. During the 1950s much of the pulpwood cut in Tasmania came from one of the companies' own forests, while in Victoria much of it came from land being cleared for agriculture. The proportion coming from State forests increased as demand increased. Pulpwood could be obtained from trees not suitable for sawmilling, enabling stands to be clear-felled and regenerated with uniform crops of even-aged trees. This particularly affected two classes of forests. New areas in the valuable mountain forests being opened up for sawmill logging could be fully regenerated, aided by new seeding methods developed by silvicultural research. Old areas in the foothill forests that had been selectively logged in the past could have their mostly old, defective trees removed to allow a new stand to grow. The advent of a pulpwood market thus enabled the forest services to advance their objective of making the forests more productive. Gains in efficiency and environmental controls were achieved by integrating the logging so that both sawlogs and pulpwood were cut in one operation.

## Woodchip exports

The Japanese pulp and paper industry expanded rapidly from the mid-1960s and sought supplies of wood for its pulp mills. In the 1970s a woodchip export trade from Australian forests was started by constructing five large woodchip mills in southern New South Wales (1), Tasmania (3) and Western Australia (1). Other operations were started later in western Victoria (1 hardwood, 1 softwood), northern New South Wales and Tasmania. Softwood woodchips have been exported from south-east Queensland.

Part of the trade was supplied from sawmill waste, but the bulk came from several types of forest and logging operations. The bulk of the trade in the east was supplied by clear-felling areas of tall and medium eucalypts in State forest that had previously been selectively cut over, while in the west it came from both clear-felling and selective cutting. As the industry expanded, wood was obtained from several other types of operation, most importantly by thinning regrowth stands. It was also integrated into operations that were still advancing into previously unlogged areas on steeper terrain. Private forests provided over 40 per cent of the wood exported from Tasmania during the 1970s. Many of these forests then reverted to rough grazing use, rather than being regenerated, which led the Tasmanian Government to establish a Private Forestry Division, and woodchip companies to adopt various schemes to address the situation.

The overall effect of the domestic pulp and woodchip export industries has varied with location. In some areas it permitted the rehabilitation of degraded forest, in others it provided increasingly efficient utilisation of forest products to previously unavailable markets, and for some it converted stands of mixed-age and sometimes old trees to even-aged young ones. The area converted is thought to be over 1 million hectares.

## Adding value to wood products

The desire to process raw materials into manufactured products prior to export and to replace imports, which had been expressed in the 1920s, continued and was re-asserted in the 1980s and 1990s. This was expressed as the desire to add more value and provide more employment by processing the wood being cut through further stages of manufacturing. It led to industry policies that only indirectly affected the state of the forests.

The major proposal was to process much of the woodchips into pulp prior to being exported. Large mills to do this have been investigated for northern Tasmania, East Gippsland and Western Australia.

CSIRO and industrial companies continued the forest products research and development work which had commenced in the 1920s. Notable improvements continued to be made in kiln-drying and machining to add value to domestic production and to provide small quantities of high-quality eucalypt timber for premium export markets.

In Victoria, a policy was adopted of allocating the logs cut from State forests only to mills equipped to process them to the highest possible value. This policy was applied across major regions and enabled some mills to develop niche product lines. By contrast, in Western Australia, purchasers of first and second-grade jarrah sawlogs are required to add value to at least 50 per cent of their sawn output.

## Environmental protection

Three associations to encourage forest conservation and four to encourage more national parks were formed between 1930 and 1957. This small beginning rapidly expanded from the 1960s as local groups, regional, State and national organisations sprang up throughout Australia to create the large, diverse environmental movement we know today. The Australian Conservation Foundation, founded in 1965, and The Wilderness Society, founded in 1976, are the principal national organisations concerned with forests, and conservation councils and forest alliances are the principal State organisations. These organisations took a critical stance and sought the preservation of all the natural environmental values of the forests. Proponents thought that conservation should be achieved by having larger areas placed in conservation reserves secure from exploitation, although the older calls for forest conservation to be achieved through 'wise use' also persisted. Associations for the wood-using industries sought continued access to the wood resources of State forests. Their National Association of Forest Industries was formed in 1987.

Public controversies between the views of environmental organisations and the timber industry have lasted until the present. Such controversies concentrated on the use of public land and especially on State forests used for commercial wood production. Less attention was directed to the state of the forests on private and leasehold land, to forests not suited to commercial wood production, or to the effects of grazing. Seven major environmental concerns, discussed below, were central to many of the controversies.

### Clearing for pine plantations

Clearing low-productivity eucalypt forest in order to plant higher productivity pines attracted widespread criticism. By the 1980s all State forest services had stopped clearing extensive areas and bought already cleared grazing properties instead. Plantation silviculture became more intense as soil cultivation, chemical weed control and fertilisation regimes were advanced, and tree-breeding improved growth rates and tree form.

### Forest practices

The expansion of clear-felling, especially for woodchip exports, also attracted widespread criticism, particularly related to the loss of wildlife habitat provided by large old trees. Silvicultural practices were modified to leave a number of such trees in the clear-felled coupes and to reserve strips of uncut forest to protect streams, provide corridors for wildlife and soften the appearance. Further modifications were made in some areas to conserve particular species.

From the 1980s, detailed coupe planning and codes of forest practice were adopted in all

States to cover road and track construction, soil disturbance and many other factors. The codes have been extended to apply to logging in private forests in some States.

## National parks

The establishment of national parks and State forests has proceeded sporadically since the 1870s. From the 1960s, continued calls for their expansion were heeded and more parks declared in all major ecosystems. The area of tall and some medium eucalypt forest and rainforest types in such reserves was increased from 1.8 to 6.2 million hectares between 1971 and 1991. Most increases involved the transfer of unoccupied crown land, but some involved State forest.

All States and Territories, as well as the Commonwealth, set up national parks and wildlife services to manage the larger areas.

## Rainforests

Although, as noted earlier, much of the original area of rainforest had been cleared for agriculture prior to World War II, there were still some areas that had hardly been disturbed by either agriculture or logging. Disputes over whether State forests in the Border Ranges of northern New South Wales should be dedicated as national parks erupted into a direct confrontation to stop logging at Terania Creek in 1979. There were further confrontations in 1983 and 1984 to stop the construction of a road through tropical rainforest north of the Daintree River in north Queensland. In both cases, the calls for preservation of rainforests were eventually recognised by the inclusion of these areas in national parks and their declaration as World Heritage Areas. Tasmania produced an interim rainforest policy to protect all areas greater than 10 hectares and to take special care of its limited resource of natural conifers; this was recently revised in a regional forest agreement that identified separate areas for conservation and harvesting. Victoria banned logging in its rainforest, which it also protected with buffer strips.

## Biodiversity

Widespread community concern for the protection of forest wildlife reached a turning point in the mid-1970s. It focused on the arboreal fauna, such as koalas, possums and gliders, and some of the birds, whose survival depended on big old trees remaining in the forests. In 1987 the Commonwealth set up a national catalogue to list endangered and vulnerable species of both plants and animals in a systematic way. Each State and Territory also maintains its own lists which, although coordinated with the national list, provide greater regional detail.

In the 1990s such concern was expressed as a call to preserve the full biological diversity of the forests. This provided a stronger ecological footing by recognising that the ecological functioning of the forest as a whole needed to be ensured because it was the framework within which measures to preserve individual species had to be taken.

The 1992 United Nations Conference on Environment and Development produced the Convention on Biological Diversity. The Australian Government ratified the Convention in 1993, having already developed a National Strategy for Ecologically Sustainable Development in 1992. In 1996 all States and Territories and the Commonwealth signed the National Strategy for the Conservation of Biological Diversity.

## Wilderness

Part of Kosciuszko National Park was reserved as a 'primitive area' in the 1930s. The term 'wilderness' became used in the mid-1970s for areas in which there had been negligible human disturbance since European settlement, although this term is unacceptable to many Indigenous peoples. Calls were made for the protection of wilderness in New South Wales by the Colo Committee, nationally by the Australian Conservation Foundation, and brought to public prominence by The Wilderness Society.

Disputes over a proposal to dam the Franklin River in Tasmania made the calls for wilderness protection more widely known. A National Wilderness Inventory was commenced in 1986, and the concept has been recognised in

State and Territory legislation, the National Forest Policy Statement and other policy documents.

## Old-growth

The ideas of preserving areas of wilderness and of high ecological value were combined in calls to delineate and preserve areas of old-growth forest (a concept dealt with in greater detail in Chapter 4). By the early 1990s the Resource Assessment Commission estimated that about 20 per cent of Australia's State forests had never been logged. This was based on a narrower definition of forest than now and also on estimates of areas unlogged, rather than precise mapping. Information for the whole forest estate is currently not known. Some of these areas in tall eucalypt forest carried stands of mature old trees that were the focus of major controversies because they were highly prized for their aesthetic and environmental values and contained some of the most valuable sawlogs.

# 3 *The Size, Distribution and Tenure of the Forest Estate*

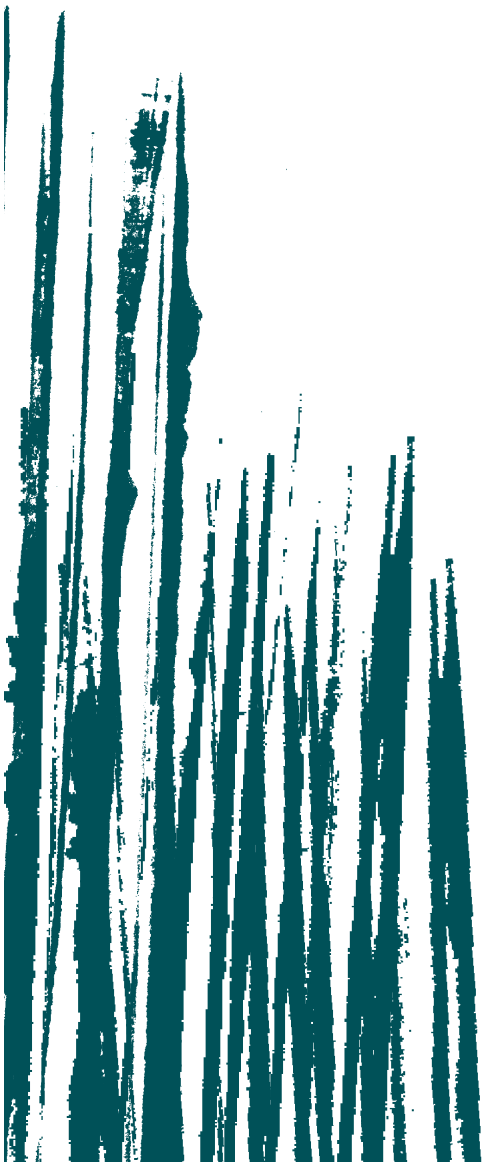


Photo: R Hnatiuk *Eucalyptus salmonophloia* (salmon gum)

# *The Size, Distribution and Tenure of the Forest Estate*

## The biogeography of Australia's forests

The availability of water and the suitability of temperatures control the broad distribution of forests across the Australian continent. At the local scale, the distribution of soils, slope and aspect also helps determine whether forests occur and what type of forest predominates. Through time, the kind of forest present in an area depends not only on the above factors, but also on others such as disturbance history and the way the forest has responded to such disturbances. Human use of the forests or their removal of entire forests also impacts strongly on the modern distribution of forests.

When viewed at the continental scale, the forests fall into two climatic categories: tropical and temperate. The tropical region across the north of the continent has two broad gradients that affect the kinds of forests to be found: one of increasing rainfall and slightly decreasing temperatures from west to east, and another of the same factors from south to north. One result of these gradients is that the tallest and densest forests occur in north-east Queensland – including Australia's main areas of tropical rainforest.

The temperate regions of the central eastern, south-east and south-west coasts support a great variety of forests that also respond to climate. Cool climate forests occur in the tropical north-east, but there they are restricted to the tops of mountains. In the south-east of the continent, cool climate forests are very extensive, only disappearing where temperatures are too cold in winter, such as in the alpine regions where a tree line determined by cold temperatures can be found, or where water becomes limiting inland. The patterns of rainfall are also generally more complex in the south-east, where relatively high mountains interact with winter rainfall from southerly directions and summer rainfall from northerly directions.

The Great Dividing Range of eastern Australia tends to mark a major divide between forest types, especially where the steep escarpment marks the eastern edge of the inland plateau. To the inland, the climate is distinctly drier and warmer than to the east and south-east of the divide and escarpment. This is partly due to the effects of increased altitude, but also to the general flow of rain-bearing weather. Thus, tall to very tall forests occur towards the coast, and low to medium height forests occur inland. A similar variation in forest types occurs in the south-west of the continent, where *Eucalyptus marginata* (jarrah) forests occur on the hills at the edge of the inland plateau, giving way to a great diversity of woodland types on the generally flat inland.

The large stature of the mature *E. marginata* forests in the south-west appears out of proportion to the duration of the summer drought they experience. Forest trees near Kalgoorlie also have a much greater stature than the climate of less than 250 millimetres of annual rainfall would suggest. Both these forested areas appear to depend on supplies of water from deep in the soil, rather than solely on direct rainfall. Another biogeographically noteworthy forest is the *E. camaldulensis* (river red gum) forest of the Murray and Darling river systems. Here again, the stature of the forests is greater than may be expected given the rainfall, but groundwater and periodic flooding maintain them.

Forests of considerable biogeographic interest are those bearing a strong resemblance to their Gondwanan predecessors. They are found primarily in the south-east, especially in Tasmania and in scattered locations in generally cool sites on mountains along the east coast, and in the tropical rainforests. Some of the plants and animals are modern descendants of those that lived when these

forests were widespread and dominated the vegetation of Australia some 60 million years ago. They are noteworthy in the primitive characteristics they have, compared to those of more recently evolved species.

## Forest types

Most of Australia's trees are hardwoods like the eucalypts, rather than softwoods (conifers). *Araucaria cunninghamii* (hoop pine), *A. bidwillii* (bunya pine) and *Athrotaxis selaginoides* (King Billy pine) dominate some native forests (although the total area of such forests is insufficient to constitute a major forest type in this report) and there are extensive areas of slow-growing callitris forests, but the few conifers elsewhere are found scattered through other forest types.

Specht and his co-authors produced a conservation atlas of Australian native plant communities in 1995. Using existing vegetation data at the time, they recognised 910 plant communities defined by dominant species and structure across the entire continent; this probably underestimates the total number of communities because of the incompleteness of the information. Of these, 457 are considered to be forest communities under the current definition.

For the purposes of this report, these communities have been grouped into eight broad native forest types. The first seven are eucalypt, acacia, melaleuca, rainforest, casuarina, mangrove and callitris. There is a long list of other forest types that are locally important (and occasionally widespread), though none cover significantly large areas. Together with forests for which information is limited for a variety of reasons, such types form the eighth native forest category – 'other forest'. Plantation forests are treated in two additional categories: hardwood and softwood.

This chapter examines the size, distribution and tenure of Australia's forest estate as a whole, and then by each of the eight native forest types and two plantation types.

## The size of the forest estate: summary

The most recent inventory of the forest estate, undertaken for this report, shows that Australia has a total forest area of close to 157 million hectares, made up of almost 156 million hectares of native forests and just over 1 million hectares of plantations. With a land area of almost 769 million hectares, this means that about 20 per cent of the continent is forested. The estimate of forest cover given here is dramatically different from some previous estimates, but well within others; this is due almost entirely to the definition of forest used. As described in Chapter 1, a forest is defined in this report as:

> *An area, incorporating all living and non-living components, that is dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding 2 metres and with existing or potential crown cover of overstorey strata about equal to or greater than 20 per cent. This definition includes Australia's diverse native forests and plantations, regardless of age. It is also sufficiently broad to encompass areas of trees that are sometimes described as woodlands.*

Table 1 and Figure 2 show the total distribution of native forests by State and Territory. Queensland has the greatest area of forest, but the position of the Northern Territory as the second most forested region may come as a surprise. Almost 28 million hectares of the Territory's total forest area is woodland that has not fallen within many previous definitions of forest.

### Distribution by crown cover category

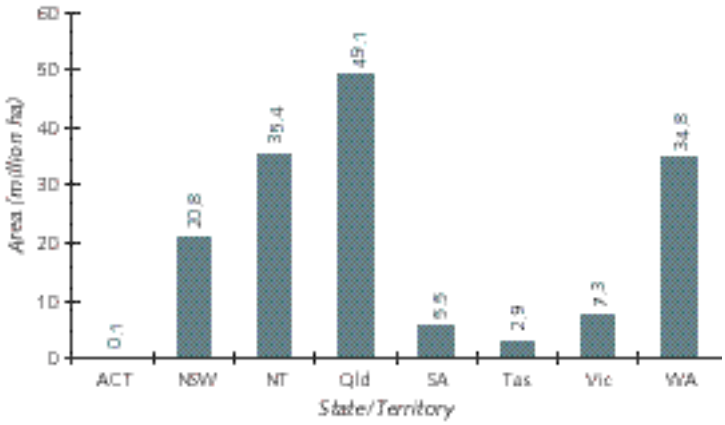
Crown cover is determined by estimating or measuring the area of ground covered by tree canopies, ignoring overlap and gaps within individual canopies. A line around the outer edge defines the limits of an individual canopy, and all the area within is treated as 'canopy', irrespective of gaps and overlaps.

The native forests can be divided into three classes by the density of their crown cover. Thus, there are:

- 112 million hectares of woodland (tree crowns cover 20–50 per cent of the land area when viewed from above), including just under 8 million hectares of woodland mallee;
- 39 million hectares of open forest (51–80 per cent crown cover), made up of 35 million hectares of what are commonly called wet and dry sclerophyll forests and 4 million hectares of open forest mallee; and
- 4.6 million hectares of closed forest (81–100 per cent crown cover), made up of 3.6 million hectares of rainforest and 1 million hectares of mangroves.

Map 1 (see colour section in back of book) shows the distribution of these three broad canopy cover categories across the country. There are a number of anomalies in these data, even though they represent the best that are currently available. For example, the larger areas of forest mapped in northern Australia are known to be less extensive than shown. In addition, the sharp border across the south of Cape York is an artefact of mapping, rather than of forest distribution.

**Figure 2: The distribution of native forest, by State and Territory**




Source: National Forest Inventory (1997).

**Table 1: The distribution of forest types, by State and Territory**

('000 ha)

| Forest type | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | Australia |
|---|---|---|---|---|---|---|---|---|---|
| Eucalypt | 120 | 17 929 | 31 138 | 31 984 | 4 820 | 2 237 | 6 845 | 29 390 | 124 463 |
| tall | 72 | 2 097 | 0 | 1 126 | 2 | 250 | 2 825 | 171 | 6 543 |
| medium | 48 | 12 842 | 23 849 | 28 511 | 497 | 1 901 | 2 986 | 20 815 | 91 450 |
| low | 0 | 1 163 | 7 288 | 2 340 | 316 | 86 | 76 | 3 431 | 14 700 |
| mallee | 0 | 1 827 | 0 | 0 | 4 005 | 0 | 958 | 4 973 | 11 764 |
| unknown | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 6 |
| Acacia | 0 | 944 | 2 439 | 4 603 | 307 | 3 | 17 | 3 986 | 12 298 |
| Melaleuca | 0 | 202 | 1 072 | 2 643 | 2 | 0 | 18 | 155 | 4 093 |
| Rainforest | 0 | 209 | 252 | 2 567 | 0 | 545 | 3 | 7 | 3 583 |
| Casuarina | 0 | 802 | 0 | 62 | 147 | 0 | 0 | 40 | 1 052 |
| Mangrove | 0 | 7 | 442 | 398 | 20 | 0 | 5 | 173 | 1 045 |
| Callitris | 0 | 382 | 0 | 309 | 139 | 0 | 37 | 0 | 867 |
| Other | 0 | 312 | 43 | 6 490 | 63 | 118 | 360 | 1 048 | 8 435 |
| *Total native forest* | *120* | *20 787* | *35 385* | *49 056* | *5 499* | *2 904* | *7 285* | *34 800* | *155 835* |
| Plantation[1] | 15 | 270 | 4 | 170 | 103 | 134 | 215 | 131 | 1 043 |
| **Total forest** | **135** | **21 057** | **35 389** | **49 226** | **5 602** | **3 038** | **7 501** | **34 930** | **156 877** |
| (% of land area) | 56% | 26% | 26% | 29% | 6% | 45% | 33% | 14% | 20% |
| Land area[2] | 240 | 80 160 | 134 620 | 172 720 | 98 400 | 6 780 | 22 760 | 252 550 | 768 230 |

*Note: Column or row total may not add up due to rounding.*
*Sources: National Forest Inventory (1997).*
*[1] Australian Forest Products Statistics (September 1997).*
*[2] Year Book Australia (1997).*

## Tree height

Currently there is no national standard used for mapping tree height: mapping compiled for this report used nearly 150 different height classes. Height data have been grouped into three categories, as follows:

- low: 2–10 metres
- medium: 11–30 metres
- tall: greater than 30 metres.

# Composition

Table 2 shows the area of forest for each of the eight native forest types used in this report, subdivided by crown cover (Figure 3 shows this graphically), and Table 1 shows the distribution of native forest types by State and Territory.

The distribution of forest types across the continent is given in Map 2 (see colour section in back of book).

## Growth stages

For some forest types it is possible to describe the growth stages of stands. Three stages are generally recognised: regrowth, mature and senescent. Additionally, some categorisations subdivide regrowth into establishment and juvenile, and mature into early and late mature. Growth stages data are available for some forests with multiple-use and conservation reserve tenure, and these are presented in Table 4. Overall, data are available for more than 26 per cent of these tenure categories, amounting to about 4 per cent of all forests. The amount of information on growth stages will increase with completion of the regional forest agreement process (see Chapter 5).

# The tenure of Australian native forests

Land tenure is crucial to our understanding of the state of the forests, since it determines the uses to which the forests may be put. This report recognises five tenure categories:

- conservation reserves: publicly owned forests reserved for conservation, including national parks and flora reserves;

**Table 2: Areas of forest types within crown cover categories ('000 ha)**

| | Crown cover category | | | |
|---|---|---|---|---|
| Forest type | Closed forest | Open forest | Woodland | Total |
| Eucalypt | nil | 32 703 | 91 759 | 124 463 |
| tall | nil | 5 475 | 1 068 | 6 543 |
| medium | nil | 22 656 | 68 794 | 91 450 |
| low | nil | 385 | 14 315 | 14 700 |
| mallee | nil | 4 187 | 7 577 | 11 764 |
| unknown | nil | nil | 6 | 6 |
| Acacia | nil | 1 695 | 10 603 | 12 299 |
| Melaleuca | nil | 878 | 3 215 | 4 093 |
| Rainforest | 3 583 | nil | nil | 3 583 |
| Casuarina | nil | 83 | 968 | 1 052 |
| Mangrove | 1 045 | nil | nil | 1 045 |
| Callitris | nil | 136 | 731 | 867 |
| Other | nil | 3 679 | 4 756 | 8 435 |
| **Total forest** | **4 628** | **39 174** | **112 032** | **155 835** |

*Note: Column or row total may not add up due to rounding.*
*Source: National Forest Inventory (1997).*

## Table 3: Extent of area, by forest type and growth stage

| Forest type | Total area for which growth stage is known | Multiple-use forests by growth stage (ha) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Establishment (1–10 years) | Juvenile (11–30 years) | Immature (31–100 years) | Mature (100–200 years) | Senescent (> 200 years) | Two growth stages | Three or more growth stages |
| Rainforests | 330 000 | 0 | 0 | 0 | 195 000 | 80 000 | 0 | 66 000 |
| Tall open eucalypt forests | 1 979 797 | 72 919 | 149 925 | 273 086 | 377 567 | 364 000 | 133 000 | 613 500 |
| Medium open eucalypt forests | 2 951 757 | 22 058 | 149 619 | 147 340 | 646 540 | 266 000 | 171 000 | 1 568 400 |
| Low open eucalypt forests | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tall eucalypt woodlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Medium eucalypt woodlands | 1 354 000 | 0 | 0 | 0 | 0 | 546 000 | 0 | 814 000 |
| Low eucalypt woodlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Eucalypt mallee forests and woodlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Callitris forests and woodlands | 223 000 | 0 | 0 | 0 | 0 | 0 | 0 | 225 000 |
| Acacia forests and woodlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other forests and woodlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 74 000 |
| **Total** | **6 838 554** | **94 978** | **299 544** | **420 426** | **1 219 107** | **1 256 000** | **304 000** | **3 360 900** |

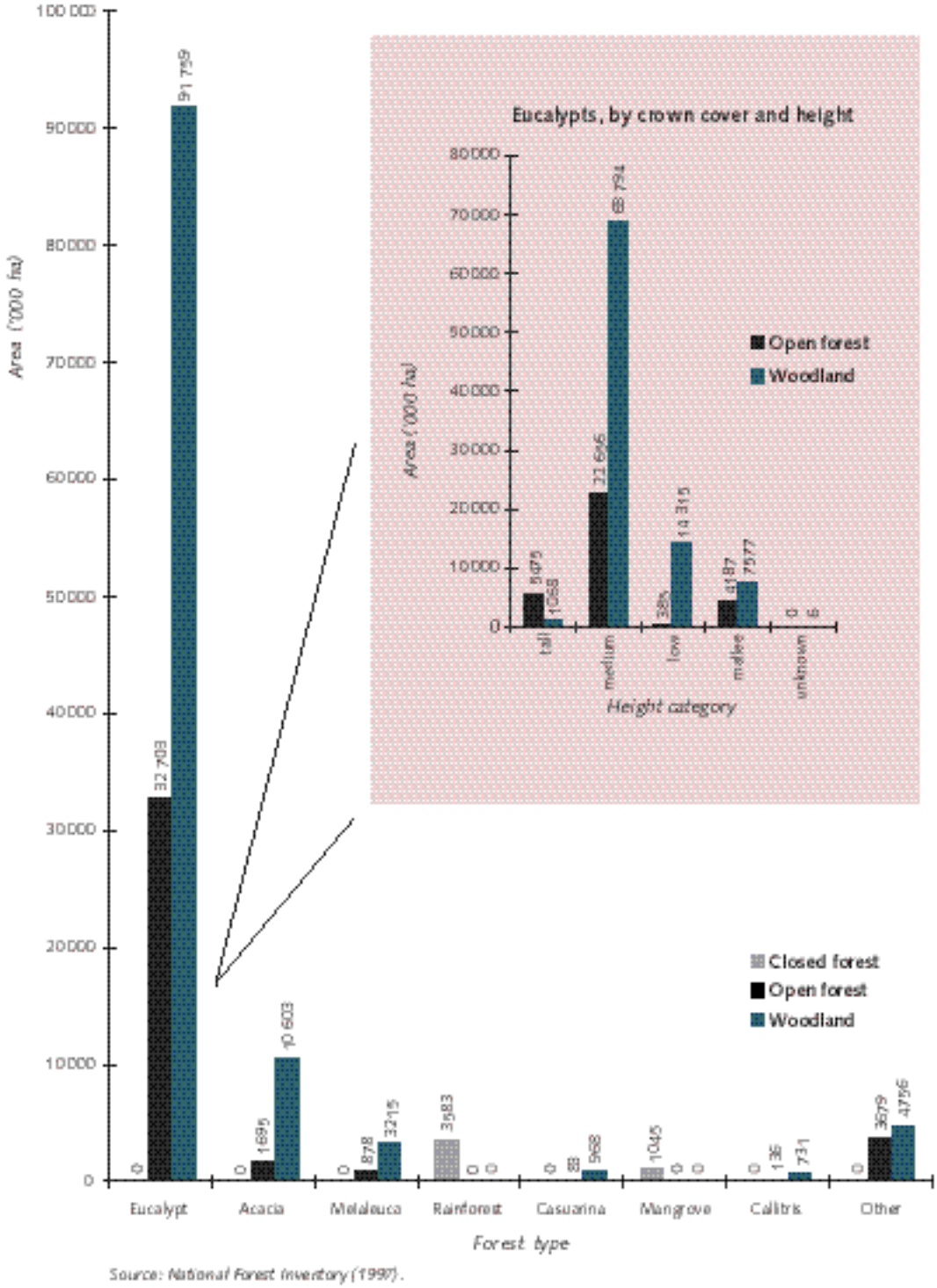
*Source: Montreal First Approximation Report (1997).*

## Table 4: First estimate of the extent of area by forest type in protected areas defined by growth stage (partial data only)

| Forest type | Forest (ha)[1] | (ha) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Total area for which growth stage is known | Establishment (1–10 years) | Juvenile (11–30 years) | Immature (31–100 years) | Mature (100–200 years) | Senescent (> 200 years) | Two growth stages | Three or more growth stages |
| Rainforests | 811 756 | 177 000 | | | | 177 000 | | | |
| Tall open eucalypt forests | 1 435 090 | 183 300 | 100 | 5 200 | 19 400 | 95 000 | | 19 000 | 46 200 |
| Medium open eucalypt forests | 3 388 029 | 757 700 | 100 | 500 | 41 000 | 203 000 | | 49 000 | 462 700 |
| Low open eucalypt forests | 16 899 | | | | | | | | |
| Tall eucalypt woodlands | 33 844 | | | | | | | | |
| Medium eucalypt woodlands | 5 843 904 | | | | | | | | |
| Low eucalypt woodlands | 641 231 | | | | | | | | |
| Eucalypt mallee forests and woodlands | 3 602 005 | | | | | | | | |
| Callitris forests and woodlands | 68 868 | | | | | | | | |
| Acacia forests and woodlands | 275 562 | | | | | | | | |
| Other forests and woodlands | 1 463 003 | | | | | | | | 31 000 |
| **Total** | **17 580 191** | **1 118 000** | **200** | **5 700** | **60 400** | **475 000** | | **68 000** | **539 900** |

*Sources: Montreal First Approximation Report (1997).*
*[1] National Forest Inventory (1997).*

**Figure 3: Area of crown cover categories within each forest type**




Source: National Forest Inventory (1997).

- multiple-use forests: publicly owned forests set aside for timber production, including State forest and timber reserves, in which timber production and mining are permitted, together with a range of other commercial and non-commercial activities;
- leasehold land: publicly owned forests on land leased from the crown;
- other crown land: forests on crown (public) land not covered by the previous three categories – this grouping includes such tenures as Aboriginal reserves, defence land, mining reserves and sundry others; and
- private forests: forests owned privately.

The *Native Title Act 1993* recognises the customary right to land of Indigenous peoples. The complex issues flowing from this Act are being worked through; at the time of publication of this report it was not possible to gauge how much of Australia's forests will come under native title following application of the Act.

Table 5 shows the tenure of native forest by crown cover category, and Map 3 (see colour section in back of book) shows the distribution of native forests by tenure across the continent. The tenure of plantation forests is dealt with more fully in another section of this chapter.

The ratio of public to private ownership for native forests mirrors the general pattern of land ownership in Australia. Approximately 27 per cent of native forests are privately owned and 72 per cent are publicly owned. Just under 1 per cent are of unclear ownership due to shortcomings in the databases used for this calculation.

The private forest category is the second largest tenure class: about 42 per cent of the native forest estate is on public land held under lease by the private sector, predominantly the pastoral industry.

The right to use land conferred by a lease does not automatically confer a right to use forest on the land; nevertheless, the forest may be affected by the uses to which the land is put, such as grazing. Relevant State and Territory governments set conditions for the use of leasehold land, and these conditions vary. For instance, pastoral leases usually only confer rights for small-scale timber use such as fencing and similar utilitarian purposes. In contrast, some leaseholders in New South Wales have entitlements similar to those of private owners. A wide range of various conditions relating to the use of forests on leasehold land also apply in other States and Territories.

Taking private and leasehold native forests together, almost 70 per cent are on land managed by the private sector.

The remaining 30 per cent are public forests, which are defined in the National Forest Policy Statement as any forest on crown land for which management responsibility has been delegated to government agencies, local governments or other instrumentalities. Public forests are divided fairly equally across three public tenure types – conservation reserves, multiple-use forests and other crown land.

About 11 per cent of the total native forest estate is in conservation reserves; 10 per cent is on other crown land; and about 9 per cent is on land with multiple-use tenure.

The influence of tenure on the management regime imposed on any given forest is discussed in later chapters.

## Tenure of native forests within States and Territories

Table 5 shows native forest tenure for each State and Territory. Some significant variations from the averages for the total native forest area are:

- forests on leasehold land are concentrated in Queensland and the Northern Territory, which between them have about 54 per cent of all native forests in the country and 67 per cent of all native forests on leased land;
- most of the privately owned forests are in the Northern Territory and Queensland;
- Western Australia has 22 per cent of the native forest estate, of which less than 4 per cent is owned privately;
- almost 85 per cent of native forests on other types of crown land are in Western Australia. Of these, more than 10 million hectares are on vacant public land and 2.5 million hectares are on Aboriginal reserves;

## Table 5: Forest area, by crown cover and tenure category, by State and Territory

| Crown cover and tenure class | State/Territory ('000 ha) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | Australia |
| **Closed forest** | | | | | | | | | |
| Leasehold | 0 | 0 | 61 | 451 | 0 | 0 | 0 | 20 | 532 |
| Private | 0 | 41 | 417 | 945 | 15 | 17 | 1 | 4 | 1 439 |
| Conservation reserve | 0 | 103 | 108 | 608 | 1 | 187 | 6 | 29 | 1 043 |
| Other | 0 | 4 | 1 | 111 | (1) | 145 | (2) | 106 | 366 |
| Multiple-use | 0 | 69 | 0 | 828 | 0 | 196 | (4) | 0 | 1 095 |
| Unresolved tenure | 0 | (4) | 106 | 21 | 4 | 0 | (1) | 21 | 153 |
| **Total** | **0** | **217** | **693** | **2 964** | **20** | **545** | **8** | **180** | **4 627** |
| **Open forest** | | | | | | | | | |
| Leasehold | 10 | 279 | 1 208 | 2 271 | 323 | 0 | 0 | 127 | 4 219 |
| Private | 6 | 3 811 | 4 729 | 4 524 | 1 336 | 783 | 665 | 270 | 16 124 |
| Conservation reserve | 80 | 1 768 | 750 | 729 | 613 | 336 | 2 179 | 870 | 7 324 |
| Other | 1 | 333 | 57 | 289 | 5 | 151 | 118 | 350 | 1 304 |
| Multiple-use | 5 | 2 166 | 0 | 2 161 | 24 | 1 088 | 3 054 | 1 385 | 9 883 |
| Unresolved tenure | 0 | 7 | 276 | 15 | 8 | (1) | 14 | (3) | 320 |
| **Total** | **102** | **8 364** | **7 020** | **9 989** | **2 309** | **2 359** | **6 029** | **3 003** | **39 175** |
| **Woodland** | | | | | | | | | |
| Leasehold | 3 | 5 687 | 18 967 | 21 274 | 1 543 | 0 | 0 | 13 877 | 61 352 |
| Private | (3) | 4 194 | 6 040 | 11 643 | 977 | 0 | 372 | 1 228 | 24 454 |
| Conservation reserve | 13 | 1 189 | 1 851 | 1 532 | 638 | 0 | 525 | 3 465 | 9 214 |
| Other | (4) | 269 | 200 | 651 | 8 | 0 | 47 | 12 750 | 13 926 |
| Multiple-use | (3) | 859 | 0 | 994 | 2 | 0 | 291 | 226 | 2 373 |
| Unresolved tenure | 0 | 8 | 613 | 8 | 2 | 0 | 13 | 69 | 713 |
| **Total** | **17** | **12 206** | **27 671** | **36 102** | **3 170** | **0** | **1 248** | **31 617** | **112 033** |
| **Plantation**(5) | | | | | | | | | |
| *All tenures* | *15* | *270* | *4* | *170* | *103* | *134* | *215* | *131* | *1 043* |
| **All forest** | | | | | | | | | |
| Leasehold | 13 | 5 966 | 20 236 | 23 996 | 1 866 | 0 | 0 | 14 025 | 66 103 |
| Private | 7 | 8 046 | 11 187 | 17 111 | 2 327 | 801 | 1 038 | 1 502 | 42 018 |
| Conservation reserve | 93 | 3 060 | 2 709 | 2 870 | 1 252 | 523 | 2 710 | 4 364 | 17 580 |
| Other | 2 | 605 | 258 | 1 051 | 12 | 296 | 165 | 13 206 | 15 597 |
| Multiple-use | 5 | 3 095 | 0 | 3 983 | 27 | 1 285 | 3 346 | 1 612 | 13 351 |
| Unresolved tenure | 0 | 15 | 995 | 44 | 15 | (1) | 26 | 90 | 1 186 |
| Plantation(1) | 15 | 270 | 4 | 170 | 103 | 134 | 215 | 131 | 1 043 |
| **Total** | **135** | **21 057** | **35 389** | **49 226** | **5 602** | **3 038** | **7 501** | **34 930** | **156 877** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area smaller than 50 hectares.*
*(2) Area of 51–100 hectares.*
*(3) Area of 101–500 hectares.*
*(4) Area of 501–999 hectares.*
*Sources: National Forest Inventory (1997).*
*(5) Australian Forest Products Statistics (September 1997).*

- almost 30 per cent of multiple-use native forests are in Queensland;
- Victoria, with less than 5 per cent of the total forest estate, has 25 per cent of all native forests in the multiple-use category, but also by far the highest percentage in the conservation reserve tenure category; and
- the Northern Territory has no multiple-use native forests and the Australian Capital Territory and South Australia have negligible areas in this tenure.

## Tenure of native forests by crown cover type

Table 5 also shows the amount of forest crown cover type in each tenure category. Points of interest include:

- woodlands make up almost 93 per cent of all native forests held under lease, reflecting their extensive distribution across the pastoral lands of the Northern Territory, Queensland and Western Australia;
- about 8 per cent of all woodlands are in the conservation reserve tenure, compared to 22 per cent of closed forests and nearly 19 per cent of open forests. Nevertheless, because the woodland estate is much larger than the closed and open forest estate, the gross area of woodland in conservation reserves constitutes almost 52 per cent of the total area of forest in conservation reserves;
- of the 4.4 million hectares of forest in conservation reserves in Western Australia, 80 per cent are woodlands, reflecting the large areas of woodland in that State;
- open forests occur largely on private land or in the multiple-use or conserved categories; and
- about 19 per cent of open forests are in conservation reserves, compared to 11 per cent for the entire national forest area.

Closed forests are proportionally more highly reserved for conservation purposes than is the native forest estate nationally. Even so, the figure does not represent the true level of conservation of closed forest. Much of the rainforest in the wet tropics of north-east Queensland – representing about 31 per cent of the national rainforest area – occurs within the multiple-use tenure but has full conservation protection under legislation. The true level of conservation of closed forests is therefore more than 40 per cent.

## Tenure of major native forest types

Table 6 shows the tenure of the eight native forest types across Australia. About half the tall eucalypt forests occur in multiple-use tenures, just over one-fifth in conservation reserves and nearly 30 per cent on private or leasehold land. In total, about two-thirds of all eucalypt forests occur on private or leasehold land. Over 90 per cent of acacia forests, virtually all casuarina forests and more than half of all mangrove and callitris forests occur on private or leasehold land. Just over half of all rainforests are found on land designated as conservation reserve or multiple-use; most of the rest (40 per cent) occur on private or leasehold land.

# National and international listings

There are several agreements and processes at the international and national levels that serve to identify forests of particular merit for the conservation of natural or cultural values. Two such agreements and processes are discussed here: World Heritage listing, and the Register of the National Estate. Areas within these categories overlap.

## World heritage areas

The World Heritage Convention encourages the protection and conservation of internationally important sites of natural and cultural heritage worldwide. One hundred and fifty countries including Australia have ratified the Convention since it came into force in 1975. More than 550 sites from 113 countries are on the World Heritage list.

Under the terms of the convention, Australia is obligated to conserve and protect particular natural and cultural sites of worldwide importance. The Commonwealth's *World*

*Heritage Properties Conservation Act 1983* provides the legal basis for fulfilling this international commitment.

Australia has 13 World Heritage sites. Six contain forest; forests were specifically mentioned in the listing purposes for several. Those containing forests are:

- Kakadu National Park (listed in three stages: 1981, 1987 and 1992);
- Lord Howe Island Group (1982);
- Tasmanian Wilderness (listed in two stages: 1982 and 1989);
- Central Eastern Australian Rainforest Reserves (1987);
- Wet Tropics of Queensland (1988); and
- Fraser Island (1992).

Table 7 shows the area of native forest by crown cover class occurring in World Heritage listed places. Table 8 shows the tenure of those native forests, and Table 9 shows the proportion of the total native forest area (by crown cover class) occurring in World Heritage or National Estate listed places. Table 10 shows the percentage of each forest type occurring in World Heritage or National Estate listed places. Map 4 (see colour section in back of book) shows the location of forested World Heritage places.

## The effects of listing

The Commonwealth has responsibility for fulfilling Australia's international obligations under the World Heritage Convention. In practice, the Commonwealth and individual States and Territories work jointly to manage World Heritage listed places. The nature of the joint arrangements is periodically reviewed.

## Register of the national estate

The Register of the National Estate encompasses natural and cultural places that have aesthetic, historic, scientific or social significance for the present community and future generations. It was established in 1975 under the *Australian Heritage Commission Act 1975*.

The Register lists both areas of forest and sites within them, including places of intrinsic aesthetic value, pre-colonial and current Indigenous sites and early settler history. Currently, 71 per cent of National Estate places containing forests are within the conservation reserve tenure.

In 1994 there were over 2200 forest areas or forest sites on the Register of the National Estate. As can be seen in Tables 7, 8, 9 and 10, registered areas cover almost 16 million

**Table 6: Tenure of major native forest types**

| Forest type | Tenure area ('000 ha) | | | | | | Australia ('000 ha) |
|---|---|---|---|---|---|---|---|
| | Private | Leasehold | Conserved | Other | Multiple | No data | |
| Eucalypt | 33 178 | 50 681 | 14 961 | 13 940 | 10 728 | 974 | 124 463 |
| tall | 1 372 | 583 | 1 469 | 110 | 3 006 | 4 | 6 543 |
| medium | 28 640 | 35 121 | 9 232 | 10 178 | 7 391 | 888 | 91 450 |
| low | 988 | 12 056 | 658 | 787 | 139 | 72 | 14 700 |
| mallee | 2 174 | 2 920 | 3 602 | 2 864 | 193 | 11 | 11 764 |
| unknown | 5 | (1) | 0 | (1) | (1) | 0 | 6 |
| Acacia | 2 784 | 8 525 | 276 | 608 | 99 | 7 | 12 298 |
| Melaleuca | 949 | 2 560 | 424 | 86 | 45 | 29 | 4 093 |
| Rainforest | 1 017 | 414 | 812 | 220 | 1 093 | 26 | 3 583 |
| Casuarina | 81 | 919 | 39 | 6 | 6 | (1) | 1 052 |
| Mangrove | 422 | 118 | 231 | 146 | 1 | 126 | 1 045 |
| Callitris | 197 | 300 | 69 | 8 | 292 | (1) | 867 |
| Other | 3 390 | 2 586 | 770 | 582 | 1 086 | 22 | 8 435 |
| **Total** | **42 018** | **66 103** | **17 580** | **15 597** | **13 351** | **1 186** | **155 835** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area less than one thousand hectares.*
*Source: National Forest Inventory (1997).*

**Table 7: The area of native forest, by crown cover class, in World Heritage or National Estate listed places[1]**

| Crown cover category | Total forest area (million ha) | Area (million ha) | |
|---|---|---|---|
| | | World Heritage area | National Estate |
| Closed forest | 4.6 | 1.1 | 1.6 |
| Open forest | 39.2 | 1.1 | 6.1 |
| Woodland | 112.0 | 1.5 | 8.1 |
| **Total** | **155.8** | **3.7** | **15.8** |

*[1] World Heritage areas and National Estate areas overlap.*
*Source: National Forest Inventory (1997).*

**Table 8: The tenure of native forest in World heritage or National Estate listed places[1]**

| Tenure class | % of total forested listed area | |
|---|---|---|
| | World Heritage | National Estate |
| Private | 4 | 10 |
| Leasehold | 7 | 8 |
| Conservation reserve | 75 | 71 |
| Other | 1 | 4 |
| Multiple-use | 14 | 6 |
| Unknown | <1 | <1 |

*Note: Column or row may not add up due to rounding.*
*[1] World Heritage areas and National Estate areas overlap.*
*Source: National Forest Inventory (1997).*

**Table 9: The proportion of each crown cover category of native forest occurring in World Heritage or National Estate listed places[1]**

| Crown cover category | World Heritage area (%) | National Estate (%) |
|---|---|---|
| Closed | 23 | 34 |
| Open | 3 | 15 |
| Woodland | 1 | 7 |
| All native forest | 2 | 10 |

*[1] World Heritage areas and National Estate areas overlap.*
*Source: National Forest Inventory (1997).*

**Table 10: The proportion of each forest type in World Heritage or National Estate listed places[1]**

| Forest type | World Heritage area (%) | National Estate (%) |
|---|---|---|
| Eucalypt | 2 | 10 |
| tall | 2 | 19 |
| medium | <1 | 9 |
| low | <1 | 2 |
| mallee | 0 | 20 |
| unknown | 0 | 0 |
| Acacia | 0 | 2 |
| Melaleuca | 2 | 13 |
| Rainforest | 28 | 38 |
| Casuarina | 4 | 7 |
| Mangrove | 7 | 21 |
| Callitris | 0 | 7 |
| Other | 3 | 12 |
| **All forest** | **2** | **10** |

*[1] Expressed as a percentage of total area of each forest type. World Heritage areas and National Estate areas overlap.*
*Source: National Forest Inventory (1997).*

hectares of forest, about 10 per cent of the total native forest estate. These are largely made up of 12 million hectares of eucalypt forest and 1 million hectares of rainforest. Map 5 (see colour section in back of book) shows the distribution of those forests occurring within places listed on the register.

## The implications of listing

An entry in the register is public recognition of the importance of a place but does not give the Commonwealth or a State or Territory any right to acquire the place or the public any right to visit it if it is private property. Nevertheless, there may be practical consequences to listing. In Tasmania, for instance, a consequence of listing some forests on the Register of the National Estate was a reduction in the volume of wood produced from those forests.

## Table 11: Extent of native forest, by forest type, classified as falling within IUCN conservation reserve classes using a narrow application of Class 6

| Forest type | Total forest (ha) | 1a | | 1b | | 2 | | 3 | |
|---|---|---|---|---|---|---|---|---|---|
| | | % of forest type | % of category | % of forest type | % of category | % of forest type | % of category | % of forest type | % of category |
| Rainforests | 3 582 535 | 0.05 | 0.16 | 0.01 | 0.06 | 21.70 | 6.61 | 0.06 | 1.38 |
| Tall open eucalypt forests | 5 475 108 | 0.61 | 2.86 | 3.38 | 22.19 | 21.14 | 9.84 | 0.61 | 20.07 |
| Medium open eucalypt forests | 22 655 994 | 0.27 | 5.21 | 0.64 | 17.49 | 11.96 | 23.05 | 0.27 | 36.50 |
| Low open eucalypt forests | 384 890 | 0.35 | 0.12 | 0.02 | 0.00 | 3.33 | 0.11 | 0.27 | 0.63 |
| Tall eucalypt woodlands | 1 067 985 | 0.00 | 0.00 | 0.00 | 0.00 | 3.15 | 0.29 | 0.00 | 0.00 |
| Medium eucalypt woodlands | 68 799 868 | 0.06 | 3.58 | 0.02 | 1.68 | 6.17 | 36.10 | 0.03 | 14.13 |
| Low eucalypt woodlands | 14 314 958 | 0.00 | 0.08 | 0.15 | 2.52 | 2.24 | 2.73 | 0.04 | 3.04 |
| Eucalypt mallee forests | 11 763 798 | 8.25 | 83.26 | 3.80 | 53.66 | 9.75 | 9.75 | 0.21 | 14.84 |
| Callitris forests | 866 667 | 0.07 | 0.05 | 0.80 | 0.83 | 6.95 | 0.51 | 0.00 | 0.00 |
| Acacia forests | 12 298 104 | 0.06 | 0.58 | 0.00 | 0.03 | 1.37 | 1.43 | 0.04 | 3.25 |
| Other forests | 14 624 742 | 0.33 | 4.10 | 0.09 | 1.53 | 7.71 | 9.59 | 0.07 | 6.15 |
| **Total** | **155 834 648** | **0.75** | **100.00** | **0.53** | **100.00** | **7.55** | **100.00** | **0.11** | **100.00** |

| Forest type | Total forest (ha) | 4 | | 5 | | 6 | | Total conserved | |
|---|---|---|---|---|---|---|---|---|---|
| | | % of forest type | % of category | % of forest type | % of category | % of forest type | % of category | % of forest type | % of category |
| Rainforest | 3 582 535 | 0.36 | 0.43 | 0.17 | 0.23 | 0.11 | 0.90 | 22.47 | 4.02 |
| Tall open eucalypt forests | 5 475 108 | 0.28 | 0.50 | 0.12 | 0.26 | 0.36 | 4.55 | 26.50 | 7.24 |
| Medium open eucalypt forests | 22 655 994 | 1.05 | 7.83 | 0.24 | 2.03 | 0.36 | 18.65 | 14.79 | 16.71 |
| Low open eucalypt forests | 384 890 | 0.39 | 0.05 | 0.00 | 0.00 | 0.01 | 0.00 | 4.37 | 0.08 |
| Tall eucalypt woodlands | 1 067 985 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.15 | 0.17 |
| Medium eucalypt woodlands | 68 799 868 | 1.90 | 42.83 | 3.47 | 90.40 | 0.24 | 38.35 | 11.89 | 40.81 |
| Low eucalypt woodlands | 14 314 958 | 1.96 | 9.22 | 0.19 | 1.02 | 0.08 | 2.70 | 4.66 | 3.33 |
| Eucalypt mallee | 11 763 798 | 7.73 | 29.82 | 0.42 | 1.89 | 0.86 | 23.16 | 31.02 | 18.20 |
| Callitris forests | 866 667 | 0.11 | 0.03 | 0.00 | 0.00 | 0.02 | 0.04 | 7.95 | 0.34 |
| Acacia forests | 12 298 104 | 0.71 | 2.88 | 0.10 | 0.49 | 0.09 | 2.65 | 2.38 | 1.46 |
| Other forests | 14 624 742 | 1.34 | 6.41 | 0.66 | 3.68 | 0.27 | 8.99 | 10.46 | 7.63 |
| **Total** | **155 834 648** | **1.96** | **100.00** | **1.69** | **100.00** | **0.28** | **100.00** | **12.87** | **100.00** |

*Notes: IUCN classes are as follows:*

1a – *Strict nature reserve: protected area managed mainly for science.*
1b – *Wilderness area: protected area managed mainly for wilderness protection.*
2 – *National park: protected area managed mainly for ecosystem protection and recreation.*
3 – *Natural monument: protected area managed mainly for conservation of specific natural features.*
4 – *Habitat/species management area: protected area managed mainly for conservation through management intervention.*
5 – *Protected landscape/seascape: protected area managed mainly for landscape/seascape conservation and recreation.*
6 – *Managed resource protected area: protected area managed mainly for the sustainable use of natural ecosystems.*

*Sources: National Forest Inventory (1997).*
*Environment Australia*

Listing on the Register of the National Estate imposes no legal obligations on private individuals or bodies, or on local, State or Territory governments. Commonwealth ministers are required, under Section 30 of the Australian Heritage Commission Act, to refrain from taking action that adversely affects a site on the register unless there is 'no feasible and prudent alternative' and the Australian Heritage Commission has been given the opportunity to comment.

## Classification of protected areas

The International Union for the Conservation of Nature and Natural Resources (IUCN) has developed a simplified classification system for protected areas to provide a basis for international comparison. There are six classes that are distinguished by the degree of protection afforded to the site. They offer a standardised way of grouping conservation reserves in Australia (of which there are more than 40 types). The six classes are:

1. strict protection (1a nature reserve; 1b wilderness area – protected areas managed either mainly for science or wilderness protection);
2. managed for ecosystem protection and recreation (for example, national parks);
3. managed for conservation of specific natural features (for example, natural monuments);
4. managed actively for conservation of habitat or species;
5. managed for conservation of landscape/seascape; and
6. managed mainly for the sustainable use of natural ecosystems (managed resource protected area).

Within Australia there are divergent views about what land should be included in Class 6. At issue is whether multiple-use forest that is reserved under legislation to protect and maintain forests for harvesting and conservation should be included in this class. The total area reported for multiple-use forests designated by States as falling within Class 6 is 3.6 million hectares.

**Table 12: Extent of native forest in conservation reserves and in other classification systems with conservation value using a broad application of IUCN Class 6[1]**

| Tenure | Area (ha) |
|---|---|
| Conservation reserve | 17 580 191 |
| Other crown land | 2 595 146 |
| Multiple-use forest[2] | 3 605 100 |
| **Total** | **23 780 437** |

*[1] 'Conservation reserve' and 'Other crown land' categories show areas in IUCN Classes 1–6. Multiple-use forest category shows the area placed in Class 6 by some agencies.*
*[2] No data available for the ACT, NT, Qld or SA.*
*Source: National Forest Inventory (1997).*

Table 11 shows forest area by forest type against the six standard IUCN classes using a narrow definition of Class 6, and Table 12 provides information for a wider application of Class 6. Map 6 (see colour section in back of book) shows the location of forests classified as falling within any of the six (narrowly defined) IUCN conservation reserve classes.

# Size, distribution and tenure by forest type

## Eucalypt forest

Eucalypts dominate 124 million hectares of open forest, woodland and mallee and share the canopy with other species in a further 10 million hectares. According to the classification by Specht and his co-authors, eucalypts are the most dominant species in 270 forest communities in Australia (these constitute the eucalypt forest type described here) and occur as co-dominants in a further 15 forest communities. Table 13 lists 101 common forest-dominant eucalypt species and the regions in which they occur naturally.

## Table 13: 101 common forest-dominant eucalypt species

| Species | Common name | Range |
|---|---|---|
| *E. accedens* | Powderbark wandoo | Sw WA |
| *E. acmenoides* | White mahogany, yellow stringybark (parts of Qld) | Nth coast NSW, coastal Qld |
| *E. agglomerata* | (Blue-leaved) stringybark | Coastal NSW & ne Vic |
| *E. alba* | White gum, poplar gum | Nth WA, NT, east coast Nth Qld |
| *E. albens* | White box | Vic, NSW, sth Qld, SA |
| *E. andrewsii* | New England blackbutt | Ne NSW & se Qld, isolated occurrences in Qld |
| *E. argophloia* | (Queensland western) white gum, lapunya, scrub gum | Sth Qld |
| *E. astringens* | Brown mallet | Sw WA |
| *E. baileyana* | Bailey's stringybark | Nth NSW & se Qld |
| *E. baxteri* | Brown stringybark | SA, NSW & Vic |
| *E. blakelyi* | Blakely's red gum | East NSW, ACT, nth & se Vic |
| *E. bosistoana* | Coast grey box, Gippsland grey box (Vic) | Coastal east Vic & sth NSW |
| *E. botryoides* | Southern mahogany, Bangalay | Coastal se Vic to central NSW coast. |
| *E. brevifolia* | Northern white gum | WA, NT |
| *E brevistylis* | Rates tingle | Southern sw WA |
| *E. calophylla* = *Corymbia calophylla* | Marri, red gum | WA |
| *E. camaldulensis* | River red gum, red gum, Murray red gum, river gum (WA) | WA, NSW, NT, Qld, Vic, ACT, SA |
| *E. citriodora* = *Corymbia citriodora* | Lemon-scented (iron) gum, spotted gum | East Qld |
| *E. cladocalyx* | Sugar gum | Sth SA |
| *E. coccifera* | Tasmanian snow gum | Tas |
| *E. consideniana* | Yerchuk | East Vic, se NSW |
| *E. crebra* | Narrow-leaved (red) ironbark, ironbark | NSW, Qld |
| *E. cypellocarpa* | (Spotted) mountain (grey) gum, monkey gum | Vic, east NSW |
| *E. dalrympleana* | Mountain gum, white gum, broad-leaved ribbon gum | Sth Qld, se & ne NSW, parts of Vic & Tas |
| *E dealbata* | Tumbledown red gum | East NSW to se Qld |
| *E. deanei* | Round-leaved gum, mountain blue gum, Deane's gum | East central NSW, nth NSW, sth Qld |
| *E. decorticans* | Gum-top ironbark | Se Qld |
| *E. delegatensis* | Alpine ash (Vic, NSW), woollybutt (Vic), gum-topped stringybark (Tas), white-top (Tas), blue leaf (Tas) | Vic, NSW, ACT, Tas |
| *E. diversicolor* | Karri | Sw WA |
| *E. dives* | (Broad-leaved) peppermint, blue peppermint (Vic) | East NSW, central & south Vic |
| *E. drepanophylla* | Queensland grey ironbark | Qld |
| *E. dundasii* | Dundas blackbutt | Sth WA |
| *E. dunnii* | Dunn's white gum, white gum | Ne NSW, se Qld |
| *E. elata* | River peppermint, river white gum | Se NSW, east Vic |
| *E. fastigata* | Brown barrel, cut-tail | East NSW into ne Vic |
| *E. fibrosa* | (Broad-leaved) (red) ironbark, blue-leaved ironbark | Sth coast NSW to mid-coast Qld |
| *E. ficifolia* = *Corymbia ficifolia* | Red flowering gum | WA |

## Table 13 (continued): 101 common forest-dominant eucalypt species

| Species | Common name | Range |
|---|---|---|
| *E. globoidea* | White stringybark | Central & south NSW coast & east Vic |
| *E. globulus* | Tasmanian blue gum, (southern) blue gum | East coast of Tas, sth coast Vic |
| *E. gomphocephala* | Tuart | Sw WA |
| *E. grandis* | Flooded gum (NSW), rose gum (Qld) | Coastal NSW & Qld |
| *E. guilfoylei* | Yellow tingle | Southern sw WA |
| *E. gummifera* = *Corymbia gummifera* | Red bloodwood | Ne coastal Vic, NSW coast, Sth Qld |
| *E. intermedia* = *Corymbia intermedia* | Pink/red bloodwood | Nth Coast NSW, coastal Qld |
| *E. jacksonii* | Red tingle, red tingle tingle | Southern sw WA |
| *E. jensenii* | Wandii ironbark | WA, NT |
| *E. laevopinea* | Silvertop, stringybark | East NSW to south Qld |
| *E. largiflorens* | Black box | NSW, south Qld, east SA & Vic |
| *E. leptophleba* | Molloy red box | Nth Qld |
| *E. leucoxylon* | Yellow gum (Vic), South Australian blue gum (SA), water gum (Eyre Peninsula, SA), white ironbark | Central west Vic, se SA, sth NSW |
| *E. macrocarpa* | Mottlecah | WA |
| *E. macrorhyncha* | Red stringybark | Vic, NSW, isolated patch in se SA |
| *E. maculata* = *Corymbia maculata* | Spotted gum | Coastal NSW, isolated in Vic |
| *E. mannifera* | Brittle gum | Central & sth NSW, east Vic |
| *E. marginata* | Jarrah | Sw WA |
| *E. melanophloia* | Silver-leaved ironbark | Inland NSW & Qld, coastal sth & central Qld |
| *E. melliodora* | Yellow box, honey box (Qld), yellow ironbark (Qld) | Vic, NSW, se Qld |
| *E. microcarpa* | Grey box, narrow-leaved box, inland grey box | Vic, NSW & Qld wheatbelt area |
| *E. microcorys* | Tallowwood | Coastal nth NSW & se Qld |
| *E. miniata* | Darwin woollybutt, woollybutt | Nth WA, NT & Qld |
| *E. moluccana* | Grey box, gum-topped box (Qld) | Central & nth coastal NSW, east Qld |
| *E. muelleriana* | Yellow stringybark | Se NSW & coastal east Vic |
| *E. nitens* | Shining gum, silvertop (NSW) | Scattered distribution in NSW & Vic |
| *E. nitida* | Smithton peppermint, peppermint (Tas) | Tas, sth Vic, se SA |
| *E. obliqua* | Messmate stringybark, messmate, stringybark | Vic, Tas, east NSW just into Qld, se SA |
| *E. oreades* | Blue mountains ash, smooth-barked mountain ash, white ash | East NSW & se Qld |
| *E. ovata* | Swamp gum, black gum (southern Tas), white gum | Tas, sth SA, sth Vic, se NSW |
| *E. paniculata* | Grey ironbark | Coastal NSW |
| *E. pauciflora* | Snow gum, cabbage gum (Tas), weeping gum (Tas), white salee (Australian standard name for the timber) | Mountainous & tableland areas of NSW, Vic, Tas & se Qld, some coastal areas of SA, NSW & Tas |
| *E. phoenicea* | Scarlet gum, Ngainggar | Nth NT, WA, ne Qld |
| *E. pilularis* | Blackbutt | Coastal NSW, se Qld coast |
| *E. polyanthemos* | Red box | Vic & NSW |
| *E. polycarpa* = *Corymbia polycarpa* | Long-fruited bloodwood | Nth NSW, Qld, nth NT, nth WA |

## Table 13 (continued): 101 common forest-dominant eucalypt species

| Species | Common name | Range |
|---|---|---|
| *E. populnea* | Poplar box, bimble box | Qld, NSW |
| *E. propinqua* | Grey gum, small-fruited grey gum | Coastal nth NSW & sth Qld |
| *E. pulchella* | White peppermint | Tas |
| *E. punctata* | Grey gum | East NSW, se Qld |
| *E. radiata* | Narrow-leaved peppermint, peppermint | East Vic & NSW |
| *E. regnans* | Mountain ash, swamp gum (Tas), stringy gum (Nth Tas) | Vic & Tas |
| *E. resinifera* | Red mahogany | East NSW, se Qld, ne Qld (coastal) |
| *E. robusta* | Swamp mahogany, swamp messmate (Qld) | Sth coast of Qld to sth coast of NSW |
| *E. rossii* | Scribbly gum, snappy gum, white gum | Inland east NSW |
| *E. rubida* | Candlebark, ribbon gum, white gum | Inland east NSW, Vic, east Tas, isolated in sth SA |
| *E. saligna* | Sydney blue gum, blue gum | Coastal NSW & sth Qld, few isolated in central coastal Qld |
| *E. salmonophloia* | Salmon gum | Sth WA |
| *E. sideroxylon* | Red ironbark, mugga, mugga ironbark | Nth Vic, NSW, se Qld |
| *E. sieberi* | Silvertop ash, coastash (NSW, Vic), ironbark (Tas), silvertop, black ash (NSW) | East Vic, sth coast NSW, ne Tas |
| *E. similis* | Yellow jacket | Qld |
| *E. smithii* | Gully gum, gully peppermint (NSW), blackbutt peppermint (NSW) | East Vic, coastal sth NSW |
| *E. staigeriana* | Lemon-scented ironbark | Nth Qld |
| *E. stellulata* | Black sally | East NSW, east Vic |
| *E. tereticornis* | Forest red gum, blue gum (Qld), red iron gum (Qld) | Coastal se Vic, NSW & Qld |
| *E. terminalis* = *Corymbia terminalis* | Desert bloodwood | Nth WA, NT, Qld & nth NSW & SA |
| *E. tessellaris* = *Corymbia tessellaris* | Carbeen, Moreton Bay ash | East & nth Qld, ne NSW |
| *E. tetrodonta* | Darwin stringybark, stringybark (NT & WA), messmate (Nth Qld & WA) | Nth WA, NT & Qld |
| *E. torelliana* = *Corymbia torelliana* | Cadaga, Cadaghi | East coast nth Qld |
| *E. torquata* | Coral gum | Sth WA |
| *E. viminalis* | Manna gum, ribbon gum (NSW), white gum (NSW & Tas) | Tas, Vic, se SA, east NSW, se Qld |
| *E. viminalis subsp. cygnetensis* | Boomsma (formerly E. huberana) | Parts of SA & sw Vic |
| *E. wandoo* | Wandoo | Sw WA |
| *E. woodwardii* | Lemon-flowered mallee | Sth WA |

*Source: Bureau of Resource Sciences, unpublished data (1997).*

### Box 1: The genus *Eucalyptus*

The genus *Eucalyptus* was named in 1788 by Charles-Louis L'Heritier de Brutelle, a Frenchman living in London, who named a specimen collected in 1777 as *Eucalyptus obliqua* (messmate stringybark). Since then over 700 eucalypt species have been recognised, most of which are trees and only four of which are not endemic to Australia.

Three closely related genera exhibit *Eucalyptus*-like qualities: *Eucalyptus*, *Corymbia* and *Angophora*. The genus *Corymbia* has been identified recently by taxonomists; it includes a number of species, broadly known as the bloodwoods, which were previously classified as *Eucalyptus* species. Most State agencies accept this division of the eucalypts into three distinct genera. The Department of Conservation and Land Management in Western Australia uses the alternative classification, which does not recognise *Corymbia*. In this report, 'eucalypt forest' encompasses the genera *Eucalyptus* and *Corymbia* (communities dominated by *Angophora* species fall into the 'other forest' type).

Some groups of eucalypt species are characterised by their bark and their common names derive from this attribute – gum (smooth bark), box (bark fragmented into small patches), stringybark (bark fissured into long strips), ironbark (similar to stringybark but very hard) and minniritchi (raised hairy appearance). Bloodwoods are named for the presence of red kino in veins or pockets in the timber. Some names derive from the similarity of the timber to overseas timbers (ash, mahogany and oak), from leaf colour (blue gum) or the oils in the leaves (peppermints, lemon-scented gum).

## Distribution

Some eucalypts have highly specific environmental conditions that control their distribution, while others are less sensitive and occur over a wide range of environmental gradients. Many of the widely distributed species may also occur in different forms, depending on the environment. An example of this is *E. microcarpa* (known as grey box in Victoria, narrow-leaved box in New South Wales and inland grey box in Queensland), which occurs as a tree of medium height in the core of its range and as a multi-stemmed mallee in harsher environments. Figure 4 shows the broad distribution of eucalypt forests across the continent.

To briefly describe the distribution of Australia's more common eucalypt forests in this report, they have been divided into three height groups – tall, medium and low. Mallees, which occur as both medium and low forests, are considered separately. The data referred to below are contained in Table 1; Map 7 (see colour section in back of book) shows the distribution of eucalypt forest by structure.

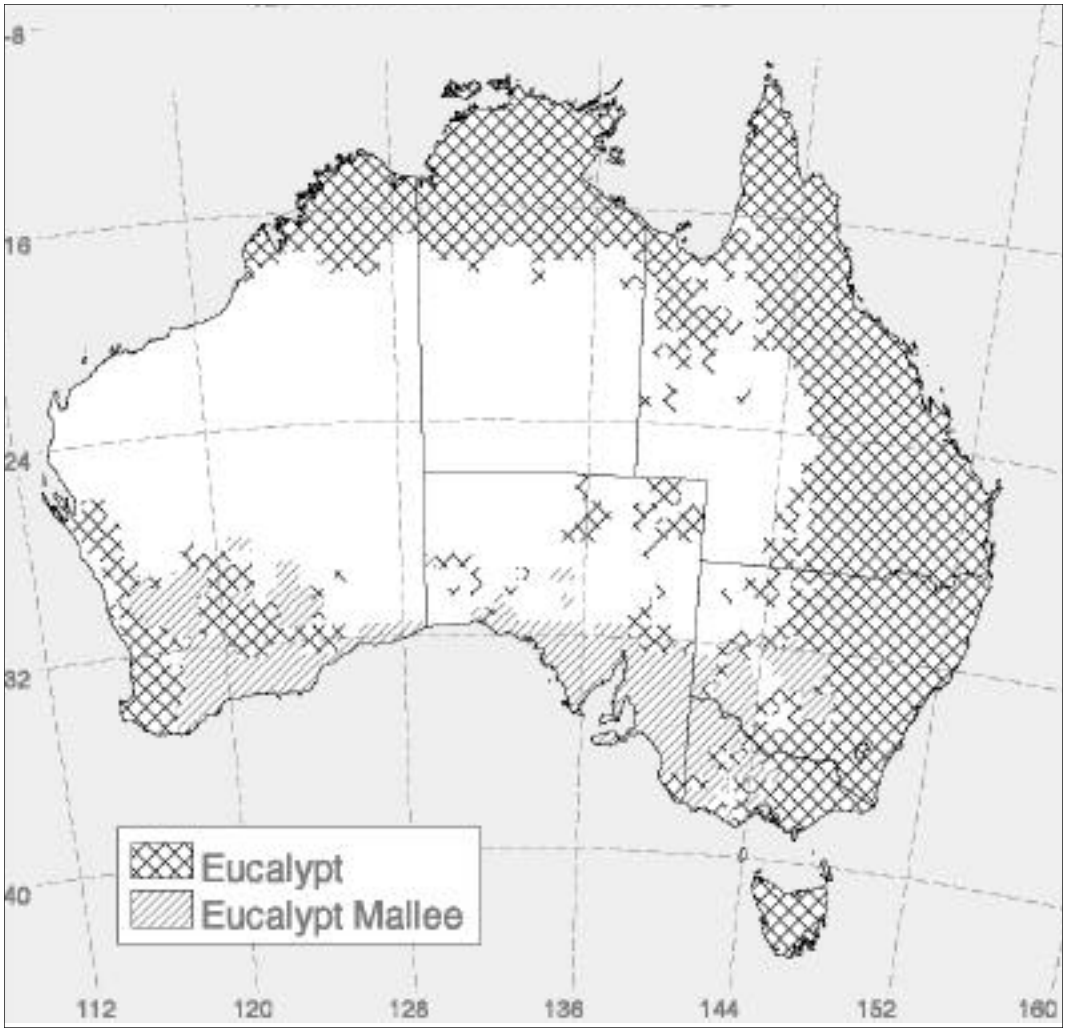



**Figure 4: Thumbprint of regions in which eucalypt forests occur**

### *Tall eucalypt forests*

Tall eucalypt forests are those that exceed 30 metres in height. There are 6.5 million hectares of these forests, constituting 4 per cent of the total native forest estate. Most of them occur in Victoria, New South Wales, Queensland and Tasmania, although there are small areas in all other States and Territories except the Northern Territory.

These forests are often referred to as wet sclerophyll forests: 'wet' reflecting the moist, lush understorey vegetation that generally occurs in them, 'sclerophyll' from the botanical term for the tough leaves characteristic of eucalypts. In some areas the understorey contains conspicuous tree ferns, or palms in the tropics and sub-tropics. The best examples of these forests are the *E. diversicolor* (karri) forests of south-western Australia and the *E. regnans* (mountain ash or swamp gum) forests of Victoria and Tasmania. Specimens of *E. regnans* have been known to reach heights in excess of 100 metres, making them the tallest flowering plants in the world.

A distinctive characteristic of many tall eucalypt forests is the predominantly even age of the canopy trees. This may be due to the suppression of new growth by the mature trees, to wildfires that in moist forests tend to be less frequent but occasionally are severe enough to wipe out the mature stand and stimulate regrowth of an even age, or a combination of the two. In the prolonged absence of fire, some understorey plants in the tall eucalypt forests may live as long as the eucalypts or longer.

The crown cover densities of tall eucalypt forests are predominantly classified as open forest or woodland (Table 2). Those classified as woodland often occur in relict stands that are in transition to rainforest. In such forests, widely spaced individual eucalypt trees emerge above the lower rainforest canopy, and are called emergents. There is debate as to whether

such forest should be classified as eucalypt with rainforest understorey or rainforest with eucalypt emergents, or as dynamic ecotones between the eucalypt forest and rainforest. In Tasmania, for instance, such forests are often called 'mixed forests', unless eucalypts make up less than 5 per cent of the crown cover, in which case they are called rainforests.

Apart from the transitional forests just mentioned, there are three principal forms of tall eucalypt forest, all characterised by the understorey:

- the *E. diversicolor* forests of Western Australia, with their understorey of sclerophyllous shrubs and small trees;
- the temperate east coast forests, where the understorey is often taller than 10 metres and may include tree ferns; and
- the warmer northern tall forests, where the understorey consists of palms, vines and small trees.

### *Medium height eucalypt forests*

Medium height eucalypt forests are those ranging between 11 metres and 30 metres in height. There are 91 million hectares of such forests, excluding mallee, amounting to more than half (58 per cent) of the country's total native forest cover. These forests constitute 81 per cent of all non-mallee eucalypt forests and occur in every State and Territory, although most are in the Northern Territory, Queensland and Western Australia, which each have 20 million hectares or more. New South Wales has comparatively less and the Australian Capital Territory, South Australia, Tasmania and Victoria collectively have just over 5 million hectares.

The boundary between open forest and woodland is sometimes difficult to distinguish and these forests often share the same overstorey species. About three-quarters of the medium height eucalypt forests are woodland: in some cases, such as in the E. melliodora (yellow box) woodlands, this may be due to partial clearing. They constitute close to half of Australia's total native forest cover, contain about 80 per cent of all eucalypt species, and occur in a variety of forms in transitional zones between humid and arid regions. They can be divided into three subgroups, depending on their understorey:

- *Medium height eucalypt woodlands with tall understorey* extend across northern Australia and occur inland in the east and south-east of the continent. Depending on whether the forests are in the northern or temperate regions, the understorey includes palms and cycads or sclerophyllous shrubs such as banksias, acacias and casuarinas. In the temperate regions, the natural distribution of these woodlands coincides with the core of Australia's agricultural regions: as a consequence, most exist as remnant patches in an agricultural landscape. In southern Queensland, central New South Wales and northern Victoria, such woodlands occur in dry areas (400–600 millimetres of annual rainfall). They are often referred to as box and ironbark woodlands and contain species such as *Corymbia polycarpa* (bloodwood), *E. populnea* (poplar box), *E. crebra* (narrow-leaf iron bark), *E. melanophloia* (silver-leaf ironbark), *E. microcarpa* (grey box) and, in Western Australia, *E. gomphocephala* (tuart).
- *Medium height eucalypt woodlands with low understorey* occur in the wheatbelt of Western Australia, where the *E. marginata* (jarrah) forest gives way to *E. wandoo* (wandoo) and *E. salmonophloia* (salmon gum) woodlands. This latter species may grow up to 30 metres in height in areas that receive little more than 200–300 millimetres of rainfall annually. Another example of this category of forests occurs on the eastern side of the continent, where *E. largiflorens* (black box) often dominates the areas bordering the floodplains of the Murray-Darling Basin. Box and ironbark woodlands similar to those referred to as 'medium height woodlands with tall understorey' also occur with a low understorey. Medium height eucalypt woodlands with low understoreys often have a succulent understorey of Chenopodiaceae (bluebush, saltbush), in addition to sclerophyllous shrubs.
- *Medium height eucalypt woodlands with grassy understorey* such as the *E. albens* (white box) and *E. melliodora* woodlands are found on the fertile western slopes of Queensland, New South Wales and Victoria. They also occur as stands

dominated by *E. similis* (yellow jacket), *E. brevifolia* (northern white gum) and *E. jensenii* (wandi ironbark) in low rainfall, relatively infertile regions of northern Australia, with hummock grasses such as *Triodia mitchellii* in the understorey. Communities of this type only reach heights greater than 10 metres under favourable conditions.

About one-quarter of the medium height forests are classed as open forest. Like their woodland counterparts, these forests occur in three types, depending on the height and nature of the understorey:

- *Medium height open eucalypt forests with a tall sclerophyllous understorey* occur where annual rainfall is 600–1000 millimetres, often adjacent to taller forests but on less fertile soils. Some of the more dominant species in the temperate zone include *C. maculata* (spotted gum) and *C. gummifera* (bloodwood) in Queensland and eastern New South Wales, *E. radiata* (narrow-leaved peppermint) and *E. sieberi* (silver-top ash) in southern New South Wales and Victoria, *E. viminalis* (manna gum) and *E. obliqua* (browntop or messmate stringybark) in Tasmania, Victoria and New South Wales, and *C. calophylla* (marri) and *E. marginata* in Western Australia. About 100 000 hectares of these forests also occur in South Australia, where they are dominated by species such as *E. viminalis*, *E. baxteri* (brown stringybark), *E. obliqua* and *E. camaldulensis* (river red gum). In the tropics of north Queensland and the Northern Territory, such forests are dominated by *E. tetrodonta* (Darwin stringybark or messmate) and *E. miniata* (Darwin woollybutt), with understoreys of *Livistona* (palms) and *Cycas* (cycads), along with dense grasses.
- *Medium height open eucalypt forests with a low understorey* (often called dry sclerophyll to differentiate them from wetter, taller forests) usually occur in areas receiving less than 600 millimetres of rain a year or on very infertile soils in wetter regions. These forests are widespread throughout temperate South Australia, Victoria, New South Wales and south-eastern Queensland. Common species include *C. intermedia* (pink bloodwood) in south-eastern Queensland, *E. crebra* and *C. gummifera* in northern New South Wales, *E. macrorhyncha* (red stringybark) and *E. mannifera* (brittle gum) in southern New South Wales and Victoria, and *E. baxteri* and *E. leucoxylon* (South Australian blue gum or yellow gum) in South Australia and Victoria. Small areas of this type of forest dominated by *E. tetrodonta* also occur in the tropics.
- *Medium height open eucalypt forests with a grassy understorey* occur predominantly in north-east New South Wales and eastern Queensland, where the dominant species include *E. tereticornis* (forest red gum), *C. intermedia* and *E. drepanophylla* (Queensland grey ironbark). Patches occur in Tasmania, where *E. delegatensis* (alpine ash) often occurs with a grassy understorey, and in tropical Australia, where large areas of *E. tetrodonta* and *E. miniata* forests have an understorey consisting of grasses like annual sorghum. Medium height open forests also occur on the flood plains of the Murray River in New South Wales and Victoria, where *E. camaldulensis* forms large stands.

### Low height eucalypt forests

About 15 million hectares, or 9 per cent, of total native forest cover is non-mallee eucalypt open forest and woodland less than 10 metres tall. Most of these forests occur in semi-arid regions in association with Acacia species. Generally they contain a range of eucalypt species similar to that in adjacent medium height forests: species include *E. baxteri* in South Australia, *E. populnea* and *E. largiflorens* in western New South Wales, *E. populnea* in southern Queensland, and *E. tetrodonta*, *E. miniata*, *E. alba* (white or poplar gum) and *E. brevifolia* in northern Queensland, the Northern Territory and the Kimberley region of Western Australia.

Low eucalypt forests also occur in the sub-alpine regions of New South Wales, Tasmania and Victoria. The best known of these are the snow-gum forests of Tasmania's sub-alpine areas *(E. coccifera)* and the Snowy Mountains of south-east Australia *(E. pauciflora)*.

### Box 2: Large river red gum

One of the largest specimens of *E. camaldulensis* (river red gum) known is on private property in the Mount Gambier area of South Australia. The tree is estimated to be at least 800 years old, is about 50 metres high and has a circumference of 11.6 metres at 1.3 metres above the ground.

*Mallee forest*

Mallee trees are low-growing eucalypts distinguished from non-mallee eucalypts by the occurrence of multiple stems arising at ground level from a large, bulbous woody structure called a lignotuber or 'mallee root'. Over 100 species of eucalypt have a mallee form. Not all are forest; non-forest mallee vegetation is not included in this report.

Mallee forests are generally 2–10 metres tall but can reach 18 metres. Maps compiled for this report establish that about 12 million hectares or almost 8 per cent of Australia's native forests are mallee. These forests occur across the south of the continent, primarily in regions with 250–400 millimetres of annual rainfall. In more arid areas mallee forest is usually replaced by acacias and at the upper rainfall limit by single-stemmed forms, sometimes of the same species. Map 7 shows the distribution of mallee forest across the continent.

Western Australia has 42 per cent of Australia's mallee forests (Table 1). A further 34 per cent are found in southern South Australia and the remainder occur in south-west New South Wales and north-west Victoria. Although Table 1 shows no mallee forests in the Northern Territory, Queensland and Tasmania, mallee-form tree eucalypts are known from each: current records do not show whether they form open forest or woodland. In other areas, such as parts of the high sub-alpine E. pauciflora forests, the trees are, in fact, mallee form, but are not mapped as such.

## Tenure

The 124 million hectares of eucalypt forest in Australia are divided by tenure (Table 14) as follows:

- multiple-use forests: 9 per cent;
- conservation reserves: 12 per cent;
- 'other' crown land: 11 per cent;
- leasehold land: 41 per cent;
- private: 27 per cent.

Tenure varies significantly from State to State and Territory to Territory. In Victoria, for example, 48 per cent of eucalypt forests are multiple-use, 38 per cent are designated as conservation reserves, and 12 per cent are privately owned. This contrasts with Queensland, where about 6 per cent are multiple-use forests, 4 per cent are within conservation reserves, 55 per cent are

### Table 14: Tenure of eucalypt forests, by State and Territory

| State/ Territory | Tenure area ('000 ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Private | Lease-hold | Conservation reserve | Other | Multiple-use | Un-resolved | Total |
| ACT | 7 | 13 | 93 | 2 | 5 | 0 | 120 |
| NSW | 7 714 | 4 039 | 2 824 | 564 | 2 776 | 12 | 17 929 |
| NT | 10 037 | 17 525 | 2 483 | 241 | 0 | 852 | 31 138 |
| Qld | 10 315 | 17 590 | 1 393 | 644 | 2 029 | 12 | 31 984 |
| SA | 2 271 | 1 279 | 1 222 | 11 | 27 | 11 | 4 820 |
| Tas | 779 | 0 | 306 | 135 | 1 016 | (1) | 2 237 |
| Vic | 825 | 0 | 2 577 | 148 | 3 279 | 18 | 6 845 |
| WA | 1 231 | 10 236 | 4 063 | 12 195 | 1 597 | 69 | 29 390 |
| **Australia** | **33 178** | **50 681** | **14 961** | **13 940** | **10 728** | **974** | **124 463** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area less than 1000 ha.*
*Source: National Forest Inventory (1997).*

designated leasehold and 32 per cent are privately owned. There are also significant variations in the ownership and level of conservation of different eucalypt forest types (Table 5).

## Acacia forest

Acacias occur on all continents except Antarctica, predominantly in tropical and warm temperate regions. Worldwide, there are more than 1200 species. In Australia, they are almost as important as eucalypts in creating the character of the landscape, forming the second most extensive forest type. As with eucalypts, acacias occur as open forests and woodlands. According to the classification by Specht and his co-authors, acacias are the most dominant species in 36 Australian forest communities (these constitute the acacia forest type described here) and are co-dominants in a further 11 communities.

There are 12 million hectares of acacia forests in Australia (8 per cent of the total native forest area) and a further 9 million hectares (6 per cent of the total native forest area) in which *Acacia* species occur in the canopy but are not the dominant species. Fifty-four *Acacia* species are known to occur as dominant or sub-dominant forest canopy species.

Acacia forests may occur in pure stands dominated by a single canopy species – the *Acacia harpophylla* (brigalow) forests of western Queensland are an example of this – or stands in which the canopy is shared by eucalypts, casuarinas or other acacias. *A. shirleyii* (lancewood), for example, may occur as a single species forest or in association with eucalypts.

Other extensive acacia forests are *A. cambagei* (gidgee), *A. aneura* (mulga), *A. pendula* (myall) and *A. papyrocarpa* (western myall). The tallest forest-forming acacia, *A. melanoxylon* (blackwood), can grow to more than 30 metres in height.

Some *Acacia* species may occur as either trees or shrubs, depending on the site. For instance, *A. aneura* is a medium-sized, forest-forming tree on favourable sites; such occurrences are therefore included in the forest inventory. In arid areas where it is a low-growing shrub, it has been excluded.

### Distribution

Acacia forests occur in all States and the Northern Territory (Table 15). In northern Australia, acacia forests are generally found in regions with less than 750 millimetres of rain a year and most occur in areas with less than 500 millimetres a year. In the wetter end of their range they form medium-to-tall open forests; as aridity increases, the density of trees and their height decrease and they form low woodlands. Figure 5 shows the regions of the continent in which acacia forests are found.

Both *A. shirleyii* and *A. harpophylla* forests occur in regions with 500–700 millimetres of annual rainfall, the former on sandstone soils, the latter on clay soil plains.

Lancewood is the most widespread of the northern acacia forests; the largest occurrence is in the central north of the Northern Territory. *A. shirleyii* forms low woodland in the drier parts of its range. As available water increases, it forms tall, open forest.

*A. harpophylla* forests are found mainly from northern Queensland through to northern New South Wales, the species growing as tall as 20 metres, depending on rainfall and other site conditions. These forests have largely been cleared in recent years to make way for agriculture.

In either woodland or open forest form, *A. pendula* and *A. aneura* forests are found from southern Queensland through New South Wales to South Australia; *A. aneura* forests continue westwards into Western Australia. These forests occur in regions generally receiving 350–500 millimetres of rain per year.

### Tenure

Table 15 shows tenure for acacia forests across all States and Territories. Nationally, less than 1 per cent are found within multiple-use forests, about 2 per cent fall within conservation reserves, 5 per cent are on other crown land, 69 per cent are on leasehold land, and 23 per cent are privately owned. There is a similar division by tenure at the State and Territory level: most occur on private and leasehold land, although about 85 per cent of the tall, dense, *A. melanoxylon*-dominated forests of Victoria and Tasmania have a multiple-use tenure and 5 per cent are in conservation reserves.

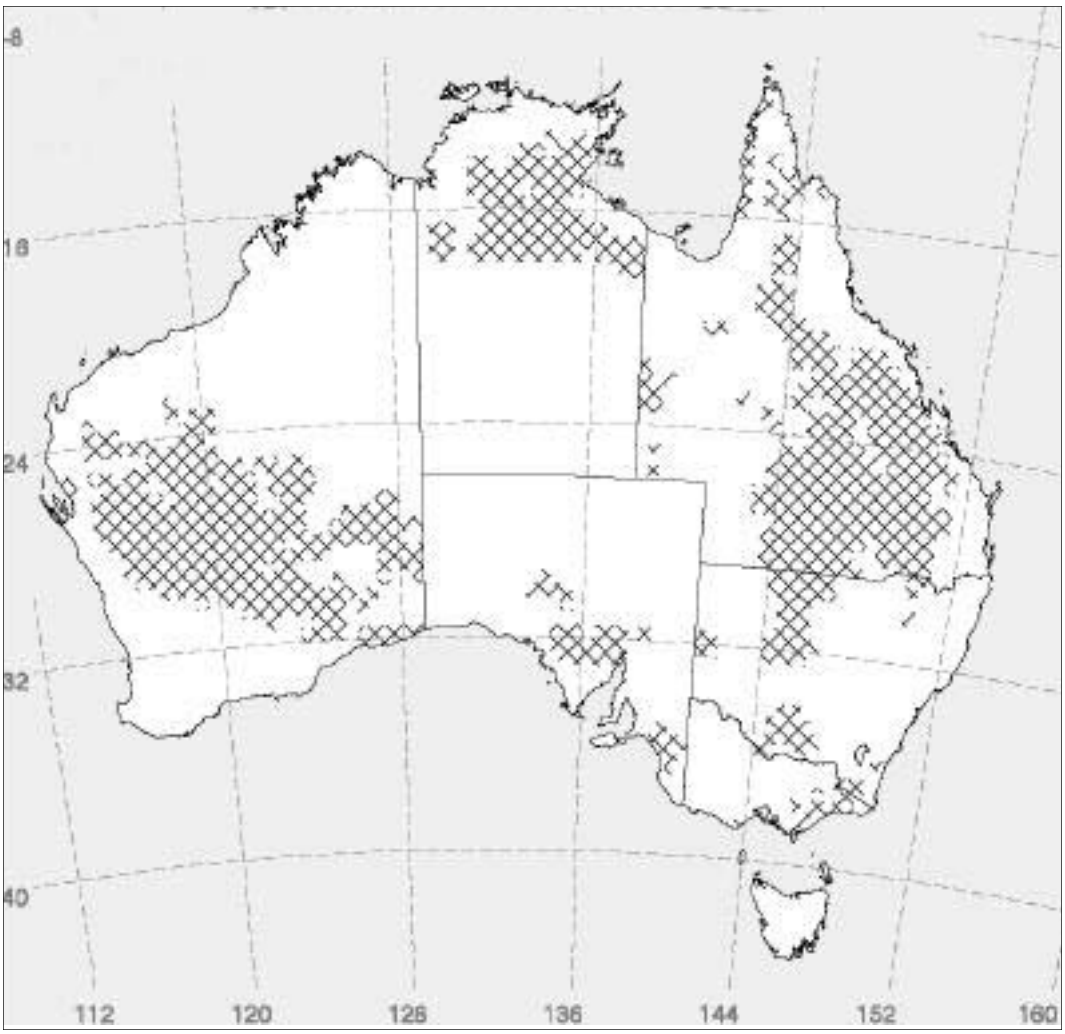



**Figure 5: Thumbprint of regions in which acacia forests occur**

**Table 15: Tenure of acacia forests, by State and Territory**

| State/ Territory | Tenure area ('000 ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Private | Lease-hold | Conservation reserve | Other | Multiple-use | Un-resolved | Total |
| ACT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NSW | 27 | 897 | 4 | 4 | 11 | (1) | 944 |
| NT | 313 | 2 108 | 2 | 10 | 0 | 6 | 2 439 |
| Qld | 2 269 | 2 103 | 118 | 46 | 66 | (1) | 4 603 |
| SA | 6 | 296 | 5 | (1) | 0 | 0 | 307 |
| Tas | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| Vic | 4 | 0 | 2 | (1) | 10 | (1) | 17 |
| WA | 162 | 3 120 | 144 | 547 | 12 | 0 | 3 986 |
| **Australia** | **2 784** | **8 525** | **276** | **608** | **99** | **7** | **12 298** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area less than 1000 ha.*
*Source: National Forest Inventory (1997).*

### Box 3: More on the acacias

Acacias are commonly referred to as wattles, a term coined by early settlers who recognised the similarity between the acacia twigs and branches and the materials used in England for wattle-and-daub construction of ancient buildings and roofs. In England, these materials were cut from coppiced stands of oak, chestnut or hazel.

Acacias are so widespread and some flower so spectacularly that one species, *A. pycnantha* (golden wattle), is the national floral emblem, forming part of the Australian coat of arms. Wattles are common to both natural landscapes and urban gardens, and some Australians celebrate national wattle day.

## Melaleuca forest

The genus *Melaleuca* is predominantly Australian, although some species occur in Indonesia, Malaysia, New Caledonia, New Guinea and the Pacific Islands. In Australia, Specht and his co-authors identified 51 *Melaleuca* plant communities. Of these, 15 form forests in which *Melaleuca* species are considered the most dominant canopy species; these constitute the melaleuca forests described below. The most extensive melaleuca forests are dominated by *M. dealbata* (blue-leaved paperbark), *M. leucadendra* (long-leaved paperbark), *M. minutifolia* and *M. viridiflora* (broad-leaved paperbark).

### Distribution

To date, more than 4 million hectares of melaleuca forests have been mapped. About 90 per cent of these (more than 3.7 million hectares) occur in the Northern Territory and northern Queensland (Table 16). Melaleucas occur as a sub-dominant canopy species in a further 3.7 million hectares of forest.

Melaleuca forests occur on a wide range of sites throughout non-arid Australia. Generally, these are damp or wet sites such as coastal or sub-coastal areas that dry out seasonally. Often these forests are narrow strips of dense pure stands, tens of metres wide, along streams and swamps. About 75 per cent of the melaleuca forests in northern Australia are large tracts of low woodland spread across estuarine plains and seasonal swamps. Figure 6 shows the regions of the continent in which this forest type is found.

### Tenure

Nationally, over 85 per cent of melaleuca forests occur on leasehold or private land, which are generally used for cattle production (Table 16), and about 10 per cent are located in conservation reserves.

**Table 16: Tenure of melaleuca forests, by State and Territory**

| State/ Territory | Tenure area ('000 ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Private | Lease-hold | Conservation reserve | Other | Multiple-use | Un-resolved | Total |
| ACT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NSW | 91 | 0 | 79 | 22 | 8 | 2 | 202 |
| NT | 382 | 543 | 115 | 6 | 0 | 27 | 1 072 |
| Qld | 470 | 1 916 | 211 | 11 | 35 | (1) | 2 643 |
| SA | 2 | (1) | (1) | 0 | 0 | 0 | 2 |
| Tas | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vic | 3 | 0 | 12 | (1) | 2 | (1) | 18 |
| WA | (1) | 102 | 6 | 47 | 0 | 0 | 155 |
| **Australia** | **949** | **2 560** | **424** | **86** | **45** | **29** | **4 093** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area less than 1000 ha.*
*Source: National Forest Inventory (1997).*

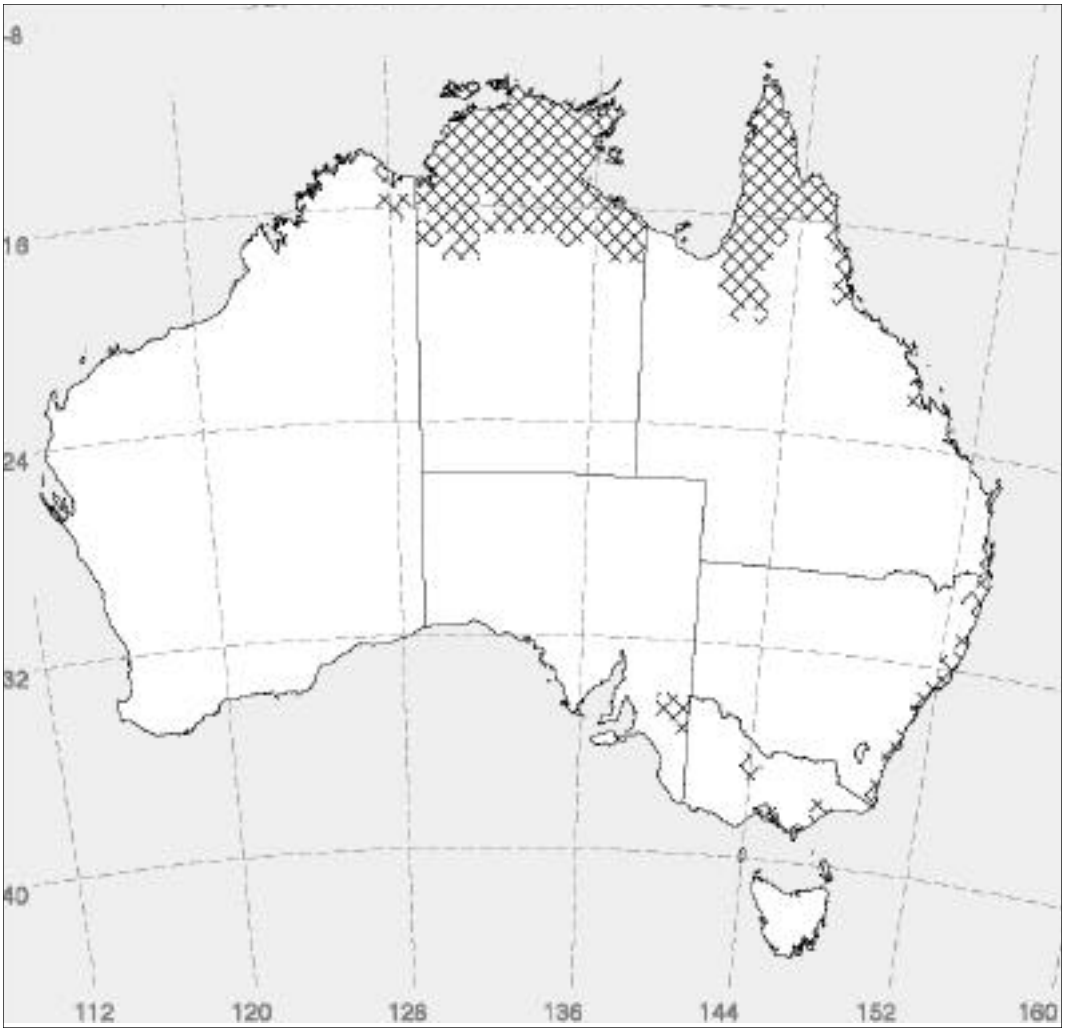



**Figure 6: Thumbprint of regions in which melaleuca forests occur**

**Box 4:** *Melaleuca* **– the paperbark**

The common name for a number of *Melaleuca* species is paperbark, an apt description of the papery bark consisting of thin layers of cork. The leaves of a few *Melaleuca* species supply the raw material for an expanding tea tree oil industry: tea tree oil is used as an antimicrobial antiseptic oil or formulated into creams, shampoos, soaps, mouthwashes and toothpastes.

## Rainforest

Specht and his co-authors identified 104 rainforest communities (including what they call vine forest and vine thicket). In this report, Australian rainforests have been divided into three types: cool temperate, warm temperate and tropical, defined more by geography than by botanical association. Thus, tropical rainforest is defined here as all rainforest occurring north of the Tropic of Capricorn: the data presented may therefore include rainforest elements, particularly those at altitude in the Great Dividing Range, that may fit a botanical definition of warm temperate rainforest. Cool temperate rainforest is made up of all rainforests in Tasmania plus those in New South Wales and Victoria dominated by *Nothofagus* species, and the remainder is designated as warm temperate.

## Box 5: More on rainforests

Rainforests are highly valued for the richness of their biodiversity, the aesthetics of their structure and their finequality timbers. About half of the north-east Queensland tropical rainforests had been logged or cleared for agriculture by the 1980s, when most were listed as World Heritage sites. While the declaration of World Heritage status did not change the tenure of these forests, those within the multiple-use tenure category (about 495 000 hectares) were progressively excluded from logging. Rainforests in the World Heritage listed areas owned privately are not bound by the 'no-logging' policy.

Currently, tourism is the main economic use of tropical rainforests. The Wet Tropics Management Authority estimated that the whole of the wet tropical rainforests of north-east Queensland earned $750 million for the region in 1997.

The tropical rainforests of north-east Queensland contain highly diverse flora, constituting a genetic resource for plantation trees and ornamental plants. Some species – *Castanospermum australe* (blackbean), for example – are potentially important sources of pharmaceuticals. Indigenous peoples have put tropical rainforest plants to a variety of uses, including food and medicines, ornamentation, string and wooden implements.

Logging of cool temperate rainforests in Tasmania has been limited for reasons such as inaccessibility, generally low sawlog yields, and formal and informal reservation for conservation purposes. About 6 per cent is designated for selective harvesting within Special Timbers Management Units, on cycles of up to 200 years, for small quantities of speciality timbers. Following an assessment process, some areas of rainforest on private land in north-west Tasmania are currently being converted to eucalypt plantations.

Tourism is an important industry in some Tasmanian rainforests, such as those in the vicinity of the Gordon River. Another economically important use of cool temperate rainforests in Tasmania is the production of honey from the blossom of leatherwood trees. More than 500 tonnes of *Eucryphia lucida* (leatherwood) honey can be produced in Tasmania in a good season.

## Table 17: Tenure of rainforests, by State and Territory

| State/ Territory | Tenure area ('000 ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Private | Lease-hold | Conservation reserve | Other | Multiple -use | Un-resolved | Total |
| ACT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NSW | 36 | 0 | 101 | 2 | 69 | (1) | 209 |
| NT | 157 | 21 | 60 | (1) | 0 | 12 | 252 |
| Qld | 807 | 392 | 459 | 68 | 827 | 13 | 2 567 |
| SA | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tas | 17 | 0 | 187 | 145 | 196 | 0 | 545 |
| Vic | 0 | 0 | 2 | (1) | (1) | 0 | 3 |
| WA | (1) | (1) | 2 | 4 | 0 | (1) | 7 |
| **Australia** | **1 017** | **414** | **812** | **220** | **1 093** | **26** | **3 583** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area less than 1000 ha.*
*Source: National Forest Inventory (1997).*

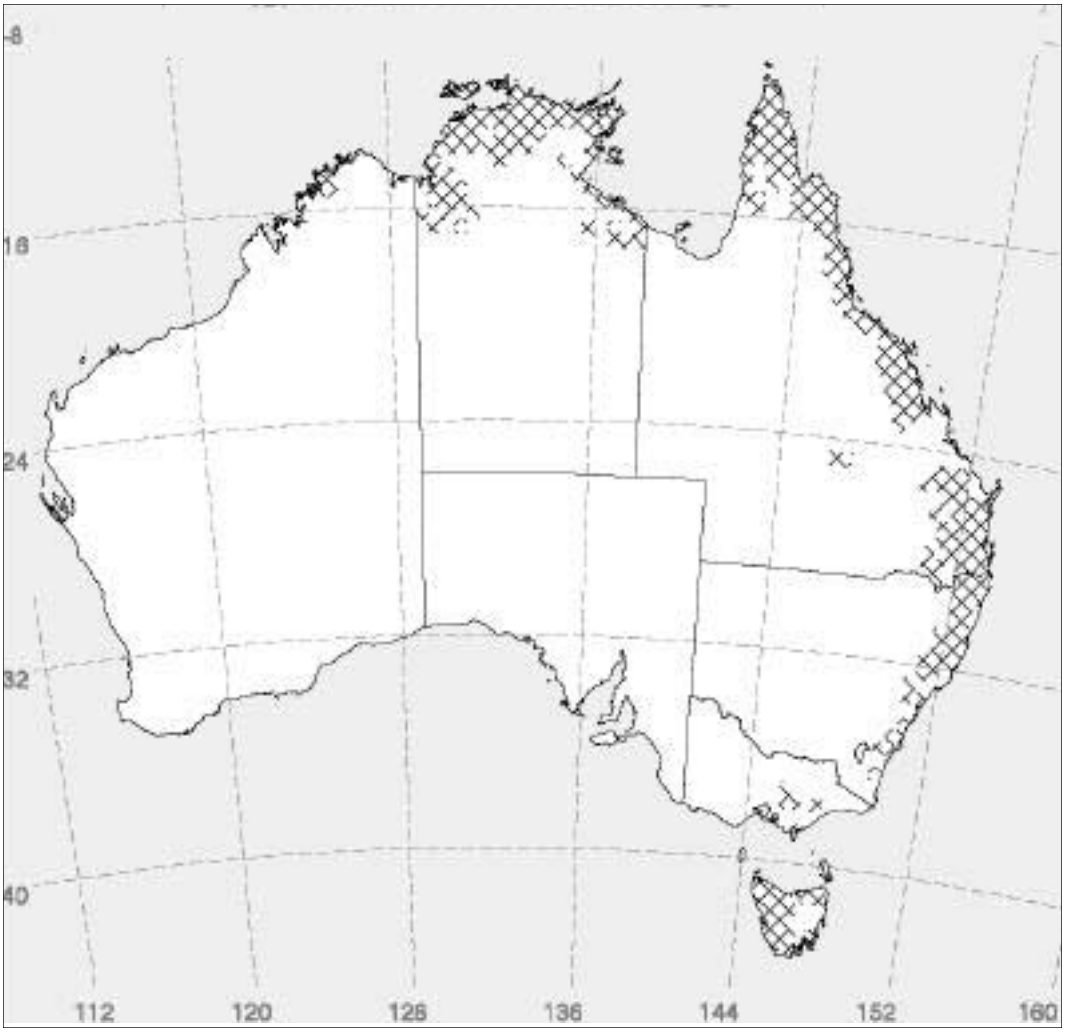



**Figure 7: Thumbprint of regions in which rainforests occur**

These definitions are arbitrary. Comprehensive mapping of rainforest types has not been completed nationally, but broad estimates of the areas, based on the above definitions, can be given. Thus, there are 0.9 million hectares of tropical rainforest, 2.1 million hectares of warm temperate rainforest and 0.6 million hectares of cool temperate rainforest. In all, there are about 3.6 million hectares of rainforest in Australia, which is about 2 per cent of the forest estate.

### *Tropical rainforests*

Tropical rainforests occur in many countries; collectively, these forests house an estimated 50 per cent or more of all species on earth. Australia's tropical rainforests constitute less than 1 per cent of the world's total area. Nevertheless, these forests are particularly significant because parts of them are the only remaining relicts of forest that once dominated Australia when areas of high rainfall were far more widespread than they are today.

Regional differences in tropical rainforests result from differing rainfall patterns and amounts: areas that receive rain for most of the year have 'wet' rainforests, whereas those that get most of their rain during the monsoon season are classed as 'dry' or 'monsoonal' rainforests. The latter are commonly called vine thickets and scrubs.

### *Warm temperate rainforests*

Warm temperate rainforests, sometimes called sub-tropical rainforests, display a high diversity of tree species, including *Ceratopetalum apetalum* (coachwood), *Schizomeria ovata* (crab apple) and Sloanea woollsii (yellow carabeen). Palms are often present, as are various climbing plants, epiphytes and ferns.

### *Cool temperate rainforests*

Cool temperate rainforests are found only in Australia, New Zealand, southern South America and the north-east coasts of North

America. Australia's cool temperate rainforests are often dominated by *Nothofagus cunninghamii* (myrtle), with conifers such as *Lagarostrobos franklinii* (huon pine), *Phyllocladus aspleniifolius* (celery top pine) and *Athrotaxis selaginoides* (King Billy pine) also forming part of the tree layer in Tasmania. In eastern Victoria, dominant canopy species include *Atherosperma moschatum* (southern sassafras) and *Elaeocarpus holopetalus* (mountain quandong). *Nothofagus gunnii* (deciduous beech) becomes important at high altitudes in Tasmania.

### Distribution

Table 17 shows the distribution of rainforest in Australia by State and Territory, and Figure 7 shows the regions of the continent in which rainforest is found.

### Tenure

The nature of the available data on rainforest distribution does not allow a breakdown by tenure category for the three rainforests types of tropical, warm temperate and cool temperate. Table 17 shows the tenure of all rainforest in Australia. About 28 per cent occurs on private land, 23 per cent in conservation reserves and 31 per cent as multiple-use forest.

## Casuarina forest

Casuarinas are common in the Australian landscape, with approximately 60 species occurring throughout Australia. The family is collectively called casuarina or sheoak and includes the genera *Casuarina*, *Allocasuarina* and *Gymnostoma*; species of the family are also found in New Guinea, Indonesia, Malaysia and the Pacific Islands.

In Australia, Specht and his co-authors identified 13 casuarina plant communities. Of these, three form forests in which casuarina species are considered the dominant canopy species; these constitute the casuarina forests described below.

### Distribution

Table 18 shows that there are about 1 million hectares of casuarina forests, mostly in New South Wales. Figure 8 shows the regions of the continent in which this forest type is found. A further 8 million hectares of forest contain casuarinas as a sub-dominant canopy species (three communities – these are not treated as casuarina forests in this report).

Nationally, forests of *C. cristata* (belah or black oak) have the widest distribution, ranging from southern Queensland through western New South Wales and north-west Victoria to

**Table 18: Tenure of casuarina forests by State and Territory**

| State/ Territory | Tenure area ('000 ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Private | Lease-hold | Conservation reserve | Other | Multiple-use | Un-resolved | Total |
| ACT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NSW | 4 | 781 | 9 | 4 | 3 | (1) | 802 |
| NT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| QLD | 56 | (1) | 0 | 1 | 3 | 0 | 62 |
| SA | 20 | 114 | 13 | 0 | 0 | 0 | 147 |
| TAS | (1) | 0 | 0 | 0 | 0 | 0 | 1 |
| VIC | (1) | 0 | (1) | 0 | 0 | 0 | 0 |
| WA | (1) | 23 | 16 | (1) | (1) | 0 | 40 |
| **Australia** | **81** | **919** | **39** | **6** | **6** | **0** | **1 052** |

*Notes: Column or row total may not add up due to rounding.*
*(1) Area less than 1000 ha.*
*Source: National Forest Inventory (1997).*

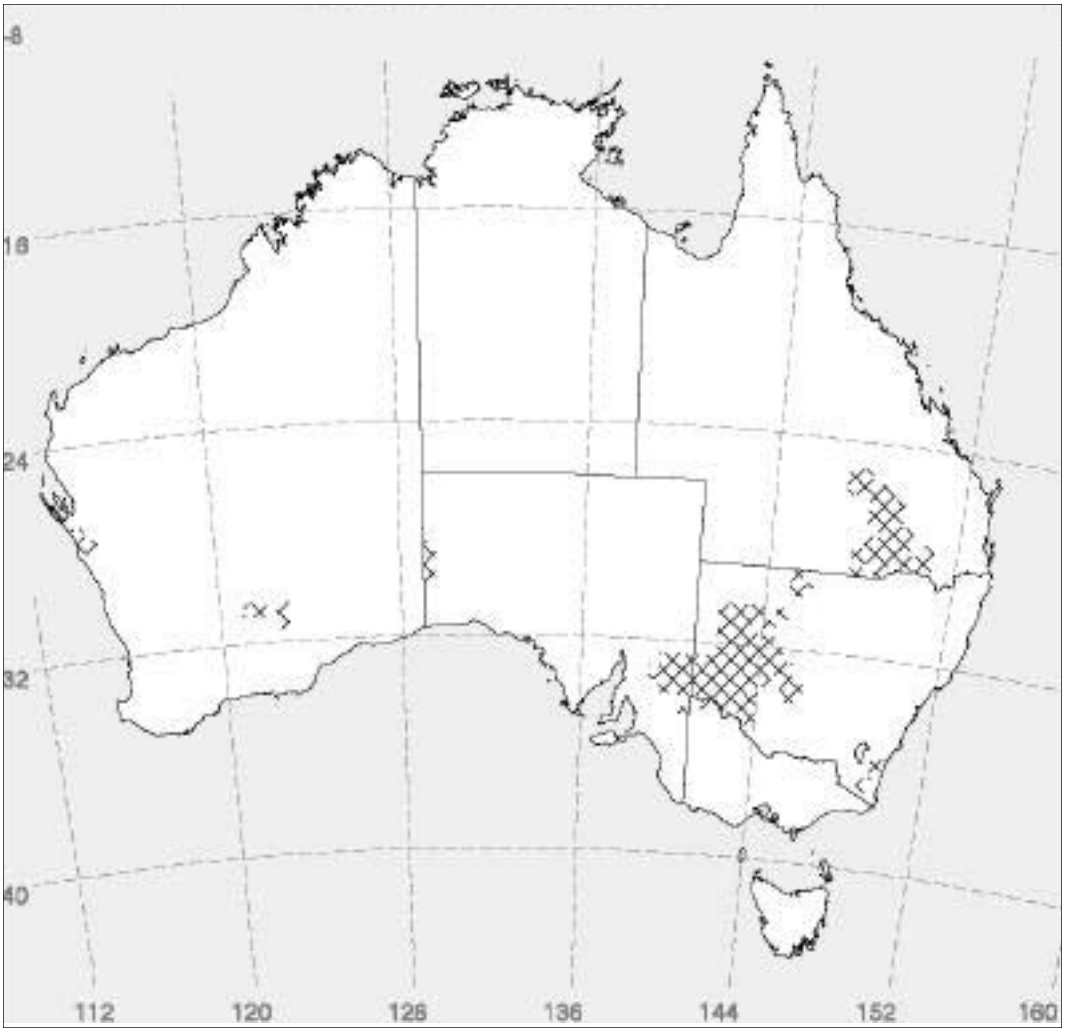



**Figure 8: Thumbprint of regions in which casuarina forests occur**

### Box 6: Some facts about casuarinas

Casuarinas are characterised by their leaf structure, which at first glance resembles that of conifers. The drooping, needle-like foliage is actually composed of photosynthetic branchlets with tiny leaves, only the tips of which can be seen by the naked eye. The name 'casuarina' comes from the perceived similarity of the drooping branches to the feathers of the cassowary bird, for which the Malay word is *Kasuari*.

Casuarinas are used occasionally in the manufacture of timber products. For example, *Allocasuarina fraseriana* (Western Australian sheoak) has been used in the Western Australian furniture industry for many years. The quantities used are very small because the resource is small, but the product is keenly sought after and very expensive. Species such as *C. cristata* (belah or black oak) are often used for fence posts and firewood, and as windbreaks on agricultural land.

central southern South Australia and across to central southern Western Australia.

*C. cristata* grows on substrates varying from stony slopes and shallow calcareous loams over calcrete to heavy clay soils, in average rainfalls ranging from 200–600 millimetres annually. It tends to grow in groves, originating from the production of root suckers, the normal method of propagation for this species. The forests vary in height up to 30 metres and form woodland or open forests, depending on site quality. The most dense stands are usually found in depressions, where *C. cristata* forest is often one of a mosaic of forest types that may include acacias such as *Acacia harpophylla* (brigalow) and *A. pendula* (myall), and other species such as *Atalaya hemiglauca* (whitewood), *Geijera parviflora* (wilga) or *Heterodendrum oleifolium* (inland rosewood).

*C. cunninghamiana*, often referred to as river oak, sheoak or creek oak, commonly occurs as open forest up to 35 metres in height along watercourses throughout eastern Australia, only being replaced by *C. glauca* (swamp oak) in saline coastal swamps.

## Tenure

Table 18 shows the tenure of casuarina forests in Australia. About 76 per cent of casuarina forests occur within New South Wales; of these, more than 95 per cent are found on leasehold land. Nationally, less than 4 per cent of this forest type is found within conservation reserves.

# Mangrove forest

Mangroves are usually small, robust trees ranging from 3 to 8 metres in height. However, certain species in northern Australia can reach 30 metres; conversely, in more hostile environments the plants may not grow as tall as 2 metres, in which case they are not considered forest in this report. Specht and his co-authors identified eight mangrove communities.

Mangrove forests are woody communities, often of dense pure stands, that develop on sediments in sheltered estuaries, inlets and bays. These areas are subject to periodic tidal inundation; mangroves have evolved various mechanisms to persist in this environment. Such adaptations include ways of excluding or secreting salts and a shallow spreading root system with various root adaptations to assist in gaseous exchange associated with metabolism.

## Distribution

Australia's 1 million hectares of mangrove forests represent less than 1 per cent of the total native forest area. They are found discontinuously along the warmer coasts, from the Pilbara and Kimberley in the west to south of Sydney in the east, and in small areas of coastal Victoria and South Australia. Table 19 shows the area of mangrove forests occurring in each State and Territory. Figure 9 shows the regions of the continent in which mangrove forests are found. High-quality mapping of the

**Table 19: Tenure of mangrove forests, by State and Territory**

| State/ Territory | Tenure area ('000 ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Private | Lease-hold | Conservation reserve | Other | Multiple-use | Un-resolved | Total |
| ACT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NSW | 4 | 0 | 1 | 1 | (1) | (1) | 7 |
| NT | 260 | 40 | 48 | (1) | 0 | 94 | 442 |
| Qld | 138 | 58 | 149 | 43 | 1 | 8 | 398 |
| SA | 15 | 0 | 1 | (1) | 0 | 4 | 20 |
| Tas | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vic | 1 | 0 | 4 | (1) | 0 | (1) | 5 |
| WA | 4 | 20 | 27 | 102 | 0 | 20 | 173 |
| **Australia** | **422** | **118** | **231** | **146** | **1** | **126** | **1 045** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area less than 1000 ha.*
*Source: National Forest Inventory (1997).*

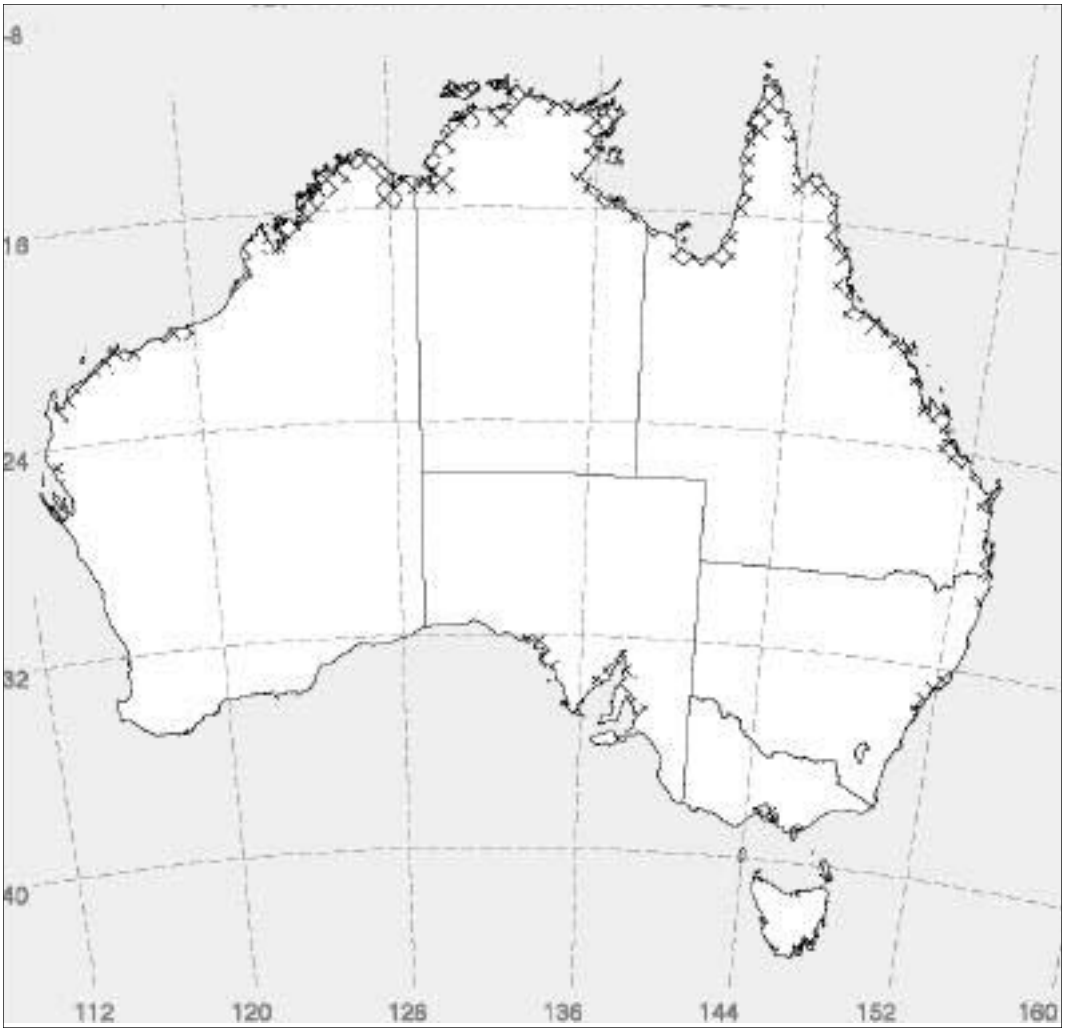



**Figure 9: Thumbprint of regions in which mangrove forests occur**

occurrence of mangrove forests remains a significant need in many places.

Mangrove forests around the tropical north-west, north and north-east coasts are the most species-diverse. The mangrove forests further south, along the south coast of Victoria and the South Australian gulfs, are much less rich in species and are dominated by one species, *Avicennia marina* (white mangrove), the most widespread and common of all mangrove species. A small outlier of mangrove forest occurs in the Lechenault Inlet near Bunbury, south of Perth. No mangroves occur in Tasmania.

## Tenure

Nationally, 40 per cent of mangrove forests are in private ownership, 22 per cent within conservation reserves and 12 per cent within leasehold (Table 19). Tenure attribution for mangrove forest is not of a high quality. Most occur below the high-water spring tidal level: it is unclear how this relates to ownership.

### Box 7: The usefulness of mangroves

Mangrove forests fulfil a useful role as food sources for humans and animals; they stabilise the shoreline and provide habitat and breeding sites for birds and other wildlife. There is also an increasing awareness of the importance of such environments as fish 'nurseries'.

Mangrove plants are an important resource for Indigenous peoples in the Northern Territory – they yield pleasant honey and fruits that can be cooked and eaten. They are also a source of medicines and implements, and the timber can be used for firewood and construction. The leaves are palatable for stock. Many fish and shellfish are common in mangrove swamps and are used by both Indigenous and non-Indigenous urban populations.

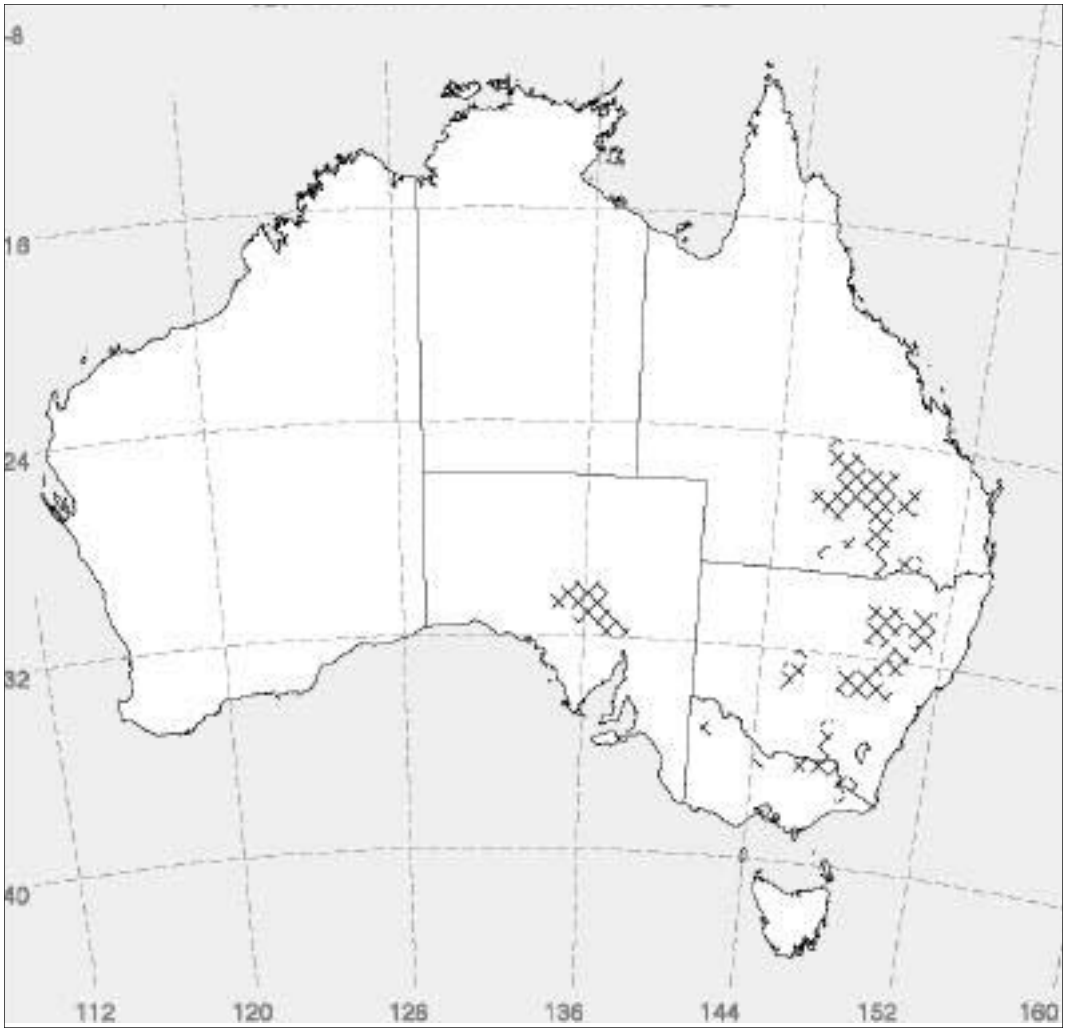



**Figure 10: Thumbprint of regions in which callitris forests occur**

## Callitris forest

The Australian cypress pine genus *Callitris* is one of a number of Gondwanan conifer genera that still survive. Specht and his co-authors identified 21 *Callitris* plant communities. Of these, seven form forest in which *Callitris* species are considered the most dominant canopy species; these constitute the callitris forests described below. *Callitris* species occur in a further 10 forest communities as sub-dominants.

There are 14 species of *Callitris*, of which the most significant forest-forming species is *Callitris glaucophylla* (white cypress). This has a straight trunk and can grow to a height of 30 metres, but typically grows to 15–20 metres.

Fuel modification through grazing has reduced fire frequency and intensity, allowing the spread of *Callitris* species, principally *C. glaucophylla*. Other common species include *C. endlicheri* (black cypress), *C. intratropica* (northern cypress), *C. verrucosa* (Murray pine) and *C. columellaris* (coastal cypress).

Previous estimates of the area of callitris forest have been in the range of about 4 million hectares. The estimated area reported here is about 0.9 million hectares (Table 20). The reason for this change is one of classification. *Callitris* species often occur in association with a range of eucalypt species and were previously classified as callitris forest because of the commercial significance of this species. However, in most cases, *Callitris* species are actually sub-dominant in the canopy. Such mixed forests are correctly classified as eucalypt forests.

Recent work done by the National Forest Inventory has estimated that, although less than 1 million hectares of callitris-dominant

forest has been identified through new mapping, there are at least another 6.5 million hectares of forest which have *Callitris* species occurring in the canopy. In total, this is an increase of approximately 85 per cent in area over previous knowledge. Thus, pure *Callitris* stands make up about 0.5 per cent of Australia's native forest estate, and *Callitris* species occur in the canopy of about 4 per cent of Australia's native forests.

## Distribution

Callitris forests are generally drought-resistant and many are frost-tolerant. They are usually found in areas with a rainfall of 300–650 millimetres a year, from the arid tropics around the Hamersley Ranges and through the coastal eucalypt forests of the Northern Territory to rain-shadow areas in the Snowy Mountains. The largest tracts of callitris forests occur in eastern Australia, where they are found discontinuously from the Murray River to the Great Dividing Range north of Injune in Queensland. Figure 10 shows the regions of the continent in which this forest type is found; Table 20 shows the area occurring in each State and Territory.

Callitris forest (mostly *C. glaucophylla*) occurs predominantly in Queensland, New South Wales and South Australia. In New South Wales, it includes the Pilliga region north of Coonabarabran, known as the Pilliga Scrub, which is the largest area of native forest in New South Wales west of the Great Dividing Range. Elsewhere in that State, the medium height woodland cypress forests have been extensively cleared for agriculture, leaving small stands in multiple-use forests and corridors along roads and travelling stock routes.

*C. glaucophylla* forests occur in the Flinders Ranges of South Australia; further south, remnants of *C. preissii* (Murray pine, mallee pine, southern cypress pine) forest occur in the largely cleared agricultural regions of that State.

## Tenure

Table 20 shows the tenure of callitris forests by State and Territory. Nationally, about 35 per cent occur on leasehold land, 34 per cent in multiple-use forests, around 23 per cent on private lands and 8 per cent in conservation reserves.

**Table 20: Tenure of callitris forests, by State and Territory**

| | Tenure area ('000 ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| State/ Territory | Private | Lease-hold | Conservation reserve | Other | Multiple -use | Un-resolved | Total |
| NSW | 97 | 20 | 35 | 4 | 226 | 0 | 382 |
| NT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Qld | 95 | 142 | 2 | 4 | 66 | (1) | 309 |
| SA | 0 | 139 | 0 | 0 | 0 | 0 | 139 |
| Tas | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vic | 5 | 0 | 32 | (1) | (1) | (1) | 37 |
| WA | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Australia** | **197** | **300** | **69** | **8** | **292** | (1) | **867** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area less than 1000 ha.*
*Source: National Forest Inventory (1997).*

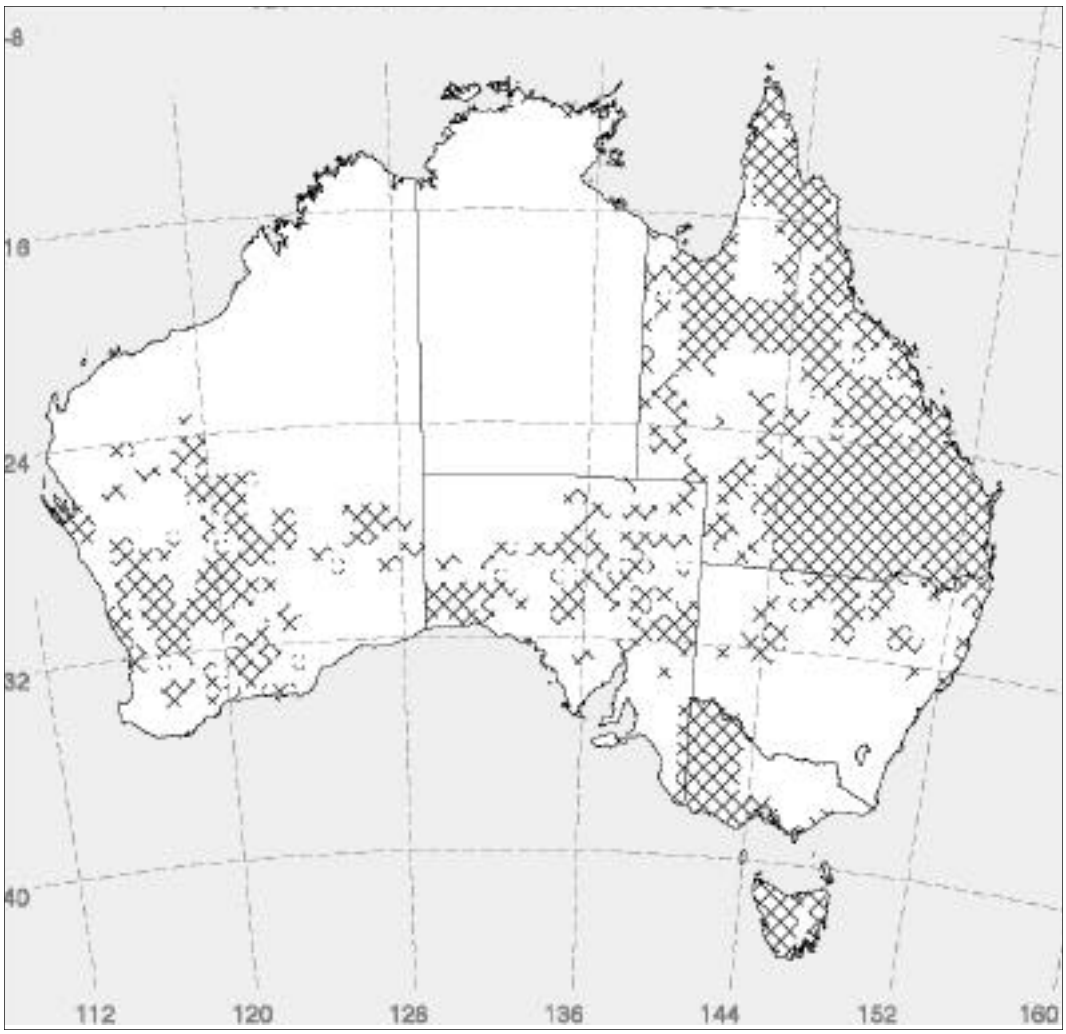



**Figure 11: Thumbprint of regions in which 'other forest' occurs**

**Table 21: Tenure of 'other forest', by State and Territory**

| State/ Territory | Tenure area ('000 ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Private | Lease-hold | Conservation reserve | Other | Multiple-use | Un-resolved | Total |
| ACT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NSW | 71 | 230 | 5 | 4 | 2 | (1) | 312 |
| NT | 39 | 0 | 0 | 0 | 0 | 4 | 43 |
| Qld | 2 960 | 1 793 | 537 | 234 | 956 | 10 | 6 490 |
| SA | 14 | 38 | 11 | (1) | 0 | 0 | 63 |
| Tas | (1) | 0 | 30 | 16 | 72 | 0 | 118 |
| Vic | 201 | 0 | 81 | 17 | 54 | 8 | 360 |
| WA | 105 | 524 | 106 | 311 | 3 | (1) | 1 048 |
| **Australia** | **3 390** | **2 586** | **770** | **582** | **1 086** | **22** | **8 435** |

*Note: Column or row total may not add up due to rounding.*
*(1) Area less than 1000 ha.*
*Source: National Forest Inventory (1997).*

### Box 8: The use of cypress timber

Cypress timber and products have been widely used by Indigenous peoples and also constitute an important part of Australia's forestry heritage. Cypress pine is a versatile, durable, termite-resistant timber; it is used in housing construction and for flooring, cladding and fence posts. In New South Wales and Queensland, large quantities of *Callitris glaucophylla* (white cypress) sawlogs are milled each year, and extensive areas are managed for long-term timber production. In the Northern Territory, *C. intratropica* (northern cypress) has been used for similar purposes.

## Other forests

For this report, about 8.4 million hectares or just over 5 per cent of Australia's native forests are classified as 'other forest'. Within this classification are three groups: 'mixed', 'unknown type' and 'minor genera'. It should be noted that in this context the term 'mixed' indicates a number of genera, not a number of species. Fourteen of the forest communities recognised by Specht and his co-authors fall into this forest type.

### Mixed forests

There are 6 million hectares of mixed forests, or about 4 per cent of the entire native forest estate. They fall into three groups:

- forests for which the dominant canopy genera were not included in the database;
- forests in which there are a number of genera in the canopy but no single dominant genus (rainforests, although often matching this criterion, are not included here); and
- forests in which communities occur in small patches and have not been mapped at a level detailed enough to distinguish the different communities. This has occurred, for example, where forest dominated by *Angophora* species is found along a creek-line within an area dominated by other species.

### Forests of unknown type

There is limited information about the species composition of the canopy for 1.9 million hectares or 1 per cent of native forests. Satellite information makes it possible to map small patches of forest in grassland and agricultural regions that previously were ignored by vegetation mappers or were only referred to as existing in a mosaic. There is good information about the location and size of many such patches, but it is not yet known for certain what species dominate the canopy. These patches are called 'forests of unknown type' in this report.

### Forests dominated by minor genera

A small proportion of the forest estate is made up of forests dominated by genera other than those already mentioned. About 0.5 million hectares of forest are dominated by genera such as *Adansonia, Angophora, Atalaya, Banksia, Brachychiton, Flindersia, Heterodendrum, Leptospermum* and *Lysiphyllum*.

### Distribution

Figure 11 indicates the regions in which 'other forest' occurs; Table 21 shows that nearly 77 per cent of the 8.4 million hectares classified as 'other forest' are in Queensland. About 12 per cent are in Western Australia and the remainder is made up of relatively small patches in the other States and the Northern Territory.

### Tenure

Table 21 shows the tenure of 'other forest'. Of forests in this category, 40 per cent are private and 31 per cent are leasehold. About 12 per cent fall into the multiple-use tenure category and 9 per cent are in conservation reserves.

## Plantation forests

Australia has just over 1 million hectares of plantations, or about 0.7 per cent of the country's total forested area. The distribution of plantations by National Plantation Inventory region (see Map 8) is given in Table 22.

**Table 22: Distribution of hardwood and softwood plantations, by National Plantation Inventory region**

| Region | Distribution (ha) | |
|---|---|---|
| | Hardwood | Softwood |
| Western Australia | 42 040 | 88 800 |
| Tasmania | 62 020 | 71 970 |
| Green Triangle | 390 | 139 060 |
| Lofty Block | 650 | 16 160 |
| Central Victoria | 10 | 25 620 |
| Murray Valley | 230 | 162 540 |
| Central Gippsland | 19 040 | 59 180 |
| East Gippsland/Bombala | 260 | 32 130 |
| Southern Tablelands | 270 | 20 000 |
| Central Tablelands | 0 | 73 110 |
| Northern Tablelands | 50 | 13 040 |
| North Coast | 32 320 | 11 260 |
| South East Queensland | 1 120 | 147 370 |
| North Queensland | 170 | 19 530 |
| Northern Territory | 0 | 4 220 |

*Source: National Plantation Inventory (1997).*

## Softwood plantations

There are nearly 0.9 million hectares of softwood plantations, representing about 80 per cent of the plantation estate (Table 23). At least 90 per cent of softwood plantations contain exotic conifers, mostly *Pinus radiata* (radiata or Monterey pine). The only native conifer used in plantations on a significant scale is *Araucaria cunninghamii* (hoop pine), although *Araucaria bidwillii* (bunya pine) has also been tried in New South Wales.

The area of softwood plantations established in each five-year period between 1940 and 1994 is shown in Figure 12. Most of the plantations established before 1960 have been harvested, and some of the more recent plantings are on those harvested areas.

The most extensive softwood plantings are in the upper Murray Valley region around the New South Wales towns of Tumut, Batlow and Tumbarumba and in north-eastern Victoria, the south-east Queensland region, and the Green Triangle region, which straddles the South Australian–Victorian border.

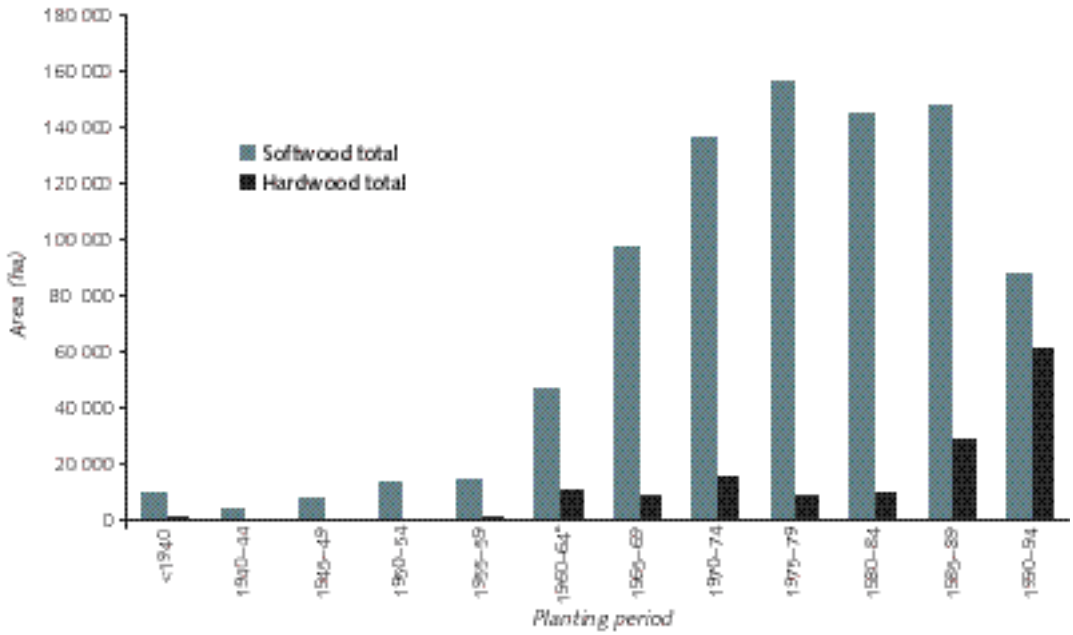
## Hardwood plantations

Australia has about 160 000 hectares of hardwood plantations (Table 23), in which eucalypt species are predominant (the remainder consists largely of tropical rainforest species). Only a few eucalypt species are used widely in plantations: these include *Eucalyptus globulus* (Tasmanian or southern blue gum), *E. nitens* (shining gum), *E. pilularis* (blackbutt) and *E. grandis* (flooded or rose gum). The area of hardwood plantations established in each five-year period between 1940 and 1994 is shown in Figure 12.

The majority of hardwood plantations occur in four regions: Tasmania, Western Australia, the north coast of New South Wales and Central Gippsland in Victoria. The Tasmanian hardwood plantation estate is the largest in Australia. In 1997 hardwood plantations were expanding at a rate of about 5000 hectares a year in that State. There are plans to further expand plantation establishment in New South Wales and Victoria, while in Western Australia 20 000 and 25 000 hectares of mainly *E. globulus* plantation were established in 1996 and 1997 respectively. Small plantations specialising in high-quality cabinet wood species are being established in north-east Queensland.

Both public and private growers have recently reported significant increases in the rate of establishment of hardwood plantations. Current planting plans suggest that about 80 per cent of new plantings will be of hardwood species.

**Figure 12: Area of plantation established in each five-year period from 1940 to 1994: softwoods and hardwoods**




*In addition to the areas shown, there are also 18,280 hectares of plantations where the age (planting period) is unknown, 13,330 hectares of which are hardwood.*
**Figures for the 1960–64 planting period include 6260 hectares that were planted in the Western Australian region before 1962. This inflates the national figures for that period by 32 percent (softwood) and 60 per cent (hardwood).*

*Source: National Plantation Inventory (1997).*

## Table 23: Plantation area, by species

| Softwood | Area (ha) |
|---|---|
| *Pinus radiata* | 642 110 |
| *P. elliottii* | 72 880 |
| *P. caribaea* | 54 160 |
| *Araucaria* species | 45 300 |
| *P. pinaster* | 28 880 |
| Minor softwood species | 13 020 |
| Unidentified softwood species | 27 630 |
| Total softwood plantation area | 883 980 |
| **Hardwood** | |
| *Eucalyptus globulus* | 41 260 |
| *E. pilularis/E.grandis* mix[1] | 22 210 |
| *E. nitens* | 12 230 |
| *E. regnans* | 5 980 |
| Minor hardwood species | 11 310 |
| Unidentified hardwood[2] | 65 580 |
| Total hardwood plantation area | 158 570 |
| **Total** | **1 042 600[3]** |

[1] *Approximately 60 per cent* E. grandis.
[2] *An estimated 70 per cent is a mix of* E. nitens *and* E. globulus.
[3] *Column total has been rounded to the nearest 10 ha.*
*Source: National Plantation Inventory (1997).*

## Plantation tenure

Table 24 shows the tenure of plantations by State and Territory. The data are presented as percentages because tenure was not reported in the 1997 National Plantation Inventory. Percentages given are based on a range of information sources. More than two-thirds of the total plantation estate is publicly owned and the remainder is private. The majority of softwood plantations are publicly owned, but more hardwood plantations are on private land than on publicly owned land. Of the States and Territories, New South Wales, Victoria and Queensland contain the most plantations.

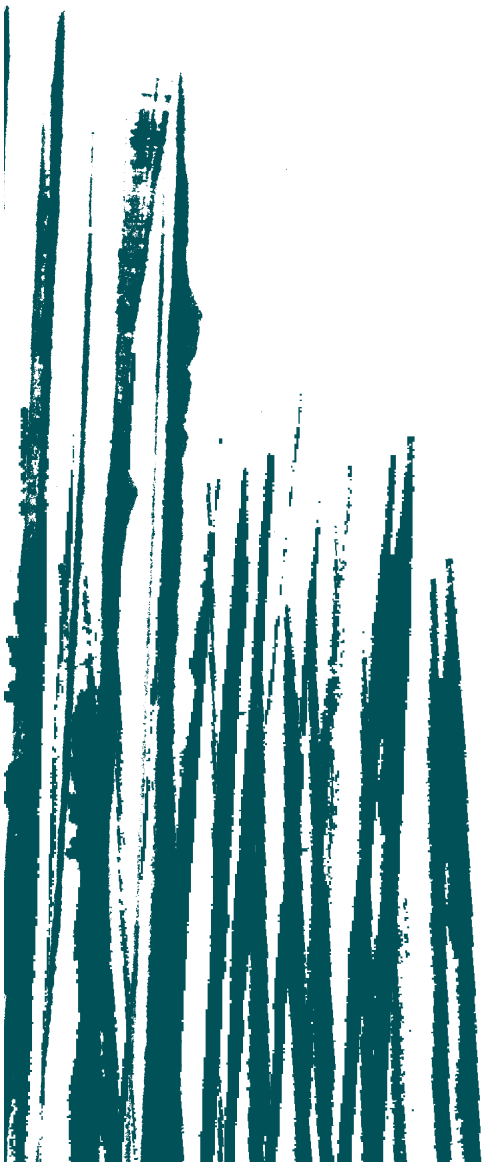
## Table 24: Plantation tenure and type, by State and Territory[1]

| | Multiple-use (%) | | Private (%) | | |
|---|---|---|---|---|---|
| State/Territory | Softwood | Hardwood | Softwood | Hardwood | Total (%) |
| ACT | 1.3 | 0.0 | 0.0 | 0.0 | 1.3 |
| NSW | 18.0 | 2.4 | 5.9 | 0.2 | 26.5 |
| NT | 0.1 | 0.0 | 0.3 | 0.0 | 0.4 |
| Qld | 15.5 | 0.1 | 1.1 | 0.0 | 16.7 |
| SA | 6.8 | 0.1 | 2.6 | 0.1 | 9.6 |
| Tas | 4.3 | 1.1 | 2.9 | 4.1 | 12.4 |
| Vic | 9.7 | 0.7 | 9.6 | 1.0 | 21.0 |
| WA | 6.5 | 1.3 | 1.5 | 2.7 | 12.0 |
| **Australia** | **62.1** | **5.7** | **24.0** | **8.1** | **100.0** |

*Source: derived from Quarterly Forest Products Statistics (March 1996).*

*[1] As a proportion of total plantation area.*

# 4 *Uses and Disturbances*



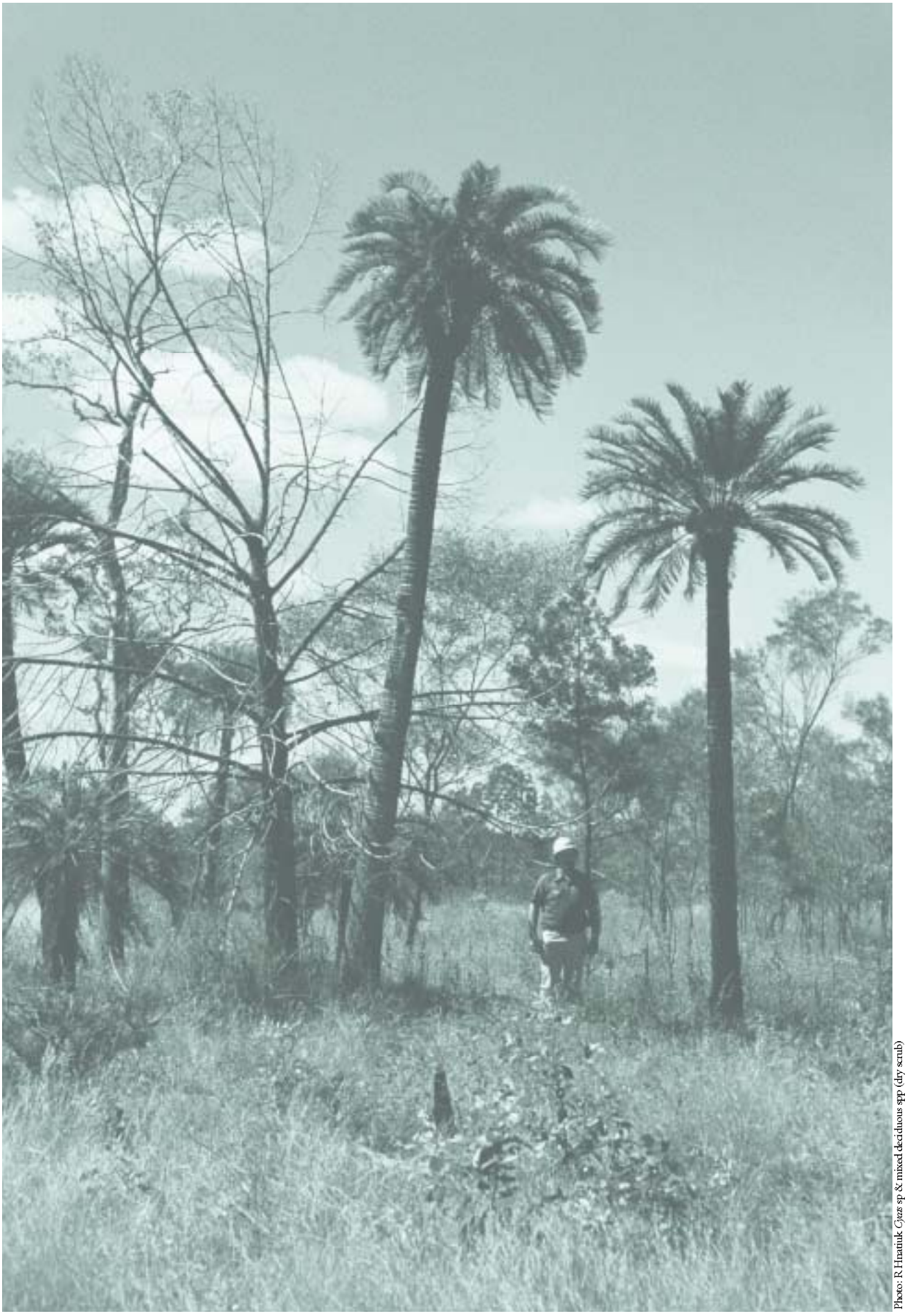


Photo: R Hnatiuk *Grass* sp & mixed deciduous spp (dry scrub)

# *Uses and Disturbances*

Many disturbances are a natural part of forest ecosystems. Fire, for example, has played a role in the Australian bush for millions of years, and forest cover has advanced and retreated over geological time as the climate has warmed or cooled.

Before Europeans, Indigenous peoples used the forests and disturbed them as they did so, particularly with their use of fire as a management tool. The nature of disturbance has changed in recent times, as we clear for agriculture and settlement and extract from the forests a wide range of products and services, and as we unwittingly introduce weeds, feral animals, pests and pathogens. This chapter describes and quantifies, where possible, the uses to which we put forests and the range of disturbances we impose upon them.

## Changes in forest cover

### Historical trends in forest cover change

Determining the historical rate of forest cover change is a difficult task, given that pre-European forest cover can only be estimated from information available today.

Land considered to have a high capability for agriculture was preferentially cleared after European settlement, resulting in remnant forests not being representative of the full range of forest types. It seems likely that about 36 per cent of Australia's forests were converted to agricultural land between the time of settlement and 1980 (Table 25). This gross figure can be broken down by State and Territory (Table 26). The areas of modern forest shown in these tables differ from those given earlier in this report, due partly to differences in the definition of forest and partly to improvements in data gathering, but the general trends in forest loss are still reasonable. Forest cover has increased in some regions, either through plantation establishment or through a reduction in pressures such as grazing, but these have not been sufficient to offset the large amount of clearing that has taken place.

Forests may change in character while retaining their status as forests. Table 27 shows that an estimated 1.1 million hectares of forest have increased in density since 1788 and 7.5 million hectares have decreased in density. The causes of these changes are not documented across the forest resource.

**Table 25: Estimated change in forest cover in Australia**

| Forest type | (million ha) 1788 | (million ha) 1980 | Change (%) |
|---|---|---|---|
| Closed forest | 4.6 | 2.9 | – 37 |
| Open forest | 65.0 | 35.0 | – 45 |
| Woodland | 182.0 | 122.0 | – 33 |
| **Total forest** | **251.6** | **160.0** | **– 36** |

*Source: derived from AUSLIG (1990).*

**Table 26: Estimated forest cover change, by State and Territory, 1788 to 1980**

| State/ Territory | ('000 ha) 1788 | ('000 ha) 1980 | Reduction (%) |
|---|---|---|---|
| ACT | 236 | 124 | 47 |
| NSW | 54 710 | 22 910 | 58 |
| NT | 27 565 | 27 474 | 0 |
| Qld | 80 609 | 55 963 | 31 |
| SA | 18 417 | 9 058 | 51 |
| Tas | 5 604 | 3 871 | 31 |
| Vic | 18 513 | 7 538 | 59 |
| WA | 46 346 | 32 934 | 29 |
| **Australia** | **252 000** | **159 872** | **37** |

*Notes: The data presented here are the only national estimates of forest cover change since European settlement. The areas differ from others used in this report due to differences in the definition of forest and improved data now available.*
*Source: derived from AUSLIG (1990).*

**Table 27: Estimated change in forest density, 1788 to 1980**

| Type of change | Area changed (million ha) |
|---|---|
| Forest to non-forest | 95.0 |
| Non-forest to forest | 1.7 |
| Increase in density | 1.1 |
| Decrease in density | 7.5 |

*Source: derived from AUSLIG (1990).*

## Contemporary trends in forest cover change

Comprehensive assessments of forest cover change at regular intervals are not routinely carried out in Australia because of the high cost. Various initiatives at the Commonwealth, State and Territory levels have gathered information on an ad hoc basis on changes in vegetation cover over time, but these measures are not always equivalent to changes in forest cover or are limited in scope to specific States, Territories or regions.

In 1995 the Commonwealth Government committed funds to a joint project between the Commonwealth and the States and Territories to develop a national land clearance database using high-resolution satellite information and covering the period 1990–95. This project is due for completion at the end of 1998.

# Forest fragmentation

Forests are naturally fragmented by rock outcrops, rivers, lakes, swamp, patches of non-forest such as shrubland, as well as the distribution of forest types and successional stages with the forest boundaries. But human activities, particularly clearing, can add to this fragmentation. Since European settlement, many of Australia's forested landscapes have been converted to a patchwork of remnants separated by a variety of non-forest land uses.

Forest fragmentation has potential implications for conservation: ecological theory and some field data suggest that small populations of species are more likely to become extinct than are large populations.

Small remnants of vegetation are also more vulnerable to clearing and to edge effects, in which habitat quality deteriorates at the boundary between the forest and cleared land. Small habitat remnants have proportionally more 'edge' than large tracts.

## Measures of fragmentation

Little work has been done to measure fragmentation at a regional or national scale, due largely to a lack of suitable map information. Nevertheless, a broad indication of the level of fragmentation was obtained for this report by analysing satellite images of the landscape. Three measures provide insight into fragmentation: patch size class, same-edge proportion, and Shannon contagion. These last two are useful because they can be repeated objectively through time for whole regions, thus providing measures of fragmentation change.

### Patch size classes

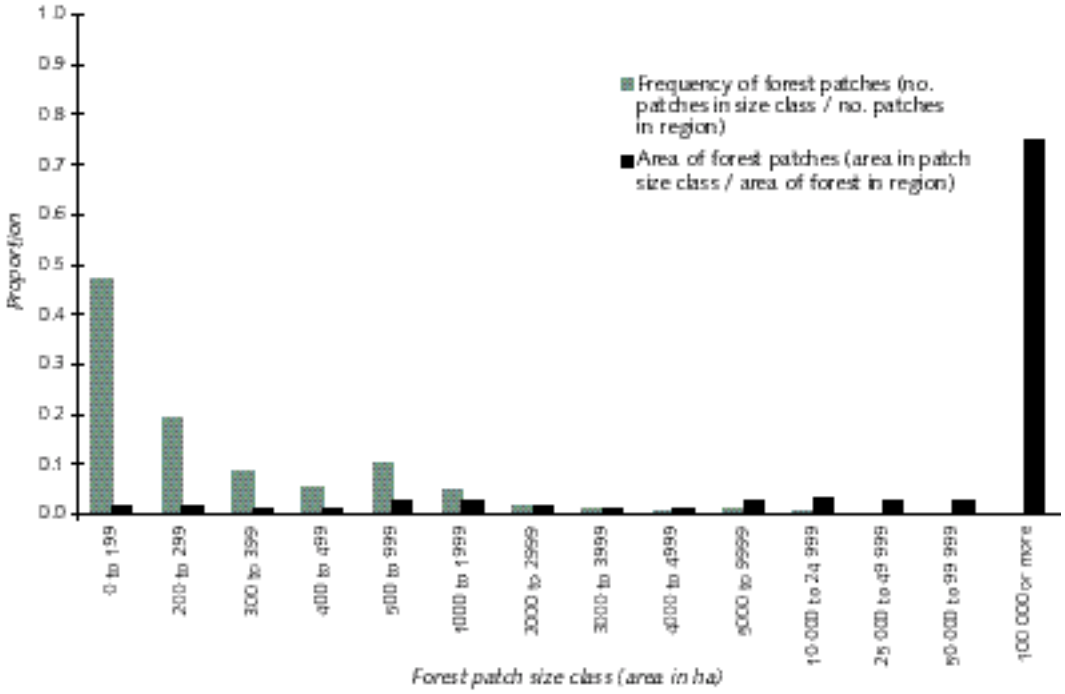
Most of the total forest area occurs in relatively large patches (about 76 per cent in patches greater than 100 000 hectares), but there are also a disproportionately large number of very small patches of forest (Figure 13). Note that estimates at the national level could significantly underestimate the number of small forest patches less than 200 hectares in size due to the low resolution of much of the mapping.

On a regional basis, the patch size results suggest that the larger the proportion of a region that is forested, the larger the average patch size will be for that region. Regions with the largest average patch size are distributed along the east coast, across the north-east and central north coasts, and in the north-western and south-eastern parts of Western Australia. Patch size generally decreases from the moister to the drier regions, with exceptions in south-western Australia and parts of the agricultural zones of south-eastern and central northern Australia.

### Same-edge proportion

Same-edge proportion is determined using characteristics of individual pixels of satellite imagery. It is calculated by the number of forest-to-forest edges in the region as a

**Figure 13: Statistics on the number and area of forest patches in Australia, by patch size class**




Source: *Montreal First Approximation Report (1997).*

## Box 9: Case studies in vegetation fragmentation

The national trend of natural vegetation fragmentation is reflected in Victoria, the only State that has mapped all vegetation patches greater than 1 hectare. Over 80 000 vegetation patches have been identified, with more than 90 per cent smaller than 50 hectares. These patches, however, only make up about 7 per cent of the total native forest area, with 45 per cent of the total area made up of patches greater than 100 000 hectares.

The pattern of fragmentation within South Australia is very different. Approximately 90 per cent of the State has been mapped with a minimum patch size of 10–100 hectares. The remainder has been mapped with a minimum patch size of 1 hectare. Statewide, about 400 000 vegetation patches have been identified, with almost 99 per cent of these less than 100 hectares in size. These smaller patches constitute at least 18 per cent of the total native forest area, making them extremely important at the State level.

A high proportion of South Australia's remnant forest patches occurs in that State's portion of the Murray-Darling Basin. This region hosts the State's most intensive agriculture and supports about 25 per cent of its native forests. All vegetation was mapped at a 1-hectare scale: over 300 000 forest patches were recorded. Of these, 99.5 per cent are less than 50 hectares in size. These small patches of forest make up about 60 per cent of the total native forest area in the region.

Similar estimates have also been made for forests with private tenure in south-west Western Australia. In the Southern, Central and Swan regions (within which the private forests constitute 9 per cent – 198 000 hectares – of the total forest area), 91 per cent of private forests occur in patches less than 50 hectares in size. These make up more than 40 per cent of the total native forest on private land within the region.

proportion of the total number of forest edges in the region. High values indicate large patches with few islands, while low values indicate a fine dispersion of small forest areas among prevailing non-forest.

Map 9 (see colour section in back of book) shows the distribution of same-edge proportion by a number of biogeographic regions (these, based on the Interim Biogeographic Regionalisation of Australia, are called IBRA regions, and have been developed by Commonwealth agencies in collaboration with State and Territory agencies; see Map 11). Forest patches are mostly clumped in the coastal forested regions, declining towards the interior of the continent. Some regions in the agricultural zone show similar values to those further inland, which may be indicative of the impact of forest clearing for agriculture.

### Shannon contagion

Shannon contagion is a measure of an entire region rather than of just forested areas. As for same-edge proportion, it has been applied to IBRA regions here. Shannon contagion measures the texture of a region: low values denote 'fine' texture (forest patches occur in small units across the landscape) and high values denote 'coarse' texture (forest patches are large and clumped).

Map 10 (see colour section in back of book) shows the distribution of Shannon contagion values by IBRA region. It suggests that patches are large and close together in coastal areas (contagion values are high) and more widely separated and smaller further inland and in the agricultural zones.

Research is under way to develop a clear understanding of fragmentation of forests from local to regional to national scales, and how to report meaningfully on it.

## Water yield

The tall and medium height eucalypt forests are most commonly found in those areas of the continent that come under the regular influence of rain-bearing weather systems and where mountainous topography reinforces rainfall due to the forced uplift of moisture-laden air. These forests make important contributions to streamflow: for example, the forested mountains of the upper Murray River comprise only 2 per cent of the total Murray-Darling catchment area, yet provide 25 per cent of the streamflow. The woodlands and mallee forests of relatively dry inland areas are not important in terms of streamflow (and thus water yield), although their high water use characteristics (compared to those of annual plants) help to maintain a low water table and thus aid the prevention of surface salinity.

Figure 14 illustrates the importance of forests in the high rainfall zone to streamflows. Not surprisingly, most research into the understanding of forest/water relationships has been devoted to the forests of the higher rainfall zones, and they form the basis of the following discussion.

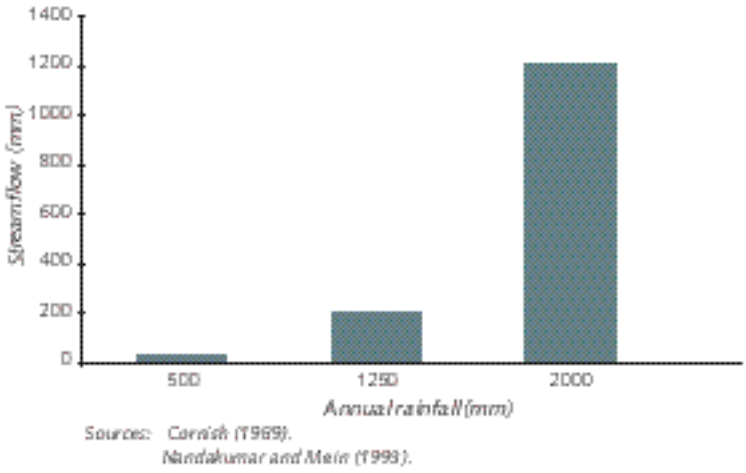
Forest soils, particularly in the higher rainfall forests, can be over 10 metres deep and can store large amounts of water that are slowly released to streams. For example, in the ash-type forests of Victoria, 80 per cent of annual streamflow is a base flow; this percentage falls to 20 per cent in an urban environment. The steady-state flow characteristic of forested catchments reduces the need to build regulating dams and reservoirs and reduces flood peaks.

A number of characteristics of particular forests, such as age, structure and type, can affect streamflow. For example, streamflows from dense regrowth stands in ash-type forests can fall to 50 per cent of those derived from an old-growth forest of the same forest type. These effects are recognised in some codes of forest practice: for example, the Victorian code requires that forest managers take steps to avoid significant streamflow declines.

### Forests and streamflow quality

Except for periods of high streamflow during and following major rainfall events, the quality of water draining from undisturbed forests is high due to its low levels of turbidity, dissolved solids and nutrients. Forest litter protects the soil from raindrop splash erosion and helps prevent overland flow. The incorporation of the litter in the soil as organic matter helps aggregate the soil into a stable crumb structure that resists dispersion and allows water to

**Figure 14: The influence of increasing average annual rainfall on streamflow volume (indicative values)**




infiltrate. The abundance of old root channels increases the infiltration of water to allow the transfer of surface water to deeper layers. Repeated high-intensity fuel reduction burning that destroys the litter layer can reduce water infiltration by affecting the fine structure of surface soils. Fuel reduction burning, which aims at reducing but not eliminating the litter layer, is unlikely to have this kind of unwanted impact.

In the multiple-use forests of all States, codes of forest practice or other management prescriptions require that road location, construction, drainage and maintenance practices are carried out according to specifications that reduce the level of disturbance and control road and logging track drainage. No-entry buffer zones are demarcated alongside streams, creating an undisturbed zone for the settlement of suspended material in overland flow. In some States, codes of forest practice also apply to private commercial forestry.

## Stream and streamside habitat

Forest streams and the vegetation on their banks provide habitat for insects, crustaceans, amphibians, fish and mammals. Long-term and permanent increases in the amount of sediment have been shown to reduce species diversity and population levels in aquatic environments. Codes of forest practice aim to prevent the loss of water quality and changes in stream-bed morphology. Buffer strips along streams maintain a forest cover that protects the stream from direct sunlight, and therefore extreme temperatures, while the canopy cover provides a continuous leaf fall that can be a source of food for aquatic inhabitants.

## National-level reporting on water in forests

There are few nationally collated data on the water supply and protection functions of forests. Research is under way via the Montreal Process Implementation Group to develop indicators that will assist in reporting on water in forests.

# Cultural values

Forests today are valued by communities and individuals for the wide range of cultural values they hold, both tangible and intangible. Indigenous peoples have lived in and used forested areas for thousands of years as hunting grounds, places for ceremony and learning, and as a source of bush tucker, medicines and raw materials. For non-Indigenous settlers of more recent times, the forests have formed an important economic resource as well as a source of contemporary cultural meaning. For

both Indigenous and non-Indigenous peoples, the cultural significance of forests stems from their material, spiritual, aesthetic and historic values. The use of the forests over time has influenced the biological shape and form of forests as well as creating an archaeological record of considerable historical interest. The cultural significance of our forests today has been formed through a complex intertwining of natural and social processes, meanings and values.

The cultural significance of Australia's forest estate varies between community groups and between different levels of community – local, regional and national. Accordingly, various approaches have been developed to enable the appropriate and effective identification of cultural values. Community consultation, primarily in the form of interactive workshops, is increasingly being used to collect information about places of cultural value. Information gathered through field survey, archival research and other community-based investigations such as oral history interviews is also used. The significance of a place may be formally determined through the application of evaluative criteria, such as those developed by the Australian Heritage Commission. The systematic survey of cultural values in forests at a regional level conducted in recent years as part of regional forest agreement processes (see Chapter 5) has greatly enhanced communication and understanding of these values and led to improved identification and assessment techniques.

## Forest conservation

The general aim of forest conservation is to ensure that forest ecosystems and the natural processes that sustain them remain intact for their own sake and for the benefit and enjoyment of future generations. This is undertaken across all tenures to some extent. In the conservation reserve system, the overriding consideration is the management of forest systems to maintain a state as close as possible to their natural condition. Multiple-use forests afford protection to many conservation values, although timber production and other resource uses are permitted. While significant conservation values exist on other tenures, including other crown land and leasehold land, these are seldom actively managed for. Recently, efforts have been undertaken to provide mechanisms and incentives to achieve conservation outcomes on private tenures.

Forest conservation outcomes fall into three broad categories:

1. realising the economic, scientific, cultural and/or social benefits derived from the retention of intact forest systems;
2. meeting obligations to inter-generational equity in natural capital; and
3. recognising the intrinsic values of forests and their associated biodiversity that transcend human utility.

The economic benefits of forest conservation include the provision of ecological services (such as water production and carbon sinks), ecotourism, wood products, recreation and pharmacological and other products. Broad economic analyses concern themselves with how to make choices that provide the greatest net benefit to the community, where 'benefit' implies consideration of all economic, social and environmental values. The Australian community recognises a form of social dividend or value coming from a knowledge that forests are protected, even if particular individuals might make little or no direct use of those forests. This suggests that there is considerable social comfort in the knowledge that forest areas will continue to exist, regardless of their conventional economic value. The various aesthetic and intangible values attached to forests, while difficult to define, are nevertheless real and significant for many people.

Natural capital includes natural ecosystems, ecological processes and natural resources. Use of natural capital requires management to try to prevent possibly irreversible changes to ecosystems that may have adverse consequences for future generations. Conservation of forest capital is part of the responsibility of the present generation of forest users for the health, diversity and productivity of the forests so that they can also be used by future generations.

While forest management and our understanding of the natural processes that

underpin it have progressed far, there is still much to learn: what are now accepted as sustainable practices may, in hindsight, prove otherwise. Retention of some forests in their natural state can thus be seen as a prudent precaution against possible impacts that may occur due to the incomplete state of our knowledge. Land clearing and other practices have caused the extinction of forest species, although the extent to which this has occurred is not documented on a national basis.

## Comprehensive, adequate and representative reserve systems

Individual States and Territories have developed reserve systems based on a range of conservation principles. In 1992 the National Forest Policy Statement, which set out principles and a national framework for forest use and conservation, advocated the development of a comprehensive, adequate and representative reserve (CAR) system for Australia's forests. A nationally agreed set of criteria for such a system has been developed and is currently being applied to forest areas subject to comprehensive regional assessments. These assessments are used to develop regional forest agreements (RFAs; see Chapter 5), covering much of the nation's productive forest estate.

One of the primary aims of the CAR reserve system is the reservation, where still practicable, of 15 per cent of the pre-1750 extent of those forest ecosystems where the Commonwealth and States have agreed to undertake comprehensive regional assessments. Other targets are specified for the protection of old-growth and forested wilderness and require the protection of adequate high-quality habitat for forest species, particularly those considered endangered. These objectives will be most efficiently and effectively achieved through the development of integrated regional conservation strategies that provide for the establishment and effective management of conservation reserves and complementary management of adjoining forest areas. Here, the current extent of the reserve system is used as one indicator of current conservation use.

The RFA process does not extend to all of Australia's forests: its scope is limited largely to regions with forests intensively managed for timber production (Map 15). For this reason, the process will not address a comprehensive reserve system for the entire forest estate. Nevertheless, it is likely to result in changes to land tenure categories on that part of the estate to which it is applied. Pending the completion of the process, Table 6 shows the current extent of forest in formal conservation reserves.

## Biodiversity

Biodiversity (biological diversity) refers to the variety or diversity of all life forms, plants, animals and microorganisms, their gene pools and the ecosystems they inhabit. Given the broadness of the term and the range of diversity in Australian forests, quantifying biodiversity is an extremely difficult task. Australia's unique forest ecosystems are a global asset, a rich repository of the history of life in Gondwana that has only partially been investigated. Australia is considered one of the world's 12 'megadiverse' countries; it is the high level of endemism in the Australian biota that makes it of particular significance. We still know little about many forest species, particularly lower plants and invertebrates.

Biodiversity is recognised at three levels: ecosystem diversity, species diversity and genetic diversity.

### Ecosystem diversity

Ecosystem diversity refers to the variety of habitats, biotic communities and ecological processes, as well as the diversity between and within ecosystems. At the landscape level, the Interim Biogeographic Regionalisation for Australia (IBRA) has been developed (Map 11 see colour section in back of book). This defines, maps and describes the major ecosystems of Australia based on an integrated classification of biotic and abiotic variation. Attributes included in the IBRA classification are climate, geomorphology, landform, lithology and characteristic soils, flora and fauna.

At the level of plant communities, Specht and his co-authors recognised 457 native forest communities in their 1995 conservation atlas.

## Species diversity

Species diversity refers to the variety of living species. Approximately 2300 species of native vertebrate fauna have been recorded in Australia. Of these, 1239 were reported to occur in forests in various States and Territories. Some 13 622 of the approximately 18 000 species of vascular plants in Australia have been recorded in forests (Table 28). There are few data on the degree to which such species are forest-dependent. There are lists of non-vascular plants, fungi and microbes occurring in Australia, but they are not summarised by habitat of occurrence, thus comprehensive lists of these occurring in forests are not available.

Figure 15 presents information on animal species known to occur in forests of various structures, although it is acknowledged that this information is far from complete and, indeed, almost non-existent for some forest structural types. Invertebrate species numbers are vastly underestimated, while estimates for mammals and birds are probably reasonably accurate.

### *Rare or threatened species*

Rare or threatened species are listed for many plant and animal groups, although these have not been classified according to the habitats in which they occur at the national, State or Territory level. This makes it difficult to report on which rare or threatened species are forest-dependent. Map 12 (see colour section in back of book) shows forested sites where rare or threatened vascular plant species have been collected during mostly ad hoc surveys. The sites depicted represent individual records and not the spatial extent of the species.

There are no recorded extinctions of species from forests due to timber harvesting or other disturbances from which the forest has time to recover. However, some species have been recorded as being sensitive to certain kinds of forestry operations. Maintenance of these species depends on appropriate forest management practices. Forest clearing for other land uses such as intensive agriculture replaces forest habitats, posing a significant threat to species dependent on those habitats.

According to estimates provided by three States and Territories for this report, 37 forest-dependent fauna species occupy a reduced range compared to their pre-European distribution. No national data are available for plant species; Tasmania reported an indicative 66 of 1537 plant species as having a significantly reduced range.

## Genetic diversity

Genetic diversity refers to the variety of genetic information contained in all individual plants, animals and microorganisms. It occurs within and between populations of species as well as between species. Empirical data on genetic variation are sparse and generally restricted to a small number of species, primarily vertebrates and vascular plants. As knowledge of intra-specific variation and techniques for assessing it improve, it will be necessary to review the strategies for ensuring the preservation of genetic variation.

## Species assessments

Species assessments are carried out primarily for rare or threatened species. State, Territory and Commonwealth governments use recovery programs to assist in protecting such species or to remove threats to them. Such programs in Western Australia have resulted in the recovery of the woylie (*Betongia penicillata*) the quenda (*Isoodon obesulus*) and Tammar wallaby (*Macropus eugenii*) to a point where they have been removed from the rare and endangered list.

Species assessments are also carried out as part of the RFA process. These consider:

- the current distribution of rare and threatened forest-dependent species;
- threatening processes affecting these species;
- the conservation requirements of these species, including on-reserve and off-reserve management; and
- the minimum area that must be managed to maintain a viable population of each species.

The information collected for these species will be used in the design of the CAR reserve system. Those species that are most vulnerable to off-reserve threatening processes will be given priority, where possible, for inclusion into this reserve system.

## Table 28: Plant and animal species recorded as occurring in forest, by State and Territory

| [1] | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | Australia[2] |
|---|---|---|---|---|---|---|---|---|---|
| **Vertebrate animals** | **ND** | **504** | **449** | **582** | **ND** | **125** | **485** | **239** | **1 227** |
| rare or threatened | ND | 7 | 4 | 76 | ND | 4 | 9 | 57 | 81 |
| mammals | ND | 96 | 87 | 104 | ND | 27 | 94 | 29 | 217 |
| birds | ND | 281 | 198 | 303 | ND | 77 | 253 | 150 | 561 |
| reptiles | ND | 73 | 134 | 122 | ND | 14 | 102 | 45 | 319 |
| amphibians | ND | 54 | 30 | 49 | ND | 7 | 36 | 15 | 126 |
| fish | ND | 0 | 0 | 4 | ND | 0 | 0 | 12 | 16 |
| **Higher plants** | **ND** | **ND** | **1 691** | **7 830** | **ND** | **1 043** | **2 959** | **2 639** | **13 622** |
| rare or threatened | ND | ND | ND | ND | ND | ND | ND | 319 | ND |

*ND – No data.*

*[1] Data for vertebrates and higher plants were provided by State agencies during the production of the Montreal First Approximation Report (1997). The national (ANZECC) vertebrate list, with 1995 revisions by Environment Australia, was used as a base for State input.*

*[2] The Australian total represents a minimum number of unique species names derived from State lists from NSW, NT, Tas and Vic, plus partial data from Qld. The remainder of data from Qld and WA are not included as they are not in a form suitable for aggregation nationally.*

*The NT provided 38 additional flora species that may or may not be synonymous with the national list of species. Qld provided 1986 additional flora species that may or may not be synonymous with the national list of species. WA provided total flora numbers only, rather than species lists – these numbers are not reflected in the national total.*

*No flora data were received from the ACT, SA or NSW.*

*NSW were revising their fauna data when it was collected in April 1997.*

*Qld provided 116 additional fauna species that may or may not be synonymous with the national list of species.*

*Tas provided 2 additional fauna species that may or may not be synonymous with the national list of species.*
*WA provided fauna numbers only, rather than species lists – these numbers are not included in the national total.*
*No fauna data were received from the ACT or SA.*
*Sources: National Forest Inventory (1997).*
*Environment Australia (1998).*

## Table 29: Species numbers in the forests of north-east New South Wales

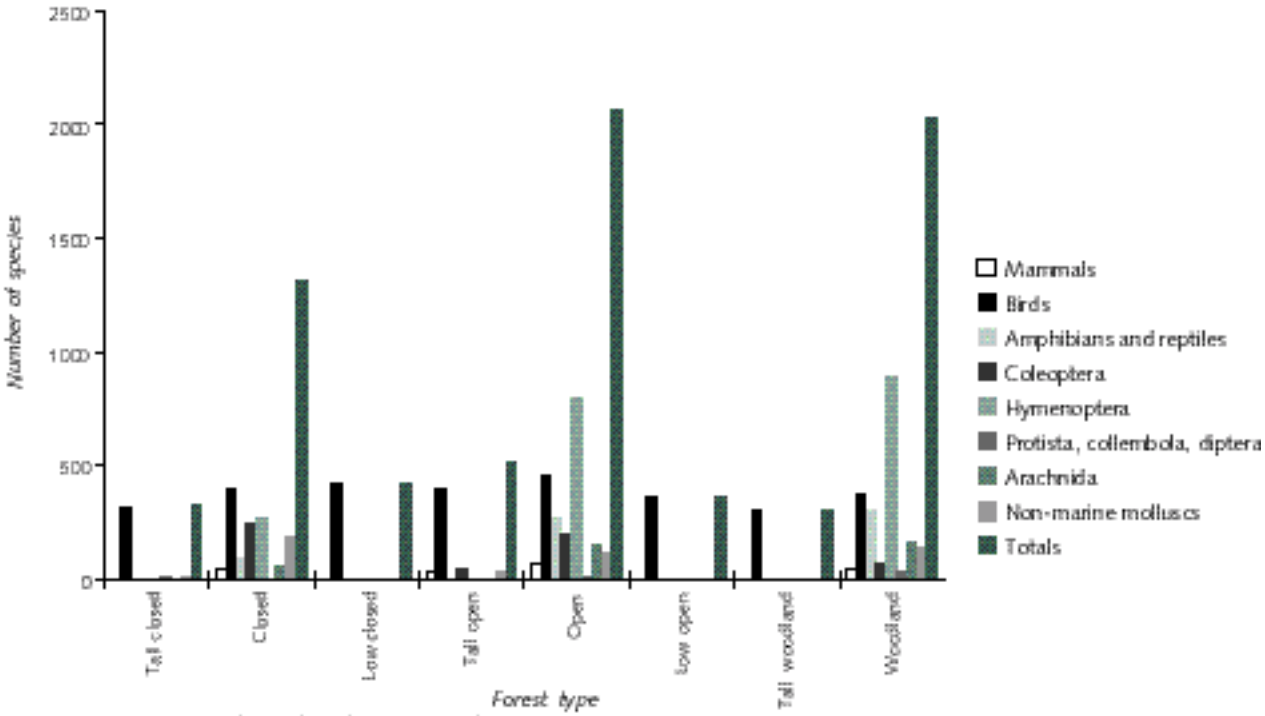
| Species group | Number of species |
|---|---|
| **Higher plants[1]** | **2211** |
| **Vertebrate animals[2]** | **405** |
| frogs | 46 |
| reptiles | 85 |
| birds | 181 |
| non-flying mammals | 64 |
| bats and flying foxes | 29 |
| **Invertebrate animals [2]** | **526** |
| spiders | 242 |
| ants | 185 |
| carabid beetles | 47 |
| drosophilids | 52 |

*Sources:*

*[1] NSW National Parks and Wildlife Service (1994b).*

*[2] NSW National Parks and Wildlife Service (1994a).*

**Figure 15: Number of animal species known to occur in Australian forests, by various forest structural types**




Sources: Australian Biological Resources Study.
Royal Australasian Ornithologists Union (1995).

## Box 10: Biodiversity case study

Current knowledge about Australia's forest biodiversity is based largely on 200 years of ad hoc species collections as well as detailed surveys. Some modern surveys currently under way aim to use a systematic approach to the collection of biodiversity information to enable the prediction of species distribution through modelling techniques.

The New South Wales North East Forests Biodiversity Study (NEFBS) is a recent example of such a survey. The information gained from it allows us to understand more clearly how biodiversity is distributed across this region.

The survey identified more than 2200 species of flowering plants, conifers, cycads and ferns. Among them are 431 species that have been introduced to Australia since European settlement. The survey also identified 405 species of vertebrate animals and 526 species of invertebrates (Table 29).

Even a survey as detailed as this underestimates species diversity because uncommon species are likely to be missed more often than common species. Nevertheless, the rigour with which it was conducted makes it possible to develop computer-based models to predict species and community distributions. These models are useful in conservation planning and management as well as for designing more efficient surveys in the future.

## Old-growth forest

Old-growth forests constitute a major determinant for identifying and developing a national forest reserve system. The CAR criteria set a target for reservation of old-growth at 60 per cent of the extant old-growth forest for each forest ecosystem, rising to 100 per cent for those old-growth elements identified as rare or depleted.

The national criteria, guided by the National Forest Policy Statement, define old-growth forest as 'ecologically mature forest where the effects of disturbances are now negligible'. The following principles have been applied as an integral part of the definition:

- 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 indicated in most forests by a significant proportion of trees with age-related features and a species composition characteristic of an ecologically mature forest ecosystem.

For application in RFAs, this been interpreted to mean that:

- ecological maturity is a characteristic of older growth stages. Trees exhibiting characteristics of maturity are usually large in terms of height or girth and experiencing slow to almost negative growth rates (this would be evident from shrinking tree crowns, dead and broken branches in the crown and branch stubs on the trunk). They may possess attributes such as burls, galls and hollows;
- features such as forest structure or the composition of flora and fauna can be used to assess the significance of disturbance; and
- forests containing a large number of trees showing characteristics of over-mature forests can themselves be evidence that the effects of past disturbance (on that ecosystem) are now negligible.

In applying this definition, additional information relating to the conservation value of forest is also used. This will include the role of the forest as breeding or foraging habitat for fauna, as protection for flora, and its value in aesthetic or cultural terms.

Old-growth forest is considered important to the conservation of biodiversity because some plants and animals are restricted to the old-growth stages or are dependent on old-growth forest for some of their habitat requirements. For example, one of the most significant characteristics of the older stages of eucalypt forests is the development of tree hollows necessary for the survival of a range of fauna.

### *Assessing old-growth*

Table 3 shows that growth stage is known for about half of Australia's multiple-use forests (some 6.8 million hectares). Table 4 shows that growth stage is known for about 6 per cent of forests in conservation reserves (some 1.1 million hectares), of which 475 000 hectares are classified as 'mature' forest (aged 100–200 years). The RFA process is expected to provide further data for that part of the forest estate within the scope of the process. At present, there is no comprehensive program to do similar old-growth data-gathering in forests outside the RFA areas.

## Wilderness

The National Forest Policy Statement gave a significant commitment to the protection of forest wilderness. It defined wilderness as:

> *land that, together with its plant and animal communities, is in a state that has not been substantially modified by, and is remote from, the influences of European settlement or is capable of being restored to such a state; is of sufficient size to make its maintenance in such a state feasible; and is capable of providing opportunities for solitude and self-reliant recreation.*

The National Wilderness Inventory has produced, cooperatively with States and Territories, a continental-scale map of wilderness quality covering most of Australia (Map 13). This work has been implemented by measuring variation in wilderness quality across the landscape using four wilderness quality indicators:

- remoteness from settlement;
- remoteness from established access routes (for example, roads and tracks);
- apparent naturalness: the degree to which the landscape is free from the presence of permanent structures associated with modern technological society; and
- biophysical naturalness: the degree to which the natural environment is free from biophysical disturbance caused by the influence of modern technological society.

Wilderness quality is assessed by the National Wilderness Inventory on a scale ranging from zero, which equates to cleared land, to 20, which equates to an area that has experienced no measurable modern development disturbance. Over 90 per cent of Australia has been assessed in this way.

The reserve criteria agreed by States, Territories and the Commonwealth set a target for the reservation of wilderness in forest areas other than those in northern Australia:

> *Ninety per cent, or more if practicable, of the area of high quality wilderness that meets minimum area requirements should be protected in reserves.*

Some wilderness areas have been delineated within RFA areas and by some States under their own processes (Map 13) (see colour section in back of book).

## Geological sites

While nature conservation commonly focuses on biological resources, many forests exhibit geodiversity, or a diversity of geological, landform and soil sites. Like plant and animal species, some landforms are common and some are rare, some are robust and some are fragile. Some sites of important geodiversity may be significant for their intrinsic value; for the role they play in sustaining natural processes, including ecological processes; or for their value to the human population in terms of scientific, recreational, educational, inspirational or economic opportunities. There are no national data on geodiversity.

# Timber use in native forests

Native forest is available for the harvesting of timber in the following tenures: multiple-use, some leasehold, some other crown land, and private. Forests with tenure as conservation reserves are excluded from harvesting.

## Multiple-use forests

### Net harvestable area

Nationally, 86 per cent, or 13.3 million hectares, of the 15.6 million hectares of land designated as multiple-use forests is actually forested. The remainder is rock outcrop, lakes, swamps, non-forest vegetation types or cleared lands purchased for plantation establishment within the forest envelope. The percentage of unforested area varies between States and Territories (Table 30).

Not all forests with multiple-use tenure are available for harvesting. Several factors reduce the harvestable area, notably:

- distance from mills, which may make harvesting uneconomic;
- terrain – access too difficult for vehicles, slopes too steep for machinery, or soils too fragile to work on;
- areas where productivity is low (that is, the number of harvestable trees per hectare is low) or the forest tree species are unsuitable for timber production;
- areas protected from harvesting for environmental or conservation reasons:
  - buffer zones (for example, to protect stream water quality)
  - steep slopes and fragile soils
  - flora, fauna and other conservation areas; and
- areas set aside because of their scenic, cultural or recreation values.

These factors reduce the net forest area available for harvesting by about 45 per cent nationally, although the proportion varies from State to State (Table 31).

**Table 30: Area of native forest under multiple-use forest tenure available for harvesting, by State and Territory**

| | ACT | NSW | NT | Qld | SA[3] | Tas | Vic | WA | Australia |
|---|---|---|---|---|---|---|---|---|---|
| Total forested MUF ('000 ha)[1] | 5 | 3 095 | 0 | 3 983 | 27 | 1 285 | 3 346 | 1 612 | 13 351 |
| (% of total MUF)[2] | 20.2 | 81.1 | 0.0 | 91.7 | 21.0 | 79.0 | 90.2 | 82.1 | 85.5 |
| **Total MUF area ('000 ha)[2]** | **23** | **3 814** | **0** | **4 346** | **126** | **1 627** | **3 710** | **1 962** | **15 608** |

*Note: Column or row total may not add up due to rounding.*
*MUF – Multiple-use forest.*
*[1] Forested portion of multiple-use forests. Percentages relate to exact figures, not the rounded figures given in this table.*
*[2] Includes unforested areas.*
*[3] No harvesting of publicly owned native forest takes place in SA.*
*Source: National Forest Inventory (1997).*

**Table 31: Partial estimate of net area of forest available for timber production (excluding plantations)**

| | ('000 ha) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Tenure** | **ACT** | **NSW[1]** | **NT** | **Qld** | **SA** | **Tas[2]** | **Vic** | **WA** | **Australia** |
| Multiple-use | N/A | 1 825 | ND | 2 367 | N/A | 730 | 1 215 | 1 135 | 7 272 |
| Other | ND | 550 | ND | 2 340 | N/A | 25 | ND | ND | 2 915 |
| Private | ND | 2 000 | ND | ND | N/A | 1 146 | ND | ND | 3 146 |

*Note: Column or row total may not add up due to rounding.*
*N/A – Not applicable.*
*ND – No data.*
*[1] Private net harvestable area is estimated.*
*[2] Private harvestable is gross area only as net area is not available.*
*Source: Montreal First Approximation Report (1997).*

## Standing timber volume

Table 32 shows an estimate of the total volume of standing timber present in native forest with multiple-use tenure. This volume represents that part of the timber resource that was available for timber harvesting in 1995, after the exclusion of areas that are set aside for general environmental protection purposes. No national data are available for the non-merchantable part of the growing stock.

## Area harvested annually

The area of multiple-use forest harvested in any one year is determined through planning processes that take into account the range of resources available and constraints placed on harvesting by such things as slopes, soils, and conservation and cultural heritage objectives. Table 33 shows the areas harvested each year in the States of New South Wales, Queensland, Tasmania, Victoria and Western Australia (South Australia and the two Territories do not have or do not harvest their native multiple-use forests). An average of 0.8 per cent (110 000 hectares) of the gross area of native forest with multiple-use tenure (13.3 million hectares) is harvested in any one year; this is about 1.5 per cent of the net area available for harvesting in multiple-use forests. Note that area harvested means different things in different places because of the differing silvicultural systems used. Thus, the area clear cut is not fully comparable to the area lightly selectively logged. As presented here, these figures indicate the area of forest that is affected to some extent by harvesting activities.

## Sustainable yield

Sustainable yield (also known as sustained yield) is the quantity of timber that can be harvested on a non-declining basis from a forest based on:

- the proportion of forest suitable for timber production;

**Table 32: Total growing stock of merchantable tree species available for timber production in native multiple-use forests, by broad forest type, by State and Territory**

| | Total merchantable volume ('000 $m^3$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Forest Type** | **ACT** | **NSW** | **NT** | **Qld** | **SA** | **Tas** | **Vic** | **WA** | **Australia** |
| Rainforests | | | | | | 43 092 | | | 43 092 |
| Tall open eucalypt forests | | 29 875 | | 4 000 | | 149 787 | 7 251 | 15 295 | 206 208 |
| Medium open eucalypt forests | | 23 398 | | 2 850 | | 64 000 | 9 965 | 125 328 | 225 541 |
| Low open eucalypt forests | | | | | | | | | |
| Tall eucalypt woodlands | | | | | | | | | |
| Medium eucalypt woodlands | | | | | | | | | |
| Low eucalypt woodlands | | 5 214 | | | | | | | 5 214 |
| Eucalypt mallee forests and woodlands | | | | | | | | | |
| Callitris forests and woodlands | | | | 6 800 | | | | | 6 800 |
| Acacia forests and woodlands | | | | | | | | | |
| 'Other' forests and woodlands | | | | | | 12 851 | | | 12 851 |
| **Total** | **N/A** | **58 487** | **ND** | **13 650** | **N/A** | **269 730** | **17 216** | **140 623** | **499 706** |

*N/A – Not applicable.*
*ND – No data.*
*Notes: Some States provided merchantable volume in cubic metres per hectare and area in hectares – this was used to calculate total merchantable volume.*
*The ACT and SA do not harvest native timber.*
*Column or row total may not add up due to rounding.*
*Source: Montreal First Approximation Report (1997).*

- the area available for timber production after the protection needs of flora, fauna, water and other environmental values have been met;
- the estimated growing stock and its future growth rates under a particular silvicultural system; and
- any predicted losses to growing stock due to fire or other causes.

The long-term sustainable yield represents the theoretical maximum rate that can be achieved based on a balanced tree age-class distribution over the forest.

All States have long-term plans in place for achieving sustainable yield of timber products. Some allow annual harvest levels to fluctuate around the sustainable yield rate, but reconciliation with sustainable yield is necessary to ensure that future availability is not compromised.

Each State has its own method of forecasting sustainable yield for its multiple-use native forests. The variation in methodology between States is due to differences in available inventory information and to regional differences in the nature of the timber products harvested. Most States forecast sustainable yield for sawlogs, but few do for pulplogs as these are generally seen as a by-product of sawlog production. Table 34 shows the sustainable yield rates forecast for sawlogs from multiple-use native forests in New South Wales, Queensland, Tasmania, Victoria and Western Australia. In 1994–95, the combined sustainable yield of sawlogs was 2.7 million cubic metres, of which 2.5 million cubic metres were harvested.

A broader concept than sustainable yield is that of ecologically sustainable yield; what this constitutes is yet to be determined. In practice, multiple-use forest planning of wood yield in all States incorporates a wide range of economic and conservation values. The extent to which this meets the expectations of ecologically sustainable management is being considered in the RFA and Montreal Process activities.

## Table 33: Area of native forest under multiple-use forest tenure harvested annually, by State and Territory

| | Area harvested (in hectares and as a percentage of forested multiple-use forests (MUF) in each State and Territory) | | | | | | | | | | | | | | | | | Area harvested nationally (% of total forested MUF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ACT[1] | | NSW[2] | | NT[3] | | Qld | | SA[1] | | Tas | | Vic | | WA[4] | | | |
| Financial year | (ha) | (%) | (ha) | (%) | (ha) | (%) | (ha) | (%) | (ha) | (%) | (ha) | (%) | (ha) | (%) | (ha) | (%) | ha | |
| 1989–90 | 0 | 0 | 37 500 | 1.2 | 0 | 0 | 33 644 | 0.8 | 0 | 0 | 6 000 | 0.5 | 12 200 | 0.4 | 15 060 | 0.9 | 104404.0 | 0.8 |
| 1990–91 | 0 | 0 | 37 500 | 1.2 | 0 | 0 | 44 226 | 1.1 | 0 | 0 | 4 700 | 0.4 | 10 800 | 0.3 | 13 060 | 0.8 | 110286.0 | 0.8 |
| 1991–92 | 0 | 0 | 37 500 | 1.2 | 0 | 0 | 49 523 | 1.2 | 0 | 0 | 4 200 | 0.3 | 9 900 | 0.3 | 15 870 | 1.0 | 116993.0 | 0.9 |
| 1992–93 | 0 | 0 | 37 500 | 1.2 | 0 | 0 | 32 637 | 0.8 | 0 | 0 | 5 800 | 0.5 | 9 300 | 0.3 | 16 000 | 1.0 | 101237.0 | 0.8 |
| 1993–94 | 0 | 0 | 37 500 | 1.2 | 0 | 0 | 53 196 | 1.3 | 0 | 0 | 5 600 | 0.4 | 7 000 | 0.2 | 15 540 | 1.0 | 118836.0 | 0.9 |
| *Average* | *0* | *0* | *37 500* | *1.2* | *0* | *0* | *42 645* | *1.1* | *0* | *0* | *5 260* | *0.4* | *9 840* | *0.3* | *15 106* | *0.9* | *110351.2* | *0.8* |
| Rotation length (nominal years) | N/A | | 60–150 | | N/A | | 50–200 | | N/A | | 80–100 | | 65–140 | | 100–200 | | | 20–200 |

*Notes: This table contains areas harvested by any technique. States utilising different techniques cannot be directly compared, for example, Qld and NSW use selective harvesting where a large area is harvested lightly. This cannot be compared to Vic, where the area harvested is done by clear-fall, which harvests almost the entire area.*

*N/A – Not applicable.*

*[1] No harvesting occurs on MUF native forest in SA or the ACT.*

*[2] Estimate only.*

*[3] The NT does not have any MUF.*

*[4] In WA, about 1500 ha is clear-felled annually and the remainder is selectively logged.*

*Source: National Forest Inventory (1997).*

## Table 34: Calculated sustained yield of sawlogs and actual harvest of sawlogs from multiple-use forests, 1992–93 to 1994–95

('000 $m^3$)

| | ACT | | NSW | | NT | | Qld | | SA | | Tas [2] | | Vic [3] | | WA [4] | | Australia | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Financial year | Sustained yield | Harvested volume | Sustained yield | Harvested volume | Sustained yield | Harvested volume | Sustained yield | Harvested volume[1] | Sustained yield | Harvested volume | Sustained yield | Harvested volume | Sustained yield | Harvested volume | Sustained yield | Harvested volume | Sustained yield | Harvested volume |
| 1992–93 | N/A | N/A | 791 | 729 | N/E | | 116 | 118 | N/A | N/A | 300 | 292 | 743 | 632 | 758 | 636 | 2 708 | 2 407 |
| 1993–94 | N/A | N/A | 791 | 782 | N/E | | 113 | 107 | N/A | N/A | 300 | 209 | 743 | 660 | 758 | 615 | 2 706 | 2 373 |
| 1994–95 | N/A | N/A | 801 | 781 | N/E | | 112 | 111 | N/A | N/A | 300 | 309 | 743 | 664 | 758 | 689 | 2 714 | 2 554 |

*N/E – Not established.*

*N/A – Not applicable.*

*[1] Applies to higher quality sawlogs meeting 'quota' sawlog specifications.*

*[2] Applies to category 1 & 3 eucalypt sawlogs from all Tasmanian crown forests.*

*[3] Sustainable yields and harvested volumes are expressed in C+ log grades plus net volumes.*

*[4] The overall harvest is set by a long-term management plan.*

*Source: National Forest Inventory (1997).*

### Annual harvested volume

Data on harvested volumes are not collected nationally for native versus plantation forests; rather, they are subdivided into hardwood and softwood. Until recently, when hardwood plantations became more widespread, it was reasonable to assume that total hardwood volumes were almost identical to total volumes harvested from native forests, since Australian native forests consist mostly of hardwood species (with *Callitris* species being the notable exceptions in terms of timber production). Similarly, values for softwood harvests can generally be assumed to consist mostly of timber derived from plantations. The discussion below, and for plantations, makes the reasonable assumption that these rules of thumb apply for the period under discussion.

Figure 16 shows that the total volume of hardwoods harvested for all purposes from the total forest estate, including private land, in the period 1970–97 was reasonably steady. This was despite a decline in the annual harvest of hardwood sawlogs (Figure 17), which was offset by a fourfold increase in the hardwood pulplog harvest (Figure 18). Native forests have consistently provided 60 per cent or more of the total pulpwood harvest. Table 34 shows the volume of sawlogs harvested from multiple-use forests by State compared to the calculated sustainable yield over the period 1992–95.

## Other tenures

In all, there are 81.7 million hectares of native forest on leasehold and other public land beyond the multiple-use and conservation reserve systems. In addition, there are 42 million hectares of native forest on private land.

Leaseholders of forested land do not automatically have the right to harvest the forest for commercial purposes – governments generally retain ownership of all vegetation on leased land – but harvesting may be permitted under licence or other arrangements. In New South Wales and Tasmania, where some leases are considered akin to private ownership, regulations governing forest clearing apply. In Queensland, a potentially extended process of converting leasehold to freehold (private) land may give the landowner immediate property rights to timbers.

Forests on other crown lands are not excluded from harvesting, although clearing regulations and, in some States, codes of practice apply. However, the occupants are generally not involved in timber production, being bodies such as the defence forces, scientific and education facilities, and utilities. On Aboriginal reserves, both the occupants and the government must agree to forest harvesting before it may occur. There are few legal constraints to the harvesting (as opposed to the clearing) of native forests on private lands.

### Net harvestable area

There are few data on the area of harvestable native forest on private land or other crown land for most States and Territories, and no data for leasehold land. Table 31 uses incomplete data to estimate the net harvestable area of native forest on the other crown land and private tenures.

### Standing timber volume

No national data on the timber volume occurring in native forests with tenure as private, other crown land, conservation reserve or leasehold land currently exist, and therefore cannot be summarised here.

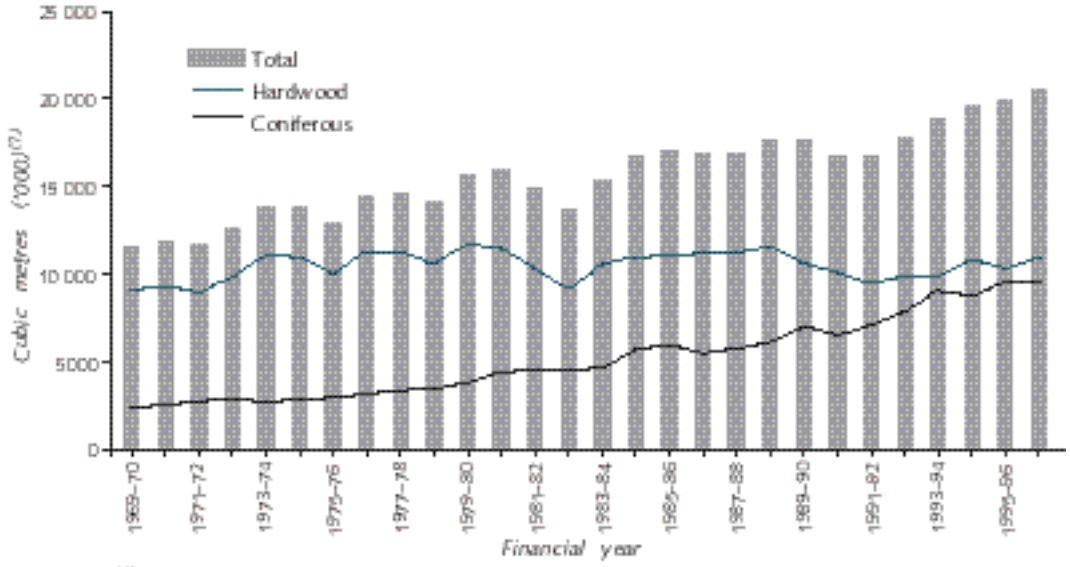
### Sustainable yield

With only a few known exceptions, sustainable yield estimates are not part of management on forests other than those with multiple-use tenure.

### Annual harvested volume

No data on annual harvested volume are available for forests with leasehold or other crown land tenures. Figure 19 shows the estimated production of sawlogs from private lands up to 1991, while Figure 20 shows how the harvest of sawlogs from private lands has declined as a proportion of the total harvest of native forest sawlogs in most States over the period 1951 to 1991.

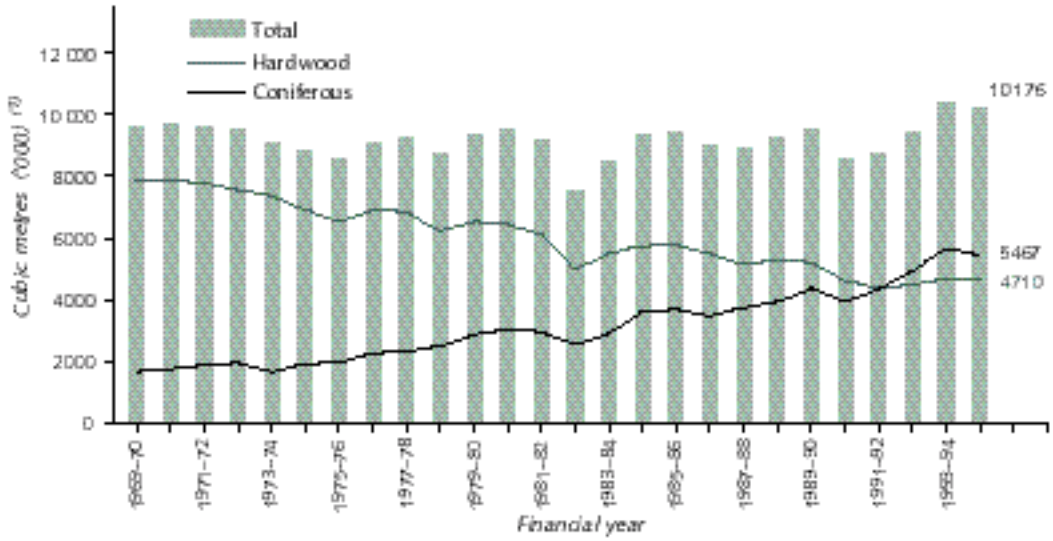
**Figure 16: Annual timber harvest from the Australian forest estate, 1969–70 to 1996–97**




(1) Gross roundwood equivalents

Sources:
Forest Resources (1975).
Australian Forest Resources (1976–1991).
Quarterly Forest Products Statistics (1992–1996).

**Figure 17: Annual sawlog harvest from the Australian forest estate, 1969–70 to 1995–96**




Notes:
Figure includes veneer timbers, sleepers and other products.
Data not published after 1994–95.
(1) Gross roundwood equivalent

Sources:
Forest Resources (1975).
Australian Forest Resources (1976–1991).
Quarterly Forest Products Statistics (1992–1996).

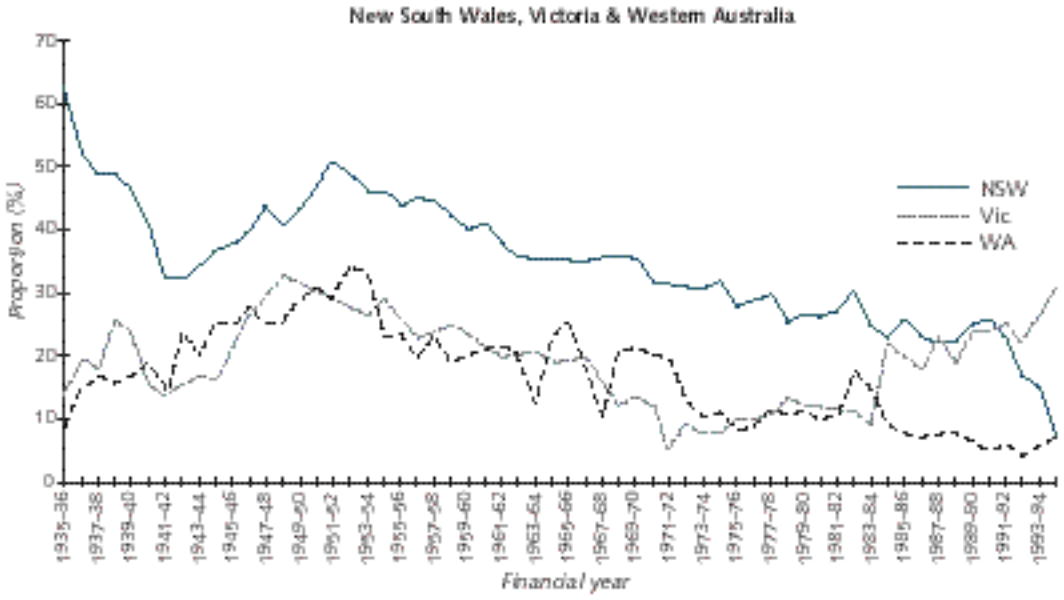
**Figure 18: Annual pulplog harvest from the Australian forest estate, 1969–70 to 1994–95**

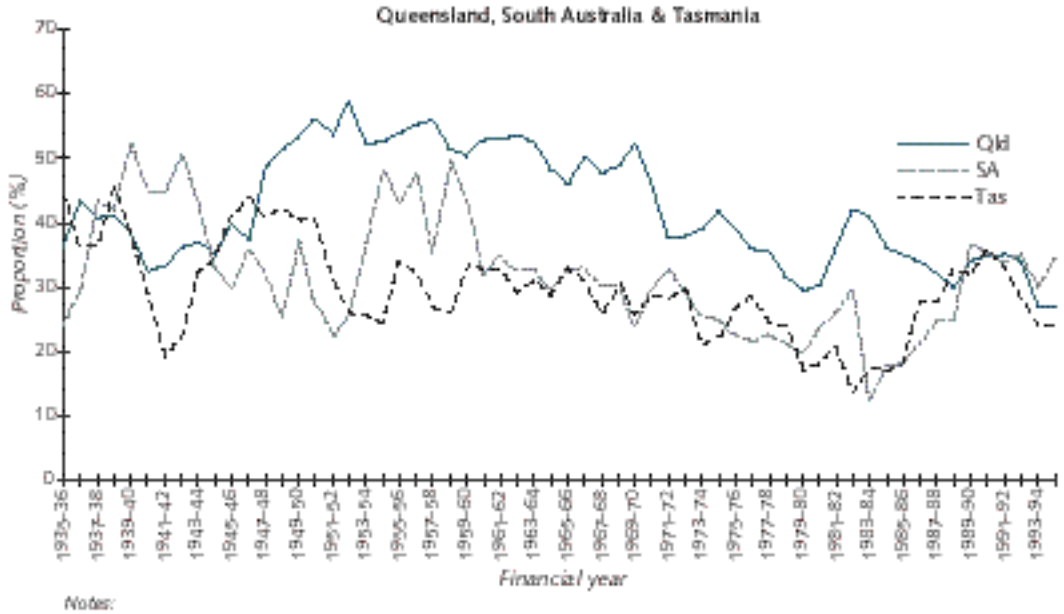

(1) Gross roundwood equivalent
Notes: Data is not published after 1994–95.
Sources:
Forest Resources (1975).
Australian Forest Resources (1976–1991).
Quarterly Forest Product Statistics (1992–1996).

**Figure 19: Production of sawlogs from public and private land, 1935–36 to 1990–91**


Sources:
Compendium of Australian Forest Product Statistics (1969).
Quarterly Forest Product Statistics and equivalents.

**Figure 20: Proportion of sawlogs from private land, 1935–36 to 1993–94**




*Notes:*
*Data not published after 1995–96.*
*Sources:*
*Compendium of Australian Forest Products Statistics (1968).*
*Forest Resources (1975).*
*Australian Forest Resources (1976–1991).*
*Quarterly Forest Products Statistics (1992–1996).*

# Timber from plantations

## Future yields

Forest managers traditionally use estimated future yields for describing potential plantation harvesting rather than timber volume of growing stock (future yields in native forests are based either solely on timber volume or a mixture of the two). A number of such estimates have been made based on a range of methods, assumptions and available data (some data are not widely available due to issues of commercial confidentiality). Table 35 shows one estimate of future yields from the softwood and hardwood plantation estates based on current plans for expansion. Other estimates vary by 10–20 per cent, due to differences in methods and available information.

**Table 35: Estimated future yield of plantation timber products, 1995–99 to 2035–39**

| | ('000 $m^3$/year) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Source** | **1995–99** | **2000–04** | **2005–09** | **2010–14** | **2015–19** | **2020–24** | **2025–29** | **2030–34** | **2035–39** |
| *Softwood* | | | | | | | | | |
| Pulpwood | 4 857 | 4 792 | 3 965 | 3 904 | 3 693 | 3 774 | 3 887 | 3 674 | 3 954 |
| Sawlogs | 5 530 | 6 904 | 8 334 | 7 857 | 8 137 | 8 582 | 8 982 | 8 663 | 8 956 |
| Veneer | 175 | 220 | 251 | 324 | 333 | 332 | 330 | 341 | 335 |
| **Total** | **10 462** | **11 916** | **12 550** | **12 085** | **12 163** | **12 688** | **13 199** | **12 678** | **13 245** |
| *Hardwood* | | | | | | | | | |
| Pulpwood | 687 | 2 344 | 3 821 | 5 922 | 6 901 | 8 626 | 9 228 | 9 867 | 10 330 |
| Sawlogs | 5 | 15 | 94 | 120 | 120 | 120 | 120 | 120 | 120 |
| **Total** | **692** | **2 359** | **3 915** | **6 042** | **7 021** | **8 746** | **9 348** | **9 987** | **10 450** |

*Note: Figures based on growers' plans for plantation expansion in January 1996*
*Source: National Plantation Inventory (1997).*

### Harvestable area

About 0.7 million hectares of plantations are managed by public forest agencies, and about 0.3 million hectares are privately owned. Taken together, Australia has a total harvestable plantation estate of just over 1 million hectares nationally.

### Annual harvested volume

Annual removal of softwood (which can be assumed to represent the plantation estate during the period, although a small proportion of softwoods originate from native forests) has risen steadily from nearly 2.5 million cubic metres (about 20 per cent of the total harvest) in 1970 to almost 9 million cubic metres (just under half the total harvest) in 1994 (Figure 16).

Figure 17 shows that the annual harvest of softwood sawlogs rose from 18 per cent of the total sawlog harvest in 1970 to 54 per cent in 1994. Figure 18 shows that the volume of softwoods directed towards the manufacture of pulp increased quite steadily in the same period, from just under three-quarters of a million cubic metres in 1970 to 3.3 million cubic metres in 1994.

## Grazing

Livestock grazing is the predominant form of land use over leasehold and privately owned forests, which comprise in excess of 108 million hectares or nearly 70 per cent of the total forest estate. Grazing is also practised widely on other crown land and in the multiple-use forests of Queensland and northern New South Wales. In Queensland, the Forestry Act specifically requires managers of the publicly owned forest estate to pay due regard to 'the benefits of permitted grazing'. Consequently, approximately 3.2 million hectares are currently grazed and have been in most areas since the late 1800s. In some circumstances, grazing by feral animals and native animals may affect forest health and structure.

There is an extensive body of literature relating to pasture and grazing productivity, only some of which relates to forested environments. Broadly based ecological studies are only now beginning to shed light on the ecological impacts and sustainability of grazing in Australian forests.

Depending on stocking rates, vegetation may be physically damaged or killed through excessive browsing, rubbing and crushing; soil may be compacted and eroded; water sources may be polluted; fire frequencies may be changed; vegetation may be cleared to enhance fodder production; and weeds may spread. Young trees and understorey species can be damaged, affecting recruitment and consequent forest structure.

In some circumstances, controlled grazing can be used to provide a cost-effective means of reducing fire hazard and controlling unwanted or surplus vegetation, particularly in cypress pine forests.

**Table 36: Proportion of forests managed for recreation and tourism, in relation to the total native forest area**

| Tenure category | Total area of forest and woodlands in Australia (excluding plantations) (ha)[4] | Area of forested land reported by States as managed for recreation (ha)[1] | Percentage of forested land managed for recreation(%)[1] |
|---|---|---|---|
| State forests | 13 350 989 | 10 584 513 | 79.28 |
| Nature conservation reserves | 17 580 191 | 10 825 947 | 61.58 |
| Other crown land | 15 596 781 | 11 966 731 | 76.73 |
| Private land[2] | 42 017 712 | 10 384 | 0.02 |
| Leasehold land[3] | 66 102 940 | | |
| Unresolved tenure | 1 186 035 | N/A | N/A |
| **Total** | **155 834 648** | **33 387 576** | **21.43** |

*Note: No data are available for the NT.*
*N/A – Not applicable.*
*(1) These totals represent the area available for recreation.*
*(2) Very little data was returned for this tenure.*
*(3) No States or Territories reported information regarding leasehold lands.*
*(4) National Forest Inventory (1997).*
*Sources: Montreal First Approximation Report (1997).*

# Tourism and recreation

The majority of urban Australians seeking forest-based recreation do so primarily in multiple-use forests and conservation reserves because these tenures are generally available for a wide range of recreation activities.

In principle, all public forested lands – except for some scientific reserves, cultural areas, or where current timber harvesting operations preclude it – are available for general recreation and tourism. However, data on public, leasehold or private forests managed for recreation are not available. Table 36 shows the area and percentage of forests available for general recreation and tourism, although these data are incomplete.

Table 37 shows the facilities available for forest-based recreation and tourism by tenure. The two most populous States, Victoria and New South Wales, have the greatest number of recreation facilities. South Australia, which is less populous and whose production forests are primarily pine plantations, reports the smallest number of facilities.

There is as yet no standard method for reporting visitor use of forested areas. Moreover, parks that offer both forest and non-forest facilities may collect data on the number of users at the point of entry but not on which attribute of the park was used. Table 38 shows the amount of visitor use that forests in national parks, multiple-use forests and other crown land received in 1995. These figures, while incomplete and of variable reliability, due partly to the factors noted, give some indication of the role that forests play in providing opportunities for recreation.

# Mining

Map 14 (see colour section in back of book) shows the known locations of mineral deposits on forested land. There are no nationally collated data on the amount of forest subject to mining or quarrying. Most mining activity in forests is restricted to access corridors and relatively small areas at the mine site. Some types of mine, such as surface mines for bauxite and coal, convert rather larger areas to non-forest, but most regenerate tree cover after mining ceases. The nature of the rehabilitation is usually different from the forest it replaced, although local species are often used.

## Table 37: Recreation and tourism facilities related to forests (partial summary)

| Tenure / Facility | ACT | | | | NSW | | | | NT | | | | Qld | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Facilities | | Trails | | Facilities | | Trails (1) | | Facilities | | Trails | | Facilities | | Trails | |
| | Number | Number per million of population | Kilometres | Kilometres per million of population | Number | Number per million of population | Kilometres | Kilometres per million of population | Number | Number per million of population | Kilometres | Kilometres per million of population | Number | Number per million of population | Kilometres | Kilometres per million of population |
| *Multiple-use* | | | | | | | | | | | | | | | | |
| Picnic sites with little development | 139 | 457 | | | 239 | 39 | | | ND | | | | 65 | 20 | | |
| Developed campsites with toilets | 5 | 16 | | | 112 | 18 | | | ND | | | | 31 | 9 | | |
| Visitor centres | 0 | 0 | | | 35 | 6 | | | ND | | | | 0 | 0 | | |
| "grandstand"developments > $1m | 0 | 0 | | | 1 | 0 | | | ND | | | | 0 | 0 | | |
| Walking Trails | | | 32 | 105 | 114 | 19 | (2) | | | | ND | | 620 | 189 | (2) | |
| *Conservation Reserves* | | | | | | | | | | | | | | | | |
| Picnic sites with little development | 6 | 20 | | | 281 | 46 | | | ND | | | | 144 | 44 | | |
| Developed campsites with toilets | 3 | 10 | | | 128 | 21 | | | ND | | | | 81 | 25 | | |
| Visitor centres | 1 | 3 | | | 14 | 2 | | | ND | | | | 19 | 6 | | |
| "grandstand"developments > $1m | 0 | 0 | | | 6 | 1 | | | ND | | | | 9 | 3 | | |
| Walking Trails | | | 184 | 605 | | | 1 296 | 212 | | | ND | | | | 986 | 301 |
| *Other* | | | | | | | | | | | | | | | | |
| Picnic sites with little development | ND | | | | ND | | | | ND | | | | ND | | | |
| Developed campsites with toilets | ND | | | | ND | | | | ND | | | | ND | | | |
| Visitor centres | ND | | | | ND | | | | ND | | | | ND | | | |
| "grandstand"developments > $1m | ND | | | | ND | | | | ND | | | | ND | | | |
| Walking Trails | | | ND | | | | ND | | | | ND | | | | ND | |
| *Private* | | | | | | | | | | | | | | | | |
| Picnic sites with little development | ND | | | | ND | | | | ND | | | | ND | | | |
| Developed campsites with toilets | ND | | | | ND | | | | ND | | | | ND | | | |
| Visitor centres | ND | | | | ND | | | | ND | | | | ND | | | |
| "grandstand"developments > $1m | ND | | | | ND | | | | ND | | | | ND | | | |
| Walking Trails | | | ND | | | | ND | | | | ND | | | | ND | |
| *Leasehold* | | | | | | | | | | | | | | | | |
| Picnic sites with little development | ND | | | | ND | | | | ND | | | | ND | | | |
| Developed campsites with toilets | ND | | | | ND | | | | ND | | | | ND | | | |
| Visitor centres | ND | | | | ND | | | | ND | | | | ND | | | |
| "grandstand"developments > $1m | ND | | | | ND | | | | ND | | | | ND | | | |
| Walking Trails | | | ND | | | | ND | | | | ND | | | | ND | |
| **Population ('000)(6)** | | | **304** | | | | **6 115** | | | | **174** | | | | **3 277** | |

| SA | | | | Tas | | | | Vic | | | | WA | | | | Australia[7] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Facilities | | Trails | | Facilities | | Trails | | Facilities | | Trails | | Facilities | | Trails | | Facilities | | Trails | |
| Number | Number per million of population | Kilometres | Kilometres per million of population | Number | Number per million of population | Kilometres | Kilometres per million of population | Number | Number per million of population | Kilometres | Kilometres per million of population | Number | Number per million of population | Kilometres | Kilometres per million of population | Number | Number per million of population | Kilometres | Kilometres per million of population |
| | | | | (3) | | | | | | | | | | | | | | | |
| 7 | 5 | | | 94 | 199 | | | 450 | 100 | | | 212 | 122 | | | 1 206 | 67 | | |
| 10 | 7 | | | 32 | 68 | | | 78 | 17 | | | 49 | 28 | | | 317 | 18 | | |
| 2 | 1 | | | 0 | 0 | | | 1 | 0 | | | 2 | 1 | | | 40 | 2 | | |
| 0 | 0 | | | 0 | 0 | | (4) | 1 | 0 | | | 2 | 1 | | | 4 | 0 | | |
| | | 15 | 10 | | | 700 | 1 480 | | | 250 | 56 | | | 1 711 | 988 | | | 2 708 | 319 |
| ND | | | | 11 | 23 | | | 900 | 200 | | | ND | | | | 1 342 | 91 | | |
| ND | | | | 53 | 112 | | | 350 | 78 | | | ND | | | | 615 | 42 | | |
| ND | | | | 4 | 8 | | | 10 | 2 | | | ND | | | | 48 | 3 | | |
| ND | | | | 6 | 13 | | (5) | 2 | 0 | | | ND | | | | 23 | 2 | | |
| | | ND | | | | 2 849 | 6 023 | | | 2 400 | 533 | | | ND | | | | 7 715 | 526 |
| ND | | | | 26 | 55 | | | 1 800 | 400 | | | ND | | | | 1 826 | 367 | | |
| ND | | | | 37 | 78 | | | 600 | 133 | | | ND | | | | 637 | 128 | | |
| ND | | | | 1 | 2 | | | 50 | 11 | | | ND | | | | 51 | 10 | | |
| ND | | | | 1 | 2 | | | 5 | 1 | | | ND | | | | 6 | 1 | | |
| | | ND | | | | (5) | | | | 1 000 | 222 | | | ND | | | | 1 000 | 222 |
| ND | | | | ND | | | | ND | | | | ND | | | | ND | | | |
| ND | | | | ND | | | | 200 | 44 | | | ND | | | | 200 | 44 | | |
| ND | | | | ND | | | | 2 | 0 | | | ND | | | | 2 | 0 | | |
| ND | | | | ND | | | | ND | | | | ND | | | | ND | | | |
| | | ND | | | | ND | | | | ND | | | | ND | | | | ND | |
| ND | | | | N/A | | | | ND | | | | ND | | | | ND | | | |
| ND | | | | N/A | | | | ND | | | | ND | | | | ND | | | |
| ND | | | | N/A | | | | ND | | | | ND | | | | ND | | | |
| ND | | | | N/A | | | | ND | | | | ND | | | | ND | | | |
| | | ND | | | | N/A | | | | ND | | | | ND | | | | ND | |
| | 1 474 | | | | 473 | | | | 4 502 | | | | 1 732 | | | | 18 054 | | |

*Footnotes from table 37*

*Notes: Column or row total may not add up due to rounding.*
*ND - No data*
*N/A - Not applicable*
*MUF - Multiple Use Forests*
*(1) Does not include management trails used by walkers.*
*(2) New South Wales and Queensland MUF walking trails are reported in number rather than kilometres.*
*(3) Defined as any area which has any more facilities than a carpark eg. interpretation, tracks, picnic tables—sites with little infrastructure or development.*
*(4) Approximate length.*
*(5) Trails on Other Crown Land have been included with Nature Conservation Reserves.*
*(6) Australian Bureau of Statistics (1997) Year book Australia, 1995 data.*
*(7) Averages are calculated for states with data only.*
*Source: Montreal First Approximation Report (1997).*

**Table 38: Visitor use of forests in 1995**

| | Number of visitor days in 1995 ('000) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Tenure** | **ACT** | **NSW** | **NT** | **Qld** | **SA** | **Tas** | **Vic** | **WA** | **Australia** |
| Conservation reserves | 140 | 20 148 | | 701 | ND | 900 | 12 960 | | 34 708 |
| Multiple-use | 735 | 4 000 | | 2 000 | 180 | 400 | 3 500 | | 10 080 |
| Other | ND | ND | | ND | ND | 500 | 30 000 | | 30 500 |
| **Total** | **875** | **24 148** | | **2701** | **180** | **1800** | **46 460** | **960** | **76 248** |

*ND - No data*
*Source: Montreal First Approximation Report (1997).*

**Table 39: Estimated total forest biomass and carbon pool**

| Forest type | Forest area (ha) | Average biomass weighted by area (tonnes/ha) | Total forest ecosystem biomass (million tonnes) | Total forest eco-system carbon pool (million tonnes) | Published source |
|---|---|---|---|---|---|
| Closed forest | 4 627 299 | 377 | 1 744 | 873 | 1 |
| Open forest | 39 174 675 | 245 | 9 616 | 4 809 | 1, 2 |
| Woodland | 112 032 674 | 131 | 14 652 | 7 327 | 1, 2 |
| Plantation | 1 042 570 | 244 | 254 | 127 | 3 |
| **Total** | **156 877 218** | **167** | **26 266** | **13 136** | |

*1 = Gifford et al. (1992).*
*2 = Grierson et al. (1992).*
*3 = National Plantation Inventory (1997); National Greenhouse Gas Inventory (1996).*
*Source: Montreal First Approximation Report (1997).*

# Other forest uses and products

There are no national, State or Territory processes for systematically recording the use of non-wood forest products. Many native forests and some plantations are used for the production of firewood. The quantity of firewood extracted is significant. It has increased steadily from 6.8 million tonnes in 1988 to 8.1 million tonnes in 1995.

Exotic honeybees are widespread in the forests of all States except South Australia, often supporting industries based on honey and beeswax. In some areas, honeybees pollinate native forest tree species during part of the year and agricultural crops at other times. Australian wildflower, foliage and live-plant sales, including many species from forests, have reached significant levels, both domestically and internationally. Australian bush foods and bush medicines are also growing in popularity.

Some animal species are also being used commercially: for example, the brushtail possum is harvested in Tasmania under an approved management plan. Other non-timber products harvested from forests include berries and game.

Awareness of the economic potential of non-wood forest products such as these is growing, but information about them is generally available by product sector (such as honey production) rather than by the vegetation type from which they originate. Thus, it is difficult to distinguish forest from non-forest production.

## Contribution to the carbon cycle

Observed levels of atmospheric carbon dioxide ($CO_2$) have increased globally from 280 parts per million in 1750 to over 350 parts per million in the 1990s. The majority of this additional $CO_2$ has been emitted through the burning of fossil fuels and clearing of vegetation, particularly in tropical regions, and has been accelerated by industrial development and population growth. The weight of scientific evidence suggests that increased levels of atmospheric $CO_2$ and other greenhouse gases such as methane cause an 'enhanced greenhouse effect' that may lead to global climate change.

Australia's forests are estimated to store 13.1 billion tonnes of carbon (Table 39). Although most forests are absorbing carbon through growth, carbon is also released to the atmosphere through processes of decomposition. The rate of carbon absorption, and hence the magnitude of the carbon sink, is greatest in the earliest stages of regeneration and declines as forests mature. Substantial contributions of carbon to the atmosphere occur through clearing and burning.

Estimating Australia's $CO_2$ sinks and emissions from forest management and clearing is made difficult by numerous uncertainties in the data. Australia's most recent national greenhouse gas inventory (NGGI) report was produced in 1997; it estimated that land use change and forest management activities caused the annual release of 75 million tonnes of $CO_2$ (or $CO_2$ equivalents) into the atmosphere. This estimate was considerably lower than the 1990 NGGI estimate of 153 million tonnes, due mainly to reduced vegetation clearing and a revision of the estimates of carbon in the vegetation removed. The greatest proportion of emissions in the forest sector is due to permanent clearing of forest in favour of other land uses.

Table 40 presents data on the contribution of multiple-use forests to global atmospheric carbon reported in 1997. These suggest that such forests were a net sink in that year, absorbing a net amount of about 19.5 million tonnes of $CO_2$.

**Table 40: Contribution of multiple-use forest growth and harvesting to global atmospheric carbon**

| Contribution | Emissions ('000 tonnes) C | $CO_2$ |
|---|---|---|
| Total annual growth increment | -20 396 | -74 786 |
| Total annual harvest | +13 462 | +49 361 |
| Net emissions | -6 394 | -25 425 |

*Note: Negative values indicate net absorption from the atmosphere; positive values indicate net additions to the atmosphere.*
*Source: National Greenhouse Gas Inventory Committee (1997).*

## Fire

Australia is particularly fire-prone due to the nature of its vegetation and climate. Variation in climates and soils produces forests with different rates of fuel accumulation and flammabilities and different ignition frequencies. Wet forests can have a high fuel load but a low probability of ignition; woodlands in northern Australia can have low fuel loads but frequent fires due to high levels of ignition during the dry season. Within a region, different locations can experience different fire intensities and frequencies.

Fire regimes have varied over geologic time. The wetter, rainforest-clad continent of 45 million years ago has dried out. The vegetation has changed to a sclerophyllous flora in many

areas and fire frequency (time between fires) and intensity have increased. Climatic oscillations produce drier periods with opportunities for fire and the contraction of wetter plant communities; these communities expand during wetter periods with few fires.

Indigenous occupation increased the frequency of fire as Indigenous peoples used fire as a tool to assist hunting and other activities. This deliberate burning appears to have been highly selective – frequent in some areas and virtually absent in others. European settlement altered existing fire regimes, initially through increased fire frequency associated with land clearing and, more recently, through large-scale hazard-reduction and other burning to assist with fire suppression in settled areas and to achieve forest management objectives, such as removing debris before forest regeneration and managing habitat. In some areas, such as conservation reserves, fire has been artificially excluded, which also has impacts on forest structure and diversity. There is debate over the extent to which present-day fire regimes reflect the regimes in place in pre-European times.

The frequency of hazard-reduction burning mainly depends on the forest type, fuel accumulation and the location of forests in relation to assets. It ranges from a 2-year interval for northern woodlands to 6–8 years in some dry eucalypt forest. Most agencies managing forests use a flexible approach to burn rotations and burning season.

## Ecological effects

The ecological effects of a given fire regime vary depending on intensity, frequency, the season of burn and the nature of the forest. Plants and animals in any particular region have evolved with the pre-existing fire regime, so alterations to this regime may have ecological impacts. In temperate fire-prone forests, a single high-intensity fire may have less long-term impact on the biota than several low-intensity fires in quick succession. In rainforests, a single fire can cause local extinctions. In some eucalypt forests, fuel build-up during a long period without fires can lead to high-intensity fires, while long-unburnt forest areas are crucial as habitat for some fauna and flora. The northern woodlands are adapted to high-frequency, low-intensity fires.

A characteristic of fire in the Australian landscape is its great spatial and temporal variability. In any single fire event, whether a wildfire or a prescribed fire, there is considerable variation in fire intensity, and some areas do not burn at all. These unburnt areas can be important refugia for some plants and animals, allowing the recolonisation of burnt areas.

Many Australian plant species have adapted to survive a wide range of fire regimes, having features such as woody fruits, hard-coated seeds and epicormic buds protected by thick bark or lignotubers located below ground. Most eucalypts readily survive fire, and some may require it periodically for their continued persistence. Periodic fire is also important for the regeneration of hard-seeded *Acacia* and other legume species that are important for nitrogen recycling and replenishment.

The site and weather conditions following fire are also important factors that help determine the species of plants that survive the fire. For example, ash on the ground and increased exposure to light and warmth create a situation in which regrowth from seed will be stimulated if good rains occur soon after fire. However, if germination is not initiated quickly, seed predation may alter forest composition.

## The extent of fire

There are no consistent continental-scale data on the amount of forest burned annually by either bushfire or prescribed burning: statistics for this were reported until recently, but their collection was discontinued because of problems with consistency and meaning.

# Forest health

Animal pests, weeds and pathogens can cause degradation of forests, even to the extent of changing their structure and species composition on a long-term basis. They can also change the capacity of the forest to provide clean water or defect-free timber and to act as habitat for native flora and fauna. Control measures are often difficult, costly or impractical.

Australia's native forests are affected by a range of indigenous pests and pathogens, the

## Box 11: Fire disasters

On 27 December 1790, two years after the British settled in Sydney, the first recorded 'blow-up' or fire disaster occurred, giving the new settlers a taste of the hazards posed by Australia's fire-prone environment.

In the last 60 years, several bushfires have caused levels of loss and damage that have profoundly affected Australian society. Some of the most devastating were:

| | |
|---|---|
| 1939: | Black Friday bushfires in Victoria |
| 1951–52: | summer bushfires in south coastal New South Wales |
| 1957: | bushfires in the Blue Mountains, New South Wales |
| 1961: | Dwellingup bushfires, Western Australia |
| 1967: | 7 February bushfires in Tasmania |
| 1968: | severe widespread fires in coastal New South Wales |
| 1983: | Ash Wednesday bushfires in Victoria and South Australia |
| 1994: | bushfires surrounding Sydney. |

The losses in these fires have been considerable. For example, in the Ash Wednesday fires, 77 people were killed, and 2528 houses, 5 sawmills and 23 000 hectares of plantation timber were destroyed. The direct cost was estimated to be $400 million.

In January 1994, fires in eastern New South Wales burned more than 800 000 hectares of forest, prompting the largest fire suppression operation in Australia's history. Fires burned through urban parkland to within 7 kilometres of Sydney's central business district. Four people died in the fires and 205 properties were burnt.

populations of which may fluctuate depending on the growth stage of the forest and climatic conditions. They may cause damage ranging from short-term reductions in growth rate to the killing of trees, leading to progressive stand degeneration. Some native animals (such as possums) may cause defoliation while others (such as wallabies) may reduce the success of regeneration. Conversely, the loss or diminution in range or abundance of some species, particularly those that play key roles in ecosystem processes within the forest, may adversely affect forest health.

Native forests may be invaded by organisms that have been introduced to Australia. These include various weed species that may invade communities and displace native species, fungal species such as *Phytophthora cinnamomi* that may kill a wide range of understorey and overstorey species (leading to changes in structure and species composition of the forest), and exotic animals such as foxes and feral cats that can decimate populations of native animal species. These introduced species can impact on the conservation and commercial values of forests: appropriate international quarantine measures are necessary to limit further introductions of organisms that may adversely affect the health of forest communities.

Exotic tree species used in plantation forestry in Australia (mainly *Pinus* species) have been maintained relatively free of pests and diseases. A small number of insects and pathogens (such as the Sirex wasp, *Dothistroma* needle cast, and several species of bark beetles) have been introduced accidentally from overseas; these can cause tree death and growth losses. Native species of insects or pathogens are not known to have adapted to exotic plantation species to the extent of causing serious damage.

Determining the extent to which pests and pathogens affect forest health is of considerable importance in assessing the state of the forests, but it is also an extremely difficult task. Currently, there are no quantitative national data on the pest and pathogen impacts that occur in Australia's forests. However, there are national threat abatement plans being prepared for serious pests such as foxes and diseases such as *P. cinnamomi*.

For this report, conservation and production forest agencies in every State and Territory were asked to identify animal and plant pests in the forests they manage and to assign a subjective score of severity. Private forest and plantation owners were not surveyed.

The agency responses, along with additional information taken from their annual reports, have been summarised by State and Territory in Table 41, which lists some of the major animal pests that occur in Australian forests, and Table 42, which lists some of the major plant pests negatively affecting the forests. Scientific names are given alongside common names in the tables.

Some consequences of major pests and diseases are discussed below.

## Dieback in native forests

Dieback is a frequently used term in relation to forest health. A number of specific pests and pathogens cause non-specific crown symptoms of progressive shoot, twig and branch dieback. Likewise, our forests are sometimes affected by dieback resulting from a complex interaction of factors, none of which is necessarily the primary cause. Combinations of factors associated with dieback include some or all of drought, exposure to frost and heat through clearing, soil and water changes through pasture management, insect defoliation, secondary pathogens and tree age. Lack of regeneration through grazing may prevent stand replacement when the stress factors abate. The term 'dieback' should be restricted to those conditions of complex origin where there is not necessarily one primary cause of disease.

Dieback of non-specific origin occurs in forests and undoubtedly occurs in all States and Territories from time to time. Notable examples of diebacks of complex origin include regrowth dieback of ash-type eucalypts in parts of Tasmania in the 1960s and 1970s; and dieback of mixed eucalypt woodlands and scattered trees in the tablelands of eastern Australia from southern Queensland to Victoria, extending into Gippsland and drier areas of central Tasmania. An extreme example of such a syndrome in the northern tablelands of New South Wales in the 1960s and 1970s was called New England dieback.

## Major pathogens in native forests

Two of the most widespread pathogens in Australia, *Phytophthora* and *Armillaria* species, cause dieback-like diseases. *Phytophthora*, especially *P. cinnamomi* or cinnamon fungus, which was probably introduced not long after European settlement, is extremely damaging. This fungus causes the roots of trees and other plants to rot, often to such an extent that the plant dies because it is unable to obtain sufficient moisture from the soil to survive. In highly susceptible genera (such as *Banksia*, *Grevillea* and *Dryandra*), over 80 per cent of individuals may die. *P. cinnamomi* is widespread in the *Eucalyptus marginata* (jarrah) forests, heaths and coastal sand plain vegetation of south-west Western Australia. Together with some other *Phytophthora* species, it causes serious disease in low-elevation forests and heath communities in southern Victoria and Tasmania.

Native *Armillaria* species also cause significant problems in south-eastern Australia and south-west Western Australia: many eucalypt and understorey species are vulnerable to infection and killing. *Armillaria luteobubalina*, a native fungus, is the most widespread. It is considered to be the primary cause of dieback in the mixed species dry forests of central Victoria and is damaging *E. diversicolor* (karri), *E. marginata*, *E. wandoo* (wandoo) and coastal dune forests in south-west Western Australia and drier forests in eastern Tasmania. It also affects orchards and amenity trees in various parks and gardens around the country. Other *Armillaria* species may be involved in other dieback syndromes, where they act as secondary pathogens, killing trees stressed by drought or insect defoliation.

Leaf pathogens are very common in eucalypt forests. They may cause extensive defoliation under some seasonal conditions, but generally do not cause long-term problems. Foliage fungi may also cause losses in plantations. Although most concern has been for the potential impacts of *Mycosphaerella* foliar disease on *E. globulus* (Tasmanian or southern blue gum) plantations, a severe epidemic occurred in *E. nitens* (shining gum) plantations in north-west Tasmania in 1996. *Aulographina eucalypti*, another fungus associated with defoliation and severe leaf spotting, was reported to be a problem in some eucalypt

plantations in higher rainfall areas of New South Wales. This species has also been associated with occasional significant defoliation events in some forests in south-eastern Australia.

In cool temperate rainforests in Tasmania and Victoria, the dominant tree species *Nothofagus cunninghamii* (myrtle beech) can be affected by a sapstreak disease caused by the native fungus *Chalara australis*. The pathogen is dispersed aerially and by root contact and kills patches of trees, leading to subsequent regeneration of the affected areas by *N. cunninghamii* and other rainforest species.

## Pathogens in plantations of exotic species

Needle blight or needle cast disease caused by the fungal pathogen *Dothistroma septospora* is widespread in eastern Australia and has been locally severe in *Pinus radiata* plantations in New South Wales and north-eastern Victoria. Unlike in New Zealand, where the higher annual rainfall and more consistent seasonal distribution of precipitation favours epidemic disease every year, *Dothistroma* needle blight in Australia has required relatively infrequent control measures. The disease can be controlled efficiently by aerial application of fungicide; in addition, growers in high hazard areas are moving to *Dothistroma*-resistant genotypes developed in New Zealand.

*Cyclaneusma minus* causes needle cast in *P. radiata*. Disease severity is variable and is highest in cool, moist environments. *Sphaeropsis sapinea* is also widely distributed in pine plantations, causing shoot death in crowns of all age-classes, and is typically most severe after stem damage caused by fire, insects, mechanical wounds, hail or drought. The fungus also causes blue stain of timber after harvest. Root rots caused by both native and introduced pathogens may be locally important.

## Nursery diseases

Numerous pathogens may affect planting stock grown in nurseries. They may cause damping-off, root rot and defoliation of both hardwood and softwood species. Important genera include *Fusarium*, *Phytophthora*, *Pythium* and *Botrytis*. These problems are controlled by a combination of nursery hygiene, nursery management and chemical application.

## Weeds

Nationwide, 48 plants are widespread or serious pests in native production forests and plantations. Of these, *Rubus fruticosus* (blackberry) is the most extensive and damaging, occurring in every State and Territory except the Northern Territory. Rubber vine (*Cryptostegia grandiflora*), originally a native of Madagascar, now densely covers more than 700 000 hectares of land in tropical and sub-tropical Queensland and threatens dry rainforest remnants in the monsoonal belt. Gamba grass (*Andropogon gayanus*) is considered to pose a risk to some woodlands and forests in the Northern Territory by virtue of its ability to drastically alter fire ecology.

Species of several Australian genera, particularly *Acacia*, *Eucalyptus*, *Melaleuca* and *Leptospermum*, are widespread in pine plantations and are often regarded as weeds there.

## Insect pests

A number of native and exotic insects are considered pests in plantations and native forests managed for timber production. These can be grouped into broad categories:

- *Defoliators and leaf miners*: many moth, beetle and sawfly species eat eucalypt leaves, particularly new growth, at some stage of their life cycle. For this reason, they can sometimes cause extensive damage in young plantations and regrowth forests, as well as harm young trees in mature forests.
- *Sap-suckers*: this group of insects comprises two broad types: scale insects and psyllids that secrete protective coverings (lerps), and bugs. Scale insects may also secrete ant-attracting honeydew which, in turn, may promote fungal growth. Psyllids defoliate some tree species by sucking the sap from growing shoots, often infesting frost-damaged trees.
- *Wood and bark borers*: some insects eat the wood of trees or set their larvae in it. Wood boring pests in Australia include termites and the larvae of beetles, moths and wasps.

Some exotic species used by industry may have deleterious ecological effects. Exotic honeybees (*Apis mellifera*), for example, may compete

## Table 41: Animal pests in Australian forests, by State and Territory.

| | ACT | NSW | NT | Qld | SA | Tas | Vic | WA |
|---|---|---|---|---|---|---|---|---|
| **Mammals** | | | | | | | | |
| Cats | ★ | – | – | ◆ | – | * | – | ★ |
| Deer | – | – | – | * | * | – | ■ | – |
| Dingoes | ■ | ■ | * | ■ | – | – | * | – |
| Dogs | ■ | ■ | ■ | ■ | – | – | * | – |
| Donkeys | – | * | ■ | * | – | – | – | – |
| Foxes | ◆ | ★ | * | ◆ | ■ | – | ■ | ◆ |
| Goats | * | * | ■ | ■ | * | *** | * | – |
| Hares | ■ | * | – | ■ | ◆ | – | * | – |
| Horses | *** | – | – | – | – | – | * | – |
| Kangaroos | ◆ | ■ | ■ | ■ | ■ | – | ■ | – |
| Mice | ■ | ■ | ■ | ■ | ■ | – | * | – |
| Other | – | ■ | – | – | – | – | – | – |
| Pademelons | – | ■ | – | ■ | – | ★ | – | – |
| Pigs | ◆ | ■ | ◆ | ◆ | – | – | * | ■ |
| Possums | ■ | ■ | ■ | ■ | * | ◆ | * | – |
| Rabbits | ◆ | ★ | ■ | ■ | ◆ | ★ | ■ | ■ |
| Rats, exotic | ■ | * | ■ | * | * | – | – | * |
| Rats, native | * | * | ■ | ★ | – | ★ | ■ | – |
| Wallabies | * | ■ | ■ | ★ | ■ | ◆ | ◆ | * |
| **Invertebrates** | | | | | | | | |
| Army worms (Noctuids) | – | * | ■ | * | – | * | – | * |
| Autumn gum moth (*Mnesampela privata*) | * | ■ | – | – | – | – | – | – |
| Bees | ★ | – | ■ | ■ | – | ■ | ■ | ■ |
| Beetle, African black | – | * | – | * | – | – | – | – |
| Beetle, Christmas (*Anoplognathus spp*) | ■ | ★ | ■ | ■ | – | * | ■ | – |
| Beetle, five-spined bark (*Ips grandicollis*) | * | * | – | ★ | ★ | – | – | ■ |
| Beetle, leaf / flea (Chrysomelids) | – | ■ | ■ | ■ | – | ◆ | ■ | * |
| Beetle, longicorn (Cerambycids) | – | – | – | – | – | – | – | ■ |
| Beetle, white fringe | – | * | – | ■ | – | * | – | – |
| Borers | – | – | – | – | – | – | ★ | – |
| Borers (Cerambycids) | – | ■ | – | – | – | * | – | – |
| Budworm | – | – | ■ | * | – | * | – | * |
| Cup moths (Limacodids) | – | ■ | – | – | – | – | – | – |
| Cut worm | – | – | – | * | – | – | – | – |
| Grasshoppers (Acridids) | * | – | ■ | ◆ | ■ | ■ | * | ◆ |
| Gumleaf skeletoniser (*Uraba lugens*) | – | ■ | – | – | – | – | ★ | * |
| Leaf miner | * | – | ■ | * | – | ■ | ■ | ◆ |
| Lerps (Psyllids) | ★ | ★ | ■ | ■ | – | ■ | ◆ | * |
| Millipedes | * | – | ■ | – | – | ■ | ■ | – |
| Mosquitoes (Culicids) | * | – | ■ | ■ | – | ■ | ■ | ■ |
| Saw fly (*Perga dorsalis, Pergagrapta bella*) | – | ■ | – | – | – | – | – | * |
| Stick insects (Phasmatids) | * | * | ■ | ■ | – | * | * | * |
| Termites (*Cryptotermes* spp, *Coptotermes* spp) | – | – | – | – | – | – | ◆ | ■ |
| Wasp, European (*Vespula germanica*) | ■ | – | ■ | – | – | ★ | * | – |
| Wasp, Sirex (*Sirex noctilio*) | ■ | ■ | – | * | ◆ | ■ | *** | – |
| Weevils (Curculionids) | * | – | ■ | ■ | – | ■ | ■ | * |
| Wingless grasshoppers (Acrididads) | * | * | – | * | ■ | – | * | * |
| **Birds** | | | | | | | | |
| Blackbirds | ◆ | * | – | – | – | – | * | – |
| Brush turkeys | – | – | – | ■ | – | – | – | – |
| Cockatoos | – | – | – | – | – | – | ■ | – |
| Indian mynahs | ■ | – | – | – | – | – | – | – |
| Parrots | – | – | – | – | – | – | – | ◆ |
| Starlings/sparrows | * | * | – | ◆ | – | – | * | – |
| **Amphibians** | | | | | | | | |
| Cane toads | – | * | * | ◆ | – | – | – | – |

* *Occurs, but is not widespread, has little impact and requires little or no control*
*** *Extent and impact is limited, but control measures are extensive*

– *Not reported*
■ *Widespread or impacting adversely*
★ *Widespread and impacting adversely*
◆ *Very widespread and having severe adverse impact*

## Table 42: Plant pests in Australian forests, by State and Territory

| | ACT | NSW | NT | Qld | SA | Tas | Vic | WA |
|---|---|---|---|---|---|---|---|---|
| Bathurst burr *(Xanthium spinosum)* | | | | ★ | | | * | |
| Bone seed | – | * | – | * | ■ | * | * | – |
| Boxthorn, African *(Lycium ferocissimum Miers)* | *** | – | – | – | – | – | – | – |
| Bracken fern *(Pteridium esculentum)* | ■ | – | – | ■ | ◆ | ■ | ■ | – |
| Briar - Blackberry *(Rubus fruticosus)*† | ◆ | ◆ | – | ■ | * | ★ | ◆ | ■ |
| Briar *(Rosa rubiginosa)* | ★ | *** | – | – | – | * | – | – |
| Broadleaved weeds | * | – | ■ | ◆ | ★ | * | – | – |
| Broom / Brome †† | *** | ★ | – | – | ■ | ■ | * | – |
| Cobbler's Peg / Canadian Fleabane *(Erigeron canadensis)* | – | – | – | ★ | – | – | – | – |
| Cotoneaster | ★ | – | – | – | – | – | – | – |
| Crofton weed / Mist-Flower *(Eupatorium spp)*† | – | * | – | ◆ | – | – | – | – |
| Dodder / Australian Dodder *(Cuscuta australis)* | – | *** | ■ | ■ | – | – | ■ | – |
| Eucalypt *(Eucalyptus spp)* | – | – | ■ | ■ | ■ | – | – | – |
| Garden escapees *(non-specific)*† | ★ | – | * | – | – | * | ■ | – |
| Gorse *(Ulex europaeus)*† | – | – | – | – | ■ | ★ | ■ | – |
| Grasses, exotic *(unidentified)*† | ★ | *** | ■ | ◆ | ★ | * | * | ★ |
| Grasses, gamba *(Andropogon gayanus)* | – | – | ★ | – | – | – | – | – |
| Grasses, giant rats tails | – | – | – | ◆ | – | – | – | – |
| Grasses, kikuyu | * | – | – | ■ | – | – | * | – |
| Grasses, native | – | – | ■ | ◆ | – | ■ | – | * |
| Grasses, pampas† | * | – | – | – | – | ■ | * | – |
| Grasses, serrated tussock *(Nassella trichotoma)*† | * | *** | – | – | – | – | * | – |
| Grasses. other | – | – | – | – | – | – | ■ | – |
| Groundsel bush *(Baccharis halimofolia)*† | – | * | – | ■ | – | – | ■ | – |
| Horehound *(Marrubium vulgare)*† | – | * | ◆ | – | – | – | – | – |
| Lantana *(Lantana camara)*† | – | ■ | * | ◆ | – | – | * | – |
| Melaleuca | – | – | * | ■ | – | – | – | – |
| Mimosa† | – | – | ◆ | – | – | – | – | – |
| Mistletoe | * | – | – | – | – | – | ■ | – |
| Noogoora burr *(Xanthium spp.)*† | – | *** | ■ | ◆ | – | – | – | – |
| Paterson's curse / Salvation Jane *(Echium plantagineum)*† | * | * | | | ■ | | * | |
| Pines *(Pinus spp)* | ◆ | – | – | * | ■ | * | ■ | * |
| Ragwort *(Senecio jacabaea)* | – | – | – | – | – | ■ | *** | – |
| She-Oak *(Casuarina)* | – | – | * | ■ | – | – | – | * |
| Sollya heterophylla | – | – | – | – | ■ | – | – | – |
| St John's Wort *(Hypericum perforatum augustifolium)*† | * | *** | – | – | – | * | ■ | – |
| Stinging nettle / Dwarf nettle *(Urtica urens)* | * | – | – | ■ | – | – | – | – |
| Sweet briar *(Rosa rubiginosa)*† | – | – | – | – | – | – | ■ | – |
| Tea tree *(Leptospermum)* | – | – | * | ■ | – | – | ■ | – |
| Thistle *(many spp)* | * | *** | – | – | *** | ■ | ■ | * |
| Tree of heaven *(Ailanthus altissima)* | *** | – | – | – | – | – | – | – |
| Vines, creepers - Bridal | – | – | – | – | ■ | – | * | – |
| vines/creepers | – | – | * | ■ | – | * | * | – |
| Wattles *(Acacia spp)* | * | ■ | * | ■ | ■ | ■ | ■ | * |
| Willow *(Salix spp)* | ★ | – | – | – | – | ■ | * | * |
| Others | ■ | – | – | – | – | – | – | – |

* *Occurs, but is not widespread, has little impact and requires little or no control*
*** *Extent and impact is limited, but control measures are extensive*

– *Not reported*
■ *Widespread or impacting adversely*
★ *Widespread and impacting adversely*
◆ *Very widespread and having severe adverse impact*

† *Garden escapees including -*
*Ox-eye daisy* (Chrysanthemum leucanthemum)
*Calliopsis/Coreopsis* (Coreopsis lanceolata)
*Prickly pear* (Opuntia spp)
*Water hyacinth* (Eichhornia crassipes)
*One-leaved Cape Tulip* (Humeria breyniana)
*Blue Morning Glory* (Ipomoea indica)
*Groundsel, variable/fireweed* (Senecio lautus)

†† *Broom / Bromes including -*
*Great Brome* (Bromus diandrus), *soft* (B. molliformis),
*Madrid* (B. madritensis), *red* (B. rubens),
*Cape Broom* (Teline monspessulana)
*Chess or Choat* (B. secalinus)

*Source: National Forest Inventory (1997).*

with indigenous bees and other native pollinators and limit pollination of some native forest plant species.

### Vertebrate pests

Several native and introduced browsing animals are regarded as pests in regrowth forests and plantations. Of the introduced species, rabbits are the most destructive, causing damage to both eucalypts and pines, although goats, hares and rats also cause serious damage in some places. Among the native animals, kangaroos, pademelons, possums, native rats and wallabies are all extensive and sometimes serious browsing pests in regenerating native forests and eucalypt plantations.

Many mammals are regarded as pests in forests in which a major land use is grazing. Deer, donkeys, goats, horses, kangaroos, mice, rabbits, rats and wallabies all may compete for resources with livestock, while young, sick or injured sheep and cattle are vulnerable to predation by dingoes, foxes and wild dogs.

Foxes and cats are regarded as serious pest species in many forests. They kill significant numbers of native animals, radically altering faunal community structure and threatening the survival of some species. The now greatly reduced number of specialised native animals that feed on and disperse certain soil fungi has suggested disruptions to ecological processes involving these fungi and other ecologically related organisms.

Birds can damage trees by stripping bark from branches and shoots – often destroying the lead shoot – and by ringbarking young shoots. While this type of damage has little effect on mature trees, it can cause extensive damage to young growth in native production forests and plantations, leading to sapling loss, stunting and deformity.

Galahs (*Cacatua roseicapilla*) remove bark from their nest trees; their distribution and abundance has increased, principally in response to increased availability of crops and water. In Western Australia, preliminary studies of damage caused to new *E. globulus* plantations by parrots known as twenty-eights *(Barnardius zonarius*) indicate that silvicultural treatment to rectify all except severe damage may be economically viable.

## Chemical use in forests

Where feasible, non-chemical control measures are used to control pests, feral animals, weeds and pathogens in forests. Nevertheless, the use of chemicals in some circumstances is unavoidable, although such use may have unintended consequences for other forest values.

Chemicals used in agriculture and forestry are registered and regulated up to the point of retail sale by the National Registration Authority for Agricultural and Veterinary Chemicals, a Commonwealth statutory authority established in 1993. Control-of-use programs run in each State and Territory aim to ensure that insecticides, fungicides, herbicides and other chemicals are used safely and appropriately in accordance with label directions in forestry operations. The management of pesticides in Australia is a responsibility shared by Commonwealth, State and Territory governments, users and the chemical industry. Efforts to develop a national strategy for agricultural and veterinary chemicals are currently under way.

A survey of forest-related chemical use for pest control, undertaken in 1991, found that most State and Territory forest agencies do not report on chemical use in their forests beyond qualitative assessments. An even greater and currently unaddressed problem of data collection relates to the extent of chemical use for pest control in forests with private, leasehold or other crown land tenure.

Tables 43 and 44 present information recorded in 1996 on the chemicals used by various government agencies to control pests and diseases, mostly on land with multiple-use or conservation reserve tenure. The tables give estimates of how widely, frequently, and at what concentration, such chemicals are applied.

### Herbicides

Chemicals used widely in forests include glyphosate, hexazinone, metasulfuron methyl, atrazine, clopyralid and triclopyr. Use of chemicals often varies with State or Territory: atrazine, for example, is not used in multiple-

use forests in Tasmania, although it is still used on private land. Most of these chemicals are used during the establishment phase of plantations and native forest regeneration to suppress competitive grasses and weeds.

## Other pesticides

Table 44 shows the extent to which pesticides (other than those used against weeds) are used by forest agencies. The most heavily applied is sodium fluoroacetate (1080™), a vertebrate pesticide commonly used to control rabbits, foxes, pigs and cats. This chemical occurs naturally in some native species of plant, particularly *Gastrolobium* species. Some native animals have therefore acquired a resistance to it, allowing the poisoning of feral animals without affecting native populations.

# Roads

A properly designed system of roads is essential for general access, fire protection and cost-effective transportation of forest products to market. In some areas, forest roads form an important component of the public rural road network, while their absence is important to wilderness experiences. The intensity of road development varies with land use; for example, there are more roads in plantations, less in

**Table 43: Herbicides and fungicides most used in native forests and plantations, as reported by various State and Territory agencies**

| Chemical | Trade name or use (example only) | Hazard rating | ACT | NSW | NT | Qld | SA | Tas | Vic | WA |
|---|---|---|---|---|---|---|---|---|---|---|
| 2,4,5-T | | 2 | • | • | • | ★ | • | • | • | • |
| 2,4-D - Amine | Amicide | 1 | • | • | ■ | ● | • | • | • | • |
| 2,4-D ethyl ester | | 1 – 2 | • | • | ■ | • | • | • | • | • |
| 2,4-D ethyl ester 2,4,5-TB | road weed mix | 2 | • | • | ■ | • | • | • | • | • |
| Amitrol, Atrazine, Simazine | | 1 | • | ◆ | • | • | • | • | • | • |
| Amitrole | | 1 | • | ◆ | • | • | ■ | • | ■ | ◆ |
| Atrazine | Gesaprim | ND | • | ★ | ■ | ● | ■ | • | ■ | ■ |
| Benomyl | Benlate | ND | • | ■ | • | • | • | ■ | ● | • |
| Clopyralid | Lontrel | 1 | • | ★ | • | ■ | ■ | ■ | ◆ | ■ |
| Copper oxychloride | Leaf curl spray | ND | • | ◆ | • | • | • | ■ | ◆ | • |
| Fluazifop-P, Butyl | Fusilade | 2 | • | ★ | • | ★ | • | ■ | ★ | ■ |
| Flupropanate | Frenock | 2 | ★ | • | • | ■ | • | • | • | • |
| Glyphosate | Roundup | 1 | ● | ★ | ■ | ● | ■ | ◆ | ◆ | ◆ |
| Haloxyfop | Verdict | 2 | • | • | • | ★ | • | ■ | ● | ■ |
| Hexazinone | Velpar | 1 | ● | ★ | ■ | ■ | ■ | ◆ | ◆ | ■ |
| Metsulfuron methyl | Ally, Brushoff | ND | ● | ◆ | ■ | ■ | ■ | ■ | ★ | ◆ |
| Non-ionic wetter | Plus 50 | ND | • | ◆ | • | • | • | ◆ | ◆ | ◆ |
| Petroleum oil | DC Trate | ND | • | ■ | ■ | • | • | • | ★ | ■ |
| Picloram | Tordon | 1 – 2 | • | ■ | • | ◆ | • | • | ■ | ■ |
| Propazine | Grazon, Gesamil | ND | • | ★ | • | ■ | • | ■ | • | • |
| Simazine | Gesatop | ND | ★ | ◆ | • | ● | • | • | ★ | ● |
| Sulfometuron methyl | Oust | 1 | • | ■ | • | ■ | • | ■ | • | ● |
| Triclopyr | Garlon | 2 | ■ | ◆ | • | ★ | • | ■ | ■ | ■ |
| Triclopyr,butoxy | | 2 | • | ◆ | • | • | • | ■ | • | • |
| Triclopyr,Butoxy,Picloram | Grazon DS | 2 | • | ◆ | • | • | • | ■ | ★ | • |

*Note: concentration of the active ingredient varies between products*

*ND - No data*

*Hazard rating:*
*1 Hazardous*
*2 Poisonous*
*3 Extremely dangerous, requiring special precautions*

- • *Not reported*
- ■ *rare or limited, low-volume use*
- ★ *limited use at medium–high volumes*
- ◆ *widespread use at low volumes*
- ● *widespread use at medium to high values*

*Source: National Forest Inventory (1997).*

## Table 44: Pesticides most used in forests and plantations, as reported by various State and Territory agencies

| Chemical | Trade name or use (example only) | Hazard rating | ACT | NSW | NT | Qld | SA | Tas | Vic | WA |
|---|---|---|---|---|---|---|---|---|---|---|
| Sodium fluoroacetate | 1080 | 3 | ★ | ★ | • | ■ | ◆ | •(2) | ★ | ● |
| Carbaryl | Carbaryl(1), Waspkil | 1–2 | • | ■ | • | • | • | ■ | • | • |
| Chloropicrin | Bromatuma | 3 | ■ | ■ | • | ■ | • | • | • | |
| Warfarin | Ratsak | 2 | ◆ | ■ | • | • | • | ■ | • | • |
| Alphamethrin | Dominex(1) | 1 | • | • | • | • | • | ★ | • | ◆ |
| Aluminium phosphide | Phostoxin | 2 | ★ | • | • | • | ◆ | • | • | • |
| Alpha-cypermethrin | Fastac | 1 | • | • | • | • | • | • | • | ★ |
| Chlorpyrifos | Peststrips, Lorsban | 2 | • | ■ | • | • | • | • | • | ◆(3) |
| Trichlorfon | Dipterex | 2 | • | • | • | • | • | • | • | ■ |

• *Not reported*
■ *Rare use*
★ *Limited use, volume varies from low to high*
◆ *Widespread use, volume varies from low to high*
● *widespread use at medium to high volumes*

*Note: concentration of the active ingredient varies between products*

*(1) Some forms of this chemical are toxic to bees.*
*(2) 1080 is used in Tasmanian forests and plantations, but the extent and frequency are unknown.*
*(3) Toxic to bees in the form used.*

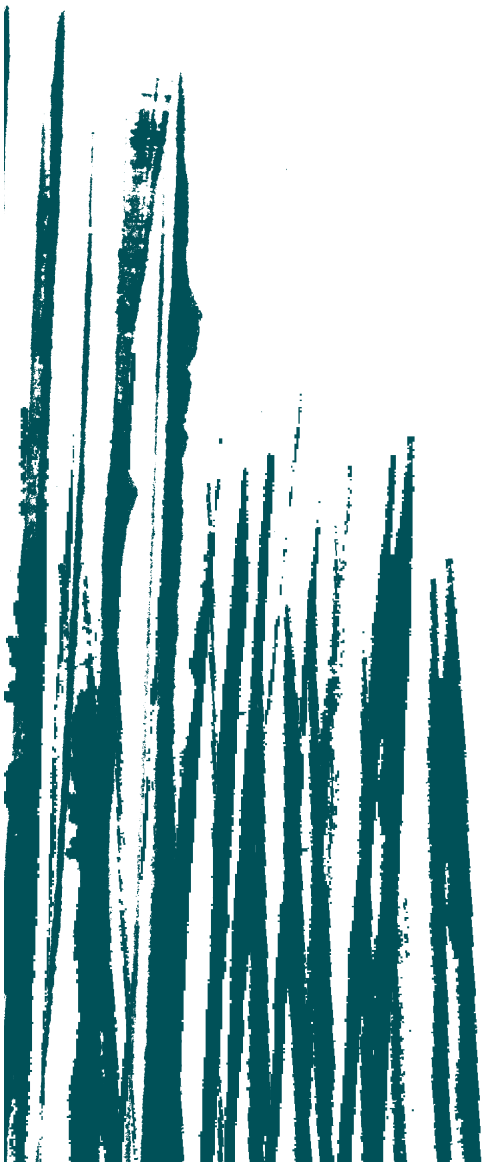
*Hazard rating:*
*1 Hazardous*
*2 Poisonous*
*3 Extremely dangerous, requiring special precautions*

*Source: National Forest Inventory (1997).*

native multiple-use forests, and less again in conservation reserves.

Roads have been identified as the major source of soil erosion and water sedimentation in timber harvesting operations. They may also provide access routes for vertebrate pests such as foxes and cats, and facilitate the movement of weeds and some diseases. The extent and distribution of the road network has been used in countries such as Canada as a measure of disturbance in forests.

# 5 *Forest Policy and Management*



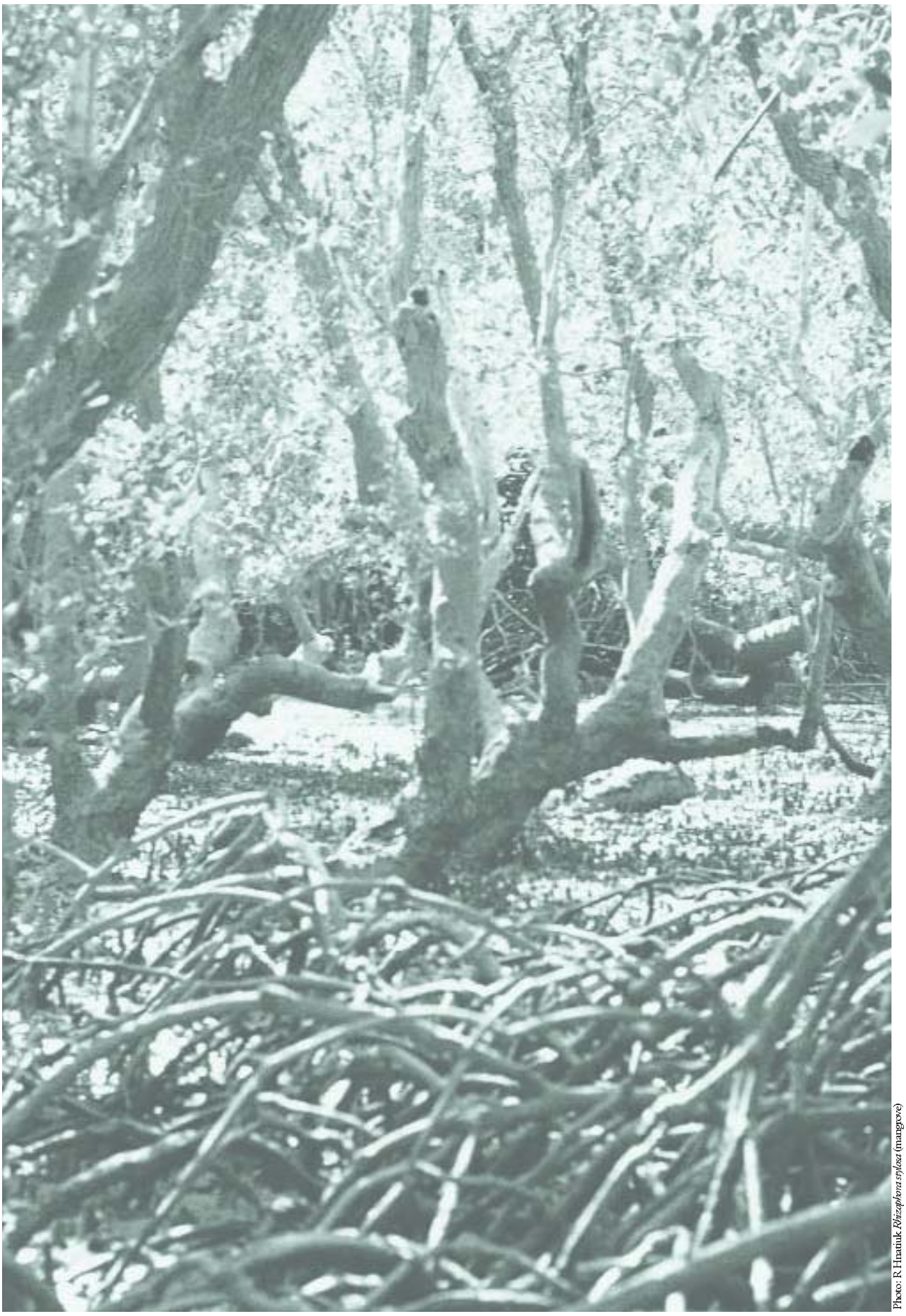


Photo: R Hnatiuk *Rhizophora stylosa* (mangrove)

# *Forest Policy and Management*

All forests in Australia are controlled by some level of policy and management regime. These controls vary from strict, comprehensive systems on public multiple-use forests and conservation reserves to limited controls on some forms of other crown land, leasehold land and private land.

This chapter sets out the regulations, policies and management practices that influence Australia's forests. By far the largest body of information is available for forests with multiple-use tenure, but forests with other tenures are addressed where possible.

## Regulation and policy

The management of forests in Australia is the responsibility of the States because it is a function not explicitly delegated to the Commonwealth by the Australian Constitution. Through Acts of Parliament (Table 45 provides a list of those most relevant to forest management) and government policy, State and Territory governments establish the framework under which public and private forests are managed. These governments are also directly responsible for the management of large areas of public forest through various agencies. The summaries of key information at the end of this report show the agencies in each State and Territory with responsibility for forest management, and their institutional evolution. Since the proclamation of their legislation, each State has managed its forests according to plans and policies developed in accord with that legislation.

The Commonwealth is responsible for ensuring that Australia's international obligations are met and that provisions of Commonwealth legislation are satisfied. Such legislation relevant to forest management and policy includes the *Australian Heritage Commission Act 1975*, the *Australian National Parks and Wildlife Conservation Act 1975,* the *Export Control Act 1982*, the *World Heritage Properties Conservation Act 1983*, the *Endangered Species Protection Act 1992*, and the *Natural Heritage Trust of Australia Act 1997*.

### State and Territory policy initiatives

A large number of initiatives related to forests have been implemented at the State and Territory level in recent years. A sample is presented here under several headings.

#### Industry development

In New South Wales, the Timber Industry (Interim Protection) Act of 1992 was enacted with the aim of maintaining a viable timber industry while providing for a full environmental impact assessment of timber harvesting operations. Victoria has implemented a range of its Timber Industry Strategy recommendations, while Queensland's Greater Planning Certainty Policy, introduced in 1993, aimed, among other things, to increase planning certainty for forest industries. The 1991 Forests and Forest Industry Strategy in Tasmania led to the development of State-level multilateral forest policy and management agreement covering the State's forests and associated industries. In the Northern Territory, the Parks and Wildlife Commission has commenced a project aimed at encouraging the harvesting of *Erythrophleum chlorostachys* (ironwood) from its forests with minimum impact on associated flora and fauna assemblages.

#### Environmental protection and conservation

While informal prescriptions for environmental protection and conservation have been in place in many multiple-use forests in Australia since the 1970s, the country's first formal code of forest practice was enacted in Tasmania in the late 1980s; it regulates operations on all public and private forests. Other States have since prepared and implemented similar codes, including Victoria, which now has codes of forest practice for

## Table 45: Key Acts of Parliament relevant to forest management at State, Territory and Commonwealth level

| State or Territory | Act |
|---|---|
| Australian Capital Territory | ND |
| New South Wales | *Forestry Act 1916* |
| | *Soil Conservation Act 1938* |
| | *Bush Fires Act 1949* |
| | *National Parks and Wildlife Act 1974* |
| | *Heritage Act 1977* |
| | *Environmental Planning and Assessment Act 1979* |
| | *Wilderness Act 1987* |
| | *Endangered Fauna (Interim Protection) Act 1991* |
| | *Timber Industry (Interim Protection) Act 1992* |
| | *Threatened Species Conservation Act 1995* |
| | *Timber Plantations (Harvest Guarantee) Act 1995* |
| | *Pollution Control Acts* |
| Northern Territory | *Control of Roads Act 1980* |
| | *Environmental Assessment Act 1982* |
| | *Soil Conservation and Land Utilisation Act 1990* |
| | *Pastoral Lands Act 1992* |
| | *Crown Lands Act 1992* |
| | *Parks and Wildlife Conservation Act 1993* |
| Queensland | *Forestry Act 1959* |
| | *National Conservation Act 1992* |
| | *Land Act 1994* |
| | *Environmental Protection Act 1994* |
| South Australia | *Crown Lands Act 1929* |
| | *Forestry Act 1950* |
| | *National Parks and Wildlife Act 1972* |
| | *Aboriginal Heritage Act 1988* |
| | *Soil Conservation and Land Care Act 1989* |
| | *Native Vegetation Act 1992* |
| | *Wilderness Protection Act 1992* |
| | *Environment Protection Act 1993* |
| | *Heritage Act 1993* |
| | *Water Resources Act 1997* |
| Tasmania | *Forestry Act 1920* |
| | *National Parks and Wildlife Act 1970* |
| | *Aboriginal Relics Act 1975* |
| | *Crown Lands Act 1976* |
| | *Forest Practices Act 1985* |
| | *Private Forests Act 1994* |
| | *Historic Cultural Heritage Act 1995* |
| | *Threatened Species Protection Act 1995* |
| Victoria | *Forests Act 1958* |
| | *Land Act 1958* |
| | *Mines Act 1958* |
| | *Environment Protection Act 1970* |
| | *National Parks Act 1975* |
| | *Environment Conservation Council Act 1977* |
| | *Conservation, Forests and Lands Act 1987* |
| | *Crown Lands (Reserves) Act 1987* |
| | *Flora and Fauna Guarantee Act 1988* |
| | *Water Act 1989* |
| | *Forests (Timber Harvesting) Act 1990* |
| | *Aboriginal Lands Act 1991* |
| | *Heritage Rivers Act 1992* |
| | *Victorian Plantations Corporation Act 1993* |
| | *Catchment and Land Protection Act 1994* |
| | *Water Industry Act 1994* |
| | *Fisheries Act 1995* |
| | *Heritage Act 1995* |
| Western Australia | *Metropolitan Water Supply Sewerage and Drainage Act 1909* |
| | *Country Area's Water Supply Act 1947* |
| | *Wildlife Conservation Act 1950* |
| | *Bush Fire Act 1954* |
| | *Aboriginal Heritage Act 1972* |
| | *Rights in Water and Irrigation Act 1979* |
| | *Environmental Protection Act 1982* |
| | *Conservation and Land Management Act 1984* |
| | *Various mining and mineral agreement Acts* |
| Commonwealth | *Environment Protection (Impact of Proposals) Act 1974* |
| | *Australian Heritage Commission Act 1975* |
| | *Export Control Act 1982* |
| | *World Heritage Properties Conservation Act 1983* |
| | *Endangered Species Protection Act 1992* |

*ND – No data.*
*Source: National Forest Inventory (1997).*

timber production on public and private land and fire management on public land (see section on codes of forest practice and Table 48 later in this chapter).

The 'Western Shield' fox control program implemented by the Department of Conservation and Land Management in Western Australia is having a dramatic effect on fox numbers on forested lands, resulting in increased numbers of small native mammals and birds. In New South Wales, the 1995 State Environmental Planning Policy 46 was developed to control the rate of vegetation clearing, including the clearing of forests, and is expected to help conserve large areas of forest on private and leasehold lands.

Management planning for multiple-use forests and in conservation reserves is an important part of environmental protection; this is discussed later in this chapter.

### Miscellaneous initiatives

In 1997 the Queensland Department of Primary Industries (Forestry) introduced an environmental management system; it hopes that by the year 2000 this system will be at a level at which it can be independently audited and certified to international standards. In the Northern Territory, the Tiwi people established a plantation of *Acacia* species recently on Melville Island in an effort to develop a viable wood-based business. The Parks and Wildlife Commission assisted by providing loans, conducting research and managing some of the associated activities.

## Commonwealth initiatives

The Commonwealth Government funds a number of programs aimed at assisting States and Territories in the management of their natural resources. Some of these are directed specifically at forests, while others are more general but have some applicability to the forest estate.

The Natural Heritage Trust is a Commonwealth Government initiative funded by the partial sale of Telstra, the national telecommunications organisation. It will provide $1.25 billion over four years towards projects aimed at maintaining and replenishing Australia's natural environmental capital. Three Trust-funded projects of relevance to forests are: the Farm Forestry Program; the Land and Water Audit, which includes funding for the National Forest Inventory; and the National Vegetation Initiative.

The Commonwealth Government is also involved with the States and Territories in the development and implementation of a number of policy statements or initiatives. These include Plantations for Australia: the 2020 Vision, the National Biodiversity Strategy, the Wood and Paper Strategy, the regional forest agreement process and the Montreal Process Working Group. A range of other national-level programs or bodies, such as the Murray-Darling Basin Commission, contain forest-related components but are not focused primarily on them.

The Commonwealth Government funds forest research through institutions such as CSIRO and certain cooperative research centres and universities. It has also provided loans to increase the plantation resource and has management responsibilities for forested Commonwealth national parks at Kakadu, Jervis Bay, Norfolk Island and Christmas Island, and for forests on defence lands.

## National Forest Policy Statement

In 1992 the Commonwealth, State and Territory governments formally agreed to a coordinated approach to broad forest policy when they signed the National Forest Policy Statement (Tasmania signed in 1995). The signatories agreed to 11 broad national goals relating to conservation; wood production and industry development; integrated and coordinated decision-making and management; private native forests; plantations; water supply and catchment management; tourism and other economic and social opportunities; employment, workforce education and training; public awareness, education and involvement; research and development; and international responsibilities.

## Regional forest agreements

The National Forest Policy Statement made provision for a joint forest planning exercise,

known as a comprehensive regional assessment (CRA) to be carried out across parts of the forest estate. The Commonwealth and each State government, in consultation with stakeholders and using results of the CRA, negotiate an agreement (called a regional forest agreement, or RFA) that sets out how the forests of the region under assessment are to be managed and used over a period of up to 20 years. The agreement in each State will be implemented through the State planning and policy mechanisms provided for in their legislation. The progress of each agreement is to be reviewed at least every five years.

RFAs do not cover the entire forest estate: in broad terms their scope is limited to those regions for which Commonwealth woodchip export licences are or may be required. Map 15 (see colour section in back of book) shows those regions to which RFAs will be applied.

By April 1998 the Commonwealth and State governments had signed three RFAs: those covering Tasmania and the East Gippsland and Central Highlands regions of Victoria. Agreements for Eden (New South Wales), Western Australia, North-east Victoria and Queensland are likely to be signed by the end of 1998. All RFAs are expected to be completed by the year 2000.

## Rare or threatened species

Individual States and Territories have legislation to list and protect endangered species, while nationally endangered species are listed in Schedule 1 of the Commonwealth *Endangered Species Protection Act 1992*. The Commonwealth is obliged to prepare a recovery plan for each species listed as vulnerable and endangered in Schedule 1 of the Act; some States and Territories have similar requirements for species listed in their legislation.

Information on rare or threatened species will be used in the design of a comprehensive, adequate and representative conservation reserve system. However, it will not be possible to include or conserve all rare and threatened species in the permanent reserve system. Thus, their management on both public and privately owned lands must be separately addressed. Most States have voluntary conservation agreements (such as the Land for Wildlife Scheme) to assist in conservation management on privately owned lands. State and Territory agencies participate in coordinated programs to protect rare or threatened plants and animals. In addition, field operational procedures in many multiple-use forests are specifically designed to accommodate the need to protect populations and habitats of rare or threatened plants and animals.

### Box 12: Principles considered by regional forest agreements (RFAs)

In reporting on ecologically sustainable forest management in the regional forest agreement process, the following principles are used:

- maintain and enhance multiple socio-economic benefits to meet the needs of societies;
- protect and maintain biodiversity;
- maintain the productive capacity and sustainability of forest ecosystems;
- maintain forest ecosystem health and vitality;
- protect soil and water resources;
- maintain forest contribution to global carbon cycles;
- maintain natural and cultural heritage values;
- maintain the full suite of forest values for present and future generations; and
- utilise the precautionary principle for prevention of environmental degradation.

In addition to these principles, regional forest agreements consider the following:

- the interests of Indigenous communities; and
- old-growth forests, wilderness areas and forest required for a comprehensive, adequate and representative forest reserve system.

## Wilderness

For those forests covered by the regional forest agreement process, there is agreement that 90 per cent or more of areas identified as wilderness are to be protected. Wilderness is protected by legislation in New South Wales and Victoria and is recognised in management planning in Tasmania.

## Greenhouse responses

Commonwealth, State and Territory governments have proposed a number of policy responses aimed at reducing Australia's overall greenhouse gas emissions. These include the National Greenhouse Gas Response Strategy (1992), Greenhouse 21 C (1995) and the draft National Greenhouse Strategy (1997). Specific measures relevant to forests include the sustainable management of native forests and plantations, a proposed trebling of the 1995 plantation area to 3 million hectares (under Plantations for Australia: the 2020 Vision), and revegetation (under programs such as the National Vegetation Initiative). If such measures *were* implemented, it has been estimated that the forestry and land use change sectors could, by the year 2020, reduce Australia's total annual $CO_2$ emissions by some 70 megatonnes. Proposed restrictions on vegetation clearing would increase this sink capacity even further.

At the Conference of Parties to the Climate Change Convention in Kyoto, Japan, in 1997, emission reduction targets were redefined, allowing differentiation between countries. Australia's agreed target was to reduce overall emissions to 8 per cent above 1990 levels by the first commitment period of 2008 to 2012. The Kyoto Protocol also stated that only net emissions from land use changes since 1990 (including trees planted or removed) could be included in calculations, although it remains uncertain whether net emissions from, for example, forests managed on set rotations or regeneration within national parks will be included. A monitoring and prediction system of carbon emissions and sinks would require the use of remotely sensed data and biospheric models (such as for soil carbon, growth and decomposition).

# International agreements with implications for forest management in Australia

Australia is signatory to a number of international agreements, some of the more significant of which are listed in Box 13.

Perhaps the most important international process in the context of this report is a non-legally binding agreement known as the Montreal Process. Within this, 12 countries, including Australia, have been working to develop criteria and indicators for the sustainable management of temperate (and boreal) forests. The Montreal Process Working Group comprises Argentina, Australia, Canada, Chile, China, Japan, Mexico, New Zealand, Republic of Korea, Russian Federation, United States of America and Uruguay. These countries cover five continents and together represent over 90 per cent of the world's temperate and boreal forests, as well as some tropical forests.

In February 1995 the Montreal Process Working Group endorsed a statement known as the 'Santiago Declaration', including a comprehensive framework of seven criteria and 67 indicators (see Box 14). These provide a common understanding of what is meant by sustainable forest management. The first six criteria deal specifically with forest conditions, attributes or functions, and the values or benefits associated with the environmental, social and economic goods and services that forests provide. The seventh criterion assesses the legal, institutional, economic and research frameworks of a country that facilitate the conservation and sustainable management of forests covered by the first six criteria. The criteria and indicators are tools for assessing national trends in forest conditions and management, and provide a common framework for describing, monitoring and evaluating progress towards sustainability at the country level. Australia produced its first report against the indicators in June 1997.

**Box 13: International forest-related agreements, forums or statements of relevance to Australia**

- Food and Agriculture Organization of the United Nations, 1945
- Rio Declaration and Agenda 21, 1992
- Statement of Forest Principles, 1992
- United Nations Framework Convention on Climate Change, 1992
- United Nations Framework Convention on Biological Diversity, 1992
- Commission for Sustainable Development, 1992
- Montreal Process and Santiago Declaration, 1994
- General Agreement in Tariffs and Trade (GATT), 1947, and World Trade Organisation, 1995
- Convention concerning the Protection of the World Cultural and Natural Heritage, 1972 (World Heritage Convention)
- Convention on Wetlands of International Importance etc, 1971 (Ramsar Convention)
- Man and the Biosphere Programme, 1971
- Convention on the Conservation of Migratory Species of Wild Animals, 1979 (Bonn Convention)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973 (Washington)
- The Convention on Conservation of Nature in the South Pacific, 1976 (Apia Convention)
- International Tropical Timber Agreement, 1983
- Convention for the Protection of the Natural Resources and the Environment of the South Pacific Region, 1986, Noumea
- CAMBA (1986) and JAMBA (1974) Agreements (bilateral agreements with China and Japan, respectively, that reinforce the Ramsar Convention)

# Forest management in native forests

The level of forest management varies across Australia, with most information on forest management available for multiple-use forests. Here we focus on a few key policies and procedures that are comparable on a national basis.

## Sustainable forest management

Sustainable forest management is a complex concept and there is no single widely used definition. Public forest managers and some private forest managers accept that the concept of sustainability includes the wide diversity of forest values such as those enunciated in the Montreal Process criteria and indicators (see 'International agreements with implications for forest management in Australia' above).

Managing forests for wood production on public land and some private land involves also managing the forests for water, biodiversity and certain cultural values. Criteria and indicators are not direct measurements of sustainable forest management but, taken together, they allow an assessment of whether and to what extent forest management is achieving an adequate level of sustainability. The nature of the measurements, analyses and reporting of indicators varies with the level of reporting: the information needed by on-the-ground managers will differ in detail and substance from that needed for regional, State, Territory or national requirements. Nonetheless, for reasons of efficiency and effectiveness, there should be compatibility between these different levels of reporting.

## Box 14: Montreal Process criteria and indicators for the conservation and sustainable management of temperate and boreal forests

| Criteria | Indicators |
|---|---|
| 1. biological diversity | |
| 1.1 ecosystem diversity | 1.1.a forest types |
| | 1.1.b age/successional stage of types |
| | 1.1.c protected areas |
| | 1.1.d protected area by age/successional class |
| | 1.1.e fragmentation |
| 1.2 species diversity | 1.2.a no. forest-dependent species |
| | 1.2.b viability of populations |
| 1.3 genetic diversity | 1.3.a species with diminished habitat range |
| | 1.3.b population levels across range |
| 2. productive capacity | 2.1.a area of timber production forest |
| | 2.1.b merchantable and non-merchantable growing stock |
| | 2.1.c area of exotic and native plantations |
| | 2.1.d wood products versus sustainable production level |
| | 2.1.e non-wood products versus sustainable production level |
| 3. ecosystem health and vitality | 3.1.a impact of processes/agents |
| | 3.1.b impact of air pollution/ultraviolet B |
| | 3.1.c extent of diminished biological components |
| 4. soil and water resources | 4.1.a area of soil erosion |
| | 4.1.b protective areas/functions |
| | 4.1.c streamflow variations |
| | 4.1.d soil chemical properties |
| | 4.1.e soil physical properties |
| | 4.1.f stream biological diversity |
| | 4.1.g accumulation of toxic substances |
| 5. global carbon cycles | 5.1.a ecosystem biomass |
| | 5.1.b ecosystem contribution to carbon budget |
| | 5.1.c forest product contribution to carbon budget |
| 6.1 socio-economic benefits | 6.1 production/consumption |
| | 6.1.a value/volume of wood products |
| | 6.1.b value/volume of non-wood products |
| | 6.1.c per capita supply and consumption |
| | 6.1.d percentage of gross domestic product |
| | 6.1.e extent of recycling |
| | 6.1.f supply/use of non-wood products |
| 6.2 recreation and tourism | 6.2.a available forest area |
| | 6.2.b facilities available |
| | 6.2.c visitor days |
| 6.3 investment | 6.3.a value of investment |
| | 6.3.b R&D expenditure |
| | 6.3.c technology (use and adoption) |
| | 6.3.d rate of return |
| 6.4 cultural, social and spiritual | 6.4.a area protecting cultural, social, spiritual values |
| | 6.4.b non-consumptive use values |
| 6.5 employment and community | 6.5.a direct and indirect employment |
| | 6.5.b wage and injury rates |
| | 6.5.c forest community viability |
| | 6.5.d area used for subsistence |
| 7. effectiveness of legal, institutional and economic framework | |
| 7.1 legal framework | 7.1.a property rights, tenure, traditional rights of Indigenous peoples, dispute resolution |
| | 7.1.b planning, assessment, policy review for range of values |
| | 7.1.c public participation in decisions/policy and access to information |
| | 7.1.d best practice codes |
| | 7.1.e conservation – environmental, social, cultural and/or scientific values |
| 7.2 institutional framework | 7.2.a public awareness/education |
| | 7.2.b planning, assessment, policy review (including cross-sectoral elements) |
| | 7.2.c human resource skills |
| | 7.2.d physical infrastructure |
| | 7.2.e regulation, guidelines, law enforcement |
| 7.3 economic framework flows | 7.3.a investment, taxation, regulatory environment, capital |
| | 7.3.b non-discriminatory trade policies |
| 7.4 capacity to measure conservation | 7.4.a data availability |
| | 7.4.b scope, frequency, statistical reliability of inventories/assessments |
| | 7.4.c compatibility with other countries |
| 7.5 capacity for and application of R&D | 7.5.a scientific ecosystem understanding |
| | 7.5.b development of national accounting methodologies for social costs/benefits, and resource depletion |
| | 7.5.c impact of technology |
| | 7.5.d human impact prediction |
| | 7.5.e climate change impact prediction |

# Management of multiple-use forests

## Forest management agencies

The agencies in each State and Territory with responsibility for forest management, including that employed in multiple-use forests, and their institutional evolution have been summarised and presented with summaries of key information at the end of this report.

### *Corporatisation*

During the 1990s most State and Territory forest agencies changed their mode of organisation, based on the need for greater transparency and accountability for revenue-generating operations. The major result was the corporatisation as business units of those functions that focus primarily on timber production and sale. The degree of corporatisation varies between agencies.

## Silvicultural systems

The choice of silvicultural system in forest harvesting depends on the objectives set for the forest (for example, to promote growth, regeneration or forest health) and the requirements of the tree species involved. Silvicultural methods can be distinguished by the degree to which harvesting exposes the forest floor to sunlight. At one extreme, clear-felling may involve the removal of the entire stand of trees in discrete patches of 10–50 hectares; at the other, single trees may be removed at dispersed locations throughout the forest. Table 46 shows the silvicultural systems employed for various forest groups in multiple-use forests in each State.

## Management plans

A forest management plan states the objectives of management that will be pursued in a given forest over a specified time period. Table 47 shows the area of public forest of various tenures, including multiple-use forests in each State or Territory, covered by management plans in 1998. In New South Wales, mandatory environmental impact statements that provide inputs to management and opportunities for public comment precede harvesting. Most other States have processes that allow public involvement in the development of management plans and operational harvesting plans.

## Codes of forest practice

The term 'code of forest practice' describes a set of principles and standards that specify minimum acceptable practices and goals in harvesting and associated forest management operations.

With the exception of the Northern Territory, which has no multiple-use forests, all relevant agencies have codes of practice that govern activities related to the management and use of multiple-use forests. In Victoria and Tasmania, the codes also cover private forestry. Table 48 summarises the content of these codes for each State and the Australian Capital Territory. The codes are reviewed periodically and revised to reflect the results of monitoring and to respond to developments in knowledge and technology.

In some States, some aspects of forest management are addressed in separate documents, such as the code of practice for fire management on public land in Victoria. In addition, operational guidelines and specific prescriptions for silvicultural operations are often documented separately. The responsibility of ensuring that the codes of practice are adhered to lies with the management agency. Timber harvesting contractors and other forest users may be penalised for breaches of mandatory codes.

In Queensland, separate codes of practice are being developed for the major forest management and use activities. These codes are based largely on current management manuals in use by the Department of Primary Industries (Forestry).

In the Northern Territory, there is no government timber production agency. All harvesting operations are undertaken by the private sector and must be licensed. The licence governs the manner and conditions under which harvesting may occur. Licence conditions are specific to each operation, and environmental requirements are common to all licences.

## Community service obligations

Agencies with responsibility for the management of multiple-use forests provide a

## Table 46: Silvicultural systems employed for various forest groups, by State and Territory

| RAC forest type | State | Harvest methods[1] | Habitat trees[2] | Regeneration methods[3] | Rotation length (years)[4] | Visits Max | Visits Min |
|---|---|---|---|---|---|---|---|
| Rainforest | NSW | NL | NL | NL | NL | NL | NL |
| | NT | NL | NL | NL | NL | NL | NL |
| | Qld | NL | NL | NL | NL | NL | NL |
| | Tas | S(l/m) | √ | b | 2004 | ND | ND |
| | Vic | NL | NL | NL | NL | NL | NL |
| | WA | NL | NL | NL | NL | NL | NL |
| S-W wet eucalypt | WA | T,C | √ | b c f | 100 - 300 | 4 | 1 |
| S-W dry eucalypt | WA | T,S(m/g) | √ | a b c | 200 | 5 | 4 |
| S-E wet eucalypt | NSW | T,S(m/h/g) | √ | a b c | 100 -150 | 3 | 3 |
| | Tas | T,C,S(l/m/h) | √ | a c f | 80 -100 | ND | ND |
| | Vic | T,C,S(h) | √ | b c d g | 80 -100 | 3 | 3 |
| S-E ash | NSW | T,S(m/g) | √ | a b c | 100 -150 | 3 | 3 |
| | Tas | T,C,S(l/m/h) | √ | a c f | 80 -100 | ND | ND |
| | Vic | C | √ | c d f g | 80 | 1 | 1 |
| S-E dry open forest & woodland | NSW | T,S(l/g) | √ | a b | 150+ | 3 | 3 |
| | Tas | S(l/m/h)C | √ | a b c | 80 -100 | ND | ND |
| | Vic | T,S(l) | √ | h b | 100 -120 | 5 | 2 |
| S-E coastal eucalypt | NSW | T,S(m/g) | √ | a b c | 60 - 100 | 3 | 3 |
| | Vic | T,C,S(m) | √ | a b c | 100 - 120 | 3 | 2 |
| Central coastal eucalypt | NSW | T,S(l/m/h/g) | √ | a b c | 60 - 150 | 3 | 3 |
| | Qld | T,S(l/h/g) | √ | a b c e f | 20 - 70 | 4 | 2 |
| N-E central coastal eucalypt | Qld | T,S(l/m) | √ | a b e | 30 -100 | 3 | 2 |
| River red gum | NSW | T,S(l/g) | √ | a b | 150 | 3 | 3 |
| | Vic | T,S(l/g) | √ | a b | 100 -120 | 7 | 1 |
| Native pine | NSW | T,S(m) | √ | a b | 150 | 3 | 3 |
| | Qld | S(m/l) | √ | a b e | 25 - 50 | 2 | 2 |
| | Vic | NL | NL | NL | NL | NL | NL |
| Northern dry sparse | Qld | S(m/l) | √ | a b e | 30 - 70 | 2 | 2 |

*NL - not logged*

[1] *C - clear-felling (<15% canopy retention)*

*S - selective logging*
*l - light, 15 - 30% canopy retention*
*m - medium, 31 - 60%*
*h - heavy, >61%*
*g - group, <1ha cleared*

*T - thinning*

[2] *√ - Habitat trees left - except where 100% clearfelling is prescribed.*

[3] *a - natural seed stock*
*b - seed trees left*
*c - regeneration burn*
*d - mechanical disturbance*
*e - top disposal*
*f - direct planting*
*g - aerial/hand sowing*
*h - coppice*

[4] *Rotation period in Qld (see text)*

*Source: National Forest Inventory (1997).*

## Table 47: The area of public forested land subject to management plans in June 1998, by State and Territory

| State/Territory | Agency | Total area managed by agency/ agencies (ha)[1] | Area under plan at 30/6/94 (as % of total area managed) | Area expected to be under plans by 30/6/99 (as % of total area managed ) | Approximate management plan review interval (years) |
|---|---|---|---|---|---|
| Australian Capital Territory | ACT Forests | 18 300 | 0 | 100 | ND |
| | ACT Parks & Conservation Service | 134 000 | 70 | 100 | 10 |
| New South Wales | State Forests | 3 355 000 | 100 | 100 | 5-10 [4] |
| | National Parks & Wildlife Service | 4 189 600 | 3 | 25 | 12 |
| Northern Territory | Parks & Wildlife Commission of the Northern Territory | ND | 1 | 4 | 1 |
| Queensland | Department of Primary Industries | 4 305 900 | 11 | 100 | 6 |
| | Department of Environment and Heritage | 4 969 100 | ND | ND | ND |
| South Australia | Department for Environment, Heritage and Aboriginal Affairs | 11 260 300 | ND | ND | ND |
| | ForestrySA | 126 400 | 73 | ND | 5 |
| Tasmania | Forestry Tasmania[3] | 1 600 000 | 100 | 100 | 1 |
| | Environment and Land Management | 2 546 000 | 59 | 63 | 1 |
| Victoria | Department of Natural Resources and Environment | 7 793 800 | 67 | 100 | 5 |
| Western Australia | Department of Conservation and Land Management | 2 472 300 | 99 | 99 | 10 |
| Commonwealth[2] | Biodiversity Group, Environment Australia | 2 166 400 | 92 | ND | 8 |

*ND - No data*

*[1] Note that the areas given in this column are tenure areas ie they include both forested and non-forested land managed by the respective agency. Also the areas have been rounded to the nearest 100 ha.*

*[2] Consists of land managed by ANCA viz: Jervis Bay NP, Kakadu NP, Norfolk Is NP and Christmas Is NP. Does not include land managed by other agencies, such as Defence etc.*

*[3] All areas are subject to review of 3 year production plan.*

*[4] Revisions are temporarily suspended pending completion of Regional Forest Agreements*

*Source: National Forest Inventory (1997).*

number of community services associated with public safety or health and community use of forests, sometimes funded by other agencies or by treasury. However, there is no national information about the value and cost of such services.

## Management of conservation reserves

Conservation reserves such as national parks and flora reserves are generally subject to less human-induced disturbance than are multiple-use forests, although they remain prone to a number of impacts and disturbances. Management goals are often based on the conservation of biological diversity, the maintenance of wilderness where recognised, and provisions for appropriate recreation uses.

### Conservation management agencies

The summaries of key information at the end of this report show the agencies in each State or Territory with responsibility for forest management in conservation reserves, and their institutional evolution.

Calculating the costs of conservation management is a difficult task: data on the costs of operating conservation management agencies have been compiled for some agencies (Table 49), but they do not distinguish between forested and non-forested land.

### Management plans

Management plans form the basis of management in many conservation reserves. Table 47 shows the area of public forest in each State or Territory covered by management plans in early 1998.

### Community service obligations

Agencies with responsibility for the management of conservation reserves provide a number of community services associated with public safety or health and community use of forests, sometimes funded by other agencies or by treasury. However, there is no national information about the value and cost of such services.

## Management of leasehold forests

In most leasehold forests, maintenance of the forest cover is not a prime objective of management. Nor, usually, is commercial timber extraction, although this does take place in some leasehold forests such as the cypress pine forests of Queensland and New South Wales.

Leasehold forests are affected by management decisions taken in the context of the main land uses, which are predominantly sheep and cattle grazing. Such grazing is normally practised as part of a package of activities including:

- introduction and husbanding of domestic livestock;
- selective harvesting of timber and some other non-timber products;
- manipulation of tree stocking to enhance pasture production;
- introduction of exotic pasture species; and
- manipulation of fire regimes to enhance production of food for domestic stock.

There is no centralised system for documenting forest management in leasehold forests.

## Management of other crown land

The management of forested other crown land varies with the legal occupant, which may be one of the defence forces, an Aboriginal group, mining company, scientific or educational institution, or a gas, electricity or water utility. Some crown land is unallocated. There are no State, Territory or national overviews of management objectives nor national information on the extent of management plans on these lands.

## Management of private forests

Management of native forests on private land is the responsibility of the owner, subject to Commonwealth, State, Territory and local government regulations. For example, some States restrict the clearing of forest on private land.

## Table 48: Content of codes of forest practice, by State and Territory

| | ACT 1995(1) | NSW 1995 | Qld 1995[1] | SA 1995[1] | Tas 1993 | Vic 1996 | WA 1996 |
|---|---|---|---|---|---|---|---|
| **Planning** | | | | | | | |
| Care of soils | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Water quality and flow | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Site productivity | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Timber harvesting plans | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Building access to the forest** | ✓[2] | | | | | | |
| Planning and siting roads | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Road design and construction | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Upgrading existing roads and tracks | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Rock quarries and gravel pits | ✓ | | | | ✓ | ✓ | ✓ |
| Bridge, causeway and ford construction | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Road maintenance | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| **Harvesting** | | | | | | | |
| Design, planning and equipment | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Wet weather | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Snig tracks and landings | ✓[2] | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Water quality and stream protection | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Salvage operations | ✓ | | | | ✓ | ✓ | |
| Steep country | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| **Conservation of other values** | | | | | | | |
| Flora | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Fauna | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Rare or endangered species | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Landscape | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Archaeology (cultural heritage) | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Geomorphology | | | | ✓ | ✓ | | |
| **Forest establishment** | | | | | | | |
| Reforestation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Maintaining forests** | | | | | | | |
| Fire management | ✓ | ✓ | | ✓ | ✓ | ✓[2] | ✓ |
| Pest, disease, weed control | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Use of chemicals | ✓[2] | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Thinning | ✓ | ✓[2] | ✓ | ✓ | ✓ | ✓ | ✓ |

*Notes: The Commonwealth and the NT have no multiple-use forests and therefore no code of forest practice. In the NT, the Parks and Wildlife Commission issues licences for individual harvesting operations, specifying the conditions under which harvesting may occur.*

*[1] Draft only.*

*[2] Written into separate documents, for example, Code of practice for fire (Vic).*

*Source: National Forest Inventory (1997).*

## Table 49: Amount spent on conservation and forest management

| State/ Territory | Agency | ($'000) 1991/1992 | 1992/1993 | 1993/1994 | 1994/1995 |
|---|---|---|---|---|---|
| *Australian Capital Territory* | | | | | |
| Forestry | ACT Forests | 5 833 | 6 110 | 7 141 | 6 538 |
| Conservation | | N/A | N/A | N/A | N/A |
| *New South Wales* | | | | | |
| Forestry | State Forests NSW | N/A | 95 951 | 94 316 | 108 531 |
| Conservation | | N/A | 103 053 | 107 508 | 151 029 |
| *Northern Territory* | | | | | |
| Forestry | | N/A | N/A | N/A | N/A |
| Conservation | Parks and Wildlife Commission | 33 713 | 34 550 | 36 104 | 35 370 |
| *Queensland* | | | | | |
| Forestry | Department of Natural Resources | 22 085 | 26 798 | 28 421 | 29 764 |
| Conservation | Department of Environment | 15 380 | 20 760 | 23 430 | 22 550 |
| *South Australia* | | | | | |
| Forestry | Forestry South Australia | N/A | 235 | 166 | 171 |
| Conservation | | N/A | N/A | N/A | 14 000 |
| *Tasmania* | | | | | |
| Forestry | Forestry Tasmania | 50 928 | 47 304 | 51 960 | 66 269 |
| Conservation | Tasmania Parks & Wildlife Service | N/A | 20 280 | 20 424 | 22 297 |
| *Victoria* | | | | | |
| Forestry | Department of Natural Resources and Environment | 58 859 | 64 933 | 64 406 | 67 369 |
| Conservation | Department of Natural Resources and Environment | 24 286 | 28 133 | 25 658 | 30 925 |
| *Western Australia* | | | | | |
| Forestry | Department of Conservation & Land Management | 34 431 | 41 195 | 45 007 | 53 190 |
| Conservation | Department of Conservation & Land Management | 12 170 | 14 574 | 15 250 | 16 837 |
| *Commonwealth* | | | | | |
| Forestry | | N/A | 14 788 | 8 718 | 7 316 |
| Conservation | | 817 | 3 092 | 3 710 | 4 459 |
| *Australia* | | | | | |
| Forestry | | 172 136 | 289 842 | 298 733 | 339 148 |
| Conservation | | 86 366 | 224 442 | 232 084 | 297 467 |

*N/A – Not applicable.*
*Source: National Forest Inventory (1997).*

The management arrangements that apply to private forests are complex because of the diversity of objectives and ownership arrangements. Land may be owned or leased privately. The management responsibility for trees on such land may be linked to the land on which the trees grow, or it may be separate from it. These arrangements also differ between States and Territories.

Private owners may manage their own forests or may make arrangements such as sharefarming, whereby other private individuals, companies or public agencies may take on some or all management responsibilities for the forests. Private owners may also enter into covenants or voluntarily register part of their land for the protection of conservation values.

Management of private plantations also has a diversity of arrangements. Large private companies and a range of farm forest growers tend to be independent, whereas many growers with medium to small holdings utilise a variety of arrangements with regional committees, private consultants, or joint ventures with large companies or public agencies.

Some States have legislation which ensures formal links between the management of private forests for timber and the forest codes of practice in force in those States, as for example, in Tasmania and Victoria.

A national summary of the amounts of forests under each of these diverse arrangements is not available.

Broadly speaking, there are two kinds of private native forests: those in regions in which intensive timber harvesting is a major land use, making long-term management for timber production an economically viable option. The second kind occurs largely in the drier agricultural zones, where forests – and the land they occupy – are perceived mostly as a source of land for agriculture. There is no centralised system for documenting forest management in either kind of private forest.

## Codes of forest practice in private forests

In Tasmania, the code of practice and the *Forest Practices Act 1985* cover private commercial forests in addition to public forests. Victoria's code also covers commercial forestry on private land. In other States, private forest management is not required to adhere to codes of forest practice.

## Management of cultural values

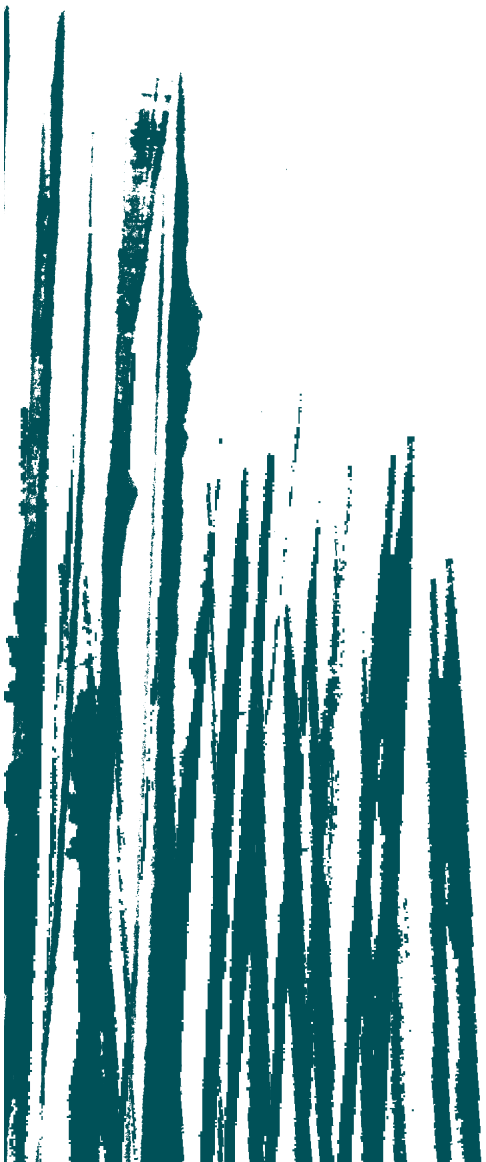
As knowledge about the range and significance of cultural values of forests improves, so do the management systems employed to maintain them. Recognition of the often interrelated nature of cultural and natural values of forest areas, such as the ecological and cultural values associated with old-growth forest areas, is leading to improvement in the integrated management of these values. The appropriateness of management techniques varies according to the particular cultural and natural values of a forest place, and may sometimes conflict. Legislative and non-legislative protective mechanisms provide for the formal recording and registering of places. Other management techniques include reservation, buffering from disturbance activities, maintenance and restoration. In many instances, however, the continued provision of access by communities to places that are culturally significant to them is the best way to ensure the maintenance of cultural values.

The cultural needs of traditional owners are increasingly being incorporated into management plans. Programs are operating which locate the sources of knowledge on traditional management of forested land and develop plans that utilise traditional practices to achieve environmental protection.

## Pest and disease control

Responsibility for pest control activities rests with the forest owner or manager. Government agencies determine which pests and diseases must be controlled, and there are some pests and diseases that managers choose to control for their own purposes. Control of some native species may require permits from relevant State or Territory agencies.

# 6 *Forest Industries*



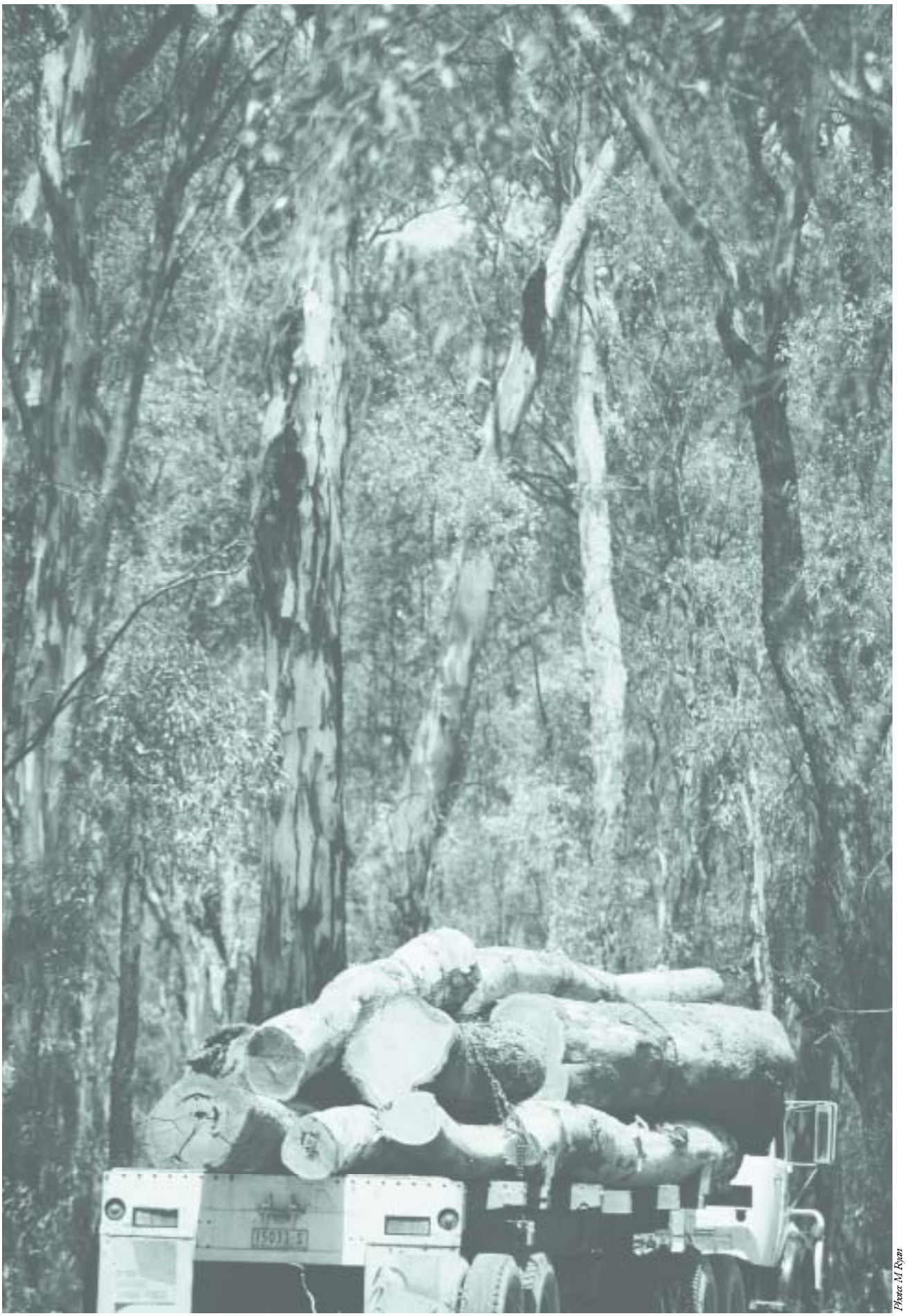


Photo: M Ryan

# *Forest Industries*

Society expects forests to deliver a wide range of products and services, from timber and grazing to the conservation of biological diversity and water quality. The emphasis placed on any one or several of such products and services in forest management regimes will influence the state of the forests. The perceived economic value of forests to any given sector and to the wider community will, in turn, influence decisions on forest policy and management. Illuminating the nature of economic activities in forests will provide the community with an opportunity to weigh the benefits of such activities against their costs. For these reasons, it is important to quantify the economic role of forest industries in Australian society.

## Value of non-wood products

Only a small amount of information on the economic role of sectors such as tourism and recreation, grazing and minor forest product extraction is presented in this report. There are two main reasons for this: first, data collection for some such products and services is ad hoc and difficult to coordinate at a national level; and, second, it is difficult to disaggregate the role of forests for those products and services – such as grazing, honey and tourism – that are produced or conducted in both forest and non-forest areas. The quantity and quality of information available for regions with major wood-producing forests are significantly better than for the forests in the agricultural and pastoral zones.

For this report, State and Territory agencies were asked to report on the revenue generated by non-wood forest products for which they were responsible. Table 50 presents the data obtained.

## Wood-based forest industries

Most of the information contained in this chapter relates only to the three principal wood-based forest industries: forestry and logging (and related services); wood manufacturing; and paper production (see Box 15 for a description of each).

**Table 50: Revenue from non-wood forest products, as reported by various State and Territory agencies**

| | ($) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Financial year | ACT | NSW[1] | NT | Qld | SA[4] | Tas | Vic | WA |
| 1990/91 | N/A | 14 281 | N/A | N/A | 180 000 | | N/A | N/A |
| 1991/92 | N/A | 14 438 | N/A | N/A | 139 000 | | N/A | N/A |
| 1992/93 | N/A | 16 597 | N/A | N/A | 134 000 | | N/A | N/A |
| 1993/94 | N/A | 17 696 | N/A | N/A | 117 000 | 1 351 654[2] | N/A | N/A |
| 1994/95 | N/A | 17 959 | N/A | N/A | 96 000 | 1 630 653[3] | N/A | N/A |
| 1995/96 | N/A | 18 737 | N/A | N/A | | | N/A | N/A |

*N/A –Not available*
*[1] Revenue from licences, permits, leases, rentals, entry and camping fees, and other miscellaneous forest uses.*
*[2] Revenue from apiary site rent and national park user fees.*
*[3] Revenue from apiary site rent, national park user fees, plus lease and licence fees.*
*[4] Revenue from recreation and grazing/agistment.*
*Source: National Forest Inventory (1997).*

### Box 15: The three wood-based forest industries

The definitions of the wood-based forest industries used here are based on those of the Australian Bureau of Statistics:

- Forestry and logging (and related services) – businesses engaged in setting up, maintaining and harvesting native and plantation forests and producing roughly cut timbers such as mine shaft supports, posts, railway sleepers and the like.
- Wood manufacturing – businesses engaged in all types of manufacture from milling rough and dressed timbers (for such uses as housing frames, floorboards, weatherboards and mouldings); to manufacturing wooden packaging, plywood, veneers, particleboard, chip board, soft and medium density fibreboard, laminated timbers, wooden doors and wooden structural fittings (such as prefabricated components); to producing hardwood chips. A notable exclusion from this category is timber furniture, which cannot be separated from furniture manufacturers using raw materials other than wood, particularly plastic and metal.
- Paper production – businesses engaged in manufacturing wood pulp, paper, paperboard, cardboard sheets and boxes, personal care products and miscellaneous other paper products such as paper dressmaking patterns, drinking straws and cellulose fibre insulation.

## The national account

There are several indicators of an industry's value to the national economy, including:

- share of the economy (measured as a percentage of gross domestic product);
- profit;
- the amount of wages and salaries paid within it; and
- the value it adds to the raw materials it consumes (value adding).

### Share of the economy

Collectively, the wood-based forest industries contributed more than $4.3 billion to the gross domestic product (GDP): this represented just over 1 per cent of GDP. In total, this contribution ranged between 0.7 per cent (net indirect taxes) and 1.3 per cent (wages and salaries). GDP (total value added to the economy) represents the total market value of goods and services produced in Australia over a given period after deducting the costs of goods and services used up in the process of production but before deducting consumption of fixed capital (depreciation).

In 1989–90, GDP was estimated at $376 billion, and comprised 109 industries, each contributing between $100 million and $31.5 billion (or 0.03–8.4 per cent) to it.

Industry gross product (IGP) refers to industry value added. The sum of the IGPs or value added by industry gives total GDP. Table 52 shows the IGP of various wood-based forest industries, and a range of others for comparison.

Three economically important industries – construction, residential and non-residential building and housing rental – are, directly or indirectly, large users of wood-based forest products: Table 52 shows the IGP of these industries. Timber is also used extensively in furniture, but the available information on furniture does not distinguish between that made from timber and that made from other materials such as plastics and metals.

### Profit

An industry's profit is known as its gross operating surplus, which is the difference between the cost of producing a product, including buying the raw materials, and the price received for it. Forest industries contributed 1.1 per cent to the nation's profit in 1989–90 (Table 51).

**Table 51: The contribution of the forestry and wood and paper-based industries to the national economy, as indicated by various economic measures, 1989–90**

| Category | Forestry ($m) | Wood and paper ($m) | Total forest industries ($m) | Total economy ($m) | Forest industries' share of category (%) |
|---|---|---|---|---|---|
| Wages, salaries | 449 | 1 770 | 2 219 | 172 528 | 1.3 |
| Gross operating surplus (GOS) | 308 | 1 476 | 1 784 | 158 551 | 1.1 |
| Industry gross product (IGP) at factor cost | 757 | 3 246 | 4 003 | 331 079 | 1.2 |
| Indirect taxes (net) | 27 | 75 | 102 | 14 361 | 0.7 |
| Commodity taxes (net) | – | 228 | 228 | 18 844 | 1.2 |
| Industry gross product (IGP) at market value | 785 | 3 549 | 4 334 | 364 284 | 1.2 |
| Gross domestic product (GDP) | N/A | N/A | N/A | 375 507 | N/A |

*N/A – Not applicable.*
*Source: Australian Bureau of Statistics (1995a).*

**Table 52: Industry gross product for various sectors of the wood-based forest industry and some non-forest-related industries, 1989–90**

| Industry | Rank[(1)] | Share of economy (%) | Value ($m) |
|---|---|---|---|
| **Forest industries** | | | |
| Sawmilling | 61 | 0.24 | 909.5 |
| Joinery and wood products (miscellaneous) | 66 | 0.22 | 811.3 |
| Pulp, paper and paperboard | 67 | 0.21 | 802.9 |
| Forestry and logging | 68 | 0.21 | 784.7 |
| Bags and containers | 79 | 0.14 | 534.4 |
| Veneers, manufactured wood boards | 99 | 0.07 | 248.5 |
| Paper products (miscellaneous) | 101 | 0.06 | 242.3 |
| *All forest wood-based industries* | | *1.15* | *4 333.6* |
| **Other industries** | | | |
| Housing rental | 2 | 7.95 | 29 860.6 |
| Construction | 6 | 4.63 | 17 393.3 |
| Coal, oil and gas | 9 | 2.76 | 10 369.2 |
| Residential building | 10 | 2.30 | 8 656.3 |
| Non-ferrous metal ores | 21 | 1.07 | 4 060.2 |
| Sheep | 22 | 1.07 | 4 035.3 |
| Cereal grains | 35 | 0.59 | 2 232.0 |
| Meat cattle | 43 | 0.46 | 1 731.4 |

*(1) Position on the list of 109 industries in the Australian economy, from largest to smallest.*
*Source: Australian Bureau of Statistics (1995b).*

## Wages and salaries

The wood-based forest industry's wages and salary bill is not collated nationally by the Australian Bureau of Statistics. However, national account figures prepared by the Bureau for the 1989–90 financial year (Table 51) indicate that the forestry and wood and paper-based industries spent just over $2.2 billion on wages and salaries in that year. The public sector is involved only in what the Bureau calls forestry and logging; this sector's component of the total wages and salaries for the period 1983–84 to 1993–94 is shown in Figure 21.

While not directly comparable with Australian Bureau of Statistics data, the Australian Taxation Office has data on the wages and salaries paid by employers engaged in both

public and private wood-based forest industries. Table 53 shows that the three wood-based forest industries paid about $1.1 billion in wages and salaries in 1994, largely in the paper-making sector. This reflects the fact that the paper industry consists mainly of a few large, geographically isolated operations, with a workforce that has traditionally consisted largely of in-house employees rather than contractors. By contrast, there are many more operators in forestry and logging, most of whom are sole traders and partnerships that do not, for tax purposes, pay themselves wages or salaries. In the sawmill industry, only about 25 per cent of sawmill operators paid wages and salaries in 1994.

### Value adding

An industry's contribution to the economy can be expressed as value adding, the value that an industry adds to its raw materials. This figure for the wood-based forest industry is shown as part of Table 51, expressed as industry gross product at factor cost.

Value adding can be viewed as the difference between the cost of raw materials and wages involved in manufacturing a product and the price received for it. Figure 22 presents value adding data for wood and paper products over the period 1984–85 to 1995–96.

### Turnover

Figure 23 shows turnover in the wood and paper products industries for the 12 years for which figures are available (1985–96).

## Employment

Table 54 shows the direct employment generated by the forest sector from 1988 to 1995. The total number of employees in the sector declined slightly over the period, from 86 300 in 1988 to 84 200 in 1995. An increase in the number of employees in log sawmilling and timber dressing (16 100 in 1988 to 19 900 in 1995) was offset by a decline in employment in paper and paper product manufacturing (28 000 in 1988 to 23 300 in 1995). The total number of people employed in Australia increased over the period; thus, the number of employees in the forest sector declined as a proportion of all employees nationally, from 1.17 per cent in 1988 to 1.02 per cent in 1995.

No national-level data are available for the role of the forest sector in generating indirect employment.

### Average wages

Table 55 shows the average annual wages in the wood-based forest industries, and compares these with wages in agriculture and with the national average.

## Industry structure

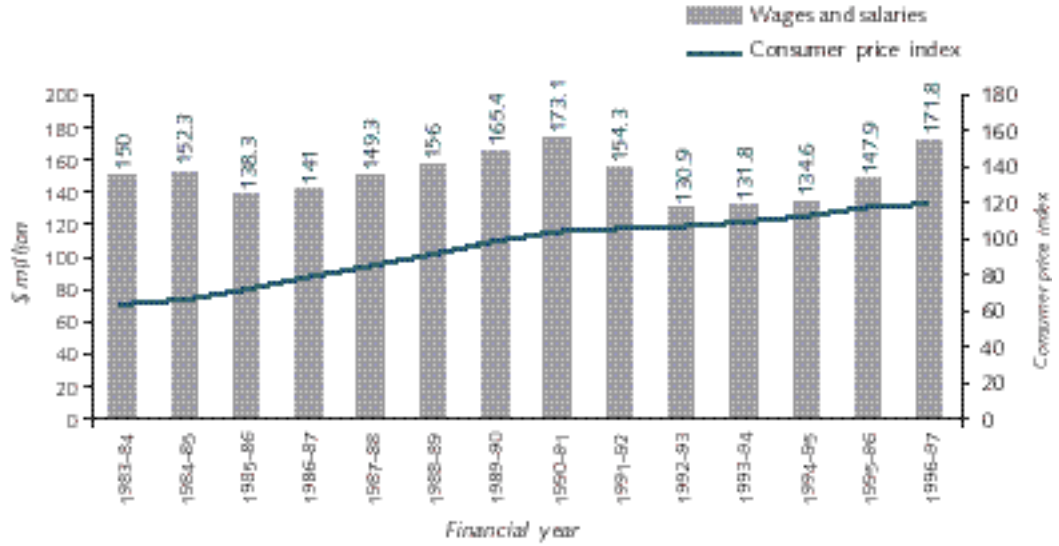
There is little information available at a national level on the economic structure of the wood-based forest industries. Being mostly private commercial enterprises, much information is considered commercially sensitive and, therefore, confidential, making

**Table 53: Wages and salaries paid by the wood-based forest industries, 1992–93 and 1993–94**

| State/ Territory | Forestry and logging ($m) | | Sawmilling ($m) | | Paper ($m) | | Totals ($m) | |
|---|---|---|---|---|---|---|---|---|
| | 1992–93 | 1993–94 | 1992–93 | 1993–94 | 1992–93 | 1993–94 | 1992–93 | 1993–94 |
| ACT | 7.2 | 7.5 | 12.1 | 3.8 | 2.7 | 1.1 | 22.0 | 12.4 |
| NSW | 11.2 | 28.6 | 60.4 | 94.8 | 220.1 | 206.2 | 291.8 | 329.6 |
| Qld | 8.8 | 10.8 | 73.6 | 76.3 | 33.5 | 33.7 | 115.9 | 120.8 |
| SA | 24.2 | 27.9 | 10.1 | 5.9 | 9.9 | 6.8 | 44.2 | 40.6 |
| Tas | 19.1 | 18.5 | 26.9 | 33.9 | 52.1 | 51.3 | 98.1 | 103.7 |
| Vic | 36.4 | 39.0 | 47.4 | 51.3 | 347.0 | 327.6 | 430.8 | 417.9 |
| WA | 4.2 | 7.2 | 52.9 | 53.1 | 5.1 | 4.8 | 62.2 | 65.1 |
| **Total** | **111.1** | **139.5** | **283.4** | **319.2** | **670.4** | **631.5** | **1065.0** | **1090.0** |

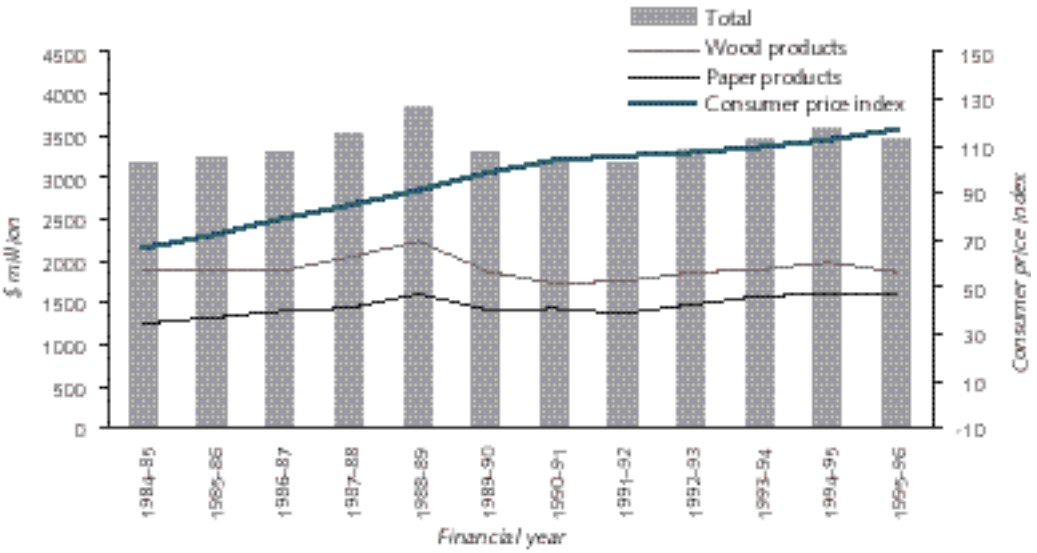
*Note: Column or row total may not add up due to rounding.*
*Source: Australian Taxation Office (1994a).*

**Figure 21: Wages and salaries (public sector only) for the forestry and logging industry**



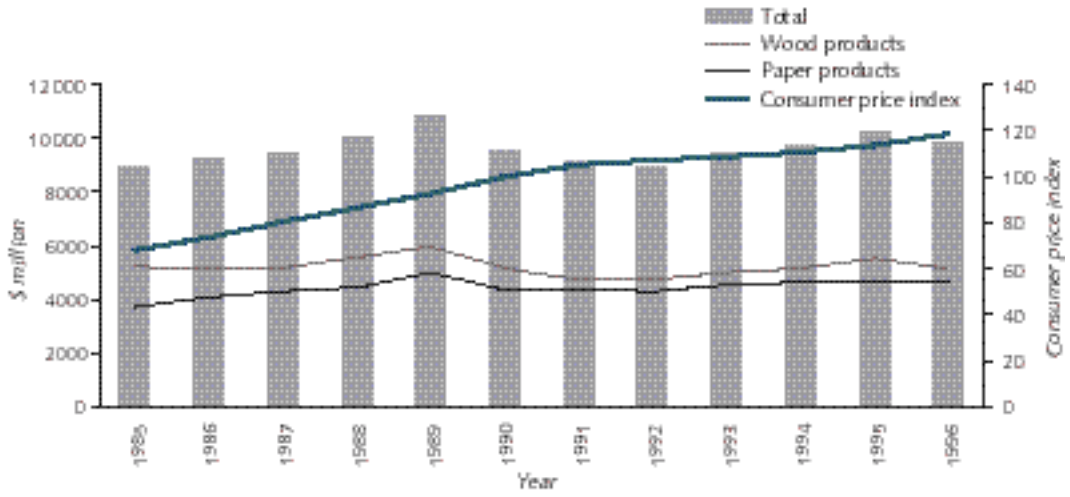

Source: Australian Bureau of Statistics (1998h).

**Figure 22: Value adding for wood and paper products, 1984–85 to 1995–96**




Note: Data points for 1985–86 are estimated.
Source: Australian Bureau of Statistics (1998c).

**Figure 23: Turnover for wood and paper products, 1985 to 1996**




Note: Data points for 1986 are estimated.
Source: Australian Bureau of Statistics (1998d).

**Table 54: Direct employment in the forest sector**

| | ('000 employees) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
| Forestry and logging | 11.8 | 12.4 | 10.9 | 10.9 | 11.0 | 10.8 | 12.4 | 11.0 |
| Log sawmilling and timber dressing | 16.1 | 19.8 | 18.1 | 16.5 | 16.9 | 19.2 | 19.8 | 19.9 |
| Other wood product manufacturing | 30.4 | 37.3 | 34.2 | 31.0 | 31.8 | 36.1 | 30.7 | 30.0 |
| Paper and paper product manufacturing | 28.0 | 24.5 | 23.3 | 22.1 | 20.7 | 18.4 | 20.2 | 23.3 |
| Total forestry and wood products sectors | 86.3 | 94.0 | 86.5 | 80.4 | 80.4 | 84.5 | 83.1 | 84.2 |
| **Total employees** | **7 366** | **7 716** | **7 837** | **7 668** | **7 612** | **7 645** | **7 885** | **8 217** |
| **Forest and wood products as a proportion of total employees (%)** | **1.17** | **1.22** | **1.10** | **1.05** | **1.06** | **1.11** | **1.05** | **1.02** |

*Source: Australian Bureau of Statistics (1995c).*

**Table 55: National summary of average annual wages in the forestry sector, compared with agriculture and the national average, 1993–94**

| Sector | Average wage ($) |
|---|---|
| Forestry, logging | 34 249 |
| Log sawmilling and timber dressing | 24 805 |
| Other wood manufacturing | 23 927 |
| Paper and paper manufacturing | 41 071 |
| Agriculture | 17 854 |
| All industry | 31 720 |

*Source: Australian Bureau of Statistics (1996).*

collection and collation difficult. The pulp and paper sector is an exception: the Pulp and Paper Manufacturers Federation of Australia, representing five major companies that claim to make up 98 per cent of the sector, produces annual statistics concerning its sector.

## Large organisations

In the public sector, there is an agency or quasi-government organisation in each State and the Australian Capital Territory responsible for selling timber from publicly owned multiple-use native forests and plantations. In the private sector, more than 30 major participants in the forest wood-based industries (listed in Table 56) and numerous small enterprises (mostly regional sawmills) participate in the industry.

## Business establishments

Table 57 shows that there was a total of 6853 business establishments engaged in wood-based forest industries in 1996. (The term 'business establishment' covers places of business, not legal entities such as a partnership or company.)

Of the 423 paper and paper product facilities in1995, 53 were large facilities (listed in Table 58) devoted either to pulp and paper-making or to the conversion of bulk products into a form used by consumers (such as individual tissues from bulk tissue and cartons from bulk cardboard).

The sawmilling sector currently comprises about 1200 sawmills of varying sizes, widely dispersed. About 10 per cent of mills produce about 90 per cent of all sawn timber. More than half – 58 per cent – employ between 5 and 50 people. Another 37 per cent are smaller than this, with fewer than five employees each.

Traditionally, sawmills have processed either softwood or hardwood, but not both. The smaller operations mostly use native forest hardwoods, while the larger sawmills, including most of the 29 mills dedicated to the production of woodchips, rely more on plantation-grown softwoods. The biggest sawmills are more capital-intensive and technologically advanced than the smaller mills.

## Capital investment

The processing of wood is dependent on machinery. If an industry is economically viable in the long term, it must either continually purchase new equipment or invest in the repair and maintenance of existing equipment. Over time, trends in capital investment, taken together with trends in the amount of money spent on repairs and maintenance, may provide an indicator of the state of a forest-based industry, which, in turn, will affect the state of the forests more generally.

There are few national statistics available concerning capital investment in the wood-based forest industries. There is also a grey area between capital investment and repairs and maintenance, as it may be a matter of judgment whether an expense is within one category or another. For example, the purchase of a new piece of plant could be considered either a repair or a capital investment.

### *Depreciable assets*

The Australian Taxation Office figure for depreciation in an industry is likely to reflect investment, depending on the depreciation schedule chosen. Hence 'depreciation' is a crude proxy for 'recent investment'. Low depreciation would indicate either very old or very small plant, and vice versa.

The figures in Table 59, obtained from the Australian Taxation Office, suggest that, of the three wood-based forest industries, the paper manufacturers have the most plant. The table also shows that the paper manufacturers increased their investments in the early 1990s. Industry figures support this: Table 60 shows that fixed capital investment (or current book value of land, forests, buildings and plant) on the part of the five major participants increased in the early to mid-1990s.

### *Repairs and maintenance*

Table 61 presents data on the amount of money the three wood-based forest industries spent on repairs and maintenance in 1992–93 and 1993–94.

## Table 56: Major participants in the wood-based forest industries, and their commercial activities

| | a | b | c | d | e | f | g | h | i | j | k | l | m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Amcor | | ✓ | | ✓[1] | | | | | | | | ✓ | ✓ |
| Associated Kiln Driers | | ✓ | | ✓ | | ✓[2] | | | | | | | |
| Auspine | | ✓ | | ✓ | | ✓ | | | | | | | |
| ANM | ✓ | ✓ | | | | | | | | | | ✓ | ✓ |
| Boral | ✓ | | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | | |
| Brims D G | | | | | | | | ✓ | ✓ | ✓ | | | |
| BTR (Laminex) | | | | ✓ | | | | | | ✓ | ✓ | | |
| CHH | ✓[3] | | | ✓ | | ✓[4] | | | ✓ | | | ✓ | ✓ |
| CSR | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Fenning Timbers | | | ✓ | | | | | | | | | | |
| Ford Timbers | | | ✓ | | | | | | | | | | |
| French Enterprises | | ✓ | | ✓ | | | | | | | | | |
| Gunnersen Companies | | | ✓ | ✓ | | | | ✓ | ✓ | | | | |
| Gunns | | | ✓ | | ✓ | | | ✓ | | | | | |
| Hansol Australia | ✓ | | | | | | | | | | | | |
| Harris Diashowa | ✓[5] | | | | ✓ | | | | | | | | |
| Henderson D&R | | | | ✓ | | | | | | ✓ | | | |
| Hyne & Sons | | | ✓ | ✓ | | | | | | | | | |
| Kimberley-Clark Aust | | | | | | | | | | | | ✓ | ✓ |
| Midway Wood Prods | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | | | |
| Mitsui | ✓ | | | | | | | | | | | | |
| North Forest Products | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | | | |
| Pacific Forest Corp | ✓[6] | ✓ | | ✓ | | | | | | | | | |
| QLD Commodity Exports | | | | | | ✓ | | | | | | | |
| Smith N Industries | | | ✓ | | | | | | | | | | |
| Starwood | | ✓[7] | | | | | | | | | ✓[8] | | |
| Tasmanian Wood Panels | | | | | | | | | | ✓ | | | |
| Timbercorp | ✓[9] | | | | | | | | | | | | |
| Wesfarmers (Bunnings) | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | |
| Wesfi | | ✓ | | ✓[10] | | | | ✓ | ✓ | ✓ | ✓ | | |
| Whittakers | | | ✓ | | ✓ | | | | | | | | |
| J Wright & Sons | ✓ | ✓ | | ✓ | | ✓[11] | | | | | | | |
| Xylem Investments | | ✓[12] | | ✓[12] | | ✓[12] | | | | | | | |

*Column heading codes:*

*a. Hardwood plantations*
*g. Softwood log exports*
*b. Softwood plantations*
*h. Decorative veneer*
*c. Sawn hardwood*
*i. Plywood/LVL*
*d. Sawn softwood*
*j. Particle board*
*e. Hardwood pulpwood exports*
*k. Medium density fibreboard*
*f. Softwood pulpwood exports*
*l. Pulp*
*m. Paper and particle board*

*Note: Organisations that are engaged solely in the ownership of forests are excluded.*

*[1] Brown & Dureau.*
*[2] Joint venture with Vic Plantations Corporation and J Wright & Sons.*
*[3] Establishment and maintenance, but not ownership.*
*[4] Joint venture with PISA.*
*[5] Limited involvement.*
*[6] Managed for investors*
*[7] Joint venture with Forestry Tasmania.*
*[8] Plant under construction.*
*[9] Managed only.*
*[10] Joint venture with Wesfarmers.*
*[11] Joint venture with Vic Plantations Corporation and AKD in the development stage.*
*[12] Involvement is through equity investment in Auspine.*

*Source: Australian Forest Products Industry Review (1996).*

## Table 57: The number of establishments engaged in the wood-based forest industries

| Industry | March '94 | June '95 | June '96 | Sept '97 |
|---|---|---|---|---|
| Forestry | 50 | 77 | 96 | 146 |
| Services to forestry | 490 | 512 | 566 | 608 |
| Logging | 883 | 1 028 | 1 235 | 1234 |
| Log sawmilling | 717 | 695 | 764 | 723 |
| Timber resawing and dressing | 159 | 141 | 156 | 145 |
| Wood chipping | 29 | 43 | 47 | 42 |
| Other wood products[1] | ND | ND | 3 565 | ND |
| Paper and paper product manufacturing | 423 | 424 | 424 | 399 |
| **Total** | **2751** | **2920** | **6853** | **3297** |

*Note: Business register data are not collected regularly, hence the irregular time intervals.*
*ND – No data.*
*[1] Plywood, fabricated wood, structural components.*
*Source: Australian Bureau of Statistics (1998a).*

## Table 58: Location of pulp and paper-making facilities

| State/town or suburb | Type of plant | Company | Main fibre source |
|---|---|---|---|
| **New South Wales** | | | |
| Shoalhaven | Pulp, paper, recycling | Australian Paper | Recycled paper |
| Botany | Packing paper | Australian Paper | Recycled paper |
| Albury | Pulp, newsprint, recycling | ANM | Plantation softwood, recycled paper |
| Smithfield | Paper | Pratt Industries | Recycled paper |
| Warwick Farm | Conversion | Pratt Industries | N/A |
| Warwick Farm | Conversion | Kimberley-Clark | N/A |
| Ingleburn | Disposable nappies | Kimberley-Clark | N/A |
| Wetherill Park [1] | Conversion | ABC Tissue | N/A |
| Albury | Non-woven materials | Kimberley-Clark | N/A |
| Rutherford | Conversion | Pratt Industries | N/A |
| Seven Hills | Conversion | Pratt Industries | N/A |
| Chullora | Conversion | Pratt Industries | N/A |
| Alexandria | Conversion | The Paper House[4] | N/A |
| Location unknown | Conversion | Envelope Manufacturers and Celpac[4] | N/A |
| **Northern Territory** | | | |
| Berrimah | Conversion | Pratt Industries | N/A |
| **Queensland** | | | |
| Petrie | Pulp, coated boards | Australian paper | Recycled paper, plantation softwood |
| Carole Park, Inala | Tissue, conversion | Cosco Holdings | Imported pulp |
| Crestmead | Tissue, conversion | Paper converters | Recycled paper, softwood pulp |
| Carole Park | Conversion | Pratt Industries | N/A |
| Bulimba | Paper | Pratt Industries | Recycled paper |
| Sumner Park | Conversion | Pratt Industires | N/A |
| Darra | Conversion | Celpac [1] | N/A |
| **South Australia** | | | |
| Millicent waste, | Pulp, tissue | Australian Paper | Plantation softwood, hardwood mill |
| Millicent | Pulp, paper | Kimberley-Clark | Plantation softwood |

## Table 58 (continued): Location of pulp and paper-making facilities

| State/town or suburb | Type of plant | Company | Main fibre source |
|---|---|---|---|
| Lonsdale | Conversion | Kimberley-Clark | N/A |
| Berri | Making and conversion of corrugated boxes | Pratt Industries | Recycled paper |
| Gepps Cross | Conversion | Pratt Industries | N/A |
| Dry Creek | Conversion | Pratt Industries | N/A |
| **Tasmania** | | | |
| Wesley Vale | Pulp, paper | Australian Paper | Plantation softwood and hardwood, native forest |
| Burnie | Pulp, paper | Australian Paper | Plantation softwood and hardwood, native forest |
| Boyer | Pulp, newsprint, paper | ANM | Plantation softwood, regrowth, native forest |
| Devonport | Conversion | Pratt Industries | N/A |
| **Victoria** | | | |
| Fairfield | Paper | Australian Paper | Recycled paper, plantation pulp, native forest |
| Morwell | Pulp, paper | Australian Paper | Plantation softwood and hardwood, native forest |
| Broadford | Paper | Australian Paper | Recycled paper imported pulp, |
| Box Hill | Tissues | Carter Holt Harvey | plantation hardwood and softwood, pulp, hardwood mill waste |
| Myrtleford | Pulp | Carter Holt Harvey | Plantation softwood, hardwood forest residues, recycled paper |
| Reservoir | Paper | Pratt Industries | Recycled paper |
| Coolaroo | Paper | Pratt Industries | Recycled paper |
| Dandenong | Conversion | Pratt Industries | N/A |
| Westall | Conversion | Carter Holt Harvey | N/A |
| Keon Park | Conversion | Carter Holt Harvey | N/A |
| Noble Park | Conversion | Pratt Industries | N/A |
| Swan Hill | Conversion | Pratt Industries | N/A |
| Shepparton | Conversion | Pratt Industries | N/A |
| Epping | Conversion | Pratt Industries | N/A |
| Mulgrave | Conversion | pratt Industries | N/A |
| Bayswater | Conversion | Pratt Industries | N/A |
| South Oakleigh | Conversion | The Paper House[1] | N/A |
| Hallam | Conversion | Tomasetti Paper[1] | N/A |
| **Western Australia** | | | |
| Spearwood | Paper | Australian Paper | Recycled paper |
| Canning Vale | Tissue, conversion | Austissue | Recycled paper |
| O'Connor | Conversion | Pratt Industries | N/A |

*[1] Owned by Australian Paper.*
*N/A – Not applicable.*
*Source: Pulp and Paper Manufacturers Federation of Australia (1995).*

## Table 59: Depreciation of wood-based forest industry assets

| State/ Territory | Forestry and logging ($m) | | Sawmilling ($m) | | Paper ($m) | | Totals ($m) | |
|---|---|---|---|---|---|---|---|---|
| | 1992–93 | 1993–94 | 1992–93 | 1993–94 | 1992–93 | 1993–94 | 1992–93 | 1993–94 |
| ACT | 1.5 | 3.7 | 1.6 | 0.5 | 0.2 | 0.3 | 3.3 | 4.5 |
| NSW | 7.6 | 11.4 | 5.6 | 24.6 | 198.4 | 67.8 | 211.6 | 103.8 |
| Qld | 3.5 | 7.2 | 10.4 | 14.9 | 13.9 | 7.2 | 27.8 | 29.3 |
| SA | 8.8 | 8.7 | 2.4 | 1.4 | 1.3 | 5.3 | 12.4 | 15.4 |
| Tas | 10.0 | 4.3 | 1.2 | 8.8 | 13.2 | 123.7 | 24.5 | 136.8 |
| Vic | 11.7 | 21.2 | 9.8 | 12.9 | 78.5 | 177.7 | 99.9 | 211.8 |
| WA | 4.1 | 9.3 | 3.1 | 19.9 | 0.8 | 0.6 | 8.0 | 29.8 |
| Total | 47.2 | 65.8 | 34.1 | 82.9 | 306.3 | 382.6 | 387.6 | 531.3 |

*Note: Column total may not add up due to rounding.*
*Source: Australian Taxation Office (1994b).*

## Table 60: Capital investment in the pulp and paper industry

| Year | Investment ($m) | Increase on previous year (%) |
|---|---|---|
| June 1991 | 2706 | – |
| June 1992 | 2742 | 1.3 |
| June 1993 | 2872 | 4.7 |
| June 1994 | 2817 | –1.9 |
| June 1995 | 2981 | 5.5 |
| June 1996 | 3681 | 19.0 |
| June 1997 | 3779 | 2.6 |

*Source: Pulp and Paper Manufacturers Federation of Australia (1998).*

## Table 61: Amount spent on repairs and maintenance for the three wood-based forest industries, 1992–93 and 1993–94

| State | Forestry and logging ($m) | | Sawmilling ($m) | | Paper ($m) | | Totals ($m) | |
|---|---|---|---|---|---|---|---|---|
| | 1992–93 | 1993–94 | 1992–93 | 1993–94 | 1992–93 | 1993–94 | 1992–93 | 1993–94 |
| ACT | 3.9 | 8.0 | 9.9 | 10.7 | 37.3 | 36.8 | 51.0 | 55.5 |
| NSW | 9.8 | 12.0 | 9.8 | 10.8 | 86.8 | 30.4 | 106.4 | 53.2 |
| Qld | 2.7 | 3.2 | 12.3 | 10.3 | 4.5 | 3.8 | 19.5 | 17.2 |
| SA | 1.5 | 2.2 | 1.5 | 3.8 | 0.7 | 0.5 | 3.7 | 6.5 |
| Tas | 6.0 | 6.6 | 1.7 | 1.3 | 1.0 | 0.8 | 8.8 | 8.7 |
| Vic | 3.9 | 6.6 | 4.2 | 6.0 | 33.1 | 34.3 | 41.1 | 46.9 |
| WA | 1.9 | 2.1 | 3.4 | 1.9 | 0.2 | 0.2 | 5.5 | 4.2 |
| **Total** | **29.7** | **40.7** | **42.8** | **44.8** | **163.6** | **106.8** | **236.0** | **192.3** |

*Note: Column total may not add up due to rounding.*
*Source: Australian Taxation Office (1994c).*

## Foreign ownership

Some of Australia's pulp and paper companies have become multinational, while offshore investors, particularly those in Asia, are increasingly becoming involved in Australian wood-based forest industries.

A variety of arrangements constitute foreign involvement: Australian companies that are subsidiaries of foreign companies, joint ventures between Australian and overseas partners, major foreign shareholdings in Australian businesses, and overseas funds managers investing in Australian operations. Examples of all these can be found in the wood-based forest industries.

Shareholdings in companies listed on stock exchanges change constantly, making it difficult to identify the level of foreign investment in publicly listed Australian companies. The Foreign Investment Review Board intervenes only in transactions where control of companies worth more than $3 million may be at stake.

### *Resource ownership*

About one-third of plantations are privately owned. Table 56 lists 20 major private organisations with plantation interests. Of these, two are subsidiaries of overseas companies, two are foreign-owned, one is an overseas funds manager with equity investments in an Australian company, and one has joint venture arrangements with foreign partners. There are no comprehensive national data on the size or ownership of private native forests used for timber production.

### *Wood product manufacturers*

At least 6 of the 24 major private organisations listed in Table 56 as producers of sawnwood, veneers or reconstituted wood panels have foreign connections. One is part of an overseas-based conglomerate, one has a foreign partner, one has foreign partners in some of its operations, one is an overseas funds manager with equity investments in an Australian company, one has significant foreign shareholders, and one has a foreign company as a major shareholder.

### *Pulp and paper manufacturers*

Table 56 lists 14 pulpwood exporters. Of these, four have foreign connections: one is foreign-owned, one is a joint venture with foreign partners, one has significant foreign shareholders, and one is an overseas funds manager with equity investments in an Australian company.

Of the major pulp and paper manufacturers, Amcor and Pratt Industries are Australian-owned, Carter Holt Harvey and ANM are New Zealand-owned, and Kimberley-Clark Australia is 50 per cent Australian-owned, with a 50 per cent foreign partner.

# Raw material mix

## Annual harvest

In 1993–94 the supply of wood fibre was obtained from three basic sources: Australian forests (native and plantation), imported wood fibre (in the form of unprocessed logs, sawnwood, plywood or veneer) and recycled paper. If the total supply of wood fibre from these sources is converted to a standard measure (such as cubic metres of sawlogs, as done here), then the proportional contribution, by volume, can be calculated for each source. Thus, the annual Australian timber harvest provided 76 per cent of the raw materials needed by the wood manufacturing and paper industries, imports provided 4 per cent and recycled paper provided 20 per cent.

Figure 24 shows the uses to which that part of the wood fibre supply obtained from the annual harvest from Australian native forests and plantations are put. The apparent consumption of wood-based products in Australia (calculated by adding production and import volumes and subtracting export volumes) is shown in Figure 25.

# Markets for manufactured goods

Australia exported about 7 per cent of domestically manufactured wood-based products in 1993–94; the rest (93 per cent) were sold domestically and represented 73 per cent of the domestic market. The remaining 27 per cent of wood-based forest products for this market were imported.

### Box 16: Recycled paper

The percentage of recycled paper used in paper-manufacturing in Australia has increased steadily in recent years. For example, it was 45 per cent in 1992–93, 48 per cent in 1993–94, 52 per cent in 1994–95, 56 per cent in 1995–96 and 61 per cent in 1996–97.

In 1995–96 Australia:

- collected 1.5 million tonnes of paper for recycling;
- exported about 132 000 tonnes of that collection (10 per cent), mostly to Asia; and
- imported about 26 000 tonnes of paper for recycling, equivalent to under 2 per cent of the quantity collected in Australia.

## Production mix trends

Figure 26 shows trends in the production by volume of wood products in the period 1971–72 to 1996–97. The production of paper has increased steadily in this period, while sawnwood production has fluctuated around a steady mean. The production of particleboard has shown a slow increase over time, while medium density fibreboard, a product made from reconstituted waste or virgin fibre, is a latecomer that shows good growth prospects.

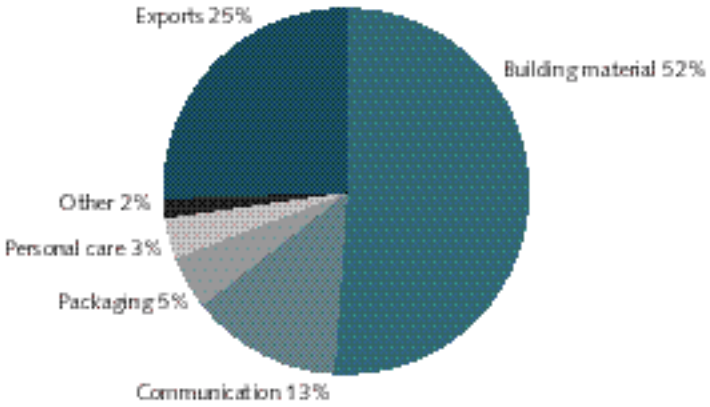
Railway sleeper production is dropping as concrete sleepers that last longer – 50 years against 20 years – replace timber sleepers. The closure of railway lines has also contributed to this decline: about 9000 kilometres of track were closed between the 1950s and the 1980s. Yet another cause of the decline is reported in Western Australia: the proportion of sawn *Eucalyptus marginata* (jarrah) timber used for value added purposes such as joinery has increased significantly in the last two decades, reducing the supply of that species for sleeper production.

## Sawnwood

Australia imports 25 per cent of all sawnwood used domestically; sawnwood exports are currently negligible. Figure 27 shows trends over time in the production, import, export and apparent consumption of sawnwood, by State and nationally.

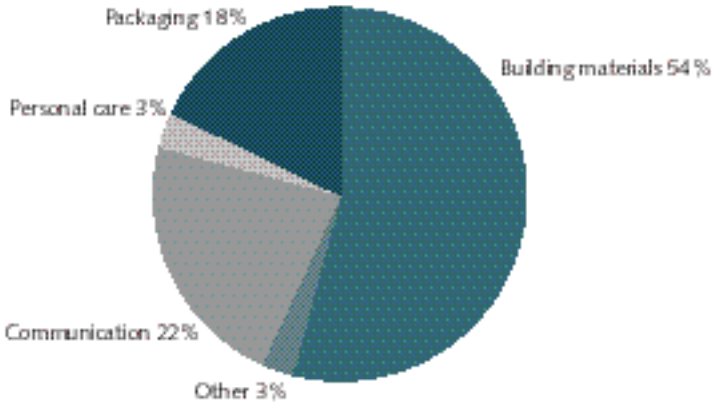
Sawnwood consumption has remained relatively constant at around 4 million cubic metres a year for 25 years. In 1996–97 consumption was about 4.0 million cubic metres, consisting of about 1.3 million cubic metres of native forest hardwood, 2.1 million cubic metres of local plantation softwood and 0.6 million cubic metres of imported timber (657 000 cubic metres of softwood, 99 700 cubic metres of hardwood).

**Figure 24: Proportion of the annual harvest of wood fibre from Australian forests assigned to each end use category**



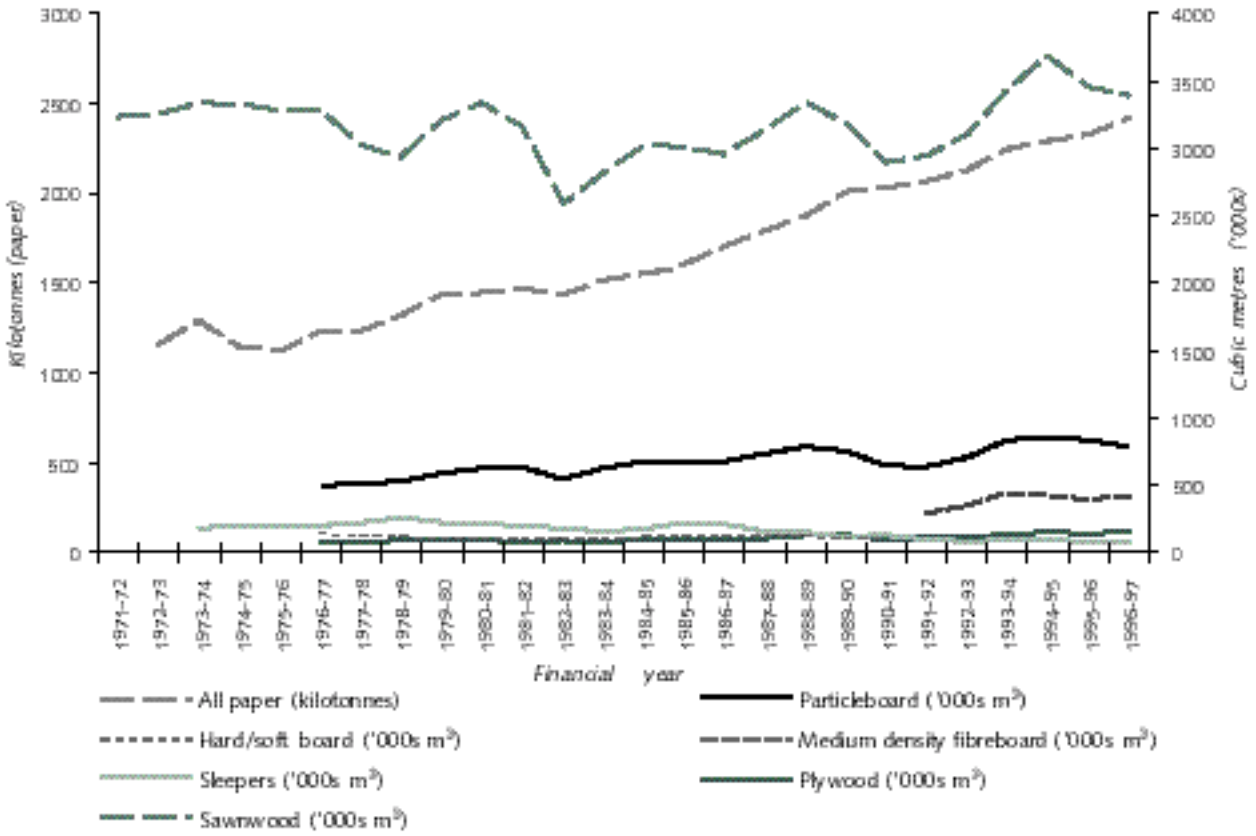

Source:
derived from Quarterly Forest Products Statistics (1993–94).

**Figure 25: Apparent consumption of imported and locally manufactured wood-based products in Australia**




Source:
derived from Quarterly Forest Products Statistics (1993–94).

**Figure 26: National production of wood-based products**




*Source:*
*Quarterly Forest Products Statistics and equivalents.*

Figure 28 shows sawnwood consumption and housing starts. Historically, the two have been closely correlated: when houses were being built, the demand for sawnwood increased, and vice versa. A divergence between the two appears to have occurred since the early 1990s, suggesting that other materials may be replacing timber in the housing construction industry.

New South Wales consistently accounts for almost half of Australia's annual sawnwood imports – close to 0.3 million cubic metres in 1996–97. Victoria, Queensland and South Australia collectively account for the other half, while the Northern Territory, Tasmania and Western Australia import negligible quantities (less than 4 per cent combined).

About 88 per cent of sawnwood imports are softwoods; the remaining 12 per cent are hardwood. In 1996–97 Australia spent $374 million on sawnwood imports.

Almost all of Australia's sawnwood suppliers are Pacific Rim nations; of these, four countries accounted for 94 per cent of the trade in 1996–97. They were:

- New Zealand (44 per cent);
- Canada (23 per cent);
- United States (19 per cent); and
- Malaysia (9 per cent).

Australia also imports minor quantities of sawnwood from Brazil, Fiji, Finland, Indonesia, Papua New Guinea, the Philippines, Singapore and the Solomon Islands.

## Other wood-based products

Figure 29 presents national data for the production, import, export and apparent consumption of railway sleepers, plywood, particleboard and medium density fibreboard. Figure 30 presents the same information for paper products.

Australia is a net importer of plywood (Figure 29) and paper products (Figure 30). While domestic production of paper and paperboard is increasing strongly, demand is increasing at a higher rate.

**Figure 27: Production, import, export and apparent consumption of sawnwood, by State and nationally**

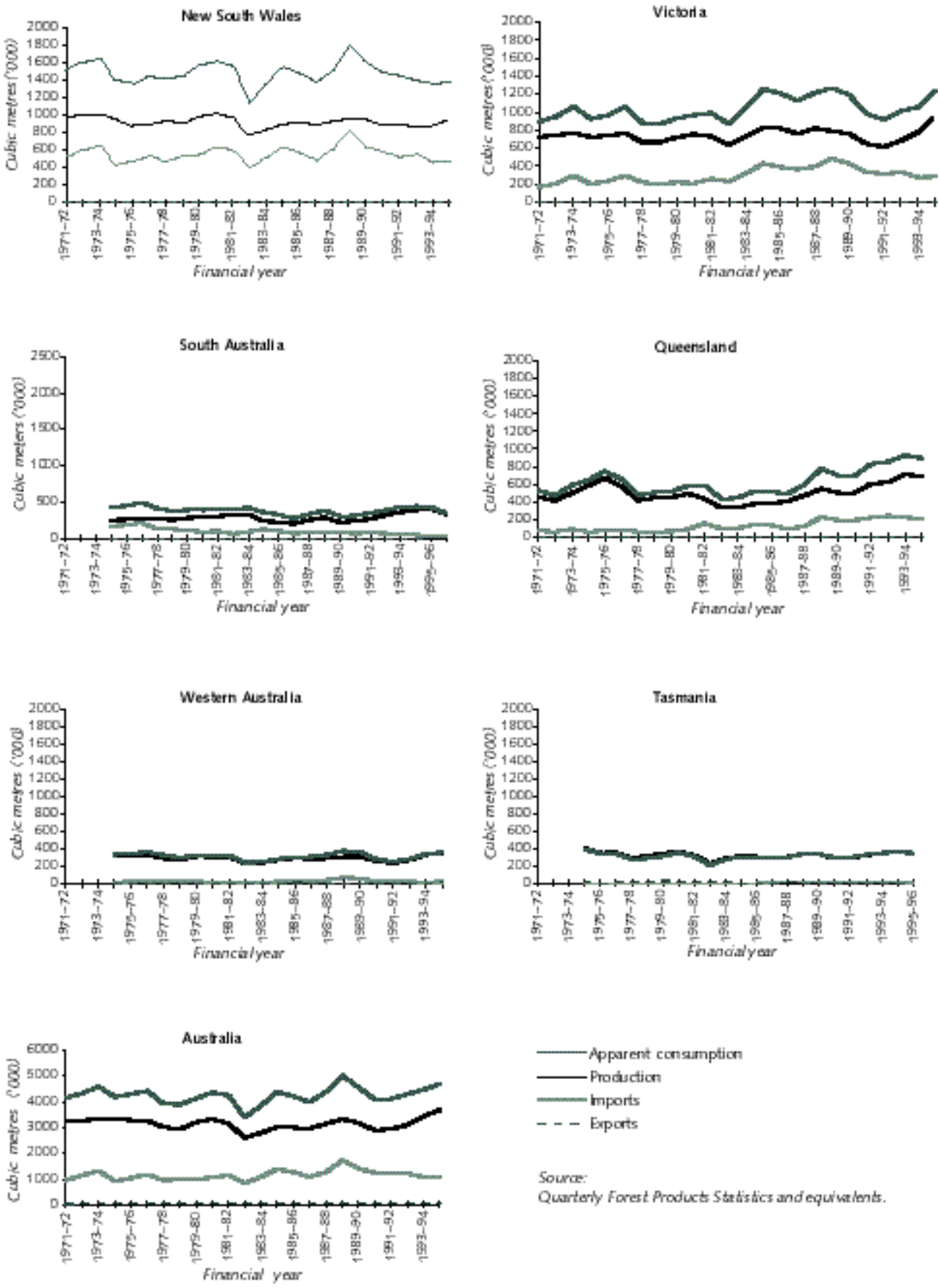
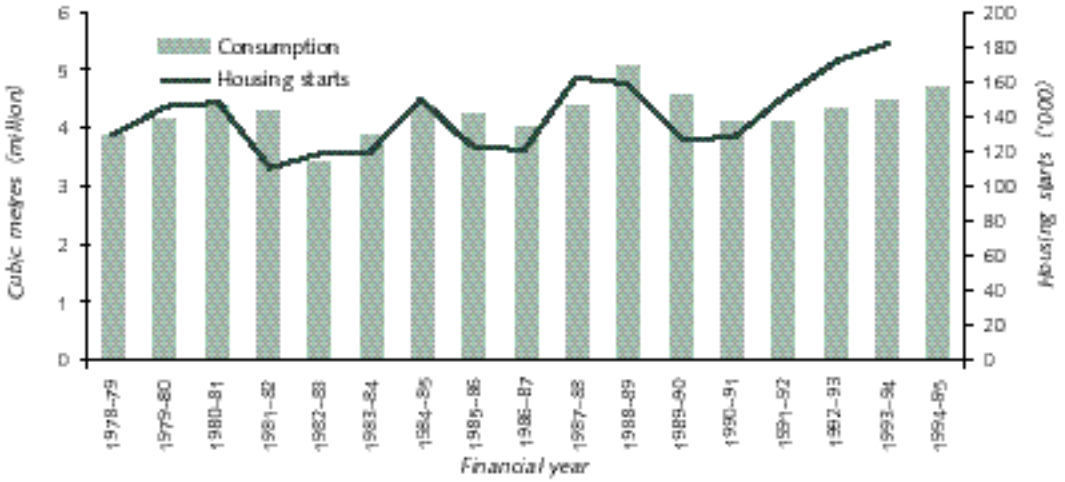
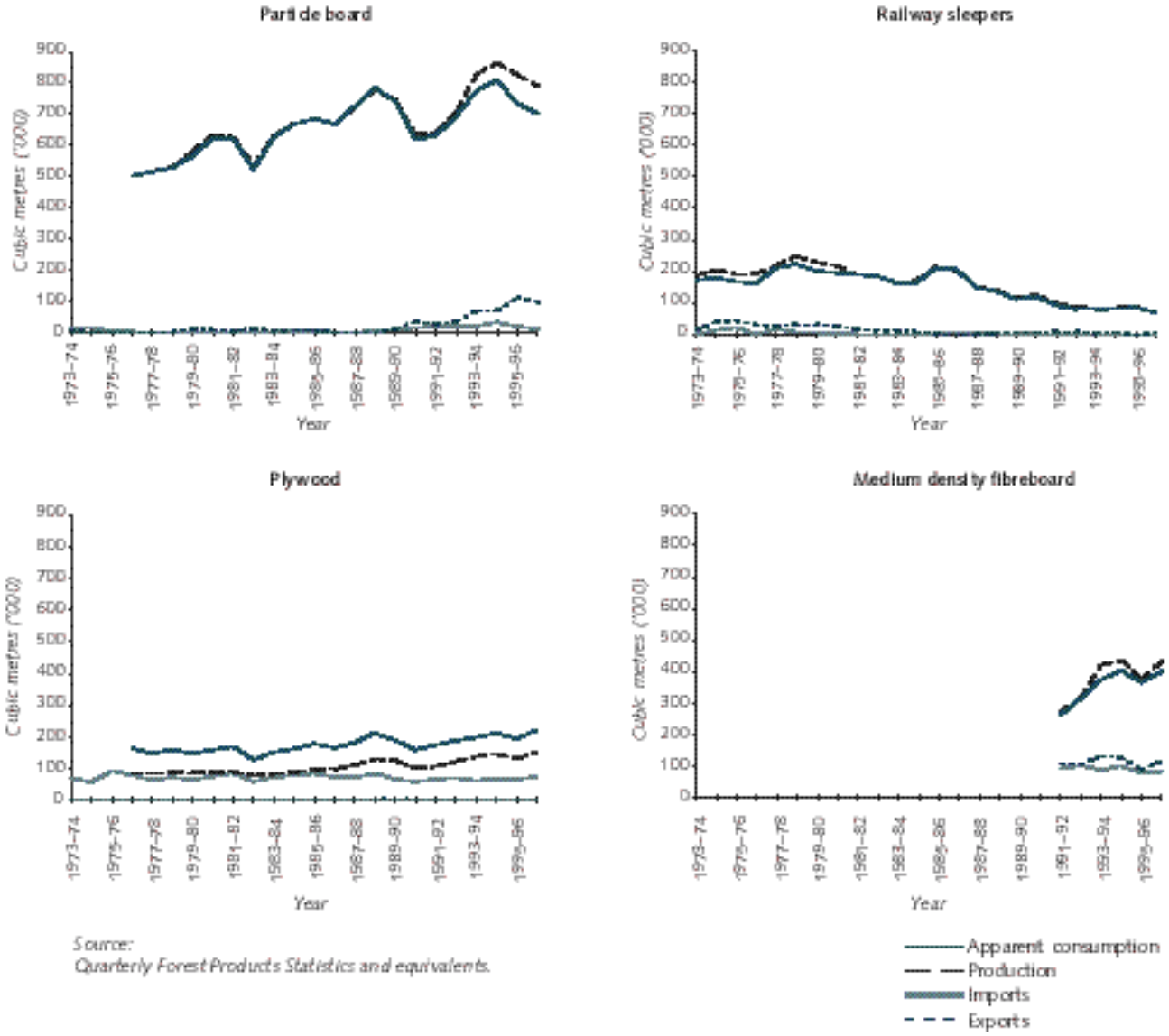


**Figure 28: Sawnwood consumption and housing starts**



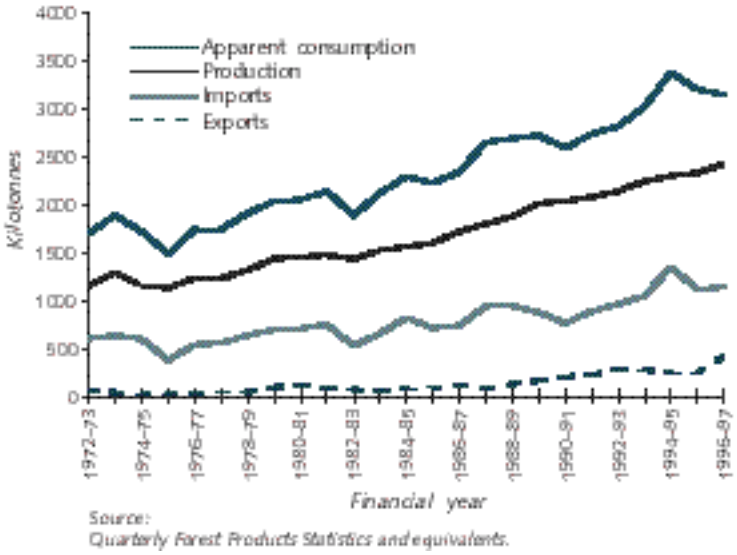

*Sources:*
*Australian Bureau of Statistics (1995d).*
*Quarterly Forest Products Statistics and equivalents.*

**Figure 29: National production, import, export and apparent consumption of railway sleepers, plywood, particleboard and medium density fibreboard**




*Source:*
*Quarterly Forest Products Statistics and equivalents.*

**Figure 30: National production, import, export and apparent consumption of newsprint and all paper and paperboard products**




Source:
*Quarterly Forest Products Statistics and equivalents.*

## Terms of trade

Australia is a net importer of forest-based products, both in volume and value. The annual deficit in the terms of trade in this sector was $1.4 billion in 1996–97. In volume terms, both imports and exports have grown in the period 1973–74 to 1996–97, but exports have grown more strongly.

To calculate the balance of trade in forest products by volume, the import and export volumes of the different forest products must be converted to the equivalent volume of roundwood needed to produce them, referred to as roundwood equivalent. Figure 31 shows import and export volumes for various products, and Figure 32 gives the balance of trade in both volume and value.

The growth in export volume is in raw materials, almost solely woodchips. Although exports of value added timber and paper products have grown substantially this decade, this growth is coming off an extremely low base and therefore has little effect on total export volume. Figure 32 suggests that the disparity in the volume versus value terms of trade is due to the fact that Australia exports mainly raw materials and imports mainly finished products. Table 62 shows that woodchip exports made up 66 per cent of all wood-based exports by volume in 1996–97and earned 48 per cent of total wood product export income.

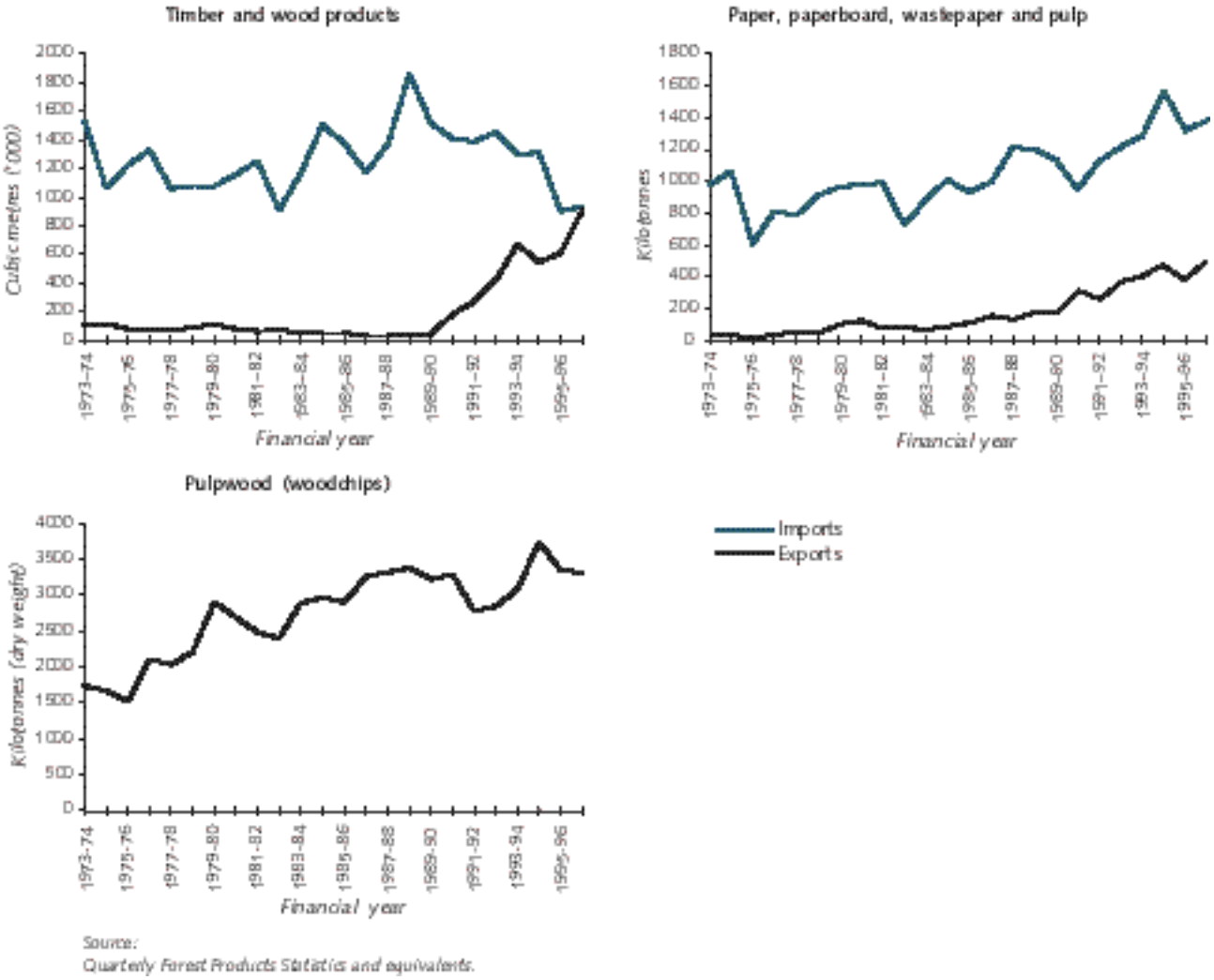
In 1993–94 imports of forest-based products cost four times as much as was earned from exports of forest-based products. Figure 33 shows that the trade deficit in wood-based products grew in the period 1973–74 to 1993–94.

## Productivity

There are too few data sets available to enable a comprehensive discussion of productivity trends nationally. Employment figures from the Australian Bureau of Statistics' Labour Force Estimates and production volume figures collected by the Australian Bureau of Agricultural and Resource Economics from State agencies have been used as a basis for productivity estimates in the three forest-based wood industries over the past 10 years.

Figure 34 shows that productivity in the forestry and logging sector (measured in thousands of cubic metres of logs delivered to the mill door annually per employee) increased by 47 per cent between 1985 and 1994. The same figure shows no clear trend in productivity in the wood manufacturing sector (measured in thousands of cubic metres

**Figure 31: Import and export volumes for various wood products, 1973–74 to 1996–97**




Source:
Quarterly Forest Products Statistics and equivalents.

processed per employee) over the 10 years between 1985 and 1994, although it was 8 per cent higher in 1994 than in 1985. The biggest increase in productivity (measured in thousands of tonnes processed per employee) over the period occurred in the paper production industry: job shedding, new technology and better waste management practices led to increases in productivity of nearly 100 per cent.

## Price indices

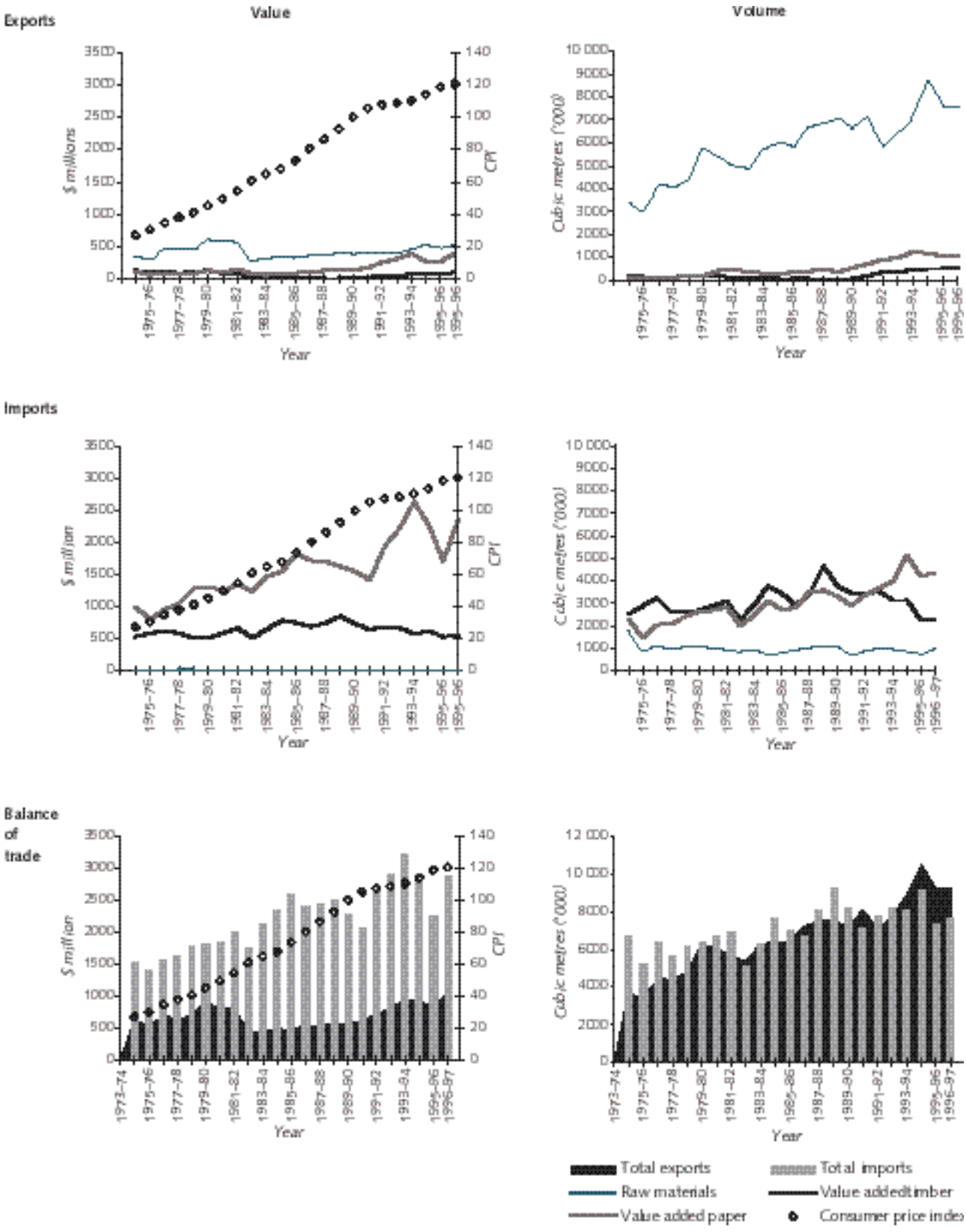
Many price indices are calculated for the wood-based forest industries. Some measure the prices of the materials used in the manufacture of particular products (the 'inputs' to production) and others measure the price of the products themselves (the 'outputs' of production). They are not adjusted for inflation.

Each index establishes a base year; the price for that year is taken as 100 points. For the hardwood and pulp and paper import indices (Figure 35 and Figure 36), the base year is 1984–85; for the woodchip index (Figure 37) it is 1988–89. In both cases, the base year is the year preceding the start of the index.

## Government revenue

Table 63 shows the total revenue earned from sales of wood from publicly owned native and plantation forests, 1991–92 to 1995–96, by State and Territory.

**Figure 32: Balance of trade in wood products, 1974–75 to 1996–97**




*Notes:*
*Volume information has been converted into roundwood consumed to allow comparisons.*
*Deflated value figures for particleboard and medium density fibreboard have been estimated from 1994–95 onward.*
*Value is given in 1989–90 dollars (SITCC).*
*Voulume is given in thousands of cubic meters (GRIWB).*
*CPI (base 1989–90 = 100).*
*Sources:*
*Australian Bureau of Statistics (1998a).*
*Quarterly Forest Products Statistic and equivalents.*

**Table 62: Export income for woodchips and non-woodchip wood products, 1996–97**

| | Woodchips | All other | Total |
|---|---|---|---|
| Roundwood used ('000 $m^3$) | 6 620 | 3 377 | 9 997 |
| | (66%) | (34%) | (100%) |
| Export income ($m) | 516 | 576 | 1092 |
| | (47%) | (53%) | (100%) |
| Unit income ($) | 78 | 170 | 109 |

*Source:Australian Forest Product Statistics (1997).*

**Table 63: Total revenue earned by State and Territory agencies from wood sales from plantation and native forests, 1991–92 to 1995–96**

| Financial year | ($'000) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | Australia |
| 1991/92 | ND | 78 550 | N/A | 43 223 | 28 550 | 27 870 | 55 819 | 70 118 | 304 130 |
| 1992/93 | ND | 82 820 | N/A | 47 328 | 32 010 | 32 182 | 53 551 | 83 896 | 331 787 |
| 1993/94 | ND | 92 293 | N/A | 58 844 | 39 040 | 35 686 | 68 812 | 93 269 | 387 943 |
| 1994/95 | ND | 102 205 | N/A | 70 183 | 41 760 | 48 682 | 80 353 | 97 714 | 440 897 |
| 1995/96 | ND | 98 394 | N/A | 70 205 | ND | ND | ND | 121 496 | N/A |

*N/A - Not applicable*
*ND - no data*
*Source: National Forest Inventory (1997).*

**Figure 33: Trade deficit in wood products (in 1989–90 dollars)**

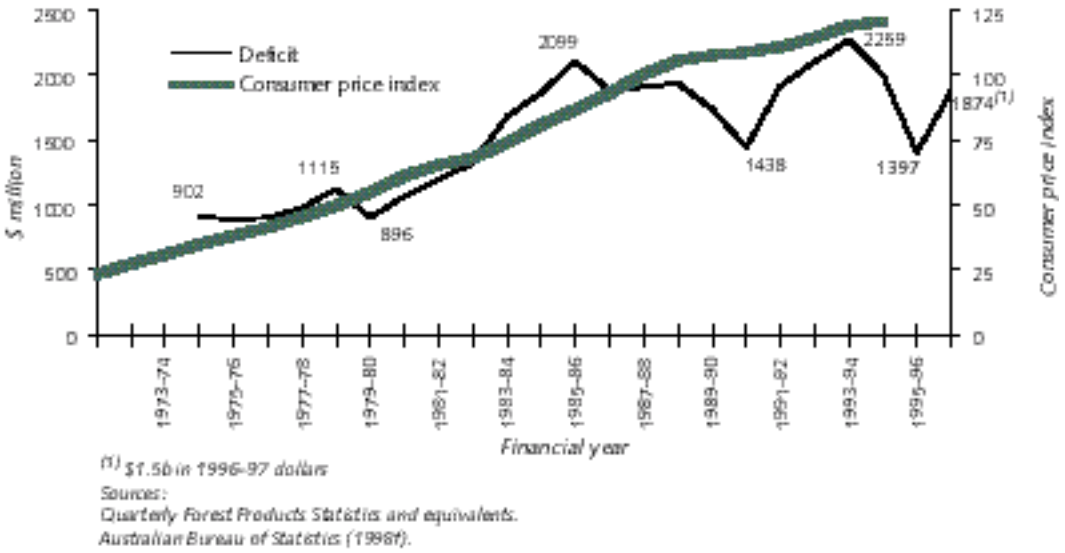
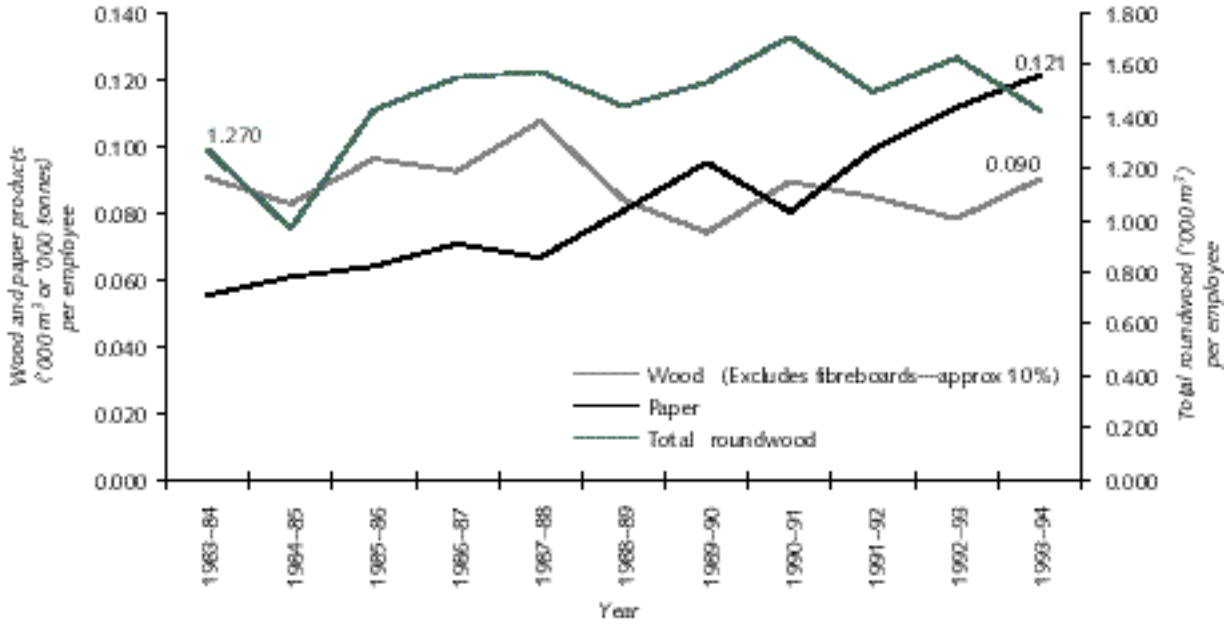
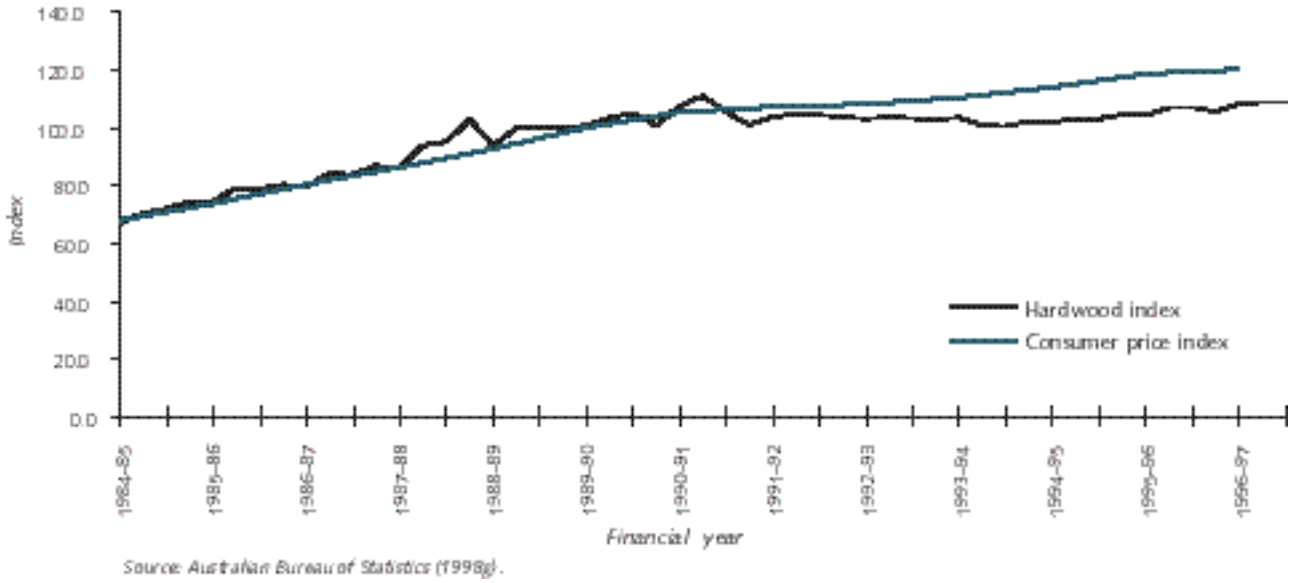


**Figure 34: Productivity of Australian forest industries per employee**



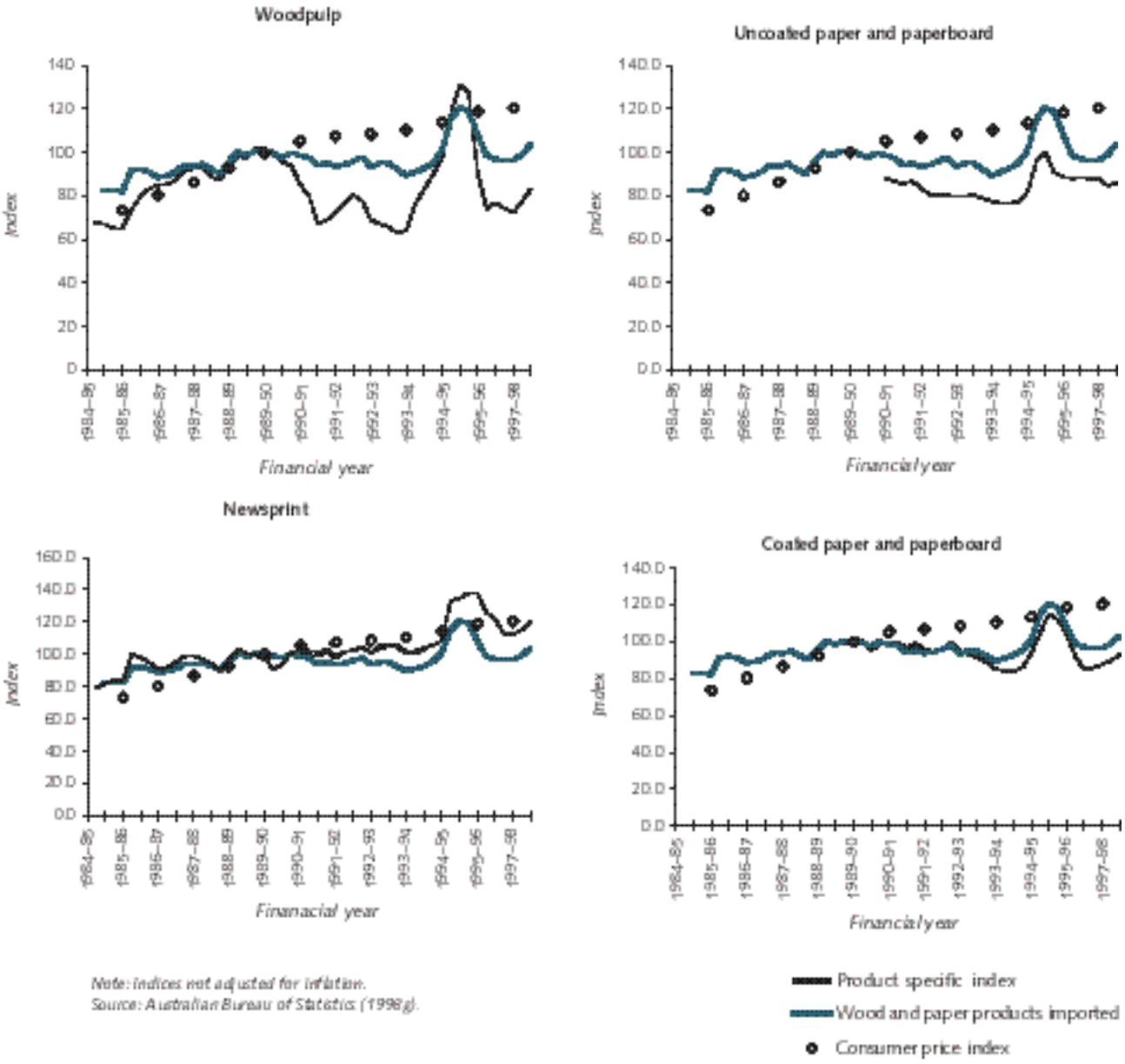

Sources:
*Year Book Australia (1997).*
*Quarterly Forest Products Statistics and equivalents.*

**Figure 35: Hardwood price index, 1984–85 to 1996–97**



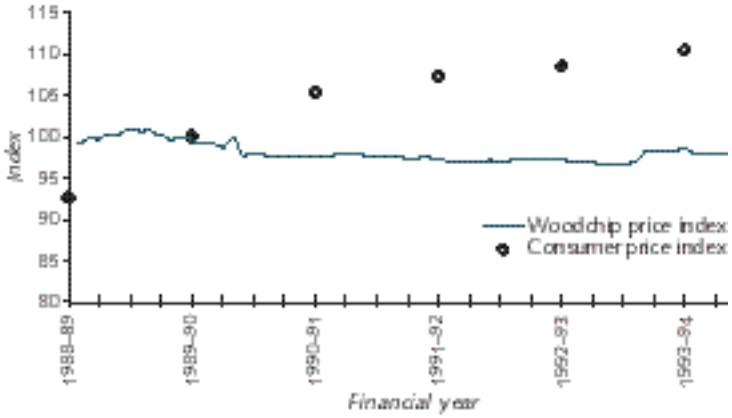

Source: Australian Bureau of Statistics (1998g).

**Figure 36: Indices for imported paper products, 1984–85 to 1997–98**



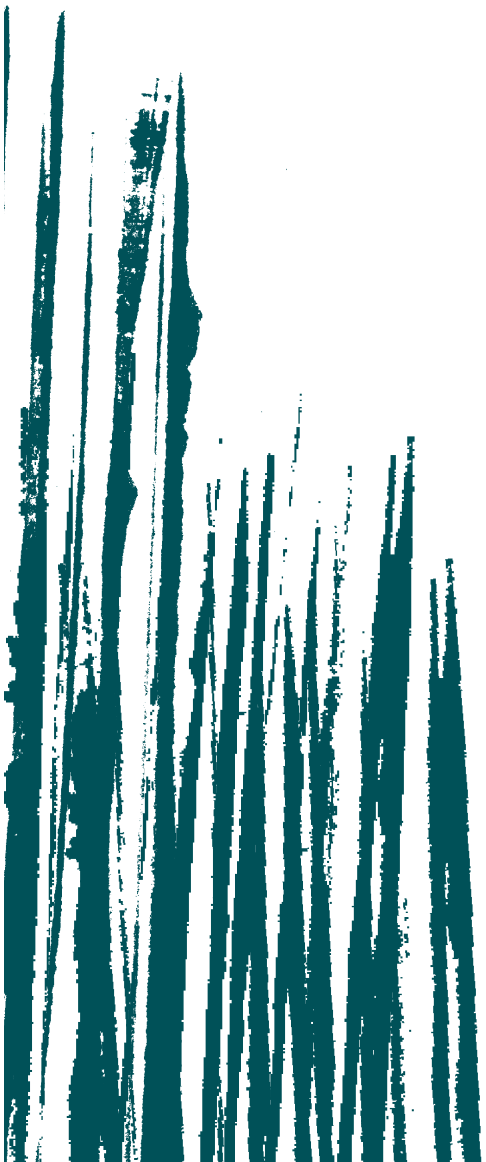

*Note: Indices not adjusted for inflation.*
*Source: Australian Bureau of Statistics (1998g).*

**Figure 37: Woodchip price index, 1988–89 to 1993–94**




*Note: Index is not adjusted for inflation.*
*Source: Australian Bureau of Statistics (1995g).*

# 7 *Social Dimensions of Forests*



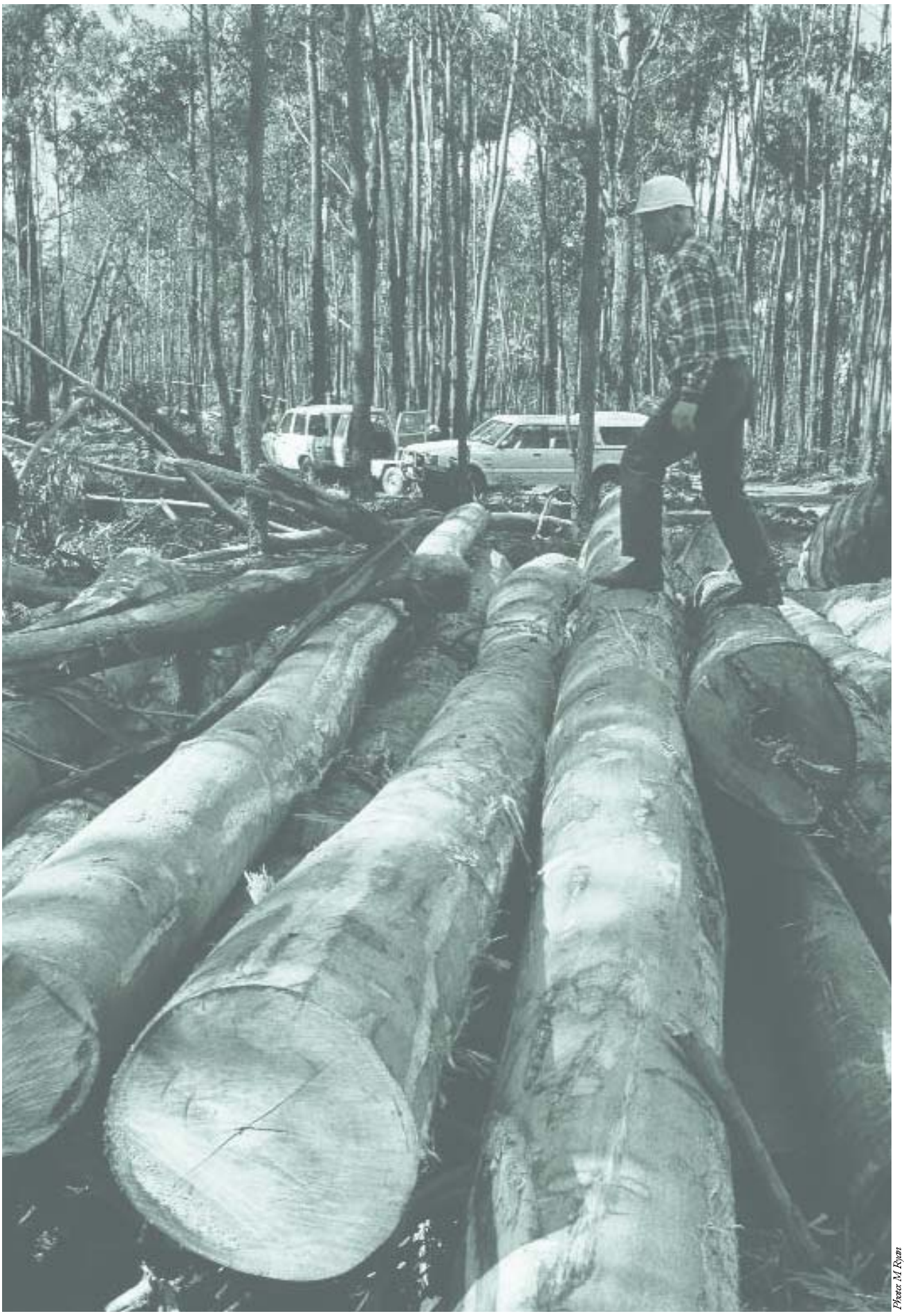


Photo: M Ryan

# *Social Dimensions of Forests*

There are a number of measures of forest worth, of which economics is only one. Forests have a social dimension: the human population interacts with them in complex ways that affect the character and well-being of the nation and the way forests are used.

Many of these interactions cannot be – or, at least, currently are not – measured. This chapter looks at those interactions between the forest and the community that are conducive to some level of quantification: the number of 'forest-dependent' communities; health and safety in the forest industries; forest research; education in the forest sector; international forest-related activities; and forest awards.

## Forest-dependent communities

Forest-dependent communities have been defined as:

> *Communities dependent upon forests for their survival. Such communities include municipalities, indigenous communities and family groups. (Technical Advisory Committee to the Montreal Process Working Group on Criteria and Indicators of Sustainable Forest Management)*

Because of the wide range of conditions prevailing amongst Montreal Process Working Group countries, this definition needs to be interpreted to meet local conditions. A measure of financial dependence of communities is the number of people employed in forest-related industries as a proportion of the total working population. In Australia, 186 towns have a forest dependency above 5 per cent (Figure 38). Of these, 104 towns (average size of the working population = 604 people) have a dependency in the range 5–10 per cent; just 5 towns (average size of the working population = 153) have a dependency of more than 50 per cent. In 35 towns, more than 20 per cent of the workforce is employed in forest industries: all are relatively small communities, the working population ranging from 75 to 2063 people.

Communities may also be dependent on forests in non-financial ways such as for food, raw materials and cultural ties. Information of this kind is not available at a State, Territory or national level and cannot be reported here.

Current data on the viability of forest-dependent communities are not adequate to support discussion of this issue at the national level. Through the regional forest agreement process, methods of social assessment and consultative processes are being developed. These may yield baseline social data for that part of the forest estate covered by the regional forest agreement process.

## Health and safety in the forest industries

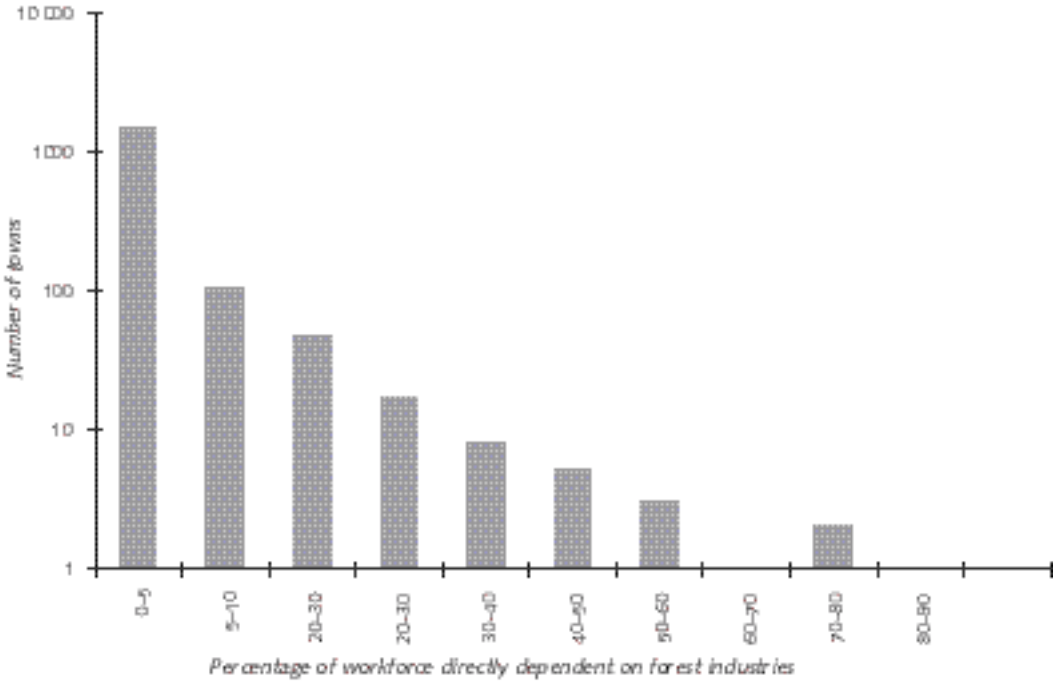
Information provided here relates solely to the three main wood-based forest industries. There are considerable health and safety issues associated with employment in other forest-related industries such as apiculture, tourism and grazing. However, it is difficult to distinguish between forest and non-forest data for these sectors.

Forest workers are exposed to a relatively high degree of occupational hazard: they work with noisy and potentially dangerous machines, often in steep terrain, felling and extracting large and unwieldy trees. They may also be involved in fire prevention and suppression activities. The wood processing industry is less hazardous (Table 64).

In the past three decades, occupational health and safety standards, together with more advanced equipment and methods, have made the forest, the sawmill and the paper mills safer. Nevertheless, the wood-based forest industries remain among the most risky of all professions.

Worksafe Australia studies published in 1994 and 1995 analysed 1991–92 workers'

**Figure 38: Relationship between the dependence of towns on forestry and the size of the total workforce**




Source: Australian Bureau of Statistics (1998f).

**Box 17: Social assessment reports in the regional forest agreement process**

Social assessments are being conducted for each forest region involved in the regional forest agreement process. Those completed so far have found that the regional forest agreement process was having the following social effects:

- communities were more informed and aware of the regional forest agreement process;
- trust between stakeholders and government authorities was being established;
- increased community participation was being achieved;
- communities had increased access to valuable local data, which could be used for other programs within a range of government agencies;
- technical expertise was being developed to map social values using a geographic information system and to assist in the integration of social data with other assessment work;
- threshold models were being developed to assess critical service impacts on local communities;
- quality scientific and technical advice was being provided to support policy development in relation to forest use; and
- the integration of social data with resource, economic and environmental data should lead to improved policy outcomes.

compensation data for the forestry, logging and log sawmilling industries. The data were collected in New South Wales, the Northern Territory, South Australia, Tasmania and Western Australia, and represented 55.3 per cent of the national workforce in these industries. Some results are presented below.

## Injury and fatality rates

Table 64 shows that forest loggers suffered 386 fatalities per 100 000 person-years, compared to 70 per 100 000 person-years in mining and quarrying and 143 in fishing. The figure for sawmill workers was 30 fatalities per 100 000 person-years; the national average is 8.1 per 100 000 person-years.

Table 64 shows the average injury rates by various task categories in the forestry sector in 1991–92. Data for the agricultural sector and the national average are presented for comparison. Additional data (not presented in the table) showed that around 20 per cent of reported logging-related injuries were severe, resulting in more than 60 days lost work time per injury. In the sawmilling sector, injuries resulting in more than 60 days off work represented 15 per cent of all injuries.

Unskilled workers suffered the highest rate of injuries. Within the logging industry, workers most at risk were machine operators, trades assistants and forestry labourers. While 38 per cent of the total wood-based forest industry workforce consists of labourers, this group makes up 47 per cent of the logging workforce. More than a third of the logging-related injuries are a result of being hit by falling or moving objects. Muscular stress due to lifting or handling is the next most common injury. This order is reversed in the sawmilling industry.

**Table 64: Incidence of fatalities, by industry sector[1]**

| Sector | Fatalities |
|---|---|
| Forest loggers | 386 |
| Forest service workers | 52 |
| Sawmill workers | 30 |
| Mining and quarrying | 70 |
| Agriculture | 19 |
| Commercial fishing | 143 |
| National average | 8.1 |

*[1] Per 100 000 employees per year.*
*Sources: Worksafe Australia (1995). Driscoll et al. (1995).*

**Table 65: National average injury rates in the forest sector compared with agriculture and all Australian industry[1]**

| Sector | Injuries |
|---|---|
| **Forest sector (1991–92 data)** | |
| Logging | 68.09 |
| Forestry | 21.23 |
| **Log sawmilling and timber dressing** | |
| Log sawmilling | 52.38 |
| Timber resawing and dressing | 28.29 |
| Woodchipping | 6.72 |
| **Other wood product manufacturing** | |
| Wooden doors | 56.16 |
| Plywood and veneer | 51.80 |
| Other | 51.67 |
| Wooden containers | 44.78 |
| Wooden structural components | 28.21 |
| Average of forest and wood (above industries) | 39.32 |
| **Paper and paper-product manufacturing** | |
| Paper bag and sack[2] | 135.65 |
| Other | 35.93 |
| Corrugated paperboard container | 35.58 |
| Pulp, paper and paperboard | 17.60 |
| Solid paperboard containers | 0.00 |
| **Comparative industries (1992–93 data)** | |
| Services to agriculture | 75.2 |
| All agriculture | 49.1 |
| Agriculture | 47.1 |
| All Australian industry (1991–92 data) | 23.7 |
| All Australian industry (1992–93 data) | 25.5 |

*[1] Per 1000 employees per year.*
*[2] Small industry but based on small sample size (19.5 per cent of the industry).*
*Sources: Worksafe Australia (1995). Driscoll et al. (1995).*

## Cost of injuries

The Worksafe Australia studies referred to above indicated that workers' compensation costs amounted to more than $1900 per employee in the logging industry in 1991–92, and more than $1200 per employee in log sawmilling. These were considerably lower than the average cost for such claims in some comparable industries. For example, workers' compensation claims for individual farmers and farm managers in 1992–93 were $6229, for sheep shearers $9545, and for farmhands and assistants $5554.

# Forest research

Forest research and development adds to our knowledge of the ecological, economic and social nature of forests. Quantifying the extent of such research and development therefore acts as an indicator of the importance we place on forests and the role they play in society.

## Range and scope of forest research

There is no consolidated national process for reporting details of forest research; thus, it is not possible to provide a comprehensive report on forest research across Australia. By the new definition used in this report, forests cover some 20 per cent of the continent. Traditionally, any collation of forest research has focused primarily on forests used for timber production (mainly multiple-use native forests and plantations) and on wood-based products. Research conducted in the forests of the predominantly agricultural and pastoral zones, which constitute the bulk of the forest estate, is currently not quantified and is not considered below.

Research can be classified into four types, although there are overlaps between these classes:

- applied: research, including inventory, done with specific applications in mind;
- strategic basic: research done in expectation of useful discoveries or solutions to practical problems;
- experimental development: using existing knowledge to create new or improved materials, products, processes or services; and
- pure basic: experimental or theoretical research for the advancement of knowledge.

Table 66 reports these research types as a percentage of the total number of forestry research projects, as reported in 1994. Table 67 lists the main forest research areas and the number of projects conducted in each.

The largest single organisation conducting research into the forest, forestry, wood and paper sciences is CSIRO Forestry and Forest Products, employing more than 270 people in research centres at Canberra, Melbourne, Hobart, Mount Gambier and Perth. Other CSIRO divisions, such as Wildlife and Ecology, also conduct forest-related research, as do a number of State and Territory agencies and universities. Cooperative research centres,

**Table 66: Research types as a percentage of total forestry projects**

| Type of research | % of total |
|---|---|
| Applied | 48.3 |
| Strategic basic | 33.7 |
| Experimental development | 11.0 |
| Pure basic | 7.0 |

*Source: derived from Fryer et al. (1994).*

**Table 67: Principal categories of industry-based research**

| Research category | Number of projects |
|---|---|
| Silviculture (systems, regeneration and formation and tending of stands, agroforestry, husbandry of non-wood forest products) | 175 |
| Environmental factors (site factors, animal ecology, general and systematic botany, plant ecology) | 95 |
| Forest products and their use (wood, bark, manufacturing, preservation, pulp) | 60 |
| Forest injuries and protection from disturbance from drought, soil erosion, fire, harmful plants and animals (including insects) | 45 |
| Forest mensuration (assessment of site quality, development and structure of stands, surveying and mapping) | 26 |
| Forests and forest policy – national viewpoint | 6 |
| Marketing and trade | 4 |
| Forest management and business economics of forestry | 3 |
| Work science | 1 |

*Source: Fryer et al. (1994).*

such as the Cooperative Research Centre for Sustainable Production Forestry and the Cooperative Research Centre for Tropical Rainforest Ecology and Management bring a range of Commonwealth, State, Territory, private and independent institutions together to focus research in particular areas.

A number of research and development corporations funded by the Commonwealth Government and the private sector sponsor forest-related research. These include the Forests and Wood Products Research and Development Corporation, the Rural Industries Research and Development Corporation (particularly through its Joint Venture Agroforestry Program) and the Land and Water Resources Research and Development Corporation.

Private research currently focuses on developing plantations, particularly through genetic manipulation of tree stock to optimise form, growth, seed production and resistance to pests and disease. Research is also directed towards improving silvicultural methods and managing plantations more efficiently, sustainably and productively. Considerable public and private effort is also being applied to the development of trees capable of growing in and contributing to the rehabilitation of salt-affected agricultural land.

## Forest conservation research

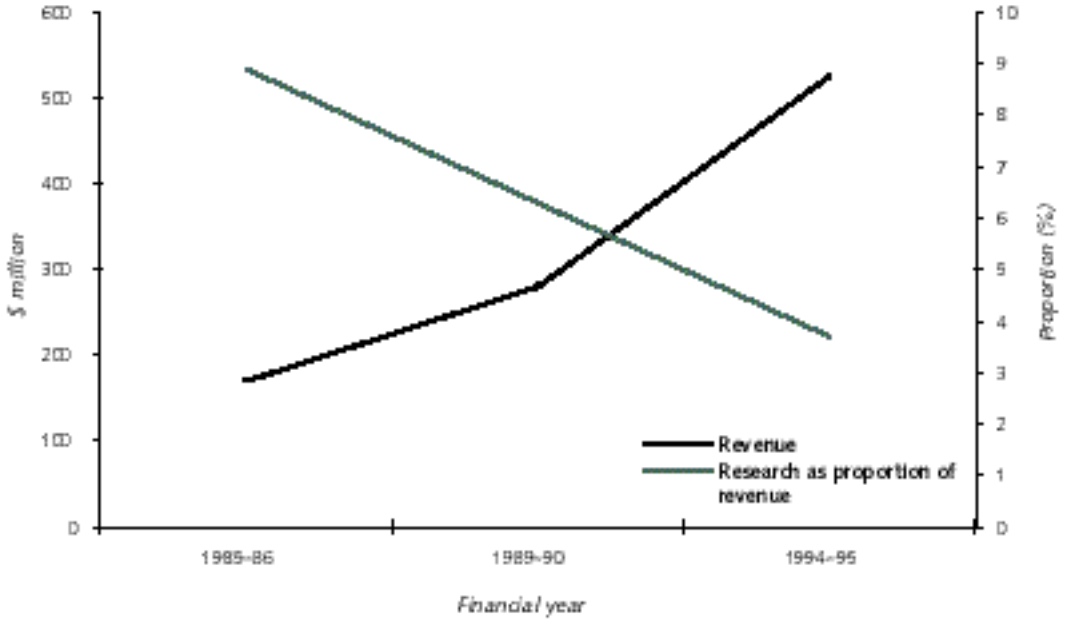
Many institutions conduct research and inventory into aspects of forest conservation. These include State and Territory agencies such as national parks and wildlife services and forestry departments, several CSIRO divisions and numerous universities. However, there are no nationally collated data available for expenditure on such research.

## Production-based research

Table 68 summarises expenditure on timber production-based research in the period 1985–86 to 1994–95. Expenditure increased over this period in actual dollar terms, but the real increase was negligible when adjusted for inflation. Most expenditure (about 86 per cent) was contributed by State and Commonwealth agencies; in 1994–95 the two government sectors spent similar amounts on forest research. Figure 39 shows that production-based research expenditure declined as a percentage of State and Territory forest service revenues in the period 1985–86 to 1994–95.

Table 69 presents research expenditure by State and Commonwealth agencies for 1989–90 and 1994–95 on a dollars per hectare and dollars per cubic metre basis.

**Figure 39: Changes in revenue and production-based research expenditure as a percentage of revenue for State and Territory forest services, 1985–86 to 1994–95**




*Note: Does not include expenditure on research by external research providers.*
*Source: Montreal First Approximation Report (1997).*

**Table 68: National summary of expenditure on production-based forest research per organisation or sector, 1985–86 to 1994–95**

| Organisation/ sector | 1985–86 Amount ($m) | 1985–86 % of total | 1989–90 Amount ($m) | 1989–90 % of total | 1994–95 Amount ($m) | 1994–95 % of total |
|---|---|---|---|---|---|---|
| State services | 15.13 | 47.4 | 17.62 | 44.9 | 19.45 | 42.8 |
| Commonwealth[1] | 12.11 | 38.0 | 14.91 | 38.0 | 19.52 | 43.0 |
| Universities | 1.94 | 6.1 | 2.22 | 5.6 | 2.65 | 5.8 |
| Private companies | 2.71 | 8.5 | 4.51 | 11.5 | 3.82 | 8.4 |
| **Total** | **31.89** | **100.0** | **39.26** | **100.0** | **45.44** | **100.0** |
| % annual change | | | +5.8 | | +3.1 | |

*Note: The definition of research varies between organisations and can include monitoring and inventory activities.*
*[1] Includes CSIRO and cooperative research centres.*
*Source: Turner, J. and Lambert, M. J. (1997).*

## Product research

### Wood products

Table 70 shows that expenditure on forest products research increased by an average 4.2 per cent a year in the four years between 1985–86 and 1989–90. In the next five years to 1994–95, the average annual increase was 2.7 per cent a year.

Commonwealth spending through CSIRO and cooperative research centres on product research increased by 67 per cent between 1985–86 and 1994–95; spending by State agencies increased by about 45 per cent. During the same period, spending by private companies and universities in this area of research increased by only 5 to 6 per cent .

Table 71 presents data compiled by the Australian Bureau of Statistics regarding research spending by the paper and paper products industries. These show that research and development spending in this sector increased over the period covered.

### Other products

There are no nationally collated data available for research on non-wood forest products and services such as water, honey, tourism, carbon sequestration or wildflowers.

## Education in the forest sector

Forest education forms a part of a large number of tertiary-level courses in Australia, and is increasingly a component of many primary and secondary school activities. Students can be taught a great deal about forests in the classroom, and the educative value of forests themselves is also high.

Broadening social expectations of forests and

**Table 69: Production based forest research expenditure, by State and Territory agencies responsible for forest management per hectare of forested multiple-use forest**

| Year | ACT Expenditure ($million) | ACT $/ha | NSW Expenditure ($million) | NSW $/ha | NT Expenditure ($million) | NT $/ha | Qld Expenditure ($million) | Qld $/ha | SA Expenditure ($million) | SA $/ha | Tas Expenditure ($million) | Tas $/ha |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985/86 | 0.095 | 20.055 | 2.777 | 0.897 | 0.433 | N/A | 4.011 | 1.007 | 1.030 | 38.726 | 1.310 | 1.020 |
| 1989/90 | 0.003 | 0.633 | 3.927 | 1.269 | 0.410 | N/A | 3.863 | 0.970 | 1.770 | 66.549 | 1.420 | 1.105 |
| 1994/95 | 0.048 | 10.133 | 4.917 | 1.589 | 0.020 | N/A | 4.500 | 1.130 | 1.823 | 68.542 | 2.950 | 2.296 |

*Notes: Forested MUF figure sourced from National Forest Inventory (1997), refer to Table 1*
*N/A - Not applicable - no native MUF in Northern Territory*
*MUF - Multiple-use forest tenure*
*Sources: Turner, J, and Lambert, M. J. (1997).*
*National Forest Inventory (1997).*

**Table 70: National summary of expenditure on products-based forest research per organisation or sector, 1985–86 to 1994–95**

| Organisation/sector | 1985–86 Amount ($m) | 1985–86 % of total | 1989–90 Amount ($m) | 1989–90 % of total | 1994–95 Amount ($m) | 1994–95 % of total |
|---|---|---|---|---|---|---|
| State services | 1.49 | 9.9 | 1.77 | 10.0 | 2.16 | 10.8 |
| Commonwealth[(1)] | 5.68 | 37.6 | 6.18 | 34.9 | 9.47 | 47.2 |
| Universities | 0.56 | 3.7 | 0.63 | 3.6 | 0.59 | 2.9 |
| Private companies | 7.39 | 48.8 | 9.11 | 51.5 | 7.85 | 39.1 |
| **Total** | **15.12** | **100** | **17.69** | **100** | **20.07** | **100** |
| % annual change | | | + 4.2 | | + 2.7 | |

*Note: The definition of research varies between organisations and can include monitoring and inventory activities.*
*(1) Includes CSIRO and cooperative research centres.*
*Source: Turner, J. and Lambert, M. J. (1997).*

the expanded definition of forests mean that many vocations apart from traditional forestry need to be considered in assessing education in the forest sector. In this report we present information mostly directed towards courses and activities readily identified as being industry-based. In the future, other vocations such as those associated with tourism, recreation, landcare, grazing management and ecology could also be considered, although reporting the forest components of such broadly based courses may be difficult.

## Tertiary training

Nationally, about one-quarter of the people in the workforce have tertiary qualifications. This is also largely true for the wood-based forest industries, although there are some differences. Compared with the national workforce, comparatively more wood-based forest industry workers have bachelor degrees and vocational skills and comparatively fewer have postgraduate and undergraduate diplomas.

**Table 71: Research spending in the paper and paper products industries, 1986–87 to 1995–96**

| Year | Amount ($'000) | % increase (per year) |
|---|---|---|
| 1986–87 | 8 289 | – |
| 1988–89 | 22 178 | 168 |
| 1990–91 | 31 936 | 44 |
| 1991–92 | 49 202 | 54 |
| 1992–93 | 36 111 | – 27 |
| 1993–94 | ND | – |
| 1994–95 | 57 185 | 58 |
| 1995–96 | 161 566 | 183 |

*ND – No data.*
*Source: Australian Bureau of Statistics (1998b).*

| Vic | | WA | | Australia | |
|---|---|---|---|---|---|
| Expenditure ($million) | $/ha | Expenditure ($million) | $/ha | Expenditure ($million) | $/ha |
| 1.898 | 0.567 | 3.579 | 2.220 | 15.133 | 1.133 |
| 3.570 | 1.067 | 2.656 | 1.648 | 17.619 | 1.320 |
| 2.946 | 0.881 | 3.038 | 1.885 | 20.242 | 1.516 |

## University

The bachelor degree courses run by The Australian National University and The University of Melbourne have historically been the principal sources of graduate foresters in Australia. Both universities offer combined forestry–commerce and forestry–economics degrees, reflecting the increasing emphasis on financial management required by skilled foresters.

By the mid-1990s, after the major data-collecting period for this section of the report, a number of other universities began offering courses with a forestry component. In 1997 there were at least 20 degree courses of

relevance to forest management available around Australia (Table 72). These included environmental management, plant ecology, agroforestry, forest management and geography.

### Certificate-level

In some States the technical and further education (TAFE) system provides certificate courses for forestry technical officers as well as a wide range of vocational training.

In Victoria, advanced certificate and associate diploma courses in resource management or technical officer training are available at six TAFE colleges. New South Wales TAFE offers a certificate course in bushland regeneration and vocational courses in farm tree management and chainsaw operations. It also acts as the delivery provider for the State Forests of New South Wales training course in forest soil and water protection.

In Queensland, TAFE courses include certificates in environmental science and applied rural science. In South Australia, TAFE certificate courses are available in timber technology and forestry technology (two years part time or four years part time for advanced certificate), and other rural courses with subjects relevant to forestry are also provided. In Western Australia, TAFE has a course in natural resource management. In Tasmania, the Hollybank Training Centre offers a TAFE Diploma of Forestry.

### Private and semi-private training providers

Colleges associated with industry, universities and TAFEs also provide training courses, as do industry bodies and private companies. A comprehensive list of such training providers has not been compiled for this report.

## Primary and secondary schooling

There is no nationally coordinated approach to the teaching of subjects relevant to forests in primary and secondary schools. For example, in South Australia and Western Australia the inclusion of information on forests is at the discretion of teachers. In Victoria, a Curriculum and Standards Framework

**Table 72: Australian university courses with relevance to forests**

| University/qualification |
|---|
| *The Australian National University* |
| BSc (Forestry) |
| Graduate diploma |
| MSc |
| PhD |
| BSc (Natural Resource Management) |
| *University of Queensland* |
| Graduate certificate |
| Postgraduate diploma |
| MSc |
| PhD |
| *Curtin University of Technology* |
| Postgraduate diploma |
| Honours |
| MSc |
| PhD |
| *University of Tasmania* |
| BSc |
| Graduate diploma/honours |
| *University of Melbourne* |
| BSc (Forest Science) (Melbourne) |
| MSc |
| PhD |
| *Southern Cross University (Lismore)* |
| BSc (Forestry) |
| *Monash University* |
| Master of Environmental Studies |
| Graduate diploma (Pulp and Paper) |
| *Griffith University* |
| BSc (Environmental Science) |
| *University of Western Australia* |
| MSc (Natural Resource Management) |
| BSc (Natural Resource Management) |
| *University of Ballarat* |
| Graduate certificate and diploma (Forestry and Wood Science) |
| BSc (Natural Resources Management) |
| BSc (Environmental Management/Park) Management) |
| *University of New England* |
| Bachelor of Natural Resources |
| Master of Natural Resources |
| Master of Environmental Management |
| *Deakin University* |
| Environmental Studies (degree) |

*Source: National Forest Inventory (1997).*

provides guidelines for key learning areas, including environmental science.

In the New South Wales syllabus, the environmental studies subject for years 11 and 12 includes topics such as rainforest logging and world rainforests. Another subject, rural technology, examines the work of the State Forests of New South Wales, pine plantations on farms, properties and uses of Australian timbers, and forestry technology. Aspects of forestry are also included in geography in years 7–10.

The curriculum operating in Queensland in 1994 included studies on forests and rainforests in the biology component of years 11–12. Other science, geography and social studies courses feature studies such as resource management, people and the environment, and forest resources.

In the Northern Territory, forestry is part of a year 12 subject, natural resource management. In Tasmania, Forestry Tasmania takes an active role in the development of primary and secondary courses covering forest education.

The Victorian Department of Natural Resources and Environment delivers a school education program through the Toolangi Forest Discovery Centre. It employs teachers on secondment from the Ministry of Education to prepare forest-related curriculum materials.

### In-service training

State government forest and natural resource agencies provide a variety of in-service training that includes natural resources skills. A comprehensive list of such training activities has not been compiled for this report.

## International forest-related activities

The Commonwealth Government is engaged in a number of international forest-related activities. Some of these, such as the Montreal Process Working Group on national and regional criteria and indicators, have been discussed in earlier chapters. Another ongoing initiative in which the Australian Government plays a significant role is the development of codes of forest practice in the Asia–Pacific region within the Asia–Pacific Economic Cooperation forum (APEC).

Australia also provides assistance to some countries wishing to improve their forest management. Information on the extent of Australia's forest-related overseas aid can be obtained from the Department of Foreign Affairs and Trade.

## Forest awards

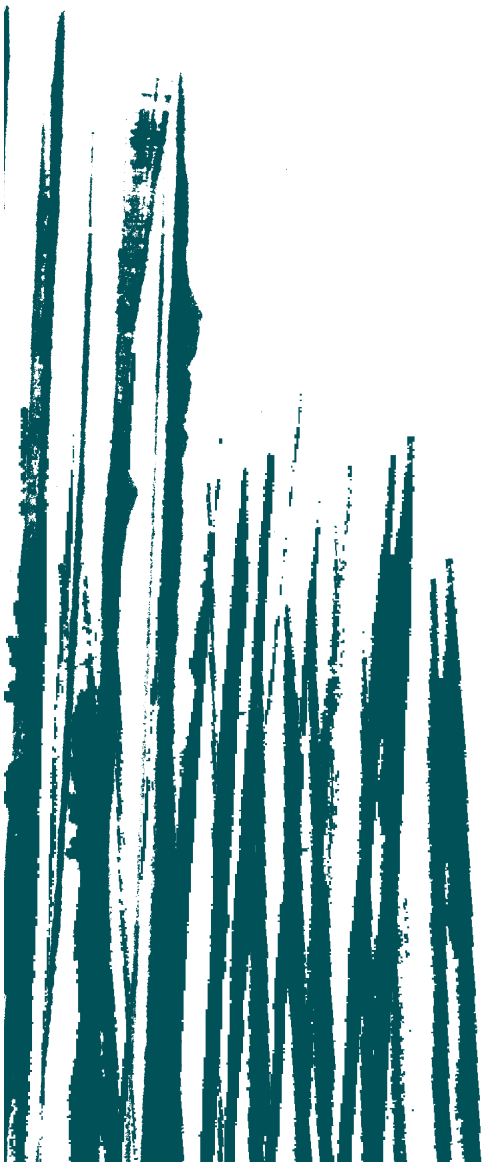
Industry and community awards encourage excellence and recognise achievement. The number of awards in a field can therefore be thought of as indicative of that field's level of commitment to quality and improvement. This section lists some of the more nationally significant awards offered in fields relevant to Australian forests. They are not arranged in any particular order.

- The National Treefarmer of the Year Award made by the Australian Forest Growers honours individuals who have made significant contributions to private forestry in Australia.
- The Timber Promotion Council Natural Feature in Furniture Award promotes the value adding opportunities and acceptance of natural features in functional furniture.
- Landcare awards include recognition of achievements in forest rehabilitation, conservation and establishment.
- The Institute of Foresters of Australia offers several annual awards to promote professional development or to recognise outstanding achievement:
    - the Henderson Travel Award for postgraduate research overseas is awarded to a forester for outstanding work;
    - the Peter Jowett Hawkins Award supports forest research;
    - the Hedges Award is given for the best article in *Australian Forestry* by a field or non-research-based forester;
    - the N.W. Jolly Medal is awarded for outstanding contributions to forestry in Australia; and

- the Institute of Foresters Professional Development Award is intended to improve the awardee's professional skills in forest management.

- The Joseph William Gottstein Trust Fund is the national educational trust of the Australian forest industries. The Trust funds fellowships, industry seminars, wood science courses and industry study tours.

# 8 *The State of Knowledge*



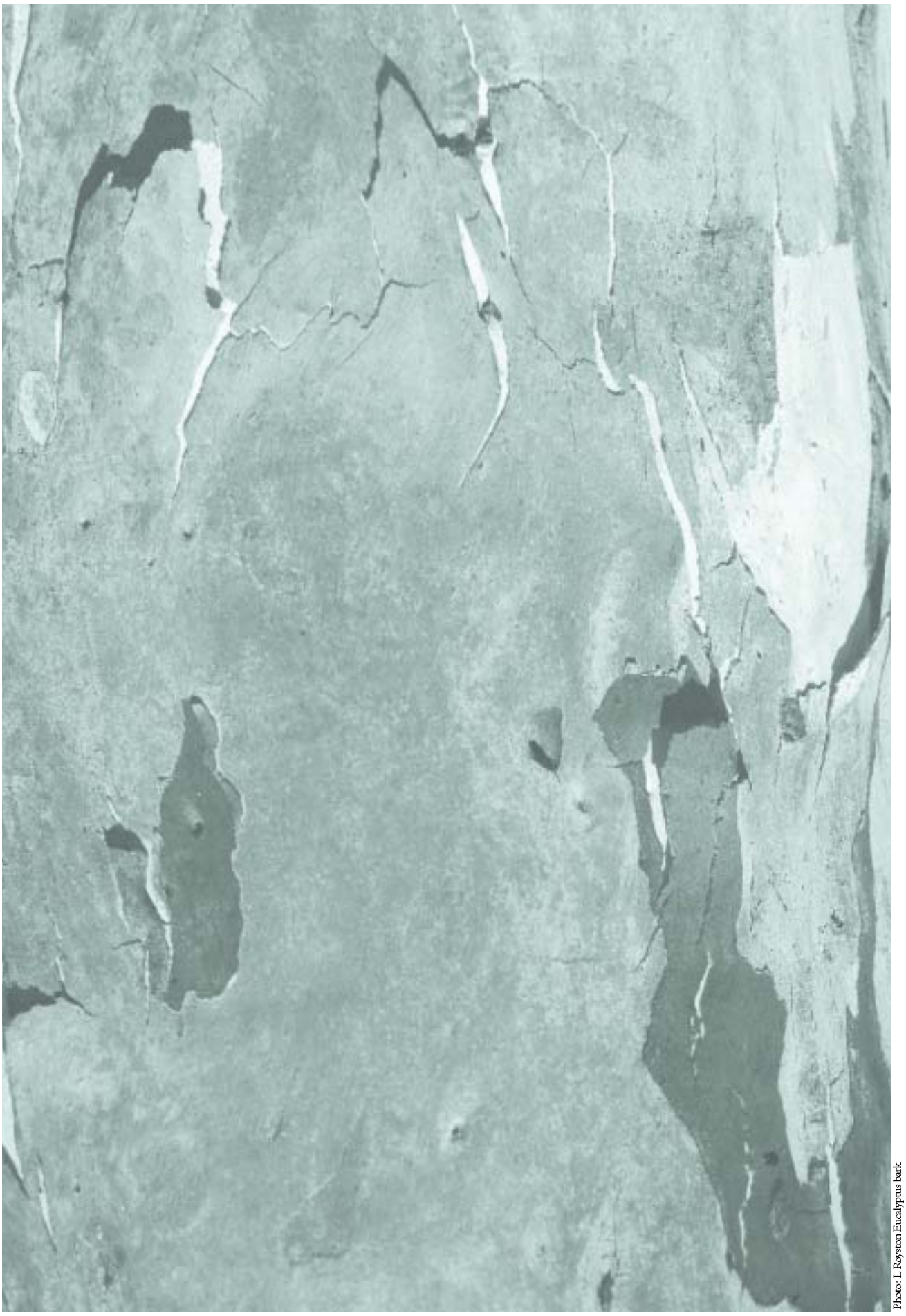


Photo: L Royston Eucalyptus bark

# *The State of Knowledge*

Our understanding of the ecological, economic and social importance of forests has grown greatly in the last 25 years, although there remains considerable room to improve knowledge about how to manage forests sustainably. Much of our knowledge is centred on the publicly owned, timber producing forests, which constitute a relatively small proportion of the total national forest estate. Less is known about forests of lower commercial quality, forests in conservation reserves and forests on the private and leasehold estates.

In this chapter, the state of knowledge is discussed under the seven headings that form the basis of the Montreal Process criteria for sustainable forest management (see Box 14). In addition, issues of concern to the Australian community are listed: this is presented as a reference point for future reports about the issues considered nationally important in 1997.

## The state of knowledge

### Criterion 1: Conservation of biological diversity

The biological diversity of Australia has been documented and studied both extensively and intensively in the traditions of western science for well over 200 years. Indigenous peoples' knowledge of biodiversity has been acquired over very long periods of time and relatively recently has begun to be recorded. Only recently has attention turned to reporting on forest habitats as distinct from the whole biota. There are estimates of national biodiversity for forest-dwelling higher plants and animals, but not lower ones. There are lists of species occurrences for many specific sites, but these are not available for all forest types. There has been detailed research into the interactions of forest-dwelling species and how they live, but the number of species studied in this way is small compared to the total number. The levels of flexibility and adaptability of the biota to changing circumstances are not known for most species, but there appears to be a wide range of capacities among species.

Knowledge of forest ecology is increasing steadily and this information is used to modify management systems. The level of such information is known to be low enough that continued major research efforts are still required.

Information on forest cover extent is available for the entire country. The resolution and accuracy of information varies considerably. Several large projects under the National Forest Inventory are under way which will ensure that the forest estate will be mapped by forest type at the 1:100 000 scale or better within five years.

While the extent of forest in Australia is relatively well known, species-level mapping is not well covered. It is now possible to accurately produce predictions of potential distribution of species and forest types, based on available, but incomplete, information. Information is available at the genus level for most of the forested country. Australia is working towards a practical but appropriate classification of forest types that relates to biodiversity conservation. Analysis of existing site-based data suggests that there are at least 457 floristically defined forest types comprising several thousand species. Information on age-class and successional stages is currently poorly known, but for RFA areas will be significantly improved on completion of the assessments.

Information on the status of some forest-dependent species exists nationally for endangered, vulnerable and presumed extinct vertebrates and for rare, endangered, vulnerable and presumed extinct vascular plants. Species recovery plans are associated with many species on these lists. Some information is available on genetic and species diversity for limited regions through survey and expert knowledge. Part of the RFA process

is devoted to increasing the understanding of biodiversity in Australia through the provision for additional surveys and monitoring through time.

In order to progress our knowledge of forest-dwelling species it will be necessary to add habitat labels to the names of species currently held in databases. At present it is generally not possible to identify those species that are either known to occur in forests or are known to occur only in forests. This knowledge is often available in unpublished research papers and in the collective knowledge of experts, but has not been consolidated for easy access.

The responses of many plants and animals (including most species listed as threatened or endangered) to particular fire regimes are incompletely known. Research is needed to determine the responses of species with different life histories to particular fire regimes. Since deliberate burning for forest management and biodiversity conservation is needed, the development of techniques of adaptive management in relation to fire is a key priority.

## Criterion 2: Maintenance of productive capacity of forest ecosystems

We have a sound understanding of the productive capacity of most forests with multiple-use tenure. Information about productive capacity on other public tenures or private lands in the wood production zones is very limited. All public forestry agencies are developing, or have developed, sustainable yield strategies based on field assessment of forest growth and modelling. Such information is generally unavailable for private forests in most regions. The growth models and spatial data used to calculate sustainable yield on public land will be (or have been) reviewed as part of RFAs. The impacts of timber harvesting, grazing and other forest uses on forest biodiversity and other values will also be (or have been) reviewed. The productive capacity of forests not covered by RFAs, including most forests in which the primary land use is grazing, is less well known than that of the wood production forests.

## Criterion 3: Maintenance of forest ecosystem health and vitality

Defining and understanding what is meant by ecosystem health and vitality is in its early days. It is posing a significant challenge to forest managers in most countries of the world. Information relating to this criterion is currently very limited at the national level, although the biology and ecology of many forest pests and diseases are often well understood. Several research projects are currently under way specifically to examine this topic. A forest health committee has recently been established under the Standing Committee on Forestry to, among other things, review pests and diseases affecting Australian forests and forest products and to advise relevant bodies on the actions that may be required for the control of specific pests and diseases.

## Criterion 4: Conservation and maintenance of soil and water resources

Catchment hydrology research in forested catchments is undertaken by organisations such as the Cooperative Research Centre for Catchment Hydrology, several divisions of CSIRO, and other State and Commonwealth bodies. Major research is being undertaken into the dynamics of soil erosion in both natural and disturbed forests and into the refinement of stream protection measures. Detailed research is being undertaken into the water relations of natural and plantation forests. Research programs are examining the role of trees on land irrigated with sewage treatment plant effluent, in terms of managing salinity on irrigated and dry lands. As the area of land dedicated to tree plantations increases in coming years, the streamflow reduction effects of converting a pasture cover to a tree cover is an issue that potentially has major implications for the regional allocation of water resources.

Work is being done by governments at all levels to develop and implement codes of practice from available information and to develop cost-effective approaches to the

monitoring and interpretation of forest management effects. Activities undertaken as part of the RFA process include the development of long-term monitoring programs for various factors related to the conservation and maintenance of soil and water resources.

### Criterion 5: Maintenance of forest contribution to global carbon cycles

Australia has been able to report internationally on the contribution of its forests to global carbon sinks and sources. Present estimates show the forest sector as a net sink for carbon. Significant research is still to be done to bring the accuracy of the estimates within narrower bounds. Detailed information on forest biomass is generally only available for commercial public forests, with little known about spatial variation. Projects are currently under way to develop rigorous models of potential growth and carbon accumulation, both above and below ground, for a wide range of forest types, including those used for timber harvesting and pastoral grazing. International efforts to manage greenhouse gas emissions are providing a major stimulus to accelerate research in this area.

### Criterion 6: Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies

Information on this criterion is readily available in relation to major commercial forest uses at the State and national level. Information with regard to non-wood uses such as recreation or apiary is not easily summarised for the forest-only component. This criterion is currently being addressed through the RFA process. Significant work is still to be done to adequately bring the cultural values of Indigenous and non-Indigenous forest users more fully into forest management practices on appropriate tenures.

### Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management

Australia has addressed most aspects of this criterion at the national level through its reports to the Montreal Process. At the State level, it is being addressed to a large extent by evaluating the processes which underpin ecologically sustainable management of forests through the RFA process. This approach includes a formalised process of monitoring and reviewing forest management practices; legal, institutional and economic frameworks; and social, economic and conservation planning at the regional level.

## Issues

A survey of a range of people working in forest-related areas of government and universities produced a list of issues considered to be important to forests at the national level in the mid-1990s. This list was then circulated to representatives of all State and Territory conservation and forestry agencies for comment. The resulting list, presented in Table 73, is organised according to the Montreal Process criteria for sustainable forest management. It focuses on national-level issues and does not include issues that may be locally or regionally important.

The list is primarily intended as a reference point against which future reports can assess whether or how the issues have been resolved. Without such snapshot records, it can be very difficult to know what people in the past considered issues at the time. The list does not attempt to present arguments for or against the issues, only to note their existence.

## Table 73: Issues for Australian forests in relation to the Montreal Process criteria for sustainable forest management

**Criterion 1: Conservation of biological diversity**

- Deforestation of major forest types: rainforest, woodland, mallee, mangroves
- Biodiversity, endangered species habitat
- Conservation of forest species
- Effects of forest use/management on forests
- Sustainable use of ecosystems
- Value forests for their own sake
- Urban expansion

**Criterion 2: Maintenance of productive capacity of forest ecosystems**

- Sustainability: definition, implementation, monitoring

**Criterion 3: Maintenance of forest ecosystem health and vitality**

- Landscape management
- Ecosystem processes: defining and maintaining them
- Managing for climate change
- Control of introduced species
- Regional planning of fire management for both protection and maintenance of biodiversity

**Criterion 4: Conservation and maintenance of soil and water**

- Catchment protection
- Soil: maintenance and protection
- Water quality and quantity

**Criterion 5: Maintenance of forest contribution to global carbon cycles**

- Carbon budget: how much is being accumulated and how much returned to the atmosphere? How much can extending forest area increase storage of carbon?

**Criterion 6: Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies**

- Recreation: its development and impacts
- Grazing: its effect on forest ecosystems, its value to industry
- To log or not to log native forests
- Woodchip exports versus local processing
- Balance of payments in forest products: how to improve Australia's position
- Adding value to forest products: what areas, and how to encourage
- Substitution for forest products
- Afforestation: softwood and hardwood plantations; farm forestry; extending the plantation estate; removing impediments; managing sustainably
- Multiple use of production areas and reserves: what range of uses to be allowed; what systems to achieve it and how to integrate with non-forest lands
- Recreation and tourism: how to encourage sustainable development
- Competition, markets
- Implementation of user pays principle
- Resource security
- Heritage and wilderness values: identification and protection
- Indigenous perspective: identification and recognition of traditional knowledge, uses, and significant cultural sites
- Viability of rural communities: facing changing conditions, employment levels, especially for young people

**Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management**

- Adequate stakeholder consultation in negotiating agreements about forest use and public involvement in planning
- International obligations arising from treaties
- Environmental education: how to develop and maintain balance
- Certification and labelling: when and how to develop and apply
- Codes of practice: development, continuing research, monitoring and compliance systems
- Regional planning
- Criteria and indicators for sustainable management of forests
- Long-term monitoring of effects of use
- Funding of management
- Corporatisation: its effect on productivity and sustainable management
- Research: capacity and funding
- Reliability of data: harmonisation of data collected in different places
- Public access to information
- Cost of providing information
- Monitoring implementation of plans and agreements
- System of reserves; conservation off reserves

*Source: National Forest Inventory (1997).*

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# *Summaries of Key Data*

## Commonwealth of Australia

| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 18 311 000 |
| Total area | | 768 230 000 ha |
| Forested land | | 156 877 000 ha |
| Native forest | | |
| multiple-use forest | | 13 351 000 ha |
| conservation reserve | | 17 580 000 ha |
| private | | 42 018 000 ha |
| leasehold | | 66 103 000 ha |
| other crown land | | 15 597 000 ha |
| Plantations (1995) | | |
| softwood | | 883 980 $m^3$ |
| hardwood | | 158 570 $m^3$ |
| Biodiversity | | |
| vertebrates | mammals | 217 |
| | birds | 561 |
| | reptiles | 319 |
| | amphibians | 126 |
| | fish | 16 |
| | rare / threatened | 81 |
| higher plants | | 13 622 |
| | rare / threatened | n/d |
| Forest expenditure (public, 1994–95) | | |
| conservation | | $297 467 000 |
| forestry | | $339 148 000 |
| Revenue (1994–95) | | $440 897 000 |
| Sustainable yield, multiple-use forests (1994–95) | | 2 714 000 $m^3$ |
| Harvest volume, multiple-use forests (1994–95) | | 2 663 000 $m^3$ |
| Harvest area, native multiple-use forests | | 110 310 ha |
| Regional forest agreements | | Completed: East Gippsland, Tasmania, Central Highlands<br>In progress: Western Australia (1), New South Wales (4), Queensland (1), Victoria (3) |

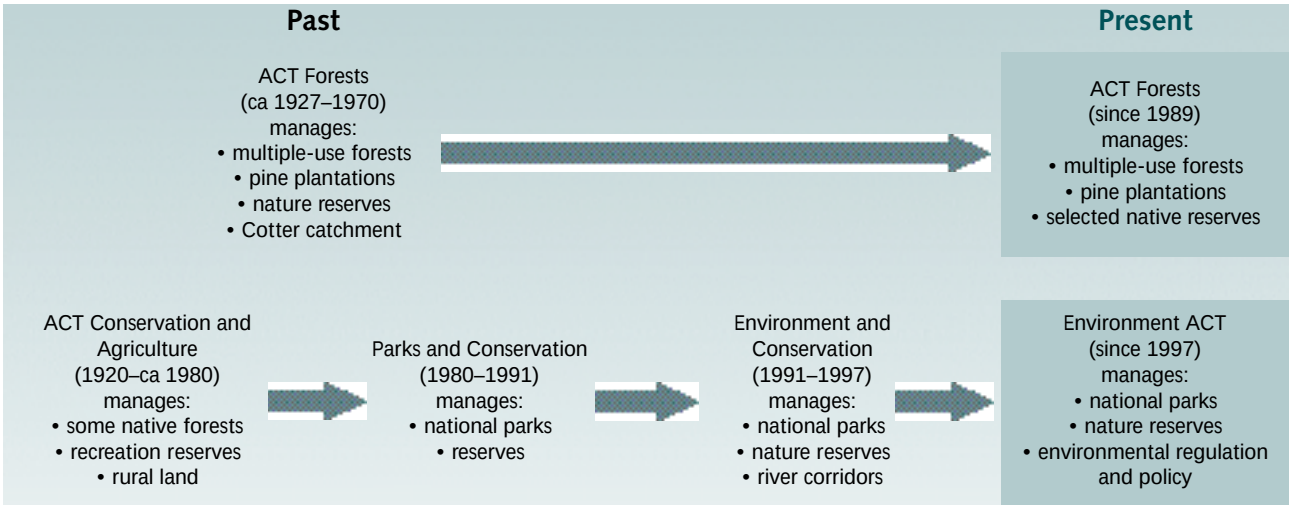
*n/d - no data*

# Australian Capital Territory

| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 308 000 |
| Total area | | 240 000 ha |
| Forested land | | 135 000 ha |
| Native forest | | |
| multiple-use forest | | 5000 ha |
| conservation reserve | | 93 000 ha |
| private | | 7000 ha |
| leasehold | | 13 000 ha |
| other crown land | | 2000 ha |
| Plantations (1995) | | |
| softwood | | 74 800 ha |
| hardwood | | 0 ha |
| Biodiversity | | |
| vertebrates | mammals | n/d |
| | birds | n/d |
| | reptiles | n/d |
| | amphibians | n/d |
| | fish | n/d |
| | rare / threatened | n/d |
| higher plants | | n/d |
| | rare / threatened | n/d |
| Forest expenditure (public, 1994–95) | | |
| conservation | | $ n/d |
| forestry | | $6 538 000 |
| Revenue | | n/d |
| Sustainable yield, multiple-use forests (1994–95) | | n/a |
| Harvest volume, multiple-use forests (1994–95) | | n/a |
| Harvest area, native forests | | 0 ha |
| Regional forest agreements | | n/a |

*n/d - no data*

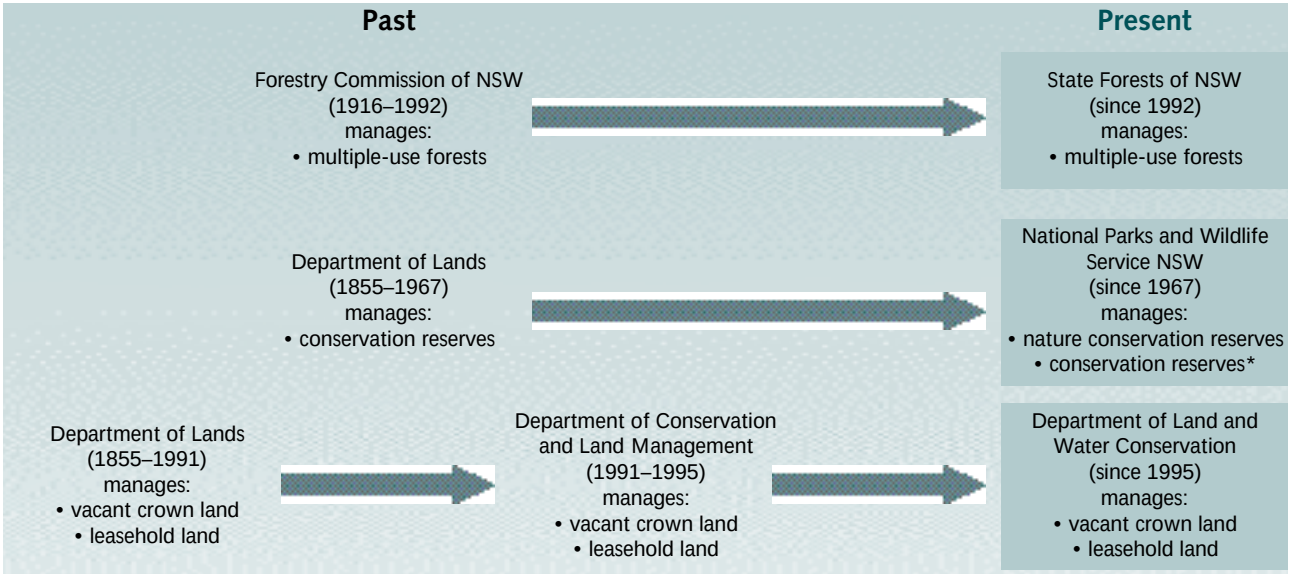
*n/a - not applicable*



# New South Wales

| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 6 203 900 |
| Total area | | 80 160 000 ha |
| Forested land | | 21 057 000 ha |
| Native forest | | |
| multiple-use forests | | 3 095 000 ha |
| conservation reserve | | 3 060 000 ha |
| private | | 8 046 000 ha |
| leasehold | | 5 966 000 ha |
| other crown land | | 605 000 ha |
| Plantations (1995) | | |
| softwood | | 266 900 ha |
| hardwood | | 29 200 ha |
| Biodiversity numbers | | |
| vertebrates | mammals | 96 |
| | birds | 281 |
| | reptiles | 73 |
| | amphibians | 54 |
| | fish | 0 |
| | rare / threatened | 7 |
| higher plants | | n/d |
| | rare / threatened | n/d |
| Forest expenditure (public, 1994–95) | | |
| conservation | | $151 029 000 |
| forestry | | $108 531 000 |
| Revenue (1994–95) | | $102 205 000 |
| Sustainable yield, multiple-use forests (1994–95) | | 801 000 $m^3$ |
| Harvest volume, multiple-use forests (1994–95) | | 781 000 $m^3$ |
| Harvest area, multiple-use forests (1993–94) | | 37 500 ha |
| Regional forest agreements | | 4 in progress (July, 1998) |

*n/d - no data*

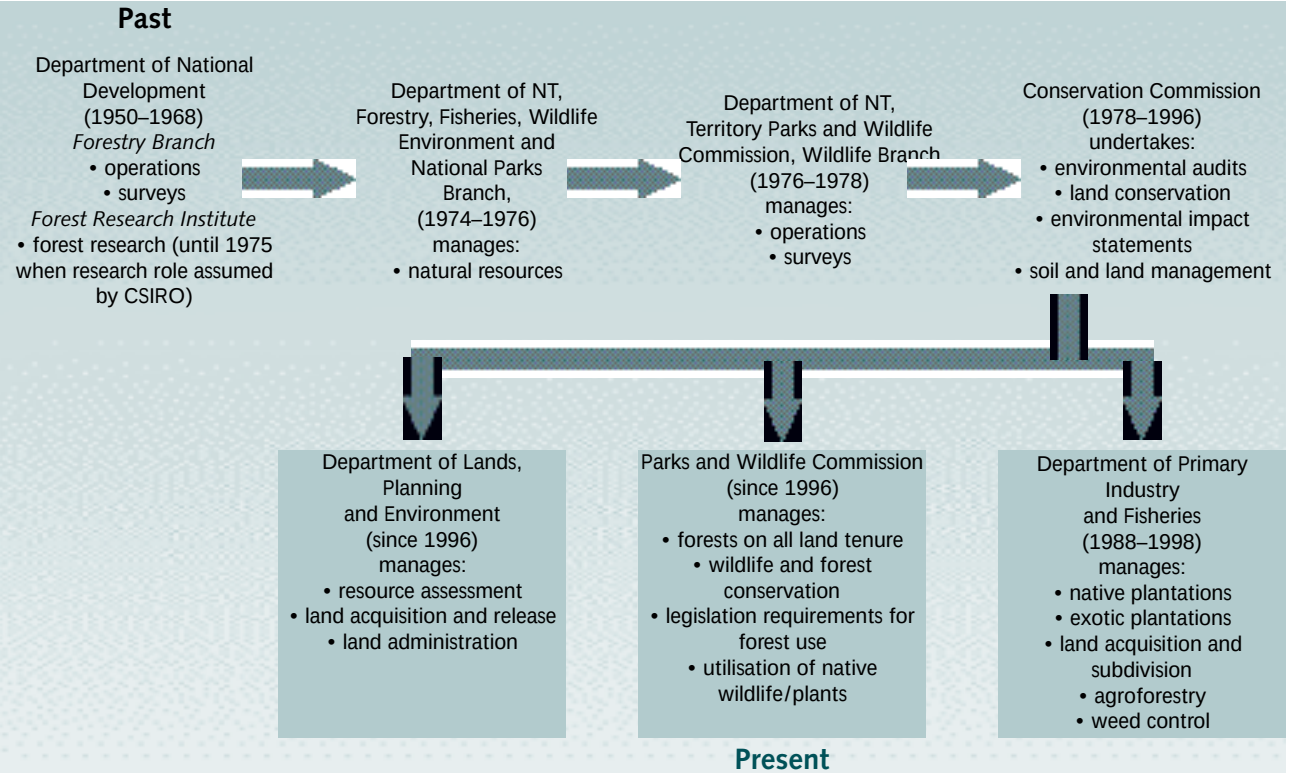



**NOTE: Most conservation reserves are currently managed by the National Parks and Wildlife Service. Some (eg some State Recreation Areas, Camping Reserves, Reserves for the Preservation of Flora and Fauna) are still managed by the Department of Land and Water Conservation.*

# Northern Territory

| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 181 900 |
| Total area | | 134 620 000 ha |
| Forested land | | 35 389 000 ha |
| Native forest | | |
| multiple use forests | | 0 ha |
| conservation reserve | | 2 709 000 ha |
| private | | 11 187 000 ha |
| leasehold | | 20 236 000 ha |
| other crown land | | 258 000 ha |
| Plantations (1995) | | |
| softwood | | 5500 ha |
| hardwood | | 64 ha |
| Biodiversity numbers | | |
| vertebrates | mammals | 87 |
| | birds | 198 |
| | reptiles | 134 |
| | amphibians | 30 |
| | fish | 0 |
| | rare / threatened | 4 |
| higher plants | | 1691 |
| | rare / threatened | n/d |
| Forest expenditure (public 1994–95) | | |
| conservation | | $35 370 000 |
| forestry | | n/a |
| Revenue (1994–95) | | n/a |
| Sustainable yield, mulitple use forests (1994–95) | | n/a |
| Harvest volume, mulitple use forests (1994–95) | | n/a |
| Harvest area, multiple use forests (1993–94) | | 0 ha |
| Regional forest agreements | | n/a |

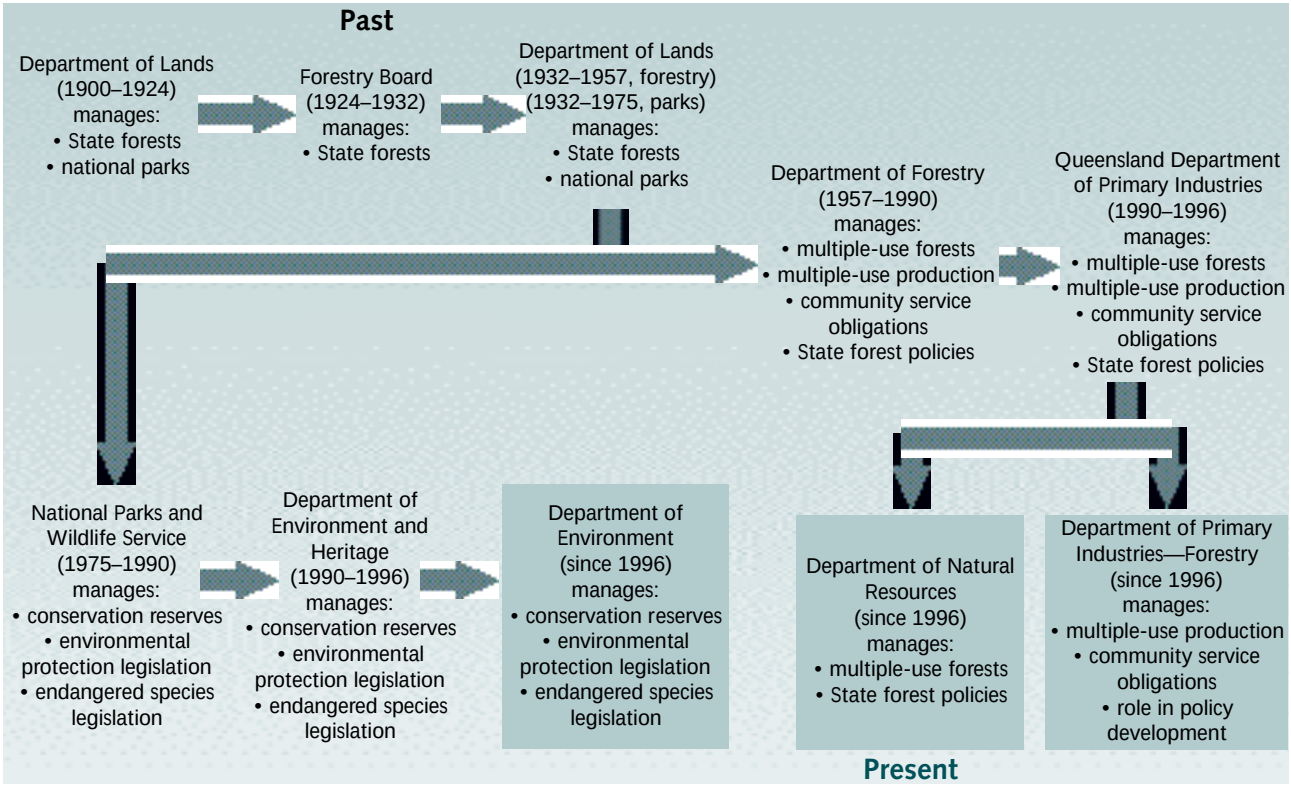
*n/d - no data*
*n/a - not applicable*



# Queensland

| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 3 339 100 |
| Total area | | 172 720 000 ha |
| Forested land | | 49 226 000 ha |
| Native forest | | |
| multiple-use forests | | 3 983 000 ha |
| conservation reserve | | 2 870 000 ha |
| private | | 17 111 000 ha |
| leasehold | | 23 996 000 ha |
| other crown land | | 1 051 000 ha |
| Plantations (1995) | | |
| softwood | | 185 700 ha |
| hardwood | | 1600 ha |
| Biodiversity numbers | | |
| vertebrates | mammals | 104 |
| | birds | 303 |
| | reptiles | 122 |
| | amphibians | 49 |
| | fish | 4 |
| | rare / threatened | 76 |
| higher plants | | 7830 |
| | rare / threatened | n/d |
| Forest expenditure (public, 1994–95) | | |
| conservation | | $22 550 000 |
| forestry | | $29 764 000 |
| Revenue (1994–95) | | $70 183 000 |
| Sustainable yield, multiple-use forests (1994–95) | | 112 000 $m^3$ |
| Harvest volume, multiple-use forests (1994–95) | | 111 000 $m^3$ |
| Harvest area, multiple-use forests (1993–94) | | 53 196 ha |
| Regional forest agreements | | south east Qld in progress (April, 1998) |

*n/d - no data*

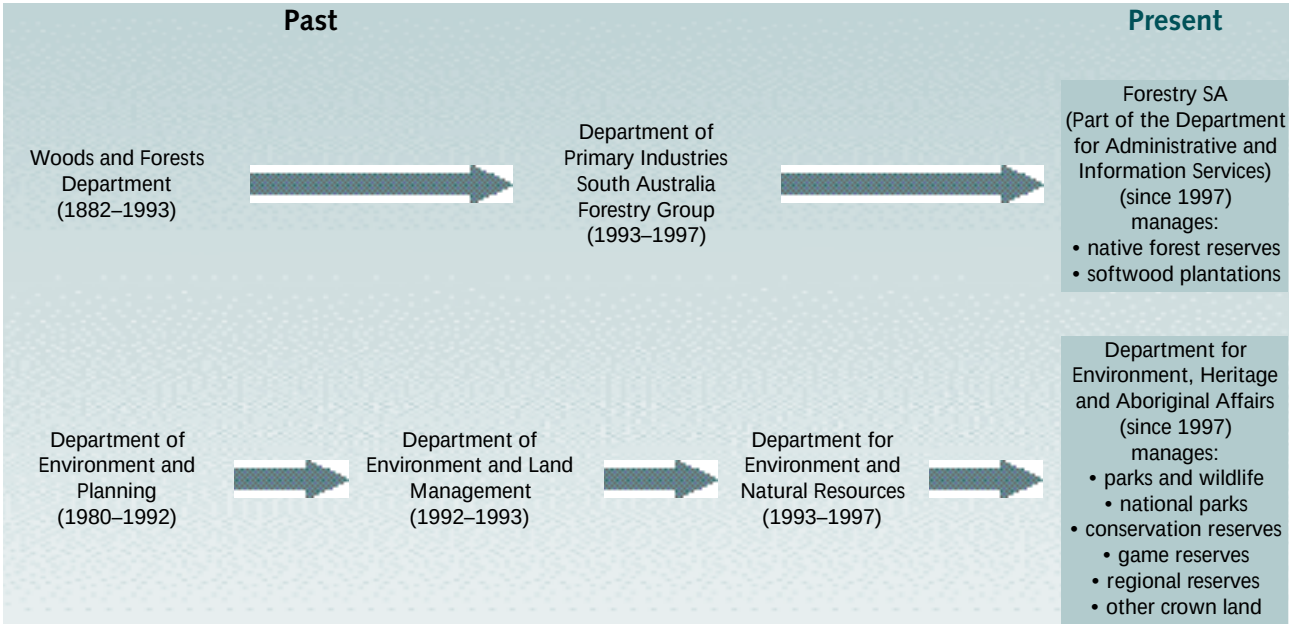


# South Australia

| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 1 474 400 |
| Total area | | 98 400 000 ha |
| Forested land | | 5 602 000 ha |
| Native forest | | |
| multiple-use forests | | 27 000 ha |
| conservation reserve | | 1 252 000 ha |
| private | | 2 327 000 ha |
| leasehold | | 1 866 000 ha |
| other crown land | | 12 000 ha |
| Plantations (1995) | | |
| softwood | | 104 800 ha |
| hardwood | | 1700 ha |
| Biodiversity numbers | | |
| vertebrates | mammals | n/d |
| | birds | n/d |
| | reptiles | n/d |
| | amphibians | n/d |
| | fish | n/d |
| | rare / threatened | n/d |
| | higher plants | n/d |
| | rare / threatened | n/d |
| Forest expenditure (public, 1994–95) | | |
| conservation | | $14 000 000 |
| forestry | | $171 000 |
| Revenue (1994–95) | | $41 760 000 |
| Sustainable yield, multiple-use forests (1994–95) | | n/a |
| Harvest volume, multiple-use forests (1994–95) | | n/a |
| Harvest area, multiple-use forests (1993–94) | | 0 ha |
| Regional forest agreements | | n/a |

*n/d - no data*

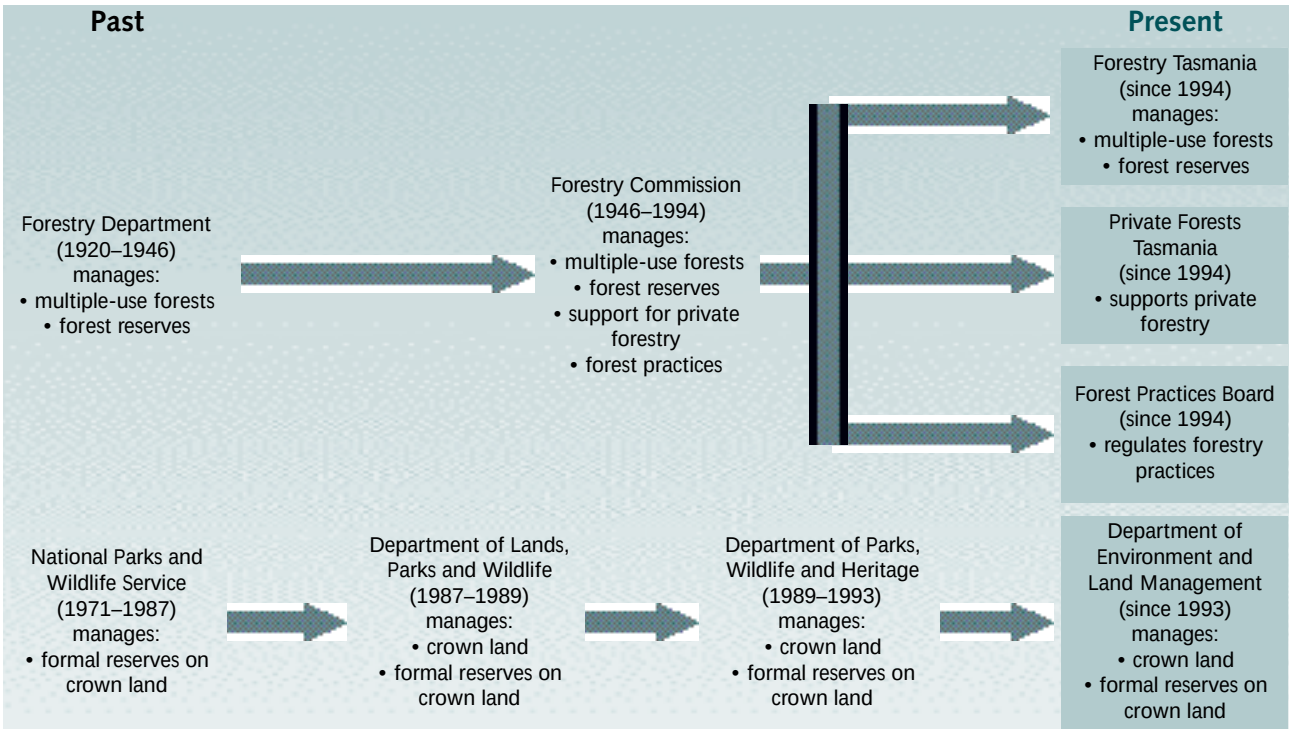
*n/a - not applicable*



# Tasmania

| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 474 600 |
| Total area | | 6 780 000 ha |
| Forested land | | 3 038 000 ha |
| Native forest | | |
| multiple-use forests | | 1 285 000 ha |
| conservation reserve | | 523 000 ha |
| private | | 801 000 ha |
| leasehold | | 0 ha |
| other crown land | | 296 000 ha |
| Plantations (1995) | | |
| softwood | | 80 900 ha |
| hardwood | | 58 900 ha |
| Biodiversity numbers | | |
| vertebrates | mammals | 27 |
| | birds | 77 |
| | reptiles | 14 |
| | amphibians | 7 |
| | fish | 0 |
| | rare / threatened | 4 |
| higher plants | | 1043 |
| | rare / threatened | n/d |
| Forest expenditure (public, 1994–95) | | |
| conservation | | $22 297 000 |
| forestry | | $66 269 000 |
| Revenue (1994–95) | | $48 682 000 |
| Sustainable yield, multiple-use forests (1994–95) | | 300 000 $m^3$ |
| Harvest volume, multiple-use forests (1994–94) | | 309 000 $m^3$ |
| Harvest area, multiple-use forests (1993–94) | | 5600 ha |
| Regional forest agreements | | Completed, 1997 |

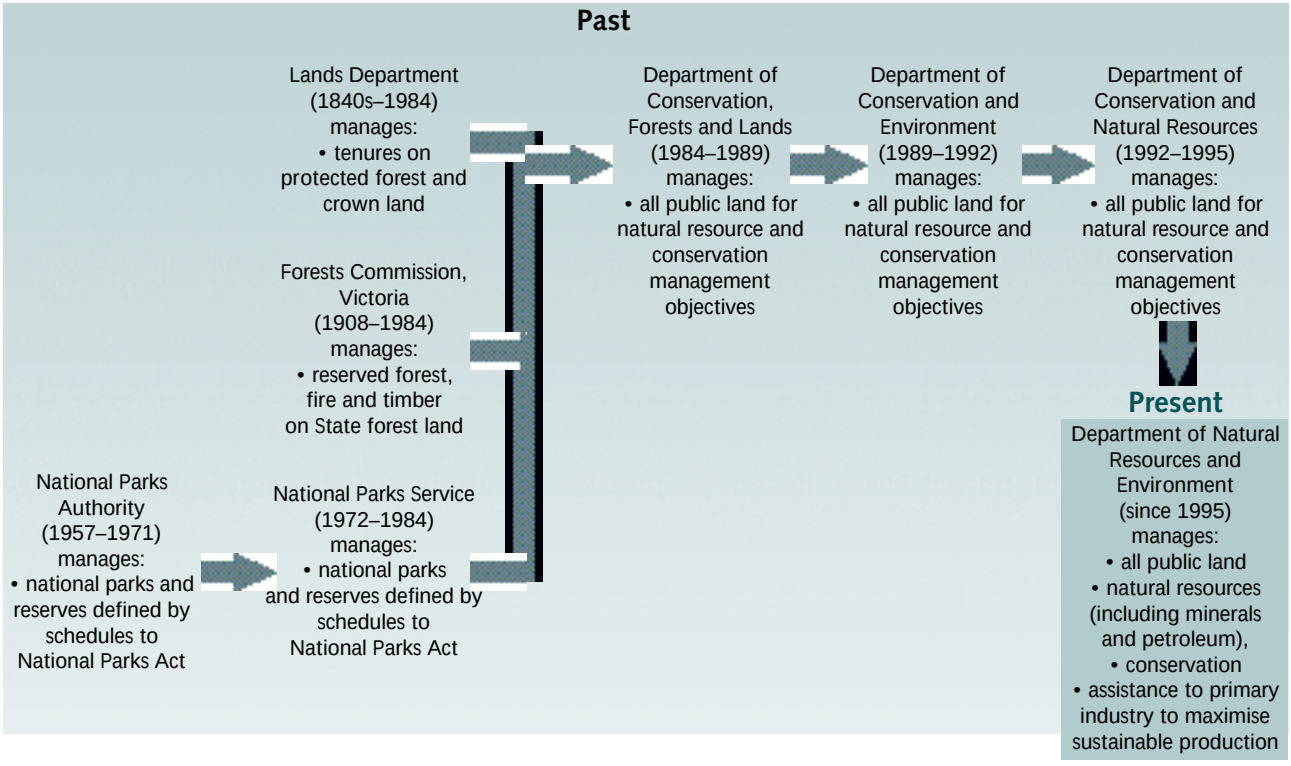
*n/d - no data*



# Victoria

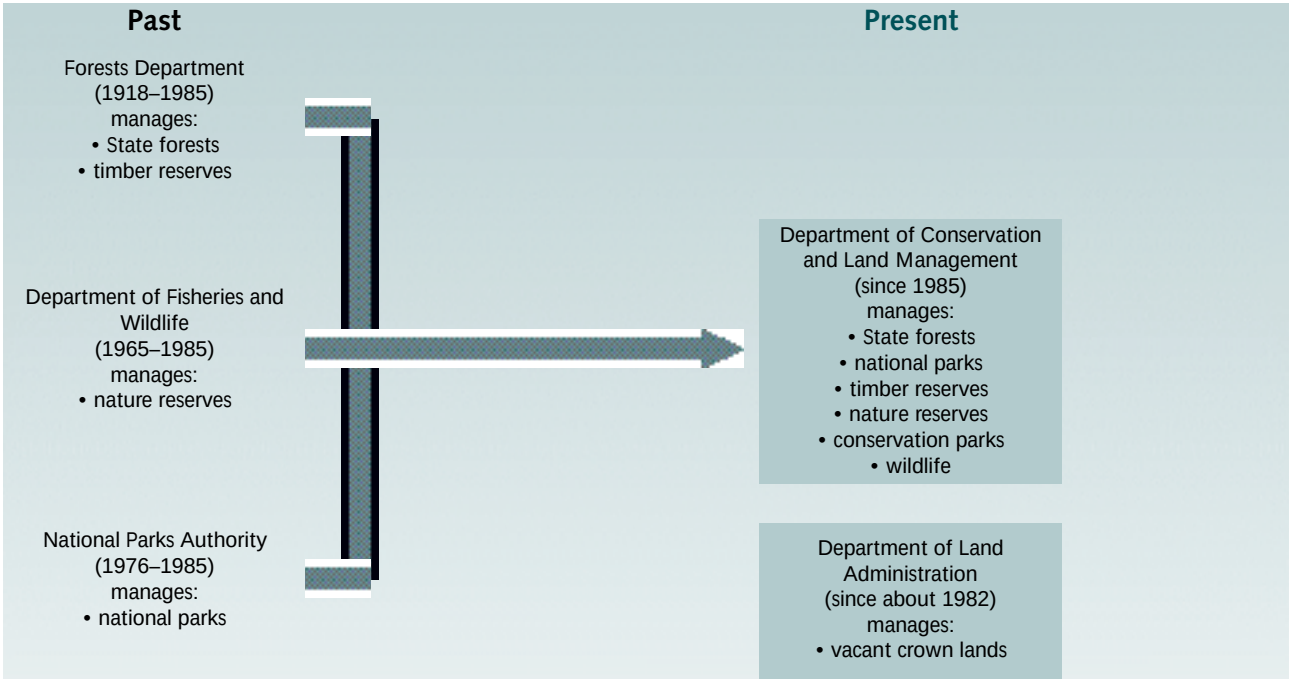
| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 4 560 800 |
| Total area | | 22 760 000 ha |
| Forested land | | 7 501 000 ha |
| Native forest | | |
| multiple-use forests | | 3 346 000 ha |
| conservation reserve | | 2 710 000 ha |
| private | | 1 038 000 ha |
| leasehold | | 0 ha |
| other crown land | | 165 000 ha |
| Plantations (1995 (1993, public)) | | |
| softwood | | 216 600 ha |
| hardwood | | 18 400 ha |
| Biodiversity numbers | | |
| vertebrates | mammals | 94 |
| | birds | 253 |
| | reptiles | 102 |
| | amphibians | 36 |
| | fish | 0 |
| | rare / threatened | 9 |
| higher plants | | 2959 |
| | rare / threatened | n/d |
| Forest expenditure (public, 1994–95) | | |
| conservation | | $30 925 000 |
| forestry | | $67 369 000 |
| Revenue (1994–95) | | $80 353 000 |
| Sustainable yield, multiple-use forests (1994–95) | | 743 000 $m^3$ |
| Harvest volume, multiple-use forests (1994–95) | | 664 000 $m^3$ |
| Harvest area, multiple-use forests (1993–94) | | 7000 ha |
| Regional forest agreements | | East Gippsland, 1997; Central Highlands, 1998; 3 more remaining as at July, 1998 |

*n/d - no data*

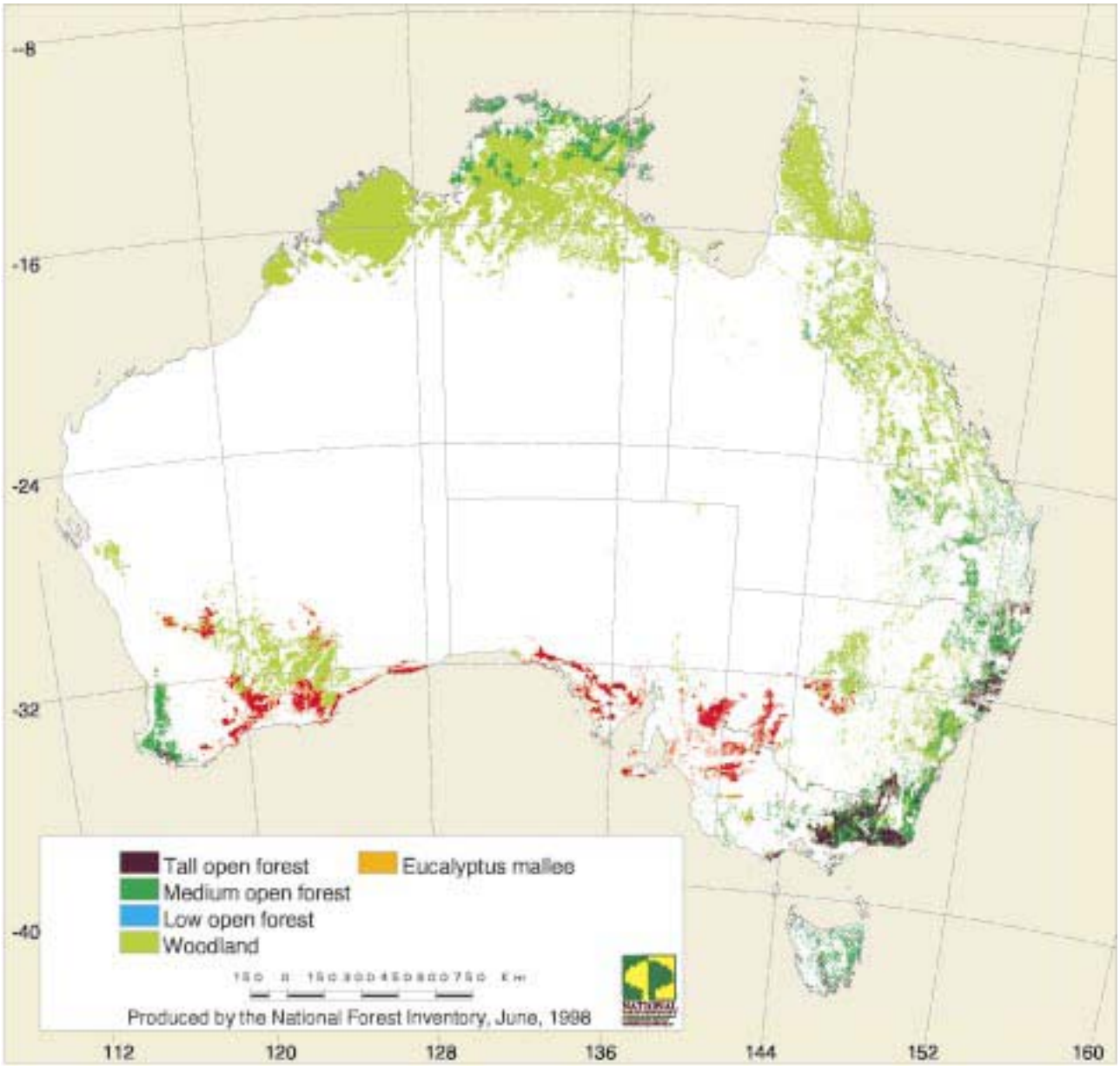


# Western Australia

| | | |
|---|---|---|
| Population 1996 (ABS 1998) | | 1 765 700 |
| Total area | | 252 550 000 ha |
| Forested land | | 34 930 000 ha |
| Native forest | | |
| multiple-use forests | | 1 612 000 ha |
| conservation reserve | | 4 364 000 ha |
| private | | 1 502 000 ha |
| leasehold | | 14 025 000 ha |
| other crown land | | 13 206 000 ha |
| Plantations (1995) | | |
| softwood | | 88 900 ha |
| hardwood | | 45 100 ha |
| Biodiversity numbers | | |
| vertebrates | mammals | 29 |
| | birds | 150 |
| | reptiles | 45 |
| | amphibians | 15 |
| | fish | 12 |
| | rare / threatened | 9 |
| higher plants | | 2639 |
| rare / threatened | | 319 |
| Forest expenditure (public, 1994–95) | | |
| conservation (forests) | | $16 837 000 |
| forestry | | $53 190 000 |
| Revenue (1994–95) | | $97 714 000 |
| Sawlog sustainable yield, multiple-use forests (1994–95) | | 758 000 $m^3$ |
| Sawlog harvest volume, multiple-use forests (1994–95) | | 689 000 $m^3$ |
| Harvest area, multiple-use forests (1993–94) | | 15 540 ha |
| Regional forest agreements | | Estimated completion August 1998 |



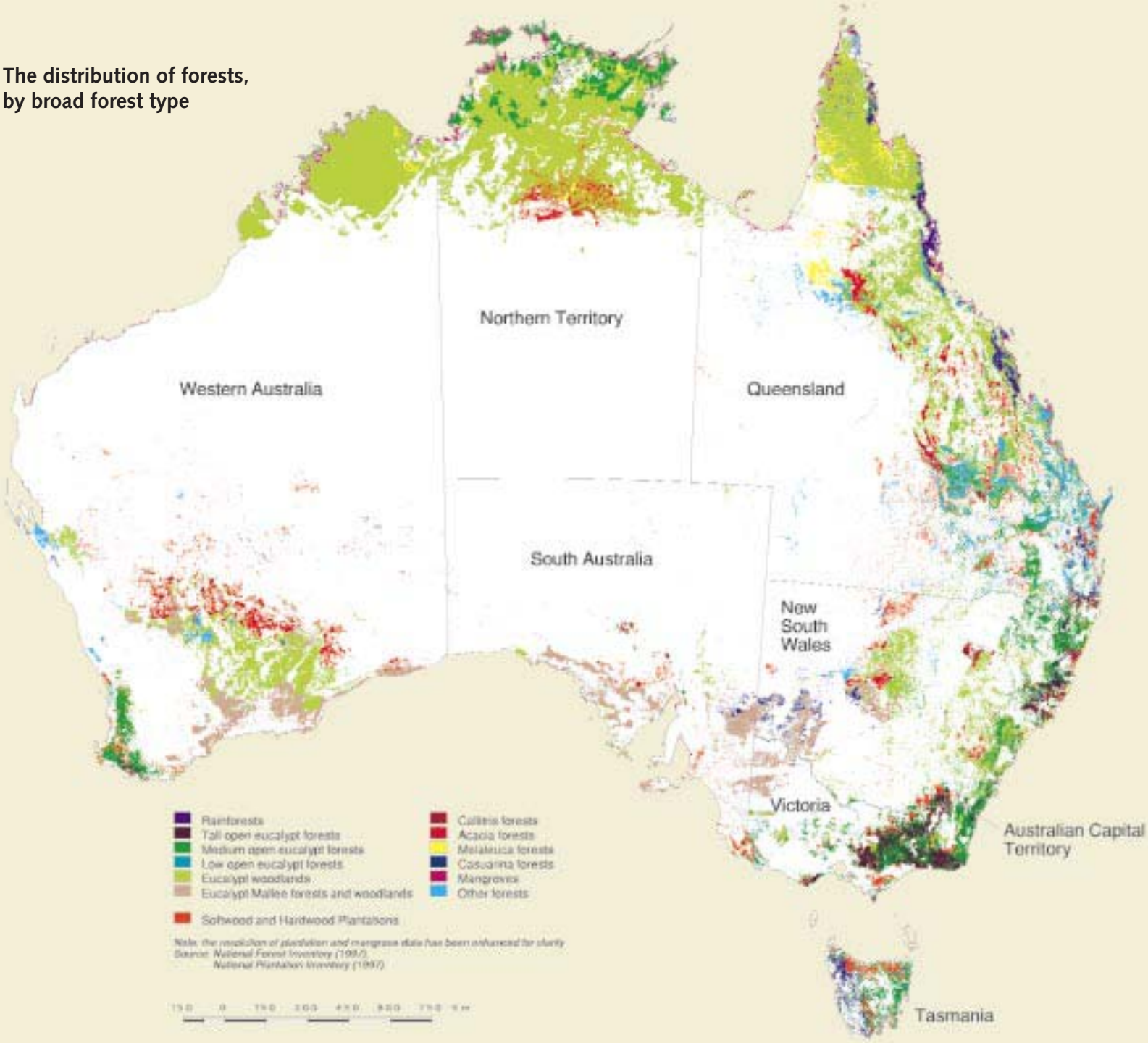
# Maps

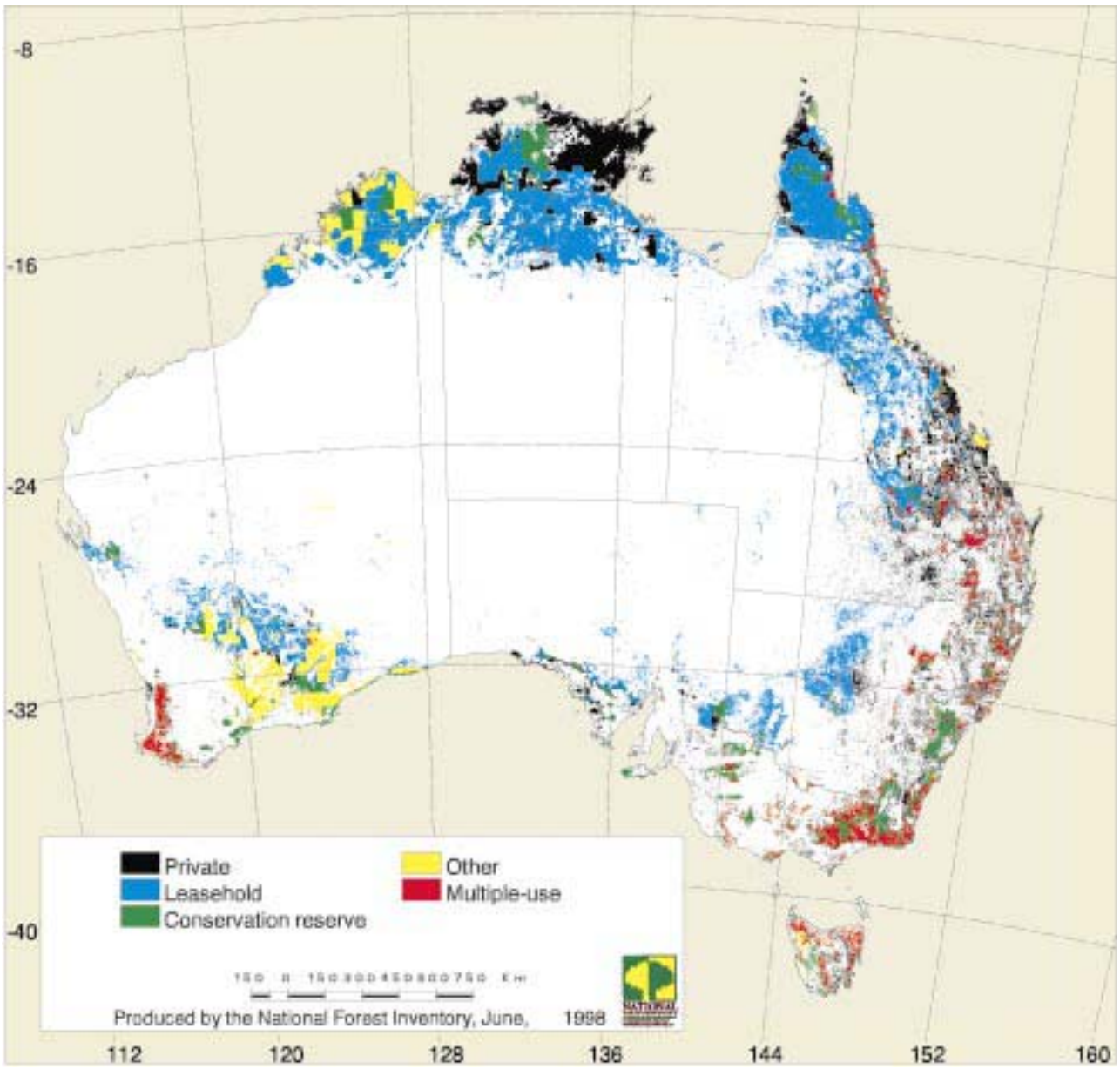



**Map 1: The distribution of forests, by crown cover density**

*Sources:*
*Distribution of forests: National Forest Inventory (1997);*
*Rainfall: Derived from ESOCLIM by National Forest Inventory (1997).*

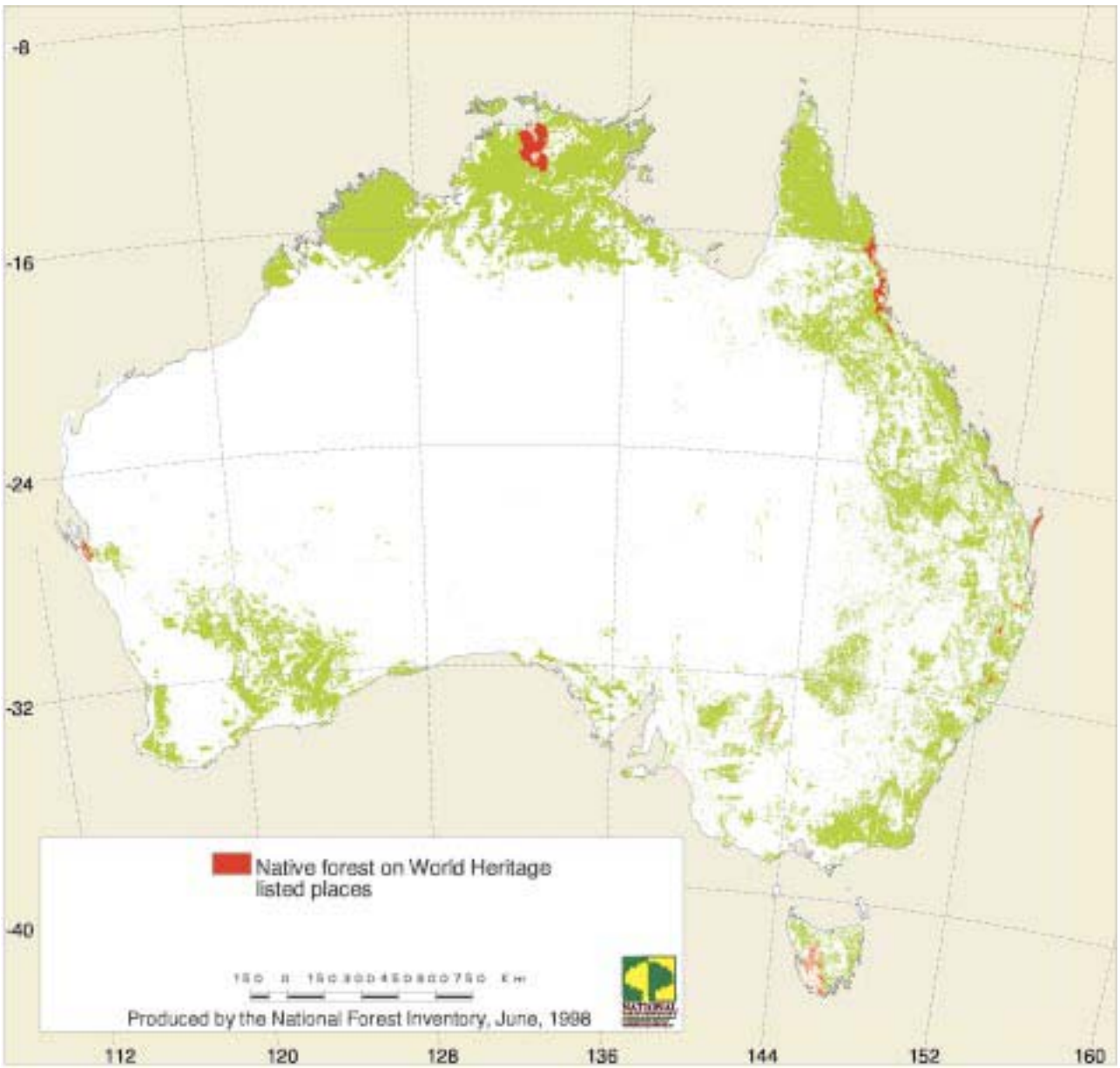
**Map 2: The distribution of forests, by broad forest type**





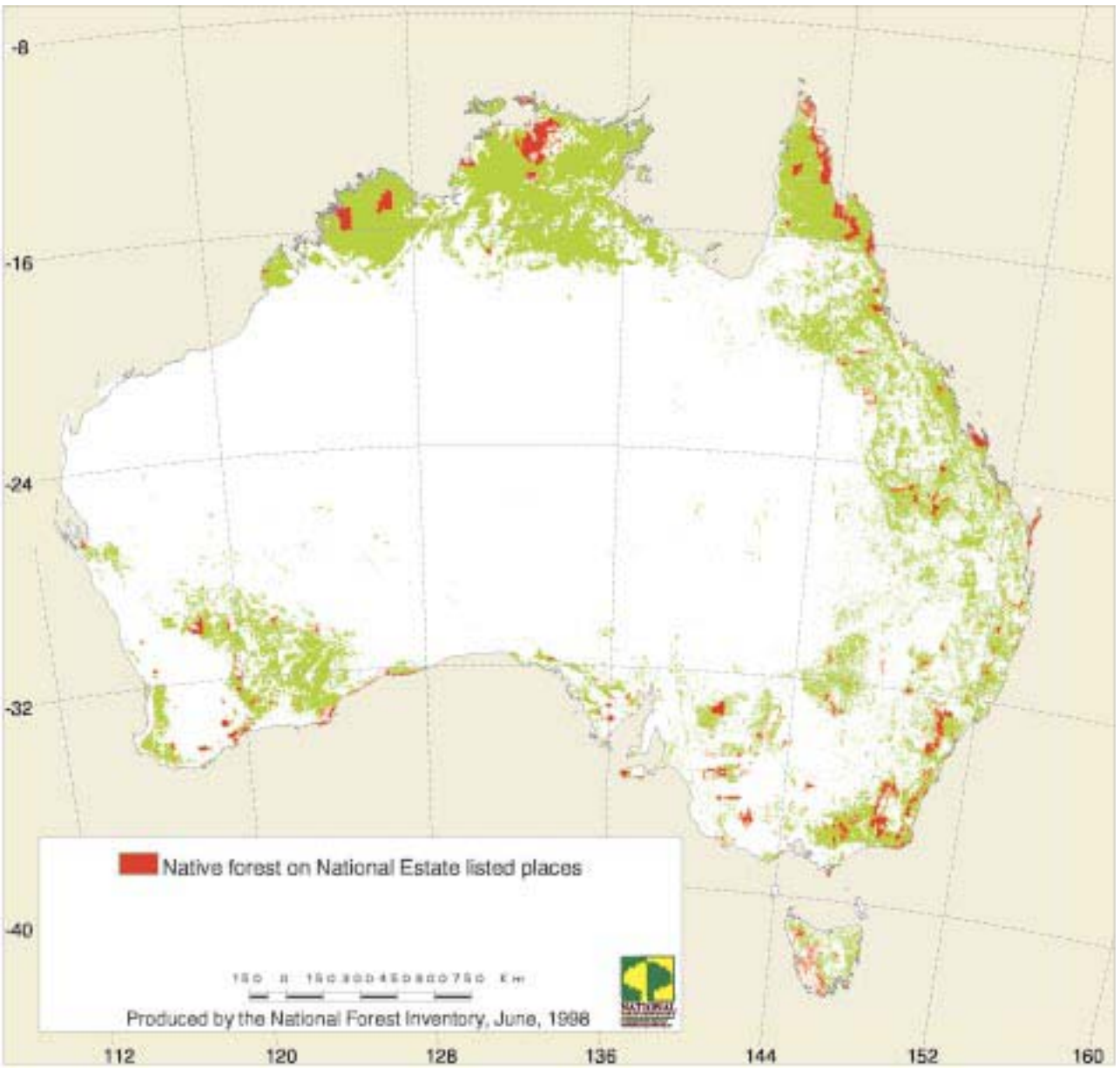

**Map 3: Native forest, by tenure classes**

*Source: National Forest Inventory (1997).*



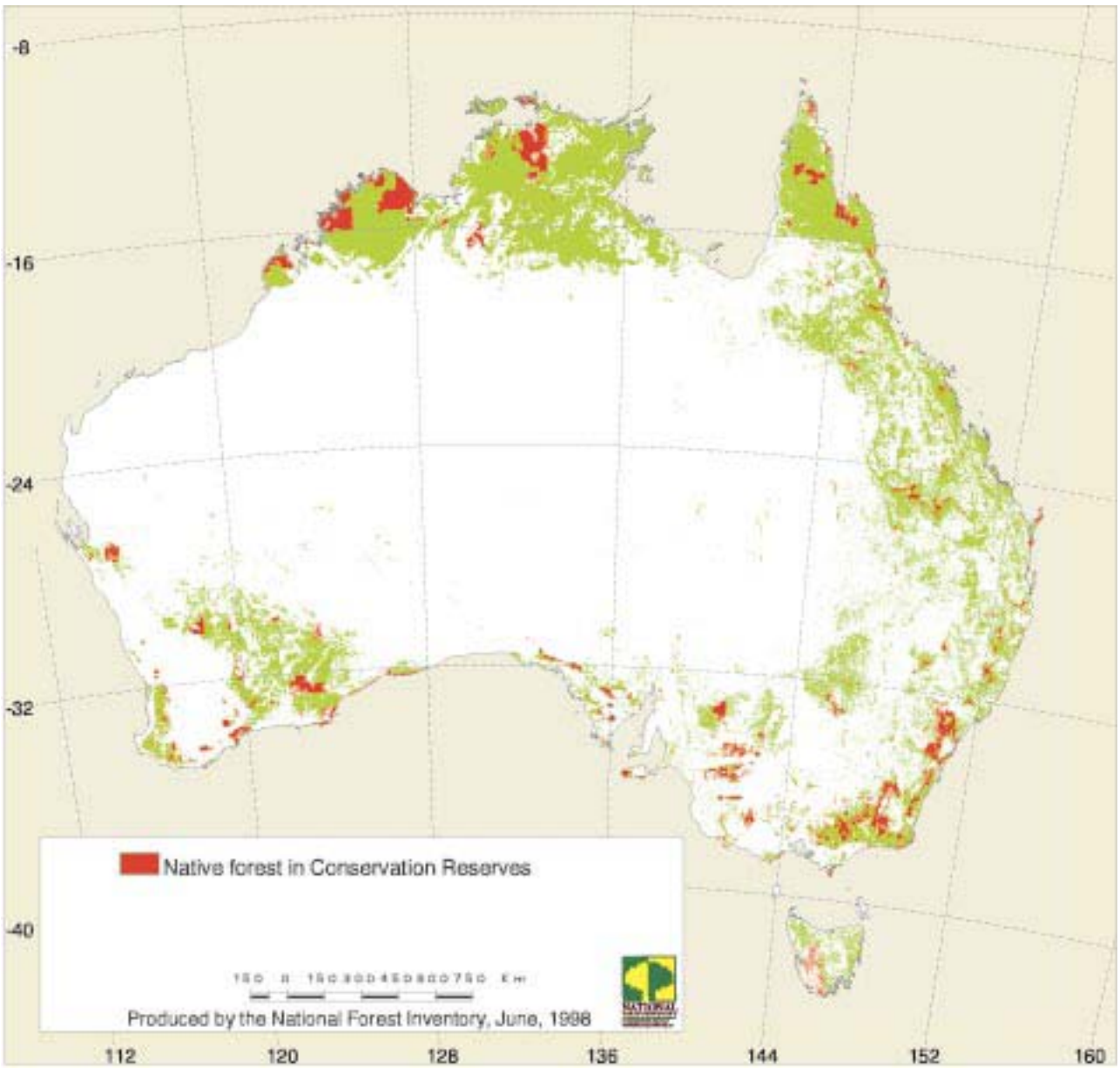

**Map 4: Location of native forest on World Heritage listed places**

*Sources:*
*Forest: National Forest Inventory (1997);*
*World Heritage Area: Environment Australia (1995).*



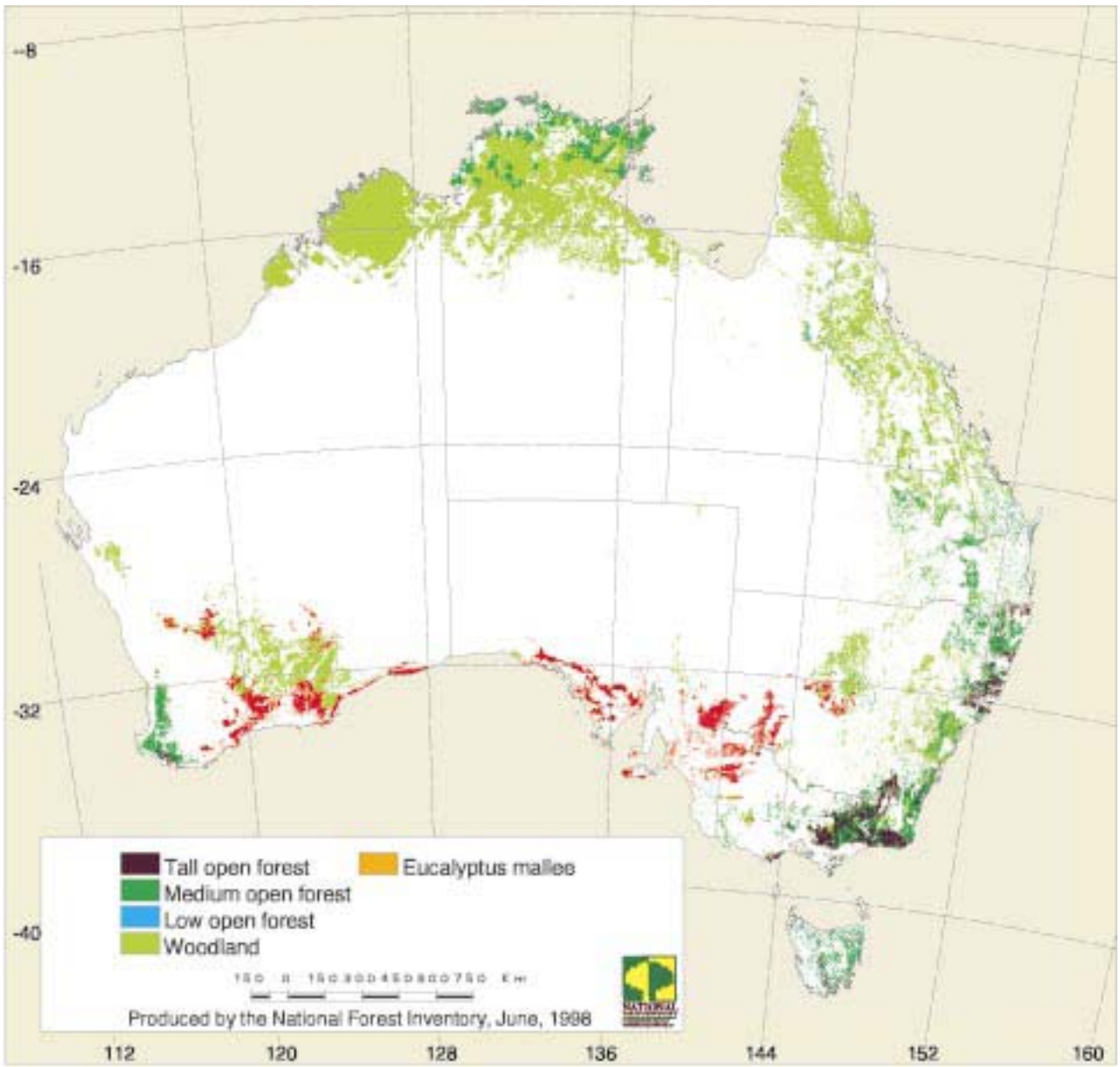

**Map 5: Location of native forest on National Estate listed places**

*Sources:*
*Forest: National Forest Inventory (1997);*
*National Estate: Environment Australia (1995).*



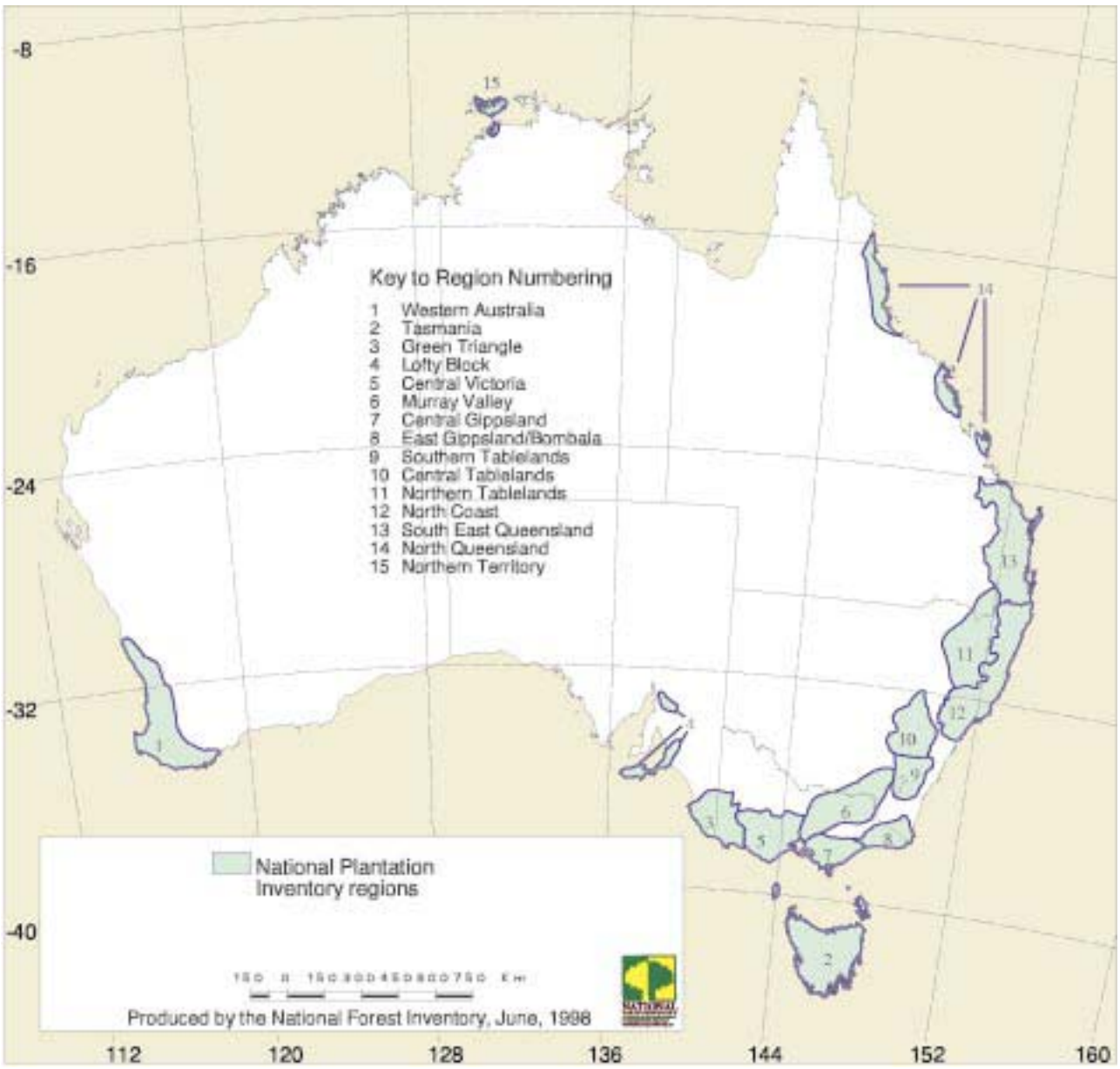

**Map 6: Location of native forest in conservation reserves**

*Source: National Forest Inventory (1997).*



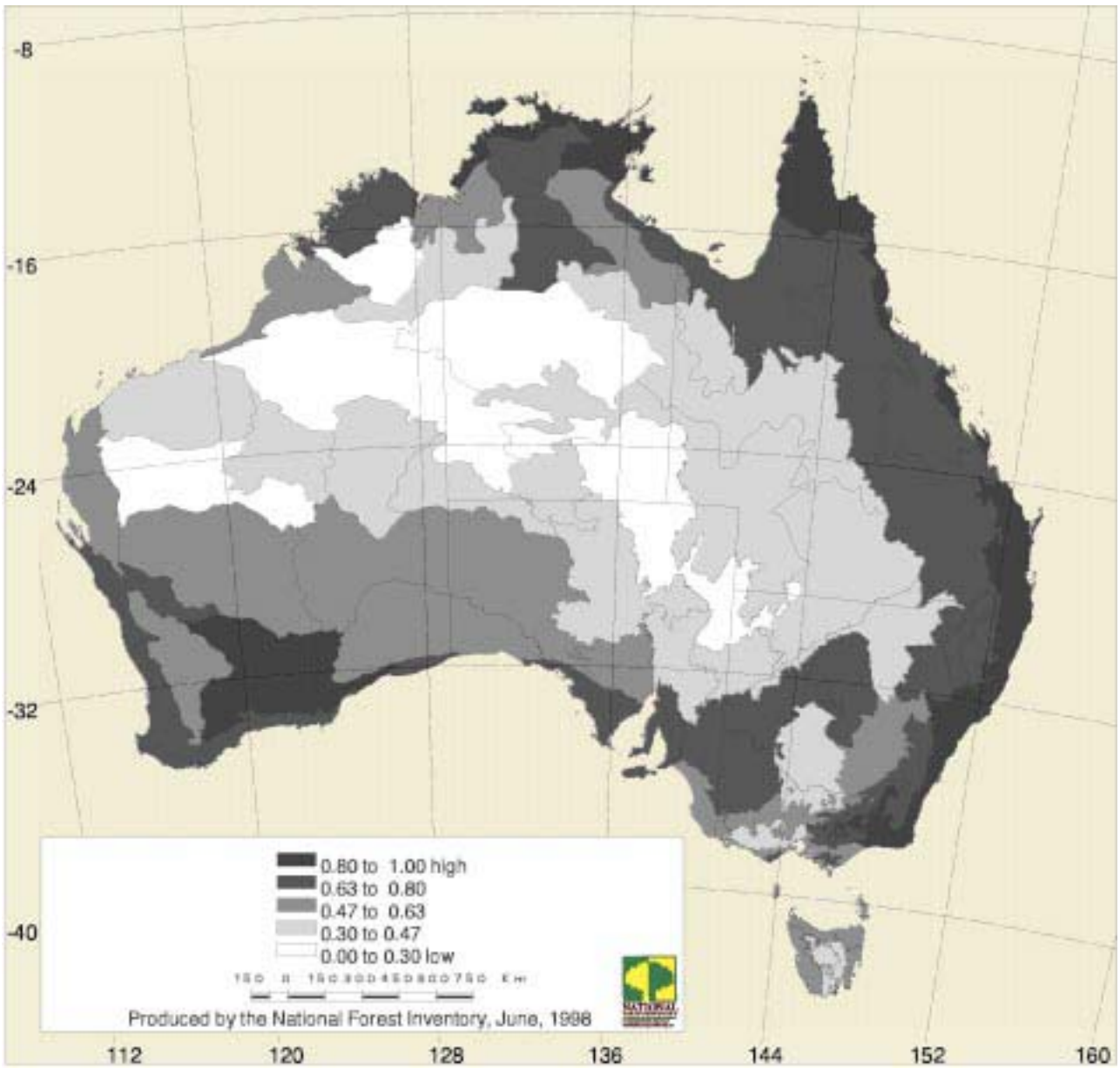

**Map 7: Distribution of eucalypt forest, by structural classes**

*Source: National Forest Inventory (1997).*



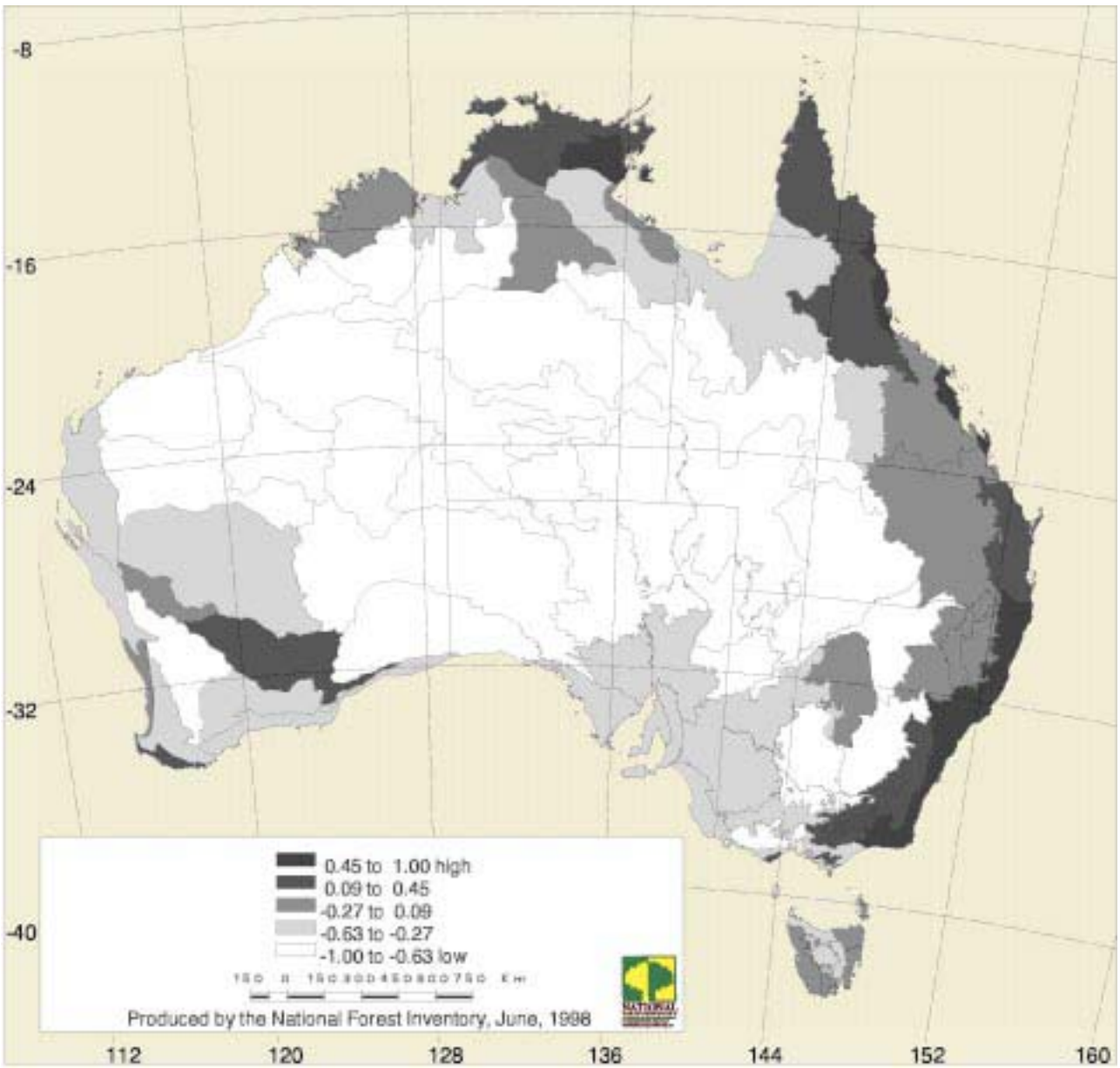

**Map 8: National Plantation Inventory regions**

*Source: National Plantation Inventory (1997).*



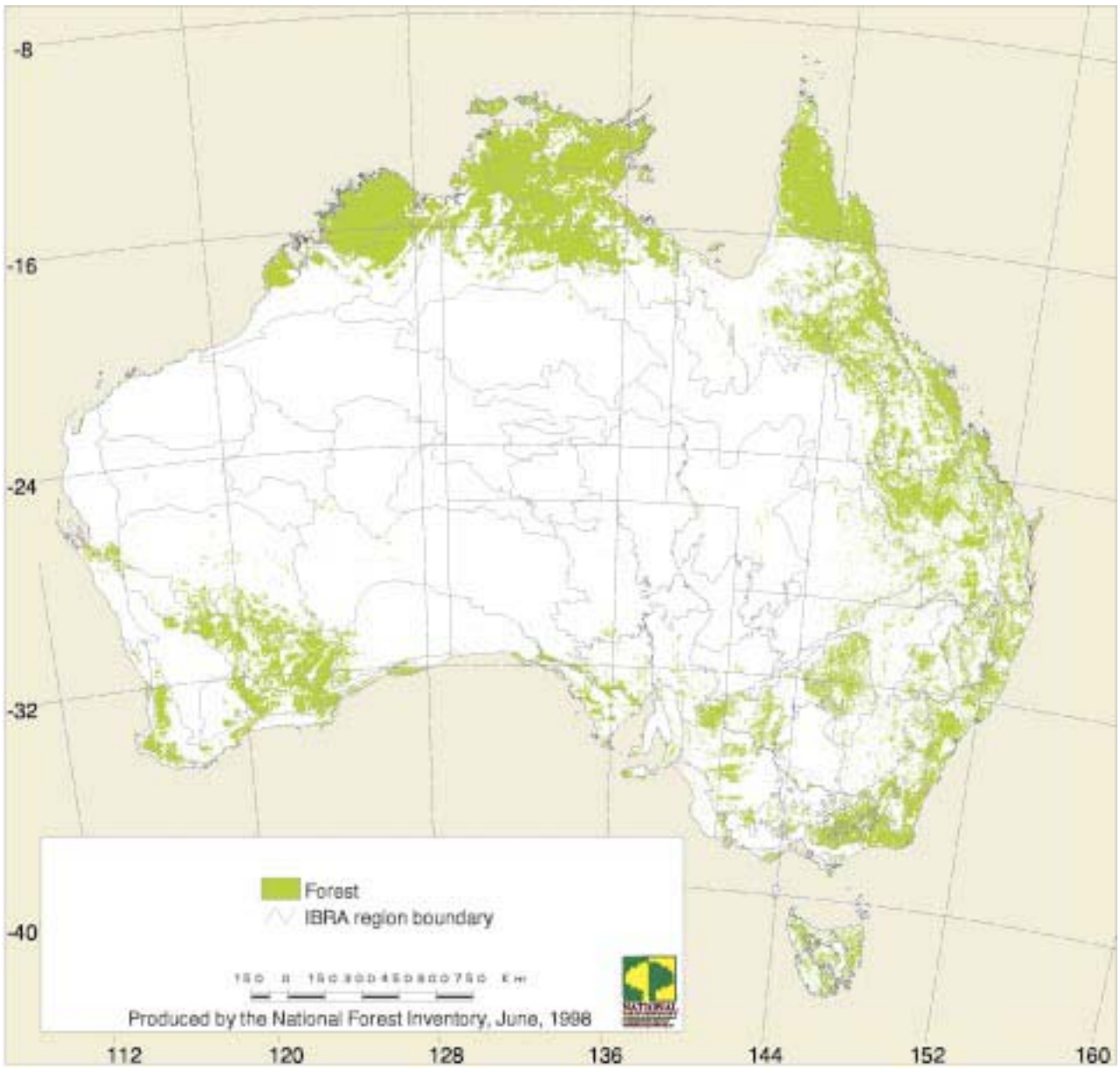

**Map 9: Forest fragmentation as measured by same-edge proportion for IBRA regions**

*Source: Montreal First Approximation Report (1997).*



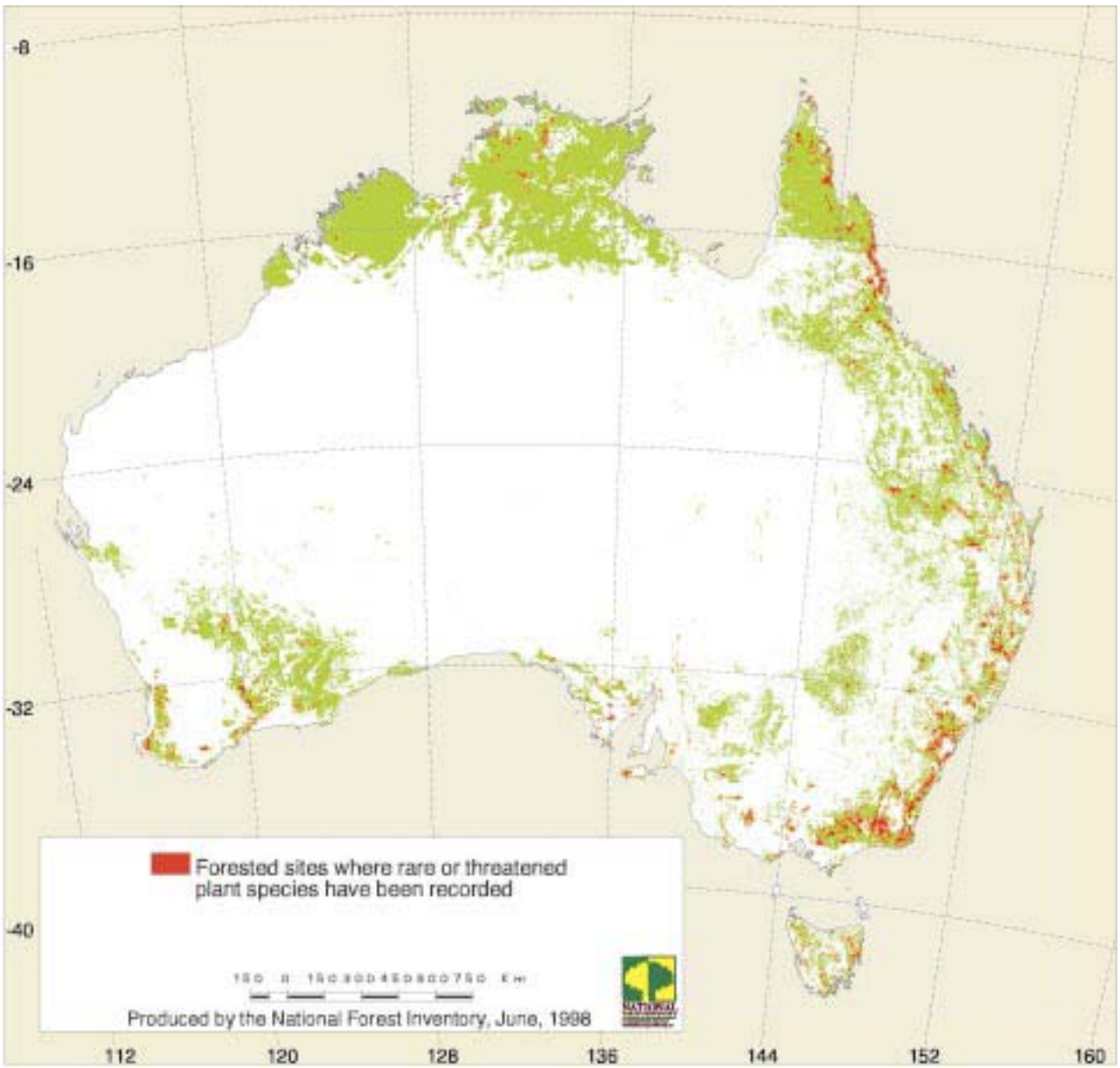

**Map 10: Forest fragmentation as measured by Shannon contagion values for IBRA regions**

*Source: Montreal First Approximation Report (1997).*



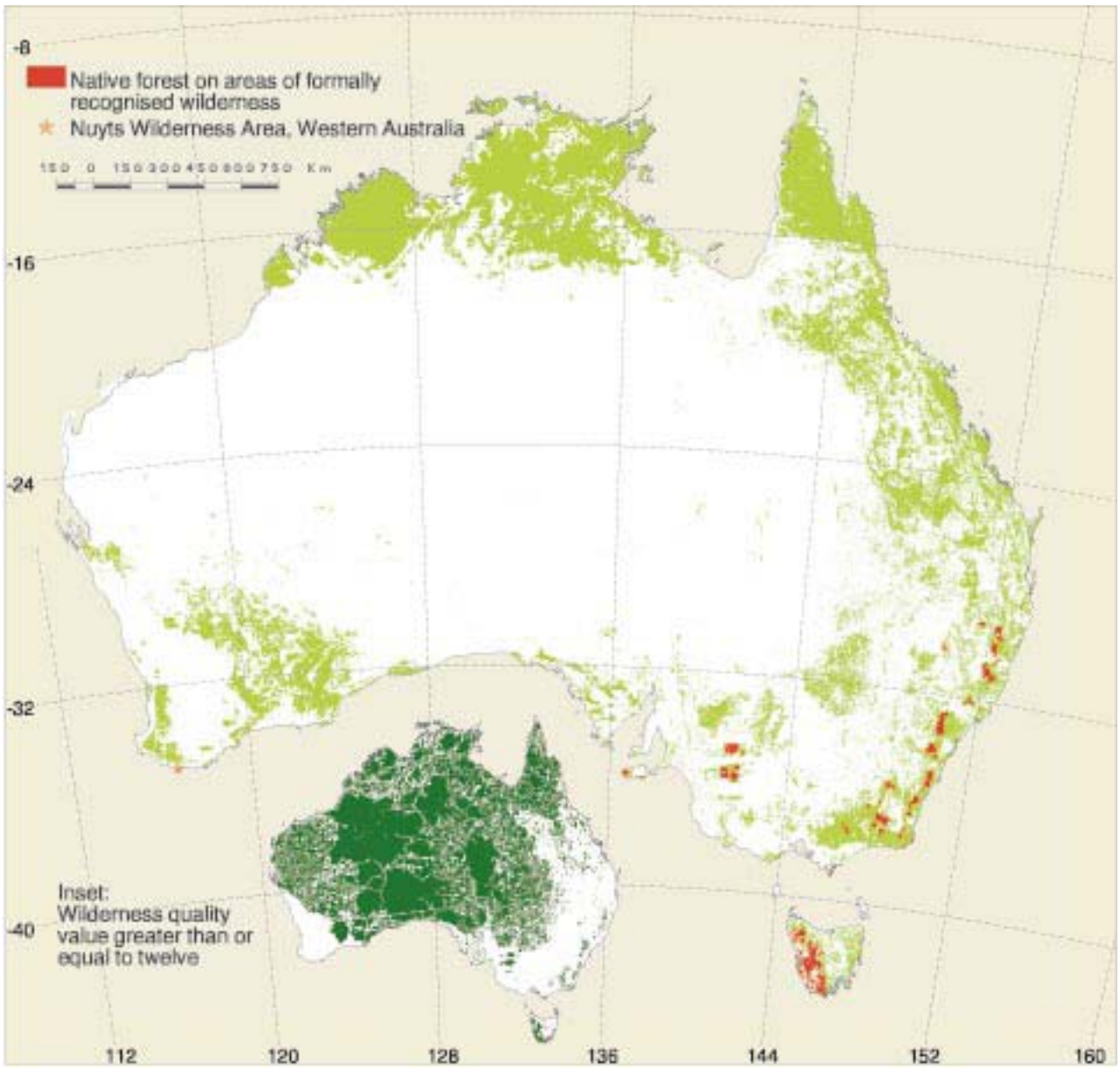

**Map 11: Interim Biogeographic Regionalisation for Australia (IBRA regions)**

*Source: ANCA (1994).*



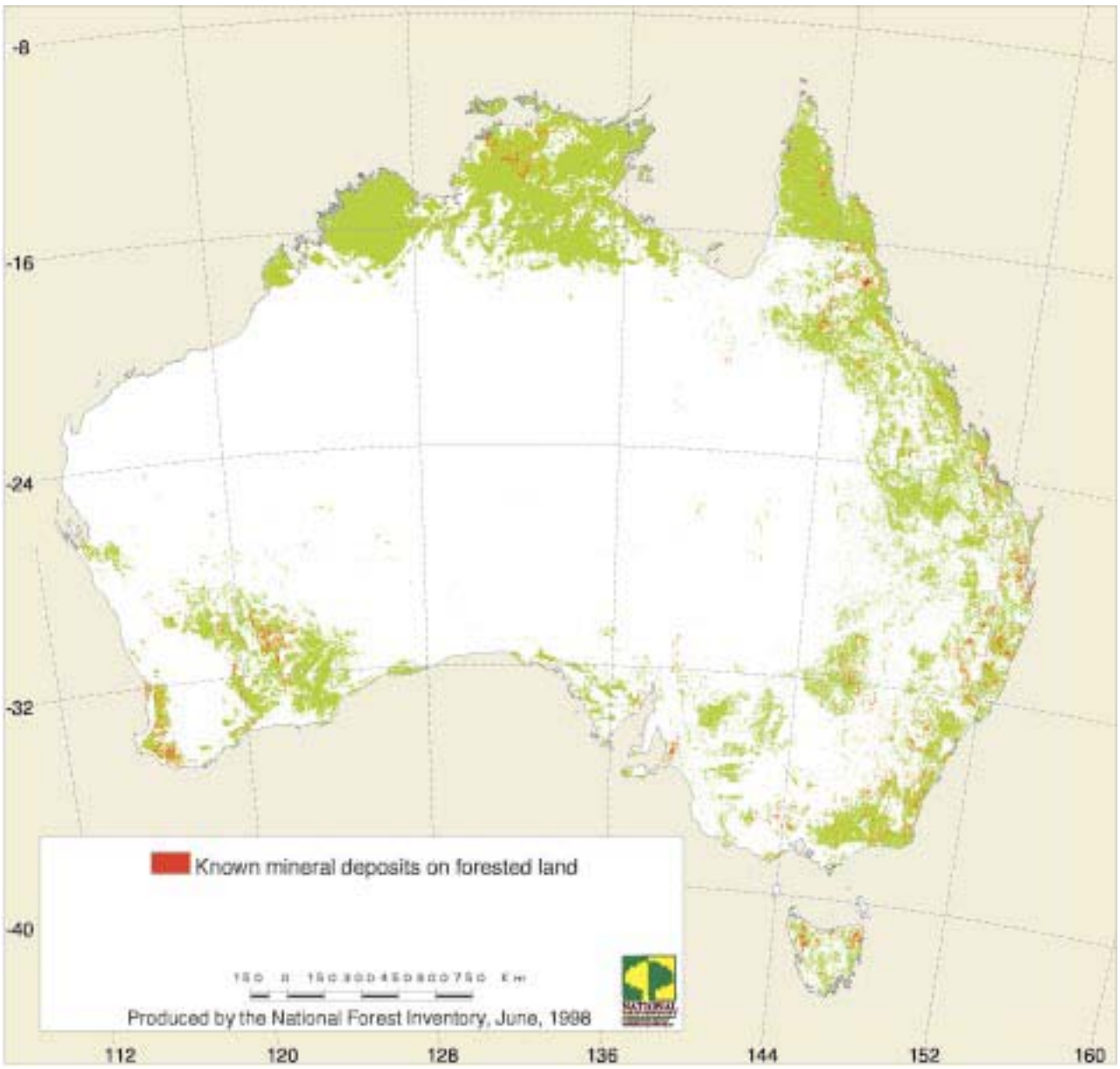

**Map 12: The locations of forested sites where rare or threatened plant species have been recorded**

*Sources:*
*Forest: National Forest Inventory (1997);*
*ROTAP: Environment Australia (1995).*
*Note: This map shows point locations only. It cannot be used to determine spatial extent of species.*



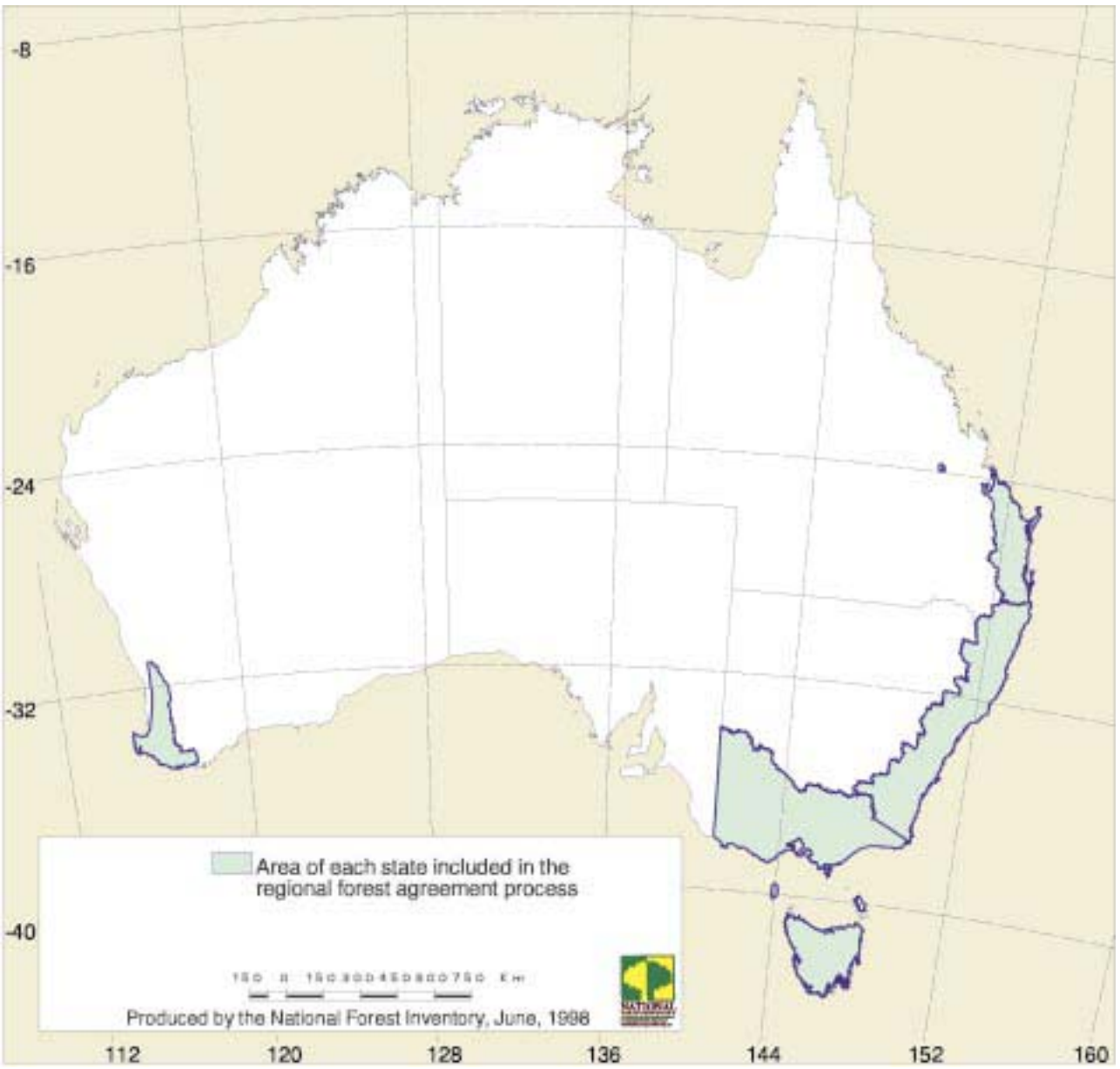

**Map 13: Location of native forest on land where wilderness has been formally recognised. Inset shows areas with wilderness quality greater than or equal to twelve**

*Sources:*
*Formally recognised wilderness: State agencies;*
*Wilderness Quality: Environment Australia (1998).*
*Note: Resolution of native forest on formally recognised wilderness has been exaggerated for clarity.*




**Map 14: Known locations of mineral deposits on forested land**

*Sources:*
*Forest: National Forest Inventory (1997);*
*Mineral locations: Bureau of Mineral Resources (1995)*
*Note: This map shows point locations only. It cannot be used to determine spatial distribution or economic value.*




**Map 15: Areas where regional forest agreements have or will be concluded**

*Source: National Forest Inventory (1997).*