

Forest Cover Changes in Victoria

1869-1987

Peter Woodgate & Peter Black



FOREST COVER CHANGES IN VICTORIA 1869-1987

A report and map describing the extent of forest cover in Victoria in 1987, the change in forest cover since 1869, and the change in forest cover over the period 1972-1987.

Peter Woodgate & Peter Black

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Remote Sensing Group, Lands and Forests Division
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Front cover: A false colour Landsat image of western Victoria (see Figure 1 for details).

Back cover: A portion of an 1869 map (known as the Everett map) covering the same area as the 1988 Landsat image on the front cover.

FOREWORD

In Australia's bicentennial year it is appropriate that Victoria should be reviewing one of its most important natural resources – its forests and woodlands. Forest clearing has long been an issue of concern. Forests and woodlands covered over 90% of Victoria prior to European settlement. But only 150 years of development has reduced the forest cover by more than half, so that now only 35% of the State is forested.

Now, with the aid of the latest earth resources satellite technology it has been possible to form a precise picture of the current extent of Victoria's forest cover. By comparing this with historic satellite imagery from 1972 it has been possible to determine the rate of clearing over the past 15 years. This is the first time in Victoria's history that an authoritative statement about the rate of clearing throughout the State has been prepared. In addition an historic and authentic map of Victoria's early forest cover in 1869 has been used to evaluate the broad decline in area of the State's forests over the past 118 years.

While this information can now be used to clarify and focus the forest clearing debate its real value will be in its application to the carefully designed programs that are now in place to preserve the environmental and economic integrity of rural Victoria. By building on this information through regular monitoring, Victoria's resource managers will be well placed to respond more quickly and effectively to the conflicting demands that are placed on the use of our precious forests.

R. P. Smith
Director Lands & Forests Division

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SUMMARY

Precise information on the change in forest cover in Victoria over the fifteen year period 1972-1987 has been derived from satellite imagery. The broad change in forest cover in Victoria over the period 1869 to 1987 has also been prepared by comparing authentic maps of the distribution of Victoria's early forests with current satellite images. This is the first time in Victoria's history that it has been possible to make an authoritative and definitive statement about the rate of clearing of the State's forests and woodlands. A total of 230 874 hectares of predominantly native forest has been cleared over the period 1972-1987. This is an average clearing rate of 15 392 hectares per year.

Area statements by both public and freehold land have been prepared for the sixteen Regions of the Department of Conservation, Forests and Lands. They show that most clearing from 1972 to 1987 has occurred on freehold land (194 376 ha) principally in three Regions; Horsham (60 315 ha), Mildura (30 434 ha) and Portland (27 678 ha). Clearing of public land over the same period was 36 498 hectares but this has been largely balanced by reforestation programs (31 568 ha). The net reduction of 4930 ha in the forest area on public land is attributable to the creation of the Dartmouth dam (5914 ha) and Thomson dam (1900 ha).

Reforestation on freehold land amounted to 37 812 hectares, mainly in the Central Gippsland and Portland Regions, but forest clearing on freehold land has exceeded reforestation by 156 564 hectares, representing an average loss of 10 438 hectares per year. In 1869 the total area of forest in Victoria was 19 983 000 hectares, representing 88% of the State. By 1987 this area had been reduced to 7 965 580 hectares (35% of the State) comprising 7 045 003 hectares on public land and 920 577 hectares on freehold land. The use of remote sensing technology has provided an authentic and authoritative baseline for monitoring future change of this depleted and valuable resource.

SECTION 1

INTRODUCTION

The primary objective of forest management in Victoria is to preserve and increase the area of Victoria's forests, to maintain or improve their ecological condition and to provide goods and services at sustainable levels. To do so effectively requires a detailed knowledge of the distribution and extent of forest cover.

BACKGROUND

While this detailed knowledge exists for Victoria's public forests, relatively little is known about forests on freehold land. The Conservation Strategy for Victoria (1987) identified forest loss on privately owned forest as being an issue of particular concern. The Strategy cited an example of clearing in south-west Victoria which if maintained would see the total removal of private forest in the region by the year 2000. Speculation of this kind emphasises the need to quantify actual clearing rates on a statewide basis. Fundamental to this is the ongoing requirement to routinely monitor forest clearing and reforestation.

Monitoring of forest clearing on a regular basis is now possible through the use of synoptically acquired satellite imagery. Landsat Multispectral Scanner (MSS) imagery has been collected over Australia since 1972. Access to new analysis techniques now permits a ready examination of this imagery for mapping and monitoring purposes. This will be particularly useful for rural land managers responsible for tackling a whole range of land issues including soil decline, salting, maintenance of water quality and preservation of environmental habitat.

This report presents definitive information on the current extent of Victoria's forests and the amount, and location, of clearing and reforestation since 1972. The report also develops a methodology for the routine use of remote sensing techniques to monitor forests at both a state-wide level and a regional level.

OBJECTIVES

The objectives of the study were:

- to map and quantify the total extent of forest cover in Victoria in the year 1987 and to use this as a baseline for monitoring future change;
- to map and quantify the change in forest cover (both loss and accretion) on both public and freehold land for each of the sixteen CFL Regions over the fifteen year period 1972-1987;
- to examine the very first attempts at mapping forest cover in Victoria from 1869 and to contrast this historical record with present day maps of forest cover; and
- to develop a procedure for monitoring forest cover at a statewide scale (1:500 000) and at regional scales (1:25 000 to 1:100 000) using remote sensing techniques based on high resolution satellite imagery.

DEFINITION OF FOREST

Forest, for the purposes of this report, has been defined as: *all woody vegetation with a height greater than 2 metres and a density (foliar cover) greater than 10 per cent.*

This broad definition includes woodlands, shrublands and mallee. It includes native forest and non-native forest such as pine plantations on both freehold and public land. The definition is drawn from the Supplementary Submission to the Timber Industry Inquiry, Department of Conservation, Forests and Lands, November 1984. The definitions are based on those of Specht (1970). The relationship between forests (as defined in this report) and other woody vegetation is shown in Table 1.

Cleared Forest is defined as:

Areas of land formerly carrying forest (in 1972) which appear to be cleared on the 1987 satellite imagery.

Reforestation is defined as:

Re-establishment of forest by 1987 on lands that appeared on the satellite imagery to have no forest cover in 1972.

In section 5 of this report, reference is made to forest cover derived from an historic map (Everett 1869). This map shows 11 wooded categories based on tree species, all of which were classified as forest for the purpose of this report. We consider that these classes very closely reflect the forest definition developed for the 1972 and 1987 mappings.

Table 1 Categories of forest that were mapped and included in the study.

Life-form & height of tallest stratum	Dense (70-100%)	Mid-dense (30-70%)	Sparse (10-30%)	Very sparse (< 10%)
Trees				
Height-class IV > 40m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland
Height-class III 28-40m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland
Height-class II 15-28m	Closed forest	Open forest	Woodland	Open woodland
Height-class I 5-15m	Low closed forest	Low open forest	Low woodland	Low open woodland
Shrubs				
2-8m	Closed scrub	Open scrub	Tall shrubland	Tall open shrubland
0-2m	Closed heath	Open heath	Low shrubland	Low open shrubland

Note: All categories enclosed by the dotted line were included in this study.

*Source: Modified from Specht (1970), and the Supplementary Submission to the Timber Industry Inquiry, CFL 1984.

Section 2

THE HISTORY OF FOREST CLEARING IN VICTORIA

The story of the progressive removal of Victoria's forests mirrors the economic history of the State. Pastoral squatting in the 1840s, gold rushes of the 1850s, a succession of Land Acts in the 1860s and the continued expansion of the transport network all combined by the turn of the century to produce a picture of forests that is similar to that of today. It was in 1907 with the passing of the Forests Act and in 1908 with the creation of the State Forests Department that the first significant steps were made towards the conservation of the State's forests.

THE SQUATTING ERA

The first permanent settlement in Victoria was established at Portland Bay in 1834 when the Henty brothers arrived with their flocks of sheep and established squatting runs in that area. The following year John Batman settled at Port Phillip. This latter event ushered in two years of expansion that saw pastoral runs spreading out as far as Winchelsea, Inverleigh and Bacchus Marsh in the west and Woodend and Kilmore in the north.

By 1840 most of the fertile plains and foothills around Melbourne were occupied by squatters. The same story was being repeated throughout the open woodlands of the state. To the west and in a wide arc from Ballarat and Colac through to Hamilton the rich basalt flats were found to support open woodlands interspersed with lush grassy plains. To the north along the Goulburn Valley and in the Murray Valley from Echuca to Wangaratta explorers reports of fertile grassy woodlands quickly encouraged new pastoralists and squatters. In the east squatters moving down from the Monaro plains of New South Wales soon occupied the rolling foothills and river flats around Omeo. By the mid 1840s the broadening push for new grazing lands had reached the Gippsland Lakes in the east and the Wimmera in the north-west.

GOLD MINING

The relatively benign impact of the early pastoralists ended in 1851 with the discovery of gold. Early deposits at Warrandyte and Clunes were soon forgotten in the rush to the big fields at Ballarat, Castlemaine and Bendigo. A massive influx of migrants demanded timber for use as pit props, firewood and for building. The need for food stimulated intensive agricultural development. Forest clearing began in earnest in the immediate vicinity of the goldfields and spread further out as transport links improved.

LAND ACTS

Effective agricultural development became the key to successful economic development of Victoria. Prior to 1860 the Imperial Land Acts had permitted 1.6 million hectares of land to be occupied primarily by squatters and pastoralists. Stung by the need for funds to finance rapid infrastructure development in the wake of the gold rush the Government passed the Nicholson Land Act in 1860. This act released about 330 000 hectares of land but was largely unsuccessful in its attempt to break the oligopoly of the

squatters. Subsequent acts in 1862 and 1865 released a further 2.2 million hectares, but widespread *peacocking* (use of titleholder names for persons not resident on the property), *dummying* (selection of water frontages, effectively locking up all the lands dependent on water) and property speculation left agricultural development floundering and government revenue unsustainable.

From the economic perspective a truly successful land act was passed in 1869. The Grant Land Act saw 4.7 million hectares surveyed and selected and encouraged a rapid expansion in the agricultural capacity of Victoria. By 1878 and with 40% of the land now alienated the colony of Victoria was producing a surplus of food for the first time.

AGRICULTURAL DEVELOPMENT

Clearing continued in the north-west and the east during the late 1860s and 1870s with the Wimmera producing large quantities of cereal crops. Cropping was also encouraged in the Swan Hill district. The Mallee was opened up in the 1880s with the advent of the stump jump plough and the stripper, the extension of the rail system and breeding of hardier strains of wheat. In the east the townships of Sale and Bairnsdale, that had been established in the 1850s, were burgeoning as the fertile river flats of the Mitchell, Avon, Thomson and Macalister rivers were alienated. During the 1880s much of the Dandenongs were cleared and development in the Strzelecki Ranges had commenced. By 1900 most parts of the Strzeleckis had been selected and dairying emerged as the dominant primary industry, no doubt aided by the invention of refrigeration in the 1880s.

EARLY FOREST CONSERVATION

The agricultural development was so swift that concern was raised over the continued alienation and clearing of public land. In 1874 the Minister of Lands and Agriculture presented a report to Parliament on "Forest Conservancy". The report dealt with the management of forests in Victoria and stated that "...no more effectual method of legalising the destruction of timber could be devised".

Indiscriminate cutting was rife and there were few forest reserves. Attempts were made to redress the situation through legislation but none of the bills brought before Parliament in 1879, 1881, 1887 and 1892 were ever enacted. In 1897 a Royal Commission on forestry was instituted. For three years the Commission rigorously examined the Victorian situation and concluded that effective management and conservation of forests was not possible without appropriate legislation, policy and bureaucratic support. Finally in 1907 the first successful Forests Act was passed and the following year a State Forests Department was formed under the direction of a new Minister of Forests (Carron 1985).

The new Department set about the task of licensing forest production and securing forest reserves from the widespread practice of illegal wholesale clearing. In the 1930s programs were instituted to reforest previously cleared areas. In the Strzelecki's, for example, soldier resettlement programs following World War I resulted in large areas of forest being cleared. Much was unsuitable for agriculture and many farms failed and land was abandoned. The Government, and private industry, instituted a replanting program replacing bracken and dogwood with either pines or eucalypts. Today this program is one of the largest reforestation schemes in Australia.

The Otways experienced a similar history of forest utilization. In the 1860s the forests were intensively logged and in the 1870s the Government made available over 140 000 hectares of forest for selection. Following recommendations contained in the 1897 Royal Commission the Government permanently reserved 64 000 hectares of Otways forests. In the 1930s the Forests Commission began purchasing abandoned farmland in the Aire Valley and commenced an extensive planting program for timber production.

SOLDIER SETTLEMENTS

Substantial clearing on freehold land did continue. During the 1920s massive development of the brown coal resource accelerated the expansion of the Latrobe Valley. In the north-west of the State, soldier settlement and closer settlement following World War I saw the northern Mallee occupied. Soldier settlement also occurred in the Wimmera but appeared to be unsuccessful prior to World War II. Subsequent to the war about forty ex-soldiers were successfully settled but this relatively low number reflects the fact that by this time the Wimmera was mostly well established. Indeed, by 1940 the limits of viable settlement in the Mallee had also been reached and the extent of public land was by then well defined.

Special legislation was enacted in 1951 to enable the AMP Society to develop leases on up to 231 000 hectares of public land in the Big Desert adjacent to the South Australian border. The leases ran for 25 years and required AMP to carry out general improvements for primary production. Some 133 000 hectares were eventually granted. The last major settlement scheme in Victoria commenced in 1956 when the Soldier Settlement Commission began to clear 40 000 hectares of the Heytesbury Forest, south-east of Warrnambool, for dairy farming. This program was subsequently taken up by the Rural Finance Commission and is now largely completed.

THE FUTURE OF VICTORIA'S FORESTS

In recent years several important factors have combined to influence the extent of forest clearing. The controversial proposal to develop about 200 000 hectares of mallee vegetation in the Little Desert by the then Minister for Lands caused a public outcry that led to proclamation of the Land Conservation Act in 1970 and the establishment of the Land Conservation Council (LCC) in 1971. This was a landmark decision for land use planning in Victoria. The work of the LCC since 1971, through its comprehensive review of public land, has made an important contribution to the attitudes of both government and individuals. There has been a developing awareness that the forest resource is indeed finite and that trees can actually assist the productivity of our agricultural lands by protecting soils, aiding in the prevention of salting and in the provision of habitat and shelter.

Clearing in future, particularly on freehold land, will be influenced by programs including LandCare, the Salt Force, the Potter Foundation Whole Farm Management Plan and the recently enacted Flora and Fauna Guarantee legislation. The challenge will be to continue to preserve and extend Victorian forests whilst also maintaining the State's economic well-being. The State Conservation Strategy and the Timber Industry Strategy map out a scenario for major changes in the way forests will be managed in the future. Additional areas of Victoria will be covered with trees as reforestation projects are implemented, hardwood plantations encouraged and agroforestry is accepted as a normal farming practice.

Section 3

SATELLITE IMAGERY FOR FOREST COVER MAPPING

BROAD AREA MAPPING AT SMALL SCALE

Multispectral Scanner (MSS) information from LANDSAT satellites has been available over Australia since 1972. The information is usually presented in picture form as a "false colour" print. The false colour in the picture is a result of a combination of information from the visible and infrared parts of the electro-magnetic spectrum. Each print, or scene, covers 185km by 185km. The pictures can be presented in transparency or print form at scales of 1:1 000 000 to 1:100 000.

The images are collected over Australia via a receiving station at Alice Springs and processed in Canberra for distribution. A range of image products may be ordered through CFL or purchased directly from the Australian Centre for Remote Sensing, PO Box 28, Belconnen, ACT (062 524 411). The images have the following specifications:

- Frequency of collection: 16 days
- Pixel size: 0.44 ha
- Geometry: AMG registered
- Scene Size: 185km by 185km
- Cost: Colour print (1:250 000) \$380
Colour transparency (1:1 000 000) .. \$210

Enhanced products (e.g. with more precise geometric corrections) are also available.

DETAILED MAPPING AT LARGE SCALE

Large scale mapping (1:100 000 to 1:25 000) requires higher resolution satellite imagery. Since 1986 Australia has been receiving imagery from two high resolution satellite scanners; the French satellite SPOT, and Thematic Mapper (TM) imagery from the Landsat satellite. For forest cover mapping at large scale it is recommended that the data be purchased in digital form, analysed on an image analysis computer (such as CFL's Microbian system) and converted to prints or maps.

SPOT has the following specifications:

- Frequency of collection: 25 days (nominally) or more often if directed.
- Pixel size: 0.01 ha (black and white)
0.04 ha (false colour)
- Geometry: Precision map registered
- Scene size: 60km by 60km
- Cost: Digital, colour or B&W \$2500
Transparency, B&W (1:400 000) \$1250
Print B&W (1:100 000) \$750
Transparency, colour (1:400 000) \$1250
Print, colour (1:100 000) \$835

Landsat TM has the following specifications:

- Frequency of collection: ... 16 days
- Pixel size: 0.09 ha
- Geometry: Prints, AMG registered
Digital, uncorrected
- Scene size: 185km x 185km
- Cost: Digital, colour \$5000
Prints or transparencies .. \$400

Landsat TM digital data is recommended over SPOT data because it is cheaper (per unit area) and contains more spectral information relevant to discrimination of vegetation cover.

Section 4

MAPPING PROCEDURE

The procedure followed in interpreting, mapping and analyzing the data to determine changes in forest cover over the 15 year period was as follows:

1. Satellite imagery coverage for Victoria was obtained for the summers of 1972/73 and 1986/87. The imagery comprised Landsat MSS colour transparencies at a scale of 1:1 000 000. Each image covered 185km x 185km and was colour enhanced and geometrically corrected to conform with the AMG map base.
2. Public land boundaries were obtained from the Land Conservation Council's Public Land Use Map of Victoria, 1988 (scale 1:500 000). These boundaries were entered in digital form into the Departmental Geographic Information System using the ARC/INFO software package. Registration to existing topographic, roading and water information was undertaken.
3. The 1986/87 forest cover boundaries were manually mapped onto the public land boundaries from the Landsat MSS colour transparencies at a scale of 1:500 000 using the KARTOFLEX analogue mapping device. (The KARTOFLEX is a mapping instrument that permits maps and images of different scales to be overlaid together for the purpose of transferring information from one to the other).
4. These forest boundaries were also entered in digital form into the Geographic Information System. An interim map of 1986/87 forest cover was then plotted automatically.
5. The 1972/73 forest cover boundaries were then mapped onto the 1986/87 forest cover map from the Landsat MSS transparencies using the KARTOFLEX.
6. These boundaries were also entered into the Departmental mapping base using ARC/INFO.
7. Interpreted forest cover boundaries were checked using a variety of sources. These included existing vegetation maps, softwood plantation records and consultation with individuals familiar with specific areas. (Of course, a map of this nature at these small scales can never be completely checked and errors or omissions will need to be corrected as an on-going task.)
8. Area statements by land tenure, year, cover class and CFL Regions were calculated automatically using the ARC/INFO software package.

Examples of the Landsat MSS imagery are shown in Figures 1 and 2. The images depict the change in forest cover in western Victoria between 1972 and 1987. Clearing of native vegetation is readily detected from aerial photographs (Figure 3). Figure 4 illustrates the impact of clearing of native vegetation for establishment of softwood plantations on public land. Clearing of native forest on public land for pine plantations is no longer permitted under present Government policy.

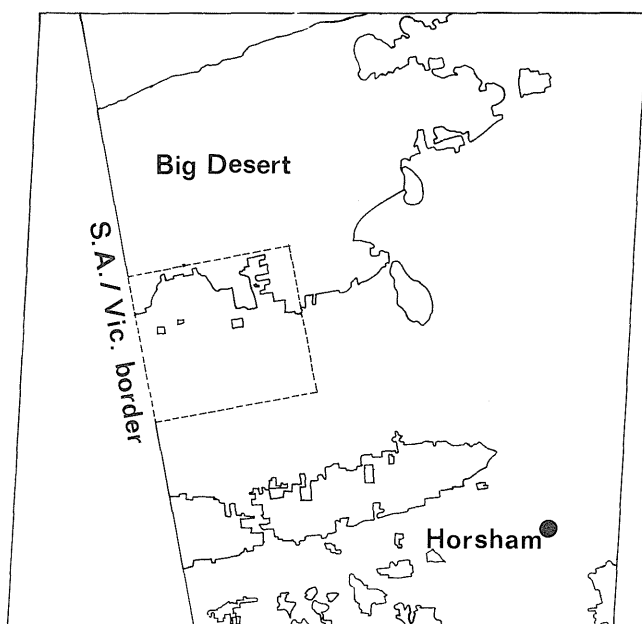


Figure 1 (above) a full 1988 Landsat MSS scene of north-west Victoria (scale 1:1 000 000) and (left) a locality map for the image. The area within the dotted line on the locality map is the area shown enlarged in Figure 2.



Figure 2 The two enlarged Landsat scenes illustrate the change in forest cover from 1972 (upper scene) to 1988 (lower scene) in the same area of western Victoria, between the Big Desert and the Little Desert. The large, regular-shaped white areas in the 1988 image are patches of native vegetation cleared back to mineral earth.



Figure 3 Clearing of native vegetation in the Mallee. The top left quadrant contains undisturbed mallee, the right quadrant shows mallee that has been chained and flattened, and the bottom left quadrant is an area that has been completely cleared. The photograph was taken by a hand held 35mm camera (August 1988).

Photo: David Venn

EXPLANATORY NOTES ON MAPPING

- The smallest unit of forest capable of being detected from the satellite imagery and presented on the map at a scale of 1:500 000 was about 15 hectares in size. Smaller units of forest, or clearings, remain unmapped.
- The Public Land boundaries were derived from the Land Conservation Councils 1:500 000 Public Land Use Recommendation Map (1988). It was subsequently found that in many instances these boundaries were inaccurately located with respect to local topography and roading. However, in order for the forest cover map to accurately reflect the distribution of forest in the State by land tenure categories it was necessary to align forest boundaries with these public land boundaries. As a consequence some forest areas, along with the corresponding land tenure boundary, will be imprecisely located.
- There are many small logging coupes created each year on public land. It was decided not to record these coupes in this study, because they are generally very small in relation to the scale of mapping and are invariably reforested, so that they produce only a transitory clearing effect. However some small areas of logging on public land in eastern Victoria may have inadvertently been mapped.
- Recent fire scars in the Mallee were not mapped as clearing but were treated as unchanged forest.
- For five of the eighteen Landsat scenes that cover the State, imagery was not available for the year 1972. More recent scenes from 1975 and 1977 were used instead (see Appendix 1). As a result, the estimate for forest clearing becomes more conservative.

A recommended procedure for future mapping and monitoring projects at large scales is contained in Appendix II.



Figure 4 Aerial photograph of the Koetong softwood plantation in north-east Victoria. The windrows result from the clearing of native forest for establishment of a softwood plantation. The large clearing at the bottom of the photograph is associated with a State Electricity Commission power-line. Since this picture was taken (1986), Victorian Government policy has prohibited the clearing of native forest on public land for the establishment of softwood plantations.

Photo: Geoff Pike

Section 5

RESULTS

FOREST COVER IN 1987

In 1987 Victoria's forests covered an area of 7 965 580 ha (Table 2) representing 35% of the total land area of the State (Table 3). Approximately 200 000 ha of this area (2.5%) was occupied by softwood plantations (Table 4). About 88% (7 million ha) of the State's forests occur on public land (Table 5); the remainder occur on freehold land and occupy approximately 6% of the total area of the State (Table 3). The two CFL Regions with the most forest cover on public land were Mildura (1.47 million ha) and the North East (1.02 million ha).

The two Regions with the greatest areas of forest on freehold land were Central Gippsland (100 201 ha) and Horsham (89 910 ha). Seven Regions have freehold forest that occurs on less than 5% of the area of freehold land in the Region. They are Mildura, Horsham, Portland, Ballarat, Bendigo, Benalla, and Melbourne (Table 3). Parks and gardens in the Melbourne metropolitan area and in the provincial cities have not been categorised as forest in this study. Public and private ownership of Victoria's forests as a proportion of the total area of the State is illustrated in Figures 5 and 6.

FOREST CLEARED SINCE 1972

Over the period 1972 to 1987 a total of 230 874 ha of forest was cleared (Table 6). Most (194 376 ha) was cleared from freehold land. Clearing in Mildura (30 434 ha), Horsham (60 315 ha) and Portland (27 678 ha) Regions accounted for 61% of the total clearing on freehold land. In Mildura and Horsham clearing was mostly for agricultural purposes while at Portland a proportion of the clearing has been for establishment of pine plantations. Some of these plantations are not yet old enough to appear as forest on the satellite imagery. Those Regions with clearings totalling less than 5000 ha on freehold land are Melbourne, Benalla, Geelong and Alexandra.

On public land in the same period 36 498 ha was cleared. This figure excludes normal timber harvesting in State Forests and fire scars in the mallee, both of which produce only transitory clearing effects. Mildura and North East Regions account for 49 percent of this clearing. In Mildura, the change reflects clearing on F1 and F2 designated blocks and, in part, a gradual deterioration of the leased grazing areas. (The F1 and F2 blocks of public land were assessed by the Land Conservation Council in 1977 as being suitable for agricultural improvement. In many cases the F1 blocks were partially cleared and cultivated prior to alienation, while the F2 blocks were approved for cultivation under long term leasing).

In the North East the largest single contribution was made by the creation of the Dartmouth dam with 5914 ha of native forest being cleared. The remaining areas are largely made up of land that was cleared and planted to pines and which again do not yet appear as established forest on the satellite images. Note also in the Central Gippsland Region that in creating the Thomson dam 1900 ha of native forest was cleared.

Table 2 Total area of forest, all classes of land in CFL Regions in 1869, 1972 and 1987 (ha).

Region	1869	1972	1987
Mildura	3 877 000	1 569 127	1 540 461
Horsham	2 214 000	589 514	529 996
Portland	1 654 000	312 646	299 352
Colac	500 000	195 129	192 206
Ballarat	625 000	153 394	148 881
Bendigo	1 932 000	308 333	299 112
Geelong	664 000	173 383	171 847
Benalla	984 000	162 727	160 843
Alexandra	1 039 000	514 489	514 837
North East	1 815 000	1 113 151	1 094 723
Dandenong	569 000	193 970	188 286
Yarram	586 000	193 739	185 798
Central Gippsland	1 361 000	931 705	933 863
Bairnsdale	1 170 000	872 880	867 679
Orbost	900 000	839 631	834 587
Melbourne	93 000	3 258	3 109
Total	19 983 000	8 127 076	7 965 580

Table 3 Total areas (ha) of public and freehold land in CFL Regions and percentage of each covered by forest in 1987.

Region (ha)	PUBLIC		FREEHOLD		TOTAL	
	Area (ha)	Forest (%)	Area (ha)	Forest (%)	Area (ha)	Forest (%)
Mildura	1 662 268	88	2 465 481	2.9	4 127 749	37.0
Horsham	465 698	95	2 034 021	4.4	2 499 719	21.2
Portland	250 120	91	1 612 122	4.5	1 862 242	16.1
Colac	182 920	83	696 931	5.7	879 851	21.8
Ballarat	122 576	90	1 025 387	3.7	1 147 963	13.0
Bendigo	268 694	86	2 250 609	3.0	2 519 303	11.9
Geelong	148 317	82	672 680	7.5	820 997	20.9
Benalla	152 472	90	1 056 486	2.3	1 208 958	13.3
Alexandra	450 957	99	589 767	11.8	1 040 724	49.5
North East	1 056 269	96	763 080	10.6	1 819 349	60.2
Dandenong	153 643	95	417 746	10.2	571 389	33.0
Yarram	162 664	86	434 961	10.7	597 625	31.1
Cent. Gippsl.	870 675	96	576 279	17.4	1 446 954	64.5
Bairnsdale	800 458	98	369 147	21.7	1 169 605	74.2
Orbost	796 222	99	103 703	45.1	899 925	92.7
Melbourne	2 120	39	173 221	1.3	175 341	1.8
Total	7 546 073	93	15 241 621	6.0	22 787 694	35.0

Table 4 Areas of softwood plantations established on public land in CFL Regions in the period 1972-1987 and the total areas as of 1987 (ha).

Region	Planted ¹ 1972-87 (ha)	Total Area ² 1987 (ha)
Mildura	0	0
Horsham	186	642
Portland	7 456	16 412
Colac	1 733	3 563
Ballarat	4 310	7 613
Bendigo	261	533
Geelong	3 284	4 256
Benalla	5 793	8 877
Alexandra	3 413	6 831
North East	19 409	32 531
Dandenong	0	5
Yarram	8 827	11 186
Central Gippsland	2 696	3 561
Bairnsdale	13	13
Orbost	0	0
Melbourne	0	0
Total	57 381	96 023

¹ The total area of softwood plantations established on freehold land in the same period was 49 955 ha. Accurate records for Regions for the period 1972-1987 are not available.

² As of 1987 the total area of softwood plantations on public land in Victoria was 99 696 ha (including 3673 ha of plantings for public utilities) and on freehold land it was 97 107 ha.

Table 5 The area of forest on public and freehold land in CFL Regions in 1972 and 1987 (ha).

Region	PUBLIC LAND ¹		FREEHOLD LAND	
	1972	1987	1972	1987
Mildura	1 473 821	1 470 183	95 306	70 278
Horsham	441 180	440 086	148 334	89 910
Portland	220 932	227 464	91 714	71 888
Colac	151 852	152 433	43 277	39 773
Ballarat	109 529	110 529	43 865	38 352
Bendigo	233 163	232 314	75 170	66 798
Geelong	120 646	121 087	52 737	50 760
Benalla	136 992	136 749	25 735	24 094
Alexandra	442 874	445 228	71 615	69 609
North East	1 021 029	1 014 205	92 122	80 518
Dandenong	146 003	145 640	47 967	42 646
Yarram	138 899	139 148	54 840	46 650
Cent. Gippsland	835 051	833 662	96 654	100 201
Bairnsdale	789 282	787 618	83 598	80 061
Orbost	787 863	787 839	51 768	46 748
Melbourne	818	818	2 440	2 291
Total	7 049 934	7 045 003	1 077 142	920 577

¹ The location of public land boundaries was taken from the 1988 LCC Public Land Use Recommendations Map (Scale 1:500 000). Land tenure changes in the period 1972 to 1987 have not been determined.

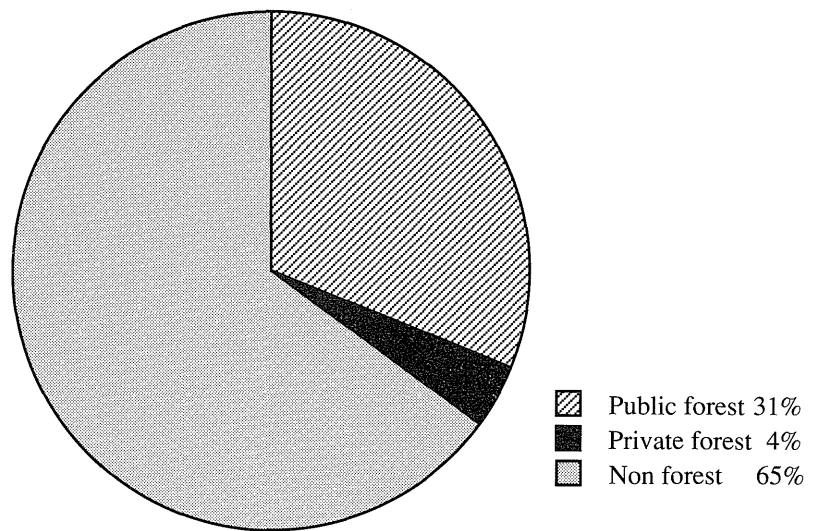


Figure 5 Ownership of forests in Victoria as a proportion of the total area of the State.

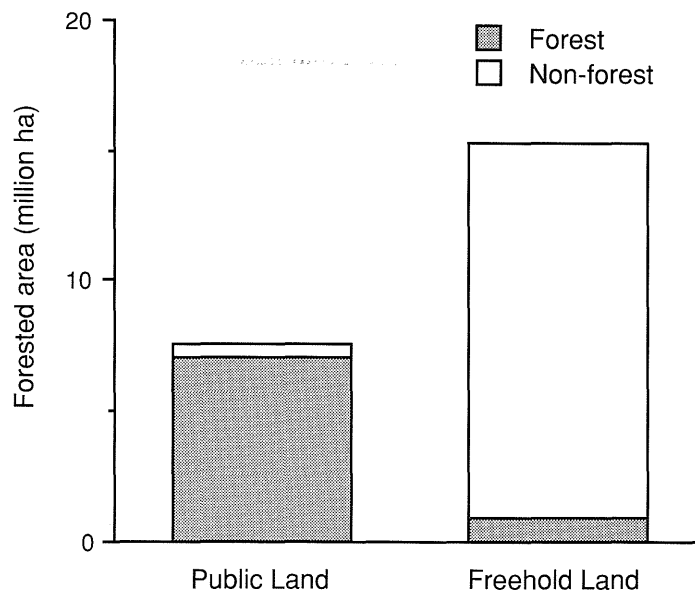


Figure 6 Area of forest on public and freehold land in Victoria.

REFORESTATION SINCE 1972

Some 37 812 ha of previously cleared freehold land were reforested in the period 1972 to 1987 (Table 6). Central Gippsland (12 461 ha) and Portland (7852 ha) Regions account for over half this figure. While the establishment of pine plantations accounts for most of these areas, a significant contribution has also been made by the hardwood reforestation program in the Strzelecki Ranges. On public land in the same period 31 568 ha have been reforested. Once again Portland and Central Gippsland figure prominently because of plantation establishment programs.

On freehold land clearings have exceeded reforestation by 156 564 ha. Therefore for every 5 ha cleared only 1 ha was replanted. This represents a net annual clearing rate of 10 438 ha, which if maintained across the State would see the complete removal of the states existing freehold forests within 90 years and in less than 60 years for Mildura, Horsham and Portland Regions.

On public land clearing has exceeded reforestation by only 4930 ha since 1972, representing only a minor loss of forest. This reflects Government policy that requires all cleared or logged areas to be routinely reforested. If the area cleared during the creation of the Dartmouth (5914 ha) and Thomson (1900 ha) dams is excluded the area of forest on public land has actually increased by 2884 ha.

FOREST COVER CHANGE 1869 TO 1987

The earliest authentic map of Victoria's forest was compiled from extensive field survey notes at an approximate scale of 1:1 000 000 under the direction of R. Brough-Smyth in the office of the Surveyor General in 1866 for the Minister of Mines. The map was revised and corrected by Arthur Everett in 1869 and subsequently printed in this revised form.

The map comprises 12 classes of forest that had been thoroughly reviewed by the then Government Botanist, Ferdinand Baron von Mueller. In 1967 Dr Joe Powell (Monash University) re-drew the 1869 map with a revised interpretation of classes and boundaries. In this current study a combined revision of both the original 1869 Everett map and Powell's 1967 maps was undertaken and the subsequently reinterpreted information was digitised and permanently stored in the Department's Geographic Information System. This has enabled direct comparison between the forest cover in 1869 and the present.

The reliability of the 1869 map was considered to be high given the detailed nature of the original information and following the thorough re-examination undertaken by Powell and the current revision. In 1869 Victoria's forests and woodlands were estimated to cover nearly 20 million ha, representing about 88% of the State. By 1987 the forest cover of Victoria had been reduced to less than 8 million ha, representing only 35% of the State (Table 7).

Four Regions have each lost more than one million hectares of forest, these being Mildura, Horsham, Portland and Bendigo (Table 8). However in a comparison of retained forest area, Melbourne (with only 5% remaining), Benalla (16%) and Bendigo (15%) and Portland (18%) have undergone the largest reduction in forest cover. Five Regions have retained at least 50 per cent of the original forest cover; Alexandra (50%), North East (60%), Central Gippsland (69%), Bairnsdale (74%) and Orbost (92%).

Table 6 Area (ha) of forest cleared and reforested between 1972 and 1987 on public land and freehold land in CFL Regions.

Region	PUBLIC LAND		FREEHOLD LAND	
	CLEARED	REFORESTED	CLEARED	REFORESTED
Mildura	6 255	2 617	30 434	5 406
Horsham	1 276	182	60 315	1 891
Portland	823	7 356	27 678	7 852
Colac	184	765	5 077	1 573
Ballarat	288	1 288	5 950	437
Bendigo	2 103	1 254	9 516	1 144
Geelong	983	1 424	2 552	575
Benalla	831	588	1 998	357
Alexandra	1 073	3 427	3 144	1 138
North East	11 690	4 866	12 501	898
Dandenong	389	26	5 381	60
Yarram	1 646	1 895	10 331	2 141
Central Gippsland	6 022	4 633	8 914	12 461
Bairnsdale	1 811	147	5 190	1 653
Orbost	1 124	1 100	5 246	226
Melbourne	0	0	149	0
TOTAL	36 498	31 568	194 376	37 812

Table 7 Comparison of the area (ha) of forest in Victoria in 1869 and 1987.

	1869	1987
Forest	19 983 000	7 965 580
Non-forest	2 792 000	14 822 114
Total	22 775 000	22 787 694

Table 8 Net changes in forest cover (ha) from 1869 and 1972 to 1987.

Region	Net Change since 1869	Net Change since 1972	<u>1987 Forest Area</u> <u>1869 Forest Area</u> %
Mildura	- 2 336 539	- 28 666	40
Horsham	- 1 684 004	- 59 518	24
Portland	- 1 354 648	- 13 294	18
Colac	- 307 794	- 2 923	38
Ballarat	- 476 119	- 4 513	24
Bendigo	- 1 632 888	- 9 221	15
Geelong	- 492 153	- 1 536	26
Benalla	- 823 157	- 1 884	16
Alexandra	- 524 163	+ 348	50
North East	- 720 277	- 18 428	60
Dandenong	- 380 714	- 5 684	33
Yarram	- 400 202	- 7 941	32
Central Gippsland	- 427 137	+ 2 158	69
Bairnsdale	- 302 321	- 5201	74
Orbost	- 65 413	- 5 044	93
Melbourne	- 89 891	- 149	3
Total	- 12 017 420	- 161 496	av. 40

Figures 7 and 8 illustrate the gross areas forest clearing on freehold land that have occurred for the periods 1869 to 1987 and 1972 to 1987. The areas of clearing are shown by CFL Regions. The distribution of Victoria's forest cover in 1869 and 1987 is contrasted in Figures 9 and 10. The back cover of this report contains a full-colour map at a scale of 1:1 000 000 depicting changes in Victoria's forests for the period 1972 to 1987.

As well as the distribution of Victoria's forest cover, the map also shows the location of forest clearings and reforestation on both public and freehold land for the 15-year period for each of the 16 CFL Regions. The digital data base produced from this study is permanently stored in CFL's Geographic Information System. The data base is available for further analysis if required including the production of higher resolution maps for specific areas.

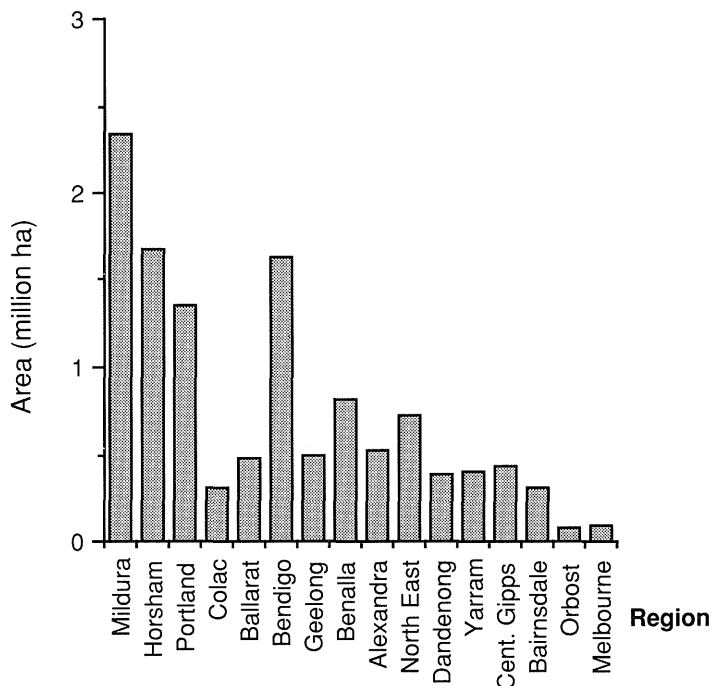


Figure 7 Forest clearing on public and freehold land by CFL Regions between 1869 and 1987.

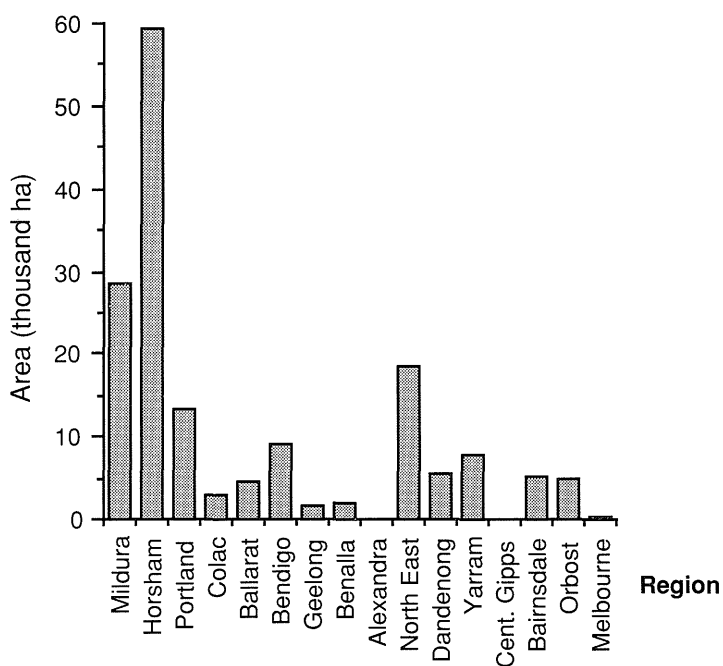


Figure 8 Forest clearing on public and freehold land by CFL Regions between 1972 and 1987.

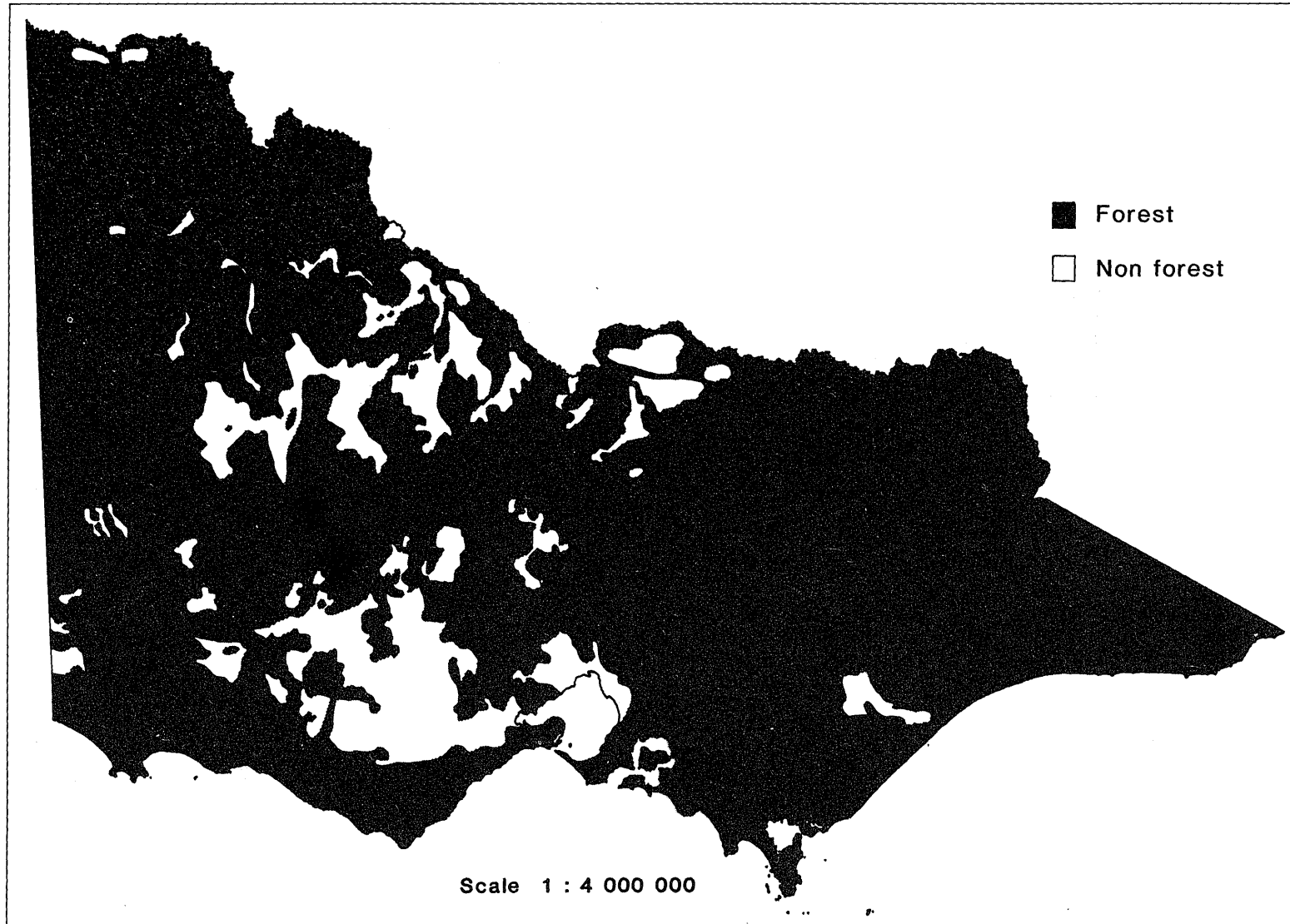


Figure 9 Victoria's forest cover in 1869. The map was derived from early survey records.

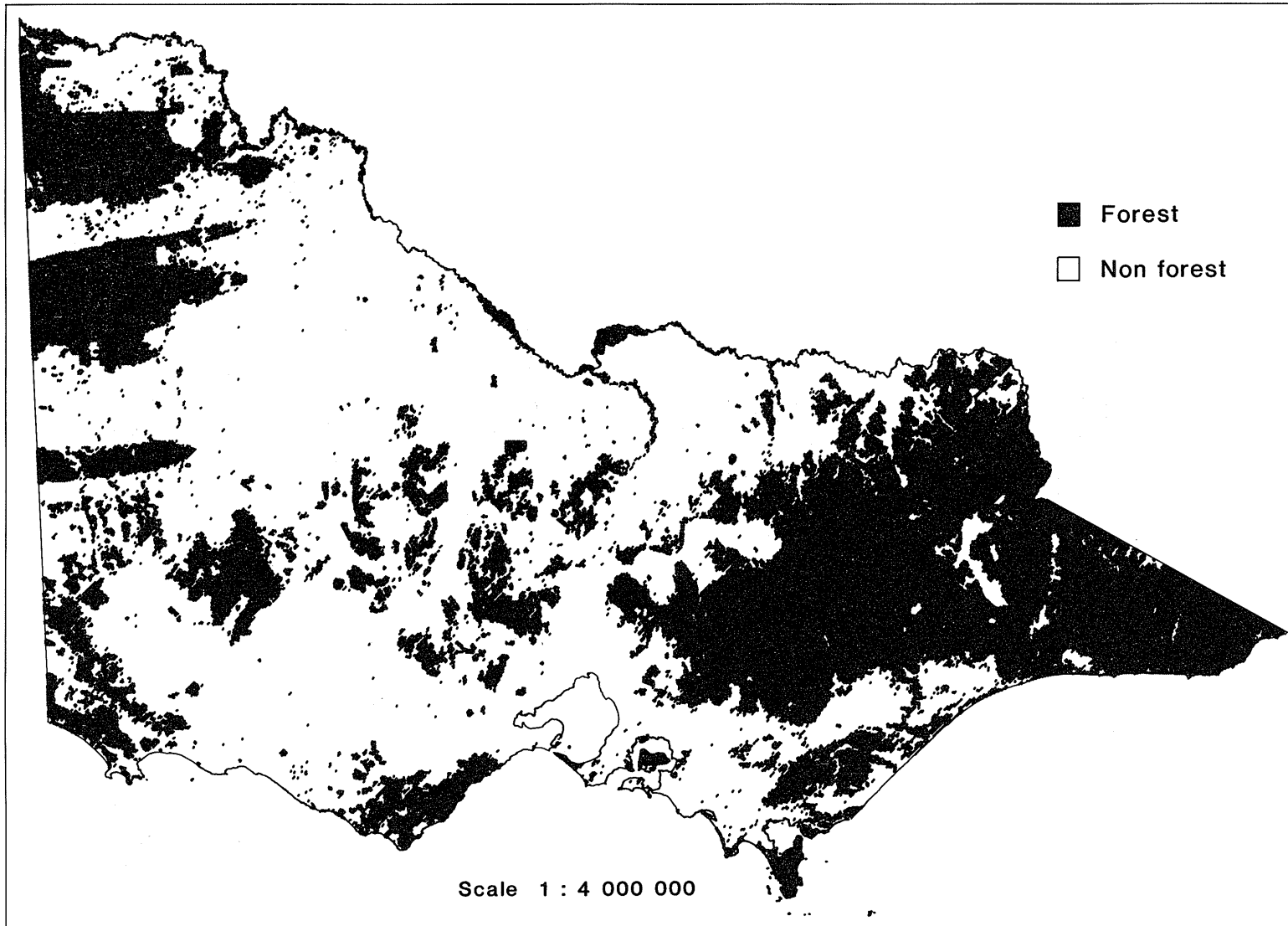


Figure 10 Victoria's forest cover in 1987. The map was derived from Landsat MSS satellite images.

Section 6

CONCLUSIONS

- In 1869 just under 20 million hectares of Victoria were covered by forest, representing 88% of the State. By 1972 forest cover had been reduced to 8.12 million hectares, equivalent to only 36% of the State, a reduction of close to 60% in a little over 100 years.
- In the 15-year period between 1972 and 1987 a further 230 874 hectares was cleared. Most of this area (194 376 ha) has been cleared from freehold land, predominantly in Victoria's three western Regions; Mildura, Horsham and Portland.
- Reforestation on freehold land amounted to 37 812 hectares mainly in Central Gippsland and Portland Regions. The net change in forested area on freehold land between 1972 and 1987 was therefore 156 564 hectares representing an average loss of 10 438 hectares per year.
- Clearing of public land over the same period was 31 568 hectares. If the areas lost to the creation of the Dartmouth dam (5914 ha) and Thomson dam (1900 ha) are excluded then a net area of 2884 hectares was reforested on public land in the period 1972 and 1987.
- If the current rate of clearing freehold land in Mildura and Horsham were to continue there would be no forest remaining on private property in these Regions by the year 2029.
- This study has been conducted as a broad scale, statewide review with the purpose of giving perspective to the debate on the clearing and reforestation of Victoria's forests and woodlands. This study establishes a clear focus for continuation of this work at larger and more detailed scales on a Regional basis. Remote sensing technology should continue to be used to assist in the collection of baseline data for future monitoring of this depleted and valuable resource.

Section 7

RECOMMENDATIONS

- Regular monitoring of forest clearing and reforestation on both public and freehold land should be undertaken in a coordinated way on a statewide and a Regional basis. This report has demonstrated that this can be readily done using a combination of satellite imagery, aerial photographs and field inspections.
- This mapping work can now be extended to describe the distribution of other non-forest native vegetation types, particularly on freehold land, and to internally discriminate the full range of forest and woodland classes. The resultant vegetation map should also distinguish substantially unmodified native vegetation from softwood plantations. A quality rating should be developed to indicate the degree of modification as a result of human intervention and invasion by weeds. This work would provide substantial assistance for the successful functioning of the Flora and Fauna Guarantee.
- Mapping procedures based on remote sensing techniques should be investigated to assist in the detection of dieback, or clearing, of scattered trees (open woodland) in the rural environment. These same techniques could also be used to assess the success of replanting programs on freehold properties. This work, in conjunction with a continued forest monitoring program, would provide baseline information for the soil conservation and salinity prevention programs.

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APPENDIX 1

Landsat MSS colour transparencies (scale 1:1 000 000) used to prepare the 1:500 000 forest cover map.

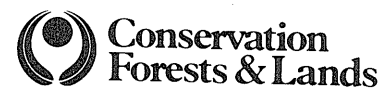
Locality	1986/1987		1972/73	
	Date	Scene ID ¹	Date	Scene ID
Cann River	06 Feb 1987	90/86	25 Aug 1972	95/86
Corryong	28 Jan 1987	91/85	31 Dec 1972	97/85
Bairnsdale	12 Jan 1987	91/86	12 Dec 1972	96/86
Yarram	13 Feb 1987	91/87	22 Aug 1973	97/87
Wangaratta	12 Aug 1986	92/85	19 Jan 1973	98/85
Warburton	04 Feb 1987	92/86	19 Jan 1973	98/86
Western Port	04 Feb 1987	92/87	19 Jan 1973	98/87
Echuca	25 Dec 1986	93/85	24 Aug 1973	99/85
Ballarat	28 Mar 1986	93/86	24 Jun 1976	99/86
Colac	28 Mar 1986	93/87	10 Dec 1973	99/87
Swan Hill	02 Feb 1987	94/84	10 Dec 1975	100/84
Wycheproof	17 Jan 1987	94/85	23 Nov 1973	100/85
Horsham	18 Feb 1987	94/86	18 Sep 1977	100/86
Warrnambool	18 Feb 1987	94/87	04 Mar 1977	100/87
Mildura	08 Jan 1987	95/84	29 Nov 1972	101/84
Dimboola	27 Jan 1988	95/85	29 Nov 1972	101/85
Portland	25 Feb 1987	95/86	29 Nov 1972	101/86
Murrayville	31 Jan 1987	96/84	15 Aug 1977	102/84

¹ Scene ID is the scene identification, made up of a path number and a row number.

APPENDIX II

Recommended procedure for mapping and monitoring changes in forest cover at large scale:

- Determine optimum scale for mapping and appropriate data sources:
Scales up to 1:100 000 – Landsat MSS imagery
Scales up to 1:25 000 – Landsat TM imagery
- Purchase digital form of imagery, display and colour enhance on an image analysis computer (e.g. Microbrian) and output as a colour plot for manual mapping. Purchase custom-made colour print or colour transparency for manual mapping using an analogue device (e.g. Sketch-master, Kartoflex etc).
- Transfer mapped boundaries to the appropriate topographic or cadastral base.
- Verify mapping units by one, or a combination of the following means; visual checking through aerial reconnaissance, comparison with recent aerial photographs and on-ground field inspection.



DEPARTMENT OF CONSERVATION, FORESTS AND LANDS
REGIONAL BOUNDARIES AND CENTRES