Land Conservation Council Victoria

Melbourne Study Area

Price $2.00

CONVERSION TABLE FOR UNITS OF MEASUREMENT USED IN THE REPORT

Common application	Metric unit		Common Imperial unit equivalent	
Distance, elevation, and rainfall	1 mm:	millimetre	0.0394	inch
	1 cm:	centimetre	0.3937	inch
	1 m:	metre	3.281	feet
	1 km:	kilometre	0.6214	mile
Area	1 ha:	hectare	2.471	acres
	1 km^2:	square kilometre	0.3861	square mile
Water yield	1 l:	litre	0.220	gallon
	1 Ml:	megalitre	0.8098	acre-feet
	1 l/s:	litre per second	0.019	million gallons per day
			791.7	gallons per hour
	1 cumec:	cubic metre per second	35.31	cubic feet per second
Salinity level	1 mg/l:	milligram per litre	1.000	part per million (total dissolved solids)
Timber production	1 m^3:	cubic metre	35.31	cubic feet
			423.7	super feet true
			332.6	super feet Hoppus log volume
			0.3531	cunit (100 cubic feet)
	1 m^3/ha:	cubic metre per hectare	14.29	cubic feet per acre
	1 kg/ha:	kilogram per hectare	0.875	pound per acre
Minerals	1 gm:	gram	0.0022	pound
	1 kg:	kilogram	2.205	pounds
	1 t:	tonne	0.9842	ton
Net calorific weight of coal	1 MJ/kg:	megajoule per kilogram	430.0	British thermal units per pound

REPORT

on the

MELBOURNE STUDY AREA

Land Conservation Council, Victoria
Melbourne: December 1973.

10695/73—PL

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FOREWORD

The *Land Conservation Act* 1970 established the Land Conservation Council whose function is to "carry out investigations and make recommendations to the Minister with respect to the use of public land in order to provide for the balanced use of land in Victoria."

This report sets out to describe and assess the natural resources of the public land in the Melbourne area and provides a factual basis on which members of the community may base their submissions to the Council. It ensures that all those persons and bodies who have an interest in the future use of public land in this area can obtain and study the basic information, which the Council will itself study, and so make informed and constructive suggestions to the Council for its consideration.

In making this report available the Government hopes that all interested parties will be able to participate in an informed fashion in the process of considering how public lands should be used. It is hoped that in making submissions, members of the community will use as a basis the information provided by this study. The Council will make its recommendations only after due consideration of these submissions.

Demands for land for various purposes are many and varied, some of which are compatible and some conflicting or competitive. It is therefore important that decisions made are based on factual evidence, not on subjective criteria.

Submissions are now invited and should reach the Secretary of the Land Conservation Council within 60 days of the publication of this report, as notified in the Victoria Government Gazette.

S.G.McL. DIMMICK,
Chairman

Land Conservation Council,
464 St. Kilda Road,
MELBOURNE. 3004.

LAND CONSERVATION ACT 1970

EXTRACT

Public Land

Section 2.

(1) "Public land" means -

(a) land which is not within a city, town or borough and is -

(i) unalienated land of the Crown including land permanently or temporarily reserved under section 14 of the *Land Act* 1958 and State forest;

(ii) vested in any public authority (other than a municipality or a sewerage authority within the meaning of the *Sewerage Districts Act* 1958); or

(iii) vested in the Melbourne and Metropolitan Board of Works; and

(b) any other land which the Governor in Council declares under sub-section (2) to be public land for the purposes of this Act.

"Reserved forest" and "State forest" have the same meanings as in section 3 of the *Forests Act* 1958.

(2) The Governor in Council may on the recommendation of the Minister made after consultation with -

(a) any Minister of the Crown in whom any land is vested; or

(b) the Minister responsible for a public authority in which any land is vested -

by proclamation published in the *Government Gazette* declare any such land to be public land for the purposes of this Act.

Functions of the Council

Section 5.

(1) The Council shall -

(a) carry out investigations and make recommendations to the Minister with respect to the use of public land in order to provide for the balanced use of land in Victoria;

(b) make recommendations to the Governor in Council as to the constitution and definition of water supply catchment areas under the *Soil Conservation and Land Utilization Act* 1958; and

(c) advise the Soil Conservation Authority concerning policy on the use of land (whether public land or any other land however vested) in any water supply catchment area.

(2) In making any recommendation the Council shall have regard to the present and future needs of the people of Victoria in relation to -

(a) the preservation of areas which are ecologically significant;

(b) the conservation of areas of natural interest beauty or of historical interest;

(c) the creation and preservation of areas of reserved forest;

(d) the creation and preservation of areas for national parks;

(e) the creation and preservation of areas for leisure and recreation, and in particular of areas close to cities and towns for bushland recreation reserves;

(f) the creation and preservation of reserves for the conservation of fish and wildlife;

(g) the preservation of species of native plants; and

(h) land required by government departments and public authorities in order to carry out their functions.

(3) Where the Council recommends the alienation of any land the recommendation shall include the Council's opinion as to the best method of alienating the land to ensure the most satisfactory use and management of the land in the public interest.

(4) Any person or body may make submissions to the Council as to how any public land can be better used to meet the needs of the people of Victoria and the Council shall consider any such submissions before making any recommendation under paragraph (a) of sub-section (1).

Investigations, Notices and Reports

Section 9.

(1) The Council shall not make any recommendation under this Act in relation to any district or area without a prior investigation of the district or area.

(2) Before commencing any investigation under paragraph (a) of sub-section (1) of section 5 the Council shall publish a notice in the Government Gazette, in a newspaper circulating throughout the State and in a newspaper circulating particularly in or in the vicinity of the area or district to be investigated stating that an investigation of the district or area described in the notice is to be carried out for the purpose of this Act.

(3) On completing an investigation of a district or area under paragraph (a) of sub-section (1) of section 5 the Council shall -

(a) publish a report of the investigation;

(b) give notice in the Government Gazette of the publication of the report, the address where copies of the report may be obtained or inspected and stating that any submissions to the Council in relation to such report will be considered by the Council if they are made within 60 days of such notice; and

(c) publish notice in a newspaper circulating throughout the State and in a newspaper circulating particularly in or in the vicinity of the area or district investigated of the publication of the report, the address where copies of the report may be obtained or inspected and stating that submissions may be made to the Council and the date before which they should be made.

(4) The Council shall consider any submissions in relation to such report made by any person or body within 60 days of notice being given under paragraph (b) of sub-section (3).

Notice to be given to public departments and authorities in certain cases.

Section 10.

(1) Not earlier than 60 days after notice being given under paragraph (b) of sub-section (3) of section 9, the Council shall send a copy of its proposed recommendation to -

(a) the Council of any municipality in the municipal district to which the recommendation relates is situated;

(b) any other public authority or government department that in the opinion of the Council has an interest in the area of the proposed recommendation; and

(c) any person or body who made a submission under section 9 -

and shall consider any submission received within 60 days of the sending of such copy to the Council, authority, department, person or body or in the case of a public authority or government department within such longer period as may be agreed upon between the Minister and the Minister administering that department or responsible for that authority.

(2) Where any recommendation is made to the Minister under this Act it shall be accompanied by a copy of any submissions received from any person body department authority or council pursuant to the provisions of sub-section (4) of section 9 or sub-section (1) of this section.

(3) Where the Council has made a recommendation to the Minister under paragraph (a) of sub-section (1) of section 5 the Minister may, after he has given not less than fourteen days notice of his intention so to do to the Minister administering a government department or responsible for a public authority recommend to the Governor in Council that notice of the recommendation or that part of the recommendation that affects the government department or public authority concerned and where notice of that recommendation or part is so given by the Governor in Council it shall be the duty of the government department or public authority to use all diligence and dispatch to give effect to such recommendation so far as it affects any land vested in or controlled by it.

Copy of every Recommendation and of Proposals to be tabled in Parliament.

Section 11.

A copy of every recommendation of the Council made under sub-section (1) of section 5 and of the proposals of the Council submitted to the Minister pursuant to section 7 shall be laid before both Houses of Parliament within fourteen days of the making thereof if Parliament is then sitting and if Parliament is not then sitting within fourteen days after the meeting of Parliament.

A copy of the *Land Conservation Act* 1970 can be obtained from the Government Printing Office, 7a Parliament Place, Melbourne, 3002.

ACKNOWLEDGEMENTS

This report covers so wide a field that its compilation would not have been possible without the generous assistance and co-operation of a great many individuals and organizations.

The Council acknowledges the assistance of the following organizations, which prepared basic information for maps and chapters of this report: Departments of Agriculture, Crown Lands and Survey, and Mines, the Fisheries and Wildlife Division of the Ministry for Conservation, the Forests Commission, the Melbourne and Metropolitan Board of Works, the Soil Conservation Authority, the State Electricity Commission, and the State Rivers and Water Supply Commission.

Many other bodies also readily supplied information, checked drafts, or contributed valuable discussion and advice. They include other Victorian and Australian government bodies, local government agencies, universities, representatives of the timber and mining industries, apiarists, members of fauna and flora study groups, outdoor recreation and sporting organizations, many individuals with expert knowledge in fields such as physiography, botany, or zoology, and those with special knowledge of particular localities. Their assistance is gratefully acknowledged.

The National Parks Service, Victorian Government Tourist Bureau, The Age, Messrs M. Gottsch, T. Pescott, and L. Winsor, and the government bodies listed above provided photographs for use in this report.

PART I INTRODUCTION

AIMS AND METHODS

This report is the fifth in a series of investigations to be published by the Land Conservation Council, which eventually will cover the entire State of Victoria. It brings together information that is relevant to decisions regarding the future use of public land in the study area. It describes the physical nature of the land and its environment, examines the likely forms of land use, and assesses the hazards associated with these uses.

The report does not contain recommendations, but aims at providing a factual basis on which land use recommendations can be formulated. It should be regarded as the first stage of a decision-making process for public land, which relies heavily on active public involvement for its successful completion.

Collection of information

Information in the form of published and unpublished material has been obtained from government departments, public authorities, private organizations, and individuals. Several short-term projects, commissioned in fields where information was lacking, have supplemented these sources.

Many people interested in the future use of public lands may lack a technical background in some relevant fields. Thus, while complex issues are not avoided, non-technical language has been used as far as possible. Sections on basic principles, included in several chapters, may help to place the descriptive material in perspective and relate the various chapters to each other.

Basic approach

Although public land has been emphasized, the investigation considered features of the entire study area to place public land in perspective. Accordingly, this report treats the study area in a State context because of its size and the importance of resources contained in its boundaries. The report then considers the main environmental, social, and economic features of the region in broad terms before finally providing more detailed descriptions of individual sections or blocks.

Although urban areas were generally outside the scope of this investigation, consideration was given to their influence on use of resources on public land in the surrounding region.

Presentation of information

The text is divided into four main sections. Part I - an introductory section - defines and briefly describes the study area and discusses its historical development. A philosophy of resource conservation is also outlined.

Part II describes the characteristics of environmental features in broad terms for the whole study area. Although the topics of geology, soils, climate, water resources, vegetation, and fauna are treated in separate chapters, frequent reference has been made to their essential interdependence.

Part III deals with the main forms of land use that are likely to make demands on public land. After describing the natural hazards that occur in the region, such as erosion and fire, it discusses any deterioration in the condition of public lands that may occur as the result of changes of land use or management practices. It then considers major types of land use in terms of their present levels of activity in the district, the likely future demand for resources, and the capability of public land to meet these requirements. The growing conflict between competing land uses for a diminishing supply of resources on public land is also examined, along with the role of private land in reducing these pressures on public land.

In Part IV, the study area has been divided into 24 blocks for ease of description and consideration. Block boundaries follow main roads, but correspond to areas of local 'identity' based on broad environmental characteristics. This section describes features of public land that could not be treated in greater detail in the earlier sections. An assessment of the potential of public land for various land uses within each block is made on criteria outlined in Part III of the report.

A number of appendices give details of fauna and flora characteristics in the study area, and water-quality standards applicable to domestic water supply.

The larger maps have been numbered and may be found in the map folder that accompanies this report.

CONSERVATION

Conservation is concerned with Man's relation to his environment. It is often said to be the wise or balanced use of resources. Because wisdom and balance are not absolute terms, the principles set out here attempt to explain this concept.

Conservation can be considered as an endeavour to anticipate and resolve conflicts between the individual and society about the present and future use of resources, and between competing uses of the same resource. The conservationist is aware of long-term needs and recognizes that a community requires land for recreational, scientific, and aesthetic purposes as well as for the production of food, timber, and minerals, or for urban and industrial use.

Natural Resources

Two broad classes of natural resource may be distinguished, according to whether they are renewable.

Non-renewable resources

The quantity of these resources does not increase significantly with time, and use consumes them. The expansion of Victoria's economy last century was based on the exploitation of gold - a non-renewable resource. The oil and gas fields of Bass Strait provide another example.

Conservation of a non-renewable resource requires the best techniques for exploration, recovery, and processing, and the efficient use of the end product.

Renewable resources

The quantity of a renewable resource such as timber or pasture may increase or decrease over time. Animal and plant communities and landscape fall within this class. Abuse of these resources may reduce them to such a poor condition that the practical opportunity to restore them to a desired state is lost for many generations.

Conservation of renewable resources requires a thorough understanding of ecological principles and the development of sound management techniques based on those principles. An ecosystem typically contains many components that are interrelated. A change in any one

of these will have effects elsewhere in the system. In general, an ecosystem with a diverse range of species will be better able to adapt and absorb the impact of sudden change - such as that caused by fire, disease, or Man's activities - than a simple ecosystem with few species.

Man is part of the ecosystem and, like every other organism, influences and is influenced by the other parts. The development of new technology has increased his ability to modify the environment. Many new techniques have both advantages and disadvantages. Often the disadvantages are not obviously linked to the new technique and only emerge in the long term - the use of insecticides can increase the production of food or fibre dramatically, but may also reduce the population of predatory birds and insects and so encourage the build-up of other insect pest populations.

Relations between Resource Uses

Many uses of a resource are compatible. They may be supplementary and add to each other, or complementary in that one use benefits from the other, but they may also be competitive when an increase in one leads to a decrease in the other.

For example, the relation between timber production and picnics within a forest may be complementary in the sense that picnickers gain access along tracks and use open spaces created during timber operations. It may become competitive if logging makes the forest an unsuitable picnic area, and at other times picnickers may present a considerable fire risk. In general, decisions on land use will involve selecting major land uses for a particular area, and determining other uses compatible with these and the intensity of use above which they become incompatible.

The Principles of Land Use

In the past our society has grown (and the economic welfare of the people improved) through mining, farming, timber production, and industrial development. These industries have been given prime importance, and the use of natural resources has often been decided in relation to short-term advantage when conflict arose. The deleterious effects of this type of development have been recognized and there is now a popular demand for attention to the total long-term needs of the community.

The concept of balance involves equal consideration of the needs of all sections of society, on both regional and State bases, as well as the needs of this and future generations. These needs should be clearly stated as aims.

The intangible values of recreation, aesthetics, and preservation must not be ignored. In addition to actively providing land for these purposes, we must also consider the impact of other land

uses upon them. Outstanding natural features should be preserved.

Where several land uses are compatible, land should be available for the most beneficial combination of such uses. It may be necessary to define major aims and to assess levels above which secondary uses are unacceptable.

Where land has been committed to a particular use, it should be managed so that its capability for that use is not impaired. Uncommitted land should be maintained in a condition that will allow the widest possible choice of future uses.

Policy measures should stimulate the best use of partly developed lands and discourage significant changes in natural areas.

Review and reassessment of land will become necessary as society and technology change.

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THE STUDY AREA

The Melbourne study area occupies a large part of southern central Victoria, extending east to Moe, north to Seymour, west to Daylesford, and south to include Port Phillip and Westernport Bays (see Map 1 and the locality plan facing this page.) This region contains the bulk of Victoria's population and much of its industrial development, and is the State's main transport focus. It is ringed by a number of growing population centres including Ballarat, Bendigo, Shepparton, and the Latrobe Valley complex of Moe, Morwell, and Traralgon. The study area coincides approximately with the day-trip recreation zone for Melbourne.

The actual boundary follows that of local government shires, except in the north-east where it bisects the shire of Mansfield. The study area covers 26,500 sq km, not including the 1,500 sq km occupied by the cities of Melbourne, Geelong, and Moe and the Boroughs of Queenscliff, and Wonthaggi, all of which are excluded.

This area encompasses a wide range of natural environments. Physiography, climate, soils, and vegetation all show marked variation over comparatively short distances. The heavily timbered and rugged north-eastern highlands with high rainfall contrast markedly with the flat, treeless, and low-rainfall basalt plains west of Port Phillip Bay. The coastal zone differs again from both inland plains and mountains, and displays a considerable internal range of environments - including cliffed coastline, low sand dunes, sweeping beaches, and the protected bay environments of Port Phillip and Western Port Bays.

The pattern of human settlement and economic activity within the study area broadly reflects this diverse range of natural environments. Agricultural, urban, and industrial development extend over most of the favourable low-lying and undulating land. The main transport routes emanating from Melbourne have avoided the more rugged mountain areas, favouring broad valleys and lower gaps through the main ranges. Population is unevenly distributed, being concentrated in Melbourne and Geelong and along the major transport routes (as shown in Map 2), while a large area in the north-east contains very few inhabitants.

Most of the alienated land has been cleared of its natural vegetation. The

LAND CONSERVATION COUNCIL
VICTORIA

MELBOURNE STUDY AREA

LOCALITY PLAN

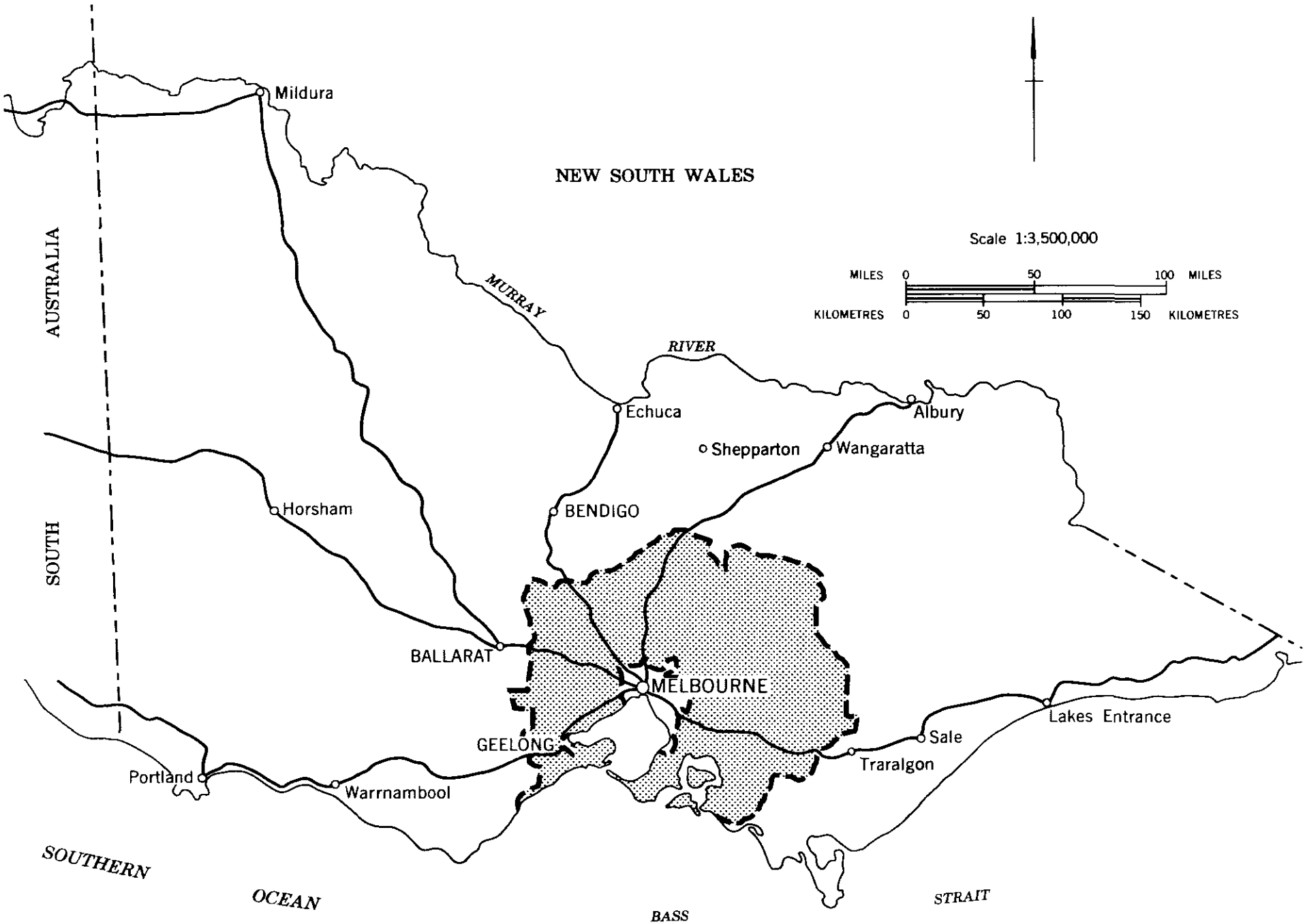


Table 1

PROPORTION OF PUBLIC LAND CLOSE TO MELBOURNE

	Distance from centre of Melbourne		
	Within 50 km	Within 75 km	Within 100 km
Total area (ha)	640,000	1,520,000	2,630,000
Public land (ha)	15,000	180,000	467,000
Public land as % of total	3%	12%	18%

bulk of remaining public land has been utilized as a valuable source of timber and water supply for domestic and irrigation purposes. To date, a relatively small proportion has been reserved specifically for recreation and nature preservation. Mining and quarrying occur in scattered locations throughout the study area, and public utility service easements traverse sections of public land.

Public land covers approximately 8,700 sq km or 33% of the total study area, and consists mainly of reserved forest and Crown land. It is unevenly distributed, with the major concentration in the north-east (as appears in Map 1). Smaller and more fragmented areas are found in the north-west (Wombat forest-Brisbane Ranges), the extreme south-west (Otways), and on French Island. Blocks of public land in the north-east and south-west adjoin larger expanses located outside the Melbourne study area, in the alpine and Otway areas. Many smaller pockets of public land throughout the study area, although of considerable local importance, are not shown on Map 1 because of its scale. Stream frontages and coastal reserves fall into this category.

Very little land remains in public ownership close to Melbourne, as Table 1 indicates. Within the study area the amount of public land increases with distance from Melbourne both in relative size and in absolute area.

The rapid spread of pastoral and agricultural activities in the two decades following colonization of the Port Phillip district, during the 1830s, largely determined the present pattern of public land holdings.

Little remains in areas suitable for agricultural development. However, subsequent reservations for forestry, water conservation, recreation, and nature preservation have consolidated the diminishing supply of public land.

History of Settlement

Man probably first entered the study area 20,000-30,000 years ago, as Aborigines gradually migrated southward along the east coast and riverine plains. It is doubtful whether the Aborigines were ever numerous within the region, probably never exceeding 1,000. No extensive relics of their existence are available.

The Kulin, a group of associated tribes with related languages and cultures, occupied the study area. The central region, to Macedon in the north-west and including Melbourne and the Yarra catchment, was the territory of the Wurundjeri tribe. To the south, the Bunerong occupied the Dandenongs, Mornington Peninsula, and Western Port, extending into West Gippsland. West of the Wurundjeri in the Werribee area, the Kurung occupied territory extending down to Geelong and as far west into the ranges as Ballan and Ballarat. Further south, the Wadthaurung ranged from Geelong to Cape Otway, including the Bellarine Peninsula. North of the Dividing Ranges - in the headwaters of the Goulburn and from Heathcote to Euroa - lived the Taungurong.

The tribes concentrated their activities in the coastal zone and along rivers, where game, waterfowl, and shell-fish wre plentiful. They hunted kangaroos and wallabies in the grassland and woodlands of the plains and foothills, firing areas both to hunt larger animals and to attract them to the tender forage of the regrowth. Aborigines never permanently occupied the forested mountain country because of uncertain food supplies and harsh climate. During spring and summer, however, short trips into the mountains were common.

European settlement in the Port Phillip region commenced shortly after its initial discovery and exploration from the sea around the start of the nineteenth century by Bass (January 1798), Grant (December 1800), Murray (January 1802), and Flinders (April 1802). Early attempts at settlement on Point Nepean (1803) and Phillip Island (1826) were short-lived. Sealers occupied small camps along the coast, but no permanent establishment occurred in the study area until a party of settlers, led by John Batman, arrived in 1835 from Van Diemen's Land. Batman was attracted by reports of Hume and Hovell's overland

expedition in 1824 from Sydney to Port Phillip, and by the success of the Henty brothers, who had settled at Portland in 1834.

Pastoral settlement

Pastoral settlement of the area around Melbourne was remarkably rapid. Within 2 years of Batman's arrival, pastoral runs had spread as far afield as Winchelsea, Inverleigh, and Bacchus Marsh in the west, and to Woodend and Kilmore in the north.

Most of the plains and foothill country were occupied by 1840, and had been alienated from the Crown. In that year, the squatters' runs covered the entire western and northern sections of the study area, except the country around Daylesford. In the east and south-east, runs skirted the foothills of the eastern highlands and extended to the northern shores of Western Port.

In these 5 years, Melbourne had grown into a town of about 4,000 residents, with many substantial buildings and a carefully surveyed street layout. As the major port for the emerging colony, it was a rapidly growing centre of trade. The nearby town of Geelong, established in 1836, was its closest rival, but suffered from an inferior harbour. Land communications were gradually developing and Melbourne had a fortnightly mail link with Sydney *via* Albury, from 1838 onwards.

Gold

The discovery of gold in 1851, shortly after Victoria became a separate colony from New South Wales, had a profound impact on the rate of development in the region. The first publicized discoveries were near Warrandyte and Clunes, but these were rapidly overshadowed by big rushes to other alluvial fields around Ballarat, Castlemaine, and Bendigo. The working of these fields soon led to the discovery and mining of valuable quartz reefs in adjoining areas, upon which the gold-mining industry became firmly established.

Development of the goldfields attracted a massive influx of migrants, most of them landing at the ports of Melbourne and Geelong. Although most of the migrants headed for the gold towns, this 'golden era' made a substantial contribution to the growth of these coastal cities.

In the early 1860s the Walhalla : Woods Point: Gaffneys Creek goldfields in the eastern section of the study area were opened up and made a major contribution to Victoria's gold production for many years. The A.1 at Gaffneys Creek is one of the few operating gold-mines left in the State, and the Morning Star mine at Woods Point operated for nearly a century before closing in 1963.

Evidence of previous gold-mining operations (in the form of diggings abandoned

machinery, and many kilometres of water races) still persists in many parts of the study area. Some of these historic relics on public lands are indicated as recreation attractions on Map 7.

The gold-mining town of Walhalla, c. 1910

The years following the first rushes saw many changes. The vastly increased population stimulated trade, and transport routes were soon established between the larger goldfield towns and the coast. The opening of the Geelong : Melbourne railway line in 1857 was the first step in the rapid expansion of the railways serving Melbourne's hinterland.

Timber was an essential resource for mining, and the gold rushes initiated the first large-scale exploitation of the hardwood forests that covered much of Victoria. Within a few decades the continued production of round, split, and sawn timbers for mining, building, and fuel resulted in the devastation of many forest areas, especially the Wombat Forest. Although reserves were set aside to ensure the supply of timber as early as 1869, it was not until the turn of the century that exploitation and management of Victorian forests were adequately controlled.

The selectors

The vast pastoral runs of the early squatters had given them control over enormous tracts of land, and only after the gold rushes were attemps made to open up the lands for closer settlement. The *Duffy Land Act* 1862 was unsuccessful in its aims, but in spirit it meant the end of the squatting era. Later amendments, and other Acts, more efficiently opened up the runs for selection. By this stage, the squatters themselves had

already successfully selected much of the land in the Melbourne area, so these laws had only limited success here. However, they did much to settle the remaining lands on a closer basis.

The settlers regarded forest as a hindrance to agricultural development, and destroyed vast areas by felling and burning. The years from 1880 to 1900 saw a great proportion of the forest in South Gippsland and the Dandenongs fall to the settler's axe, much of it unwisely, as time has shown.

By the 1880s the need for softwood timber was already felt and small-scale plantations of radiata pine were established at Macedon.

The increased size of Melbourne and the large rural population were reflected in a concentration of dairying, market-gardening, and other forms of intensive agriculture in those areas close to Melbourne with good soils and adequate rainfall. West Gippsland was the major centre for dairying, while other produce came from the Latrobe Valley and the foothills north-east of Melbourne.

Wine production from vineyards on the Yarra and Barwon Rivers progressed steadily, until phylloxera wiped out the industry in the 1870s.

The 1880s saw the extension of the railways into Gippsland and the commencement of major schemes to drain the Kooweerup and Cardinia swamps. These drainage projects ran into many problems over a number of years, including subsidence, and scouring and siltation of the main channels. By the turn of the century, however, they had converted these swamp areas to highly productive agricultural lands.

Black coal was mined at Korumburra from the late 1890s and at Wonthaggi from 1908, reaching peak production in the 1930s. A steady decline in output led to the closing of these mines in the 1960s.

Further north at Yallourn, brown coal had been discovered in the 1880s and in 1924 was developed for electricity production. From then on, massive operations at Yallourn and Morwell by the State Electricity Commission have made it the mainstay of the State's industrial and domestic power needs.

Forest areas

After 1900 came steady but unspectacular progress in strengthening the control of timber utilization and in silvicultural improvement of the stringybark forests, which had suffered severely from unrestricted cutting. Thinnings from areas such as the Wombat Forest and the Brisbane Ranges became an important source of firewood for Melbourne and Geelong.

The mountain forests east and north-east of Melbourne had been exploited for

Mountain ash logging camp in the Noojee district, c. 1920.

split palings and shingles from the earliest days of settlement. Despite their ease of working, these ash timbers had not been favoured for sawmilling because they were difficult to season satisfactorily. However, from about 1910 onwards successful seasoning techniques had been developed and large-scale milling of the ash forests commenced around Warburton. By the early 1920s it had extended to the Noojee and Erica districts. Further technical developments in the 1930s permitted the use of hardwoods in paper-making. A mill opened at Marysvale in 1937 utilized pulpwood obtained from clear fellings, thinnings, and logging residue.

On several occasions, damaging forest fires have occurred throughout the State - including the study area, where a large area of mountain ash was destroyed in 1926. Disastrous fires in 1939 killed most of the remaining mountain ash and other valuable montane forest in the eastern part of the State. A massive salvage operation over the following 10 years enabled some of the standing fire-killed timber to be utilized, either as sawlogs or pulpwood, but after that attention was turned to alpine ash forests in eastern Victoria.

Much of the present mountain forest in the study area consists of regrowth from the 1939 fires. Scrub areas occur near Powelltown, Lake Mountain, and Toorongo, and north of Toolangi, where successive wildfires have prevented ash regeneation (see Map 6).

The advent of modern earth-moving equipment and the strengthening of the Forests Commission permitted a rapid expansion of fire protection services, and made previously uneconomic forests commercially accessible.

Water supply

Water supply has been essential for the economic activity and continued population growth of the area. Melbourne's supply was initially drawn from the Yarra River close to the township, but since the mid 1850s tributaries of the Yarra have become the main source.

Construction of the Yan Yean system began in 1857 and was followed by the progressive utilization of catchments further east- Maroondah (1891), O'Shannassy and Coranderrk (1911), and Upper Yarra (1957).

Water supply was first established to Geelong in 1865 and to the Bellarine Peninsula in 1927. Catchments, initially in the Wombat Forest and Brisbane Ranges, were later extended to the Otways. Supplies to the Mornington Peninsula commenced in 1917 from the Bunyip and Tarago catchments, and have been progressively upgraded and extended.

The major irrigation source in the study area, the Eildon Reservoir, was completed in 1955. It impounds water for the Murray-Goulburn irrigation district and provides a source of hydro-electric power. A series of three reservoirs on the Coliban River supply irrigation and domestic needs in the Bendigo region. Irrigation has been possible in the Werribee and Bacchus Marsh districts since the early decades of this century.

Transport

The basis of the existing transport system was established towards the end of the nineteenth century, making Melbourne the major transport focus in the State and ensuring its future continued growth. Because of this the study area contains a dense road and rail network, creating a high degree of accessibility

Upper Yarra Reservoir. Melbourne's water supply comes from forested catchments on public land north-east of the city.

over most of the area. No substantial areas remain inaccessible by two-wheel-drive vehicles. Recent modifications in the transport network have mainly comprised improvements to the existing road routes, especially close to urban areas, and the construction of new access roads for timber extraction and fire protection purposes.

Population

In 1971, the combined populations of Melbourne, Geelong and the study area totalled 2.8 million, of which about 0.59 million or 20% were contained within the study area proper. The combined region therefore accounts for almost 80% of Victoria's population.

Distribution

Map 2 shows distribution of population in the region, indicating the marked concentration in Melbourne and to a lesser extent in Geelong. During early years Geelong challenged Melbourne as the largest city, but the latter surpassed it partly because of decisions not to remove a natural impediment from Geelong harbour. Melbourne subsequently developed as the State's main transport node (land, sea, and air) and centre of manufacturing, commerce, and administration. Outside these two cities, population is distributed in a large number of small towns lying close to the major transport routes. As the map shows, the north-eastern sector of the study area contains relatively few people, reflecting its mountainous terrain and poor accessibility.

Regional population centres adjacent to the study area, mentioned earlier, have the effect of compounding pressures on public land between themselves and Melbourne for a variety of land uses, including recreation and water supply and other public utility services.

Population densities vary considerably, reaching their highest levels of about 7,000 persons per sq km in the inner suburbs of Melbourne and Geelong and generally declining with distance from these centres. Densities in non-urban shires on the metropolitan fringe (200-500 persons per sq km) are higher than in the more-distant agricultural areas, reflecting higher-intensity agricultural activity and the presence of residential subdivision.

In recent years, the two metropolitan centres have been growing at about 2.5% or 50,000 per annum (see Table 2). Much of this growth has been absorbed into shires that lie on the inner perimeter of the study area. This pattern of events is reflected in the map facing this page, which shows an inner ring of shires around Melbourne with population growth rates that have continued to rise over the last two intercensal periods. In contrast, the more outlying shires in general have sustained steady population declines.

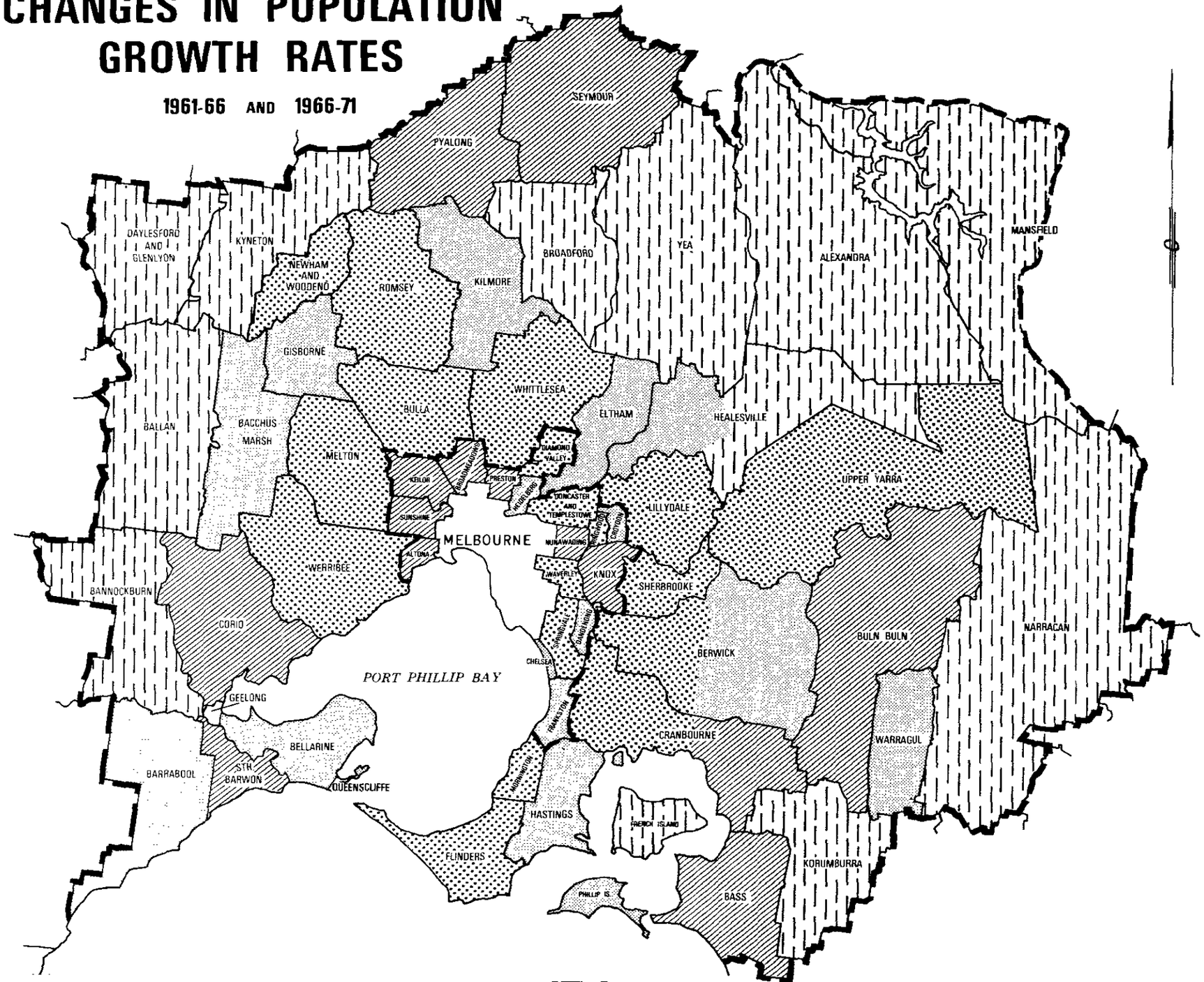
CHANGES IN POPULATION GROWTH RATES

1961-66 AND 1966-71

LAND CONSERVATION COUNCIL

VICTORIA

MELBOURNE STUDY AREA



LEGEND

	Local Government Areas where population growth during 1966-71 exceeded growth during 1961-66.
	Rate of population growth constant during both periods.
	Local Government Areas where population growth during 1966-71 continued but was less than growth during 1961-66.
	Areas of steady population decline.
	Areas not studied.

Scale 1:1,000,000

Miles 0 16 32

Kilometres 0 15 30 45 60

SOURCE: Commonwealth Bureau of Census and Statistics.

Railway cutting near Korumburra, c. 1890.

Table 2

POPULATION GROWTH

	Population (millions)					Average annual growth (%)			
	1947	1954	1961	1966	1971	1947-54	1954-61	1961-66	1966-71
Melbourne statistical division	1.341	1.589	1.985	2.223	2.498	2.5	3.2	2.4	2.3
Geelong statistical district	.055	.076	.096	.111	.122	4.6	3.4	2.9	1.8
Combined Melbourne & Geelong	1.396	1.665	2.081	2.334	2.620	2.7	3.6	2.4	2.5

Source: "Victoria - Population of Local Government Area. 1947-71." (Commonwealth Bureau of Census and Statistics: Melbourne 1972.)

Note: The Melbourne and Geelong statistical divisions adopted by the Bureau overlap the inner study area boundary and represent the area likely to contain a large part of Metropolitan growth over the next 20 years.

Population projections for the Melbourne-Geelong region, based on existing trends, estimate a total of between 5 and 6 million by the year 2000. These figures indicate a doubling of present population levels, and it is expected that most of this increase will occur at suburban densities similar to present levels.

As well as holding the bulk of Victoria's population, the Melbourne region over the last 5 years absorbed almost 80% of the State's increase. Public housing authorities recently announced the provision of new accommodation in several towns beyond Melbourne's urban fringe, which will continue to boost the population concentration in this region.

Despite a growing effort to decentralize industry and people, it appears unlikely that Melbourne and Geelong can expect any drastic reduction in the percentage of total State population increase they are currently attracting.

Direction of Melbourne's growth

Melbourne's expansion has not proceeded evenly in all directions. The bulk of population growth during the last decade has been concentrated in the east, south-east, and south of the city, with smaller increases in the north and west. In the period 1961-66 these eastern and southern suburbs absorbed 75% of the total metropolitan increase. Suburban expansion in this direction has resulted from the suitability of topography for engineering works and residential development, and accessibility to open space elements and recreation attractions of the coastline and mountain ranges. Northern and western suburbs of Melbourne are comparatively less well endowed. Metropolitan planning authorities are aware of this trend and have planned to accommodate a large part of Melbourne's future growth in this area. Possible industrial development at Westernport will stimulate urban expansion in the Mornington Peninsula and West Gippsland areas even further.

Effect on public land

Melbourne's growth has generally placed increasing pressures on public land within the study area, particularly that in close proximity to the city. Public land is being used for activities that service the domestic and industrial requirements of this urban population, including water supply, provision of public utility easements, and harvesting of timber and the extraction of minerals for building and industrial uses.

The presence of a large population with increasing affluence, mobility, and leisure time has generated a large and rapidly expanding demand for outdoor recreation. A widening interest in many forms of nature conservation also draws on public land close to the city.

Suburban expansion is effectively making public land more accessible to an increasing sector of the population and is threatening the integrity of small and isolated blocks of it. Subdivision for residential and recreation purposes in the Dandenongs, Yarra Valley, Mount Macedon, and Mornington Peninsula areas has increased management problems on public land, causing concern about the increasing incidence of bushfires, removal of natural vegetation, soil erosion, and recreation uses.

The future use of public land in the study area is very much related to the continued growth and expansion of metropolitan Melbourne and Geelong, in terms both of direct and indirect land requirements for the continued operation of these cities, and of land use

requirements that result from broad State Development plans in which Melbourne plays an important role.

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PART II

NATURE OF THE LAND

GEOLOGY

The study area has a diverse geological history and includes evidence of all the major geological changes that have occurred in south-eastern Australia since the early Palaeozoic era (more than 500 million years ago).

The area stayed beneath the sea for much of the Palaeozoic. Sediments deposited during this time were lifted late in the Devonian and folded along axes tending north-south, intrusions of granitic rocks occurred below the surface, and in places thick flows of acid volcanics occurred. These Palaeozoic rocks form the bedrock of the study area. Erosion of the relatively soft sedimentary rocks has exposed the granitic rocks, which now often form high-level plateaus and massives, as do the resistant volcanics. Examples are the Baw Baw and Strathbogie massives and the Cerberean Ranges.

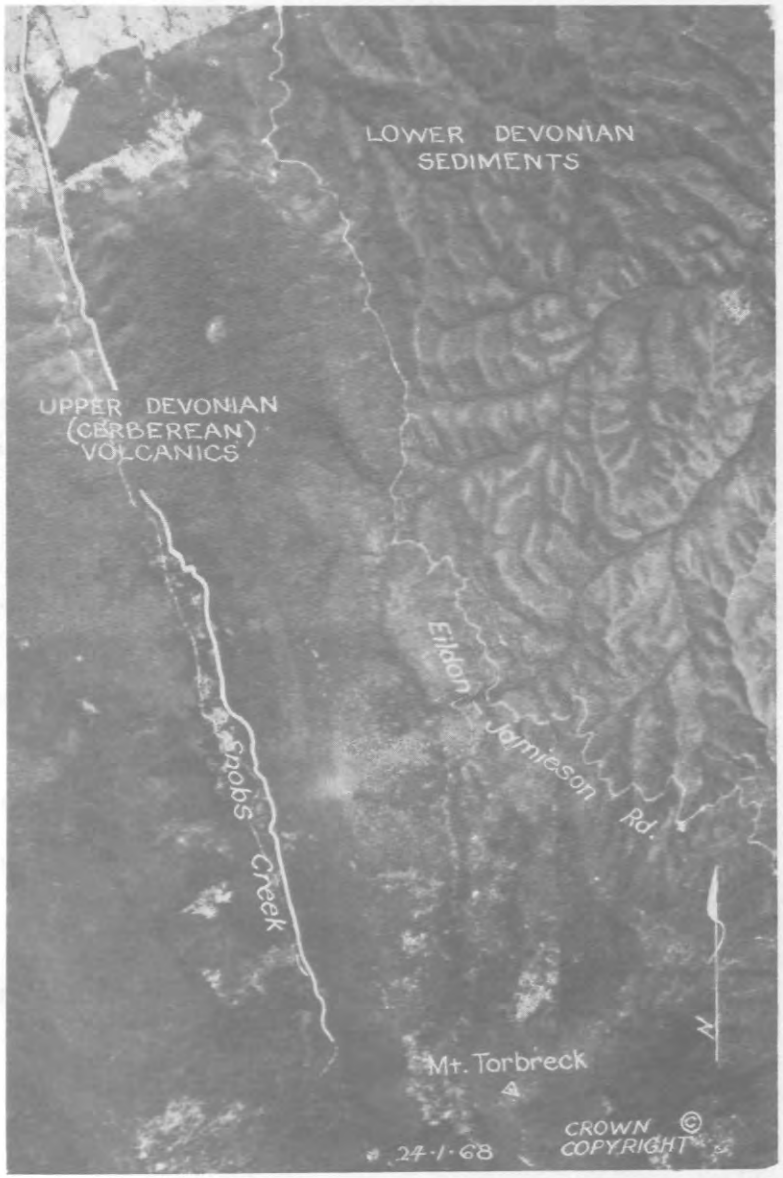
The major development during the Mesozoic (230-65 million years ago) was the formation of an east-west chain of lakes and swamps across southern Victoria. These rapidly filled with sediments, which have now been lifted by block faulting to form the Strzelecki Ranges, Otway Ranges (which are largely outside the area), and Barrabool Hills.

Earth movements during the Cainozoic resulted in the formation of three sunklands - Port Phillip, Westernport, and Latrobe Valley - in which both marine and terrestrial sedimentation occurred. These deposits are now important sources of sand, gravel, brown coal, oil, and natural gas. The earth movements also rejuvenated the highland areas. Intermittent volcanic activity occurred during the late Pliocene, when the extensive Werribee Plains were formed.

During the past 20,000 years differential erosion of hard and soft rocks has continued, giving the present landscape. Important features have been the flooding of Port Phillip and Westernport Bays at the close of the last ice age, continued movement along the old fault lines such as Selwyn's, and fluctuations in the climate of the area. Map 3 shows the surface geology of the area, and diagrammatic sections illustrate the underground features.

Cambrian to Carboniferous

The geological history of the area begins in Cambrian times, when extrusions of submarine volcanics were



Patterns of topography and vegetation developed on different rock types.

followed by the deposition of marine cherts and shales. This event marked the onset of marine sedimentation in a long, wide trough known as the Tasman Geosyncline, which extended from Tasmania to Queensland.

Within the study area, marine sedimentation continued uninterrupted throughout the Ordovician, Silurian, and early Devonian periods for approximately 180 million years (from 550 to 370 million years ago). A thick pile of sediments resulted, with maximum calculated thickness of 3,600 m for the Ordovician at Lancefield, 5,800 m for the Silurian west of Melbourne, and 4,300 m for the Lower Devonian north-east of Melbourne. The sediments consist of rhythmically interbedded sandstone and siltstone and black shale.

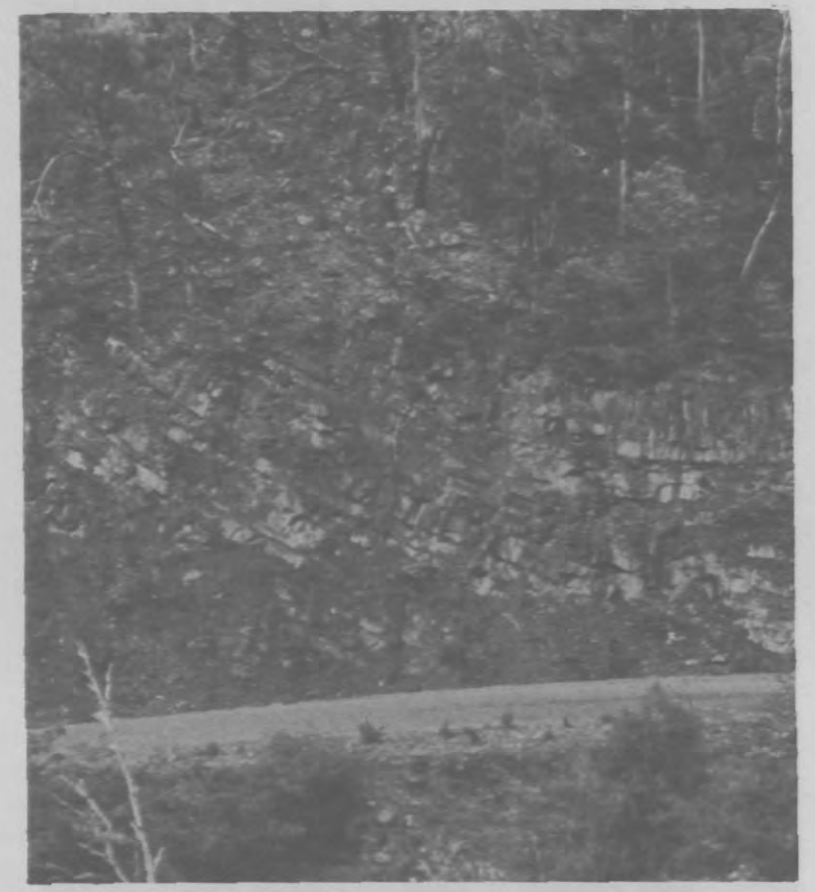
Most of the fossils in these sediments belong to a group known as graptolites, with shelly fossils becoming more abundant in the late Silurian. These shelly faunas heralded the shallowing and filling of the trough, and reached their climax in richly fossiliferous early Devonian sandstones, siltstones, and limestones found at Heathcote, Lilydale, and Walhalla. In the Devonian sediments, graptolites are accompanied by the first land plants, which were carried into the sea.

A period of folding, known as the Tabberabberan Orogeny, followed in Middle Devonian times.

The folding displays a marked variety in fold patterns. The Ordovician sediments are tightly and closely folded. However, the folding in the Silurian and Devonian sediments near Melbourne and Heathcote is more open; it increases in complexity towards the east and culminates in a tightly folded slate belt running from Jamieson through Mount Selma.

In late Devonian times, intrusions and flows of acid igneous rocks into or over the folded sediments occurred in many areas. Thick piles of acid volcanics (rhyolites, rhyodacites) known as ignimbrite or "welded tuff" were extruded into dish-shaped downfaulted basins called cauldron subsidences (see diagrammatic section BC on Map 3). The volcanics are preceded by (or interbedded with) conglomerates, sandstones, and siltstones laid down in river and lake systems. The fine-grained sediments sometimes contained plant and fish fossils. Cauldron subsidences occur in the Macedon, Dandenong, and Cerberean-Acheron Ranges, and are in each case closely associated with intrusions of granodiorite.

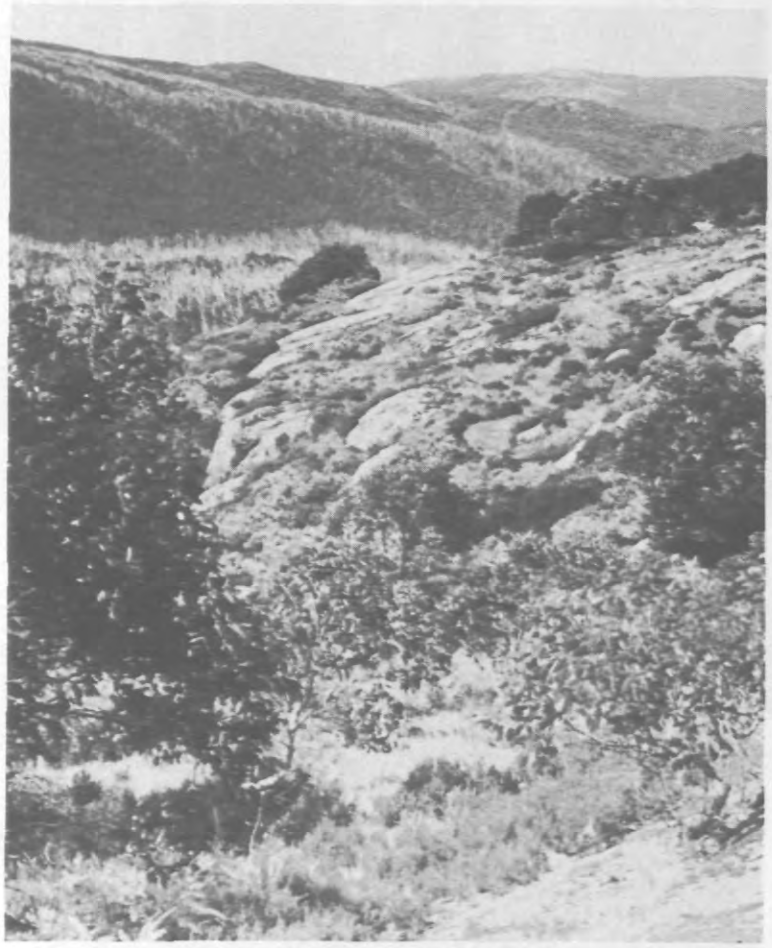
Many other granitic intrusions occurred, sometimes having complex intrusive histories. The main granitic bodies are the Strathbogie, Mount Disappointment, Cobaw, and Baw Baw-Gembrook granodiorites and granites, and small bodies are known from the You Yangs, Bulla, Ingliston, Geelong, Arthur's Seat, Mount Martha, and Mount Eliza and from Cape Woolamai.



Folded Silurian sediments exposed in a road cutting near Jamieson, in the Eildon block.

In the extreme north-east of the study area, a large basin, downwarped in late Devonian times, became filled during late Devonian and early Carboniferous times with a thick sequence of "redbeds" - comprising red siltstones, sand-

stones, and conglomerates - and interbedded acid volcanics. The redbeds were deposited in an extensive river system, and contain fish fossils at several localities.



Granite outcropping on the Baw Baw plateau, looking along main ridge towards Mount Erica.

The "redbeds" and interbedded volcanics mark the close of deposition in the Tasman Geosyncline. They were gently folded during the Middle Carboniferous Kanimblan Orogeny, which included major strike faulting along the western boundary of the redbed sequence, and by renewed faulting along the adjacent axes.

Permian - Triassic

In the Permian period, deposits included tillite and interbedded sandstones and siltstones. The tillites in several cases lie on striated and grooved pavements and are considered to have been deposited by glaciers. The interbedded sandstones and siltstones are mainly of fluviatile origin, and contain plant fossils. Several horizons of marine shelly fossils occur in the sequence, so at least part of the deposits were laid down under marine conditions.

Originally probably widespread, the Permian deposits have since been removed from most of the area by erosion, and the present ones at Bacchus Marsh owe their preservation to downfaulting. They underlie a thin sequence of fluviatile conglomerates and siltstones, which contain plant fossils of probable Triassic age.

The long gap following the Permian period, lasting throughout the Triassic and Jurassic periods, was a time of slow erosion and probably resulted in the area being reduced to a landscape of low

relief. With the exception, of the above-mentioned Triassic sediments, no rocks formed during the time gap have been preserved.

Cretaceous

Just before the Cretaceous period, a long east-west trough was formed in southern Victoria. This trough rapidly filled with a thick sequence of arkose (a sandstone containing abundant feldspar and andesitic rock fragments), mudstones, and conglomerates. Prominent throughout the sediments is a fossil flora including liverworts, club mosses, horsetails, cycads, ferns, and conifers. Local accumulation of plant debris in swamps resulted in the formation of coal seams, as at Wonthaggi and Korumburra.

A thin sequence of claystones at Koonwarra, near Leongatha, contains a rich fish and insect fauna. It has been suggested that deposition of these beds occurred in a cold climate, which probably persisted throughout early Cretaceous times. The only recorded find of dinosaur remains from the lower Cretaceous is a claw from Cape Patterson.

By the close of the Cretaceous the fundamental topography of the study area had been formed. Earth movements had given rise to an upwarped highland region tending east-west, flanked by depressions to the north and south that correspond to the present Murray Basin and Bass Strait.

Tertiary

Cainozoic sedimentation, mainly confined to the southern part of the study area, occurred in three main basins partly bordered by faults. These are (from west to east) the Port Phillip sunkland, the Westernport basin, and the Latrobe Valley.

In general, three main phases of Tertiary deposition can be distinguished: an early Tertiary phase of terrestrial sedimentation, a middle one of marine sedimentation, and a late one of terrestrial sedimentation. Intermittent volcanic activity took place during each of these phases.

The early and late Tertiary terrestrial phases are known from all three basins, but middle Tertiary marine sediments are absent from the western part of the Latrobe Valley.

The early Tertiary terrestrial phase is represented in each of the basins by a sequence of sands, silts, gravels, and brown coal seams. These seams are mined at Anglesea, Bacchus Marsh, Morwell, and Yallourn. The sands, silts, and gravel are fluviatile, whereas the coal seams were deposited in extensive swamp systems. The sediments are of Paleocene to perhaps Oligocene age.

In the Anglesea area, the Palaeocene terrestrial sediments underlie a sequence of marine dark carbonaceous and

Tertiary sediments near Anglesea.

pyritic silty sand, sandy silt, and rare gravel. The rocks contain foraminifera and plant microfossils, indicating late Eocene age.

During this phase, and continuing into the Miocene, basalts of the older volcanics were extruded. In some cases they formed thick piles in downfaulted basins, as on the Mornington Peninsula (where the thickness exceeds 450 m) and in the Ballan sunkland. Flows of older volcanic basalts also occurred outside the three basins, mostly in the form of elongated valley flows overlying fluviatile gravels and sands; these are widespread in the Gembrook, Noojee, and Erica districts.

Slow subsidence beginning in the late Oligocene marked the onset of marine deposition in the southern part of the area. During this time, a uniform sequence of silt and silty clay, grading locally into bioclastic limestones, was deposited in the western basins. The silts are often abundantly fossiliferous, containing foraminifera and shelly fossils. The fauna is remarkable for its diversity of molluscs, especially gastropods.

Towards the close of the Miocene the sea retreated, probably as a result of minor uplift, and the marine silts were overlain by a widespread thin sequence of mainly terrestrial sand, gravel, and silt, deposited in the lower reaches of stream systems draining the higher country to the north. This fluviatile sedimentation was in turn followed, in the late Pliocene, by widespread extrusion of numerous flows of basaltic lavas of the newer volcanics in the western half of the area.

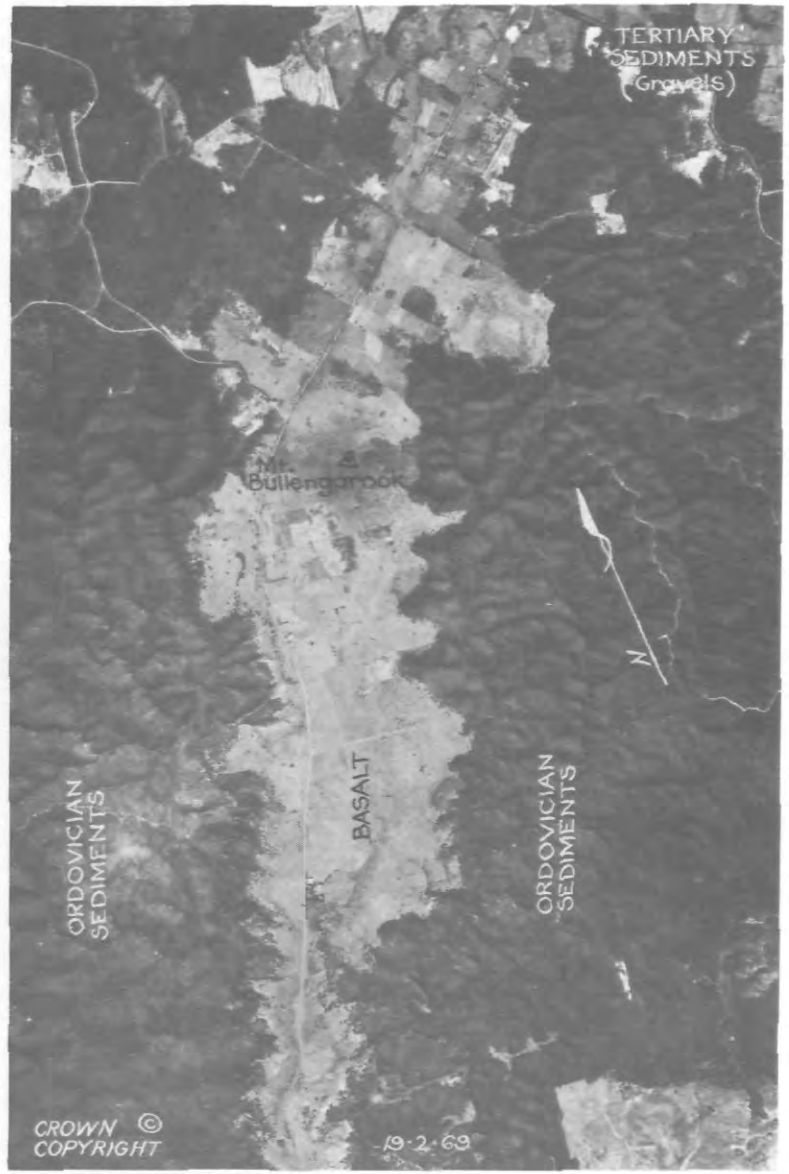
To the north, the basalts occurred mainly as valley flows, locally merging into basalt sheets, but in the south the basalt formed the very extensive sheets

of the Werribee Plains. Extrusions occurred from a large number of small vents, many of which are still preserved as low hills throughout the plains. The newer volcanics mostly are normal basalts (or, less commonly, ultra-basic limburgites), with acidic and alkaline trachytes common in the Macedon district.

Quarternary

The events that followed the extrusion of the newer volcanics were mostly restricted to small areas. Following early Pleistocene, the developing modern drainage systems dissected the Pliocene sediments and volcanics. The main streams of these systems eroded wide valleys, in which relatively thin veneers of alluvial sediment were deposited. Colluvial aprons formed along some of the faults, especially those to the west of Port Phillip. Renewed movement along older fault lines has had important local effects, for instance the creation of the Yarra flats, caused by restriction of downward erosion of the Yarra River downstream of the Yarra fault at Yarra Glen.

Pleistocene sedimentation in the Werribee and Yarra deltas, in the Carrum and Kooweerup swamps, and in Port Phillip reflects the influence of the sea-level changes during the ice age. Events during the past 20,000 years, although only a fragment of geological history, are of great importance to Man.



Basalt valley flow at Bullengarook. Note twin lateral streams, and dissected Ordovician sediments.

A reduction in polar ice sheets, which commenced about 18,000 years ago, marked the close of the ice age and resulted in a rise in sea level of about 80 m to near the present level. This flooded the Port Phillip and Westernport sunklands and separated Tasmania from Victoria. Since then, fluctuations in climate have had a marked effect on the distribution of flora and fauna. The sequence appears to have started with conditions wetter than at present, followed by an arid period some 6,000-4,000 years ago, which has meliorated to give the present climate.

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PHYSIOGRAPHY

The physiography of the Melbourne study area varies from rugged highlands reaching 1,530 m in the north-east to extensive volcanic plains and swamps in the west and south. The area may be divided into three broad entities:

Northern highlands
Southern highlands
Central lowlands

These and their subdivisions are shown on Map 4.

Northern Highlands

The northern highlands and surrounding foothills form the oldest recognizable physiographic entity in the study district. They originated in alternating periods of erosion and uplift, which produced a series of stepped plateaus. Three such plateaus or erosion surfaces can be recognized : the Baw Baw, Kinglake, and Nillumbik surfaces.

Baw Baw surface

The Baw Baw surface - the oldest and highest - was probably uplifted in the late Cretaceous. It has restricted extent and is situated chiefly in resistant Upper Devonian volcanics and granites. It includes the mildly to deeply dissected high plateaus of the Cerberean, Acheron, and Baw Baw Ranges, and the relatively flat Macedon Range. Outlying remnants occur at Mounts Toorongo, Useful, Selma, Matlock, and Terrible, and in the prominent range between Mounts St. Leonard and Tanglefoot.

The surface rises gradually to the east and north - from about 1,000 m at Mount Macedon to 1,250 m at Mount Donna Buang, 1,500 m at Mt. Torbreck, and 1,550 m at Mount Baw Baw.

The steep erosional escarpments that mark the borders of these plateaus in certain areas are prominent features of the Baw Baw and Acheron plateaus and around the Cerberean Ranges, where the steep falls of the Rubicon and Royston Rivers are used to produce hydroelectricity. Associated with the escarpments are numerous other waterfalls, such as Snob's Creek and Steavenson's Falls.

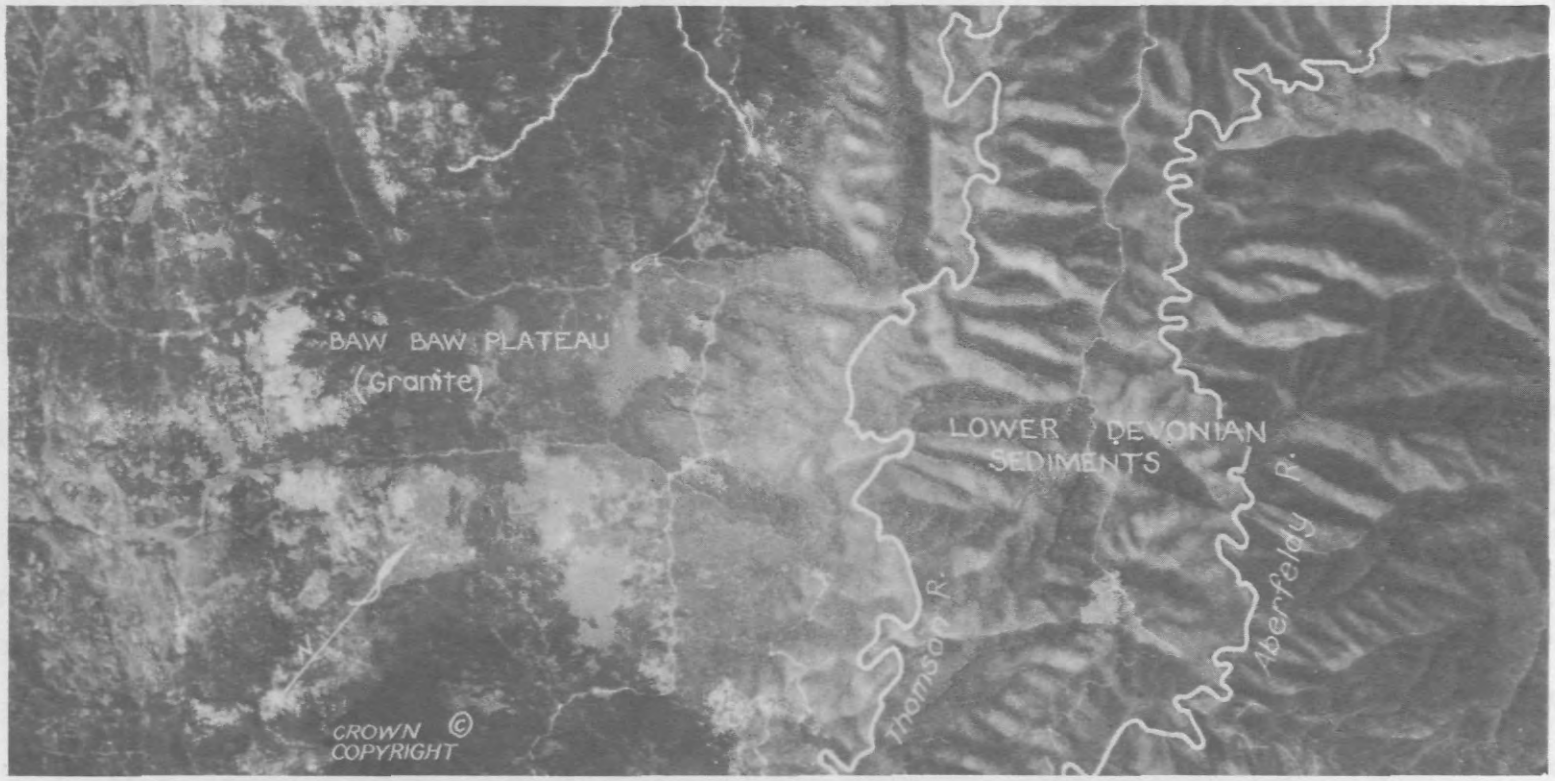
Kinglake surface

The Kinglake surface, uplifted in early Tertiary times, lies about 300 m lower than the Baw Baw surface and comprises a

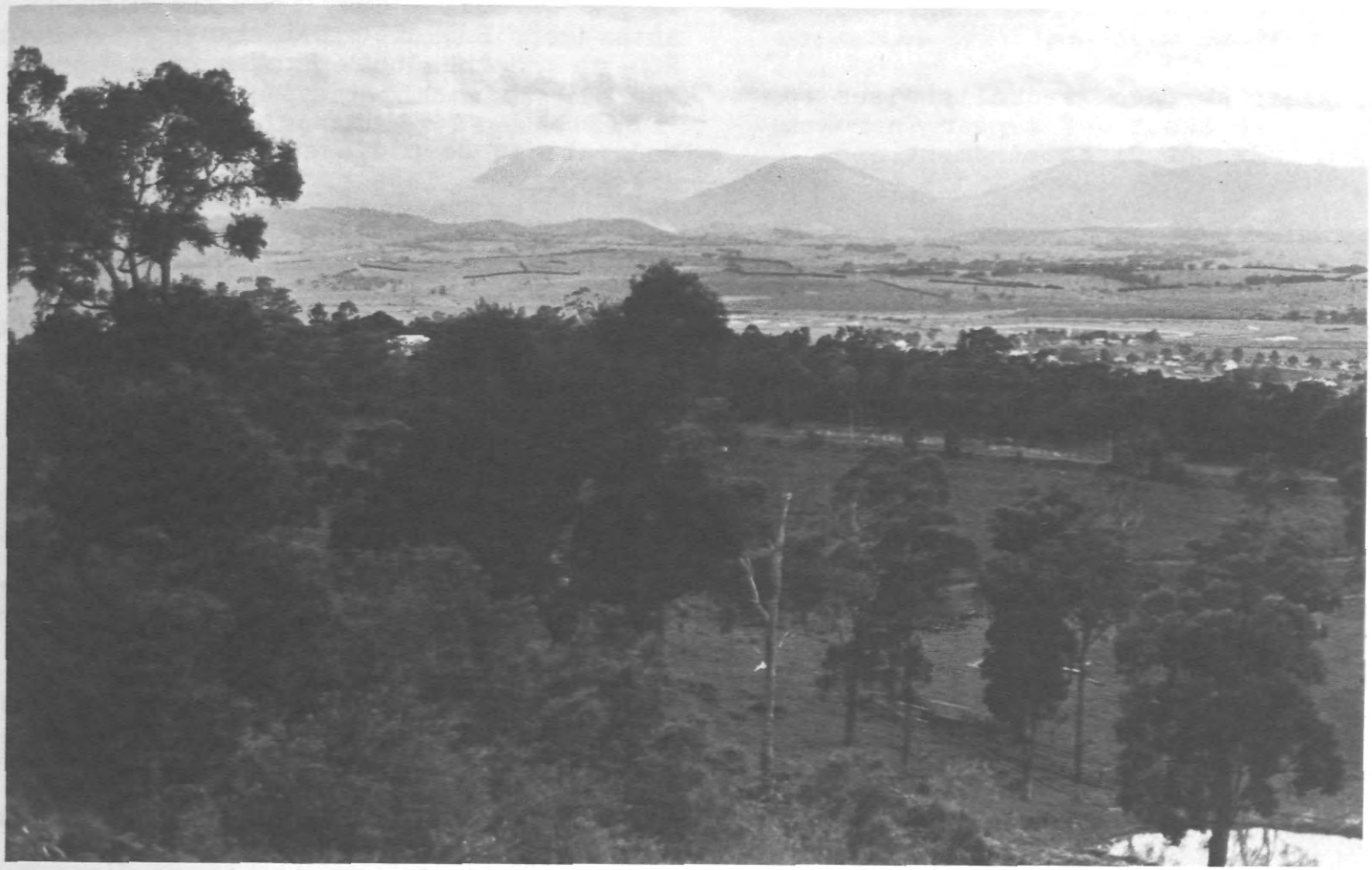
number of moderately dissected extensive plateaus, including the Gregory, Strathbogie, and Kinglake-Black Range plateaus. They are situated in Palaeozoic sedimentary and igneous rocks.

Again, steep erosional escarpments border these plateaus in certain areas. The prominent southern edges of the Kinglake and Strathbogie plateaus and the western edge of the Gregory plateau are good examples. Waterfalls in these areas include Mason's, Wombelano, Wilhelmina, and Toorongo Falls.

Elsewhere, in the upper reaches of the Thomson, Latrobe, Goulburn, Big, and parts of the Yarra Rivers, the borders



Example of differential erosion between the Baw Baw plateau (granite) and Thomson River valley (lower Devonian sediments).



The Acheron plateau, a remnant of the Baw Baw surface, and the Yarra flats viewed from Christmas Hills.

may be poorly defined, grading into deeply to moderately dissected foothills. In the headwaters of the Goulburn and Big Rivers, dissection has all but destroyed the former plateau and has produced a rugged mountainous terrain.

Deep dissection and rugged topography also characterize the outlying remnants

of the Kinglake surface, in the Cathedral and Blue Ranges and in the Cherokee area near Mount Macedon.

The Kinglake surface gradually rises to the east from about 700 m near Cherokee to 800 m at Mount Disappointment and Mount Tallarook, 900 m on the Black Range plateau, and 1,100 - 1,200 m on the Gregory plateau.

Nillumbik surface

This surface is the lowest and youngest and, although not part of the highlands, has been included because of its similar origin. It was moderately uplifted in the late Tertiary and has a relatively subdued relief. This is especially so in its western portion, where the Nillumbik plateau ranges from less than 100 m near Melbourne to about 300 m near Gembrook. Its eastern portion - the Erica plateau in the Noojee area - is more elevated (up to 500-600 m) and is consequently more deeply dissected, with a relatively rugged topography.

Outlying hills

The Nillumbik surface has not been recognized in the area west of the Hume Highway, where its absence is probably due to the interruption of normal erosional processes in the Tertiary by block faulting and widespread extrusion of volcanics. It lacks the prominent erosional escarpments that frequently mark the boundaries between the various surfaces further east, and instead slopes gradually away from the highest areas near Bullarto and Blackwood (about 800 m) and the Cobaw Ranges (about 700 m).

Moderate to deep dissection in these areas becomes less pronounced in the surrounding lower country. Subdued relief is also typical of the hills and strike ridges protruding through the basalt sheet north-west of Melbourne. Steep dissection occurs north of Bacchus Marsh, where faulting has rejuvenated the streams crossing the uplifted Blackwood block.

Stream valleys and foothills

Rapid downward erosion (following the uplift of the Kinglake surface and continuing to the present day) has cut deep and rugged valleys into the eastern part of the northern highlands. The main streams of the Goulburn system in their lower reaches frequently flow through an extensive terrain of gently undulating hills, resulting from the retardation of downward erosion of the Goulburn River where it crosses the Strathbogie granite massif upstream from Seymour.

Southern Highlands

In contrast to the northern highlands, the southern highlands originated as a result of block faulting. They comprise the relatively elevated and deeply dissected Strzelecki and Otway Ranges

horsts, the Barrabool hills, and the less elevated and moderately dissected Mornington Peninsula horst. They are bordered to the north by low-lying volcanic or alluvial plains or undulating hills, and by Bass Strait in the south.

Central Lowlands

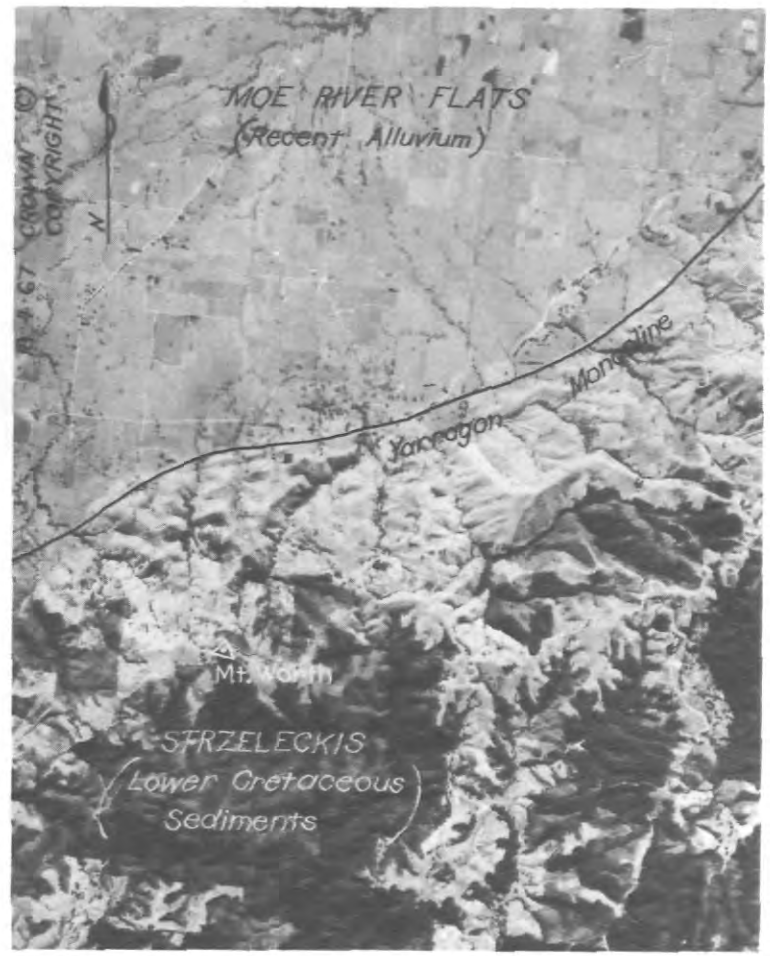
The borders between the central lowlands and the northern and southern highland belts are ill-defined except in the Strzelecki and part of the Otway Ranges, where they occur along major faults.

However, important faults occur within the lowland belt, frequently marking the boundaries of different physiographic units. Among them, the Rowsley, Coimadai, and Barrabool faults form the western border of the Port Phillip sunkland with its extensive volcanic plains; the Selwyn fault lies on the eastern side of Port Phillip; other systems form the western and eastern borders of the western sunkland, in which the extensive Kooweerup swamp lies; and rather less important faults border the Carrum swamp.

Tertiary sedimentary and older volcanic plains

The Tertiary sedimentary and older volcanic plains have their greatest development on the elevated blocks west of the Rowsley fault, on the Bellarine and Mornington Peninsula horsts, and in the Moe area.

Deep dissection is typical in the uplifted block west of the Rowsley fault, where the Werribee, Little, Moorabool, and Barwon Rivers and Sutherlands Creek



Yarragon Monocline. Dissected lower Cretaceous (Strzeleckis) and Recent alluvial flats (Moe River).

Basalt plains near Werribee looking south-west to granite outcropping at the You Yangs.

have cut deep gorges. Dissection has modified the original plain-like topography on all the uplifted blocks to a greater or lesser extent, and the Tertiary sediments may be present only as hill-cappings, on the Brisbane Ranges, and on part of the Mornington Peninsula horst.

Low-lying gently undulating sedimentary plains that have been little dissected are restricted mainly to the sunklands, for instance the Brighton coastal plain, French and Phillip Islands, and the Lang Lang area.

Newer volcanic plains

These have their greatest extent in the Werribee plains, where coalescing basalt flows have produced a gently undulating surface dotted with numerous low volcanic cones and occasional bedrock hills and ridges. Dissection is restricted to a few major streams, which lack tributaries almost entirely and receive their water from outside the plains.

The volcanic plains merge into the highlands to the north and west as valley flows.

Post-Tertiary sedimentary plains

The post-Tertiary sedimentary plains include coastal flats and swamps and fault apron deposits, especially along the Rowsley fault. A similar flat terrain occurs in the alluvial sediments of the main streams, especially the Goulburn, Yarra, and Moe Rivers. Undulating Pleistocene dunes form the Point Nepean peninsula.

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CLIMATE

The Melbourne area has a temperate climate, with warm dry summers and a tendency for maximum rainfall in winter. Considerable topographic variations make the climate within the area variable, with annual average rainfall ranging from as little as 400 mm on parts of the volcanic plains west of Port Phillip to more than 1,400 mm in the highlands to the east. Summer drought conditions over most of the area not only create an environment particularly susceptible to fire, but inhibit plant growth for up to 3 months. Moreover, winter temperatures retard plant growth in all areas, and frost occurs commonly in some. Hail associated with thunderstorms causes occasional crop damage, while snow is a regular feature of the highlands in winter and has been known to occur throughout the study area.

Precipitation

The pattern of precipitation is considered to result from two main influences; the topography and the general westerly origin of the rain-bearing winds. Thus the areas of high elevation form corresponding regions of high precipitation, while regions of low precipitation occur at low elevation or in the lee of mountain ranges tending north-south, across the direction of moisture-bearing winds.

Rainfall

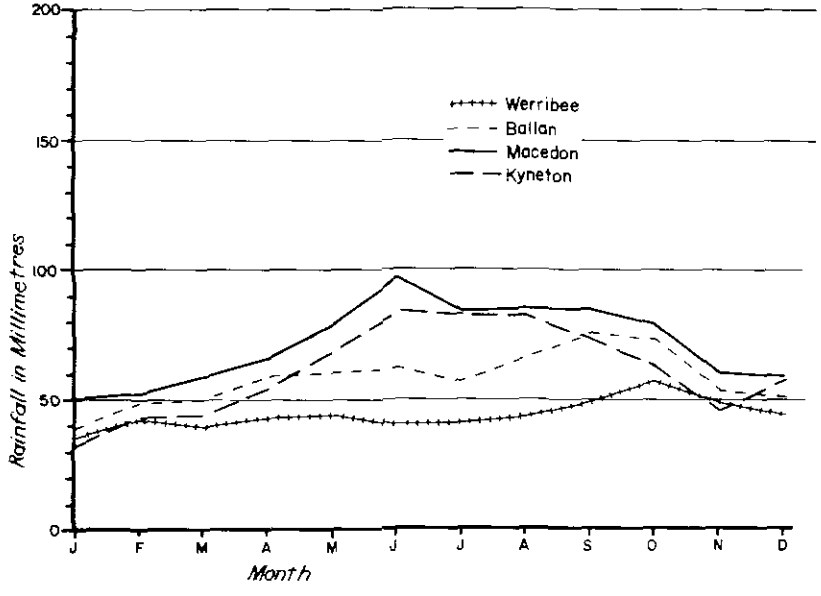
Map 5 shows average annual rainfall in the study area.

This exceeds 1,000 mm annually over most of the hill and mountain country to the north and east of Melbourne, and 1,400 mm in many places. Average rainfall also exceeds 1,000 mm annually in other areas of high elevation - in the Otway and Strzelecki Ranges and in the Macedon-Trentham area. Marked rain shadows are found near Yea, Alexandra, and Mansfield, which receive averages of less than 700 mm annually, and in the area north of Werribee, which has less than 500 mm annually. The Cerberean and Baw Baw plateaus and the Strzelecki Ranges cause other noticeable rain shadows.

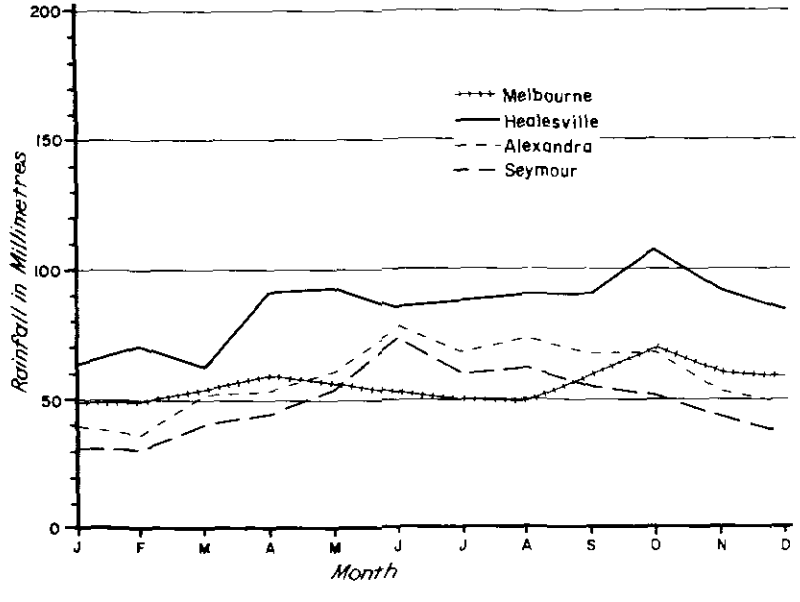
Figure 1 shows the rainfalls at 12 selected stations in the area, and indicates the kind of variation experienced. Summer is the driest season throughout (except on the western outskirts of Melbourne, where winter is drier). Many

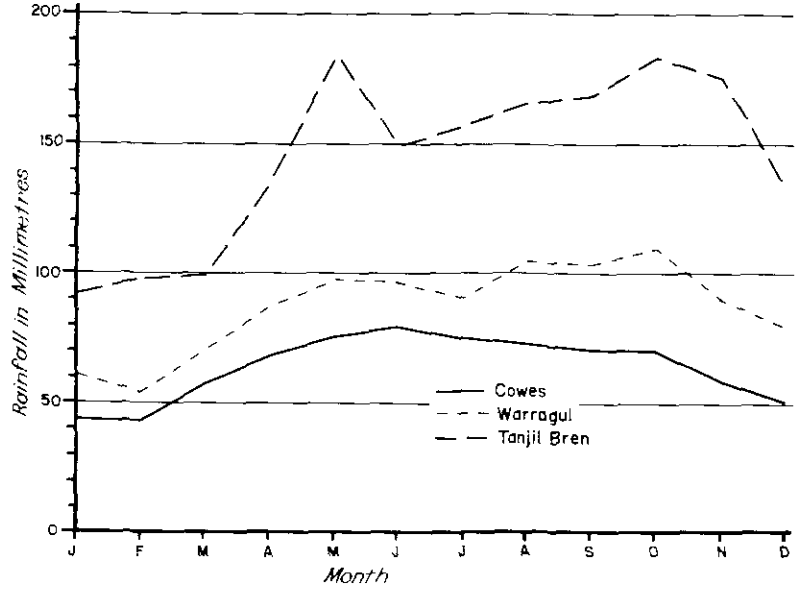
FIG. 1 RAINFALL

MEAN MONTHLY RAINFALL AT SELECTED STATIONS



STATION	ELEVATION	STATION	ELEVATION
Werribee	23m	Alexandra	208m
Ballan	442m	Seymour	152m
Macedon	914m	Cowes	5m
Kyneton	511m	Warragul	122m
Melbourne	35m	Tanjil Bren	838m
Healesville	91m	Baw Baw	1524m





areas have their heaviest falls in October, although the heaviest rainfall tends to occur as early as June north of the Divide.

Snowfall

Snow is an important source of water in the higher parts of the study area. The snow season may last from about May to October, although falls have been recorded on the highest peaks at all times of the year. Annual variation is high, and in some years very little snow falls.

Regular falls only occur above 950 m, but at this elevation snow lies only for a few weeks or so. Above 1,200 m, depending on aspect, persistent snow may lie for most of the season. Snow cover is adequate to support winter sports (at least for a limited period each year) on the Baw Baw plateau and on Mount Torbreck. Less reliable falls occur on Lake Mountain, Mount Donna Buang, and Mount Macedon.

Temperature

Temperatures vary appreciably - from the coastal areas in the south to the mountainous ones of the north-east and the inland ones of the north. Figure 2 shows the mean monthly temperatures for selected stations. The seasonal pattern is consistent in all areas, with the highest temperatures generally being recorded in February and the lowest in July

Coastal areas have relatively cool summers and mild winters. At Cowes the mean monthly temperatures range from about 19°C to 10°C. Lowland areas away from the coast tend to have higher temperatures in summer and lower ones in winter: mean monthly temperatures range from 20°C to 9°C at Melbourne and from 21°C to 8°C at Seymour. With increased elevation, temperatures become lower and the range between summer and winter may widen slightly: at Macedon (914 m) is 17°C to 5°C and at Baw Baw (1524 m) 13°C to 0°C.

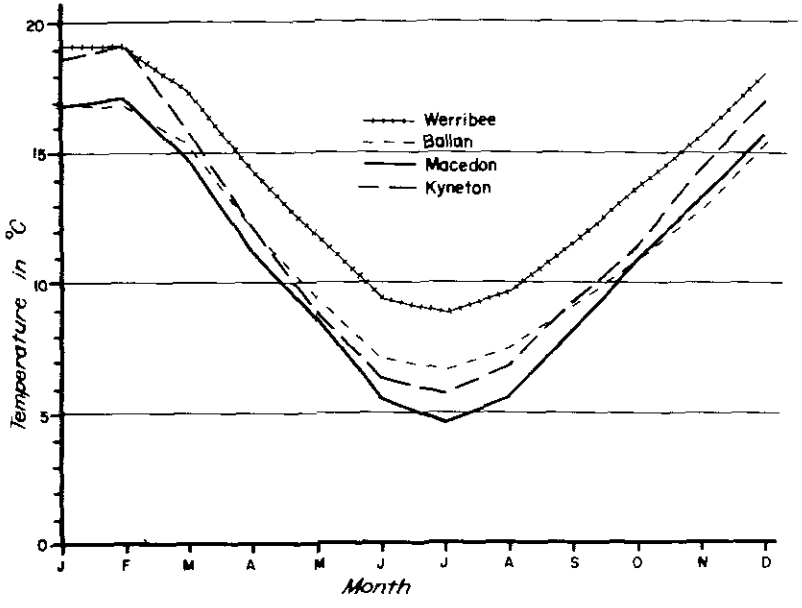
Frost

The occurrence of frost depends not only on the temperature and humidity of the air, wind speed, and cloudiness, but also on the characteristics of the partirular site - its vegetation cover, its slope, and the slope of the surrounding land. Susceptibility of a particular piece of ground to frost is a peculiarity of site, nevertheless some general observations are useful.

Frosts are rare near the coast and in the lowlands, and become progressively more frequent and heavy with increasing distance inland and elevation. Highland valleys may experience more than 100 frosts per year, averaging 1 or 2 per month during the summer and more than 18 per month during the winter. In contrast, coastal areas may have a frost free period in excess of 9 months, and average less than one frost per month

FIG. 2 TEMPERATURE

MEAN MONTHLY TEMPERATURE AT SELECTED STATIONS



STATION	ELEVATION	STATION	ELEVATION
Werribee	23m	Alexandra	208m
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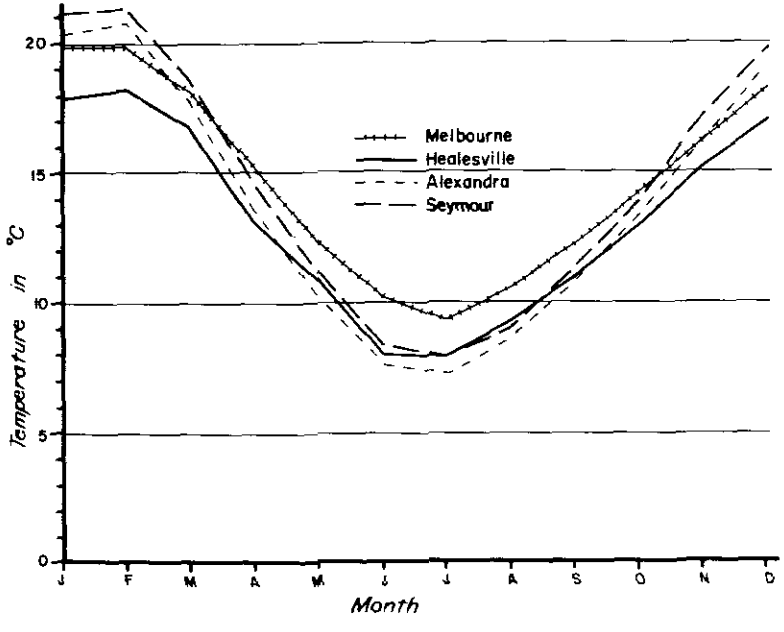
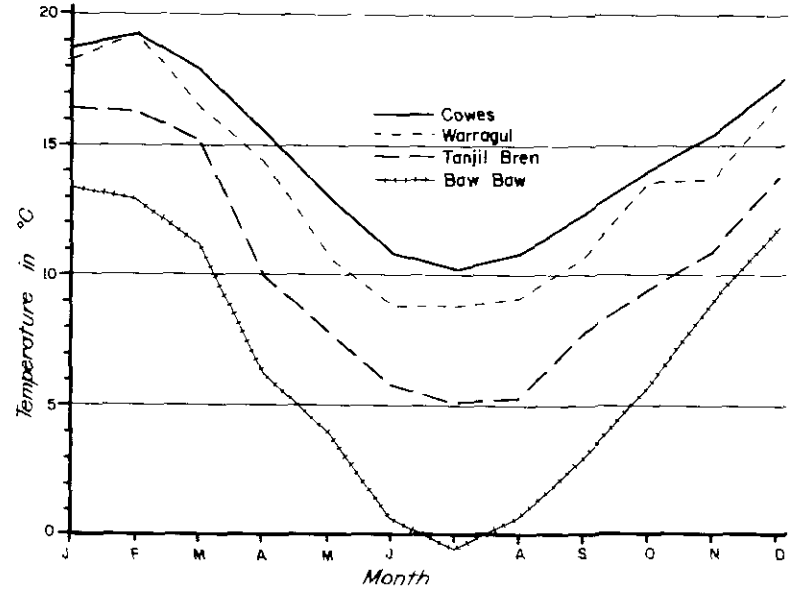




during the remaining period. In most areas frosts are most likely to occur during July and least likely during February.

Growing Season

Two major climatic factors limit plant growth in the study area: inadequate soil moisture in summer and excessive cold in winter. The amount of soil moisture available to plants depends on a number of factors in addition to rainfall, and these include evaporation, slope of ground, soil type, and plant species (see chapter 8). Effective rainfall is the minimum amount of rain required after the dry period to start and sustain plant growth, and can be calculated from data on evaporation.

The growing season can be defined as the number of months for which the probability of receiving effective rainfall exceeds 50%, plus one month. The additional month allotted at the finish of the growing season makes allowance for moisture stored in the soil. Low temperatures can restrict or completely stop plant growth and must be combined with the above data on growing season. The commonly accepted temperature limit for active growth is 10°C mean monthly temperature, and no significant growth at all occurs below 5.5°C.

Growing seasons calculated from rainfall and temperature data for selected stations appear in Figure 3.

The four categories - growth, growth restricted by cold, no growth due to cold, and no growth due to drought - are indicated accordingly. These comprise a useful indicator of climatic suitability for plant growth but, as indicated earlier, the actual length of growing season would also depend on the characteristics of the plant being grown - for example its tolerance to low temperatures and the depth to which its roots can penetrate - and on the characteristics of local soils and topography.

Figure 3 shows that almost all areas, except those receiving very high rainfall, have a summer drought of some duration. This is especially so in the lowlands west of Melbourne and north of the Dividing Range. In the hills and highlands, the effect of elevation first appears in restricted growth due to cold; and at higher elevations no growth occurs at all for periods ranging from 1 to 6 months.

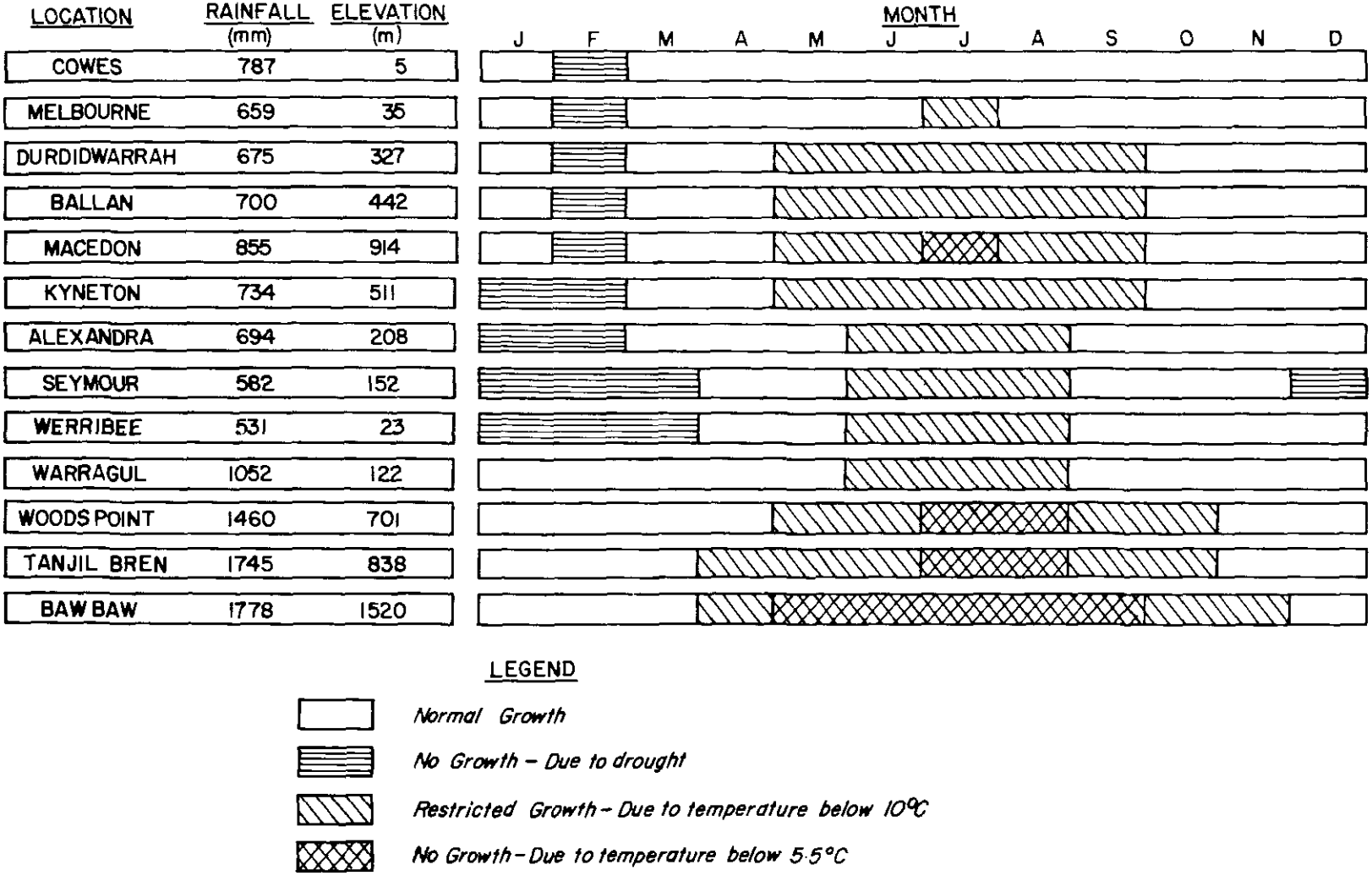
It is notable that no station has good growth all the year around. Either some degree of summer drought, as at Cowes (at low elevation, on the coast, with only moderate rain), or winter cold, as at Warragul (inland, at 122 m elevation), inhibits growth.

Reference

Bureau of Meteorology: "Climatic Survey, Region 10, Port Phillip, Victoria." (Melbourne 1968.)

FIG. 3 GROWING SEASON

ESTIMATED GROWING SEASONS AT VARIOUS LOCATIONS, DERIVED FROM EFFECTIVE RAINFALL PROBABILITY AND MEAN MONTHLY TEMPERATURES



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WATER RESOURCES

Localized combinations of climate, physiography, geology, and vegetative cover strongly influence both surface and groundwater resources.

Much of the study area contains large amounts of good-quality surface water, in contrast to the relatively localized sources of groundwater. The value of these supplies in terms of existing and potential utilization for domestic, industrial, and agricultural consumption is discussed in chapter 18.

Surface Water

About one-fifth of the State's total stream flow originates within the study area. The location of these surface water resources in proximity to the bulk of Victoria's population, and to productive inland agricultural districts, enhances their regional significance.

Major streams

Apart from Lake Connewarre, the area contains no large natural inland water bodies. Prior to European settlement, it included extensive swamplands at Kooweerup near Western Port, at Carrum, and in the Port Melbourne area. These have subsequently been drained and the areas now carry agriculture, industry, and urban settlement. The clearing of vegetation for agriculture has had an important although unmeasured effect on natural drainage systems. At present most of the main streams are regulated in flow to some extent by reservoirs, weirs, and other development works (see chapter 18).

The map facing page 42 shows the 13 major drainage basins occupying the study area, which contain a large number of streams (see Table 3). The main topographic influence on direction of river flow in these basins - the Great Dividing Range - runs east-west through the area, directing the headwaters of the Goulburn, Loddon and Campaspe in a northerly direction. All other basins drain towards the southern coast.

The two largest river systems, in terms of both average annual discharge and extent of catchment within the study area, are the Goulburn and Yarra basins. Together these account for almost two-thirds of total discharge and cover one-half of the study area.

Table 3

DRAINAGE BASINS IN THE STUDY AREA

Wholly contained within L.C.C. boundary	Headwaters only	Lower reaches only
Bunyip Maribyrnong Werribee Yarra	Campaspe Goulburn Latrobe Loddon Thomson South Gippsland	Barwon Moorabool Otway

Gauging stations

Many gauging stations exist on streams throughout the study area. For this study, records from a sample of these stations have been chosen to show:

a) stream flow from public land

b) total discharge within the study area, especially where its boundary overlaps some basins

Stream gauging facilitates water conservation planning by enabling estimates of river discharge to be made. It has also permitted development of flood warning systems. The reliability of predictions relating to stream flow improves with the length of time for which records are available.

Table 4 lists records from gauging stations for major streams and drainage basins, at locations shown on the map facing this page.

The mountainous zone north-east of Melbourne (the southerly extension of Victoria's eastern highlands) is the major source of surface water within the study area, and most of the larger streams have their headwaters there. Total discharge of streams in the western half of the area is noticeably lower.

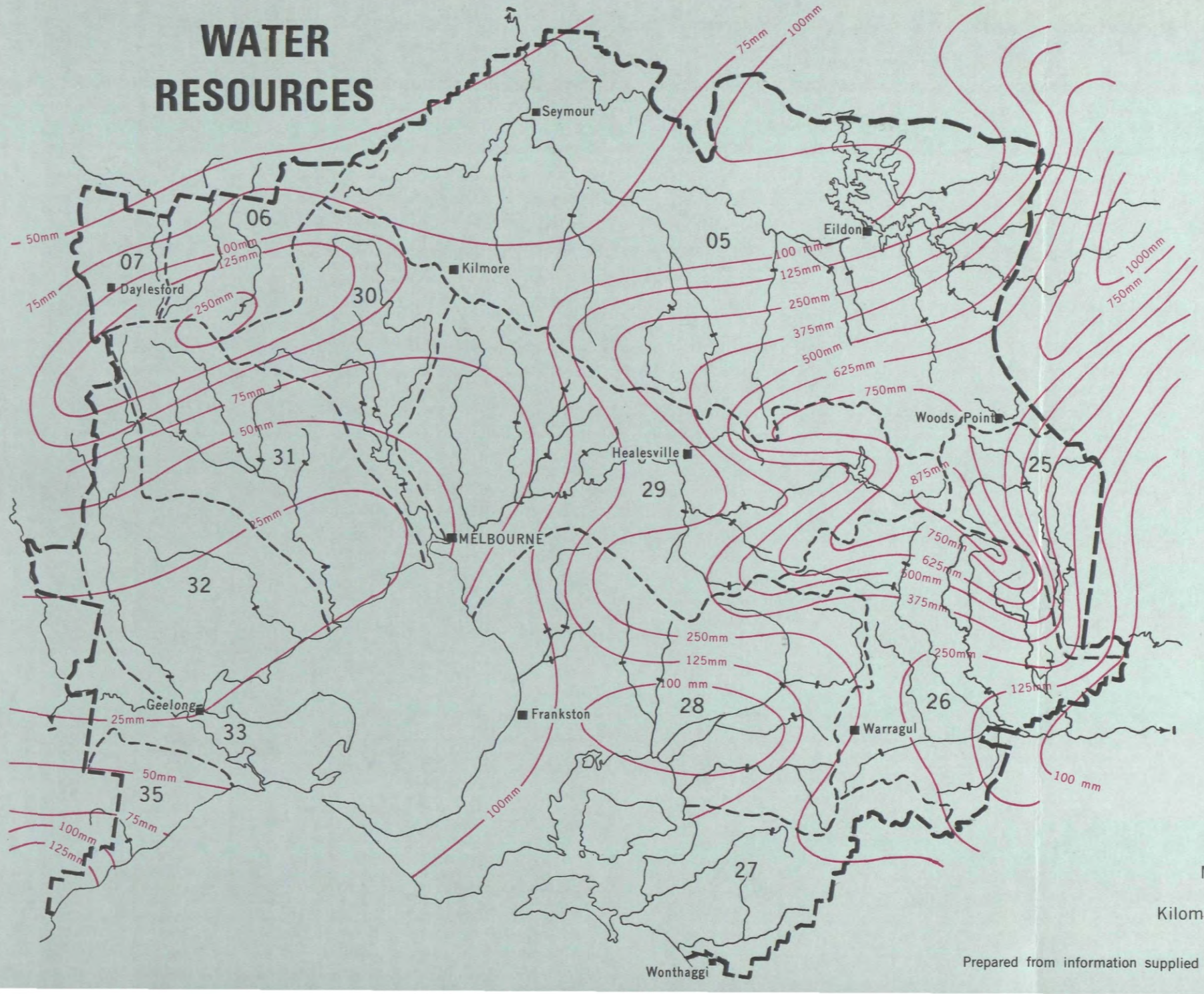
Variability of stream flow

Average annual records of stream flow provide a convenient summary of discharge, but should be treated with caution. Gauging records show that stream flow can vary considerably between minim-

WATER RESOURCES

LAND CONSERVATION COUNCIL
VICTORIA

MELBOURNE STUDY AREA



LEGEND

Drainage Basin Boundaries

Major Streams showing Gauging Stations

100 mm *Average run off per annum*

INDEX TO BASINS	
NUMBER	NAME
05	*Goulburn*
06	*Campaspe*
07	*Loddon*
25	*Thomson*
26	*Latrobe*
27	*Sth. Gippsland*
28	*Bunyip*
29	*Yarra*
30	*Maribyrnong*
31	*Werribee*
32	*Moorabool*
33	*Barwon*
35	*Otway*

Scale 1:1,000,000

Miles 0 16 32

Kilometres 0 15 30 45 60

Prepared from information supplied by the State Rivers and Water Supply Commission.

mum and maximum rates (see column 9 of Table 4). These divergencies are caused by periods of flood or drought, and the probability of extreme conditions being recorded depends on the period for which records have been kept. At some stage during the last 100 years all rivers in the study area have either dried up completely or contained very little flow.

Seasonal variations in stream flow are also hidden in the average annual figures. Column 4 shows that most rivers have a marked increase in flow during winter and spring, reflecting the general rainfall patterns. Seasonal variation is less pronounced in streams south of the Dividing Range and east of Melbourne, especially the Yarra. This partly reflects their location in relation to moisture-bearing winds.

Factors affecting catchment yield

Yield is regarded as the total stream flow available at a particular place and time within a catchment, after allowing for water losses through evapotranspiration and aquifer recharge. It comprises surface run-off (overland flow) and subsurface flow resulting from infiltration.

Within a catchment, these two types of flow are influenced by a number of variable factors, including climate, soil structure, land slope, and age and composition of the vegetation cover - e.g. native forest, introduced pine forest, shallow-rooted pastures, or bare ground. Knowledge about the precise effect of any one factor or combination of factors on water yield is still incomplete. Several hydrological experiments are now in progress within the study area

Hydrological research in Stewarts Creek experimental catchment, Wombat block.

Table 4

SURFACE WATER RESOURCES

Drainage basin Name	No.	Av. annual discharge of total basin (10^3Ml)	Estimated av. ann. discharge from study area	Seasonality of stream flow	Major streams	Gauging station *	Area of catchment (km^2)	Av.annual discharge (10^3Ml)**	Variability of flow Max. daily (cumecs)	Variability of flow Min. daily (cumecs)	Salinity (mg/litre) ***
Goulburn	5	2,900	45%	45% winter 41% spring 7% summer 7% autumn	Goulburn	Shepparton	16,125	2,130	1,340	0.68	140
						Above Jamieson	694	400	267	0.20	32
					Rubicon	Rubicon	129	108	39	0.31	47
					Snobs	Above falls	35	36	15	0.08	NA
					Delatite	Tonga bridge	367	138	164	0.05	46
					Howqua	Howqua	388	240	148	0.11	45
					Jamieson		367	249	131	0.25	37
					Big		619	322	145	0.60	25
					Acheron	Taggerty	621	342	86	0.25	56
					Murrindindi	Colwells	101	59	65	0.04	57
					Yea	Devlins bridge	360	115	140	0.02	66
					King Parrot	Strath Creek	388	90	88	0.01	NA
					Sunday	Tallarook	336	28	39	NIL	471
					Huges	Tarcombe road	471	73	119	0.02	146
Campaspe	6	314	45%	53% winter 37% spring	Campaspe	Elmore	3,211	237	840	NIL	488
						Ashbourne	38	4	50	NIL	84
					Coliban	Malmsbury	305	66	250	NIL	177
Loddon	7	253	41%		Loddon	Vaughan	292	41	79	NIL	366
Thomson	25	858	47%		Thomson	Cowwarr	1,087	402	580	0.14	47
					Aberfeldy	Beardmores	310	65	110	NIL	46
					Jordan	Aberfeldy	124	47	27	NIL	38
LaTrobe	26	965	58%		Latrobe	Rosedale	4,144	937	1,220	1.35	NA
						Noojee	284	107	18	0.54	NA
					Narracan	Thorpdale	64	28	13	0.08	NA
					Moe	Darnum	207	46	24	0.02	NA
					Tanjil	Tanjil South	370	150	155	0.51	NA
					Tyers	Gould	220	132	270	0.60	NA
					Jacobs	O'Tooles	36	7	8	NIL	NA
					Toorongo	Near Noojee	64	38	5	0.25	NA
South Gippsland	27	420	4%		Bass	Loch	51	15	14	NIL	262

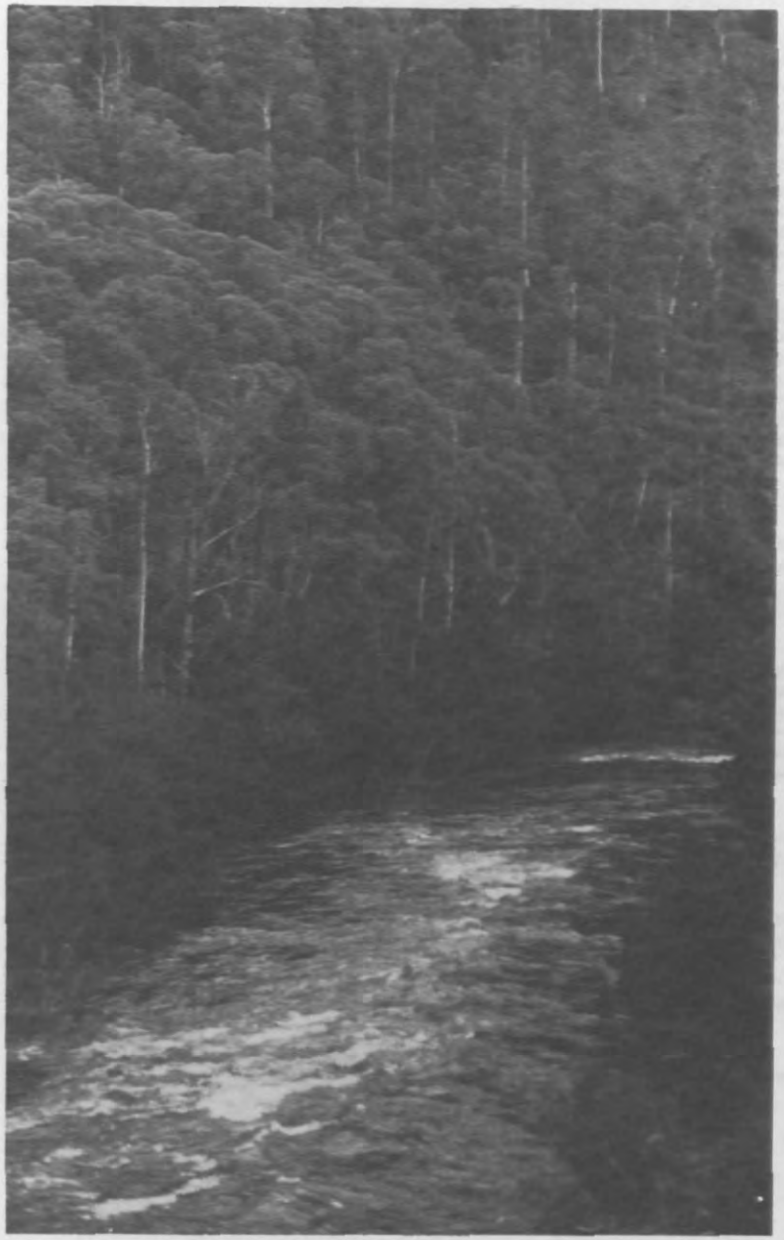
* Location of gauging stations is shown on Map 2.

** These figures represent the actual flow passing gauging station. No allowance has been made for the effects of storages and diversions upstream.

Table 4 (continued)

Bunyip	28	163	100%	70% winter and spring	Bunyip	Bunyip	660	149	500	0.42	NA
					Lang Lang	Heathhill	259	47	65	NIL	NA
					Cardinia	Beaconsfield	98	11	39	NIL	NA
					Eumemmering	Lyndhurst	145	18	103	NIL	NA
					Tarago	Drouin West	217	57	28	NIL	NA
					Mile	Dandenong	44	9	13	NIL	NA
					King Parrot	Longwarry	41	5	4	NIL	NA
					Toomuc	Pakenham	41	5	5	NIL	NA
					Dandenong	Dandenong	269	55	97	NIL	NA
Yarra	29	1,165	100%	65% winter and spring	Yarra	Warrandyte	2,328	810	625	0.23	94
					Plenty	Mernda	297	5	18	NIL	429
					Diamond	Wattle Glen	196	13	22	NIL	178
					Little Yarra	Yarra Junction	139	38	9	0.11	67
					Woori Yallock	Woori Yallock	310	81	25	0.05	114
					Running	Arthurs Creek	20	15	2	NIL	95
					Watsons	Watsons Creek	36	1	4	NIL	222
					McCrae	Beenac	5	1	0.28	NIL	64
Mari-byrnong	330	75	100%	89% winter and spring	Maribyrnong	Keilor	1,302	99	400	NIL	869
					Jacksons	Sunbury	336	20	126	NIL	772
					Emu	Sunbury	163	14	65	NIL	NA
					Riddells	Riddell	80	9	22	NIL	178
Werribee	31	99	100%	75% winter and spring	Werribee	Werribee	1,388	38	256	NIL	540
						Ballan	101	21	58	NIL	235
					Lerderderg	Darley	310	35	192	NIL	NA
					Pykes	Reservoir	124	19	113	NIL	196
					Toolern	Melton	72	6	82	NIL	110
					Coimadai	Bacchus Marsh	101	2	19	NIL	561
Moorabool	32	74	100%	90% winter and spring	Moorabool	Batesford	1,113	71	235	NIL	628
					Little	Little River	416	5	40	NIL	2,596
Barwon	33	68		90% winter and spring	Barwon	Winchelsea	1,051	139	300	0.005	942
					Leigh	Inverleigh	416	91	150	0.04	NA
Otway	35			90% winter and spring	Anglesea	Anglesea	NA	NA	NA	NA	NA

*** Salinity scale - salinity levels suitable for
irrigation - up to 500 mg/l
domestic use - up to 1,500 mg/l
stock - up to 6,000 mg/l



The Big River upstream from Lake Eildon.

assess the effects of various vegetation types and of logging operations on water volumes and flow regulation.

The combinations of factors influencing stream flow display marked differences between catchments throughout the study area. Within any one catchment this set of factors can be managed to achieve better water yields by giving attention to both the volume of flow and its regularity.

Surface run-off tends to reduce the regularity of stream flow by the rapid removal of rainfall into streams. Excessive run-off will cause problems of erosion, water turbidity, increased sedimentation in storages, and possible flooding. The infiltration of precipitation improves the regularity of stream flow by ensuring a more constant supply of water, even during periods of dry weather. Infiltration also contributes to aquifer recharge in appropriate areas and provides moisture for plant growth.

Run-off

Surface run-off provides a large part of total stream flow in the study area. It can be calculated in approximate terms from the empirical relation between precipitation, evaporation, and local conditions of topography, vegetation, and geology.

Mean annual run-off isopleths (see on the map facing page 42) give a general indi-

cation of the surface run-off that can be expected throughout the study area. They show a marked variation in run-off levels, reflecting differences in precipitation, slope, and ground cover.

The highest recordings occur in the mountainous north-east near the Baw Baw plateau, with a smaller peak in the north-west near Trentham. Both these zones have high rainfall and are heavily forested. Run-off is least in the rainfall shadow area on the Werribee plains, and a belt of land with lower run-off (less than 75 mm per annum) - between the Werribee plains and Seymour - separates the two higher run-off zones.

Water quality

Several important aspects of water quality - affecting suitability for agricultural, domestic, and industrial uses - are influenced by natural conditions as well as human activity. These include salinity, turbidity, discolouration, and bacteriological and chemical contamination. Although extensive testing of water quality in domestic and irrigation catchments is carried out, the only widespread indicator of water quality for streams in the study area is salinity.

Salinity occurs in streams flowing through parent material with high concentrations of soluble salts, and generally increases in low-rainfall zones. Salt content in soils is also higher in catchments with low rainfall. The final column of Table 4 gives available records of salinity levels for streams in the study area. Salinity levels are low, indicating good water quality, for streams with their headwaters north-east of Melbourne, tend to increase in those rivers flowing across the western plains, especially the Little River and lower reaches of the Barwon and Maribyrnon Rivers. A table indicating the upper limits of salinity for various uses is included as Appendix 1.

Stream turbidity arises from the deposition of soil into streams by surface run-off. The disturbance of vegetation brought about by men, machines, and animals in the catchment facilitates this.

Discolouration is largely due to the "kino" effects of certain types of vegetation. Recent experiments have shown that highly soluble extracts occur as exudations on eucalypts. Kino exudes as sap when trees are damaged (e.g. from broken branches; splitting in bushfires) and is readily dissolved in rainwater, which then enters the stream as coloured run-off. Pines and bracken-fern are also high colour producers, but their effects can be reduced by burning to remove dead litter.

Bacteriological pollution by animal populations occurs to some degree in all catchments. Human activities associated with recreation can also impair the

chemical purity of water, especially at and downstream from popular sites.

Water quality is noticeably poor in the lower reaches of all streams entering Port Phillip Bay, due to pollution from industrial, domestic, and agricultural sources. Several of these streams, including the Yarra and Maribyrnong Rivers and Dandenong Creek, have been the subject of recent water-quality investigations.

Flooding

Major flooding posing threat to life and property seldom occurs in the study area. Nuisance flooding does occur on many streams, especially in the western part of the area after sudden heavy downpours or prolonged wet periods, but the duration of these floods is generally short. Flows in most streams are now regulated to some degree by the presence of water-supply and/or river improvement works.

Groundwater

Groundwater is present throughout the study area, but the yield and quality varies considerably according to local differences in geology, rainfall, elevation, and surface land use. Although no general surveys of groundwater to assess the combined value of these resources have been carried out, a number of localized investigations are in progress to monitor water quality, to determine safe yields from aquifers, and to study problems of depletion and salt intrusion.

Yield

Yields are generally low but variable (less than 0.63 litres per second) in the Palaeozoic and Mesozoic rocks that form the bedrock of the study area. These rocks usually have a low permeability and low porosity, and groundwater is localized in fractures, joints, and shear zones, and in the weathered zone (which seldom extends more than 60 m below the surface). However, individual bores may have high yields, depending on the features intersected. The Kinglake area, for example, contains high-yielding bores (7.6 l/sec) of good-quality water (less than 200 mg total dissolved solids per litre) occurring on deeply weathered Silurian and Devonian sediments.

Many springs are found in Palaeozoic sediments throughout the highland areas, indicating some storage and movement of groundwater, but flows are small. Mineral springs charged with carbon dioxide and salts are numerous in the Daylesford - Hepburn area. This water is probably derived from local recharge by creeks, while the carbon dioxide originated either from the decomposition of carbonate shales or from a volcanic source.

Yields are typically larger in areas of Tertiary and Quaternary rocks where por-

ous, permeable deposits overlie lower impervious strata. These include the districts of Kooweerup, Wandin Yallock (Silvan), Rosebud, and the south-eastern suburbs of Melbourne. They are almost always unconfined acquifers, recharged by local rainfall infiltrating downward into the porous formations directly beneath the surface. Bores in these zones commonly yield up to 25 l/sec.

Water quality

Salinity levels provide the main indicator of water quality. Acceptable levels of salinity for domestic stock and irrigation use are shown as a footnote to Table 4. As with yields, groundwater quality varies, both within the same geological formation, and between different formations, depending on local rainfall, elevation, and proximity to the coast.

Human influences can also adversely affect water quality. Domestic and industrial disposal of untreated solid and liquid waste, the over-utilization of groundwater resources, and the improved surface drainage of agricultural land can be cited as factors impairing groundwater quality.

With a few exceptions, salinity levels tend to be higher than in the bulk of surface water resources in the study area. Good-quality groundwaters with low salinity levels occur in parts of the Western Port and Port Phillip

Mineral springs near Daylesford

basins, and at Anglesea, from Tertiary volcanics and sediments. Poor-quality groundwater supplies (greater than 1,500 mg/l) occur in the Bellarine Peninsula and Barrabool Hills from Mesozoic sediments.

Water from igneous Palaeozoic rocks in the Dandenongs and Mount Macedon districts, and around Lysterfield, although generally low in yield, tends to have lower salinity levels than water from Palaeozoic sediments.

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SOILS

The wide range of environments in the Melbourne area gives rise to great variation in soils. The soil-forming factors climate, geology, topography, vegetation, and age of land surface all cover a wide range.

The small-scale maps of Skene, Northcote, and Downes have established the broad distribution of soil patterns.

Considerable detail is available, mainly in the central and western parts of the area, from reconnaissance surveys in which the dominant soils are identified and mapped as complexes. Published maps show terrain patterns in the Melbourne and Queenscliff 1:250,000 areas, or soil associations in the Shire of Whittlesea and to the east of Carrum.

Unpublished data have been made available by the Department of Agriculture on soil groups in the Barwon Region and by the Soil Conservation Authroity on land systems in several areas, namely the Eildon catchment, the Tyers River catchment, the Shires of Kyneton and Pyalong, the area of volcanic plains to the north and west of Melbourne, and the districts at the eastern end of the Otways.

Some detailed surveys, mainly from the school of Agriculture, University of Melbourne, have mapped soil types in relatively small areas. The largest are those around Wollert and Whittlesea, and Kooweerup.

Broad soil groups found within the area and their environmental relations are shown in Table 5 and Figure 4. In the eastern mountains, a climatic sequence is linked with elevation, ranging from organic loams and peats in alpine areas above approximately 1,370 m through brown friable gradational and yellowish gradational soils to acidic duplex soils on the warmer lower slopes. The sub-humid plains and hills have less climatic variation but a greater variety of soils, related mainly to differences in parent materials.

Considerable differences occur within most of the soil groups listed, particularly with changing parent materials. For example, soils on basalt are usually relatively fertile, while those on granite rocks tend to have low water-holding capacities because of high proportions of coarse sand in the A horizons.

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Table 5

SOIL GROUPS AND THEIR ENVIRONMENTS IN THE MELBOURNE AREA

Profile form	Soil group	Synonyms and included soil types	Geology	Topography	Climate	Native vegetation formation
ORGANIC	Peats		Variable	Swales on high plains	Alpine	Bog
UNIFORM uniform texture throughout	Organic loams	Alpine humus soils	Variable	Upper slopes of mountains above 1,370 m elevation	Alpine	Grassland Herbfield Woodland
	Leached sands	Sandy podzols Nomopodzols Cranbourne sand	Marine, fluviatile sands	Plains near coast	Sub-humid	Heath, woodland
	Calcareous sands		Young marine sands	Dunes	Sub-humid	Scrub, grassland
	Grey clays	Grey soils of heavy texture Grenville clay	Mainly basalt, some lacustrine clays	Plains	Sub-humid	Grassland
	Black clays	Chernozems Mooleric clay Prairie soils Eumemmering clay Dalmore clay Kooweerup peaty clay	Basalt Alluvium mainly from basalt	Plains	Sub-humid	Grassland Woodland Scrub

Table 5 (continued)

GRADATIONAL gradual increase in clay with depth	Shallow gradational soils on basalt	Lithosols Chocolate soils Corangamite stony loam	Basalt	Stony rises and dissected slopes	Sub-humid	Grassland, woodland
	Yellowish gradational soils	Leptopodzols	Palaeozoic sediments and granitic rocks	Lower slopes of mountains	Humid	Forest
	Shallow stony soils	Lithosols	Palaeozoic sediments and granitic rocks	Upper slopes of hills	Humid	Forest
	Friable brownish gradational soils	Brown mountain soils Acid brown earths Cryptopodzols	Mainly Palaeozoic sediments and acid igneous rocks	Moderate elevations in mountains	Humid	Forest
	Friable reddish gradational soils	Krasnozems	Mainly basalt	Mountains, hills	Humid	Forest
DUPLEX sharp increase in clay at depth	Acidic duplex soils	Podzolic soils	Mainly Palaeozoic sediments and granitic rocks	Lower slopes of mountains, hills	Humid	Forest
	Sodic duplex soils	Podozolic soils Solodic soils Hallam loam	Variable	Hills, plains	Sub-humid	Open forest Woodland.
	Reddish calcareous duplex soils	Red-brown earths	Alluvium Residual on basalt	Plains	Sub-humid	Grassland, woodland

Soils of minor occurrence - for example terra rossas and rendzinas on limestone near Geelong, alluvial soils in many districts on deposits too young to show much profile development, and saline soils scattered along the coast, - have been omitted from this discussion.

Organic loam at Echo Flat, Lake Mountain.

Peats

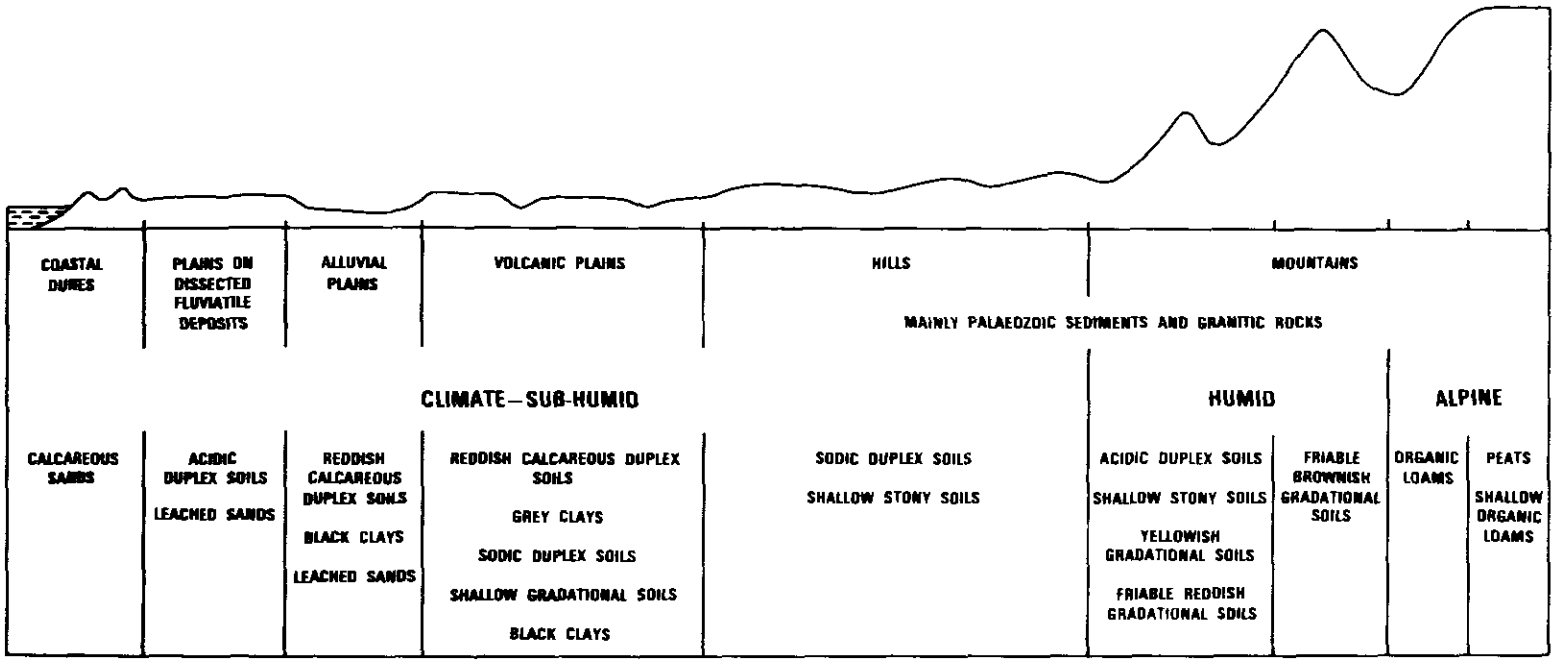
The wetter parts of depressions in the eastern alpine and subalpine areas contain peats, consisting of variably decomposed plant remains, dark and greasy when wet and friable when dry. Profiles vary in depth on these acidic soils, which have organic carbon values as high as 45%. They occur in bogs dominated by sphagnum moss, shrubs, and herbs, and their ability to absorb large quantities of moisture and to release it gradually, sponge-like, is invaluable where the high plains are used to supply water.

Organic loams

These loams dominate the moist but well-drained slopes of the eastern mountains above approximately 1,370 m where precipitation exceeds 1,500 mm per annum and where there is persistent winter snow. The dark-brown or black well-structured loam of the upper 40 cm or so merges gradually with depth into yellowish brown weathered rock. Reaction is acidic, and there is no significant eluviation of clay or iron.

Associated vegetative communities are grasslands, tussock herbfields in which snow grass and snow daisy are prominent, or shrublands and woodlands dominated by snow gum. The soils have moderate water-holding capacities and are permeable - characteristics suited to their main use of supplying large volumes of high-quality water.

FIG.4 SOIL–LANDSCAPE RELATIONSHIPS IN THE MELBOURNE STUDY AREA



Leached sands

These occur on sandy fluviatile and aeolian deposits along most parts of the coast, extending inland in places for several miles, as at Cranbourne. Beneath the dark surfaces the sands are pale and deep with low water-holding capacities. The B horizons of iron oxide and organic matter accumulation are variably hardened into "coffee-rock", which causes impeded drainage when well developed. The sands are acidic and of low fertility, lacking several major nutrients as well as trace elements such as copper. The native vegetation is most commonly heath or heath woodlands.

Calcareous sands

Dunes along most of the beach-front carry siliceous sands with abundant shell fragments. Little profile development has occurred, apart from accumulation of organic matter when the dunes are stabilized by coast tea-tree. The seaward slopes of the foredunes are bare or variably stabilized by species such as marram grass and hairy spinifex. Fertility is low, with deficiencies of several major nutrients as well as elements such as copper, zinc, and cobalt.

Grey clays

These are found on almost level plains overlying basalt to the north of Melbourne and to the west of Bacchus Marsh. Profiles are generally deep, with marked cracks, coarse pedality, and abundant lime in the subsoils. They contain adequate nutrients, apart from phosphorus, but moisture availability appears to be low, probably because of low permeability, restricted root penetration in the dense subsoils, and evaporation from deep cracks.

Acidic grey clays are less common and confined to swampy land in districts such as those near Kooweerup and Trafalgar. Here potash and lime are often applied in addition to superphosphate.

Black clays

Occurring mainly on basalt, and usually on alluvium therefrom, these clays usually have grey, calcareous, and slowly permeable subsoils, leading to problems with waterlogging. Structure is strong, but coarse at depth and cracking is marked. Fertility is high, but physical features are limiting.

Occasional swampy land draining non-basaltic country has black clay soils that originally carried scrubby species such as swamp paperbark. These soils are usually weakly acidic, coarsely structured at depth, and poor agriculturally even when drained. Striking exceptions occur in the intensively cropped Kooweerup district where the A horizons are relatively high in organic matter.

Shallow gradational soils on basalt

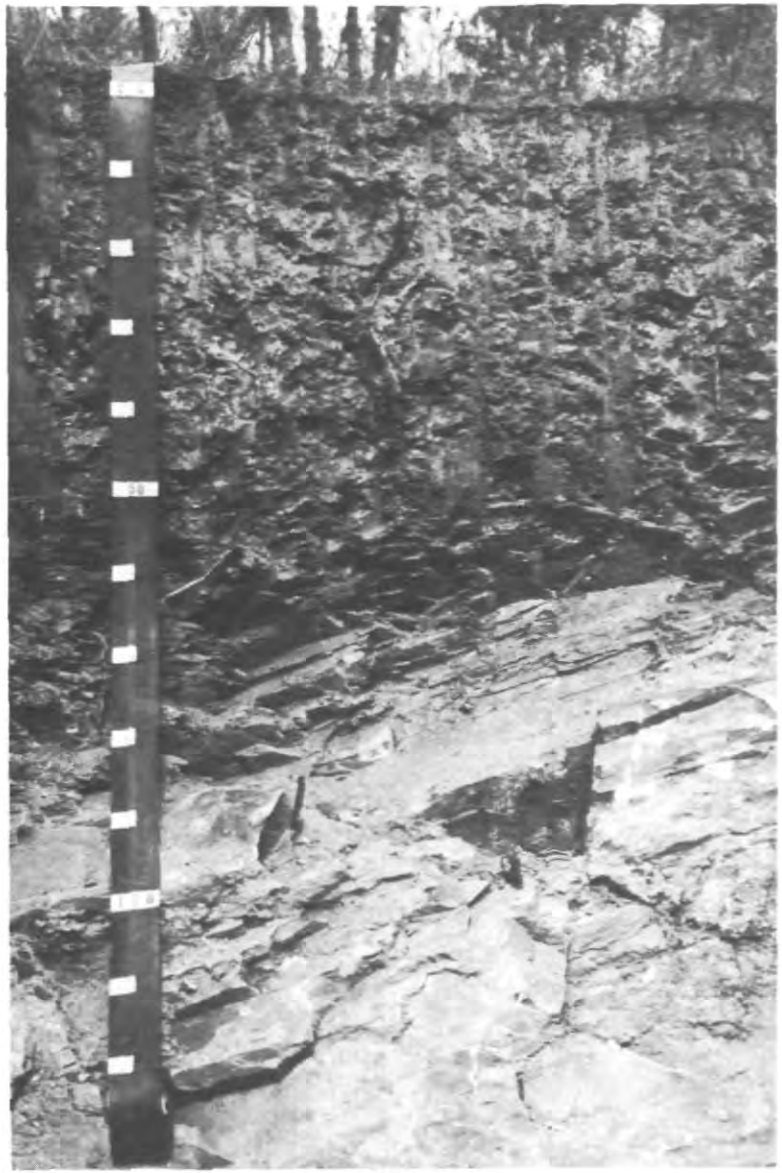
The colour of these soils varies from red on the upper slopes through brown to black on the lower sites, apparently depending on moistness of the site. Loams and clay loams occur on stony rises and dissected scarps, interspersed with outcropping stone. The deeper pockets have subsoils of clay texture but remain moderately acidic, weakly structured, and earthy. Water-holding capacities vary with soil depth, but on the average are low. Natural fertility is high, and the native vegetation appears to have been mainly grasslands and savannahs.

Yellowish gradational soils

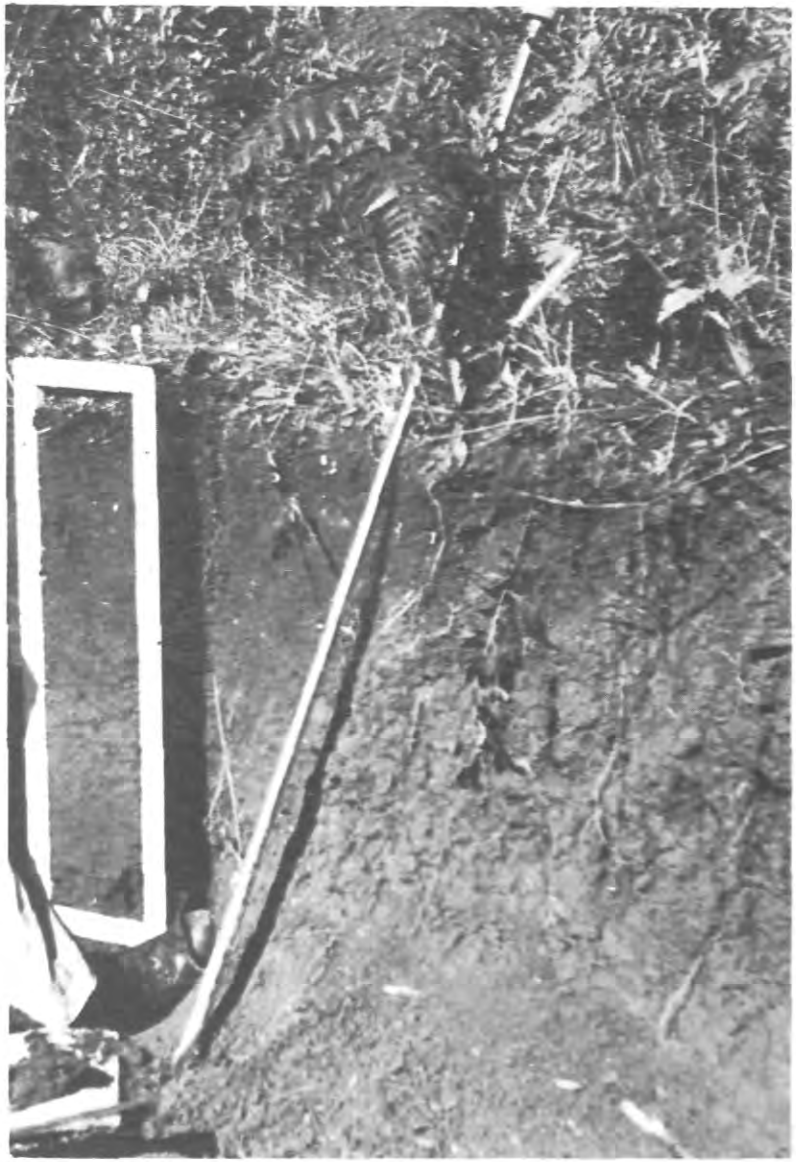
These occur on sedimentary and igneous rocks at lower elevations in mountainous country. From generally sandy surfaces, the texture increases gradually with depth to medium clay. Profiles are frequently deeper than 60 cm. Structure is poor, but permeability and water-holding capacity are moderate. Reaction is acidic and the natural fertility low.

Shallow stony soils

These are found in erosive situations in hilly country, and are frequently termed "Lithosols". Profiles are usually stony, with loamy surfaces and light clay subsoils. They are frequently less than 30 cm in depth. Structure is weak, permeability high, and water-holding capacity low. They have an



Shallow stony soil on Palaeozoic sediments, Puckapunyal.



Friable reddish gradational soil on older basalt, Monbulk.

acidic reaction throughout and low natural fertility.

Friable brown gradational soils

These occupy most of the forested steep country in the eastern mountains above approximately 600 m elevation, with annual rainfalls of 1,250 mm or more and with occasional winter snow. The upper 10-20 cm of dark organic loams overlie brown, yellowish brown, or reddish brown horizons of slightly heavier texture, extending to depths of 100 cm or more. The reaction is acidic and the low reserves of nutrients are concentrated near the surface.

Although weakly-structured at depth, profiles are friable and porous. Water-holding capacities are high and thus the soils have favourable characteristics for the supply of water.

Friable brown gradational soils also predominate on the upper slopes of the Strzelecki and Otway Ranges composed of Mesozoic felspathic sandstones. Here the fertility is somewhat higher.

Friable reddish gradational soils

Apparently relics of ancient soils, these are found in the humid hills and mountains. Although formed on a variety of rocks, they are most widespread on basalt in districts such as those around Trentham, Silvan, Warragul, Thorpdale, and Mirboo. These areas support intens-

ive cultivation and grazing because the soils have excellent physical characteristics, being deep, finely-structured, friable, and permeable. The reaction is acidic and the natural fertility moderate to low, so heavy applications of nutrients are required under intensive use.

Acidic duplex soils

The lower slopes of the eastern mountains carry acidic duplex soils, frequently associated with shallow stony soils on the steeper slopes. The loamy A horizons are weakly-structured and give way abruptly to reddish, moderately pedal clays of moderate to low permeability. Bedrock usually occurs at depths greater than 1 m. The profile is acid throughout, although the subsoils appear to become less acid with declining rainfall. Natural fertility is moderate to low, but the water-holding capacity is high.

Minor areas occur on Tertiary gravelly deposits near the coast, particularly to the south-east of Melbourne and on the Bellarine Peninsula. Profiles are deep with mottled yellow-red-grey subsoils, and frequently contain fragments of ironstone derived from ancient lateritization of the parent materials.

Sodic duplex soils

These predominate on a variety of rocks in the drier, western half of the area.

Acidic duplex soil on Palaeozoic sediments, Christmas Hills.

poorly structured with a pronounced A_2 horizon, which is seasonally waterlogged and usually contains ironstone nodules.

The clay B horizons are moderately structured but slowly permeable, neutral to alkaline, mottled red-yellow-grey, and have relatively high proportions of sodium and magnesium in the exchange complex. Considerable local variation can occur in the thickness, colour, and structure of the B horizons, probably related to differences in age of erosional surfaces.

In hilly country these soils are particularly susceptible to deterioration, suffering from sheet, gully, and tunnel erosion as well as from salting in low sites. However, the response to pasture improvement is good following heavy dressings of superphosphate together with lime and molybdenum for clover establishment.

Reddish calcareous duplex soils

Such soils are found on alluvium derived from a variety of rocks and as residual soils on basalt where the average annual rainfall is less than approximately 500 mm. The loamy acidic A horizons, usually thin, give way abruptly to red, moderately pedal but hard clay B horizons of moderate to low permeability. Lime occurs in the B-C horizons, usually in small amounts.

Notable occurrences on alluvium occur around Werribee, Melton, and Seymour. The residual profiles predominate on gently undulating basaltic land to the west of Melbourne. Physical and chemical characteristics are moderate, although the surfaces tend to set hard under cultivation.

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VEGETATION

The natural vegetation of an area is determined largely by the physical factors of the site - soils and their parent materials, topography, and climate. The preceding chapters have described these factors and noted the very wide variation of each within the study area.

It is not surprising therefore to find that the vegetation varies correspondingly, and that - excepting those xeromorphic alliances on Mallee sandhills or inland saltpans, the Grampians complex, and the remnants of subtropical rain-forest ("jungles") in East Gippsland - practically all the structural forms and major ecosystems of Victoria occur somewhere in this study area. Of the 62 major vegetation alliances tabulated for Victoria by Frankenburg, examples of no less than 41 - or two-thirds - appear within the Melbourne area, mostly on public land.

The following numbers of indigenous plant species, which have been reliably recorded and are currently accepted, fall in these major categories:

Flowering plants	-	1,260	(52.7% of Victorian vascular plants)
Ferns and club-mosses	-	73	
Mosses	-	180	
Hepatics	-	95	
Larger fungi	-	560	(at least)

In addition, there are several hundred species of lichens and algae, but time has not permitted any accurate assessment of these groups. The figure for flowering species (1,260) is exceeded only in East Gippsland, which has slightly higher mountains (to 1,830 m at the Cobberas) and includes more than 200 species with subtropical affinities - chiefly found in jungle tracts - that do not extend to any other parts of the State. Flowering plants of the Melbourne area include 90 indigenous grasses, 90 sedges, 131 orchids, 32 wattles, 20 bush-peas, 42 eucalypts, and 21 daisy-bushes.

The Melbourne study area is important strategically as a meeting place for plant species from east and west. No less than 184 vascular species (including 9 ferns, 26 grasses and sedges, 14 orchids, 7 wattles, and 15 eucalypts) range no farther west in the Australian continent. These consist chiefly of alpine plants (from the Baw Baws etc.), members of taller mountain forest communities, or stragglers that are more

typical of East Gippsland and the subtropical coastal areas beyond.

On the other hand, at least 110 species (including 16 grasses and sedges, 7 orchids, and 1 eucalypt) enter the area from the west but do not extend any farther eastwards. They comprise members of grassland and savannah formations on the basaltic plains near Bacchus Marsh, and Grampians-type heaths of the Brisbane Ranges and Anglesea hills.

The flora of the study area includes about 500 species of alien vascular plants that have been introduced into Victoria over the past 200 years. These species are not discussed in this report except where they are of special importance on public land. Such exceptions include softwood plantations and noxious weeds, which are discussed in chapters 15 and 11 respectively.

Importance of Vegetation

Natural vegetation is particularly important when considering possible uses of land. It integrates and quite sensitively reflects subtle changes in environmental factors. Because of this, and because it can be readily seen and mapped in the field or from aerial photos, it provides a very convenient way for assessing site factors that by themselves would be hard to measure directly. Moreover, the vegetation itself often provides for many of Man's needs (such as timber and recreation), protects other values such as soil stability and water quality and yield, provides habitats for animals, and constitutes a major part of what we regard as scenery, naturalness, or wilderness.

For these reasons frequent reference is made to vegetation in the chapter on fauna and in those discussing the capability of land for various uses.

Classification

Because of its diversity, only a broad description of the vegetation can be presented in this chapter. More detail - especially on the floristics of the vegetation - appears in the block descriptions. As in previous reports, the vegetation has been classified into a number of structural forms, based on the height and form of the tallest stratum and on the percentage of projective foliage cover. These are presented in Table 6 and their distribution on public land is shown on Map 6.

The classification is based on that developed by Specht, but has been modified to better suit the vegetation of the study area and the data already available. Within the structural framework, the vegetation has been grouped according to commonly occurring combinations of species. These have been chosen subjectively and have been termed vegetation units. They are not based on detailed study of species relations, but

are readily recognizable in the field and each unit reflects the operation of a certain set of environmental factors.

Sub-alpine complex of woodland, heath, and herbfield on the Baw Baw plateau.

The units follow closely the major alliances detailed by Frankenberg. Complexes have been mapped where several distinct structural classes form a mosaic over large areas.

Sub-alpine complex

This vegetation type is confined to exposed situations on the remnants of the Baw Baw surface at elevations above 1,000 m (see Map 4 - Physiography). It occurs most extensively on the Baw Baw plateau and at Lake Mountain, where the full range of structural forms included in the complex is encountered. The other occurrences - at Mounts Useful, Torbreck, Bullfight, Donna Buang, and Macedon - comprise almost entirely woodland:open forest of snow gum. In all cases rainfall exceeds 1,200 mm annually, with regular and usually persistent winter snow. Mild summers, cold winters, and strong winds characterize the climate.

Differences in exposure, aspect, drainage, and soils give rise to marked changes in structure over short distances. Sedge-fields (sphagnum bogs) occur on peat in waterlogged depressions. These usually form a mosaic with a bog heath dominated by candle heath and silver astelia. Grassland and herbfields are found on organic loams that are better drained, often on sites where cold-air drainage is a feature of the microclimate. Heath, often including alpine phebalium and alpine mintbush, is

Table 6 **VEGETATION UNITS**

Structural form	Major species of tallest stratum	Associated tree species	Form and common species of lower strata
SUB-ALPINE COMPLEX: Open-forest I - Woodland	*White sallee.*	*Mountain gum, Ash mallee, Black sallee, Tingaringy gum.*	*Grass, low shrubs or heath; Tussock grass, Mountain cotula, Sub-alpine beard-heath, Alpine wattle.*
SUB-ALPINE COMPLEX: Heath	*Alpine mint-bush. Alpine phebalium.*		*Alpine pepper, Baw-Baw berry, Alpine oxylobium, Mueller's bush-pea, Leafy bossiaea.*
SUB-ALPINE COMPLEX: Heath	*Candle heath, Alpine heath, Silver astelia.*		*Snow heath, Mountain baeckea, Alpine baeckea.*
SUB-ALPINE COMPLEX: Herbfield Grassland	*Tussock grass, Snow daisy. Alpine wallaby-grass.*		*Grass trigger-plant, Glacial eye bright, Mountain gentian.*
SUB-ALPINE COMPLEX: Sedgefield	*Sphagnum, Spreading rope-rush, sedges.*		
OPEN FOREST IV Taller than 40 metres	*Alpine ash.*	*Shining gum.*	*Ferns, sparse to dense shrubs, scattered small trees; Mountain hickory wattle, Elderberry panax, Hop bitter pea, Tussock grass, Derwent speedwell, Mother shield-fern.*
OPEN FOREST IV Taller than 40 metres	*Mountain ash.*	*Shining gum, Manna gum, Mountain grey gum, Messmate stringybark.*	*Tree ferns, dense layers of shrubs and small trees; Musk daisy-bush, Blanket-leaf, Silver wattle, Mountain correa, Hazel pomaderris, Forest wiregrass.*
OPEN FOREST IV Taller than 40 metres	*(Closed forest in the wet gullies)*	*Myrtle beech, Blackwood, Sassafras.*	*Ferns and mosses*
OPEN FOREST IV (Unstocked)	*(Scrub and closed forest resulting from repeated fires)*	*Silver wattle, Blackwood, Mountain hickory wattle, Acacia frigescens.*	*Common cassinia, Hop goodenia, Austral bracken, Forest wiregrass, Hop bitter-pea.*
OPEN FOREST IV (Regrowth)	*as for mature*		
OPEN FOREST III 28-40 metres	*Messmate stringybark*	*Narrow-leaf peppermint, Mountain grey gum, Manna gum, Eurabbie.*	*Varies with micro environment and fire history, generally dense tall shrubs; Narrow-leaf wattle, Hop goodenia, Prickly bush-pea, Red-fruited saw-sedge Prickly moses, Hairpin banksia, Forest wiregrass.*
OPEN FOREST III 28-40 metres	*Narrow-leaf peppermint*	*Candlebark, Manna gum*	
OPEN FOREST III 28-40 metres	*Silvertop*	*Messmate stringybark, Brown stringybark, White stringybark, Yertchuk.*	
OPEN FOREST II 15-28 metres	*Messmate stringybark*	*Narrow-leaf peppermint, Candlebark, Manna gum, Brown stringybark.*	*Generally low open shrubs; Narrow-leaf wattle, Prickly tea-tree, Juniper wattle, Narrow-leaf bitter-pea, Smooth parrot-pea, Purple coral-pea, Thatch saw-sedge, Tussock grass, Spear grass.*
OPEN FOREST II 15-28 metres	*Narrow-leaf peppermint*	*Candlebark, Broad-leaf peppermint.*	
OPEN FOREST II 15-28 metres	*Silvertop*	*White stringybark, Brown stringybark, Yertchuk.*	
OPEN FOREST II 15-28 metres	*Red stringybark*	*Narrow-leaf peppermint, Candlebark, Eurabbie, Messmate stringybark.*	
OPEN FOREST I less than 15 metres	*Red stringybark*	*Red box, Long-leaf box, Broad-leaf peppermint, Eurabbie.*	*Sparse ground cover of grasses and low shrubs; Tussock grass, Spreading flax-lily, Purple coral-pea, Showy guinea-flower, Silver wattle.*
OPEN FOREST I less than 15 metres	*Broad-leaf peppermint*	*Scent bark, Red box, Candlebark, Long-leaf box.*	*Sparse ground cover of grasses and low shrubs; Small grass-tree, Mountain grevillea, Gorse bitter-pea, Common correa, Bushy needlewood.*
OPEN FOREST I less than 15 metres	*Red ironbark*	*Red box, Yellow box*	*Sparse ground cover of grasses and low shrubs; Daphne heath, Kneed wallaby-grass, Spreading wattle, Austral grass-tree, Myrtle wattle.*
OPEN FOREST I less than 15 metres	*Messmate stringybark*	*Brown stringybark*	*Sparse ground cover of grasses and low shrubs; Tussock grass, Common heath, Small grass-tree, Heath tea-tree. Myrtle wattle.*
OPEN FOREST I less than 15 metres	*Manna gum*	*White sallee, Narrow leaf peppermint, Swamp gum*	*Sparse ground cover of grasses and low shrubs; Tussock grass, Kangaroo grass*

Table 6 VEGETATION UNITS (CONTINUED)

Structural form	Major species of tallest stratum	Associated tree species	Form and common species of lower strata
WOODLAND (Heath or scrub understorey)	*Shining peppermint*	*Messmate stringybark, Brown stringybark.*	*Low heath; Thatch saw-sedge, Dwarf she-oak, Horny cone-bush, Austral grass-tree, Sweet wattle, Heath tea-tree.*
	Messmate stringybark	*Narrow-leaf peppermint*	*Low heath; Prickly tea-tree, Scented paperbark, Showy bossiaea, Pink swamp heath, Scrub she-oak, Spreading rope-rush.*
	Silver-leaf stringybark	*Broad-leaf peppermint*	*Low heath; Thatch saw-sedge, Dwarf she-oak, Horny cone-bush, Austral grass tree, Sweet wattle, Heath tea-tree.*
	Broad-leaf peppermint	*Silver-leaf stringybark*	*Low heath; Thatch saw-sedge, Silver banksia, Heath tea-tree, Pouched coral-fern, Common heath, Furze hakea.*
	Manna gum	*Narrow-leaf peppermint*	*Dense shrubs; Prickly tea-tree, Scented paperbark, Burgan, Smooth parrot-pea, Pouched coral-fern, Common heath.*
WOODLAND (Grassy or open understorey)	*River red gum*		*Grassy; Kangaroo grass, Spear grass, Blushing bindweed, Pussy tails, wallaby-grasses, Black wattle.*
	Grey box	*Yellow box*	*Grassy; Golddust wattle, Varnish wattle, Tussock grass, Variable sword-sedge, guinea-flowers.*
	Red ironbark	*Long-leaf box, Red box, Red stringybark, Yellow gum*	*Open; Golden wattle, Spreading wattle, Goldfields grevillea, Drooping cassinia, Common bog-rush, Daphne heath.*
	Manna gum	*River red gum, Swamp gum*	*Grassy; Kangaroo grass, Spear grass, Erect guinea-flower, parrot-peas, sedges.*
	Yellow gum		*Grassy; Guinea-flowers, parrot-peas, sedges.*
DRY COAST COMPLEX Woodland	*Coast banksia, Drooping she-oak*		*Dense shrubs; Moonah, Wirilda, Coast tea-tree, Coast beard-heath, Sweet bursaria, Small-leaf clematis.*
Scrub	*Coast tea-tree, Coast banksia*		*Small-leaf clematis, Sweet bursaria, Knobby club-rush.*
Scrub	*Sallow wattle, Coast beard-heath*		*Coast everlasting, Seaberry saltbush, Common boobialla.*
Shrubland	*Cushion bush*		*White correa, Coast everlasting, Sea box, Coast twin-leaf, Climbing lignum.*
Grassland	*Coast fescue, Hairy spinifex, Marram grass*		*New Zealand spinach, Coast swainson-pea, Variable groundsel, Knobby club-rush, Sand-hill sword-sedge.*
WET COAST COMPLEX Scrub	*White mangrove*		
Scrub	*Swamp paperbark, Scented paperbark, Woolly tea-tree*		*Spreading rope-rush, Prickly tea-tree.*
Heath	*Scented paperbark, Prickly tea-tree.*		*Pink swamp heath, sedges, rushes.*
Shrubland	*Shrubby glasswort, Grey glasswort.*		*Beaded glasswort, Creeping brookweed, Salt couch, Austral seablite, Selliera, Sea rush.*
Herbfield-Grassland	*Rounded noon-flower, pigface. Prickly spear-grass, rushes.*		
PLANTATION (Softwood)	*Exotic conifers*		
PLANTATION (Hardwood)	*Various eucalypts*		
CLEARED LAND	*Pasture, cultivated, abandoned farm land, recreation grounds, public utilities.*		

characteristic of rocky areas or sites where snow does not persist for as long as elsewhere.

Snow gum (white sallee), the common eucalypt of sub-alpine areas, grows on less severe sites, usually on well-drained brownish gradational soils. It generally occurs as open forest I or woodland with a continuous ground cover of grasses, forbs, and shrubs, but on exposed sites (as at Mount Useful) it may form a dense mallee-type scrub.

Open forest IV

Open forests with heights exceeding 40 m are widely distributed over much of the Kinglake surface and the lower parts of the Baw Baw surface where rainfall exceeds 1,100 mm annually. Two eucalypt species, mountain ash and alpine ash, dominate these forests.

Alpine ash forests occur at elevations above about 950 m, and ascend to the sub-alpine zone. Major occurrences are on the Cerberean, Gregory, and Baw Baw plateaus. Summers are mild and winters cold with frequent light snows. Friable brownish gradational soils are characteristic. At higher elevations the forests often have a grassy understorey with sparse low shrubs, but on more favourable sites tall shrubs and ground ferns become prominent.

Mountain ash forests predominate below about 950 m and are widespread on the Kinglake, Black Range, Cerberean, and Acheron plateaus and extend to about 450 m on their sheltered southern

Mature stand of mountain ash open forest IV near Powelltown.

Closed forest of myrtle beech near Mount Donna Buang.

escarpments. Other occurrences are in the headwaters of the Yarra, Bunyip, Latrobe, and Thomson Rivers. Deep friable brownish gradational soils are typical, but at lower elevations on igneous parent materials reddish gradational soils may be found. The dense understorey consists of small trees, tall shrubs, tree ferns, and ground ferns.

Shining gum, either in pure stands or in mixture, occurs at the junction between the alpine ash and the mountain ash zones. At its lower elevations mountain ash may become mixed with mountain grey gum,messmate stringybark or manna gum.

A closed forest of myrtle beech, blackwood, and sassafras is widespread in the moister gullies, particularly those with southern aspects. The headwaters of the Ada, O'Shannassy, and Taggerty Rivers contain good examples.

In the Toolangi, Powelltown, and Toorongo localities, considerable areas of former mountain ash forest now carry a closed forest of various acacias or scrub in which common cassinia, hop bush, and bracken are frequent. This is the result of repeated wildfires. Such areas would have existed in pre-European times, but it is not likely that they would have been as extensive.

The open forest IV that formerly covered much of the Strzeleckis was cleared for agriculture late last century.

Open forest III

Open forests with top heights between 28 and 40 m are widely distributed in the foothill areas, generally below 900 m elevation where annual rainfall exceeds 1,100 mm. They are typically found on yellowish gradational soils and, in some areas (especially on igneous parent materials), occur on friable reddish gradational soils. Understorey varies with the micro-environment. In moist sheltered situations it may comprise tall dense shrubs similar to those in the mountain ash forests. On less favourable sites short shrubs may predominate. Ground cover is usually complete

and may consist of abundant litter with scattered grasses and herbs. Fire history is also a major factor in determining the structure and floristics of the understorey.

These forests are often known as "mixed species" forests because, in contrast to the pure stands of alpine and mountain ash at higher elevations, they may contain a number of eucalypt species on any one site. Differences in the fertility of the soil, in soil moisture availability, and sometimes in fire history are among the factors determining which species are present. Three broad groupings can be recognized.

Open Forest III of messmate stringybark and manna gum in the Wombat Forest.

Open forest III of narrow-leaf peppermint on the Royston Range.

Messmate stringybark forests are widespread in the area, usually on deep clayey soils. Although sometimes in pure stands, messmate is usually mixed with narrow-leaf peppermint and frequently with a gum species as well. This is often mountain grey gum in the north-eastern part of the study area, manna gum or candlebark in the western parts, and eurabbie on the granite parent material of the Strathbogie Plateau.

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Open forest II of red stringybark and narrow-leaf peppermint near Eildon.

Narrow-leaf peppermint forests, often mixed with candlebark or manna gum, tend to replace the messmate stringybark forests where available soil moisture is lower. They are also widespread in the study area.

Silvertop in pure stands or more often in mixture with white stringybark, yertchuk, brown stringybark, or messmate stringybark, is found south of the Divide, usually on sandy textured soils with well-drained clay subsoils. Its main occurrence is on the Nillumbik surface east of the Dandenong Ranges and in the valleys of the Yarra and Thomson Rivers at elevations up to 900 m.

Open forest II

Open forests with top heights between 15 and 28 m are typically found in the foothills below 600 m elevation in areas where the annual rainfall is between about 700 mm and 1,000 mm. They generally occur on yellowish gradational soils. Their species composition often resembles that of open forest III, but the forest is not as tall and the trees have poorer form and more open canopy. Ground cover is still complete, but tall shrubs are generally absent and tussock grass becomes more prominent.

Messmate stringybark seldom occurs in pure stands in this zone, but is mixed with narrow-leaf peppermint and candlebark. Brown stringybark is often present in the areas west of Melbourne.

Narrow-leaf peppermint, mixed with candlebark and sometimes broad-leaf peppermint, grows on the drier sites. Red stringybark and narrow-leaf peppermint occupy drier sites north of the Divide.

Silvertop, in mixture with yertchuk, brown stringybark, white stringybark, and messmate stringybark, is found on

parts of the Nillumbik surface and Tertiary sedimentary plains east of the Dandenong Ranges.

Open forest I

Open forests with top heights of less than 15 m occur on sites where soil moisture availability is low. They are thus found on shallow stony soils in the steep hill country of the north-east, particularly in the relatively dry area of the Thomson and Big River valleys, and on sodic duplex soils to the north and west of Melbourne where rainfall is less than 700 mm annually. Various eucalypts, often in mixture, form the tallest stratum in these forests. Vegetative ground cover is often discontinuous and soil protection largely depends on forest litter. On poor sites, open forest I grades into woodland.

At higher elevations, broad-leaf peppermint commonly predominates, often in mixture with narrow-leaf peppermint and candlebark. Red stringybark becomes prominent at elevations below about 600 m, forming mixtures with broad-leaf peppermint, long-leaf box, and red box on progressively drier sites. Yellow box may be found on the more fertile soils along the valley floors, generally at elevations below 400 m, while eurabbie frequently grows along the drainage lines north of the Divide.

Mixed forests in which red ironbark predominates occur at Aireys Inlet, the Brisbane Ranges, the Bacchus Marsh area, Christmas Hills, and north of the Divide at Broadford and Puckapunyal. These areas all lie below 400 m elevation and have annual rainfalls of less than 700 mm. Sodic duplex soils are characteristic. Frequent associates are red box, yellow box, and yellow gum.

Mixed forests of messmate stringybark and brown stringybark occur in the

Open forest I of red box and red stringybark in the Loddon block.

Heathy woodland of silver-leafed stringybark east of Gembrook.

Anglesea area while manna gum, often associated with narrow-leaf peppermint, is common in near-coastal areas such as the Mornington Peninsula.

Woodland with heath or scrub understorey

This type of vegetation occurs on a variety of soils at elevations up to 300 m with annual rainfalls as high as 1,100 mm. These soils share a very low fertility and often have an impeding horizon that leads to waterlogging in winter and drought in summer. Usually only one or two types of eucalypt are present, while the ground cover of dense heath or shrubs is often particularly rich in species. Various heaths and leguminous, proteaceous, and myrtaceous plants are common.

The dominant eucalypts for each of the main occurrences of heathy woodlands on leached sands are shining peppermint near Aireys Inlet, messmate stringybark and narrow-leaf peppermint at French Island, and manna gum (often with narrow-leaf peppermint) in coastal areas around Westernport. Those on yellowish gradational soils are mealy stringybark east of Gembrook and broad-leaf peppermint between Gembrook and Moe.

Drainage lines in this vegetation zone are frequently very swampy. Peat soils predominate and support a scrub or heath containing scented paper-bark, pink swamp-heath, spreading rope-rush, and pouched coral-fern.

Woodland with open or grassy understorey

Woodlands of this type are found at elevations below 300 m in areas with an annual rainfall of less than 600 mm. Much of this type of vegetation has been cleared for agriculture and only remnants remain in the study area. Even where the trees themselves remain,

Grassy woodland of river red gum. A remnant on private property near Bulla.

the natural grassy ground cover has usually been completely changed by the addition of fertilizers, the grazing of domestic animals, and invasion by exotic plants.

River red gum woodland occurs on grey loams, grey and black clays, and sodic duplex soils. It formerly grew along the flood plains of the Goulburn and lower Yarra Rivers and on the basalt plains. The only extensive example remaining in the study area is on private land north of Woodstock. Exotic grasses dominate the ground cover in this area.

Woodland of grey box and yellow box reaches its best development on the more fertile sodic duplex soils found on the lower slopes of broad valleys in the

Grassy woodland of grey box with some bull-oak. A remnant on private property south of Melton.

northern part of the study area. South of the Divide, this type occurs near Coimadai. A good remnant of the grey box woodland that grew on reddish calcareous duplex soils west of Melbourne can be seen on private property south of Melton.

Red ironbark woodland is found in the northern part of the study area, where it occurs on shallow sodic duplex soils. Other eucalypts are often associated with this type.

The best remnant of grassy woodland dominated by manna gum is found on leached sands near Inverleigh.

Remnants of yellow gum woodland occur at Studley Park, east of Toolern Vale, the You Yangs, and Bannockburn on duplex soils.

Dry coastal complex

This vegetation type occurs on leached sands and calcareous sands along much of the coast of the study area.

Grassy woodland of red ironbark near Heathcote.

Dry coast complex of scrub, shrubland and grassland at Point Nepean.

Well-marked zones characterized by particular structural forms and plant assemblages occur from the high-tide level inland. These zones result from changes in the degree of exposure to salt-laden winds and from changes in soil moisture conditions and soil salinity. Grassland is found on the most exposed situations, such as on the frontal dune. The secondary dunes often support scrub or shrubland depending on

exposure, while the sheltered interdune areas support scrub or woodland.

Wet coastal complex

This vegetation type occurs on dark saline soils at several low-lying points along the coast, notably at Westernport Bay, often with sharp zonal boundaries between structural forms and plant assemblages. Tide levels, the degree of soil salinity, and the degree of soil saturation are the main factors influencing zoning.

A typical sequence from low-tide level inland would be a scrub of white mangroves, shrubland of glassworts, herbfield including pigface, grassland including prickly spear-grass and rushes, and heath or scrub including paper-barks and tea-trees.

Other natural types

The only occurrence of whipstick mallee south of the Dividing Range is an area of about 800 ha near Melton. Here bull mallee grows on sodic duplex soils receiving about 600 mm of rain annually. Virtually all of it lies on private property.

An isolated remnant of the native grassland that formerly covered parts of the basalt plains remains on private property near Rockbank. It occurs on reddish calcareous duplex soils receiving about 500 mm of rain annually.

Softwood plantations

Chapter 15 gives details of the softwood plantations in the area.

Hardwood plantations

The largest hardwood plantation in the study area is at the You Yangs, where 700 ha have been planted with various species of eucalypts.

Approximately 65 ha at Childers and Allambie in South Gippsland have been planted with mountain ash. Within the montane parts of the study area, numerous small areas (totalling a few thousand hectares) have been reforested with ash-type eucalypts. These areas previously carried bracken and shrubs as a result of repeated wildfires in the past. The most notable ones are in the Mount Disappointment forest, near Powelltown and Toolangi, and on the Toorongo plateau. The Maroondah Highway east of Fernshaw passes through one such area of about 40 ha planted between 1940 and 1944.

Endemic and Endangered Species

The following 13 plant species are endemic in the area (the number of parenthesis following each species indicates the number of the block in which more detailed information is given): *Carex alsophila* (20), *Astelia australiana* (17), *Thelymitra murdochae* (23), *Microtis biloba* (22), *Microtis holmesii*

(22), *Caladenia pumila* (2), *Persoonia arborea* (20), *Grevillea repens* (4), *Grevillea steiglitziana* (2), *Tetratheca stenocarpa* (20), *Pultenaea weindorferi* (4), *Eucalyptus crenulata* (12), and *Choristemon humilis* (2).

Two other species probably now extinct have only been recorded within the Melbourne city area - *Diuris fastidiosa* at Tottenham and *Prasaephyllum colemanae* at Bayswater.

Five other species are almost confined to the study area: *Grevillea barklyana* (20, except for a very disjunct occurrence in New South Wales near Jervis Bay), *Acacia nanodealbata* (16, extending to the Otway region), *Wittsteinia vacciniaceae* (13, except for a small isolated occurrence near Mount Cobbler), and *Trochocarpa clarkei* (13, extending to Mounts Buller, Skene, Wellington, and Kent and the Snowy Plains). *Wittsteinia* is of particular interest as it is a monotypic genus occupying a distinct sub-family, Wittsteinioideae, in the Erica family.

The 34 plants listed in Appendix 2c are endangered species known to occur in the study area.

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FAUNA

Animal distribution reflects both the physical and biological nature of the environment as well as the biological characteristics of the organisms themselves. Topography, light, soil, moisture and chemical contents in the soil, and temperature extremes all profoundly influence the distribution of any animal species. However, most of these physical factors are integrated and reflected by plants. Plants also provide food, shelter, and breeding sites for animals.

Chapter 9 presented a classification of the vegetation in terms of structure, and variations in floristics within each structural class. The major vegetation types defined can also be utilized for analysing the distribution of animals. This is a necessary first step in determining those environmental circumstances, including trophic position and relations, allowing for the presence of any species of animal. It should be recognized that this type of habitat classification has shortcomings, but based on present data it is considered to be the best available approach. This chapter also deals with a few habitats, for example, oceans, urban, etc., that have not been described in terms of vegetation.

An introductory section on habitats precedes brief discussions of the distribution of major faunal groups within the study area, which emphasize characteristic species occurring in each habitat and the niches they fill. The endemic species and certain other species of significance are discussed at the end of the chapter.

The north-eastern portion of the Melbourne study area extends to the edge of the mountainous area of eastern mainland Australia. A lower, less rugged, and relatively drier environment occurs in the west and north-west portions. Along its southern boundary are Westernport and Port Phillip Bays, Bass Strait, and various off-shore islands. The occurrence of these diverse areas within the Melbourne region results in the presence of a large variety of animals. More than 20 amphibian, 40 reptile, 50 mammal, and nearly 300 bird species have been recorded as occurring in the Melbourne study area. Full lists of these species and the habitats in which they are most likely to be seen are given in Appendix 3. The report does not include a detailed assessment of all fish and invertebrate species occurring within the study area.

Habitats

In general, vegetation formations form the basis for the following attempt to indicate general relations existing between particular habitats and their associated fauna. The habitats selected are, for the most part, similar to those described in detail in chapter 9 and are as follows:

General forest habitat
- (Wet open forest
- (Dry open forest
- (Grassy woodland
- (Heathy woodland
- (Sub-alpine complex
- Dry coast complex
- Natural grassland
- Agricultural land
- Wetland
- Littoral habitat
- Ocean and bay
- Urban

General forest habitat: Open forest and woodland cover most of the public land in the study area and support a diverse fauna. Many of the animal species are widely distributed and have no known affinity for particular types of forest. Other species with a known affinity for a particular forest type are discussed under the relevant habitat.

Most forest-inhabiting species use specific niches within the forest structure for breeding and feeding purposes. Many individual species are closely associated with specific plant layers within the forest community.

Wet open forest: Open forests IV and III can be conveniently grouped as one broad habitat type for animals. The tall trees, often-dense shrub layers, and frequently occurring moist ferny gullies provide a variety of niches, resulting in a relatively diverse fauna.

Dry open forest: Open forests I and II can be conveniently grouped as a drier type of forest habitat for animals, characterized by shorter trees, a lower and more open understorey, and a decreased litter layer. On poor sites it often approaches woodland.

Grassy woodland: The grassy woodlands of the study area support a particularly rich fauna because they contain a wide range of microhabitats. Trees and patches of undergrowth are interspersed with open grassy areas; the climate is warm; and a good supply of food is available for most of the year.

Heathy woodland: This habitat type does not support a large variety of animals, however some of the species that it does support are adapted to the particular conditions occurring there and are not found elsewhere. Its important features are the dense low ground cover and the frequent occurrence of low-lying swampy areas, especially during the winter months.

Sub-alpine complex: Although it is not a favourable habitat for most animals becasue of the relatively harsh climate, a number of species use the area as feeding and breeding grounds during the summer months.

Dry coast complex: This habitat type contains a diversity of plant communities that form a mosaic pattern along the coastal hinterlands.

Natural grassland: Prior to agricultural development, the natural grasslands to the west and north of Melbourne supported a characteristic fauna. Today, only relics of the original vegetation remain and consequently many of the endemic species are now locally extinct, or are surviving in low numbers in small parts of their once more-extensive range.

Agricultural land: Much of the land in the study area has been considerably modified to produce domestic crops and stock to meet Man's specific needs for food and fibre. Management usually involves the suppression of competition by other plants and animals. Many of the original species have been eliminated from these areas, but some (especially birds) have been able to adapt to the new habitat, which is usually of a woodland or grassland nature.

Remnants of the original vegetation along roads and watercourses form valuable connections between areas of uncleared land and provide corridors to allow movement of migratory and nomadic wildlife.

Wetlands: These land areas, which are seasonally or permanently inundated by fresh water, include swamps, reservoirs, lakes, and streams. A number of habitat zones can be defined and these are correlated with water quality, water levels, and the duration of inundation.

European settlers have considerably altered the wetland habitats in the area. On the one hand they have drained swamps for agricultural purposes or filled them for urban development. On the other, they have built many small dams, constructed large reservoirs, irrigated drylands, and established sewage farms.

Littoral habitat: This includes the coastal lands and waters that are subject to tidal influences. Coastal beaches, estuaries (including associated sandflats and mudflats), salt-marshes, and mangroves are all components of the littoral zone.

Fluctuating water levels and high rates of nutrient exchange make these areas highly productive of invertebrates, an important food for many fish and waterbirds. The shallow waters provide spawning and nursery grounds for many marine fish. Adjoining salt-marshes and mangrove areas are important for nutrient production and also provide nest sites for a number of birds.

Ocean and bay: This habitat type supports a number of diverse animal species. Future land use decisions in the Melbourne study area will be important in maintaining the viability of such large bodies of water as Port Phillip and Westernport Bays as well as the smaller shallow inlets and bays elsewhere along the coast.

Urban: The urban habitat represents those areas now intensively occupied by Man. Most mammals and brids in the larger urban areas are introduced species that have had a long history of association with Man. However, some native species still find refuge in the semi-natural surroundings of large city parks and suburban gardens.

Mammals

General forest habitat

Insectivorous bats of the sub-order Microchiroptera are common in the study area throughout all woodland and forest habitats. All small bats require secluded sites for roosting during daylight and most can be classified as either forest bats (which roost in hallow limbs of trees) or cave bats (which seek tunnels, caves, and mine shafts). The bent-winged bat lives in colonies located in aqueducts, mine shafts, and caves throughout the study area. The large-footed bat, another cave-roosting type, occurs rarely here. The forest bats of the area are Gould's wattled bat, chocolate wattled bat, little flat bat, yellow-bellied bat, white-striped bat, and lesser long-eared bat. The large herbivorous fruit bats of northern and eastern Australia are only sporadic visitors to southern Victoria.

Five species of possums are widely distributed in the forest areas. All are nocturnal and nest in hollows in trees. The brush-tailed possum feeds on leaves, buds, and fruit of various trees and shrubs. It spends most of its time in the taller vegetation. Ring-tailed possums have similar habits, but have a complex social system with several nests often being grouped closely together. Sugar gliders have an even more highly developed social system, with several family groups living in one nest. They feed on insects as well as the buds and blossoms of eucalypts and shrubs. The feather-tailed glider and eastern pigmy possum, although widespread, are rarely observed under natural conditions. They are insectivorous, but also feed on nectar.

The black wallaby is common wherever dense thickets provide shelter. It browses on low shrubs and grasses.

Two other common terrestrial species are the bush rat and the brown antechinus. Both are nocturnal. The bush rat is omnivorous, with invertebrates forming the major food during spring and summer, and fungi and fibrous plant material

during the winter. It nests in burrows or in hollows of trees or fallen logs. The brown antechinus feeds largely on arthropods inhabiting the litter on the forest floor. It nests in hollows of trees or fallen logs. The insectivorous echidna is also widespread throughout wooded areas.

Wet open forest

Leadbeaters possum, greater glider, and bobuck reach the western-most limit of their range in the wet forests of the study area. Leadbeaters possum is insectivorous. It is found in areas of thick understorey where old and dead eucalypts provide adequate nesting sites. The greater glider is a vegetarian. A combination of suitable food trees such as narrow-leaf peppermint and suitable nest sites, often located in messmate or gums, can result in large numbers of this species in relatively small areas. The bobuck, Victoria's largest possum, occurs in the same type of habitat as leadbeaters possum. It is a vegetarian and usually forages on the ground.

The koala.

Other characteristic species are the yellow-bellied glider (which is largely insectivorous), the long-nosed bandicoot (which inhabits areas with dense ground cover and eats mainly invertebrates), and the wombat (a powerful burrower, which feeds on roots and other vegetable matter).

The sambar deer, introduced into Victoria from Asia during the 1860s, is now firmly established in the wet forests of the ranges to the east of Melbourne.

Dry open forest

The characteristic mammals here are generally the wide-ranging forest species. The koala, an arboreal animal that feeds on the leaves of certain eucalypts, is re-establishing itself in this habitat following liberations by

the Fisheries and Wildlife Division. The tuan and yellow-footed antechinus have been recorded in this type of forest, particularly in areas north of the Divide, and the eastern grey kangaroo frequently appears.

Grassy woodland

Apart from the wide-ranging species (previously discussed under general forest habitat), the characteristic mammals of this habitat are the eastern grey kangaroo, the tuan, and the yellow-footed antechinus. The tuan is mainly nocturnal and feeds on insects and small vertebreates; it frequently uses hollows in trees as nest sites. The yellow-footed antechinus feeds mainly on invertebrates and usually nests under fallen timber.

Heathy woodland

The short-nosed bandicoot is common in heath woodland, especially where the soils are sandy, and lives mainly on invertebrates. The swamp rat lives in colonies and constructs elaborate runways through the dense undergrowth. Swainsons antechinus is another common mammal of this habitat. These three species also occur in areas of wet forest.

Koalas are plentiful in heathy woodland where manna gum is present. In the study area the southern potoroo occurs near Aireys Inlet and on French Island.

Sub-alpine complex

The sub-alpine areas contain a few of the general forest mammals. Further investigations may reveal the presence of the mountain pigmy possum. This species has been recorded in alpine areas to the north-east, but as yet not in the Melbourne study area. The broad-toothed rat has been recorded at Mount Baw Baw.

Dry coast complex

The arboreal ring-tailed possum occurs in most woodland habitats, and will build a nest in tree branches where no suitable hollow limbs are available. This characteristic enables it to colonize thin-stemmed scrub such as tea-tree, which occurs in the habitat.

Populations of the white-footed dunnart, a small insectivorous marsupial, are found on the Mornington Peninsula, and may also occur in other coastal areas.

The swamp antechinus, originally considered an endemic Tasmanian species, has now been found at several localities along the Victorian coast, including the Powlett River mouth and near Anglesea.

Natural grassland

The only typical grassland mammal still recorded in this habitat is the fat-tailed dunnart. This insectivorous species lives under rocks or in holes in

The Australian fur seal.

the ground. Fat stored in the tail enables the animal to survive lean periods. Gunns bandicoot formerly occurred in the area, but is now locally extinct.

Agricultural land

Most of the wild mammals in agricultural areas are introduced species. They include rabbits, hares, house mice, black rats, foxes, dogs, and cats. The native ring-tailed and brush-tailed possums and a few bat species are frequently found in areas where adequate tree cover remains. The fat-tailed dunnart still occurs in some of the drier grassland areas.

Wetland

The platypus is common in Victoria, but its crepuscular habits make observation difficult and give a false impression of its abundance. These animals require soft friable river-bank soils in which to dig burrows for shelter during the day and to lay eggs in the breeding season. They feed on aquatic invertebrates such as molluscs, worms, and yabbies, obtained by sifting through bottom sediments.

The eastern water rat is also very common through the streams and swamps in Victoria, from the estuaries and bays up to mountain streams, but is most common in the tepid sluggish waters of the inland rivers. The species causes trouble in some areas by digging into and eroding irrigation banks. Populations of water rats on Phillip and French Islands are associated with swampy habitats.

Ocean and bay

Four species of seals were formerly common in Bass Strait, with breeding colonies occurring on the off-shore islands. However, early in the 19th Century commercial sealing resulted in the loss of the southern elephant seal, the Australian sea lion, and the New Zealand fur seal. The Australian fur seal population was reduced to a very low level. Since then seal populations have gradually increased, although only

the Australian fur seal has become common, and a breeding colony of about 5,000 individuals is located on Seal Rocks off Phillip Island.

Today whales are infrequently encountered in Victorian waters. The southern right whale was common until whaling operations depleted its numbers in the early 19th Century. Observers have noted a gradual increase in the numbers of this species near New Zealand, and this could reflect a general increase of the populations in Australian seas.

Urban

Most common mammals occurring in this habitat are introduced. They include sewer and black rats, house mice, cats and dogs. The two native species still found in urban areas are ring-tailed and brush-tailed possums.

Birds

General forest habitat

A number of bird species are widespread in forested areas. The red wattle-bird, white-naped honeyeater, yellow-faced honeyeater, striated thronbill, and spotted pardalote feed among the crowns of the trees; the shrike-tit and white-throated tree-creeper feed in the branches and along trunks of trees; the grey fantail feeds in the air beneath the tree canopy; the brown thronbill feeds in crowns of the understorey; and the superb blue wren and white-browed scrub-wren feed in the shrubby ground cover.

Other species that frequent forest habitats include the boobook owl, yellow-tailed black cockatoo, crimson rosella, and laughing kookaburra, all of which nest in hollows in trees. The golden whistler, southern yellow robin,

The wedge-tail eagle.

Olive-backed oriole, a summer migrant from northern Australia.

grey shrike-thrush, Australian goshawk, white-eared honeyeater, eastern spinebill, common bronzewing, and Australian raven can also be considered general forest inhabitants. The blackbird is the only introduced species to have become well established in forest areas.

Wet open forest

Several birds that frequent the moist gullies of eastern Australia have the western limit of their range in the wet open forests of the study area. Among these, the terrestrial species superb lyrebird and pilot-bird nest close to the ground; the wonga pigeon feeds upon fallen fruits and seeds in the east of the study area, where it is reasonably common; and the red-browed tree-creeper forages in the upper trunk and branches of trees. Others include the rare sooty owl, the large-billed scrub-wren, the eastern whipbird, the satin bower-bird (which may be seen in small numbers at the western extremity of its range in the Otways), and three summer migrant species - the lewin honeyeater, black-faced flycatcher, and brush cuckoo.

Other species characteristic of these forests are the olive whistler, rufous fantail, pied currawong, Australian ground-thrush, crescent honeyeater, pink robin, rose robin, and common bronzewing.

Dry open forest

The more open understorey and tussock-grass ground cover of the drier forests provide ideal habitat for the spotted quail-thrush and buff-rumped thronbill, which both frequently utilize the grass tussocks for nesting. Other characteristic species are the grey currawong, which feeds on insects, fruits, and the eggs of other birds, the white-winged chough, which lives in family groups with a well-organized social structure, and the scarlet robin, which tends to move out of the forest to more open

areas at lower elevations over the winter months. The white-throated warbler is a summer migrant to this type of habitat in the north-east of the study area.

Grassy woodland

Grassy woodland areas carry a wide range of birds. The trees provide nectar, pollen, and insects for the fuscous, brown-headed, and yellow-tufted honeyeaters, the purple-crowned, musk, and little lorikeets, the striated pardalote, and the brown weebill. Orange-winged sittellas forage for insects on the trunks and branches of the trees, while the brown tree-creeper forages on the trunks and on fallen timber. Superb blue wrens, buff-rumped thornbills, and speckled warblers inhabit the low bushes and ground cover. The horsfield bronze cuckoo and the pallid cuckoo are common in the study area during the summer. Other common species are the eastern rosella, red-rumped parrot, jacky winter, rufous whistler, and Australian raven.

Heathy woodland

The southern emu-wren is only found in areas of wet heath, while the heath wren prefers drier heath areas. Heathland is also the usual habitat for the tawny-crowned honeyeater and the field wren. New Holland honeyeaters and eastern spinebills are also characteristic. Brown quail are frequently encountered in the wetter areas. The white-browed scrub-wren, superb blue wren, and brown thornbill are common in the dense understorey.

Sub-alpine complex

Some birds that occur in the grassland and open forest habitats are also found in sub-alpine areas. The common species are the Australian pipit, brown hawk, nankeen kestrel, black-faced cuckoo-shrike, grey shrike-thrush, and little raven. Pied currawongs are plentiful during the summer, but descend to lower areas in the winter. Large numbers of flame robins breed in the sub-alpine areas, but they also move to lower altitudes in winter.

Dry coast complex

The vegetation of the coastal complex provides ideal habitat for a number of honeyeaters, the common species being the white-eared, New Holland, and spiny-cheeked honeyeaters, eastern spinebill, red wattle-bird, and little wattle-bird. Small insectivorous species such as the grey fantail, superb blue wren, white-browed scrub-wren, and brown thornbill frequent the more scrubby areas, while the Australian ground-thrush and southern yellow robin prefer dense tea-tree thickets. The grey-breasted silvereye (which eats insects and fruits), the brush bronzewing (a seed-eater), and the predatory brown hawk are other common species here.

The habitat also provides the breeding ground for a number of sea birds. The best known is the little penguin, which breeds on off-shore islands along the eastern and southern coasts of Australia. Several large colonies are found on Phillip Island. The short-tailed shearwater, an intercontinental migrant, breeds on Bass Strait islands. Some 250,000 of these birds breed in colonies on Phillip Island with lesser numbers on French Island. Thousands of white-faced storm-petrels breed on Mud Island. These three species nest in burrows dug into the dunes.

The caspian tern, crested tern, and fairy tern breed in small numbers on isolated sandy and shelly beaches in the study area.

Natural grassland

Populations of several characteristic terrestrial birds of the grasslands have declined greatly. The plain wanderer is now an endangered species and the Australian bustard is locally extinct, while the little quail and southern stone curlew are seldom seen. Other species such as the Australian pipit, stubble quail, white-backed magpie, nankeen kestrel, and brown hawk continue to thrive.

Agricultural land

Many native bird species are common in agricultural areas. The Australian pipit (which nests on the ground), the yellow-rumped thornbill (which nests in small shrubs), the predatory nankeen kestrel and brown hawk, the white-backed magpie, and the little raven are all widespread. Stubble quail are found in areas of tall grass or crops, while the brown songlark is a migrant to the drier areas during summer. The barn owl and black-shouldered kite, both predators of insects and small vertebrates, vary greatly in numbers according to seasonal conditions. Other common species are the flame robin, an altitudinal migrant that descends to cleared agricultural land in winter, the spur-winged plover, and the galah. Among the introduced species the starling is very common, while the skylark and goldfinch are well established in coastal areas.

Wetland

The birds living in the wetlands of the Melbourne area are discussed according to the microhabitat they utilize for feeding. Birds that can dive after small fish and aquatic invertebrates utilize open waters deeper than 1 metre. These include the Australian pelican, little pied cormorant, little black cormorant, and little grebe. However, it should be noted that the very deep waters of lakes and dams are of little value to water-birds. Grey teal, black duck, chestnut teal, mountain duck, and black swan feed in the shallower waters, between 15 cm and 1 m deep, while the white-faced heron, white egret, yellow-

billed spoonbill, and pink-eared duck use the shallow margins. The black-fronted dotterel is common along gravelly stretches of streams.

Sheltered mud banks around wetlands provide resting areas for most waterbirds, and fringes of tall reeds and low scrublands provide nesting sites for some species. They also provide feeding grounds for dusky moorhen, coot, spotted crake, swamphen, reed warbler, and little grassbird. Seasonal wet meadows are feeding grounds for straw-necked ibis, white ibis, and black swans. In the west of the study area, swamps also support small numbers of brolga. Wetland predators are the swamp harrier, whistling eagle, and (rarely in the study area) white-breasted sea eagle.

Some swamps are important breeding areas: Rhyll Swamp contains spoonbill, ibis, and cormorant colonies. Two of the three known breeding colonies of pied cormorants in Victoria are located at Lake Borrie and at Somers. Reedy Lake supports large numbers of nesting spoonbills, ducks, and other waterbirds.

Littoral habitat

A number of wading birds have been recorded in the study area. Waders as a group are highly specialized, having adapted to feeding from shallow waters, mudflats, beaches, and under mangroves. Many are of international significance,

Straw-necked ibis at Lake Borrie

because they migrate from their summer breeding grounds in various parts of the northern hemisphere to feeding grounds along the coasts of the southern continents.

The commonest of the species visiting the study area are the eastern curlew, greenshank, sharp-tailed sandpiper, curlew sandpiper, red-necked stint, and bar-tailed godwit. Spur-winged plovers, silver gull, and dabbling ducks such as grey teal frequent areas of salt marsh.

These areas are also the habitat of the red-capped dotterel. The white-fronted chat, little grassbird, and field wren live in the glasswort and samphire shrublands.

Ocean and bay

The open waters of Bass Strait and Port Phillip and Westernport Bays provide the feeding grounds for large numbers of sea-birds. Common species are the black-browed albatross, Australian gannet, short-tailed shearwater, giant petrel, white-faced storm-petrel, little penguin, pied cormorant, pacific gull, and crested tern. Some of these birds breed in large colonies within the Melbourne area and the location of these nesting colonies is discussed under dry coast complex.

Urban

Introduced species dominate the avifauna of the urban areas. The starling, house sparrow, domestic pigeon, Indian turtle-dove, blackbird, goldfinch, and Indian mynah are all widespread and common, while the tree sparrow and song thrush have more restricted distributions. Several native species have adapted themselves to urban environments: the white-plumed honeyeater, red wattle-bird, eastern spinebill, superb blue wren, magpie lark, white-backed magpie, grey-breasted silvereye, and galah are common in suitable garden or open areas. The silver gull has become a very common scavenger in urban areas, and the little falcon and nankeen kestrel are occasionally found among tall city buildings.

Reptiles

General forest areas

The garden skink can be considered a general forest inhabitant. It forages in bark, twigs, and other litter in all areas except white sallee woodland, where temperatures become too low. Although heliothermic, it is small and only requires small areas of sunlight for temperature regulation.

Wet open forest

The high elevations, relatively low temperatures, and dense foliage cover contribute to this forest type being less suitable for reptiles than drier, more open types. Nevertheless 13 species have been recorded living in these tall forests. A species of special interest is Spencers skink, which occurs at elevations above 1,000 m in the study area. It is arboreal and especially common where dead trees extend beyond the scrub canopy, thus providing open basking sites. It can also be found on rock faces and logs.

Dry open forest

The distribution of the 28 reptile species recorded in the study area within this habitat is largely determined by

the presence of suitable microhabitats. Rocky outcrops are necessary to support Cunninghams skink, but are unsuitable for the delicate and garden skinks, which live among the litter on the forest floor. Variations in elevation also influence species distribution within this broad habitat type. For example, the black rock skink replaces Cunninghams skink in forests at higher elevations. Copperhead and brown snakes are common. The omnivorous tree goanna is found in this habitat near Healesville and in the Shady Creek block.

Grassy woodland

This habitat supports a greater variety of reptiles than any other in the study area. Characteristic species are the common bearded dragon, tree dragon (a largely arboreal species), common blue-tongue lizard, and striped skink. Cunninghams skink frequents boulder outcrops in granite country, such as the You Yangs. The brown snake is common and feeds on small mammals and lizards.

Heathy woodland

The mourning skink is confined to this type of habitat. It burrows under dense litter in waterlogged areas. Bougainvilles, weasel, and delicate skinks are more widespread, but are frequent in heath areas. They also are thigmothermic and to some degree fossorial. The metallic skink and tiger snake are common.

Sub-alpine complex

Only eight species of reptiles have been recorded here. Grass meadows are ideal for grass skinks and white-lipped snakes. Copperhead snakes and water and copperhead skinks are found in swampy areas, and Spencers skink in rocky ones.

Dry coast complex

The most widespread species are three-lined skinks, tree dragons, southern blue-tongue lizards, Whites skink, and white-lipped snake. Banksia and tea-tree scrub provide suitable habitats for the grass skink and common blue-tongue lizard.

Natural grassland

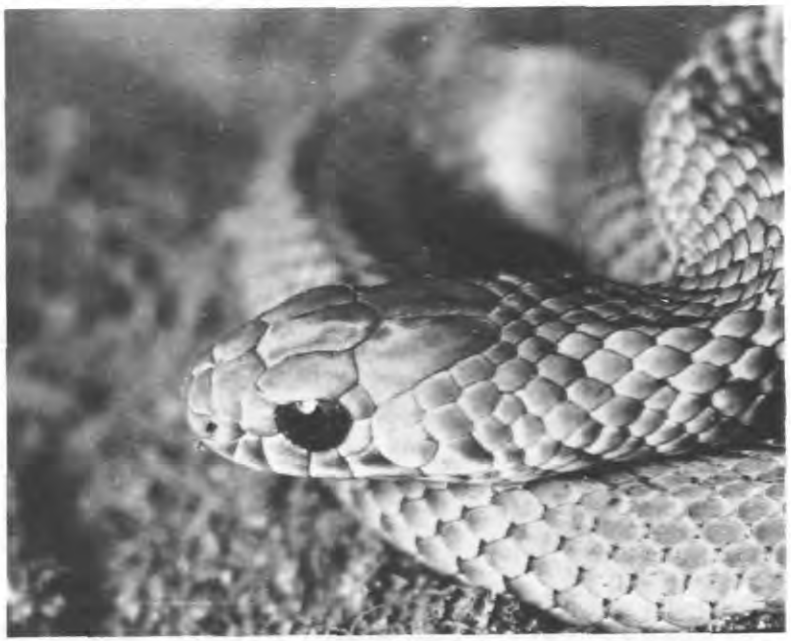
A number of reptiles are still widespread, often finding shelter under rock piles and fences. They include the spinifex lizard, white-lipped snake, little whip snake, brown snake, and several skinks. The earless dragon, a rare species in Victoria, still survives in this habitat.

Agricultural land

Reptiles generally are poorly represented in farmland, but large populations may occur in localized areas. On the basalt plains the ground cover of the farmlands resembles that of the original woodlands, and substantial reptile populations still persist.

Wetlands

The common snake-necked tortoise and Macquarie tortoise occur naturally in the Goulburn catchment in rivers, swamps, and billabongs. Pet-trading, especially with the snake-necked tortoise, has extended their ranges to include swamps and slow-moving fresh waters of the Melbourne metropolitan area. These species require sandy river banks for successful egg-laying. The mainland tiger snake, red-bellied black snake, and both the high- and low-elevation forms of the copperhead snake also live near streams and swamps within their respective ranges. They feed mainly on frogs. Eastern water dragons and both forms of the Golden water skink are usually associated with streams.



The copperhead snake, widespread except in the drier areas.

Urban

The urban environment is generally unsuitable for reptiles, the only common species being the garden and weasel skinks. Open areas of grassland and creeks do, however, support substantial populations.

Amphibians

The distribution of amphibians is greatly influenced by the presence or absence of free surface water or high humidity, which are necessary for survival and reproduction. The breeding habitat of most frogs is restricted to shallow waters and adjoining moist vegetation, although a few species reproduce in moist litter. Adult frogs can move away from water holes into other habitats, and Appendix 3d shows the various dryland types in which adult frogs have been recorded. However, the following discussion only considers frogs under sub-alpine, wetland, and agricultural land.

Sub-alpine complex

Four frog species have been found in the small streams, swamps, and sphagnum bogs of the sub-alpine plateaus. On of them, the Baw Baw frog *(Philoria*

frosti), is endemic to the Baw Baw Plateau. Another, *Litoria verreauxi alpina*, lives at high elevations and has been recorded at Mount Lookout and on the Baw Baw Plateau, while *Ranidella signifera* and *Geocrinia victoriana* are widespread and common throughout the area.

Wetlands

The brown froglet *(Ranidella singifera)*, Ewings tree frog *(Litoria ewingi)*, and *Geocrinia victoriana* are common amphibians occurring throughout the Melbourne area. The brown froglet is very common, particularly in shallow flooded situations. Ewings tree frog is frequently found on reeds and low vegetation around dams and streams. Other species occurring in all but the high-elevation wet forest areas are the bull frog *(Limnodynastes dumerili)*, which does not require permanent water, the spotted marsh frog *(L. tasmaniensis)*, which frequents shallow swampy areas, the green and gold frog *(Litoria aurea raniformis)*, frequently found along the grassy margins of streams and swamps, and Verreaux's tree-frog *(L. verreauxi verreauxi)*, which is often found on low vegetation fringing permanent water.

The southern toadlet *(Pseudophryne semimarmorata)* occurs in the low southern and central parts of the study area. During the breeding season it constructs small tunnels under the moist litter.

Crinia haswelli, *Heleioporus australiacus*, *Litoria citropa* *L. phyllochroa*, and *Pseudophryne dendyi* occur only in the east of the study area, which forms the south-western limit of their range.

Neobatrachus pictus, *Pseudophryne bibroni*, and *Ranidella parinsignifera* are only found in the northern or western parts of the study area.

Agricultural land

The construction of many farm dams has probably extended the distribution of frogs, which are opportunistic breeders.

The spotted marsh frog occurs in shallow swampy areas at lower elevations.

Fishes

Wetlands

Small fish inhabiting the streams of the area include galaxiids (Galaxiidae), smelt (Retropinnidae), gudgeons (Eleotridae), small lampreys (Petromyzonidae), the mosquito fish *(Gambusia affinis)*, and the fresh-water hardhead *(Craterocephalus fluviatilis)*. These provide forage for larger species and for water-birds. The dwarf minnow *(Brachygalaxias pusillus)* is known in only a few localities in Victoria, including the Mornington Peninsula in the study area. Middle reaches of streams that have sand, gravel, or rock bottoms support populations of river blackfish *(Gadopsis marmoratus)* and in some cases, Murray cod *(Maccullochella macquariensis)*, as well as introduced brown trout *(Salmo trutta)* and rainbow trout *(S. gairdneri)*. Eels (Anguillidae) carp *(Cyprinus* sp.*)*, English perch *(Perca fluviatilis)*, and brown trout inhabit the lower reaches, while the introduced roach *(Leuciscus rutilis)* and tench *(Tinca tinca)* are found in polluted waters such as the lower Yarra.

Ocean and bay

The commercial and amateur fisheries of Port Phillip and Westernport Bays are the largest in Victoria, and decisions affecting land use around the foreshores of these bays will have some effects upon this industry, as many of the fish that support the industry either spawn in the shallow waters of the littoral zone or obtain nutrients from the littoral zone and river discharges.

Important fishes occurring in Port Phillip and Westernport Bays include snapper *(Chrysophrys auratus)*, snook *(Australuzza novaehollandiae)*, pilchard *(Sardinops neopilchardus)*, Australian salmon *(Arripis trutta)*, garfish *(Hemirhamplus* sp.*)*, spotted whiting *(Sillaginodes punctatus)*, and flathead *(Leviprora laevigata)*.

Invertebrates

Invertebrates vastly outnumber the vertebrates in the study area both in species (in the ratio 95:5) and in individuals. They include worms, molluscs, and arthropods. Collectively they form a vital part of any ecosystem. Some provide food for higher animals, some are parasites (ticks and lice), some (bees, wasps, and flies) cross-pollinate plants, and others (termites, borers, and worms) consume vegetable matter. Those invertebrates at the decomposer level of the food chain play a basic role in maintaining energy flow within biological systems. The importance of this function alone suggests that basic knowledge of maintaining such populations is essential.

However, despite their importance, a report such as this can do little more than mention a few representative

species. Their small size and immense species diversity make them a difficult group to study. There has been considerable research on species that have direct economic importance, such as insects that damage crops or transmit disease. The following discussion refers to a few land planarians, molluscs, and arthropods. Pest species are discussed in chapter 11.

General forest habitat

Southern Victorian forests contain many representatives of endemic Australian insect fauna, in contrast to New South Wales and Queensland, where many species have general tropical affinities. Some of these endemic insects are archaic and localized; others are relatively widespread but produce local variants, for example ghost moths (Hepialidae).

Wet open forest

The tall trees, dense understoreys, and thick litter layers of these humid forests provide a wide range of microhabitats for insects and other invertebrates. Insect species representing at least 15 orders have been recorded in the mountain ash forests of Victoria. These include mainly Diptera and also many Coleoptera, Hymenoptera, and Hemiptera. Many of the species do not occur in the dry forest areas.

Among the more obvious species that inhabit the wet forests are butterflies of the brown family (Satyridae) and many rare blues (Lycaenidae). Mayflies (Ephemeroptera), caddisflies (Trichoptera), and stoneflies (Plecoptera) - representatives of the archaic indigenous insect fauna - are frequently found in this habitat, as they require the rapidly moving cool water of mountain streams.

Other common insects include stick insects (Phasmatidae), which can become forest pests, leaf beetles (Chrysomelidae), and sucking insects such as cicadas (Cicadidae) and scale insects (Coccidae).

The moist litter and fallen logs support a rich variety of cryptozoic fauna, including earthworms, the nemertine worm *(Geonemertes australis)*, a *Peripatus* species, and at least ten land planarians, in which the blue species predominate. One characteristic blue planarian of these forests, *Geoplana spenceri*, inhabits rotten logs and feeds on many of the small arthropods found in this microhabitat. There are large populations of terrestrial leeches and many land molluscs, such as the only native Victorian slug *Cystopelta purpurea* and the snails *Mulathers fordei* and *Victaphanta atramentaria*.

Dry open forest

This habitat may be regarded as generally the most prolific for insects. The less-dense upper storey of trees allows

Geoplana quinquelineata, a strinking yellow and brown planarian of the dry forests.

penetration of sunlight and heat, both of which the majority of adult insects require.

Moths and butterflies (Lepidoptera) - including cup moths (Limacodiadae), which can become forest pests - beetles (Coleoptera), termites (Isoptera), cockroaches (Blattodea), grasshoppers (Orthoptera), bugs (Hemiptera), flies (Diptera), and ants, bees, and wasps (Hymenoptera) - including sawflies (Pergidae), whose lava form conspicuous clusters - are all commonly encountered. Lack of free-flowing streams restricts aquatic insects.

There is generally a demarkation between butterfly species inhabiting wet and dry open forest areas. For instance, skippers (Hesperiidae) are more common in the drier forests, although some blues and browns may still be found.

Although dry, these forests support varied populations of some 14 species of land planarians in which yellow-brown species predominate. The yellow and brown striped planarian *Geoplana quinquelineata* is found exclusively in areas of low rainfall.

Grassy woodland

Although drier than the forest areas and less well endowed with vegetation, these areas contain large insect populations, but species diversity is reduced.

A number of plant feeders such as sucking bugs (including scale insects, some species of which induce the formation of galls), cicadas, tree-hoppers (Eurymelidae and related families), and grasshoppers are commonly encountered. Rocky outcrops and fallen timber harbour large colonies of ants (Formicidae), ground beetles (Carabidae), and cockroaches.

Heathy woodland

Most of the insects associated with heathlands are not specific to that

habitat, but are generally also found in adjacent habitats.

Crane flies (Tipulidae) are often encountered, their larvae inhabiting pools or damp soils that contain an abundance of decaying vegetable matter. Stagnant surface water produces many other Diptera such as March flies (Tabanidae), midges (Chironomidae), and mosquitoes (Culicidae). Ants and ant-lions (Myrmeleontidae) are found in the sandy soils.

Sub-alpine complex

This habitat generally merges with the upper levels of the wet open forest, but altitude and climate restrict the number of insects.

A number of alpine moths and butterflies - including case moths (Psychidae) - and many beetles - including jewel beetles (Buprestidae), long-horn beetles (Cerambycidae), and leaf beetles (Chrysomelidae) - are commonly encountered. Several of the Hymenoptera are found in this habitat, including a number of both solitary and gregarious bees, some of the former making their nests in the damp soil. Grasshoppers (Acrididae and Tettigoniidae) are often conspicuous.

Around streams and bogs, archaic groups such as mayflies, caddisflies, stoneflies, and dragon flies (Odonata) found.

Wetlands

Many invertebrates inhabit the wetlands of the area. Provided the water is not stagnant, but has either some flow or an abundant supply of aerating aquatic plants, insect populations can be extensive.

Mountain wetlands are prolific for the archaic fauna, including such groups as the stoneflies, caddisflies, mayflies, and dragonflies. Stagnant water attracts Diptera - mainly mosquitoes, gnats, and midges.

Crane flies are usually found resting on overhanging foliage in damp shady places.

Some bugs such as pond-skaters (Gerridae), water boatment (Corixidae), and back-swimmers (Notonectidae), and several beetles such as whirligig beetles (Gyrinidae) and water beetles (Dytiscidae) are associated with wetlands. Where both larval and adult forms live in the water, the adults have the ability to fly to other pools or swamps as the need arises.

Fresh-water limpets *(Pettancylus* sp.*)*, fresh-water snails *(Bulinus* sp. and *Potomopyrgus* sp.*)*, and the bivalves *Pisidium* sp. are common in most streams. The larger streams contain the fresh-water mussel *Velesunio ambiguus*.

At least seven species of land planarian, the most common of which is *Geoplana munda*, inhabit the banks of streams and dams.

Littoral habitat

The insects here are generally distinct from those of other wetlands. Their variety is limited in mangroves and salt-marshes, but the bordering estuarine areas contain more varied insects.

Estuarine fauna are well represented in Lake Connewarre and the mouth of the Barwon River. The littoral fringe and salt-marsh area along Swan Bay is one of the few in Port Phillip Bay where salt-marsh invertebrates such as the molluscs *Salinator* sp., *Ophicardelus* sp., and *Marinula* sp., are found. This shallow, very sheltered area is also important as a breeding ground for many marine species of invertebrates.

In the northern parts of Westernport Bay, a series of mollusc species demonstrates a clear zonation pattern with respect to tide height. Many of the molluscs - such as *Orphicardelus* sp., *Assiminea* sp., *Marinula* sp. - are unique to this environment.

Endemic and Endangered Species

The helmeted honeyeater *(Meliphaga cassidix)* and the Baw Baw frog *(Philoria frosti)* are the only vertebrates endemic in the study area.

This honeyeater is now known only in the Yellingbo area, where it inhabits manna gum, swamp gum, and tea-tree vegetation fringing three creeks. Its total population is thought to be less than 300. The frog is found along streams and in sphagnum areas on the Baw Baw Plateau.

There are a number of endemic invertebrate species. They include the snail *Victaphanta atramentaria* and the nemertine worm *Geonemertes australis*, which inhabit wet open forest to the east of Melbourne, the giant earthworm *Megascolides australis*, found only in an area of less than 25 sq km near Loch, and the bright yellow planarian *Artioposthia fletcheri*, recorded only in the Wombat Forest.

Endemic insects include the rare butterflies *Candalides goodingi* and *Hesperilla chaostola* found only in dry open forest north of Drouin-Moe, a genus of caddisflies named *Tanjilana* recorded in the Tanjil Bren area, a number of beetles that occur only in the Warburton- Donna Buang area, and the small ant blue butterfly *(Pseudodipsas myrmecophila)*, which lives in the nests of the ant *Iridomyrex nitidus* and is now known only in the Ocean Grove area.

Three relict mammal species known to occur in the area are endangered. The broad-toothed rat survives in isolated colonies in the Dandenongs, Baw Baws and Strzeleckis, and in other cold humid forest areas in south-eastern Australia. The New Holland mouse has only been found in heath woodland near the coast Tyabb, and at Loch Sport in Gippsland and a few locations in New South Wales. The smokey mouse, originally described from a find in wet open forest areas in the Otways, has more recently been recorded in the Grampians, East Gippsland, and the Upper Thomson River.

Endangered bird species recorded in the study area are the orange-bellied parrot, which visits salt-marsh and adjoining grassland from breeding grounds presumed to be on Bass Strait islands, and the plain wanderer, which is still occasionally observed in grassland areas of the Werribee and Torquay blocks.

The New Holland mouse, an endangered species found near Tyabb.

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PART III

LAND USE

10695/73—8

HAZARDS

Changes in ecosystems may occur as the result of normal geological processes. It appears that they have occurred relatively rapidly during short periods of instability and relatively slowly in the long intervening periods. European settlement came during such a period of slow change, when the Aborigines' activities formed part of a fine ecological balance. European Man has altered this balance, and many natural features have changed over most of the area.

Generally the hazards associated with these changes have been overcome, and a new balance has been reached in which the usefulness and productivity of the land for our purposes have greatly increased. However, in some localized areas an imbalance has been created, resulting in instability or loss of productivity.

Activities that would result in instability or a decline in productivity could be predicted if we had a complete understanding of the interrelations between the environmental variables. As we do not, we must rely to a large extent on past experience. Consequently the following discussion concentrates upon known hazards associated with various land uses in the study area.

Soil Deterioration

The soils of the area very greatly in the extent to which they can withstand disturbance by human activities such as cultivation, grazing, burning, extraction of timber, construction of roads, tracks, dams, and buildings, or trampling by people. Damage affects not only the productivity and aesthetic appeal of the land but also the quality and flow rates of water in streams, many of which are used for domestic, industrial, or irrigation purposes, and can lead to siltation of dams and reduction of their storage capacity.

The humid mountainous country with porous soils and dense vegetation is relatively resistant to deterioration, although landslips occur in places, particularly in the Strzelecki Ranges. Many of the sub-humid lands likewise have reasonable stability, particularly where the slopes are gentle as on the volcanic plains. Here the most significant form of deterioration is compaction of surfaces by intensive cultivation and graz-

Severe erosion along heavily used walking track in the You Yangs

ing, particularly on reddish calcareous duplex soils.

Water erosion is most widespread and salting is common in the sub-humid hilly country where annual rainfall averages less than about 760 mm. Two localized and specialized ecosystems, the sub-alpine grasslands and the coastal sand dunes, are particularly prone to wind erosion.

Water erosion

Sheeting, gullying, rilling, and tunnelling are most severe in the drier areas on Palaeozoic slates and sandstones, and on less common parent materials such as Tertiary fluviatile deposits and Permian tillites. Notably affected areas are found to the north of Melbourne, in the Brisbane Ranges, in the You Yangs, and in the Seymour-Alexandra districts. Sodic duplex soils predominate, with hard-setting surfaces and subsoils of low permeability and high dispersibility.

The various forms of erosion follow damage to the native eucalypt forests or their replacement by poor native pastures, leading to a hydrological imbalance.

The establishment of introduced clovers and grasses following treatment with superphosphate, lime, and molybdenum has achieved considerable success in prevention and reclamation. However, investigations are needed to gain a detailed knowledge of the processes involved and required treatments.

Gully erosion is also common in the sub-alpine areas, where it interferes with the rate of water delivery to streams. The run-off, formerly retained in bogs, rushes down shallow gullies once the vegetation and peaty soil have been destroyed by overgrazing or through trafficking of vehicles or people.

Wind erosion

Minor wind erosion occurs in many types of country, but the hazard is severe in sub-alpine areas and on coastal dunes, particularly when overgrazing or heavy traffic have damaged the vegetation.

In the sub-alpine areas the soils are highly organic, light, friable, and thus prone to wind erosion when the vegetation is disturbed. Sheeting during heavy rain and frost action, which loosens the soil particles, aggravate the process. Soils are frequently deflated until a stony pavement results. Infiltration and water-holding capacity decline, leading to concentration of run-off. Reclamation under alpine conditions is particularly difficult.

Erosion of coastal sand dunes follows destruction of grasses and shrubs, mainly through trafficking, but also from other causes such as grazing by stock and rabbits, fire, construction of buildings, roads, or pipelines, and mining for sand, lime, or beach materials.

The ecology of coastal dunes in Victoria and their conservation and stabilization have been discussed by Mitchell (1971), who stressed the need for zoning of uses according to situation, for example on primary, secondary, and tertiary dunes or on interdune corridors. Prevention of erosion and reclamation of dunes are limited less by the lack of techniques (such as the use of fences, brushwork,

Destruction of vegetation by trampling on a coastal dune

grasses, and shrubs) than by administrative and financial difficulties.

Salting

Loss of production through salting of soils is common in many parts of the study area receiving less than approximately 760 mm average annual rainfall. Deterioration is associated with seepage water accumulating beneath the lower, more productive sites. Saline surfaces develop in the form of saltpans, which are bare or variably covered by salt-indicator species. Apart from having direct adverse chemical and physical effects, salting reduces productivity by promoting sheet and gully erosion.

Salting and gullying on alluvial terraces near Puckapunyal

Salting is initiated when evapotranspiration is reduced on rising ground in the drier soils that contain significant quantities of soluble salts. This reduction is caused by disturbance and removal of the perennial, deep-rooted native vegetation and its replacement with crops, pastures, and fallows. Deep percolation and lateral seepage increases, resulting in increased accumulation of moisture and salts in low sites. Here reduced transpiration and increased evaporation associated with croping and overgrazing encourage the development of saltpans.

Current prevention is based on minimizing seepage from rises and maintaining cover on low sites. On the rises, timber is retained where possible and deep-rooted species such as phalaris and lucerne established.

Fire

Wildfire is a common and often destructive occurrence in the study area. The

climate combines with the amount and character of "fuel" produced by the native vegetation to produce an extremely high fire danger.

Damaging fires occurred in 1851, 1886, 1898, 1901, 1914, 1919, and 1926. Disastrous fires in 1939 killed 71 people and destroyed 1.2 million ha of forest. In more recent years, major fires occurred in 1944, 1951, 1962, 1967, and 1969.

The fire control problem

Most forest fires are caused by lightning and by Man. Others sweep into forests from adjacent alienated land. Fires that burn in the litter produced by native vegetation spread at rates in proportion to the amount of litter and shrubs available for burning. Bark, leaves, and twigs are continually cast from eucalypt trees and accumulate on the ground. Some of this fuel decomposes. However, particularly in productive sites where summer drought is marked and where the dry summer and cold winter keep the population of microorganisms to a low level, decomposition cannot keep pace with additions.

The probability of an uncontrollable and destructive fire increases as the amount of fuel builds up.

The fire control problem is severely aggravated by spectacular "spotting" fires well ahead of the main fire front. These are caused by the bark on eucalypt trees, which ignites easily and is carried forward by the wind to start new fires - sometimes many miles downwind.

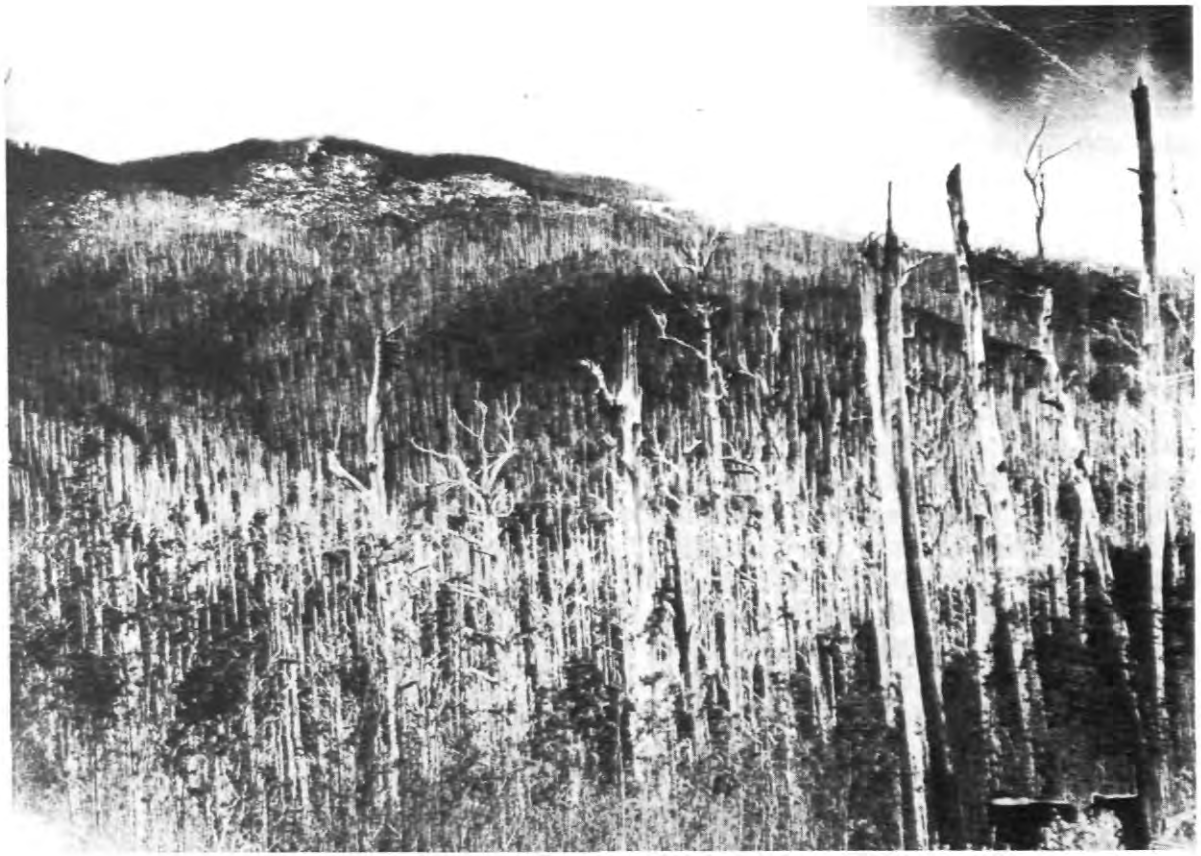
Fire suppression is based on quick detection by means of lookout towers and aerial patrols, and on rapid access via the extensive road and track network that has been built up over the years. Protection activities include the construction of dams, improvement of access, and the reduction of fuel levels by controlled fires in strategic areas.

Potential for damage

The native vegetation and its associated fauna tolerate fire remarkably well, and in many instances fire is an essential factor in the ecology of species and communities. However, items of value in our European-type society can suffer greatly. These include straight stems for poles, clear water for domestic use, introduced plants and animals, fences, buildings, and human life.

The protection of life and property from fire deserves special consideration in the study area. Places where urban development encroaches into a forest environment have enormous potential for damage. Eight deaths and 454 houses destroyed by wildfire in the Dandenong Ranges in 1962 provide testimony to this fact.

The problem exists where people site houses within a forest environment with-



The Tanjil Bren area following the 1939 wildfires

out removing the potential for a fast-moving fire to occur. Some home-owners create this situation deliberately, if perhaps unwittingly, by seeking a natural and unaltered environment in which to live. The increased number of people and vehicles in such areas compounds the problem, causing an increase in the likelihood of a fire starting.

In addition to the Dandenongs, parts of the Mornington Peninsula, Mount Macedon, and some of the coastal resorts (such as Anglesea and Phillip Island) present a like situation with similar potential for damage. The itinerant high-density camping on some of the coastal foreshores during summer creates a similar hazard.

Ecological aspects

Fire has been a significant and dominant factor in the ecology of the natural environment for thousands of years - so much so that the structure of the natural vegetation, in all but a few instances, exhibits patterns of regeneration and floristic composition allied to the frequency with wich it is burned.

However, the full ecological effects of fire are not yet understood. We have some knowledge of the effects of different fire regimes on vegetation, but very little of the effects on animal populations, the soil and its hydrological properties, or nutrient cycling.

The mountain ash forests are ecologically adapted to infrequent but destructive fires. This species is readily killed by fire, but its successful recycling or regeneration is always associated with an intense fire, which kills the trees but at the same time produces seed-bed conditions necessary for the new crop to establish and survive. In the total absence of fire for a period longer than the life span of the species (say 200 years), mountain ash forest is replaced in the process of plant succession by closed forest, with myrtle beech and sassafras as the dominant species.

If the ash forest is burnt too frequently for it to be able to produce a seed supply, the area will regenerate with understorey species such as hazel pomaderris and silver wattle. Very frequent fires will reduce this type to austral bracken.

Fires rarely kill the eucalypts in the drier open forests, but their frequency determines the character of the understorey vegetation. The time interval between successive fires on an area acts as a selective factor in determining which species may be present. High frequencies (perhaps once every 5 years) can produce sparse understoreys with tussock grasses dominating the ground flora, particularly on slopes inclined to the north and west. As fire frequency decreases, woody shrubs increase. If the interval between successive fires is longer than the life span of the shrubs, then they disappear and most of the ground flora may be smothered out by a thick layer of bark, leaves, and twigs.

Very frequent or particularly severe fires can lead to site deterioration through excessive water run-off, soil erosion, and loss of plant nutrients.

Water

Changes in the quality and flow regime of streams are closely associated with changes in vegetation or soils. Depletion of ground cover (following say clearing, fire, or overgrazing) may result in rapid surface run-off, which leads to sediment-laden flash floods. Total yield may increase, but both quality and flow regime may suffer. Total

yield may also increase when deep-rooted plant species are replaced with shallow-rooted ones, but associated undersirable changes in soil stability may occur.

Flooding

Flooding occurs to some extend on all streams within the study area, but is of little serious consequence in terms of property damage. No areas suffer extensive repeated flooding. Many streams now contain storages and/or river improvement schemes that have helped to reduce the impact of flooding, but clearing of parts of catchments has offset this to some extent. The most important stream within the study area is the Yarra River. Major floods have been recorded in 1863, 1891, and 1934. It is realized, particularly in the case of the Yarra, that increased urbanization of a river's catchments will increase its flooding potential in its lower reaches.

Pollution

Contamination of surface water and groundwater by discharge of pollutants is a hazard usually associated with settlement, particularly following industrial development, but can also occur in agricultural areas. Water quality is poor in the lower reaches of all streams entering Port Phillip Bay, due to pollution from industrial, domestic, and agricultural sources. Industrial and domestic waste has adversely affected the quality of groundwater on the Mornington Peninsula and at Brooklyn, Laverton, and Sunshine.

Fungi

Cinnamon fungus

The soil-inhabiting cinnamon fungus *(Phytophthora cinnamoni)* attacks the small feeder roots of a wide variety of native trees and shrubs, making it difficult for them to absorb water and nutrients from the soil. There is very strongy evidence that this pathogen was introduced into the study area relatively recently, possibly about the time of early European colonization.

The symptoms of damage appear in the foliage of trees and shrubs and strongly resemble those produced by drought and nutritional disorders. The fungus is spread by the transfer of infected soil and by running water. It attacks plants most vigorously in warm moist soils.

Once a soil has been infected, the fungus cannot be eliminated without incurring great expense and jeopardizing the survival of the existing flora. To date the only successes have been recorded in nurseries, where small amounts of soil can be treated with soil fumigants.

Damage caused to native forests

Reports of damage, intensive but localized surveys, and past records show that

the fungus is widely scattered in home gardens and in agricultural land. It has been detected along roadsides and from dead patches of vegetation in many parts of the Brisbane Ranges and in the Wombat forest. Despite numerous investigations it has never been detected in the ash-type forests of the study area. This suggests that these areas are infection-free. Spot infections have been recorded in the Otways.

Studies in the Brisbane Ranges indicate that the fungus spreads rapidly on poorly drained shallow soils, its spread being shown by the death first of the woody ground vegetation and then of the grass-trees.

Some eucalypt species are highly sensitive to the fungus, while others tolerate it. The disease represents a severe threat to the drier open forests in parts of the study area.

Damage *via* nurseries

Cinnamon fungus attacks a number of ornamental shrubs and trees used in gardens and parks. Azaleas, camelias, and rhododendrons are very sensitive to damage, and because they are prized by amateur and professional gardeners the fungus has been widely distributed to many parts of the State, in diseased nursery stock.

The economic impact of the fungus in this type of plant-propogation system is difficult to assess. It will certainly create a continuous demand for plants as they are destroyed in the home garden, and at the same time add considerably to the cost of production as special precautions are taken to keep the soils disease-free.

Control measures

Apart from the routine chemical control measures adopted on a restricted basis to remove the fungus from soil, no method of eradicating it from large volumes of soil is known so far.

Plant quarantine and special measures, such as cleaning infected soil from vehicles and road-making machines, will help to slow the spread of the fungus.

Other fungi

The needle-cast fungus *Sclerophoma pitophylla* does affect radiata pine within the study area, but does not appear to be a serious threat under Victorian conditions.

Pest Plants

A survey carried out in 1970 showed that the area contains 72 noxious weeds. These have been proclaimed under the *Vermin and Noxious Weeds Act*, and legal provisions require control measures to be carried out. Appendix 4 lists these species.

Many are widespread throughout the study area, occurring in more than half the blocks. Their distribution and effects on agricultural land are well known and documented, however, the situation for public land is not as clear.

Generally, noxious weeds do not colonize undisturbed areas of native vegetation. Along creeks downstream from infected areas, and in areas where disturbance has occurred (such as along roads, in grazed areas, or at sites of old sawmills, camps, and farms), weed species may become very plentiful. They may be of concern on public land, as they compete with desirable species, impede access (especially to streams), and often have undesirable characteristics such as prickles, thorns, or poisonous properties.

Any proposed change in land use must take into account the presence of weed species, the likely effect of the change, and the feasibility of successful control.

The most important weeds of the area are discussed below, and their habitats are shown in Table 7.

Boneseed

This is particularly prevalent along the coastline of the Mornington and Bellarine Peninsulas and in the You Yangs. It has the ability to establish itself in areas of native vegetation and to eliminate native species through competition, particularly for light.

Since in invades areas where preservation of native vegetation is desirable, control of boneseed is difficult, although by no means, impossible. It is not regarded as a problem on agricultural land.

Blackberry

The widespread distribution of blackberry throughout the area is due to its efficient reproduction, its rapid growth rate (which enables it to compete with other plants and to recover when damaged), and its prickles (which tend to protect it from grazing). Blackberry grows mainly in areas where annual rainfall exceeds 750 mm.

It is found on roadsides, in neglected areas, and along water-cources, where it forms prickly impenetrable thickets.

On agricultural land blackberry causes problems where lack of access makes control difficult, or where management is poor. It also poses a serious problem in areas where abandoned farmland is being reforested, in which it must be controlled for the first few years to allow the young trees to become established.

Spraying with picloram or 2,4,5-T can keep most infestations under control, but many areas of public land are in-

Table 7

HABITATS OF THE MAIN NOXIOUS WEEDS IN THE MELBOURNE STUDY AREA

Habitat	Blackberry	Boneseed	St. John's wort and ragwort	Boxthorn	Brooms	Hawthorn	Stink wort	Sweet briar, furze	Spear, shore, & variegated thistles
Undisturbed native vegetation		*							
Disturbed native vegetation (by logging, grazing, and recreational usage)	*	*	*	*				*	*
Native vegetation cleared for timber, mining or agriculture	*		*	*		*	*	*	*
Roadside easements	*	*	*	*	*	*	*	*	*
River frontages	*			*					
Coastal foreshores		*		*					

St. Johns wort in the Eildon block

accessible and so no control is carried out.

St. John's wort

St. John's wort is found in most blocks, often occurring as isolated patches on farms and roadsides. However, around Eildon it presents a serious problem in Fraser National Park and surrounding areas, where it occupies rocky timbered country. It competes with understorey native vegetation, which makes the control measures most successfully used on agricultural land undesirable in this area.

Woody weeds

Several woody weeds are widespread in the area and have the potential to limit the use of many areas of public land by limiting access. They also harbour vermin, and many have objectionable prickles and/or thorns. These plants include boxthorn, sweet briar, hawthorn, furze, Cape broom, and English broom.

Bracken

Although not a noxious weed, bracken is considered a problem plant by many people. It grows widely in the area on both public and private land. It hampers establishment of pine plantations, and on agricultural land is usually a sign of poor management, particularly failure to establish pasture properly.

The other noxious weeds listed are considered to be of minor importance on public land at present, but they could spread rapidly if control measures are relaxed. Weeds are distributed by the river systems, and new infestations frequently appear near streams after flooding. These areas warrant close attention.

Vermin

The following species have been proclaimed as vermin under the *Vermin and Noxious Weeds Acts*, and legal provisions require control to be carried out.

Rabbits

Rabbits are found throughout the entire study area, but sustained high populations are uncommon. In most cases, they present a maintenance task only, although problem areas do occur, particularly in the hilly sections of the Tallarook, Disappointment, and Eildon blocks, and also in parts of the Upper Goulburn block.

Other examples occur in areas of specialized land use, for example Puckapunyal army camp, Fraser National Park, and most of the newly established pine plantings. In the latter situation, routine poisoning compaigns generally prevent damage to seedlings.

Generally speaking, rabbits will present some difficulty on most newly cleared land. Windrows of timber (produced in the clearing operation) provide an excellent harbour for them, and high local populations can result unless some control measures are carried out. Neglect in this respect can result in damage to existing or establishing ground cover, and this can further lead to erosion problems.

Rabbits may also cause problems in plant nurseries, golf courses, and urban fringe areas.

Control measures include poisoning with 1080 on baits, myxoma virus, and the ripping and fumigation of burrows.

Feral dogs (including dingoes)

Dingoes and feral dogs occur in the Strathbogie, Eildon, Disappointment, Break O'Day, Black Range, Upper Goulburn, Upper Yarra, Bunyip-Latrobe, Thomson, and Tyers blocks.

Some predation by feral dogs occurs in these areas. However, stock losses are usually small and sporadic. The main food of feral dogs comprises large native mammals, particularly wallabies and wombats. The hydatid tapeworm *(Echinococcus granulosus)* is an extremely common parasite in these dogs, but their significance as reservoirs of potential infection for Man and domestic livestock is unknown. The presence of hydatid disease among black wallaby in the study area suggests that a sylvatic hydatid cycle operates.

Foxes

Foxes are common throughout the whole study area and occupy almost all types of habitat, from the city to the dense forests. Their predation on lambs is now generally considered to be of little economic significance, but its effects on native fauna are unknown.

A dietary survey of 100 foxes from the study area has indicated that rabbits and sheep carrion provide their main foods, with lesser emphasis on native mammals, birds, and insects (see Table 8). Intake of native fauna species is

Table 8

MAJOR FOOD ITEMS OF 100 FOXES IN THE STUDY AREA

Food item	Percentage	
	Occurrence *	Volume **
Rabbits	30	30
Mice	18	11
Sheep (mainly carrion)	32	27
Possums	11	10
Other native mammals	12	3
Birds	15	3
Reptiles and amphibians	5	1
Insects and other invertebrates	35	9
Herbage	61	8

* % occurrence = number of stomachs in which the particular food item was present, expressed as a percentage of the total number of stomachs examined.

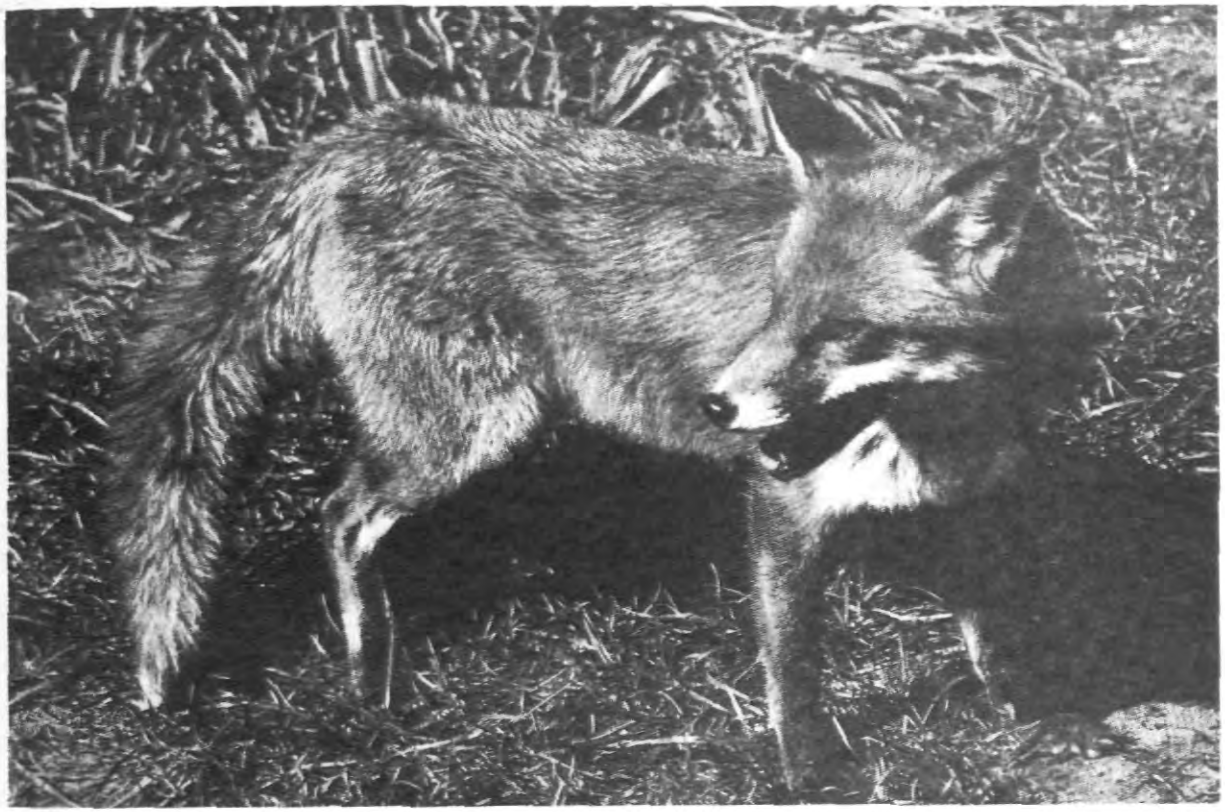
** % volume = the sum of the volumes of the particular food item found in the stomachs examined, expressed as a percentage of the total volume of all the food found.

highest in heavy bush, and it is possible that prexation by foxes in such situations significantly affects the population of some smaller indigenous species.

Feral cats

Feral cats commonly range throughout many parts of the study area. These animals thrive in a great variety of habitats, and the wild population is being continually boosted by the straying of domestic farm cats and the abandonment of unwanted cats in bush areas.

Recent studies on the diet of these predators in Victoria have indicated that, in forest areas, some 40% of their diet comprises smaller native mammals and birds. The significance of such predation is unknown.



The fox is widespread in the study area

Wombats

In some instances, wombats in farmland adjacent to forest or scrub present a problem to farmers by virtue of their damage to netting fences. However, it is usually possible to prevent continued damage by removal of the offending individuals. The species has become uncommon to the west of Melbourne, and there is evidence to support its removal from the list of proclaimed *vermin*.

Sparrows and starlings

House sparrows and starlings (both introduced species) have been proclaimed as vermin for a number of reasons. They are a reservoir of various diseases that can infect poultry, and carry insect pests such as lice and ticks. They can

cause damage to soft fruit in orchards and to seedlings in freshly sown paddocks, and their large numbers and untidy nests can cause a considerable nuisance in urban areas. Both species are aggressive and usurp the nesting holes of native bird species. The starling is particularly significant in this respect. Not only has it spread throughout urban and agricultural land (as has the sparrow), it has also invaded adjoining areas of dry open forest and woodland.

The tree sparrow is also proclaimed as vermin, but being less numerous and more localized than the other species, it is less of a problem.

Insects

Phasmatids

The plague of the phasmatid insect *Didymuria violescens*, which has built up in the mountain ash forests south of the Great Dividing Range since 1961, has threatened complete destruction of many stands. The insects feed on the foliage and may completely defoliate the crowns of the hosts. Most severely infested are forests near Powelltown (Upper Yarra Shire) and, to a lesser extent, within the shires of Buln Buln, Healesville, Broadford, and Whittlesea.

Outbreaks occurred either simultaneously in spatially isolated localities or independently during different years. Collectively, however, the separate infections from part of a general regional outbreak in dense luxuriant ash regrowth of 1939 origin between 300 and 900 m elevation. Forests of messmate stringybark mixed with peppermint-gum and other vegetation on adjacent foothills or above the mountain ash zone have not sustained outbreaks.

Mountain ash ranks among the most valuable seasoning-quality hardwoods in Victoria. It grows naturally only on deep fertile soils in certain restricted mountain regions with high rainfall.

Heavy repetitive loss of foliage through phasmatids can be lethal, and its prevention is essential for survival of the species. Failing such prevention, many stands of mountain ash will probably revert to scrub vegetation of no commercial value.

During 1971, when some 6,700 ha of forest were threatened, the potential loss of increment on the growing trees were estimated at $156,000. Landscape values fell through crown deterioration, and would have been seriously reduced if stands had died.

Control has taken the form of aerial application of small quantities of malathion, an insecticide of low persistence and low toxicity to birds, reptiles, and mammals. Fish, however, are susceptible and hence spraying near watercourses must be avoided. These

measures have led to a decline in phasmatid numbers in many localities.

Cup moth

Apart from phasmatids, the cup moth *(Doratifora vulnerans)* is the most serious defoliator of eucalypts. During dry years, attacks in mixed-species forests can be severe. During the drought year of 1972, serious defoliation by this species occurred in the Whittlesea area. No methods of control are exercised, as the attacks cease after heavy rains.

Sirex

The wood wasp *Sirex noctilio* has caused widespread death of radiata pine in New Zealand. It was discovered at Woori Yallock in 1962 and subsequently in other parts of the study area.

In Australia the species confines its attack to suppressed trees or freshly cut green timber. A variety of biological control methods have achieved success in Victoria and the species does not cause any serious damage, but it must always be regarded as a potential threat.

Other insects

Various insects are minor hazards in this study area. These include bark beetles, the gum-leaf skeletonizer, and the blue-gum moth.

Other Pest Animals

The mountain possum, brush-tailed possum, black wallaby, and bush rat cause damage to radiata pine, by gnawing or tearing bark from boles or apices of trees. In extreme cases, complete girdling of the tree occurs, resulting in its ultimate death.

Attacks appear to occur in cycles, and these animals have not caused any serious damage to radiata pine in the study area within the past 5 years.

Where a local build-up in population has occurred, control measures (including shooting and poisoning with 1080 on baits) may be permitted by the Fisheries and Wildlife Department. Poison bait is supplied only by the local Lands Department inspector.

The introduced blackbird has invaded coastal habitats and both the wet and dry open forests of the study area. It poses a threat to the naturalness of these areas, and may be partly responsible for the spread of noxious weeds such as blackberry.

The European carp *(Cyprinus carpio)* is another introduced species that poses a threat to native species. Its feeding habits tend to destroy the aquatic vegetation and increase the turbidity of water, making the stream less suitable for most native fish. At present it is not a problem in the study area, but is

Blackberry forms impenetrable thickets along many streams in the mountain areas

well established in the Gippsland Lakes area.

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NATURE CONSERVATION

Conservation is concerned with Man's relation to his environment. It was described in chapter 2 as being the wise or balanced use of resources to provide for his physical and spiritual needs, both now and in the future. This chapter discusses those aspects concerned with the native species, communities, and landscapes of the area, which are commonly grouped under the collective heading "nature conservation". The following chapters consider other aspects, related to the production of foods, fibre, and minerals. In some cases these activities also depend on native species.

Ecology

Irrespective of their particular interest, all conservationists are basically concerned with environments and their use. The environment has both spiritual attributes, such as inspiring landscapes and remoteness, and physical attributes such as topography, timber, and minerals. Its character is due to the combined effect of all its individual features. Knowledge and understanding of these and of their interactions are essential for conservation.

Ecologists have developed terms and concepts that, although only convenient working abstractions, clarify our thinking and enable us to describe and discuss the otherwise incredibly complex web of interactions.

The ecosystem - the unit of study - is applicable on many scales: the whole world may be regarded as an ecosystem, as can a lake, a forest, or a small part of the soil beneath the floor of the forest. Each ecosystem contains four interacting parts: the inorganic materials, producers (green plants), consumers (chiefly animals), and decomposers (chiefly bacteria and fungi).

Biological communities

Biological community is the term given to any naturally occurring group of different organisms whose members inhabit a common environment, interact either directly or indirectly with each other (especially through food chains), and are relatively independent of other groups. Some communities form more readily recognizable entities than others, for example the flora and fauna of a pond, but in fact no community is

ever a closed system since interactions, movement of animals, and transfers of energy continuously take place across any arbitrarily defined boundary.

Stability

Each community has evolved within its particular environment, and so together the species form a dynamic but stable system. Undisturbed, the community represents the best combination and relative abundance of the available plant and animal species that can continue to live and compete with each other in the prevailing soil, topographic, hydological, and climatic conditions.

Different systems have different degrees of stability. The more stable tend to be those containing the greatest variety. In some of the most vulnerable, stability depends on some particular facet, such as specialized vegetation; others may have inherent topographic, soil, or hydological weaknesses.

The influence of Man

Man is obviously part, and to us a very important part, of any world ecosystem. Although he is only one of many species, his dense and rapidly growing centres of population and his ability to manipulate other species and parts of his physical environment make him a very significant and influential one. He has affected - either directly or indirectly - all parts of the study area. Pressure of grazing by rabbits and domestic stock and invasion by exotic plants have changed the original pastures. Timber harvesting has changed for generations - and perhaps for all time - the nature of the virgin forest, while the fire regime has been drastically altered.

Despite this pervading effect, it is convenient and generally accepted to arbitrarily distinguish between artificial systems (such as urban areas and farms) in which Man's influence is obvious and natural ones (such as eucalypt forests) in which it is not obvious.

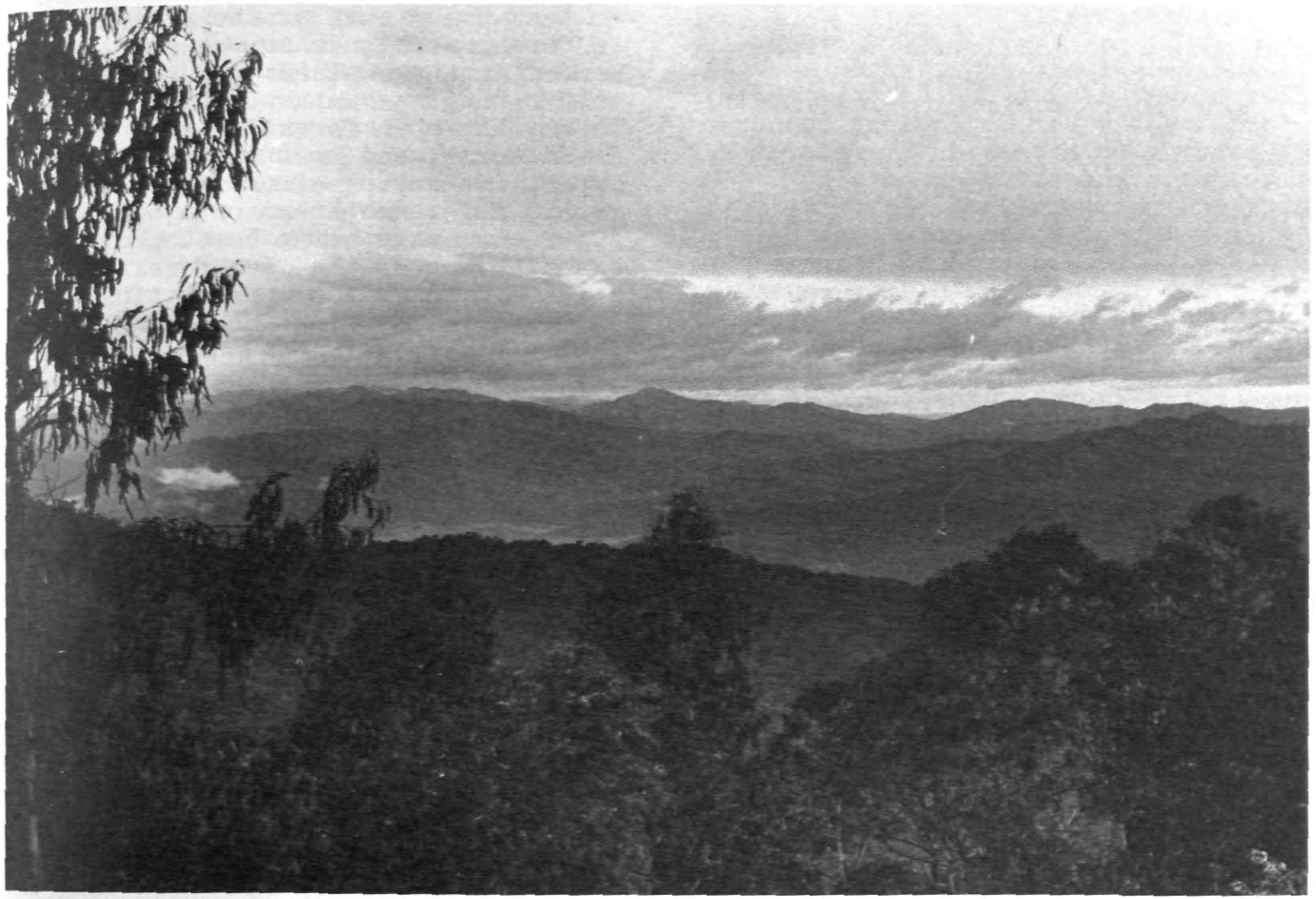
Man must provide himself with adequate supplies of food and fibre, many of which he can best obtain from artificial systems. He must manage such systems in a way that permits them to maintain general stability within the environment, just as the original natural combination did.

Certain other of Man's needs can best be provided by natural systems. Awareness of this is causing a rapidly growing demand, here as elsewhere, for land to be set aside and managed specifically to preserve the natural or native fauna, flora, and landscapes.

Conservation Needs

Some of the types of land required to satisfy the needs of nature conservation are discusses below. Each has value for our edification, inspiration, and rec-

reation; each requires different levels of management and manipulation. Their "naturalness" can vary considerably, being greatest in large areas used for reference and least in those intensively managed to preserve some endangered species or the remnant of a former landscape, and in areas that people are encouraged to visit for education and recreation.



Relatively undisturbed rugged terrain in the Upper Goulburn block

None of them necessarily requires a monoply of the land. Often they are compatible with each other or with commercially productive uses.

Areas for reference

Viable and relatively undisturbed examples of all land types (differing in land forms, soils, or biological communities) need to be set aside as reference areas to which those concerned with changing and managing land can refer when trying to solve the resultant problems. As with references and standards used in other fields, these areas must not be tampered with and natural processes should be allowed to continue undisturbed. Access should be restricted to competent observers carrying out approved work.

Continued studies of natural features and their dynamics increase our knowledge of the ecological laws and processes on which Man's survival may ultimately depend. Reference areas act as standards against which the progress and effect of human alteration and utilization of the land can be measured. They may also provide a valuable gene pool of plant and animal species. Such material is already being used, and will be increasingly used, to produce genetically strong domesticated species. Although all land types need to be represented in reference areas, the need is most urgent in those that have been extensively developed for uses such as agriculture or softwood timber production.

As in most developed regions, few if any areas suitable for reference remain in land types such as the native grasslands and woodlands to the west of Melbourne, the swamplands around Kooweerup, the Mornington Peninsula heath woodlands, the open forest of the Strzeleckis, and most of the coastal types. Conscious effort must be made to retain reference areas of other land types currently being developed, for example some of the open forests being converted to softwood plantations, mountain ash areas being increasingly utilized for recreation and hardwood timber, and heath woodlands being cleared and mined for sand and gravel.

Park areas

Other examples of each major land type and its biological communities are also required for the less restrictive educational, cultural, and recreational purposes.

Several categories of park are needed. Large parks containing outstanding natural features and diverse land types are of nation-wide significance. These have visitor density restricted to a generally low level in order to impair their naturalness as little as possible (although limited areas such as information centres may be intensively used). They may contain areas of wilderness

suitable for solitude, inspiration, and primitive unconfined forms of recreation.

On the other hand, smaller parks are of particular importance to regional populations. High densities of visitors are permitted and so their naturalness correspondingly declines. However, they still provide opportunities for contact between Man and nature, and reduce the pressures of visitors on more restricted parks. Examples are found at the You Yangs and in the Dandenongs block.

Details of the recreational use of existing parks in the study area are given in chapter 13.

Education areas

Education in the components and functioning of ecosystems is an important step in conserving natural resources. It is becoming an increasingly important feature of school curricula at primary and secondary levels, and with other groups concerned with nature appreciation.

The study of ecosystems is indispensably linked with field studies. Obviously some aspects of this type of education can take place in areas primarily used for the production of, say, hardwood timber. Other aspects can only be dealt with in areas where the flora and fauna have been preserved in their natural state.

However, nature is to be felt, heard, smelled, and collected, and in some circumstances laboratory facilities and associated accommodation are needed so that successive groups can undertake long-term studies. As these activities may not always be compatible with full preservation, some land will need to be set aside specially for education.

At present the Education Department uses 30 school camp sites within the study area, and these cater for more than 20,000 children each year. The development of six more sites is currently being planned.

Endemic and endangered species

Every living thing is a unique assortment of biological characteristics, evolved over millions of years. Each offers a potential enrichment of human knowledge, limited only by our capacity to appreciate and understand. The loss of any species therefore erodes the quality of the human environment. Many people feel that Man also has a moral responsibility to preserve endangered species.

It may be possible to ensure the continued survival of all species in zoological and botanical gardens, but only preservation in their natural environment will permit a full understanding of the species and their interaction with the physical and biological factors that surround them.

Grevillea steiglitziana is endemic in the Brisbane Ranges

Species endemic in the study area and endangered species must receive high priority for preservation, as opportunities for doing so are limited. Chapters 9 and 10 list those found in the study area.

Special values

Particular areas of land are often needed to preserve distinctive natural values.

The occurrence of a species is of unusual scientific interest near the limits of its distribution.

A number of both plant and animal species, mentioned in chapters 9 and 10, reach these limits within the study area.

Some animal species, for instance the colonies of Australian fur seal, little penguins, and short-tailed shearwaters on Phillip Island, favour certain areas as breeding localities. Other areas are favoured as stop-over places for nomadic or migratory animals. Some of these, such as the sand spit in Port Phillip Bay near the mouth of Little River, are discussed in the block descriptions.

Some areas provide particularly good examples of a geological feature or process, for instance the Werribee Gorge and the Organ Pipes on Jacksons Creek.

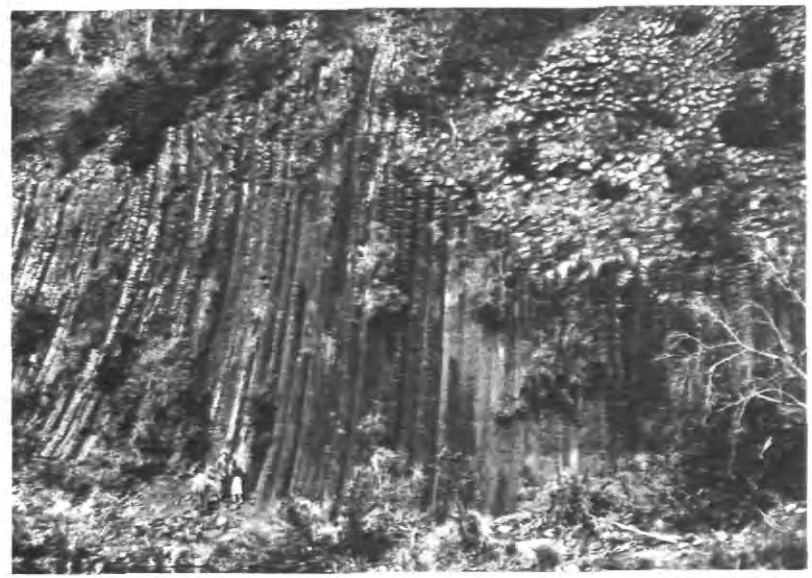
The Melbourne area has special significance to systematists. The validity of much research work hinges on the accurate identification of the materials involved. The type specimen chosen by an author, when naming a new plant or animal species, fixes the application of that name and is basic to correct identification. The locality at which the type specimen was collected is therefore of considerable importance, and every possible protection from destruction or degradation should be approved for such areas.

A recent survey shows that 130 species of flowering plants and at least 84 species of mosses have been described from specimens that come wholly or in part from within the study area; Appendices 2a and 2b list these and the location of their types. In other natural sciences, type sections or materials are used to define, for example, soils or stratigraphic units.

Small areas

A host of smaller areas can contribute to nature conservation. They include narrow reserves along coasts, streams, and roads, and remnants of the natural vegetative cover that have survived on areas originally set aside for purposes such as gravel, water, cemetery, and camping reserves.

Since these small areas of public land still bear, perhaps in a modified form,



The Organ Pipes on Jacksons Creek have considerable geological and educational value

their original type of vegetation, they make a contribution to regional character out of all proportion to their size. They are also the only refuge for many of the remaining native animals. In the study area these small remnants are particularly important in the Bellarine and Mornington Peninsulas, the basalt plains, the Strzeleckis, and the Seymour area.

In the past, many of these small areas have not been properly administered nor have they been well known to the public. Because of this they have not been used as they might otherwise have been, nor have they been as secure

Remants of natural vegetation are important in nature conservation; Maribyrnong River near Mickleham

against alienation or despoliation as they should have been. Proper management and rights of access are essential.

Productive areas

Some native species have high value for productive uses. Game-shooting, a popular form of recreation, depends on the reliable supply of native ducks and quail. Many of the eucalypt species provide honey and hardwood timber.

Viability of Areas

The viability and effectiveness of nature conservation areas depend on a number of factors, including the size of the area, the type of community or ecosystem we wish to conserve, and the degree to which we can manage the area and control influences that tend to upset the natural balance.

Large reserves have less perimeter relative to their area and so tend to be better buffered against the effect of intrusive factors. Generally the conservation of birds and mammals will require areas larger than those required for the maintenance of plants, insects, or amphibians. Communities that exist in more variable climatic zones - prone to drought, floods, or fire - usually require larger areas (or more examples set aside) to ensure survival.

Careful management may enable small areas to remain viable. Management may take the form of controlling fire, culling animal populations, practising silviculture, strictly controlling the number of visitors, fencing to exclude introduced animals, or eradicating introduced species.

Choosing areas

In addition to viability, many other

factors influence the selection of areas for nature conservation.

Land is a scarce resource and good planning requires compatible uses to be grouped together on the one area if possible.

Where possible, a single reserve should cover a number of land types, and should have high scenic value.

The migratory and nomadic existence of some animals requires corridors of habitat linking, for example, breeding and feeding grounds. Such corridors may be used for a number of other uses, such as hardwood production, or they may be planned strips left through areas used for agriculture or softwood production.

In many cases few alternatives are available, as only remnants of the natural systems remain. Where alternatives do exist, areas with natural boundaries such as watersheds should be selected, as they are usually easier to manage and maintain.

It is likely that, in practive, a balanced system of nature conservation in Victoria will include a few fairly large areas (more than 20,000 ha) in which the major communities and land types are represented, supplemented by a greater number of smaller areas more intensively managed for a particular purpose.

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OUTDOOR RECREATION

The term recreation loosely applies to a broad range of activities that occupy an individual's leisure hours. Outdoor recreation in the countryside - a part of this wider spectrum - has particular appeal to many Australian residents and overseas visitors.

In the study area, the bulk of outdoor recreation resources occur on public land. These extend the diversity of recreation opportunities available within the region by complementing forms of urban-based recreation. They are used mainly by the populations of Melbourne and Geelong, but are also subject to use by several smaller centres surrounding the study area, including Ballarat, Bendigo and Morwell. Some, such as the Mornington Peninsula, attract visitors from other parts of Victoria and interstate.

Recreation Resources on Public Land

Of the public land in the study area, only about 3% is specifically reserved for various forms of outdoor recreation. Opportunities for recreation, however, are not solely confined to these reserves, and are available in varying degrees on most of the remaining public land. The role of private land in a broad review of recreation can be seen as supplementing those opportunities.

Recreation facilities include resources already being used for leisure activities and those potentially suitable but as yet unused or unavailable. They combine the natural resource base and Man-made developments that have facilitated their utilization, such as access roads and the provision of barbecues and interpretative services.

Public land occurs in several distinct environments, offering different types of recreation experiences, some of which are extremely popular at present. The following discussion, together with Map 7, gives an indication of the salient features of each environment and the range of recreation possibilities each contains.

Urban and industrial zone

Melbourne, the major industrial and urban centre for the region, is expanding outwards into the study area. In 1950 the built-up area covered 600 sq km. By the year 2000, if present growth rates continue, it will occupy about

1,900 sq km. The spread or urban areas will lengthen the time that many residents in the inner city will take to reach recreation sites in non-urban areas. It will also mean that more people live closer to existing sites and thus multiply the present use of them.

Agricultural zones

These cover a large portion of the study area, particularly in the north and west, and are characterized by extensive clearing of natural vegetation and the absence of large blocks of public land. Three categories can be identified, based mainly on topographic differences: flat, undulating, and steeply dissected.

Broad tracts of *flat* agricultural land occur immediately west of Melbourne and Geelong, and at the head of Westernport Bay (Kooweerup).

These extend into surrounding *undulating* areas of mixed farming. Together, the two zones virtually enclose Melbourne and Geelong. They contain some opportunities for recreation, including horse-riding, but for many people they represent a barrier to be crossed before reaching recreation sites in the foothills or at the coast. The few elevated areas such as the You Yangs and Arthurs Seat have become very popular for day visits.

Areas of *steeply dissected* country have been cleared for grazing in the Strzeleckis and north of the Divide near Yea. This zone differs markedly from the agricultural lowlands, affording scenic views for pleasure driving, picnicking, and hiking.

Mixed agricultural, urban, and forest zone

This type of environment occurs in the foothills north-east of Melbourne and in

Entrenched streams across the basalt plains west of Melbourne provide opportunities for picnicking and bush-walking

western Gippsland, with smaller areas in the Mornington Peninsula and near Daylesford. Characteristically undulating to hilly terrain contains a mixture of agricultural land, natural forest, and scattered urban development.

Their diverse and scenically attractive landscape and their location close to Melbourne have made these areas very popular recreation centres for pleasure driving, picnicking, sight-seeing, and walking. The Dandenong Ranges have been a traditional playground for Melbourne's residents since the late 19th Century.

Public land holdings in this type of environment are not extensive, but attendance records at the few public recreation sites attest to the zone's popularity.

Softwood zone

About 13,000 ha of softwood plantations are scattered throughout the area, mainly on public land. The soft carpet of fallen needles and lack of undergrowth in some plantations make them popular for camping, picnicking, and orienteering. Plantations also add to the visual diversity of a landscape.

Zones of natural vegetation

These cover most of the public land in the study area and some adjoining areas of private property. The vegetation generally consists of open forests of various eucalypt species, with some areas of heathland, grassland, and scrub near the coast and in the sub-alpine region.

The various types are shown on Map 6. Each has its own particular attractions, such as fern gullies in the wet open forests and spring wildflower displays in the drier open forest and woodlands.

Three zones can be identified, based mainly on differences in topography and altitude: flat to undulating, steep, and sub-alpine.

In areas of *flat to undulating* terrain (slopes generally less than 20°), the surrounding vegetation encloses the landscape and distant views are seldom seen. In areas of *steep terrain* (slopes generally greater than 20°), distant views can be seen through the trees and there is the impression of rugged mountains. They occur around the edges of plateaus, and frequently include waterfalls and rock outcrops.

Sub-alpine zone

This type of environment covers less than 2% of public land in the study area and occurs in several isolated pockets, including the Baw Baw Plateau, Mount Torbreck, Lake Mountain, and Mount Donna Buang. These areas provide some winter snow sports, and bush-walking and nature study during warmer months.

Southern coastline east of San Remo. Access is difficult to the coastline in places because of adjacent private property

Coastal zone

More than 500 km of coastline form the southern boundary of the study area and provide a variety of ocean and bay environments, with different degrees of human intervention. Public land, however, is restricted in most places to a narrow strip along the waterfront. Although most of the coastline is accessible, in some stretches direct public access is either made difficult by the presence of private land or actually denied because of some institutional uses.

The most intensively used section of the coastline includes the Mornington Penin-

Horse-riding on private property near Warburton

sula, Phillip Island, and the southern coast between Barwon Heads and Lorne.

Other recreation opportunities

The vegetation along the edges of many country roads often provides a valuable landscape element for the motorist.

These narrow strips of public land usually contain remnants of the original vegetation in areas now cleared for agriculture. They also serve as a local refuge for wildlife.

Abandoned railway lines, disused forest tramways, and logging tracks make good graded walking tracks if clear of undergrowth. The study area contains a number of these routes (see Map 7).

Inland water-based recreation is confined to streams and artificial water storages, there being no large natural water bodies. Activities permitted in water catchments and on storages are listed respectively in Map 8 and Table 9, while Map 7 shows streams popular for canoeing and fishing.

Private land

Private land makes an important contribution to the types of recreation available in a locality, although its precise effect on the use of public land has not been determined.

The landscape value of many agricultural districts appeals to a wide cross-section of the urban population, especially when it can be contrasted with areas of natural vegetation.

Several commercial enterprises established on private land, especially in Melbourne's urban fringe, cater for a wide range of activities : water-skiing; picnicking; animal displays; train rides; and other children's amusements. The presence of these enterprises probably diverts some of the demand from public land.

Recreation farms, where the public can inspect daily farming activities, have

Table 9

RECREATION ON WATER STORAGES

	Power boating	Non-power boating	Fishing	Swimming	Camping or caravanning	Picnicking in specified areas	Duck-shooting
Irrigation storages							
Lake Eildon	X	X	X	X	X	X	X
Pykes Creek	X	X	X	X		X	X
Melton	X	X	X			X	X
Domestic storages							
Lake Merrimu						X	
Devilbend			(from shore only)			X	
Tarago			X			X	
Upper Coliban			X			X	
Lauriston			X			X	
Malmsbury			X			X	
Yallourn			X	X		X	X
						(outside catchments)	
Moondarah						X	
Toorourrong						X	
Yan Year						X	
Donnelly Creek						X	
Maroondah						X	
Fernshaw						X	
Coranderrk						X	
Upper Yarra						X	
Silvan						X	
Greenvale						X	
Cardinia		X (specified area only)				X	

been suggested as a useful means of bolstering economic returns to the urban-fringe farmer and thus retaining the district in its visually attractive and rural character. Parts of the Mornington Peninsula and Yarra Valley offer good prospects for this kind of activity.

Recreation Activities

Activities vary considerably in their requirements for land types, size of area, site location, and degree of obvious human intervention, and in their relations with other land uses. Some are quite flexible and occur throughout the study area. At the other extreme, some activities have a set of requirements that confines them to very limited parts of the study area.

Individuals seldom confine themselves to one form of recreation. They usually participate in a number of activities during the course of a year and frequently combine several activities during the one outing. The wide range of opportunities on public land therefore appeals to a very wide cross-section of the community.

Pleasure driving

Being very popular, especially with family groups, driving for pleasure involves large numbers of motor vehicles, and the number of trips is likely to increase with the greater degree of individual mobility. Trips generally last half to one day. Although quite versatile in environmental requirements (see Map 7), this activity favours loop roads with scenic value and those that have landscape interest or lead to places of historic interest and picnic facilities. It is well catered for in the study area and does not rely exclusively on public land. It often occurs in conjunction with picnicking and sight-seeing.

Road congestion in popular areas such as the Dandenongs, Mornington Peninsula, and Mount Macedon creates traffic problems and reduces the recreation value of the trip. It could induce visitors to use other areas or to substitute other forms of recreation.

Picnicking

This very popular activity can occur in conjunction with pleasure motoring or be the main reason for a trip. The most popular sites have picnic facilities, toilets, and running water and are located near prominent natural features, including look-outs, waterfalls, and streams. The distribution of these facilities is widespread on public land and over most types of environments (see Map 7).

Sight-seeing

Popular with a wide cross-section of the community, sight-seeing may involve individuals, family groups, or special

tour groups, usually in conjunction with pleasure motoring and picnicking. Sites are generally small and are often overcrowded on Sundays or public holidays, especially when group visits coincide with normal visitor levels. Requirements include natural features of particular interest, historic artefacts, and outstanding wildlife and flora displays. The most popular sites are those with good vehicular access along recognized tourist routes.

Wildlife displays

In addition to zoos and animal parks on private land, several places in the study area allow the public to observe large animal populations that have been carefully managed for various reasons. They include places where native animals would otherwise be endangered (such as the penguin parade on Phillip Island), where public land has been developed for wildlife preservation (such as Healesville Sanctuary), and where animals are bred for subsequent release in areas depleted of that species (such as Snobs Creek trout hatcheries and the Phillip Island koala colony). These displays are both educational and recreational, attracting large crowds throughout the year.

Car rallies

Two distinct types of rally can be identified in the study area. Social ones or 'treasure hunts' occur regularly at week-ends throughout the study area and are not confined to public land. They often terminate at picnic sites.

Competitive rallies are supervised by a special co-ordinating body, which prohibits rallies in the more populous parts of the study area and distributes events fairly evenly throughout the remainder, subject to approval by local authorities. Of more than 250 events planned throughout the study area in 1973, most use unsealed roads on public land within a few hours' driving distance of Melbourne. Events are usually held overnight, and avoid roads with regular traffic use.

Motorized recreation vehicles

Vehicles capable of off-road movement include trail bikes, dune buggies, and four-wheel-drive vehicles. They have increased the range and mobility of individuals in areas previously inaccessible to conventional motorized vehicles, and are coming into increasing conflict with some recreation groups - notably bush-walkers.

The popularity of trail-bike-riding has increased markedly in recent years. Private land provides a venue for a growing number of club events and competitions. But many areas of public land meet the requirements of riders seeking to combine riding skills with the challange of remote and rugged areas.

The use of dune buggies is limited, in the study area, to coastal sites in the south-east and south-west. Locations outside the study area suit this type of activity better.

Legislation has been introduced recently to restrict the use of recreation vehicles on public land to specially gazetted 'free-access' areas and main roads. Registration of recreation vehicles has also been made compulsory.

Bush-walking

Several types, with different requirements, can be identified: short walks for pleasure or interest along graded tracks with interpretative services provided (includes nature trails with educational emphasis); half-day or day hikes with definite origin and destination, sometimes along made tracks; and overnight and extended walks, often into untracked bushland.

Graded walking track at Angahook Forest Park

Short walks can be accommodated in fairly small areas, but longer ones require larger tracts of relatively undisturbed bushland. Most opportunities for bush-walking are confined to public land.

Walking is sometimes associated with camping, rock-climbing, and various aspects of nature study.

The growth in club membership and the creation of new clubs suggests that bush-walking has regained popularity in recent years. It is now being used as a way of educating children about community life and could expand its popularity even further if young people retain their interest as they mature.

Orienteering

Although only a new sport, orienteering has shown rapid annual increases in club membership and participants within the study area. Orienteering courses are now being introduced in school curricula.

The most suitable land types for this sport are flat to undulating terrain and

forest cover with little undergrowth. Location within a couple of hours' driving time of Melbourne, the choice of several localities, and safe car-parking conditions are also desirable. In the study area, these conditions are present in established pine plantations (for example, at Mount Macedon) and in areas of dry open forest (see chapter 9 and Map 6).

Camping and caravanning

Developed camping grounds equipped with modern facilities are scattered throughout the study area and especially at tourist centres, either on or adjacent to public land. The facilities are popular, especially during summer holiday periods.

Camping at undeveloped sites in conjunction with bush-walking, canoeing, fishing, hunting, and motoring trips has also increased in popularity over recent years.

Hunting, shooting, and fishing

Fishing is widespread throughout the study area on coastal and inland waters. Land requirements include access to and use of stream frontages and shorelines, and minimal water pollution. Many streams through public land have been stocked with introduced trout species and provide good fishing. Special provisions for fishermen have been made on some water supply storages (see Table 9), but access to many Crown land frontages often presents problems.

Deer-hunting occurs to a limited extent on public land in the mountainous north-east. Requirements include effective management of species and habitat, control of animal predators, and continued access to suitable hunting areas.

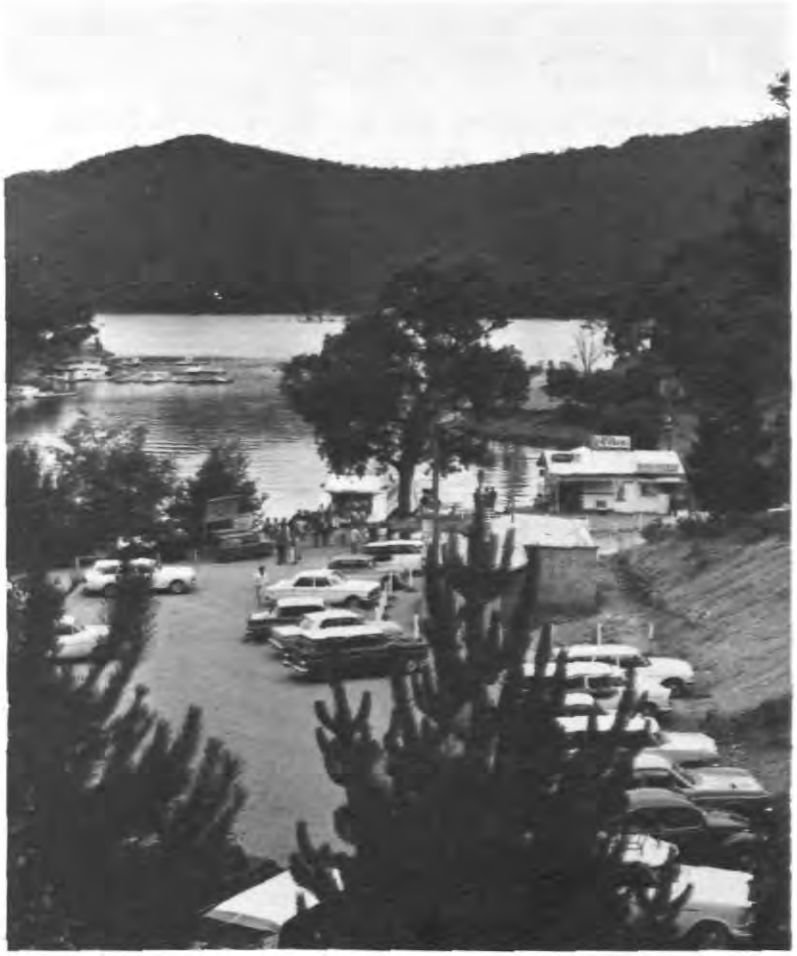
Duck-shooting in season is limited to Lake Connewarre and Reedy Lake, and requires continued management of species.

Water-based activities

Swimming, sailing, canoeing, and power boating are among the most popular forms of outdoor recreation, attracting large crowds to suitable coastal and inland sites. Their requirements vary considerably, but they all need: access to shoreline or water; maintenance of water-quality standards; and usually the provision of parking areas, picnic facilities, and other amenities. There are relatively few inland water bodies on which a full range of activities is permitted.

Snow sports

Snow sports include downhill-skiing, ski-touring, and other forms. With the possible exception of Mount Torbreck, the most suitable downhill-skiing sites in Victoria lie outside the study area, although there are several cleared runs at Mount Baw Baw and Lake Mountain.



Lake Eildon is intensively used for many types of water-based recreation, as well as conserving water for irrigation

Conditions for ski-touring are very favourable on Mount Baw Baw, where several huts and marked trails have been established. Occasional snow-falls on mountains closer to Melbourne (for example, Mount Donna Buang) attract large week-end crowds. These activities occur only on public land.

Golfing, tennis, horse-racing, etc.

These activities require substantial modification to the original site, which usually lies in or adjacent to population centres. Individually, their land requirements are relatively small, and they are often administered by local committees of management.

Land Use Compatibility

Recreation activities vary in their interactions with each other and with forms of non-recreation land use. The study area contains many examples of growing competition between activities with quite distinct site requirements.

Organized sports requiring extensive site development (for example golf courses) tend to exclude other pursuits. There is a growing gulf between activities benefiting from minimal disturbance to the natural environment (such as bushwalking) and those that disrupt vegetation, wildlife, and land forms (such as indiscriminate use of motorized recreation vehicles). The most flexible activities are those without specialized or large-scale land requirements that can use existing roads. These include pleasure driving, picnicking, and sightseeing.

Compatibility with non-recreation land users also varies. The quality of many recreation invironments and, in some cases, the actual areas available are subject to increasing pressure from urban development, the provision of utility services, and mining and forestry activities.

These conflicts are greatest in the zone surrounding the metropolitan areas of Melbourne and Geelong. Relevant chapters and block descriptions discuss the localized effects in greater detail.

Carrying Capacity

Intensive recreation pressures at a number of sites have resulted in the deterioration of many of the features that originally made them attractive. Carrying capacity refers to the acceptable level of usage, beyond which ecological deterioration and reduction of user satisfaction set in.

Further research is needed to establish these maximum safe levels for various types, but there is evidence that many of the more popular sites surrounding Melbourne reach saturation point during periods of peak demand.

Examples of site deterioration through over-utilization are given in block descriptions (Part IV).

The ability of a site to withstand large numbers of visitors depends mainly on the type of environment in which it is located. The most fragile sites are those in coastal, sub-alpine, and low-rain-fall areas.

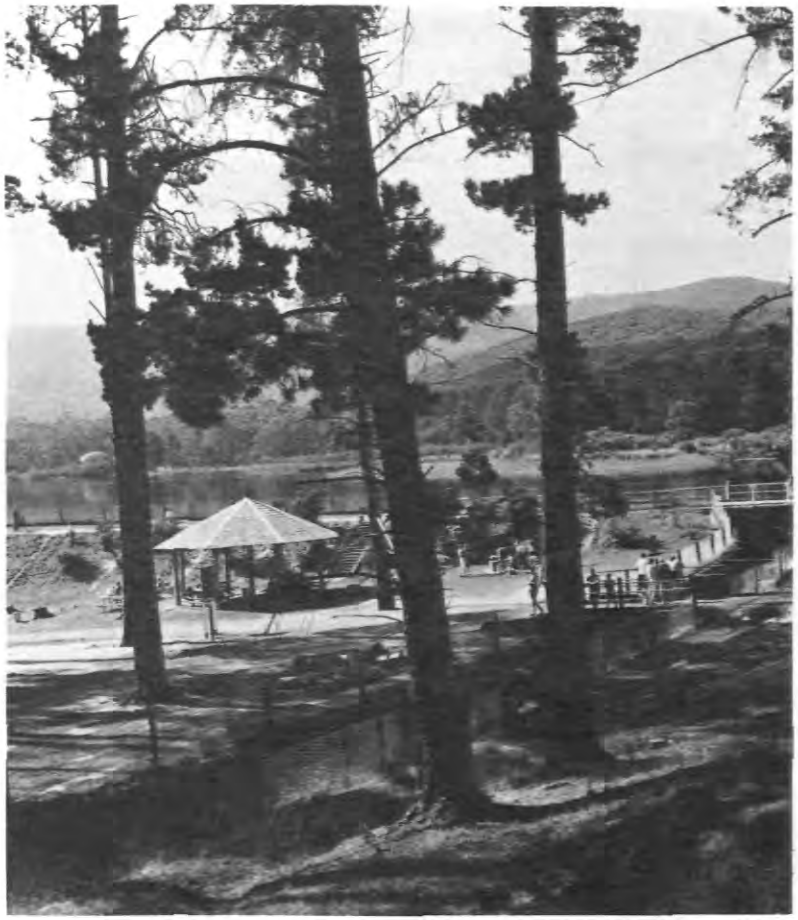
The Pattern of Recreation Trips

Traffic-volume statistics indicate the relative volumes of recreation traffic along major highways and are supported at a more detailed level by records of visits to individual sites.

However, no comprehensive information on recreation travel patterns in the study area is available. Existing data sources have many limitation; nevertheless they can be used to give a general guide.

Most forms of outdoor recreation usually involve a journey of some distance, either incidental to the main purpose of the outing or as an integral part of it. Most recreation trips are made by private vehicles or, to a lesser extent, by hired bus or coach. Generally, recreation sites on public land are not accessible by public transport although some bush-walkers use the railway to reach the area from which their walks commence and terminate.

Table 10 shows average Sunday traffic volumes along main highways radiating from Melbourne in 1964-66. Although these statistics include more than just outdoor recreation traffic, they do show the importance of recreation traffic



Toorourrong Reservoir. Picnic sites with all amenities have been developed at many of the water storages around Melbourne

relative to average daily traffic flows normally associated with work trips.

In general, traffic flows decline markedly with distance from the city. This suggests that, while some people are prepared to travel long distances for one-day recreation, the bulk of recreation traffic is contained within a radius of approximately 70 km from Melbourne.

Table 10 shows that the volumes of recreation traffic differ markedly between sectors in the study area. This situation is partly explained by the nature of recreation opportunities in each sector. For example, the relatively large traffic flows in the south-east and south-west reflect the popularity of coastal areas.

Site visits

Unfortunately, comparable attendance records have not been collected for many recreation sites over a useful period. Comparisons of site popularity are therefore difficult, and projections of growth rates for visitor numbers based on these figures are subject to some limitation.

Estimated visitor levels of national parks in the study area listed in Table 11. During 1972/73, at least 350,000 people visited five national parks at varying distances from Melbourne.

There is some indication that the growth rate in annual visitor numbers is beginning to level off for Kinglake and Fraser Parks, although visitor levels at the others are continuing to increase.

Table 10

ESTIMATED AVERAGE ANNUAL SUNDAY TRAFFIC ON MAJOR HIGHWAYS 1964-66

Sector	Highway	Distance from Melbourne GPO (km)	Annual average vehicles per day (both directions)	
			Sunday	Week-days
South-east	Nepean	44	12,914	8,240
		91	5,564	3,560
	Bass	108	5,403	2,690
	South Gippsland	50	7,796	4,880
		102	2,587	3,560
	Princes (east)	52	9,085	6,500
East	Warburton	58	4,992	3,030
	Maroondah	58	6,053	2,890
		93	1,916	940
		168	1,100	590
North-east	Goulburn Valley (north of Seymour	110	3,285	2,660
	Goulburn Valley (east of Seymour	131	1,638	990
North	Hume	52	8,988	6,840
North-west		127	3,922	3,620
	Calder	23	7,530	4,360
West	Western	41	8,540	5,400
South-west	Princes (between Geelong and Melbourne)	33	17,148	10,674
	Princes (west of Geelong)	114	3,427	2,840

Source: Victorian Country Roads Board Traffic Volume Counts 1964-66

Table 11

ESTIMATED VISITORS TO NATIONAL PARKS, 1958-73

Year	Ferntree Gully	Kinglake	Fraser (a) day visitors	Fraser (b) camper days	Churchill	Organ Pipes
1958/59	65,000	16,000				
59/60	65,000	-				
60/61	-	21,000				
61/62	65,000	-				
62/63	70,000	35,000	4,900			
63/64	70,000	40,000	6,600			
64/65	65,000	44,700	7,100			
65/66	70,000	57,000	10,100			
66/67	70,000	63,000	11,100	9,300	12,000	
67/68	65,000	71,600	11,600	11,000	13,000	
68/69	70,000	97,500	17,500	14,500	23,700	
69/70	75,000	98,500	25,700	22,700	33,000	
70/71	85,000	106,500	34,900	29,700	35,000	
71/72	90,000	111,600	30,700	36,500	41,300	
72/73	110,000	98,100	29,000	38,300	46,000	25,000

Source: National Parks Service, 1973

Table 12 gives estimates of visitors in 1972 to recreation sites controlled by the Forests Commission.

A recent survey of visitor numbers at reserves operated by the Melbourne and Metropolitan Board of Works estimated a probable total in excess of 1 million visitors during 1972.

Reliable attendance figures based on gate receipts at Healesville Sanctuary show an average 5% per annum increase in numbers of visitors over the last 10 years. The 1971/72 attendance was 351,566.

In general, the number of visitors at a site is influenced by a combination of

many factors, including the effects of distance and direction, accessibility, reaction to overcrowding, knowledge of alternative sites, and population sizes and densities relative to sites. Weather conditions and the presence of group outings (such as car rallies, club picnics, or school outings) are important random elements that effect numbers present on any given day.

Table 12

ESTIMATED ANNUAL VISITOR NUMBERS AT RECREATION SITES CONTROLLED BY FORESTS COMMISSION

Site	Estimated visitors 1972
Mount Macedon	120,000
Mount Disappointment	24,000
You Yangs	96,000
Sherbrooke	150,000

Characteristics of Recreation Visits

Several important characteristics associated with recreation visits in the study area help to explain these patterns.

For a discussion of travel behaviour, recreation traffic beyond the metropolitan area can be divided into extended trips and day visits.

Extended trips

Overnight, long-week-end, and vacation journies tend to have a recreation hinterland wider than the Melbourne study area. Alpine resorts are growing in popularity for both summer and winter recreation. Wilsons Promontory, Gippsland Lakes, and the Grampians are examples of resource-oriented attractions outside the Melbourne region.

Nevertheless, many extended holidays still occur within the study area at sites also frequented by day visitors, often at holiday cottages or camping grounds in coastal and popular mountain resorts.

Day trips

Week-end day trips account for the largest proportion of total recreation trips. The destinations are concentrated within a zone 30 to 80 km from the city centre, which suffers the heaviest demand and includes most of the popular recreation outlets, namely Mornington Peninsula, the Dandenongs, Yarra Valley, Kinglake, Mount Macedon, the You Yangs, and the Bellarine Peninsula.

Only a very small percentage of day visitors will travel longer distances for recreation. Metropolitan residents make considerably fewer day visits to Wilsons Promontory and Lake Eildon than to nearer locations; the average 'round trip' is less than 100 km.

Day trips vary in mode of travel, timing, purpose, directional bias, and general origin.

Mode of travel

The private car dominates as the means of transport to most non-metropolitan recreation sites. It allows considerable independence in the choice of timing, route, and destination, and many recreation pursuits are taken in close proximity to it and depend almost entirely on its use. Parking at recreation sites presents a difficult challenge to those responsible for site design and management. No substantial change in the mode of travel is anticipated within the foreseeable future.

Use of the foreshore for car-parking at Ocean Grove

Timing

The timing of trips varies according to season of the year, day of the week, and hour of the day. Coastal zones are subject to peak demand during summer (December-March). Mountain areas receive relatively more visitors during spring and autumn, except for localized sites where snowfield activities have been established. Demand for recreation in National Parks and Forest Parks tends to peak in March and April, with lowest use during mid-winter.

Most recreation trips occur on Sundays and public holidays. In general, these trips commence between 10 and 12 a.m. and end between 3 and 6 p.m. The regularity in time of day for most recreation outings contributes to excessive congestion along main highways near the city.

This tendency to concentrate demand in certain peak periods results in most recreation areas being under-utilized for relatively long periods. It may provide valuable "breathing space", enabling sites to recover from excessive week-end pressure.

Trip purpose

On recreation outings, some individuals travel directly to a particular site and remain there, while others visit several places. These decisions are influenced by the type of recreation

sought, and in turn reflect the opportunities available at various sites. Thus sites can be classified according to whether the attractions they offer occupy visitors for long or short periods, and to their location relative to frequently used recreation routes.

Look-outs, often scattered along scenic drives, retain visitors for only short periods and daily visitor turnover is relatively high. In contrast, recreation outlets with attractions of an educational nature (such as Healesville Sanctuary) and summer beach resorts retain visitors.

Between these two extremes lie numerous recreation sites that retain visitors only long enough to picnic or amuse themselves for a couple of hours.

Directional bias

Recreation trips in the study area show a noticeable directional bias. People tend to take the shortest and most direct route out of the urban area into the surrounding country, especially along main highways. Residents often know the recreation opportunities in their 'sector' quite well but are less certain about opportunities on the other side of Melbourne. This partly accounts for the heaviest recreation pressures being currently experienced to the east and south-east of Melbourne, because of the bias in population towards this side.

Trip generation

Not all of Melbourne's suburbs generate the same proportion of recreation trips within the study area. Differences in socio-economic status affect the number of trips originating in various suburbs. Areas where car, boat, and caravan registrations and second-home ownership ratios are higher than average tend to generate more recreation trips than others.

The eastern half of Melbourne again emerges as the zone generating the most trips. Location near recreation resources with high amenity value also affects trip generation rates.

Factors Affecting Demand

Within the community, a number of factors collectively influence demand for outdoor recreation, although the precise effects of each have not been fully determined.

Although not considered in detail here, changes in the demand for recreation will also follow other psychological, demographic, and technological changes occurring in the community.

Population

The size of the population of Melbourne and Geelong strongly influences current demand for recreation in the study area. The 1971 figure of 2.8 million is ex-

Suburban expansion is encroaching onto valuable recreation areas in the urban fringe

pected to almost double over the next three decades, bringing total population enclosed by the study area to more than 4 million.

A population of this size will have servicing requirements that increase the competition for space around the metropolitan fringe.

Population distribution has important implications. In general, residential proximity tends to increase the number of visits to recreation resources. Surveys in the study area suggest that a large proportion of visitors to a site live within a 50-km radius of it.

Studies of house location preferences have shown that access to recreation resources is one of several important factors in the decision. Suburban expansion south and east of Melbourne and south of Geelong confirms the desirability of access to recreation resources and is resulting in unequal pressure on a few areas, including the Mornington Peninsula, Dandenongs, Yarra Valley, and the south-west coastline.

The proportion of young people in Melbourne's population is increasing, with outer suburbs receiving the largest intake of young families. Since the recreation patterns of this group tend to be associated with pleasure motoring, picnicking, and water-based activities, recreation demand for the relevant facilities around the urban fringe is likely to increase.

Disposable income

Overseas studies in western civilizations have suggested that people often spend an increasing proportion of disposable income on recreation as their real and disposable incomes rise. In addition, a general increase in outdoor recreation can be expected as the community becomes more affluent.

Most forms of recreation require financial outlays for specialized equipment, travel, or accommodation. Expenditure in Australia and in the study area on many of these items has increased in recent years. Evidence also suggests that the percentage increase in expenditure is greater than the percentage increase in household income.

Purchase of one or more motor vehicles for private use is tied closely to household income and has important implications for recreation.

Mobility

The increasing availability (to an expanding section of the population) of a motor vehicle for private use is markedly increasing recreation travel in the study area. Few recreation sites on public land are readily accessible by public transport.

In 1964, the Melbourne Transport study showed that less than 65% of Melbourne's households had access to a vehicle for private use, while only 14% of households had more than one car available.

These figures are expected to rise to 83% and 29% respectively by the year 2000. Since the frequency of recreation trips increases with higher car ownership ratios, the amount of future recreation traffic will expand considerably over present levels.

Parts of the mountainous north-east of the study area are inaccessible to conventional vehicles

Accessibility

The existing road network in the study area influences the extent to which recreation sites are utilized. Main roads are shown on Map 7. In general, areas of public land close to main roads tend to receive more recreation visits than those in less accessible locations. This fact partly accounts for the relatively low utilization of recreation resources of the rugged north-east.

Discretionary time

Time not committed to the basic requirements of eating, sleeping, education, and employment can be regarded as discretionary or leisure time. The amount available to individuals varies mainly with age. It normally occurs in recognizable periods, ranging in length from short periods in the evening to week-ends, annual holidays, long service leave, and retirement.

Outdoor recreation on public land normally involves commitments of several hours or more. Since most people are committed to school or work during the week, recreation pressures tend to coincide with week-ends, public holidays, and annual holidays.

Apparent increases in the availability of leisure due to a reduced working week and longer holidays could generate more demand, but indications are that much of this increase is taken up by overtime, second jobs, and other activities.

Changes in the structure of leisure time are also significant. Three-day week-ends, for example, could lead to more long-distance recreation trips.

Education

Studies have shown a relation between the levels of education and recreation. Formal schooling increasingly involves outdoor activities, while education curricula are now incorporating a wider range of environmental studies that, as well as enhancing environmental awareness, require access to tracts of natural bushland and geological and botanical sites in close proximity to schools.

The number of people receiving tertiary education is growing rapidly. In the study area tertiary enrolments increased from about 57,000 students in 1954 to more than 90,000 in 1966.

Advertising and promotion

Evidence from field surveys suggests relatively little community awareness of the choice of recreation opportunities. However, publicity about the type of sites available in the region could have two effects: it may help to redistribute recreation visits over a wider range of sites, but at the same time may result in an increase in the total number of visits.

Available supply

The stock of recreation resources and developed facilities available at any time will also influence the extent of recreation usage. Land will be used in different ways as new forms of recreation activity are developed.

Predicting Future Demand

The number and type of variables involved make accurate prediction of future

recreation demands difficult. Random changes in community attitudes and emphasis towards certain forms of recreation complicate it further.

The evidence available points to a continued increase in actual demand for most types of recreation on public land. Undoubtedly, upper limits on an individual's use of outdoor recreation opportunities result from household economic limitations, other commitments, and a substitution of different forms of entertainment. However, it appears that many individuals will continue to increase their level of outdoor recreation.

Even if this greater *per capita* use does not occur, aggregate community demand will increase as the result of population growth. Increased recreation pressures can be expected at all sites, particularly those near areas of planned future population growth and those with outstanding natural resources. Although most pressure will remain focussed on a relatively small proportion of land, there are signs that forms of outdoor recreation needing large areas of land will also increase.

In particular, the noticeable growth in recreational activities requiring near-natural surroundings will make public land increasingly significant for outdoor recreation.

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HARDWOOD TIMBER

Hardwood forests cover most of the public land in the study area. They have been utilized for timber products since the earliest days of European settlement and have played an important part in the State's development. As the character of the present forests results largely from past operations concerned with timber production, this chapter first outlines the history of utilization. It then describes the various forest types and their products, with some discussion of the expected demand for timber products and the capability of the study area to supply the necessary raw materials.

History of Production

Many references to the magnificence of the virgin forests that covered much of the area at the time of European settlement appear in contemporary records. These provided the building materials and firewood for the growing settlement of Melbourne.

The gold boom of the 1850s brought the first heavy demand for forest products. Stringybark forests around mining centres such as Steiglitz, Daylesford, Trentham, and Walhalla were ruthlessly exploited for fuel, building materials, and mining timbers. Similar uncontrolled logging at Macedon, Broadford, and other accessible areas close to Melbourne provided timber for the rapidly growing capital.

The Wombat Forest, situated close to Melbourne and the mining centres of Ballarat and Castlemaine, bore the brunt of this attack. Output of sawn timber from the forests in the 1870s was about 141,600 m^3 annually, but by 1896 it had dwindled to 16,500m^3. In 1899 it was described at a Royal Commission as "a ruined forest ... the result of the mismanagement and neglect of the past 30 years".

By this time large areas of forest on better soils had been ring-barked and alienated, as land settlement and agriculture expanded. The irregular boundaries of much of the present public land in the stringybark forest zone of the foothills reflects the encroachment of these settlers with little regard to other uses, possibly more suitable.

Despite the devastation, these forests regenerated naturally. Strong demand for industrial fuel, as well as for

sawlogs and other timber, in the period 1900-1950, together with much stricter supervision, enabled the regrowth to be tended and improved.

The mountain forests largely escaped the exploitation of the gold rush era. Timber from these forests had been used for split palings and shingles since the earliest days of settlement, but difficulties in drying and seasoning the sawn timber made them unpopular for milling.

Land settlement during the 1880s resulted in the clearing of large areas of mountain forest, especially in the Strzelecki Ranges. Often the conditions of slope and climate proved too difficult for agriculture, and many farms were abandoned and in recent years have been purchased and re-forested by the State and private companies.

The success of ash timber for milling was assured from about 1910 onwards, when techniques for proper seasoning were developed. Logging operations, initially in the Yarra valley near Warburton, quickly spread further afield to the valleys of the Latrobe and Thomson Rivers.

The sawmills and associated settlements were mainly located in the forest, with logs and sawn timber carted on tramways. These ranged from wooden rails and horse-drawn trucks to more elaborate steel tramlines with steam locomotives. Logging of the huge trees in the steep

Horse team and steam locomotive - early methods of timber extraction in the mountain forests

country was beyond the ability of horses and bullocks, and large stationary steam winches were introduced.

These logging operations left large quantities of lower-quality wood, considered useless for sawing. Investigations proved this waste to be suitable for paper-making, and in 1936 Australian Paper Manufacturers Ltd built a chemical pulp mill at Maryvale, drawing supplies from nearby forest areas.

Notable areas of mountain forest not harvested were in the catchments of

Wallaby Creek, Maroondah, and O'Shannassy, all of which were closed to logging prior to 1910.

Disastrous fires in 1926 in the Acheron area and south of the Yarra - extending to Toorongo and Noojee - were followed in 1939 by even more extensive and severe wildfires. These killed almost all of the remaining mature stands in the study area. Some stands on the steep southern slopes of the Wallaby Creek and O'Shannassy catchments, as well as pockets and gullies in the other areas, survived. A vast salvage programme was undertaken to utilize the standing dead trees, and more than 4.5 million m^3 of sawlogs were successfully salvaged over 10 years. Utilization was finally stopped in the late 1940s to avoid danger to the dense crop of seedlings that established after the fires, and most logging operations in mountain forests were forced to move further afield to the east of the study area.

The very extnesive regrowth forests, now more than 30 years old, are a dominant feature of the high-rainfall parts of the study area. The supply of high-quality hardwood timber for the future depends greatly on this resource.

Forest Types and Products

Mountain forest zone

Mountain forests occur on friable reddish or brownish gradational soils above 450 m where rainfall exceeds 1,200 mm. Mature stands exceed 40 m in height and in places may reach 80 m. Their distribution is shown on the vegetation map - (open forest IV). Within the study area they total about 172,000 ha (63% of the State's total). Typically, mountain forests grow in pure stands or mixed with only a few species. In the study area, mountain ash and alpine ash predominate, with lesser areas of shining gum. The high volumes per hectare and fast growth rates of these species (see Table 13) - together with the moderate weight and attractive appearance of their timber, which is free from gum veins and other blemishes - make them some of the most important commercial species in Australia.

Currently, 0.4 million m^3, or about 25-30% of the sawlogs produced annually in Victoria, are obtained from ash species. They provide the main source for the select-quality board timbers used for flooring, architraves, panelling, window frames, and cabinet-making.

The ash species also have a number of desirable properties for paper-making. They have comparatively long fibres for hardwoods, and a favourable diameter: fibre length ration produces a strong opaque paper. The light colour lessens the cost of bleaching pulp. In comparison with softwoods, they have a high yield of pulp per unit volume of wood. Young fast-growing trees produce the best pulp. About 64% of the 0.3 million

Table 13

HARDWOOD PRODUCTIVITY

Category	Structural form	Main timber species	Predominant soils	*Productivity (MAI in m^3/ha/an)
A High to very high	Open forest IV	Mountain ash, alpine ash with some shining gum, messmate stringybark, mountain grey gum	Friable brownish gradational	Actual MAI range is 7-21 depending on site index, average is about 14; potential MAI in plantations under intensive management could reach 28: suitable for sawlogs and pulpwood.
B Moderate	Open forest III	Messmate stringybark, mountain grey gum, silvertop, narrow-leaf peppermint	Friable reddish and yellowish gradational	Estimated present MAI about 2.8; potential MAI about 4.9: suitable for sawlogs and pulpwood
C Low	Open forest II	Various stringybarks, gums and peppermints	Yellowish gradational	Estimated present MAI about 1.4; potential MAI about 3.5: suitable for sawlogs and minor timber products and pulpwood depending on suitability of species
D Very low	Open forest I	Various stringybarks, boxes, and peppermints	Shallow stony and duplex soils	MAI very low; suitable only for minor timber products

* Notes on productivity:

1. MAI (mean annual increment) = Total volume production to a 10-cm small-end diameter under bark, divided by the number of years in the rotation.
2. Actual MAI for category A is based on detailed recent resource surveys. Estimated MAI for other categories is based on less detailed information. In both cases they are broad hectare figures for large forest areas including unstocked and sparsely stocked areas.
3. Potential MAI is that expected to be achieved from natural forests with improved utilization, better stocking and more intensive management.
4. The proportion of pulpwood volume to sawlog volume varies from about 7:1 to 1:1 depending on the site index of the stands and their past history of utilization and fire.
5. In the study area, mountain ash has site indices in the range 21.5 - 36.5, the most common being 30.5; for alpine ash the range is 18 - 33.5, the most common being 26. Site index is height in metres of the dominant trees at age 20 years.

m^3 of hardwood used for paper-making in Victoria comes from ash species.

Conditions required for the regeneration of these species are exposed soil or an ash bed, no overhead shade, and a supply of seed. Such conditions occur naturally following wildfires in mature stands. They may be artificially created by clear-felling, controlled burning, and seeding.

The study area contains about 19,000 ha of public land that originally carried ash forests but, due to successive fires, is now covered with scrub and bracken. These currently unproductive areas could be successfully reforested if funds were made available. Their distribution is shown on Map 6.

Stringybark forest zone

This general term covers the forests occurring on various duplex and gradational soils in areas receiving between 600 and 1,200 mm annual rainfall. Mature stand heights are in the range 15 to 40 m. Their distribution is shown on the vegetation map (open forest II and III), with a total of about 270,000 ha lying within the study area.

These forests tend to comprise stands of several species mixed together. The most important species are messmate stringybark, mountain grey gum, silvertop, and narrow-leaf peppermint. Species of less importance are brown stringybark, manna gum, candlebark, yertchuk, white stringybark, and blue gum. Although growth rates and volumes per hectare (see Table 13) are far lower than those for mountain forests, the vast extent of the stringybark forests and their ready access make them very important commercially. They produce sawn timber for house-framing and a wide range of general construction purposes, pulp for both paper and hardboard, and a variety of round-wood products, including posts, poles, piles, and firewood. About 0.8 million m^3, or more than two-thirds, of the State's sawn timber comes from the stringybark forest zone. It is estimated that messmate alone contributes 0.3 million m^3.

Regeneration of these forests differs from that of the mountain forests.

Occupying a drier more fire-prone environment, these are not easily killed by fire. Even when completely defoliated, the larger trees can produce new crowns from dormant buds in the branches and stems, while saplings can regenerate from ligno-tubers just below ground level. Seedlings can become established in small gaps caused by the death or removal of one or two mature trees, provided the seed-bed is suitable.

The stringybark forests are therefore more flexible to manage, with regeneration methods varying from clear-felling as in ash (giving rise to even-aged stands) to removal of single trees or

Timber extraction in the Powelltown area

groups of trees (leading eventually to uneven-aged stands). Regrowth may be of either coppice or seedling origin.

Although wildfire may not kill trees in this forest type, it may seriously degrade their timber and retard their growth.

Box-ironbark forests

These forests grow on poor soils below 500 m in areas where the annual rainfall is less than 700 mm. They are not well developed in the study area, occurring only in Torquay, Brisbane Ranges, and Puckapunyal blocks. Mature stands rarely exceed 33 m top height, and in the drier areas form woodland rather than forest.

Small quantities of durable timber for posts and poles have been produced from these forests in the past. Current production of wood products is low.

Present Situation

It is estimated that more than 3,000 men are employed in harvesting wood from the study area and in processing the green timber at some 140 plants. The total wood intake of these plants is estimated at about 870,000 m^3 annually (this includes about 225,000 m^3 of softwood) and comes from both public and private land. Table 14 gives details of these estimates.

The forests of the study area provide about 20-25% of the 1.3 million m^3 of hardwood sawlogs currently produced each year from public land in Victoria, and about 70-75% of the 0.34 million m^3 of hardwood pulp.

Outlook

Softwood and hardwood timbers (especially ash-type) are interchangeable for a wide range of purposes, although in a particular case one or other may be preferred. In order to put the hardwood forests of the study area into true perspective, some reference must be made

to the outlook for softwoods, although details of this appear in chapter 15. It is worth noting that from the point of view of timber production one hectare of softwoods is the equivalent of several hectares of hardwoods (compare the growth rates shown in Tables 13 and 17).

Sawlog demand

Victorian hardwood and softwood forests currently produce about 1.6 million m^3 of sawlogs annually. Public forests contribute almost 90% of this total. The demand for sawlogs, however, is far greater, and the State imports the equivalent of about 800,000 m^3 of sawlogs annually. Of these imports, about 200,000 m^3 is softwood from South Australia, about 300,000 m^3 hardwood from Tasmania (representing between 30% and 40% of the sawlogs production of those States), and about 300,000 m^3 from overseas (mainly softwood from New Zealand and the west coast of North America).

The present population of Victoria is about 3.5 million, so the current *per capita* consumption of sawlogs is about 0.69 m^3 per annum. In all developed countries there is evidence of a steady decline in the *per capita* consumption of sawn timber. This is due to many factors, including the change in the type of buildings required and the increasing use of substitutes such as plastics and aluminum. It is generally agreed that this trend will continue and estimates of the *per capita* consumption for the year 2020 are the equivalent of about 0.5 m^3 of sawlogs per annum. However, demographers predict steady increases in the State's population during this time, and conservative estimates for that year are about 8 million. The demand for sawlogs in the State is therefore expected to increase from the present level of about 2.3 million m^3 per annum to about 4.8 million m^3 in 2020.

Sawlog supply

Three important sources of sawlogs can be recognized in Victoria. The first, softwood plantations, have been rapidly increasing in area over the last decade (see chapter 15). The second, mature forests of native hardwoods, have been husbanded to maintain a reasonable sustained supply of sawlogs until the trees from the third source, regrowth forests of ash-type hardwoods resulting mainly from wildfires in 1926 and 1939, reach maturity over the next 20 or 30 years.

Softwood plantations in Victoria currently produce about 300,000 m^3 of sawlogs annually. Provided the current planting programmes are maintained, the supply of sawlogs is expected to increase gradually over the next 20 years to a level of about 900,000 m^3. From then, availability will increase rapidly as plantations established during the 1960s reach maturity, and by the year 2020 output is predicted to be about 2.7 million m^3.

Table 14

SUMMARY OF WOOD INDUSTRIES BASED ON THE STUDY AREA

Type of plant	Number of plants (1)	Estimated wood intake (m^3 p.a.) (2)	Estimated proportion of softwood (2)	Estimated number of employees (3)
Sawmill	120	390,000	20%	1,460
Wood preservation	18	40,000	80%	100
Veneer manufacture	3	10,000	90%	90
Fibre board	1	70,000	-	300
Paper pulp	1	360,000	30%	1,150
Total	143	870,000	25%	3,100

(1) Several of these plants lie outside the study area (often within the metropolitan zone) but draw their supply from the area.

(2) These figures are at best only rough estimates - although accurate records are kept of output or produce from public land, the boundaries of the record units seldom coincide with those of the study area; records of output from private land are generally poor.

(3) Employment figures consist of the number of employees at the plant plus an estimate of the number of men engaged in harvesting, computed at the rates of 1 man per 1,200 m^3 per annum for sawmills and veneer manufacture and 2 men per 1,200 m^3 per annum for the other types of plant.

The mature hardwood stands in Victoria are currently producing about 1.3 million m^3 of sawlogs annually. It is expected that supply of timber from this source will steadily decline to a level of about 0.4 million m^3 in the year 2020.

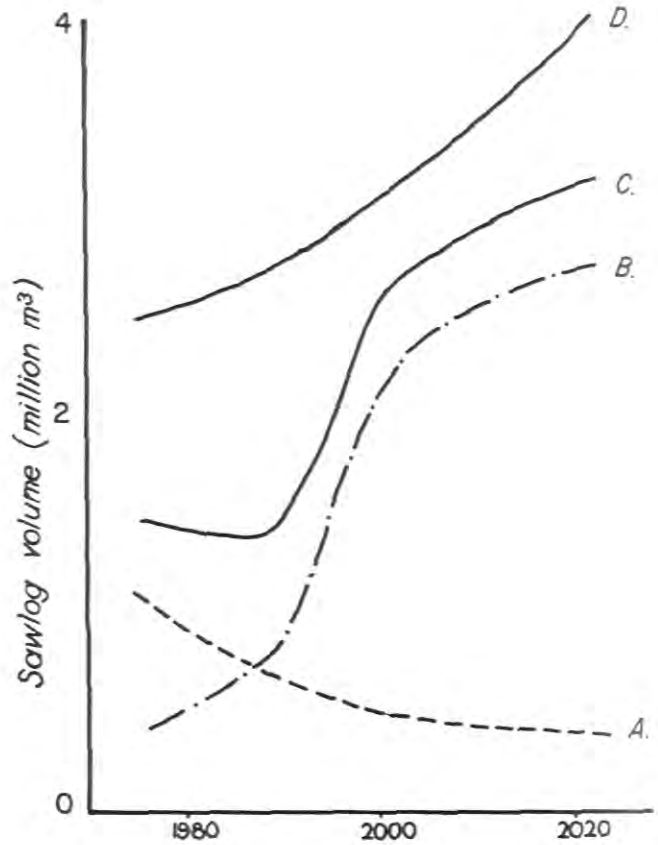
The combined supply available from mature hardwood stands and softwood plantations will therefore not meet the anticipated demand. The present shortfall is expected to increase until the 1990s, when maturing softwood plantations will reverse the trend. Figure 5 illustrates these expected trends in supply and demand.

The regrowth forests of ash-type hardwoods could significantly reduce this expected shortfall. Totalling about 157,000 ha, they have far higher growth rates than any other native forest (see Table 13), and will be maturing at a time when the availability of sawlogs from other sources within the State will be at its lowest relative to the expected demand. These forests will therefore be heavily relied on if the State's output of hardwood sawlogs is to be maintained or increased.

The study area

The present annual cut of hardwood sawlogs from public land in the study area is about 270,000 m^3. This represents about 20% of the State's output. About 210,000 m^3 comes from stringybark for-

FIG. 5. TRENDS IN VICTORIAN SUPPLY AND DEMAND FOR SAWLOGS



A. Predicted supply from mature hardwood stands

B. Predicted supply from softwood plantations

C. Predicted supply A. and B combined

D. Predicted demand

ests and 60,000 m^3 from ash forests. Over the next 20 years, output of sawlogs from the stringybark forests in the west of the study area should continue at its present level (about 70,000 m^3), while the capability of mature ash and stringybark forests in the east of the area to produce sawlogs will decline.

The ash regrowth forests here, as they mature, have a very high capability to supply sawlogs, and are particularly important when considering the State's future production. Of the 157,000 ha of ash regrowth in Victoria, about 106,000 ha (67%) are on public land in the study area.

In addition, unlike such forests in other parts of the State, those in the study area are very favourably located close to the major population centres of Melbourne, Geelong, and the Latrobe Valley. Moreover, they occur over very extensive areas on the relatively flat (and therefore readily accessible and loggable) terrain of the Black Range, Acheron, Cerberean, Gregory, and Baw Baw plateaus. The extent of this type of terrain, where slopes are generally less than 20°, is shown on Map 7.

Pulpwood demand

The only other major timber product from Victorian forests is pulpwood, for paper and for panel products. Current annual demand in Victoria for paper products is equivalent to about 700,000 m^3 of sawlogs. There is little doubt that we will follow the trend of other developed countries and the present *per capita* consumption will steadily rise. This rise, combined with population increase, will probably lead to a three- to five fold increase in demand by the year 2000. Current Victorian demands for fibre-board and for plywood total the equivalent of about 200,000 m^3 of logs annually, and at least a threefold increase is expected by the year 2000.

Paper and fibre-board manufacture, both capital-intensive processes, require machines and ancillary equipment costing tens of millions of dollars. Production is therefore limited to a small number of sites to achieve economies of scale, and these are generally located close to the sources of raw materials rather than close to the markets.

A processing plant at any one site usually specializes in one type of product and supplies a national rather than a local market. Thus Victoria imports virtually all its newsprint requirements from Tasmania and overseas, while paper packaging materials manufactured in Victoria supply not only the State's needs but much of Australia's as well.

Because of the very high coasts incurred in establishing pulp-processing plants, and the need for an assured supply of raw materials (most of which are on public land), it is usual for an agree-

ment to be made between the government and the manufacturer. This agreement is ratified by Act of Parliament and provides for the government to make available annually certain quantities of wood for specified areas, while it binds the manufacturer to accept certain minimum quantities of wood annually or make certain minimum royalty payments. Provision is made for periodic review of the agreement.

Industries based on pulpwood can lead to considerable improvement in the management of commercial forest areas, as they can process poor-quality timber not suitable for sawlogs. They can thus promote a more complete utilization of wood on areas being logged, more economical regeneration of hardwood forests that have been degraded due to wildfires or to past selective logging, and earlier and more regular thinnings in young stands.

Pulpwood supply

The ratio of pulpwood volume to sawlog volume in Victorian hardwood forests ranges from about 1:1 in better-quality stands to 7:1 in poorer stands.

In the study area, however, most of the hardwood pulpwood available is already committed to the two companies that have entered agreements to utilize this type of wood in Victoria. Hardboards of Australia Limited (H.A.L.) has a hardboard mill at Bacchus Marsh, and Australian Paper Manufacturers Limited (A.P.M.) has a paper mill at Maryvale.

The study area has a limited capability to supply additional pulpwood from the Disappointment, Strathbogie, Eildon, and parts of the Upper Goulburn blocks.

Hardboards of Australia

Supplies of pulpwood to H.A.L.'s mill from public land are provided pursuant to the *Forests (Pulpwood Agreement) Act* 1959. The area of supply fixed by this Agreement lies substantially within the study area. It includes all of the Wombat block and parts of the Brisbane Ranges, Loddon, and Romsey blocks. The Forests Commission is bound each year to make available to the Company such quantity of pulpwood not exceeding 65,000 m^3 as the Company may require. In any year, the Commission can, by arrangement with the Company, supply a greater quantity or provide a proportion of pulpwood from outside the supply area.

Australian Paper Manufacturers

The mill is located just outside the study area at Maryvale, near Morwell. Supplies of pulpwood to the Company from public land are obtained under the provisions of the *Forests (Wood and Pulp Agreement) Acts* of 1961 and 1966. These *Acts* define the "forest area" in which the Company has exclusive rights for pulpwood and the "mill area", which consists of part of the forest area closest

to Maryvale. The Melbourne study area embraces most of the ash forest resources within the forest area and much of the better-quality stringybark stands favourably located to Maryvale.

From the forest area the Forests Commission is bound each year during 1970-74 inclusive to make available to the company 340,000 m^3, of which 198,000 m^3 is to be from ash-type forests. The total rises to 425,000 m^3 in 1975 and 453,000 m^3 in 1980 by increases in the amount of pulpwood from stringybark forests. Certain minimum volumes must be provided from the mill area, and a certain volume from the stringybark forests must be from regrowth stands.

The company manufactures different grades of wrapping paper, cardboard, and pulp by using various proportions of ash, other eucalypt species, softwood, regrowth, and mature pulpwood, each of which has different fibre characteristics.

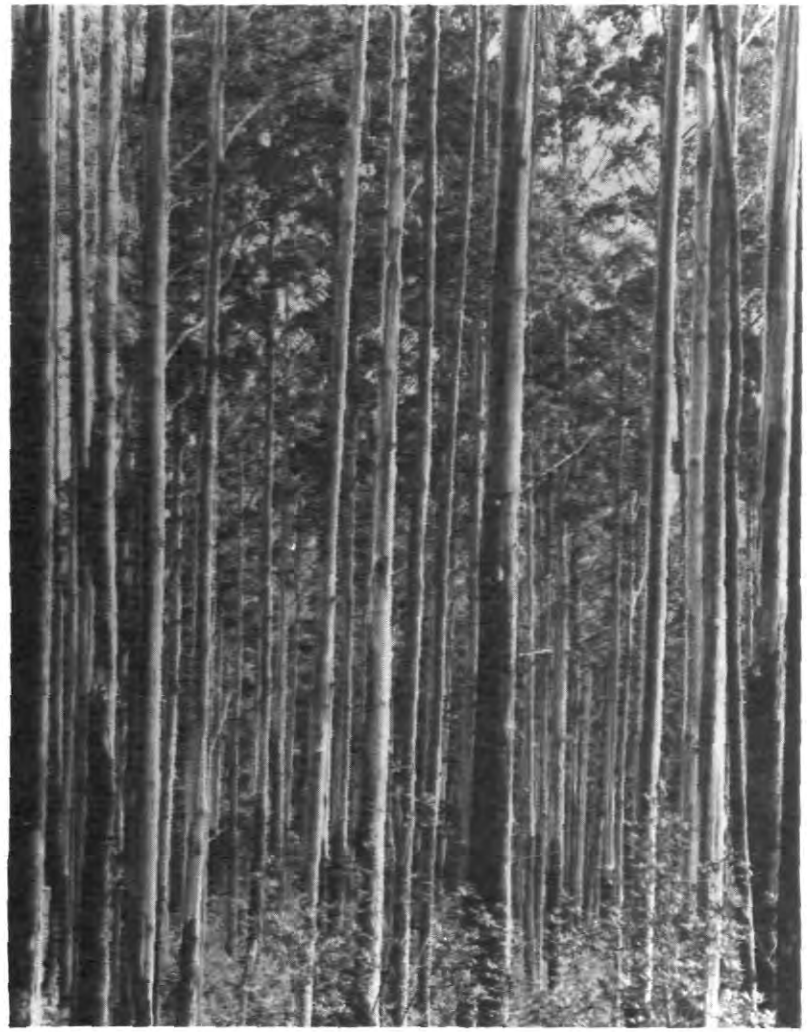
During 1972 the company used 529,000 m^3 of wood - 220,000 m^3 from public land and the rest from company-owned forests, private land, and sawmill waste.

Other industries

The mixed-species forests of Trentham and Daylesford are the main sources of poles harvested in the study area for Hicksons Timber Impregnation Plant (Aust.) Pty Ltd. located at Trentham.

Other Forest Values

The hardwood forests of the study area undoubtedly have a very high value for timber production.



Mountain ash regrowth near Powelltown

They also have considerable value for other, possibly conflicting, uses. They provide all of the water for Melbourne, Mornington Peninsula, Latrobe Valley, and numerous small towns, as well as about one-half of the water for Geelong. At present 70,000 ha of forest (including about 50,000 ha of ash-type - 29,000 regrowth, 21,000 mature and unstocked) in the Melbourne catchments are used solely for water production, timber harvesting being excluded.

Many of the forest areas, particularly stands in catchments where disturbance by humans has been kept to a minimum, have very high value as references and for scientific study. Because of their intrinsic qualities and their location, the forests have a very high capability for outdoor recreation, and the steep forested scarps surrounding the plateau surfaces, for example at Kinglake and Mount Donna Buang, are important visual features of the landscape.

As well, the forests provide habitat for many plant and animal species, a number of which have a strong association with the ash forests of the study area.

SOFTWOOD TIMBER

Softwood plantations, consisting mainly of radiata pine *(Pinus radiata)*, cover 12,920 ha of private and public land in the study area. The area has been increasing in the last few years at the rate of about 1,400 ha per annum.

Table 15 lists the major plantation-owners and the tenure of the land under plantations. In addition, a few hundred hectares are also held in school endowment plantations, farm wood-lots, and water supply reserves. Map 6 shows the exact location of plantations on public land, while Map 7 shows their general location on both public and private land.

Sawlogs from plantations are supplied to sawmills at Boolarra, Neerim South, Narbethong, Macedon, Woodend, and Emerald. Peeler logs for manufacture of veneers and plywood are supplied to four manufacturers in the metropolitan area.

Round pine timbers are treated with preservatives for fencing timber and shed poles, for transmission poles for telephone and electricity supplies, and for a number of other purposes. Two preservation-treatment plants have been established in Gippsland and one plant in the metropolitan area.

Historical

Baron von Mueller made the first recorded planting of radiata pine (for windbreaks in the Doncaster locality) in 1859. Further widespread plantings in the 1860s and 1870s demonstrated this species' suitablility for a wide range of climates and soils, and its success led to interest in other exotic species.

The need for softwood timber became apparent early in the State's history. The Macedon Forest Nursery was established in 1872, and the first commercial planting followed in 1880. In the period 1880-1910, many exotic species were established in plantations at Macedon and the You Yangs.

Radiata pine was the outstanding success on a number of soil types and through a range of climates. This led to the mistaken belief that the species would grow practically anywhere and a number of plantations were established without adequate knowledge of the essential requirements for good growth. Plantations established at Frankston (1910), French Island (1911), and Anglesea (1923) have all failed, and only remnants persist today.

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A young plantation of radiata pine - Delatite Arm, Lake Eildon

Small plantations were established at Narbethong (1933) and Noojee (1933) using unemployment-relief grants during the depression years. The Macedon plantations were also extended during this period.

The disastrous forest fires in 1939 destroyed 970 ha of plantation at Narbethong and Noojee.

During this period 1939-1960 plantings were small, initially because of World War II and later through lack of finance. Some extensions were made to plantations at Macedon and Noojee and a new project commenced in south Gippsland (1945). In this area, reforestation with both softwoods and hardwoods commenced on marginal farmlands purchased by the Forests Commission. These lands originally carried prime-quality native forest and had been cleared for agriculture.

An expanded programme to lift Victoria's annual planting to 2,020 ha, begun in 1961, reached its target in 1964. This expansion included a project of planting 160 ha annually on land adjoining Lake Eildon, which had previously been cleared for agriculture. Small additions were also made to plantations at Noojee and Macedon in this period.

In 1966 an agreement between the States and the Commonwealth enabled Victoria's softwood planting programme to be expanded further to 4,850 ha annually. Several new plantations were commenced and existing ones enlarged.

Social and other benefits

Softwood plantations and associated industries contribute to the welfare of the community by providing employment in rural areas and provincial towns. A plantation resource capable of supplying a complex of wood-using industries can support one family for about each 10 ha of plantation.

Plantations of successful species produce a high volume of wood per hectare.

Table 15

PLANTATION-OWNERS

Tenure	Owner	Location	Area (ha)
Public	Forests Commission	Study area	7,269
Public	Latrobe Valley Water and Sewerage Board	Latrobe Valley	393
Public	Geelong Water and Sewerage Trust	Western	230
Public	Melbourne and Metropolitan Board of Works	Melbourne catchments	176
Public	State Rivers and Water Supply Commission	Myrniong	40
Public	State Electricity Commission	Latrobe Valley	61
	Sub-total public land		8,169
Private	A.P.M. Forests	Shire of Narracan	3,670
Private	Cathedral Valley Softwoods	Taggerty	512
Private	Misc. Private (other than Farm Forestry Loan)	Study area	325
Private	Farm Forestry Loan	Study area	243
	Sub-total private land		4,750
	Total		12,920

The total annual output of wood from these plantations is currently about 34,000 m^3.

This permits development of efficient growing, harvesting, conversion, and marketing techniques, with resultant economic benefits to the consumer. The high volume of production also means that a significant part of the demand for timber (which would otherwise have to be met by imports or from larger areas of native forest with lower production) can be accommodated on small, highly specialized plantations.

Industry requirements

In general, industry requires plantations in large, compact blocks, close to centres of population, and served by good transport facilities. Large plantations enable the owner to benefit from economies of scale in establishment, fire protection, roads, and maintenance costs. As log transport costs make up a high proportion of the cost of the raw materials, the plantations must be located close to milling centres.

The most efficient utilization of raw materials is achieved by a complex of integrated industries, which can handle small-sized material from thinnings as well as logs and in which one industry can utilize the by-products of another. However, modern wood-processing plants such as sawmills and particle-board plants are capital-intensive installations, and an assured supply of raw material is a prerequisite to their construction.

Production of fence posts from plantation of radiata pine

In general, economies of scale are realized in plantations larger than 4,000 ha, and a plantation resource of at least 16,000 ha is necessary to support an integrated complex of industries.

The Demand for Softwoods

Australian native softwood resources are restricted to some rain-forest species in the tropics and Tasmania, and the slow-growing *Callitris* forests of the dry inland. These make up only 1.9 million ha of total commercial forest of 35 million ha.

Australia's forest products industries have expanded and become more sophisticated with the country's growth in population and affluence. Many of these industries prefer softwood as the raw material, due to its lightness, lack of defect, and pulping and chipping characteristics. Australian production of softwoods has remained at a low level, and consequently large volumes have been imported.

Balance-of-payment difficulties in the early 1960s caused the Commonwealth Treasury to examine the main sources of import expenditure. This examination revealed that Australia's import bill for timber and timber products was about $200 million per annum. Additionally, it was estimated that the deficiency in home-grown softwood supplies would increase in the future.

Unlike some other raw materials such as iron ore and oil, timber is a resource that can be created and, with proper management, can be renewed. Australia has large areas of land suitable for growing softwood timber, which could produce substitutes for most of the present imports.

These facts caused a complete review of softwood availability, including estimates of future demand. As a result the Commonwealth government accepted for planning purposes that by the year 2000 A.D. Australia's annual requirements for forest products would be 31.2 million m^3 (expressed as the volume of logs used).

It was estimated that 1.2 million ha of coniferous plantations could provide half of this requirement, while the remainder would be obtained from 10.1 million ha of native forest. Having regard to these figures, the balance-of-payment difficulties, and the possibility of finding adequate supplies of wood on world markets, the Government embarked on a scheme to substantially increase softwood plantings, subject to a review every 5 years.

The scheme has been criticized on several grounds - more recent projections of demand for the year 2000, based on different assumptions, are as low as 20 million m^3; it is claimed that undue emphasis has been placed on balance-of-payment difficulties, as Australia has recently accumulated large reserves of foreign exchange; and it is argued that it may be in our best interests to import wood products in exchange for other goods in which Australia has a comparative production advantage.

Commonwealth assistance

In 1967, the federal government passed the *Commonwealth-States Softwood Forestry Agreements Act* to ratify an agreement between the Commonwealth and the States, meeting as the Australian Forestry Council. The agreement was renewed in 1972.

The act is designed to overcome the projected shortfall in the supply of softwood in Australia and provide Commonwealth financial assistance to help the States undertake expanded softwood planting programmes. The national target is 1.2 million ha of plantations by the year 2000. The target for the State forest services for the first 5-year period 1967-71 was 103,900 ha.

Victoria planted 20,200 ha during this period. The State financed the first 2,400 ha of planting in each year and the Commonwealth the balance with loan funds that are interest-free for the first 10 years.

The Victorian Forests Commission expects to plant 4,690 ha per annum for the current 5-year period, which ends in 1976. Private companies which do not receive Commonwealth assistance, will plant about 3,200 ha per annum, bringing the annual total for the State to 7,890 ha.

Plans for the Study Area

The Forests Commission's plans for plantation development are concerntrated in eight zones of the State. These zones are selected with a view to providing sufficient wood resources to support large permanent industries capable of sustained and efficient utilization of the resources. Thus, each must have sufficient suitable land potentially available for plantations. Other requirements include the proximity of plantation areas to population centres, industrial sites, and transport.

The study area covers all of the central zone and parts of the Latrobe and Ballarat zones.

Central zone

This has a target of 32,000 ha. The current planting programme of 800 ha per annum includes projects in the Acheron Valley and near Kinglake. As at October 31st, 1972, the plantations had a total area of 2,670 ha.

The plantations planned for this zone, together with those in the Benalla-Mansfield zone to the north of the study area, will form an economically viable resource that together with nearby resources of hardwoods, will be capable of supporting a large integrated industry. This could include a major pulp mill. These plantations will provide an economic basis for a decentralized industrial development in the Yea-Alexandra-Mansfield locality.

Latrobe zone

With a target of 32,000 ha, the zone has a current planting programme of 690 ha per annum. Only part of it, including the established plantations at Noojee (856 ha) and the western Strzeleckies (1,200 ha), lies in the study area, where the current planting rate is 162 ha per annum. New plantations were es-

tablished at Moondarra in 1969 (now 455 ha) and Nerrim East in 1972 (now 40 ha). Plantations in this zone will provide raw material for paper-making, sawmilling, and associated industries in the Latrobe Valley. Australian Paper Manufacturers whose pulp and paper mill at Maryvale is an established user of pulpwood, intend to plant 160 ha of softwood in the study per annum.

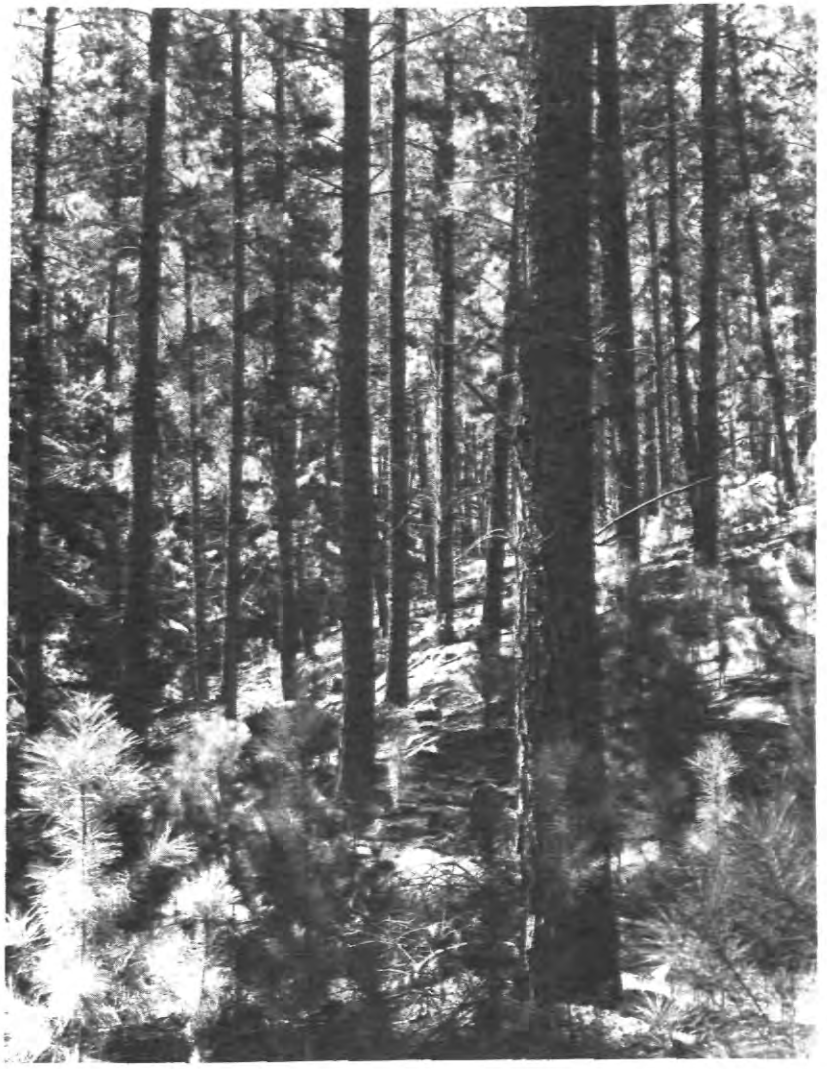
Ballarat zone

With a target of 28,000 ha and a current planting programme of 580 ha per annum, this zone lies only partly in the study area. Since 1970, the Macedon Plantations have been extended at the rate of 140 ha per annum. In 1969 a new project commenced between Daylesford and Ballan with planting at the rate of 200 ha per annum.

The planting programme in the zone is planned to provide wood for local sawmilling and wood-preserving industries, plus raw material for particle-board manufacture in a plant operated by A.V. Wehl Industries Ltd. at Ballarat. Legislation passed in 1969 guarantees supplies of wood to this industry from Forests Commission plantations.

Study area total

Table 16 shows the area of plantations' within the whole study area as at 31st October 1972. Projected total annual production from these plantations in the year 2000, based on an annual planting rate of 1,300 ha, is 456,000 m^3, of which about 255,000 m^3 will be sawlogs.



Mature radiata pine, Mount Macedon plantation

Table 16

PLANTATION AREAS
(hectares)

	Central zone	Latrobe zone	Ballarat zone	Total
Forests Commission	2,671	2,554	2,044	7,269
A.P.M. forests		3,670		3,670
Other	753	498	487	1,738
Farm forestry				243
				12,920

Capability

Requirements for radiata pine

Sites for commercial plantations of radiata pine require:

* a minimum annual rainfall of 760 mm
* an acid soil of at least moderate fertility
* good drainage
* an optimum of 0.75 m and a minimum of 0.5 m topsoil over any root- or water impeding layer
* freedom from heavy falls of snow

It is not possible to quote soil nutrient figures that set adequate levels for radiata pine, but experience with established plantations and special trials make some generalizations possible. The gradational soils developed about the highlands support good growth, provided there is no impeded drainage. Growth rates on some marginal sites can be improved by deep ripping of heavy clays and shallow soils. This may be done on the contour to conserve water and facilitate root penetration or, in flat low-lying areas where the problem is too much water, down the slope to assist drainage.

Application of phosphate fertilizers on soils deficient in phosphorous (and/or those with high phosphorus absorption) is often worth while. Applications of 600-1,000 kg of superphosphate per hectare have increased growth by 25-30% on young soils on granite in West Gippsland and on heavy clay soils in the central highlands (Ballarat zone). A similar response has been obtained on the light sands over clay subsoils in areas planted by A.P.M. in Gippsland.

A programme of foliar analysis to detect nutrient deficiencies, now being carried out in State plantations and nurseries, may extend the range of sites on which, conifers can be grown economically.

Site quality

Although radiata pine grows quite rapidly in this region by world standards, wide variations in growth rate occur due to differing site factors. Growth rates can be expressed in terms of site quality, which is a measure of the total volume of timber produced. Plantations are assessed and placed into site-quality classes (SQ) at about 10 years to form the basis for calculating growth rates and the quantities of the various classes of log material that will become available for industry.

Seven qualities have been defined. SQ1 to SQ5 cover healthy stands, SQ VI means marginally healthy, and SQ VII ranges from marginal to failed. Maritime pine *(Pinus pinaster)* has often been planted on sites judged SQ VII for radiata pine.

Site quality of a stand can be estimated from the height of the trees at the age of 20, called Site Index: a stand with a Site Index of 27 would fall into class SQ III. Table 16 sets out the productivities of the different classes. It is impossible to classify a site accurately until a stand of trees has actually grown on it. However, the form and composition of native vegetation, and soil, climatic, and topographic factors, are useful indicators of suitability.

Table 17 divides the land in the study area into categories based on suitability for radiata pine.

Requirements for Douglas fir

In the study area, Douglas fir has been planted as a demonstration forest or where radiata pine has failed because of climatic factors such as snow and exposure. It is now being used on high-quality sites to provide a break from the monoculture of radiata pine. Some 138 ha have been planted in the area. Probably no more than 200 ha per annum will be planted on public land within Victoria, including about 40 ha per annum in the study area. Its timber characteristics resemble those of radiata pine.

Douglas fir requires a cool climate with an annual rainfall of 1,000 - 1,500 mm,

Table 17

SITE QUALITY FOR RADIATA PINE

Site quality	Site index (height in metres at age 20)	Total yield over 30 years (m^3 per/ha)*	Average annual yield (m^3 per ha)*
I	31	955	32
II	29.5	850	28
III	27.5	745	25
IV	26	645	22
V	24	535	18
VI	21.5	380	13
VII	18.5	235	8

* Volumes shown are under bark to a 10-cm small-end diameter.

sheltered southerly or easterly slopes, and deep well-drained soils of moderate to high fertility. These conditions are found on most mountain ash sites.

Growth rates in Victoria are expected to be similar to those achieved in New Zealand on comparable sites. New Zealand experience indicates that Douglas fir, although it requires a longer rotation, has a mean annual increment similar to that of radiata pine. For example a site capable of producing 17-20 m^3 of radiata pine per ha per annum over a 35-40 year rotation will produce 14-17 m^3 of Douglas fir per ha per annum over a 60-year rotation. Sites capable of producing 19-21 m^3 of radiata pine per ha per annum over a 35-40 year rotation will produce 19-23 m^3 of Douglas fir per ha per annum over a 60-year rotation.

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Table 17

SOFTWOOD PRODUCTIVITY

Category	Structural form and main species of natural vegetation (1)	Predominant soils	Estimated potential for radiata pine	
			Site Index (m)	Productivity (MAI m^3/ha/an) (2)
A very high	Open forest IV: mountain ash, at elevations below 950 m (3)	Friable brownish gradational	29.5 - 27.5	28 - 25
	Open forest III: messmate stringybark	Friable reddish and yellowish gradational	29.5 - 26	28 - 22
B high	Open forest III: narrow-leaf peppermint	Friable reddish and yellowish gradational	27 5 - 24	25 - 18
	Open forest II: messmate stringybark with narrow-leaf peppermint	Friable reddish and yellowish gradational	26 - 24	22 - 18
C moderate to low	Open forest II: narrow-leaf peppermint	Friable reddish and yellowish gradational	24 - 21.5	18 - 13
	Open forest III or II: silvertop	Well-drained soils only	24 - 21.5	18 - 13
	Open forest II: messmate stringybark with broad-leaf peppermint	Yellowish gradational	24 - 18.5	18 - 8
	Open forest II: red stringybark	Yellowish gradational	21.5- 18.5	13 - 8
D unsuitable	Open forest I: all types	Duplex and shallow stony soils	less than 18.5	less than 8
	Open forest III or II: silvertop	Shallow stony or poorly drained soils	less than 18.5	less than 8

(1) for full details of species refer to Chapter 9 Table 6, Vegetation Units.

(2) MAI (mean annual increment) = total volume production to a 10-cm small-end diameter under bark, divided by the number of years in rotation.

(3) areas above 950 m are generally unsuitable for commercial plantations of radiata pine, as heavy falls of snow can cause widespread damage by breaking and uprooting trees.

AGRICULTURE

The study area contains a wide variety of agricultural activities, ranging in intensity of production from pastoral and cereal-growing activities north and west of Melbourne to localized market gardening and poultry production on the metropolitan fringe. Agriculture is the primary land use over a large proportion of the study area.

Most agricultural production occurs on private land. Exceptions to this include the use of public land for apiculture, limited forest grazing, and various agricultural research stations.

Because of the large area farms occupy, these lands form an important component of the regional landscape and may be significant for the distribution of plant and animal populations.

The percentage of private agricultural land remaining under natural vegetation is very small. Where present, these remnants have complemented blocks of vegetated public land in the maintenance of wildlife habitats and visual diversity. In recent years, however, the amount of uncleared land has been noticeably reduced. This reduction may be partly due to the operation of income tax concessions and an increase in the number of "Collins Street" farmers.

The Melbourne area makes a significant contribution to Victorian production in many industries, including dairying and poultry, horticulture, barley, and vealer production. For other products it achieves only a small percentage of State output. Most agricultural production in the study area is oriented to the metropolitan market.

In several other important aspects also, the influence of Melbourne and Geelong has had a significant impact on agriculture, especially on the metropolitan fringe. These aspects include the economics of farming, increasing competition for water supplies and suitable land, and increasing pressure from recreation activities.

The bulk of public land remaining in the study area is generally not suitable for large-scale expansion of agricultural activity, compared with public land in other parts of Victoria. In fact there is evidence of a trend towards the use of agricultural land for other purposes.

Private land being cleared east of Berwick

Environmental factors

Environmental factors influencing agricultural use are those associated with creating conditions favourable for plant growth. The distribution and types of agriculture depend on local combinations of climate, topography, and soils, and can be effected by biotic factors including pests and disease. These phenomena and their interactions have been treated at length in Part II.

Environmental factors can be modified to some extent by human intervention. The use of irrigation water, pesticides, and plant breeding techniques can improve the efficiency of production.

The irrigation districts along the Werribee River at Bacchus Marsh and Werribee support enterprises that would be impossible with natural rainfall only; in some instances irrigation from farm storages in the higher-rainfall areas has increased yields of summer-growing crops.

Present Agricultural Land Use

Most of the agricultural enterprises common in Victoria are found in this study area. These include:

* animal production - dairy products, beef, mutton, lamb, wool, eggs, poultry meats, and honey

* plant production where the environment favours cereals, hay and grain, peas, potatoes, vegetables, fruits, berries, and cut flowers.

The area has had a diversified agricultural use since the days of early settlement. In certain localities, some specialization of production has developed, based on physical resources, improved irrigation and drainage works,

Table 18

DISTRIBUTION OF DAIRY FARMS AND MILCH COWS
1972

District centre		No. of dairy farms	No. of dairy cows
Warragul		2,216	167,649
Leongatha		2,391	189,390
Melbourne		665	39,288
	Total	5,272	390,327
	State	17,161	1,247,060

and growing market demand. Recent changes in the spatial pattern of agriculture have been mainly on the urban fringe, caused by suburban expansion and subdivision.

Economic conditions over recent years have also caused many farms to diversify their enterprises.

Dairying

The study area contains approximately 33% of the State's dairy farms and cows, concentrated in the south-east from Berwick to Warragul and to Leongatha. A smaller concentration occurs on the irrigation country of Werribee and Bacchus Marsh, with other dairy farms scattered through the area. This industry has developed as Melbourne's main supplier of whole milk. Surplus milk is used for cheese and butter production.

Beef

Beef cattle are increasing in number. Although found in all districts in the study area, their numbers are concentrated in the higher-rainfall foothill country along the Great Dividing Range. Newcomers to agriculture favour beef cattle on their farmlets or larger holdings.

Breeding for vealer production in the study area forms a substantial percentage of the State's output and tends to be favoured over the raising of bullocks.

Sheep

Over the last few years, the decline in wool prices has led to a reduction in sheep numbers and replacement by beef in the higher-rainfall districts or by crops in the less favoured areas. On the cereal farms, first-cross ewes are joined with Dorset Horn rams particularly for spring lamb production. In the higher-rainfall country, lamb is often held for better prices in the late summer-early autumn period. The lambs are frequently "topped off" on summer forage crops.

On the drier northern slopes of the Divide - from Kyneton to Kilmore, Seymour, and Yea - Merino wethers are raised for wool production.

Poultry

About 90% of the State's broiler industry is concentrated on the Mornington Peninsula, with a few sheds in the Dandenong Ranges. All are within close proximity of the processing plants.

Egg production is scattered throughout the district, but the number of farms is declining through pressure of urban development and poor economic returns. Its scale is still significant in the State's output.

Pigs

Suburban expansion has caused many piggeries to close and re-establish outside the expanding urban fringe.

Cereals

Cereals are the major crops grown in the area, being concentrated on the low-rainfall, basaltic plains to the north-west of Melbourne. They comprise only a

Harvesting barley on the Werribee State Research Farm

small percentage of the State's total, nevertheless are important crops for the locality. Wheat is delivered in bulk to silos at Sunbury, Melton, and Geelong. The Balliang district is recognized as a major barley-growing locality and the grain is delivered to Sunshine or Geelong. Oats production for grain and hay is of less importance, but the Melton district maintains the tradition of supplying hay to the horses of Melbourne - racehorses and ponies instead of the delivery horses of earlier days.

Overnight dews or cool weather often prevent early-morning harvesting of cereals at the start of summer, by keeping the moisture level of stripped grain too high for bulk storage.

Pea-growing on broad acres has increased on cereal farms in recent years. Peas are grown as a winter crop, enabling processors to harvest and receive peas over an extended period.

Potatoes

Potatoes are grown on the Bellarine Peninsula and the Kooweerup Swamp, on larger farms along the Great Dividing Range from Daylesford to Kinglake, and in Gippsland at Neerim and Thorpdale.

Irrigation from underground or surface catchments has increased productivity, as in the Kooweerup district, which utilizes extensive groundwater resources in the Westernport Basin.

Vegetables

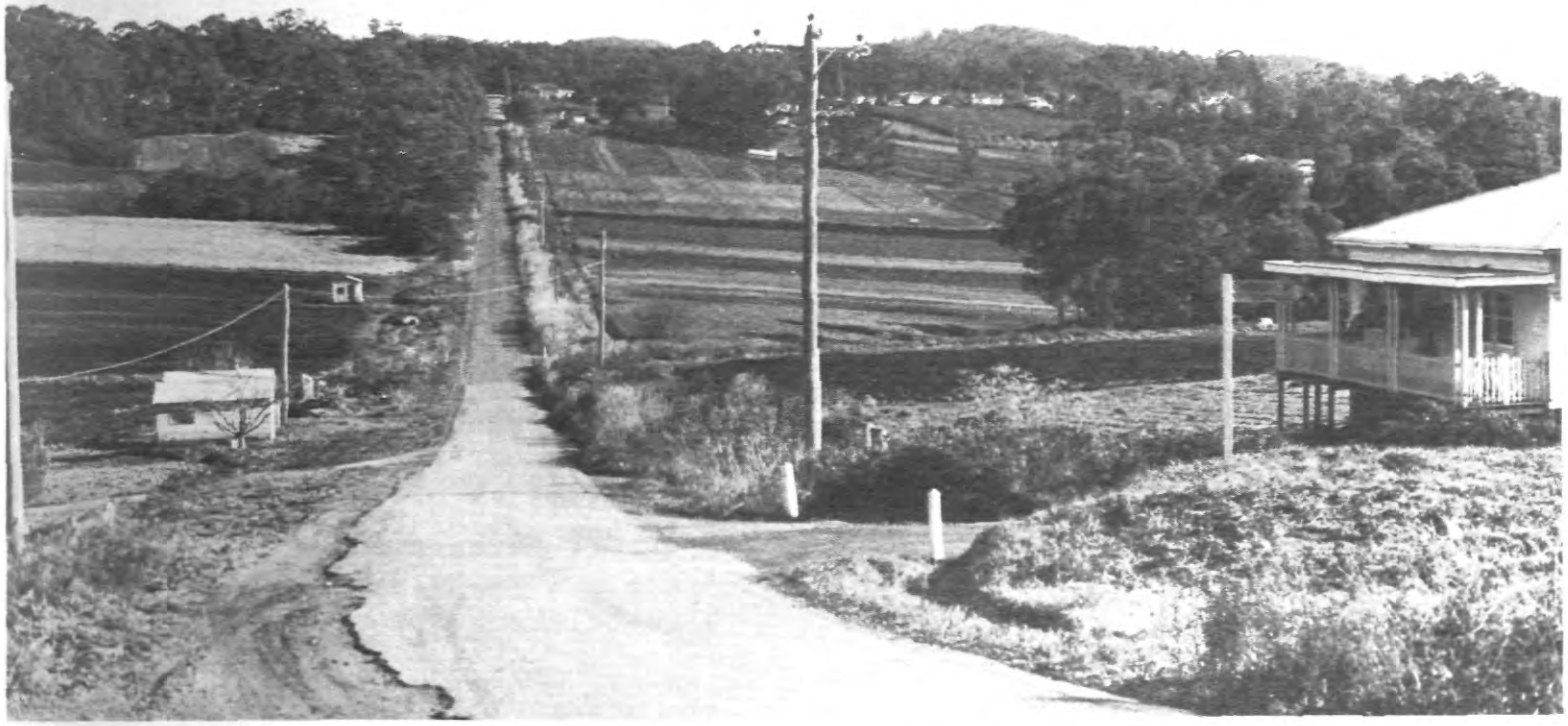
For many years the inner study area has been of great importance for the supply of fresh vegetables to Melbourne. The main centres of production include Werribee and Bacchus Marsh, using surface water irrigation, and the district of Kooweerup-Dalmore using underground water supplies. Pockets of intensive market-gardening also occur in the Silvan area and elsewhere, depending on the availability of reliable water supply.

Vegetable production is a labour-intensive enterprise. Large-scale growing of cabbages and cauliflowers has recently commenced on the Yarra flats at Yarra Glen.

Orchards

Orchards lie mainly to the east of Melbourne in the Dandenong Ranges, and on the Mornington Peninsula. These produce table fruits - apples, pears, apricots, plums, cherries, figs, passion fruit, lemons, chestnuts, walnuts, and berry fruits. Some fruit is also used for jam and juice production. Small quantities of apples are exported from the region.

The number of growers is declining because of low economic returns. Former orchards used for urban development at Doncaster and on the Mornington Peninsula are generally not being replaced



Intensive market-gardening near Silvan: an example of the mixed environment shown on Map 7

by plantings elsewhere in the study area. Competition from other centres of fruit production, including the Goulburn Valley and Tasmania, is also strong.

The Dandenong Ranges provide a favourable environment for berry fruits. This area produces more than 80% of the State's berries, the main crop being strawberries.

Cut flowers and the nursery trade

This small industry persists on the sand belt in the outer suburbs of Keysborough, Dingley, and around Cranbourne. It is specialized and labour-intensive.

Beehives on a site in mixed stringybark - gum forest

Forage crops

The most favoured forage crops are oats for winter grazing and lucerne, millet, and rape over the summer. They are grown to supplement paddock feed during seasonal decline in pasture growth.

Apiculture

Compared with other primary industries, the bee industry in the study area is of relatively minor significance in terms of both total value of output (wax and honey) and employment generated. It depends largely on vegetation remaining on public land, although many hive sites are situated on private land and bees assist in the pollination of agricultural crops.

The main honey-producing areas occur north-west of Melbourne in the Wombat and Loddon blocks, with honey flows of lesser importance north of the Great Divide, in the Brisbane Ranges, in the Dandenong Ranges, and around Kinglake. Climatic conditions at higher altitudes in the north-east are unsuitable.

Production statistics for the study area are incomplete, but records indicate an average annual honey yield over the last 12 years of about 900,000 kg, representing about 15% of the State's total for 1972. At current wholesale market prices of around 55¢ per kg, this has a value of about $500,000 gross.

Although annual yields vary because of climatic and other conditions, steadily rising market demand indicates that honey production is likely to increase. There are still large areas in the study area capable of more intensive honey production.

At present the industry employs only a small work force, many of whom operate on a part-time basis from Melbourne using earnings from apiculture as a supplementary source of income. Probably less than 100 people actually

derive their income solely from apiculture in the study area.

Efficient production of honey requires that colonies of bees be kept healthy and at top strength. The bees must have access to supplies of nectar, pollen, and water that are sufficient to enable them to provide for their basic needs of food (including a reserve stored in autumn to tide them over the winter months) and to produce a surplus of honey that can be harvested.

In Victoria the eucalypts provide the main supply of nectar and pollen, although numerous other native and introduced species are also valuable. Beekeeping is forced to be migratory or nomadic, as the flowering period of eucalypts varies from species to species, and for the one species from district to district. Flowering intensity also varies with climatic and other conditions.

As a general rule, however, the majority of important eucalypts flower heavily every second or third year. Some species are valued for their yield of either nectar or pollen, others for their yield of both.

In the study area, river red gum, grey box, and red stringybark produce the heaviest yield of honey per hive and also provide good yields of pollen. Other important species are red ironbark, yellow box, red box, messmate stringybark, eurabbie, manna gum, and yellow gum.

Of some 400 sites that have been utilized over the last 12 years, about half occur on public land and mainly in forest areas. Stream frontages and roadside verges are of lesser importance. Many of the sites on private land adjoin forested public land.

Use of Public Land for Agriculture

In addition to its extensive use for honey production, public land supports several other examples of agricultural use in the study area.

The Department of Agriculture has research stations on public land. Their work is directed towards improving the economic efficiency and profitability of production, and has been of great value to agriculture in the State.

The State Research Farm at Werribee is the Department's largest research and teaching complex and is involved in work on the following:

* plant breeding - cereals, oil-seed crops, pasture species, and vegetables
* cereal agronomy
* fodder conservation
* irrigation

Agricultural Research Farm, Ellinbank

* animal husbandry - nutrition, reproduction, and management of pigs, poultry, sheep, and dairy cattle
* artificial insemination
* dairy products
* machine milking
* teaching-courses for dairy factory operators, artificial inseminators, and milking-machine technicians

In addition, the Veterinary Clinic of Melbourne University and Australia's only tractor-testing station are located at the State Research Farm.

Other important agricultural research centres in the study area are the Potato Research Station at Toolangi, and the Ellinbank Dairy Research Station near Warragul. The Horticultural Research Station at Scoresby, and the Vegetable Research Station and the Turf Research Institute, and the Keith Turnbull Research Station (Vermin and Noxious Weeds) at Frankston are on public land within the Melbourne metropolitan area.

The Board of Works Farm at Werribee is the main treatment area for Melbourne's sewage. The irrigated pastures are intensively stocked with cattle and sheep, for meat production. This grazing is an integral part of the disposal system and

the sale of fat stock contributes to maintenance costs of the system.

The Sunbury Mental Hospital Farm is run as a dairy farm to provide produce for the patients. The French Island Prison Farm is being used in the rehabilitation of prisoners.

These farms hava a large total capital investment in facilities, and they make a substantial contribution to the economic and social welfare of Victoria.

The Metropolitan Influence

Land values

Land values in the study area are rising faster and to higher levels than elsewhere in the State for several reasons, all associated with proximity to the concentration of population in Melbourne and Geelong. Adjacent rural land is being used for residential allotments, and land at greater distance is being subdivided for commuter settlement.

Rising values extending beyond Melbourne's urban fringe are making commercial agriculture uneconomic as municipal rates and other costs increase, and return relative to market value of the land decreases.

The high price of rural land makes it impossible for the commercial farmer to expand the size of his holding to increase his scale of operation, and so, to remain, he has to adopt intensive forms of production.

Marketing

Until decentralization of industry becomes effective, farmers near Melbourne will retain an advantage over those further away, through savings on freight charges for produce or for supplies, on telephone calls, and on the time and travelling expenses involved in goint to Melbourne for business reasons.

Newmarket is a central market and a barometer for sheep and beef cattle prices in southern Australia, while Dandenong is a leading market for dairy cattle, pigs, and calves. Good store-stock markets exist at Geelong, Ballarat, Kyneton, and Warragul. Proximity to Newmarket gives meat-producers an opportunity to present stock in a fresh condition, and to react to short-term market fluctuations.

Visitors

Often unwelcome visitors or trespassers pose a much greater problem to farmers in this area than elsewhere in the State. The city-dweller's ignorance of rural life causes much of this problem. Once out of the suburbs, he often treats farm-lands withoug a house in sight as public space for his use and enjoyment.

A combination of legislation and education is reducing the problem. The major-

ity of shooters and anglers, particularly members of sporting clubs, now seek permission to enter a property for their sport. In many cases, the sportsman has developed goodwill and friendliness with the farmer to the extent that he uses the telephone to obtain approval prior to a dawn visit.

Wood-gatherers are decreasing with increasing affluence of the community and as other fuels become more popular for home heating.

The problem remains of the picnicker, or mushroomer, entering properties and disturbing stock, especially lambing ewes, or leaving gates open and "boxing up" different stock.

The theft of stock is probably a greater hazard near Melbourne than elsewhere, as is the dumping of rubbish.

Relations with other Uses

Urban expansion

Mention has already been made of suburban development extending across valuable market-gardening areas and pricing out agricultural uses from the urban fringe. This has created a situation of direct competition for land and has resulted in intervention by town planning authorities to identify and reserve from urban expansion those areas in the fringe with a high comparative advantage for intensive agriculture.

Recreation

Over the years, agricultural districts have played an important if passive role in recreation based on pleasure driving. In certain areas, however, private land has restricted access to frontages along streams and coastal areas.

In recent years farm-based recreation has noticeably increased, catering for day visitors and holiday demand. This added activity on agricultural land has diversified and increased some farm incomes. It appears to result from a recognition that considerable latent demand exists for this type of recreation and that it counters 'intrusion' of urban dwellers into rural areas.

Typical farm-based activities include horse-riding, fishing, shooting, organized open-air group meetings (such as music festivals) and general demonstration of farm activities. The emergence of this type of use as a commercial enterprise could provide a economic stimulus to the retention of rural atmosphere close to urban centres. The acquisition of rural holdings by urban dwellers, some of whom are seeking week-end release from city pressure, can also be interpreted as a further outlet for farm-based recreation.

Water supply

Agriculture uses much less of the total water supply than domestic and industri

al consumers in the study area, and in general can tolerate poorer-quality supplies. (Appendix 1 gives details of water quality standards for various agricultural products.)

Several important irrigation catchments, covering a large area of public land, provide agricultural needs within the study area. They include Lake Eildon and Pykes Creek and Melton Reservoirs. Small quantities of groundwater are also used to meet stock irrigation needs (see chapters 7 and 18).

Demand for future domestic supplies in the western half of the study area could increasingly compete with irrigation requirements in the Bacchus Marsh and Werribee districts, although such competition is only manifest at present during critical times of water shortage.

Spray irrigation, Silvan

Market Propsects for Main Products

General outlook

In 1973, the outlook for most commodities, particularly beef, mutton, and wool, improved dramatically. Immediate prospects are bright for all grains, but fruit and dairy products still face a difficult future.

The prosperity of most rural industries, however, depends substantially on export markets, as in recent years more than 60% of gross rural income has been derived from exports. Continuing world currency realignments react against our exports, and profitability is affected by increasing freight rates and a shortage of refrigerated shipping. Market conditions in 1973 have been particularly buoyant.

Fruit

Apple consumption per head has shown little growth over recent years, in spite of a reduction in real prices, but the quantity of apples being processed for juice is increasing. A light apple crop in 1972 resulted in favourable

prices on the local market but not on the export market.

The entry of the United Kingdom into the European Economic Community, has offset to some extent recent advances in cool-storage technology, which will increase the period available for Australian apples to find a market. This development, together with the increasing production by E.E.C. member countries, will create further difficult market conditions in Europe. New markets are being developed in Canada and U.S.A., but in all Northern Hemisphere outlets Australia has to compete with South Africa, New Zealand, and Argentina.

Eggs

Prospects are poor in the egg industry, as production exceeds local consumption and export markets are restricted and offer extremely low prices. Higher feed costs have contributed to the poor position of most producers and are forcing some to leave the industry.

Poultry meats

This industry is market-oriented and controlled by a relatively few big firms. Competitive pricing has been the main factor in promoting consumption and recently the take-away food outlets and processed poultry products have stimulated sales. However, it is a labour-intensive industry with a high capital investment and these factors, together with rising feed costs, make the return to the grower unrewarding.

Agricultural Capability of Public Land

Part IV of this report discusses the agricultural potential of specific public lands in the study area. Any such assessment requires the consideration of both physical and economic factors. The agricultural potential within the region should also be seen in the context of that elsewhere in the State.

In general terms, the bulk of public land in the study area is unsuitable for extended agricultural production. Although land north and east of Melbourne receives sufficient rainfall for pastoral activities, slopes are often too steep for clearing and low winter temperatures (especially at higher elevations) restrict growing season for a large part of the year. Access to some parts of public land is difficult and would add appreciably to total development costs.

The larger blocks of public land west of Melbourne also have a low agricultural capability, due to poor soils or unsuitable topography. Moreover, these tend to have a lower annual rainfall than those in the east of the study area. Where the average annual rainfall is below 700 mm, sloping lands are susceptible to severe soil erosion when cleared.

The areas potentially suitable for agriculture include the perimeter of public land adjacent to existing clearings, and parts of the Kinglake and Black Range plateaus. Some forested areas north-east and west of Melbourne are suitable for light grazing and for continued honey production.

An important element in the demand for agricultural land around Melbourne in recent years has been the demand for week-end farmlets and rural commuter properties, Subdivision of large rural holdings has met this so far and is expected to continue doing so, even though future demand is likely to the strong.

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MINERALS

Construction materials (stone, sand, clay, and limestone) are currently the most valuable mineral products won from the Melbourne study area. Annual production of these minerals from Victoria is approximately 30 million tonnes, valued at $45 million. Of this total, an estimated 75% would be produced within the study area.

Brown coal extraction is the only other large-scale mining activity in the study area. A total of 1.5 million tonnes valued at $1.6 million has been produced.

The area contains a range of metallic and non-metallic minerals, but their commercial utilization is limited to relatively small-scale operations. Favourable geological conditions also exist for the occurrence of several other metallic minerals, but their significance has not yet been confirmed.

Production of construction material is growing at the rate of 5% per annum. With the notable exception of large sand deposits on public land north of Anglesea and near Lang Lang, the bulk of such materials will in the future be extracted from private land.

Historically, the most valuable mineral product from the area is gold, particularly from the Walhalla-Woods Point and Daylesford districts. Current and future mining operations associated with quartz reef gold will be mainly underground, with only limited surface area requirements.

Continued exploration and development of mineral and stone resources is necessary to establish the extent and quality of reserves and to ensure a continuous supply of materials for a growing market demand. Because of the size of anticipated future demand, the industry finds it necessary to locate and reserve in any one year a quantity of material greater than that quarried during the year, to maintain reserves for a fixed period.

Mineral resources differ from many other natural resources in several respects. They are non-renewable and of very restricted occurrence, their presence is not readily obvious, and they can only be mined where found.

To prove the existence of a mineral deposit required detailed and costly investigations, often extending over a

Quarrying in the Lysterfield Hills

period of several years. In the study area, private exploration companies, and the Mines Department, are exploring for stone, minerals, and petroleum.

Mining activities in general only cover a very small percentage of public land, but in some cases they have attracted public attention where their operations occur in areas important for nature conservation or recreation. As a result, there have been moves from within the industry, and by outside authorities, to give more emphasis to site rehabilitation and landscaping.

This chapter discusses each of the main minerals present in the study area, giving details of the distribution of their source materials and the extent and value of existing operations. It also considers reserves, factors affecting economic utilization, and estimated future demand.

Construction Materials

Construction materials are mined within the study area largely for consumption in the metropolitan markets of Melbourne and Geelong. They are used as aggregate

for concrete, for road-making, building, harbour filling, airfield, and other major construction works, and in the manufacture of cement-lime, bricks and tiles. Materials of this type generally have low value per unit volume, making transport costs an important industrial consideration where long haulage distances are involved. For road-construction projects, material haulage costs can account for upwards of 20% of total project cost where materials are transported distances exceeding 30 km. It follows that working deposits in close proximity to centres of demand are more economically desirable than deposits at greater distances.

Crushed and broken stone

Within the Melbourne Statistical Division (M.S.D.), 14 million tonnes of crushed and broken stone were extracted during 1970/71. No detailed figures are available for the Melbourne study area, which is larger than the M.S.D., but a figure between 15 and 17 million tonnes seems likely, and this represents about 75% of the total Victorian production. By far the greatest portion of it is used within the Melbourne metropolitan area.

The most important source of material is the basalt of the new volcanics west and north of Melbourne, which account for about 55% of total production. Other important sources are basalts of the older volcanics from Berwick and Narre Warren, acid lavas in the foothills of the Dandenong Ranges, hornfels from Lysterfield, and granite from Arthurs Seat.

Basalts of the newer volcanics are extremely variable in quality, with the result that often excessive quantities of overburden and waste materials have to be disposed of. Basalts are also limited in depth, and thickness of quarryable basalt is usually less than 30 m.

The other rocks quarried are much more uniform in quality and of virtually unlimited depth, so a much larger quantity of stone can be extracted per hectare. It is expected that the proportion of basalt quarried will gradually decline, with a corresponding increase in the proportion of hornfels, acid lavas, and granite.

Production of crushed and broken stone is expected to increase at 5% per annum. On this basis the annual supply within the M.S.D. would be 65 million tonnes and the cumulative production to the year 2000 approximately 1,020 million tonnes (see Table 19). Known reserves in 1973 have been estimated at 425 million tonnes. Further exploration will be necessary to determine the location and value of reserves for expected future consumption.

Sand

Sand production in the M.S.D. for 1970/71 was 3.8 million tonnes. No records

are available for the study area, but a figure of between 4 and 4.5 million tonnes is likely.

Main producing areas are Springvale (wtih an annual production of 2.8 million tonnes, which is mainly used for mortar and plaster sands, hot-mix fillers, and packing). Outside the metropolitan area, the main producing centres are Bacchus Marsh, the You Yangs, and Lang Lang, which yield high-purity sands for glass manufacture.

Most sand production comes from Tertiary sediments (often containing up to 20% clay, which is removed by washing in a treatment plant), from Pleistocene to Recent dunes in coastal or ancient coastal areas, and from Recent alluvial deposits, particularly areas receiving detritus from weathering granites.

Granite quarry at Arthurs Seat

For the period 1961-68, sand production increased at 10% per annum and future growth is expected at about 7% per annum. Sand reserves are estimated to be 65 million tonnes, compared with an estimated requirement to the year 2000 of 330 million tonnes.

An estimated area of 2,600 ha would be required to supply this quantity of sand, and an increasing demand for land for sand extraction is certain.

Extensive sand deposits outside Melbourne but within reasonable haulage

Table 19

ESTIMATED ANNUAL AND CUMULATIVE PRODUCTION AND RESERVES OF CRUSHED AND BROKEN STONE, SAND, AND STRUCTURAL CLAY FOR MELBOURNE STATISTICAL DIVISION

(million tonnes)

	1971	1980	1990	2000	Known reserves 1973
Crushed and broken stone					
Annual	16	25	40	65	425
Cummulative		215	520	1,020	
Sand					
Annual	4	7	13	25	65
Cumulative		50	150	330	
Structural clay					
Annual	1.7	3	5	10	110
Cumulative		20	55	115	

distance are restricted. Large reserves occur on public land at Lang Lang, French Island, and north of Anglesea towards Moriac. Reserves on private land are small.

Clay

Clays used in Melbourne were formed or deposited in two main periods of time. During the Silurian and Lower Devonian, a thick sequence of claystones and siltstone was deposited. These rocks have provided the basic raw material for the structural clay industry for more than 100 years. During the Cainozoic, clays were deposited in a number of small basins, and deep lateritic weathering in that period resulted in the formation of residual granitic and other clays.

The most important source of clay outside Melbourne but within the study area is the Parwan Valley, where a thick sequence of igneous clays, coals, ball clays, and semi-refactory and refractory clays extends over an area of about 80 square km. More intensive exploitation of these deposits is expected in the future.

Among other sources of clay, isolated deposits at Packenham, Officer, Cranbourne, Somerville, and Egerton yield a high-grade kaolin, mined by underground methods.

Clay production is expected to increase at an annual rate of 5.5%. Total clay reserves are generally adequate, although individual companies may have limited reserves. It is unlikely that large areas of public land would be required in the future for this purpose.

Limestone

Approximately 1.8 million tonnes of limestone are quarried within the study area annually. The limestone is used in the manufacture of cement-lime for building purposes and for agriculture.

Cement plants located at Fyansford and at Waurn Ponds near Geelong both use Tertiary limestones from adjacent quarries. At Fyansford the limestone is about 24 m thick and varies in grade from about 95% calcium carbonate near the top to 65% near the base. Overburden varies from 12 to 25 m in thickness and consists of clays, marls, impure limestones, and basalt.

At Waurn Ponds limestone with an average calcium carbonate content of about 90% is blended with marl containing approximately 41% calcium carbonate. The limestone marl sequence is approximately 20 m thick and occurs beneath an overburden of clay, basalt, and low-grade limestone.

At Lilydale, a steeply east-dipping limestone lens 220 m thick and extending along strike for 1,200 m has been quarried for lime manufacture since the last century. Impure magnesium-rich

Limestone quarry and plant near Lilydale

Gravel pit rehabilitation, You Yangs

sections are sold as crushed rock or as a decorative stone.

Fresh-water limestone at Lara is used for agricultural purposes. The limestone has an average calcium carbonate content of 88% and is up to 6 m thick. A similar limestone has also been quarried at Coimadai.

A Recent shell-grit deposit near Queenscliff is currently worked as a source of relatively pure calcium carbonate.

Small lower Devonian limestone lenses worked at Coopers Creek, Tyers, and Marble Creek, have provided either lime or building stone. Further operations on these small deposits are unlikely.

Gravel

Deposits of alluvial and hill gravels and granitic sands occur throughout the study area on public and private land. Although production figures are far from complete, it appears that a volume of gravel exceeding 2 million m^3 has been used for road construction and maintenance purposes in the study area during the past 5 years. While well over half the total used came from private land, in general the proportion of gravels obtained from public land is higher than that of other construction materials.

Plentiful supplies of gravels and granite sands are known to occur west and south of Geelong between Pyalong and

Yea, and in the Labertouche district north-west of Warragul.

Gravel deposits have been worked at numerous small and scattered sites, mainly for road construction and maintenance. The low unit value of this material makes its long-distance haulage to project sites uneconomic.

For most projects, gravels are usually sought within about an 8 km radius. The economics of gravel extraction and transportation make the use of a few large regional gravel pits less feasible than a series of smaller ones adjacent to actual construction projects.

Future growth in demand for road construction materials will be especially noticeable in areas on the metropolitan fringe where new urban development is planned and where major new road projects occur. As existing local sources of material are exhausted, material will be transported from more distant sites, thus increasing total construction costs. Exploration for additional local supplies can also be expected to intensify.

Gravel extraction inevitably results in the removal of existing vegetation from the site of operations. Although specifications for rehabilitation of gravel pits relate to some operations in the study area, many disused pits remain without any attempted reclamation or rehabilitation.

This situation has attracted adverse comment from sections of the community interested in local flora preservation and visual aesthetics. For many of these sites, rehabilitation costs have been relatively high in proportion to the value of materials extracted. In addition, some authorities have not had the resources to effectively control gravel extraction.

Metallic Minerals

Gold

An estimated 135,000 kg of quartz-reef gold has been extracted in the study area since the mid-1850s, mainly from major goldfields at Walhalla-Woods Point and Daylesford. Smaller fields at Steiglitz, Egerton, Blackwood, and Lauriston also contributed to this total, which represents about 14% of Victorian gold production from quartz-reef sources.

Table 20 lists the aggregate gold production from the significant mines in the study area. It must be realized, however, that the bulk of this was extracted in the early gold-rush days up to about the end of the 1880s. In 1972, the only operating mine within the study area produced 52 kg.

The most important goldfield within the study area, at Walhalla-Woods Point, has produced a total of approximately 93,000 kg. The gold-bearing quartz reefs are commonly associated with basic to inter-

Table 20

GOLD MINES WITHIN THE STUDY AREA WITH A PRODUCTION OF MORE THAN 1,000 kg

Goldfield	Mine	Total gold production (kg)
Egerton	Black Horse	2,333
	Egerton Co.	1,866
	Gordon Gold	3,110
Daylesford	Ajax	3,981
	North Cornish	2,584
	Rising Star	2,386
	Cornish Co.	2,103
	Ajax Central	1,638
	Ajax North	1,456
	North Nuggety Ajax	1,226
Lauriston	Russell and Co.	1,432
	Queens Birthday	1,209
	O'Connors	1,206
Blackwood	Sultan	2,054
Central Victoria	Diamond Creek	1,866
Walhalla-Woods Point	Long Tunnel	32,365
	Long Tunnel Extended	13,694
	Morning Star	19,599
	A.1	11,607
	All Nations	4,105
	Loch Pyne	3,525
	Rose of Denmark	1,831
	Toombon	1,476

mediate dykes. The metal occurs in reefs either parallel to the walls of the dykes, as in the Long Tunnel Mine at Walhalla, or in flatly dipping reefs cutting across large dyke bulges, as in the Morning Star Mine at Woods Point and the A.1 mine at Gaffneys Creek.

A notable feature of these mines is their relatively high average grade of approximately 30 gm per tonne. The steep topography has enable ready access to these mines by adits to the upper levels, with the lower levels often being serviced by internal shafts. The goldfield is entirely within public land.

Exploration licenses for gold current in the Walhalla-Woods Point and Jamieson districts could result in the discovery of further economic reserves. Current mining operations near Gaffneys Creek and any future operations will probably be underground. Only relatively small areas will be required for pit heads and tailing dumps.

In addition to the reef mines, shallow alluvial deposits at numerous localities produced an unknown quantity of gold. Most of these deposits are now worked out and are largely of interest to amateur prospectors only. Alluvial deposits buried beneath a thick cover of younger sediments or basalt (the deep leads) have yielded gold at Daylesford and Blackwood and may not be exhausted.

Early prospector's hut, Woods Point district

Antimony

Stibnite (the main ore of antimony) occurs at numerous locations within the study area, which forms part of a larger area (the Melbourne Trough) characterized by antimony mineralization. These locations include Ringwood, Coimadai, Steeles Creek, Clonbinane, and Doogalook.

Steep rises in the price of antimony during 1969 and 1970 resulted in a spate

of applications for exploration licences to search for antimony. Instability in the antimony market caused an equally dramatic drop in price and a cessation of exploration. Any further price rises in the future could stimulate a renewal of such activity.

Copper

The only production of copper within the study area is from the Thomson River Copper Mine near Walhalla. The mine has been worked in three periods, the latest being 1969-71 when it produced 119 tonnes of copper matrix. The ore occurs disseminated in a basic dyke, and in a vein parallel to the dyke contact.

At least two other dykes, the Mount Shamrock and Maynards Gully, contain disseminated copper mineralization. Platinum, palladium, gold, and silver are valuable minor components of the ore from the Thomson River mine.

In comparison with other Australian copper mines, any ore bodies located are likely to be small. Workings would probably be by shaft, adit, and perhaps restricted open-cuts.

Tin

Alluvial deposits of cassiterite, the main tin ore, have been worked in streams draining from granitic rocks near Buxton, Maindample, and Beenak, in the upper reaches of the Latrobe River, and in Rysons Creek, a tributary of the Bunyip River. All of these areas have low production figures and are unlikely to support operations, although small-scale operations, particularly along Rysons Creek, are likely.

No lode cassiterite deposits have been found in the area and the alluvial material is probably derived from disseminated cassiterite mineralization in granitic rock, particularly in the Tynong-Powelltown granite.

Iron

Deposits of limonite (hydrated iron oxides) have been reported at Coimadai, Mirboo North, Narracan, and Langwarrin. All deposits are low grade, of very limited depth and area, and consist largely of ferruginized Tertiary sediments. Siderite (iron carbonate) veins have been found on French Island.

A limonite deposit at Lal Lal, just outside the western boundary of the study area, was worked during the 1870s and contains an estimated 0.7 million tonnes of low-grade iron ore. This deposit is a potential source of yellow ochre and other iron oxide pigments.

Titanium and zirconium

Ilmenite (iron titanium oxide) and zircon (zirconium silicate) are present in the Acheron River. The deposit extends upstream from the Maroondah

Highway for approximately 16 km. The sands have an average depth of 4 m and the width of the deposit varies from 400 m in the lower sections to 40 m or less in the upper sections.

Reserves are estimated to be 8 million m^3, with each cubic metre containing 24 kg of heavy mineral, of which 84% is ilmenite and 1.5% zircon. Total ilmenite content is estimated to be 142,000 tonnes and the zircon content 2,700 tonnes.

The deposit is small in comparison with other mineral sand deposits in Australia and it could not be worked without serious environmental damage to the Acheron Valley.

Tungsten

Wolframite, an important ore of tungsten, has been mined from a narrow vein near Wilks Creek, 6.5 km south-east of Marysville. Total production is reported to be 8.6 tonnes of concentrate containing 5.4 tonnes of tungsten oxide. Reserves are estimated to be 1,500 tonnes, with an average grade of approximately 1% wolframite. During times of high wolframite prices, limited mining activity is likely. On prices prevailing early in 1973, the *in situ* value of the ore would be approximately $33,000.

Small amounts have also been mined from narrow lodes on Opas Creek in the same area.

Molybdenum

Flakes of molybdenite (molybdenum sulphide) are disseminated in granitic rocks at Yea and Arthurs Seat. The occurrences are very limited in size and no mining has taken place.

Non-metallic Minerals

Phosphate

An isolated outcrop of phosphate rock occurs at Phosphate Hill south-west of Mansfield. It is a typical marine phosphorite and is interbedded with cherts and shales. The beds are highly contorted, and the larger phosphate bodies occur where folding resulted in duplication of beds. These bodies are up to 3 m wide and occur on the crests of anticlines, in synclinal troughs, and near abrupt changes in strike. The rock has an average phosphate content of 10 to 15%15#, and lime and alumina vary from 0 to 13% and 20% respectively. The phosphate has been redistributed by weathering and now occurs on bedding planes.

A total of 16,334 tonnes was mined between 1916 and 1926 for use as a low-grade phosphatic fertilizer. Reserves are limited and commercial exploration is unlikely.

Bauxite

Small bauxite deposits are widespread in the Mirboo North district. The

bauxite has formed by deep weathering of basalts and tuffs, particularly along fault lines.

Deposits have a sand and clay overburden of variable thickness. The 40 deposits reported range down in size from 200,000 tonnes. Several have been worked, and produced between 2,000 and 4,000 tonnes annually for the period 1946-65. Production has been intermittent since then, but is likely to continue at a low level.

Diatomite

Small diatomite deposits occur north-west of Melbourne. The principal localities where production has exceeded 1,500 tonnes are Newham, Moranding, and Redesdale. Smaller occurrences are at Mickleham, Coimadai, Lancefield, and Gisborne.

The deposits consist of the accumulation of opaline silica shells of diatoms (small Organisms), with varying amounts of detrital material and, in some cases, sponge spicules. The deposits invariably are intercalated with or underlie basalts, and volcanic emanations probably provided the soluble silica that enabled the diatoms to flourish. Typically the material contains 87% silica on an oven-dried basis.

Continued small-scale intermittent production from some of these deposits is likely.

Salt

Salt is harvested from solar evaporation pans at three separate sites in the vicinity of Geelong, but production figures are unavailable. Operations at Stingaree Bay on the foreshore of Corio Bay are on leased public land.

Fuel Minerals

Brown coal

Brown coal is mined by open-cut at Anglesea and Bacchus Marsh and was formerly mined by underground methods at Altona.

The most important deposits are at Anglesea, where the coal provides fuel for power generation for the Point Henry aluminium smelter. Future use of these deposits will be directly related to expansion of output at the smelter. The coal has a low moisture content (46%) and a net wet calorific value of 12.5 MJ per kg. Mineable reserves in five seams are estimated to be 160 million tonnes. The upper seam is 24-36 m thick and lies beneath an overburden of 12-30 m of sands and clays. Production commenced in 1959 and currently yields 1.1 million tonnes annually.

Brown coal production commenced at Bacchus Marsh in 1944 and reached a peak of 0.56 million tonnes in 1959. Since then production has declined to between 0.2 and 0.3 million tonnes per annum,

which is currently used for industrial purposes in Melbourne.

The seam is approximately 30 m thick and lies beneath about 10 m of sand, clay, and basalt overburden. The coal has a moisture content of 60% and a calorific value (as received) of 11 MJ per kg. The coals extend from Bacchus Marsh beneath the volcanic lava plains to Werribee and Altona, where they were mined between 1910 and 1919.

Black coal

Deposits of black coal are confined in Victoria to the lower Cretaceous sediments. The main producing localities have been Wonthaggi, Korumburra, Outtrim, Jumbunna, and Kilcunda. Total production was 22.6 million tonnes, of which 75% came from Wonthaggi.

The seams vary in thickness from a few centimetres to a maximum of 3 m. Most of those worked were between 1 and 2 m thick. At Wonthaggi, numerous normal faults with displacements between 30 and 200 m intersect the coal seams. These divided the area into fault-bounded blocks, which had to be mined as separate units. Within these units, numerous smaller faults with displacements up to 14 m made coal extraction difficult and costly. Similar small-scale faulting also downgraded the other fields.

Wonthaggi coal contains an average of 9% moisture and has an average calorific value (as received) of 23 MJ per kg. Reserves at Wonthaggi are estimated to be 9 million tonnes, but further mining is unlikely.

Early coal-mining in the Strzelecki Ranges, about 1895

Oil and gas

Most parts of sedimentary basins containing thick sections of Tertiary and Mesozoic sediments are currently held under petroleum exploration permits. Important exceptions are the "inland waters" of Port Phillip and Westernport

Bays, which have been excluded by government direction.

In the open seas, the permits cover all submerged lands other than the neritic strip extending from Cape Schanck to Wilsons Promontory. Deep drilled at Hindhaugh Creek south-west of Geelong, at Anglesea, and offshore 16 miles south of Anglesea (Nerita No.1) but without success.

Potential for finding oil or gas is generally low, but is higher in the offshore areas, including the southern part of Port Phillip Bay, where thicker sediments are present.

Capability

Section four of this report assesses the capabilities of specific parcels of public land in the study area for various uses. Although some are known to contain extensive mineral reserves, the values of many other areas have not been assessed in detail.

Mineral capability assessments are therefore limited by the state of existing knowledge, but several general considerations can be noted.

The exploration for and extraction of construction material will generate the most widespread demand for public land. Extensive deposits of gravel exist in the northern Otways, Brisbane Ranges, and You Yangs, while Lang Lang, Grantville, and French Island have large reserves of sand.

Construction projects will continue to utilize materials available close to the centre of operations. Consequently, often the location of public land rather than its intrinsic quality of mineral reserves gives it a high capability rating. The savings in transport costs due to market proximity make better-quality deposits at greater distances less commercially attractive.

Lack of worked deposits on public land in an area often forces construction authorities into negotiation with private landholders. In many cases this has contributed to increases in total construction costs.

For some minerals, the only significant occurrences or known reserves are located on public land. This situation further increases the capability of suitably endowed public land.

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WATER UTILIZATION

Demand for water in the study area is met largely from surface water resources, with groundwater supplying only small quantities. Catchments south of the Great Dividing Range have been extensively used to meet the demands of Melbourne and Geelong, which are the main centres of water consumption in the region. North of the Divide, surface water is harnessed for irrigation supplies.

Map 8 shows the location of major storages and catchments, and Table 21 lists their characteristics. Their combined extent covers about 7,000 km^2, or one-quarter of the study area. Domestic catchments are generally located on public land, although catchments for many small towns cover private land. Irrigation catchments have a higher proportion of alienated land within their boundaries.

The study area, as well as providing for most of its internal water requirements, is an important source of surface water supplying to adjacent areas, including Ballarat, Bendigo, Gippsland, and the Goulburn Valley. Only a relatively small quantity is imported to meet the needs of Geelong and the Bellarine Peninsula.

Water supply and areas serviced

Map 8 and Table 21 indicate areas serviced by major storages in the study area and the responsible authorities.

The bulk of Melbourne's domestic water supply comes from sub-catchments of the Yarra River basin. In addition, small quantities have been obtained from the headwaters of the King Parrot Creek (north of the Divide) since the mid-1880s, and from the headwaters of the Tanjil and Thomson Rivers since 1967. Work is nearing completion on stage one of a programme to divert water from the upper Thomson River into the Upper Yarra Reservoir.

The recently completed off-river storages at Greenvale and Cardinia have doubled Melbourne's previous storage capacity.

At present Mornington Peninsula and West Gippsland are supplied from the Tarago-Bunyip catchments via storages at Tarago, Lysterfield, Beaconsfield, and Devilbend. Most of the industrial and urban water demands in the Latrove Valley are met by supplies from Moondarra Reservoir and Yallourn Storage.

Table 21

MAIN STORAGE AND CATCHMENTS

Storage	Year of construction	Capacity (10^3ML)	Stream	Catchment area (km^2)	Controlling authority	Use*	Areas serviced
Lake Eildon	1955	3,392	Goulburn	3,885	SRWSC	I, H	Goulburn irrigation system
Cardinia	1973	287	Off river	-	MMBW	D	Melbourne
Upper Yarra	1957	200	Yarra	327	MMBW	D	Melbourne
Lal Lal	1972	59	West Moorabool	220	GSWT	D	Geelong, Ballarat
Silvan	1931	40	Off river	9	MMBW	D	Melbourne
Upper Coliban	1917	32	Coliban	192	SRWSC	D, I	Central Victoria
Tarago	1971	37	Tarago	117	SRWSC	D	Mornington Peninsula system
Moondarra	1962	37	Tyers	274	LVWSB	D	Latrobe Valley
Yan Yean	1886	30	Off river	16	MMBW	D	Melbourne
Greenvale	1971	27	Off river	-	MMBW	D	Melbourne
Pykes Creek	1930	24	Pykes	130	SRWSC	I, D	Bacchus Marsh, Werribee
Maroondah	1927	22	Watts	102	MMBW	D	Melbourne
Lauriston	1941	20	Coliban	223	SRWSC	D	Bendigo, Castlemaine, Maldon
Merrimu	1971	19	Coimadai	85	SRWSC	I, D	Bacchus Marsh and Werribee irrigation districts, Melton urban
Malmsbury	1865	18	Coliban	290	SRWSC	I, D	Bendigo, Castlemaine, and smaller towns
Melton	1934	17	Werribee	1114	SRWSC	I	Werribee
Devilbend	1964	15	Off river	-	SRWSC	D	Mornington Peninsula
O'Shannassy	1928	4	O'Shannassy	132	MMBW	D	Melbourne
Lysterfield	1934	4	Off river	-	SRWSC	D	Mornington Peninsula

* D = domestic and industrial

I = irrigation

H = hydro-electricity generation

The upper reaches of the Barwon River, which also supplies water to the Bellarine Peninsula system, provides about one-half of Geelong's water needs. The remainder is drawn from several reservoirs on the Moorabool River. Water from Lal Lal Reservoir will shortly be used to augment existing supplies.

Lake Eildon's catchment covers more than 1,600 km² of public land in the study area.

Several important irrigation storages lie in the study area. Lake Eildon, the largest storage in Victoria, supplies water to the Goulburn-Murray irrigation district. Eildon township draws its supplies directly from there, while a number of towns downstream augment local supplies from the Goulburn River. Pykes Creek Reservoir serves the town of Bacchus Marsh and adjacent irrigation areas. The Werribee irrigation district is supplied by Melton Reservoir. Three storages on the Coliban River store water for irrigation and urban use in the Bendigo region.

Water Treatment

With the exception of some rivers with high salinity levels, surface waters in the study area are generally suitable for domestic and industrial requirements. However, many town supplies are subject to some form of treatment to avoid the possibility of contamination. Table 22 lists the range of treatments currently applied to domestic water supplies in the study area.

Treatment methods

Improvement in the quality of water can be brought about in many ways, either naturally or artificially. Natural purification by retention in storage is the oldest and often the cheapest means of treatment. This improves quality by the removal of suspended material through sedimentation and destruction of pathog-

Table 22

TREATMENT OF DOMESTIC WATER SUPPLIES

Town	Treatment process: Sterilization (chlorination)	Clarification	Softening	Filtration
Alexandra	X			
Bacchus Marsh	X	X	X	X
Ballan	X			
Bannockburn	X			
Drouin	X	X		
Frankston	X			
Geelong	X i			
Hallam	X			
Hurstbridge	X			
Kooweerup	X			
Korumburra	X p	X p		X p
Mansfield	X			
Malmsbury	X			
Melbourne	X i			
Melton	X	X		
Moe	X	X		
Neerim South	X			
Noojee	X			
Seymour	X	X		
Thorpdale	X			
Trafalgar	X	X		
Warragul	X			
Woodend	X	X		
Yarra Junction	X	X		
Yea	X	X		

(p - proposed 1973)
(i - only intermittent treatment necessary)

Source: State Rivers and Water Supply Commission

enic and intestinal bacteria. It also reduces discolouring and carbonate hardness, and an uptake of oxygen generally occurs.

Sterilization (chlorination) is the simplest form of artificial treatment, and is achieved by adding chlorine to water supplies as a dissloved gas or as a hypo-chlorate solution. In controlled concentrations, this will destroy all bacteria without any risk to consumers.

Clarification may be desirable for water originating in clay districts or water with organic colouring, which cannot be purified by storage and simple sedimentation. The addition of chemical agents that induce coagulation of the particles aids the removal of this suspended material.

Filtration and softening are not widely used in the study area. The former involves straining the water through filter beds, often after the addition of small quantities of flocculating agent. Softening involves the addition of selected chemicals to reduce water hardness, and can be combined with other treatment processes.

Artificial-treatment costs add significantly to the final cost of water supply to consumers. Table 23 details treatment costs for two plants, representative of conditions in these areas. If no controls were imposed on land use in catch-

Table 23

CAPITAL AND ANNUAL COSTS OF TREATMENT AT SELECTED TREATMENT PLANTS

Town	Capital cost	Annual cost (cents per thousand litres) 1970				
		Chemicals	Power and operation maintenance and administration	Depreciation	Investigation and research	Total
	$					
Moe	155,000	0.25	0.22	0.08	0.27	0.83
Yarra Junction	40,000	0.34	0.78	0.29	0.46	1.86

ments, full treatment would probably cost about 4 cents per 1,000 litres. Allocation of capital would also required for the additional treatment plants.

Clearing and developemnt for agricultural and residential purposes has caused detioration of water quality in a number of catchments within the study area.

Concern for these adverse effects has resulted in legislation designed to check undesirable changes in land use. Under provisions of the *Soil Conservation and Land Utilization Act* (1958), a catchment may be formally proclaimed. Under this Act, the Soil Conservation Authority can determine those land uses and management practices that are acceptable in various parts of the catchment. At present, 24 proclaimed water supply catchments in the study area extend over public and freehold land. Land use determinations covering 16 of these areas have been gazetted.

The policy of land use control in catchments therefore becomes a major issue, affecting several groups with interests in these areas. The question of multiple-use catchments in the Melbourne area will be examined below.

Water Consumption

The study area faces steadily increasing water demands, resulting from a combination of growing *per capita* consumption levels and increases in population and industrial activity.

In 1971/72, Melbourne's total water consumption reached 331,500 Ml, following an average annual consumption over the last 5 years of 298,000 Ml. Existing and projected *per capita* consumption figures listed in Table 24 show a continuing rise, indicative of a gradual increase in living standards.

Table 24

Year	Daily average consumption per head (litres)
1890	200
1941	328
1951	353
1961	382
1971	400
1981	448
1991	482
2001	514

Source: Melbourne and Metropolitan Board of Works, 1973

Urban consumption rates (both total and *per capita*) are expected to continue rising, reflecting population growth, improved standards of living, and anticipated expansion of industry. Table 25 gives estimates of urban water needs to the year 2000 for metropolitan Melbourne and for Mornington Peninsula and West-

ernport, based on the need to obtain supplies for a population of 6 million.

Urban population in the upper Latrobe Valley - including Traralgon, Moe, Warragul, and Morwell-Yallourn - reached 60,000 in 1971, with an estimated water consumption, including industrial use, of about 61,000 Ml. Growing at about 4% per annum, urban population in this region is predicted to reach 180,000 by the year 2000 and by that stage have an annual water demand of at least 75,000 Ml. Total S.E.C. water consumption by 1980 will be 67,000 Ml, expanding to 230,000-330,000 Ml by the year 2000 depending on the type of future power station developments. Water for compensation river flow will also add to total requirements.

Equivalent figures for stock and irrigation water needs in the study area over the same period are not readily available, but both of these activities will continue to require substantial water supplies in the near future.

Apart from direct consumption of water, the demand for indirect uses should not be neglected. In the study area, these involve the use of rivers and streams for a variety of recreation activities, including fishing, canoeing, and swimming. Stream flow is also necessary to maintain the ecological balance of waterways, and especially to conserve valuable wildlife habitat in wetlands.

Future Water Supply

Existing water supply system in the study area will not have sufficient capacity to meet estimated future demands for urban and industrial uses, especially those associated with Melbourne's growth. In planning future water supplies for the region, inter-departmental inquiries over a number of years have considered several possible sources. The main ones include:

* desaliniation of sea water and recycling of treated effluent
* improvements in water yield and extensions to the storage capacity of existing catchments
* harnessing of water resources in new catchments and the construction of off-river storages

Each possibility involves varying financial costs, and the second and third have direct implications for the future use of public land, especially in regard to multiple land use on water catchments.

Desalination and recycling

At present desalination is not considered to be an economically viable method of augmenting water supply. Water produced by the latest desalination process would cost at least twice to three times as much as that from conventional sources.

Table 25

FUTURE WATER REQUIREMENT ESTIMATES - URBAN AND INDUSTRIAL

Year	Metropolitan area (Ml per annum)	Mornington Peninsula Westernport (Ml per annum)	Total (Ml per annum)
1967	364,000	18,000	382,000
1974	418,000	34,000	452,000
1980	527,000	63,000	590,000
1985	609,000	88,000	697,000
1990	691,000	123,000	814,000
2000	818,000	272,000	1090,000

Source: Public Works Committee Inquiry into Water Resources of Victoria, 1972

Reclaimed water as a direct source of domestic supply has limitations in terms of public acceptability, but has considerable potential for use in agriculture, industry, and aquifer recharge. The use of reclaimed water for aquifer recharge in the Westernport area has been given serious attention by a technical study group. Ways are also being investigated to encourage industry to use second-class water or recycle processed water.

Despite the potential future contribution from these sources, the bulk of additional water will continue to be provided from surface resources.

Improved Yields

Several existing storages in the study area have been increased by the construction of higher dams. Often this additional construction has been justified in economic terms by the diversion of water from adjacent catchments, where the creation of a new storage on these smaller streams would not have been justified. Merrimu dam wall will be increased in height to permit the storage of additional water from Goodmans Creek and Lerderderg River diversions.

Catchment hydrology research in the study area aims at determining the effects on water yield and quality of selected activities and management practices. The research follows results (mainly from American studies) that indicated that, under some circumstances, changes in catchment vegetation can result in very significant changes in stream flow.

Detailed investigations into the effects of stocking densities, logging, thinning, and clearing are in progress at Coranderrk, Stewarts Creek, East Armstrong Creek, and North Maroondah, but results are not expected before the end of this decade.

Experimental logging within the Coranderrk research catchment.

Additional catchments

Despite other alternatives, the development of additional catchments, together with a system of off-river storages, still remains the most economically feasible means of sunstantially increasing the volume and reliability of water supply in the study area. However, this situation cannot last indefinitely, as:

* only a few suitable but as yet uncommitted catchments lie within reasonable distance of centres of demand

* Competition between users for these limited water resources is growing

Moreover, where public access to domestic catchments is restricted, proposed additional catchments will conflict with existing activities that do not involve water conservation, such as mining, logging, and recreation.

Several catchments in the eastern part of the study area still have sufficient unused capacity to supply Melbourne's water needs uo to the end of this century, and to improve reliability in the existing system. Catchments with the best potential include the Thomson, Aberfeldy, and lower Yarra Rivers.

The potential of rivers north of the Divide has been studied, but at present these resources are committed to irrigation use in the Goulburn Irrigation District.

Apart from the Lerderderg River, which has already been earmarked for diversion into Merrimu storage, there is little scope for additional catchments to be developed in the west of the study area.

In 1967-68, the Parliament Public Works Committee held a public inquiry into proposals to extend Melbourne's water supply sources and made recommendations to the Government. It considered the use of water from the Thomson and Aberfeldy catchments in relation to growing demand from urban, industrial, and agricultural uses in Melbourne, Mornington Peninsula, and the Latrobe Valley.

The Committee recommended progressive diversion of water from the Thomson River into the Upper Yarra storage in two stages. A third stage was the construction of a major storage on the Thomson River above Talbots Creek. River flow sufficient to meet downstream water commitments would be maintained. In addition, a storage at Yarra Brae was recommended to impound some of the remaining uncommitted water from the Yarra and to supply future off-river storages at Watsons Creek and Sugarloaf Creek in the Christmas Hills.

Since the publication of those recommendations, two excessively dry periods in 1967/68 and 1972/73 emphasized the need to augment Melbourne's water supply as soon as practical. This resulted in a decision by the Government to approve construction of stages I and II of the upper Thomson scheme, and to proceed with the Yarra Brae scheme subject to the outcome of a public inquiry into the environmental impact of the dam. A

Water for the upper Thomson River will augment Melbourne's future water supply.

decision to continue with stage III of the Thomson project and to establish two off-river storages at Sugarloaf Creek and Watsons Creek, in conjunction with the Yarra Brae scheme, is awaiting further review of the situation.

Multiple Use of Catchments

Water catchments in the study area vary in the degree to which other land uses are permitted on public land. Some, such as the major portion of those supplying water to Melbourne, are closed to the public and to all activities not directly associated with water conservation. Others are managed for multiple purposes.

Much of the forested public land within these catchments has been logged for timber at some time in the past.

Four categories of land use within catchments are indicated on Map 8. Table 9 indicates the type of recreation activities permitted on or near reservoirs and storages within the study area.

The policy of restricting land use on catchments solely to water production is based on the assumption that other land use practices will impair water quality, increase fire hazards, and possibly reduce water yields.

Deterioration in quality would require additional and expensive treatment, the cost of which would have to be met by the whole community.

A State Development Committee issued a report and recommendations on this matter, in so far as utilization of timber is concerned, in 1962.

The bulk of catchment research in the study area has concerned the effect of timber extraction on water yield. No systematic long-term studies have investigated the impact of recreation activities on water quality.

A few localized studies of recreation impact have been made, including those into discharge of houseboat effluent on Lake Eildon and fishing at the Tarago Reservoir. Their results have shown that water quality has been impaired, but that the adverse effects could be reduced by enforcing stricter management controls and by providing more facilities such as toilets, rubbish bins, camp sites and picnic places.

In general terms, activities involving only the use of catchments, as distinct from storage areas, are not regarded as posing a substantial threat to either water quality or yield. Trail bikes and other motorized recreation vehicles are a notable exception, however, as in some instances their uncontrolled use causes discolouration of water and increased siltation of water storages. Recent research indicates that walkers pose a similar threat on some shallow soils

Maroondah catchment is one of several in which public access is prohibited

Catchments within the study area managed exclusively for water yield contain extensive timber resources. They also have potential to provide a wide range of opportunities for outdoor recreation. Their proximity to and accessibility from Melbourne are factors increasing the pressure for multiple use of these areas.

Closed-catchment policies have resulted in large areas of natural habitat being maintained in a more undisturbed state than would be possible had they been subject to large-scale public intrusion. Despite the previous history of logging and the need for internal road works for fire protection, these catchments have value as areas of scientific reference.

Groundwater

Chapter 7 discussed distribution, yield and quality of groundwater resources in the study area. Although comprising only a small portion of total water, groundwater provides a useful source, mainly for irrigation, stock-watering, and industry. Only in a few localities is it used for domestic supplies.

The extensive use of groundwater is restricted to areas of Tertiary volcanics and sediments. These include the Kooweerup, Wandin Yallock (Silvan), Rosebud, and south-eastern Melbourne metropolitan areas, which contain many high-yielding irrigation and industrial bores. Groundwater is used for stock watering where salinity levels are low. Reliable high-quality water is used for domestic supplies at Kinglake, Silvan, and Trafalgar.

Groundwater management

A basic principle of groundwater conservation is that recharge, in the long run, should balance the sum of natural and artificial discharge from an aquifer. Because of the local value of groundwater resources for agricultural, industrial and domestic uses, some degree of management is necessary to ensure their proper conservation.

In the study area, the various management problems related to groundwater quality and yield include:

* depletion of groundwater resources
* salt-water intrusion
* depletion of recharge by improved surface drainage
* groundwater pollution

In the Westernport Basin, extensive utilization of groundwater from more than 200 high-yielding irrigation bores has depleted water resources, notably around Dalmore and Cora Lynn. Here, water levels have been falling at the rate of 0.3 to 0.6 m per year and are currently about 10 m below the original levels. A groundwater conservation area has been declared in the Kooweerup-Dalmore district under the *Ground Water Act* (1969) in an attempt to control this problem, and investigations are in the progress to determine how much water may safely be extracted annually. Treated effluent from the proposed Carrum sewerage treatment works has been suggested as a source of recharge for this aquifer.

Salt-water intrusion has been suspected as the cause of high salinity readings from some bores on the Mornington Peninsula and parts of the Westernport Basin. The pumping of groundwater in these areas has increased the risk of contamination by salt water.

The disposal of industrial waste has adversely affected the quality of groundwater in several areas. Dumping of

soluble waste in disused sand pits in the Baxter and Brighton formations is leading to contamination of water in these sands. Industrial pollution of the basalt aquifers has reached a high level in the Deer Park, Brooklyn, Laverton, and Sunshine areas from bores and quarry sites used for the disposal of effluent. A recent inquiry into waste disposal considered the adverse effects of groundwater quality from industrial waste disposal in Melbourne's western and south-eastern suburbs, and a series of recommendations were directed towards the amelioration of this problem.

Another form of groundwater contamination is seepage from domestic septic tanks in unsewered residential areas. Water in coastal aquifers between Mordialloc and Frankston has been affected by bacteriological pollution in this way.

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OTHER PUBLIC UTILITIES AND INSTITUTIONAL USES

In addition to the supply of water, several other types of public services within the study area have important implications for the use of public land. The continued need for these services is created by the location and expected future growth of large population centres.

Waste Disposal

The volume of solid, liquid, and gaseous waste has been growing at an exponential rate over recent years, in conjunction with population increase and industrial expansion. Although Melbourne and Geelong account for a large part of total waste produced, country towns and rural industries are also faced with growing levels of waste material and disposal problems.

In the study area, waste disposal is becoming an issue of growing magnitude for both public and private sectors in socal, economic, and environmental terms. Problems associated with waste disposal have received consideration in a recent public inquiry and in the creation of legislation for environmental protection.

The bulk of solid waste disposal has traditionally occurred by land fill in disused quarries, on land reserved for municipal dumps, and on land with low economic productivity (e.g. swamps, flood-prone land, etc.) Many waste-disposal sites have been established in scattered locations on public land throughout the study area. A system of licensing for such sites has been operative for many years, but illegal disposal of waste still occurs. Littering and the indiscriminate dumping of domestic rubbish, including old motor vehicles, is also a form of waste disposal and is widespread throughout the study area.

In the major towns, effective sewage-treatment systems account for the bulk of liquid waste from domestic and industrial sources. In Melbourne liquid waste is currently treated at the Werribee sewage farm and several smaller plants scattered throughout the city. These facilities will shortly be augmented by a new treatment works at Carrum on the Mornington Peninsula. Quantities of liquid waste from industrial sources are still discharged directly into rivers or the ground with-

out proper treatment. Seepage from septic tanks in unsewered residential areas also contribute to ground and surface water pollution.

The disposal of untreated waste has created a number of adverse effects. In addition to general health hazards, unconfined waste disposal has had serious effects on surface and groundwater quality in the vicinity of these sites. On a local scale, waste uisposal has destroyed a number of wildlife habitats and reduced the amenity of recreation areas, which are important to the local community. Most disposal sites are generally regarded as unsightly, often smell unpleasant, and are responsible for generating road traffic of an undesirable nature.

The availability of suitable land-fill sites to meet projected solid waste volumes is rapidly diminishing. Municipal authorities are currently paying high prices for the rights to utilize abandoned quarries within reasonable distance of collection points. In recent years, public criticism of established methods and sites for waste disposal has been growing. This has effectively reduced the supply of potential disposal sites and has led to the imposition of more stringent regulations regarding their siting, operations, and rehabilitation.

The growing intensity of recreation pressures and an interest in nature conservation at a local level have further

Many small parcels of public land are used for municipal waste disposal

increased the conflict with waste disposal, especially on public land.

Electricity

The State Electricity Commission is responsible for electricity generation and bulk transmission throughout Victoria. It operates base-load thermal power stations in the Latrobe Valley that produce more than 80% of the State's total electrical energy, and peak-load thermal stations in the Melbourne metropolitan area. Hydro-electric stations are operated at Eildon-Rubicon, Kiewa, and Cairn Curran. These stations are linked to centres of electricity demand by an integrated State-wide network of transmission and distribution facilities. Electricity is also supplied from the Snowy Mountains Hydrolectric Scheme.

The study area lies between the State's major centre of demand (Melbourne) and points of supply. It is thus traversed by numerous transmission easements, and is also the subject of investigations for future power station sites. Map 9 indicates the main facilities associated with generation and transmission within the study area, and shows in schematic form regions of investigation for future power stations.

Present and future demand

Annual maximum demand for electricity in the study area proper has been estimated at 190 MW (1971/72), with a predicted annual growth rate for the next decade of around 8%. This growth rate is higher than for the State as a whole (6.3% per annum) and is due to the anticipated expansion of urban Melbourne into the area. Maximum demand for the study area including Melbourne reached 2,227 MW in 1971/72, representing about 82% of total State demand.

Existing and future system capacity

The capacity of existing generating stations and transmission facilities is not sufficient to meet projected increases in electricity demand. Because of Melbourne's expected rate of growth, approval has been given for the construction of two additional thermal power stations - at Yallourn W (700MW) and Newport (1,000 MW) - which, together with further electricity entitlements from the Snowy Mountains Scheme, will meet requirements to the end of this decade.

During the early 1980s, proposed extensions to Yallourn W (700 MW) and the construction of a hydroelectric station at Dartmouth Dam (150 MW) will further increase the system's capacity.

Additional easements for transmission lines and sites for terminal stations and sub-stations will also be needed as the system develops. Main transmission easements will be associated with any future power station development. Sev-

eral new lines can be expected to traverse the study area within the next decade.

Power stations

The various types of power station being considered for future use in the SEC system include thermal power stations (using brown coal, oil, natural gas, or nuclear fuels), gas turbine stations (using lighter oil fractions), hydro stations, and pumped storage stations. Pumped storage stations recycle water between upper and lower storages, using low-cost energy for pumping at times of low system demand and generating at times of peak system demand.

System economics indicate that thermal power stations burning brown coal will continue to generate most of Victoria's electricity, but that an increasing proportion of the future demand may well be met by nuclear-fuelled thermal power stations.

The use of natural gas for power generation will depend on the availability and price of natural gas supplies.

Selection of power station sites

A number of factors must be considered in the siting of power stations, including:

* the location of energy sources and their transport flexibility

Installation of natural gas pipeline through private land near Berwick

* the availability of water resources for power station use, particularly for condenser-cooling purposes

* proximity to the main load centres of Melbourne and Geelong

The importance of each factor will vary with the type of power station considered, but in general the study area has very favourable locational advantages in comparision with the rest of Victoria and offers good prospects for the location of most types of generating station.

Thermal stations using brown coal are restricted to sites adjacent to the extensive coal reserves of the Latrobe Valley, because of uneconomic transport costs in moving this comparatively low-grade fuel over long distances.

Hydro-electric and pumped storage stations are also restricted in possible location. Conditions suitable for providing hydro-electricity have already been utilized in the mountainous region forming the north-east portion of the study area, and at present there are no plans to develop these resources further. Pumped storage stations require sites that maximize the ratio of elevation to horizontal distance between storages. Suitable sites for these stations are found around the edge of the plateaus north and east of Melbourne, where quite steep drops in elevation occur over short distances (see Map 9).

Oil, natural gas, and nuclear fuels are more readily transportable than brown coal and allow greater flexibility in the siting of new stations. However, in all cases, location at increasing distances from Melbourne will significantly add to total capital outlay by increasing transmission costs. The main natural gas grid in the Melbourne region is shown on Map 9.

Power stations relying on light or heavy fuel oil would achieve tranport-cost savings if located close to refineries providing these types of fuel. At present these refineries are located on the western side of Westernport Bay and in Corio Bay near Geelong.

Fresh-water resources of the upper Latrobe River would be adequate to meet the needs of thermal power stations in this area for some time, but are currently subject to a public inquiry to determine their future allocation between a number of competing users.

Since salt water is a major alternative to fresh water, sites for oil, gas, or nuclear stations have been considered along the Victorian coastline and on suitable brackish or salt lakes in Gippsland and the Western District. The marine estuaries of Westernport and Port Phillip Bays show significant cost advantages over ocean sites. They are not as subject to damaging storm conditions and to salt-spray drifts, which cause corrosion and fouling problems, and they benefit from being closer to Melbourne.

The feasibility of using water from the Carrum sewage plant, now under construction, is being studied.

Since transmission-line costs are a significant element in the total costs of providing electricity, the siting of power stations close to Melbourne could be a distinct economic advantage. In practice, however, the final decision will, among other things, tend to favour a location that minimizes aggregate costs.

Transmission lines and easements

The transmission and distribution networks convey electricity from power stations to ultimate consumers. The greater part of the main transmission system operates at 200,330, or 500 kV and transmits power to terminal stations located near load centres. Electricity is then transformed to lower voltages and distributed via substations to users within urban and rural areas.

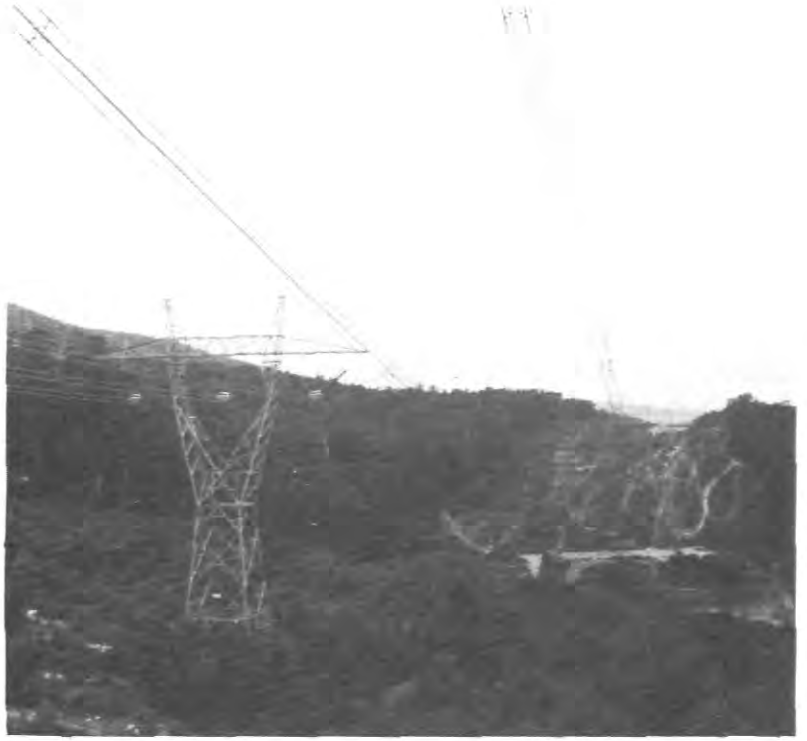
It is usually efficient and economic to transmit large blocks of power over long distances at high voltages, although the choice of voltage and hence the number of lines will depend on total system economics.

Easement requirements

In general, easements must be taken along all transmission-line routes to permit access for construction and maintenance purposes. Their widths vary with: transmission voltage; the number of lines required; and the nature of terrain over which the line passes.

Easements must be maintained in a manner that will provide for safe transmission of electricity and access for construction and line maintenance (particularly in emergencies), and will minimize the effects of bushfires.

The cost of transmission lines and easements represents an important part of total capital outlay in the generation and supply of electricity. At present, the minimum capital cost of a 500 kV line is about $50,000 per kilometer per circuit. Straight-line transmission routes are preferred where possible, to keep line capital expenditure at a minimum and to reduce electrical losses.



Single-circuit 500 kV transmission lines and easement on public land east of Gembrook

The cost of underground high-voltage transmission lines is many times that of equivalent overhead facilities.

Multiple use of easements

In practice the multiple use of transmission easements is not a simple issue. It may create problems concerning the compatibility with other services, vandalism, and responsibilities to power-users in the event of breakdown. At present the issue is being studied by an interdepartmental committee. Chapter 13 mentioned the potential of such easements for recreation use.

Transport

The area reserved for roads and railways in the study area includes almost 5% of total public land. The width of these reservations varies between 20m and 200 m, and they often contain valuable relics of natural vegetation through areas that have been extensively cleared for agriculture or other uses. Chapter 9 discussed the significance of these vegetation strips as landscape features

Vegetation on road easement through cleared agricultural land east of Lake Eildon

and fauna habitats, while chapter 13 considered the recreation potential of abandoned railways and tramways on public land.

Transport routes have facilitated the closer settlement of land in the Melbourne region since early times. At present the main routes (see Map 7) traverse country that has been extensively settled. The general level of accessibility is also relatively high, even in more rugged parts of the study area, with only very few localities more than 3 km distant from conventional two-wheel-drive vehicular access. Off-road vehicles allow even greater accessibility to the most remote areas, and use of these vehicles has increased markedly in the last 5 years.

The construction of roads in forested mountain areas for a variety of reasons, including timber extraction and fire control, has increased the level of public accessibility into forested environments. Although some narrow forestry roads have been permanently upgraded to form important thoroughfares, many of the roads made for timber extraction usually revert to overgrown tracks after logging operations have ceased.

Other Institutional Uses

Military

Various public and private institutions have extensive non-urban land requirements throughout the study area. Among these, the Australian Army and Citizens Military Forces need large areas of public land for field training purposes to supplement operations on land owned by the Commonwealth government. These areas form an important part of the army's total land requirements.

Proclaimed Military Training Areas occupy forested areas and cover almost 10% of public land within the study area (see Table 26). Additional areas of public land are needed on an *ad hoc* basis for specific exercises. The use of all public land for military operations requires prior approval from the responsible managing authorities.

The regular army, the C.M.F., and school cadet units use training areas intermittently throughout the year. Large-scale manoeuvres occur on proclaimed training areas every 2 or 3 years. At other times, these and other public lands are used for communication exercises, orienteering, and engineering as well as general manoeuvres, but usually involve less than 100 men. Most exercises normally involve a week-end, although occasionally they extend to a week or longer.

The nature and duration of these military exercises on public land are such than they are unlikely to pose a threat to public safety or create a prolonged hinderance to public movement. Where necessary, rehabilitation work is

Table 26

PROCLAIMED MILITARY TRAINING AREAS IN THE STUDY AREA

Training areas	L.C.C. block	Approx. area (km^2)
Big River	Upper Goulburn	474
Mount Hickey	Strathbogie	46
Bullengarook	Werribee	65
Cobaw	Romsey	33
Salt Water Creek	Wombat	174
Tooborac	Puckapunyal	142
		934

carried out or compensation made for any damage caused to roads or vegetation.

The Melbourne area is not suitable for large combined defence operations. Assuming, however, that the organization of C.M.F. activities will not alter substantially, the demand for public land in the study area for military training purposes should continue at about its present level.

Other services

The P.M.G. Department occupies small areas of land in elevated sites surrounding Melbourne for telecommunication transmission and reception. As the communication needs of the region grow, additional facilities on existing and new sites will be required to meet these demands.

Location studies for a second international airport to serve the Melbourne region are being undertaken by the Department of Cival Aviation. These studies follow pressure for decisions on the siting of additional small aerodromes. With the exception of French Island, investigations have been concentrated on private land as most public

land in the study area is topographically unsuitable.

Apart from the above, many other institutional uses require small areas of public land. These include hospitals, schools, cemeteries, harbour facilities, navigational beacons, and trigonometric stations.

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LAND USE RELATIONS

The preceding chapters of this report have described the natural resources of the study area and discussed the existing and potential utilization of resources on public land. The hazards associated with these uses have also been considered.

It has been shown that the Melbourne area is characterized by a growing demand for resources on public land from groups with a wide range of interests. In such a situation, with increasing competition between land uses for a relatively fixed supply of land resources, the interaction of various uses becomes an important issue that must be considered before decisions can be made regarding the allocation of public land resources. This chapter examines the nature of these interactions.

Land use compatibility

Each type of land use requires a certain set of resources for its operation and these have been discussed in the relevant chapters. In many cases the resources required overlap in both time and space, thus providing a source of potential conflict. Moreover, the operation of each will have a series of direct and indirect effects on most other uses. These effects may be considered as being:

* beneficial - resulting in an increase in another activity or activities (complementary uses)

* harmful - resulting in a decrease in another activity or activities (competitive uses)

* negligible - having no effect in either direction (supplementary uses)

The nature of these effects will determine the degree of compatibility between two or more land uses and hence their ability to be combined into a multiple land use policy.

In practice, however, no simple relation between land uses exists. Several complicating factors include:

* Activities occur at different levels of intensity. (Compatibility between two activities at a low intensity of operation may be reduced if the operations of one intensify.)

* Often an activity only occurs at any one time in a small part of a wider area, thus localizing its effect. (This enables other activities to continue in the general area.)

* Spill-over effects of an activity may have ramifications for other uses outside the immediate area of the former's operations.

* Compatibility between uses in an area changes over time as the once-harmful effects of one activity are lessened.

* Prevailing social attitudes towards the tolerance of harmful inter-effects may change. (In some cases improved technology - for example better methods of water treatment - helps change these attitudes.)

* Management techniques can reduce possible harmful effects of one activity on others.

Land use flexibility refers to the degree to which any one activity precludes, by its operation, other activities' utilization of a given resource. Flexible uses include those having either negligible or beneficial effects on others.

The following sections give a general outline of relations between broad land use categories in the study area. It has not been possible to deal with relations between internal aspects of each major category of use, although the same principles would apply.

Agriculture production

Agricultural activities in the study area have in many cases introduced a diversity of visual interest that has provided enjoyment for many people, including those sight-seeing, picnicking, and driving for pleasure. This is particularly so in areas where steeply dissected land has been cleared,as around Yea and in the Strzeleckis, and

Numerous picnic sites occur within forest areas along roads that were originally constructed for logging

Plantation clearing, showing native vegetation retained along streams

where patches of native vegetation remain to provide contrast, as in the Yarra Valley below Warburton. Increasing numbers of other recreational and educational activities are now being centred on agricultural lands, as evidenced by the emergence of recreation farms as viable commercial enterprises.

Some native animals such as galahs and white-backed magpies have benefited from the increased area of grassland and of forest margins resulting from agricultural development. Farm dams have extended the range of some frog and bird species. Many other aspects of nature conservation have of course suffered.

The use of additional public land for agriculture would compete with timber production, apiculture, recreation activities requiring forested country, and many aspects of nature conservation.

Softwood timber production

Timber production in plantations is a relatively inflexible land use, as it involves the intensive management of a single crop species. Since about 80% of a pine plantation complex is cleared of natural vegetation, softwood planting competes with nature conservation, hardwood timber production, honey production, and some recreational activities. It also competes with agriculture.

On the other hand, softwood plantations can add visual diversity to an area, as at Mount Macedon. Because of their relatively open understorey, they provide good opportunities for picnicking and other recreational activities such as orienteering. They provide habitat for a number of native animals that would not survive in agricultural land.

Hardwood timber production

This is a relatively flexible land use. It can be beneficial to many forms of

outdoor recreation and is compatible with water production, forest grazing, honey production, and all but the strictist forms of nature conservation.

Harvesting operations have an immediate but short-term effect on local vegetation, fauna, and recreation. These effects generally become more noticeable as the size of the area being harvested increases. In mountain terrain the visual impact of harvesting may adversely affect some recreation values at points some distance from the actual operation.

Increasing the levels of hardwood production decreases its compatibility with other uses. It may favour certain timber species, remove poorly formed trees containing nest sites for animals, considerably reduce the size to which trees are allowed to grow, and often intensify harvesting activities.

Hardwood timber production competes with agricultural and softwood timber production and with recreation activities requiring solitude.

Production and conservation of water

Water production is another major use on public land in the study area. To some extent it is competitive with agriculture, softwood and hardwood timber production, mining, and recreation, depending on the intensity of production and the management techniques employed in these other activities.

The competition applies especially to the quality of water and the seasonal distribution of yield.

Logging, clearing, overgrazing, and excessive pedestrian or vehicular traffic contributes to soil disturbance, causing increased overland flow, which results in stream turbidity and siltation of reservoirs.

Closed catchments are competitive with all other uses except some aspects of nature conservation.

Water storages increase the opportunities for some forms of recreation, such as foreshore picnicking and waterbased activities.

Inundated areas have a localized adverse effect on wildlife habitat. Fish and waterfowl populations can also be affected by downstream alterations of flood regimes and stream characteristics.

The draining of swamps (for example in the Kooweerup district and at Carrum), together with river improvement works (such as Dandenong Creek), has benefited agricultural and urban development, but reduced local water-fowl habitats.

Mineral extraction

Mining and extractive industries are scattered throughout the study area, but do not have widespread effects on other uses. They are only competitive with

most uses in the particular locality of their operations. The compatibility of deep mining differs markedly from that of open-cut or surface stripping operations.

Some quarries are complementary with the study of certain aspects of natural history, providing sites for fossil collection and geological study. Quarry sites often make gemstone collection possible. Expired quarries have been used as rubbish dumps and recreation sites.

With time, some mining activities become the focus of considerable historic interest, as is the case at Walhalla, Woods Point, Stelglitz, and Daylesford.

Public utility services and transport

In addition to water supply, these include the generation and distribution of electricity, the network of oil and gas pipelines, telecommunication installations, roads, and railways.

In general these activities use only small areas of public land, but in most cases they represent inflexible uses.

Transport routes have been essential for the development of all economic land uses and have widened the range of most recreationists. Road construction in remote areas may reduce the solitude appeal of these areas.

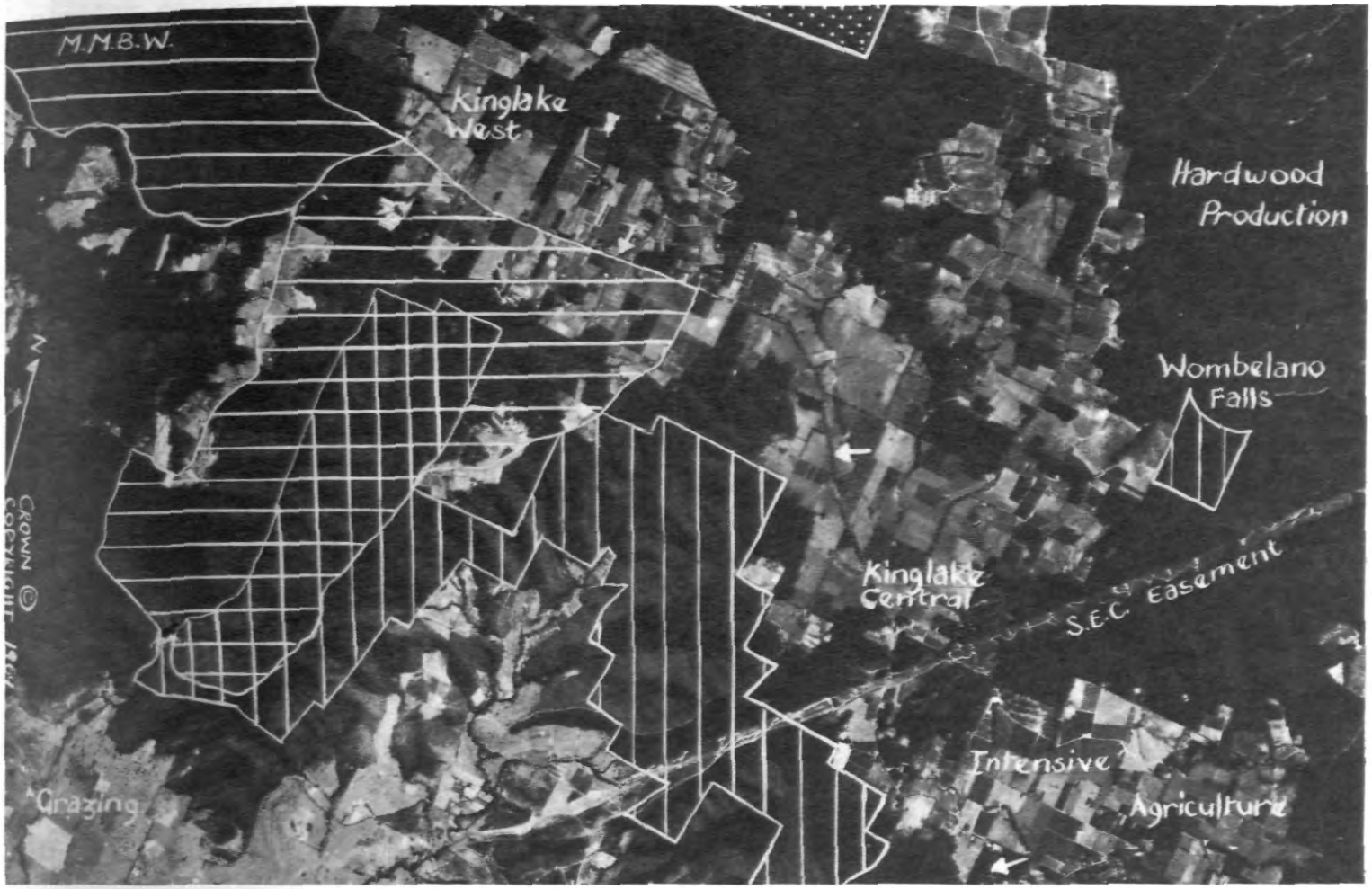
Separate easements for electricity transmission and pipeline installations are competitive with vegetation and some wildlife habitats, and are visually unattractive along their alignments. But they are useful as fire breaks and access tracks and could from part of a network of horse riding and bicycle tracks, especially around the metropolitan fringe.

The development of pumped-storage generating stations at escarpments on public land represents an inflexible use of land in the immediate vicinity of the project. Only a few of these sites are needed, however, and the recreation potential of other sites could be utilized.

Urban and industrial uses

Urban areas contain a multitude of different activities that collectively are competitive in space with most non-urban uses, including agriculture, timber production, apiculture, water conservation, mining, and many forms of outdoor recreation. Moreover, the presence of large urban areas (by intensifying the utilization of or requirement for most resources) undoubtedly compounds the competition between many activities in adjacent areas of public land.

As discussed above, the intensity or potential pressure for utilization of public land by several different activities often serves to reduce land use



Patterns of land use in the Kinglake district

Key: Vertical lines *show Kinglake National Park.* Horizontal lines *show domestic water catchment boundaries. (Note multiple-use catchment at Hurstbridge Reservoir compared with Board of Works catchment).* Arrows *denote popular tourist road.* Dots *show area now converted to softwood plantation.*

compatibility.

Outdoor recreation

This collection of activities makes generalizations difficult because of their variation in resource requirements and degrees of compatibility with other land uses. Solitude-based recreation appears competitive with even low intensities of timber production, mining, agriculture, utility services, and transport, and is thus an inflexible land use. At the other extreme, pleasure motoring is often enhanced by a diversity of visual elements and is therefore quite flexible.

Nature preservation

Areas set aside for strict nature preservation and for scientific purposes are competitive with all other uses, except perhaps water production, and are therefore inflexible.

PART IV

BLOCK DESCRIPTIONS

BLOCK DESCRIPTIONS

This part describes for each block its general characteristics, the nature of the land, its capabilities for various uses, and the likely hazards and conflicts involved with such uses, and finally highlights those outstanding capabilities or other features that are of special significance.

A consistent format of headings and subheadings has been used so that the reader can readily find specific information within one block and compare it with others. The discussion under most sections refers specifically to public land. Only in the cases of A(2) - General description, B(1) - Climate, B(2) - Geology and physiography and B(3) - Soils do comments apply to the entire block.

A key diagram at the beginning of each description gives the approximate location of that block in the study area. Greater detail for all blocks is shown on Map 1.

Capability

This term refers to the suitability of public land for various uses, and is based on a number of considerations. These include the inherent characteristics of the land, the proximity of public land to centres of population, the level of accessibility within it, and the relative scarcity of the type of land.

In most cases, this report has dealt with assessment of capabilities in general terms, because the amount of information available has varied from block to block, and because some of the values have been difficult to quantify. In assessing capability, comparisons have been made with other blocks and with other parts of the State.

Where productivity measures have been used, various categories have been defined and given capability ratings. Hardwood and softwood production ratings are shownon pages 151 and 171.

1. TORQUAY

A. General

(1) Location and present tenure

Public lands total 14,660 ha and is distributed between two large parcels (the eastern Otways and the Lake Connewarre. State Game Reserve) and numerous smaller ones. The parcel in the eastern Otways adjoins much larger areas of public land outside the study area.

Tenure is evenly divided between reserved forest, unreserved Crown land, and special reserves established under the *Lands Act*.

County of Grant: Parishes of Barrabool, Bellarine, Connewarre, Corio, Duneed, Jan Juc, Moolap, Modewarre, Paraparap, Paywit and Puebla

County of Polworth: Parishes of Angahook, Boonah and Lorne.

(2) General description

This block consists largely of an undulating plain that has been almost entirely cleared for grazing. Small areas of public land fringing the ocean and Port Phillip Bay foreshores, and the swampy lower reaches of the Barwon River, still support native vegetation. On the only large area of public land (in the south-west) open forest and heathy woodland still cover the rugged terrain of the eastern Otway Ranges. The coastline contains a range of sandy beach and cliffed environments.

(3) Present land use

The coastal zone is used intensively for bay- and ocean-based recreation. Lake Connewarre and Reedy Lake provide habitat for waterfowl and, in season, sport for duck-shooters. Reserves at Edward's Point and Mud Island protect the habitat of many water-birds. The forested eastern Otways are used for sight-seeing, bush walking, picnicking, and nature study. The block contains a number of youth camps at Anglesea,

Fairhaven , Ocean Grove and Point Lonsdale .

Honey production is significant between Point Addis and Point Roadknight.

Brown coal is mined near Anglesea, and about 6,000 ha of public land (mainly within the study area) are held under long-term lease for this purpose. Sand, gravel and stone are extracted from a number of scattered sites in the west of the block.

B. Nature of the land

(1) Climate

This relatively dry area lies in the lee of the Otway Ranges. Average annual rainfall varies from about 500 mm near Geelong to 800 mm near Lorne, with a winter maximum. Growing season could be expected to last from April to December, with restricted growth from June to August. In the high-rainfall areas, the season may last from March to January.

(2) Physiography and Geology

Flat or gently undulating plains developed on Tertiary and Quaternary sediments predominate. Their general elevation is about 60 m and they are bounded along the coast by the Torquay and Bellarine faults, with the Curlewis monocline forming the north side of the Bellarine Peninsula. Remnants of

This aerial photograph shows coastal recreation, urban development and remnant vegetation at Torquay.

Pliocene plateau are sometimes conspicuous, particularly around Anglesea.

In the extreme south-west, steep dissected terrain has developed on the uplifted Cretaceous sandstones and mudstones that form the Otway Ranges. West of the study area these reach an elevat-

tion of about 600m.

An area of Tertiary volcanic remains on the Bellarine Peninsula, while a broad band of Pleistocene basalts fills a former east west valley across the plains. Thompson Creek flows along the southern edge of these basalts. The Barwon River crosses the block from the north, through Lake Connewarre, to its outlet at Barwon Heads.

Heath woodland at Bald Hills near Anglesea

(3) Soils

The more widespread soils on cleared land are acidic duplex soils on Tertiary deposits, or sodic duplex soils, black clays, and grey clays developed on basalt. Shallow red and black gradational soils (terra rossas and rendzinas) have developed on limestones near Geelong. On public land, calcareous sands predominate on dunes, and areas of leached sands adjoin the coast. In the Otway foothills sodic duplex soils predominate with yellowish gradational soils where annual rainfall exceeds 800 mm. Dark saline soils occur extensively around Lake Connewarre.

(4) Vegetation

In the eastern Otways, messmate stringybark with brown stringybark forms open forest II and I on gradational and duplex soils developed on Tertiary sediments. Red ironbark, sometimes in mixture with eurabbie, forms an open forest II and I in a rain-shadow area extending close to the coast from Grassy Creek to Point Addis.

Messmate stringybark with mountain grey gum, narrow-leaf peppermint, and sometimes eurabbie forms open forest II or III on gradational soils developed on Cretaceous sediments in the extreme west where elevation and rainfall are higher. The chief understorey trees are blackwood, silver wattle, and tree everlasting. Small colonies of tree-ferns and assoc-

iated gully vegetation occupy the heads of Distillery Creek, and the drier valley slopes are covered with a varied assortment of shrubs, principally myrtle wattle, narrow-leaf wattle, prickly moses, common wedge-pea, large-leaf bush-pea, pink-bells, hop goodenia, dusty miller, and common heath. Swamp and manna gums grow extensively on the valley flats, which may also carry thickets of prickly tea-tree, scented paperbark, and prickly moses intermingled with tall saw- and sword-sedges.

Heathy woodlands are widespread on the Tertiary sediments in the south-west. Shining peppermint occurs on leached sands that have an impeding layer near the surface, while brown stringybark grows on leached sands without an impeding layer or on sodic duplex soils. The heath understorey includes thatch saw-sedge, tassle rope-rush, austral grass-tree, dwarf she-oak, silver banksia, furze hakea, spreading wattle, sweet wattle, heath tea-tree, prickly broom-heath, and bundled guinea-flower.

A remnant of manna gum woodland occurs on public land at Ocean Grove. In most areas, the moderately fertile leached sands and duplex soils this plant association favours have been alienated and cleared.

Typical dune communities of climbing lignum, coast wattle, white correa, coast tea-tree, coast beard-heath, coast daisy-bush, coast everlasting, cushion-bush, and dune thistle are to be found along many parts of the seafront reserves between Anglesea and Point Lonsdale. Moonah forms a coastal scrub on sand at Anglesea and Airey's Inlet, providing a shaded habitat for the very rare and interesting fungus *Underwoodia beatonii*.

Examples of white mangrove scrub and extensive salt-marshes with seablite, glass-worts, noon-flowers (pigface), and other succulent halophytic vegetation are found at Lake Connewarre and the Barwon estuary - the most westerly occurrence of mangrove in Victoria. Some areas of tangled lignum and beds of native reeds still occur at Reedy Lake.

Dry coastal vegetation, including mature stands of coast tea-tree and wirilda, are found at Edward's Point, while salt-marsh vegetation fringes Swan Bay and a number of small lagoons scattered along the coast on public land from Breamlea to Portarlington.

Mud Island carries salt-marsh and dune vegetation, including a few low shrubs such as coast beard-heath.

(5) Fauna

Several animal habitats occur on public land in this block, the general forest habitat in the eastern Otways, including areas of dry open forest and heathy woodland; wetlands, especially at Barwon Heads, Swan Bay (Queenscliff),

Port Henry (Geelong), and Mud Island; dry coastal complex in a narrow strip along most of the coast from Fairhaven to St. Leonards, and, adjoining this, the open waters of ocean and bay.

The common species found in these habitats are discussed in chapter 10 and listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The public land of this block supports significant areas of heathy woodland and of wet and dry coastal complexes - environments that have very restricted occurence. Consequently, most of this land has a very high capability for nature conservation.

The eastern Otway area is one of the richest floristic localities in Victoria. The 360 indigenous species recorded include 17 ferns, 56 orchids, 13 wattles, and 10 eucalypts. Several plants have strong affinities with the Grampians flora and occur no farther eastwards, notably branching fringe-lily, Victorian smoke-bush, variable prickly grevillea, leafless bitter-pea, winged spyridium, twisted beard-heath, and ixodia (a white everlasting). Blue finger flower is at the southern extremity of its range in an isolated colony at Distillery Creek. Featherheads have been found on coastal heath at Anglesea; velvet daisy-bush occurs along the road to Point Addis, but not on public land. Slender velvet-bush reaches its eastern limit at Barwon Heads.

Among the rarer orchids on record for Anglesea and its environs are: *Thelymitra fusco-lutea, T. matthewsii, T. mucida, Calochilus herbaceus, Orthoceras strictum, Caladenia filamentosa, C. iridescens. Leptoceras fimbriatum,* and *Lyperanthus suaveolens.*

The very rare *Thelymitra epipactoides* once grew at Bellbrae and Ocean Grove, whereas *Potamogeton australiensis* (thin pondweed) is still known in Victoria only by old collections from Wilson's Promontory and Merrijig Creek north-west of Bellbrae.

The area is the type locality for three vascular plant species (see Appendix 2b)

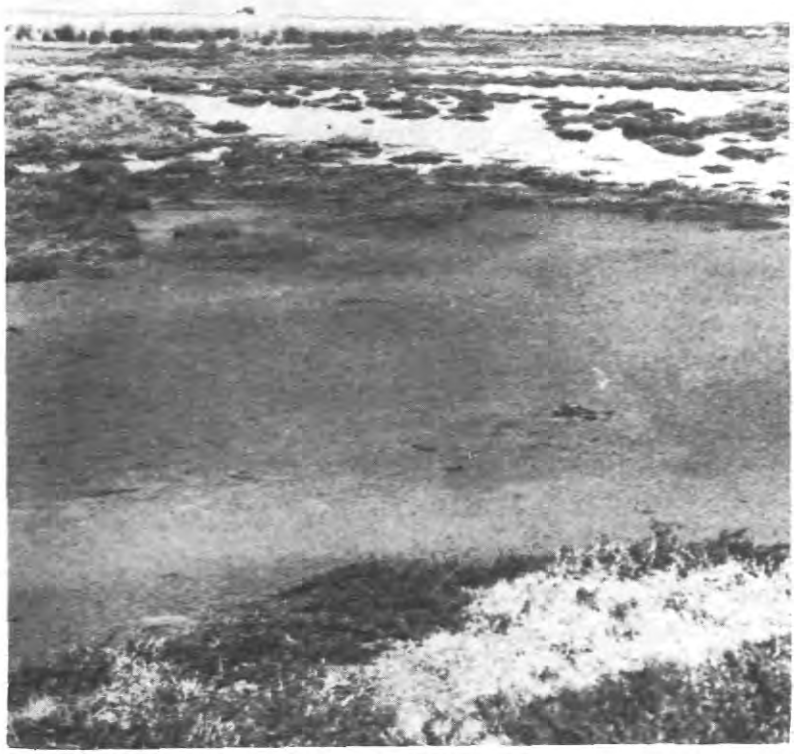
A number of animal species of particular significance occur in the eastern Otways. Heathy woodlands here support breeding populations of the southern potoroo, southern emu-wren, field wren, heath wren, and tawny-crowned honeyeater, all of which have a high degree of association with this habitat type and are now regarded as uncommon.

A snail, *Charopa sp.*, has only been recorded in the coastal heathlands of this area, while another interesting snail, *Austrosuccinea sp.*, is also found in this type of environment. One of the few Victorian records of the swamp

antechinus is from dry coastal vegetation at Hutt Gully west of Anglesea, while the rare white-footed dunnart has been recorded in similar vegetation near Aireys Inlet.

The rufous bristle-bird reaches its eastern limit at Torquay. It inhabits a narrow coastal strip westwards to the mouth of the Murray, and again from Cape Leeuwin to Cape Naturaliste in West Australia. While not rare, it has a very restricted habitat. The beautiful firetail is restricted to coastal scrubs and adjoining timbered gullies and is uncommon in Victoria. It is known to breed near Anglesea. The rare white-throated nightjar reaches its western limit in the heathy woodlands near Aireys Inlet, where it is known to breed. The singing honeyeater, although widespread in other parts of Australia, is confined in Victoria to a narrow strip from Port Phillip Bay to the lower Murray Valley. It inhabits coastal tea-tree areas in this block.

The lower Barwon River, Lake Connewarre, and the associated flood plain have an estuarine fauna not found elsewhere along the Victorian coast. It includes species specially adapted to fluctuations in salinity from full salt-water to full fresh-water conditions, over both short and long periods. The area forms a very important link in the chain of swamps along the east-west flight line of migratory waterfowl, providing



Saltmarsh near Breamlea

feeding and breeding ground for many ducks, spoonbills, and other waterbirds, as well as feeding areas for the migratory waders during summer.

The lagoons and littoral zone surrounding Swan Bay are particularly valuable areas for waders and waterfowl, large flocks of which congregate there to feed and shelter. The salt-marsh and dune vegetation is one of the few known winter refuges for the endangered

orange-bellied parrot. Swan Bay itself is of special interest, as it supports a rich salt-marsh fauna and provides a sheltered breeding ground for many marine species on invertebrates.

A new species of *Limapontia*, a small saccoglossan sea slug, has recently been found in this area. Previously the genus had only been recorded in Britain and the coast of eastern Europe.

Mud Island is a very important summer feeding area for the intercontinental migratory waders. Among those regularly recorded are a number rarely seen in other parts of south-eastern Australia. These include mongolian and large sand dotterels, whimbril, little whimbril, black-tailed godwit, grey-tailed tattler, little terek, and pectoral sandpipers, and the knot. Mud Island and the adjacent Fort Island are the only known breeding sites of the white-faced storm-petrel, thousands of which nest there annually. Other breeding species are silver gulls and crested, fairy, and caspian terns.

Many points along the coast of this block provide resting sites for the black-faced cormorant, a species confined to the Bass Strait area.

Four camp sites in the block are used by the Education Department for environmental studies. A natural history education centre is being developed on public land north of Ocean Grove.

Significant fossil localities occur on public land along the Torquay-Anglesea coast (Tertiary), along the Curlewis-Clifton Springs coast (Tertiary), at Lake Connewarre (Tertiary), and at Queens Park, Geelong (Lower Cretaceous).

Coastal middens are also present on the shoreline of the Bellarine Peninsula.

(2) Recreation

The public land here has a very high capability for recreation. The block adjoins the growing city of Geelong, is within 2 hours' driving time of Melbourne and Ballarat, and includes popular holiday centres such as Queenscliff, Torquay and Anglesea.

The main attractions are swimming at surf beaches along the ocean coast and at sheltered beaches in the Bay, fishing, boating, and (in season) game birds at Lake Connewarre.

Although most activities are water-based the bushland areas backing the coast enhance the beach environment and provide opportunities for camping, picnicking, walking and nature study.

The heath woodlands provide good wild flower displays during spring, and eastern grey kangaroos may be readily observed in these areas. The undulating terrain and varied coastal landscapes

Intensive recreation at Ocean Grove (Note use of foreshore for car-parking)

provide many scenic drives, including the eastern end of the Great Ocean Road. Access is good and climate relatively dry. The area contains many youth camps.

Expansion in the development of holiday homes, tourist facilities, and residential accommodation oriented to Geelong is increasing both local recreation demand and visitor numbers, especially during summer and along the coastal fringe.

(3) Hardwood timber

Capability is very low. At Aireys Inlet stands of red ironbark have potential to continue providing small volumes of minor timber products.

(4) Softwood timber

Capability is low. Both rainfall and soils are inadequate, except on lower Cretaceous sediments in the far west. Plantations established on leached sands in the Anglesea area during the 1920s proved unsuccessful.

(5) Agriculture

Most public land has a low capability for agriculture. Pasture establishment and maintenance costs are very high on infertile leached sands, and the estimated carrying capacity of such pastures is not high. Slopes in the eastern Otways are too steep for agriculture.

Geelong and district apiarists have worked the coastal area between Point Addis and Point Roadknight extensively over many years for honey production. The most useful species include red ironbark (nectar), moonah (nectar and pollen), and numerous native ground flora (pollen).

(6) Minerals

Public land in the south-west of this block has a high capability for gravel, sand, and brown coal production. The eastern Otways contain valuable deposits of gravel and sand, which could be economically used within a radius of about 35 km.

Alcoa of Australia Pty Ltd work brown coal deposits near Anglesea, with known reserves estimated to be 160 million tonnes. The *Mines (Aluminium Agreement) Act* 1961 provides for the company to lease about 6,000 ha of public land for a period of 50 years, subject to the provisions of the agreement.

The area may contain deposits of oil, and some exploration has taken place. Shellgrit is mined at Queenscliff.

(7) Water

Surface water resources are of little consequence in this block. Water from the public land in the eastern Otway Ranges drains to the ocean and has some capability for supplying water for local needs between Torquay and Lorne.

About one-half of supplies to Geelong and the Bellarine Peninsula system are obtained from the Barwon catchment, west of the study area.

The eastern end of the Otways is a significant groundwater-intake area for the Barwon Downs. The Mines Department is conducting groundwater tests to obtain data on intake areas and the capacity of the lower Tertairy sand and gravel aquifers. These have some potential for augmenting the water needs of Geelong and other towns, as well as for private agricultural supplies.

This intake area also serves an aquifer containing small quantities of good-quality groundwater at Anglesea.

(8) Utilities

The coastal zone around Breamlea is being investigated as a possible power station site utilizing ocean cooling water. A transmission easement catering for two single-circuit 500-kV lines would be needed to connect this power station to Moorabool terminal station. The area is close to the expanding load centre of Geelong.

Sewerage from Geelong is discharged into Bass Strait at Black Rock, about 3 km east of Breamlea.

D. Hazards and Conflicts

Fire poses a constant threat to the woodlands and scrubs from late spring to autumn. The hazard is particularly high along the coast, due to the presence of large numbers of people and the proximity of holiday homes to large areas of public land.

The coastal dunes are very prone to wind erosion when the vegetation is disturbed. Heavy recreational use of beach areas has already caused serious problems, for example at Anglesea, at Point Roadknight, and west of Barwon Heads.

A moderate water erosion hazard exists on slopes in the eatern Otways, and on soils developed on limestone.

There is considerable evidence of infection by cinnamon fungus , particularly in the stringybark forests. Boneseed is well established at many localities along the coast and poses a serious threat to the native vegetation.

An obvious conflict exists between nature conservation and the extraction of coal, sand, and gravel in the Anglesea area.

E. Significance

Public land in this block has a very high potential for recreation, especially along the coast. It has a high capability for nature conservation, particularly important areas being at Anglesea, Lake Connewarre, Swan Bay, and Mud Island. Land in the Anglesea area has a high capability for production of brown coal, gravel, and sand.

Of some significance is the lack of large areas of public land within 40 km of Geelong.

2. BRISBANE RANGES

A. General

(1) Location and present tenure

Public land covers 15,580 ha (or 8% of total area) and includes one large central parcel (the Brisbane Ranges) and several smaller outlying ones, including the Inverleigh and Bannockburn Commons and the Werribee Gorge.

Tenure is distributed between reserved forest, unreserved Crown land, and national park. Several smaller areas of special reserves have been established under the *Lands Act*.

County of Bourke: Parishes of Gorong, Korkuperrimul, and Myrniong

County of Grant: Parishes of Anakie, Ballark, Balliang, Bamganie, Barrabool, Beremboke, Borhoneyghurk, Bungal, Bungeeltap, Cargerie, Carrah, Coolebarghurk, Darriwil, Duneed, Durdidwarrah, Gheringhap, Gnarrwarre, Gorong, Gorrockburkghap, Kerrit Bareet, Lara, Meredith, Modewarre, Moorabool West, Morrpanyal, Moranghurk, Moreep, Murgheboluc, Parwan, Wabdallah, Yaloak, and Yowang

County of Greenville: Parish of Doroq

(2) General description

The Rowsley Fault breaks this block into two parts. Both the uplifted western and lower eastern sections are gently undulating and have been largely cleared for grazing. The few blocks of public land remaining are confined to the strongly dissected terrain along the fault scarp, and to other areas with soil unsuitable for agriculture. They support low open forest and woodland.

The main streams, flowing generally to the south-east, have cut deep but narrow gorges as they leave the uplifted western part of this block.

Velvet daisy-bush, a rare shrub found in the Stony Creek gorge

(3) Present use

The Brisbane Ranges provide for a variety of recreational activities, including pleasure driving, picnicking, sightseeing, bush-walking, and nature study. Part of Geelong's water supply is held in storage at Durdidwarrah and Bostock, and small softwood plantations have been established in these areas. Small volumes of posts, firewood, and pulpwood are harvested. Honey production is significant. Gravel, slate, and clay are extracted at some localities.

Other areas are used for nature study (Werribee Gorge), for sand and gravel extraction (Bannockburn and Inverleigh), and for local recreation (including a golf course at Bannockburn).

B. Nature of the Land

(1) Climate

This is a relatively dry area in the lee of the Otway Ranges. Average annual rainfall varies from about 500 mm at low elevations to about 700 mm at higher elevations in the north-west, with a winter maximum. The growing season could be expected to last from March to January at higher elevations, with restricted growth from May to September, and from April to December at lower elevations, with restricted growth from June to August.

(2) Physiography and geology

The Rowsley Fault, which bisects the block from north to south, is the dominant feature. Deep dissection is typical in the uplifted western areas, where the Little and Moorabool Rivers and Sutherlands Creek have cut deep gorges exposing Ordovician shales and slates. Although uplift in the northern part,

known as the Ballan Sunkland, has not been quite as great, the Werribee River has cut a deep gorge exposing Ordovician, Permian, and Tertiary sediments, Devonian granite, and both Tertiary and Pleistocene basalts.

Remnants of the original Tertiary sedimentary plain are still present as hill cappings, and become more extensive in the less-dissected areas to the south and west, where they merge with the newer volcanic plains.

The fault scarp has elevations of about 410 m along its crest and about 230 m at its foot. The region east of the fault has flat to undulating plains of Pleistocene basalts in places underlying fault aprons and Recent alluvium. West of Geelong, an uplifted block of Cretaceous sediments forms the Barrabool Hills, which reach an elevation of about 155 m.

(3) Soils

The more widespread soils on basalt and alluvium are reddish calcareous duplex soils and grey clays. The few areas of public land occur mainly on Palaeozoic and Tertiary deposits, where sodic duplex, shallow stony, and acidic duplex soils predominate. White leached sands occur in some parts of the Brisbane Ranges. They are extremely infertile and sometimes a hardpan develops. Orange leached sands occurring on the Inverleigh Common are more fertile, and never develop a hardpan.

(4) Vegetation

Open forest I vegetation predominates. The flat upland areas of the Brisbane Ranges, and near Mount Doran and Bamganie, carry messmate stringybark mixed with broad-leaf peppermint, red stringybark, or sometimes brown stringybark or scent bark. The open understorey includes silver banksia, bushy needlewood, myrtle wattle, and austral grass-tree, together with erect guinea-flower, common flat-pea, horny conebush, and common beard-heath. Red stringybark in varying association with broad-leaf peppermint, red box, and occasionally long-leaf box occurs widely on shallow stony soils.

In the Brisbane Ranges, particularly at the northern end, red ironbark also grows widely - in mixture with red box on shallow stony soils, or, on better soils, in pure stands or mixed variously with brown stringybark, yellow box, or yellow gum. In these areas understorey includes narrow-leaf bitter-pea, austral grass-tree, various wattles, common heath, silver wallaby-grass, and tussock grass. Swamp gum, manna gum, yellow box, and red gum occur along the drainage lines and on alluvial flats.

An open forest II of manna gum, swamp gum, and white sallee is found on lateritic duplex soils near Durdidwarrah. The understorey consists mostly of grasses and seasonal herbs, with rushes and sedges in wetter situations.

Sizeable patches of heathy woodland occur on leached sands between Steiglitz and Staughton Vale. Heathy tea-tree, silver banksia, golden grevillea, horny cone-bush, bushy needlewood, myrtle and spike wattles, bush-peas, guinea-flower, pink-bells, common correa, and various epacrids are all conspicuous components of the understorey. In shaded gorges, a few montane plants have become established, for example alpine greenhood and austral dandelion.

East of Mount Egerton, the land carries open forest I and II of messmate stringybark and narrow-leaf peppermint, with tall riverine manna gums on the lower slopes and valley bottoms. Some broad-leaf peppermint occupies the drier ridge-tops, with an understorey of blackwood, silver wattle, various shrubs, and occasional grass-trees.

Public land west of Bannockburn still carries some original woodland of yellow gum and manna gum with drooping she-oak. Golden wattle is the dominant understorey with a ground flora of dwarf shrubs (parrot-peas, rice-flowers, and austral guinea-flower), herbs, and grasses.

The Inverleigh Common supports woodlands of manna gum and, in low-lying situations, red gum. The understorey is predominantly grassy with occasional patches of heath; at least 24 species of orchids and 13 of lilies are known from this relatively small tract.

(5) Fauna

The animal habitats on public land in this block are the general forest habitats including dry open forest and small areas of grassy woodland in the Brisbane Ranges, grassy woodlands in the Inverleigh and Bannockburn areas, and dry open forest in several small scattered areas in the north and west of the block. Small areas of wetland occur as permanent streams and earth tanks.

The common species found in these habitats are discussed in chapter 10, and listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The public lands at Brisbane Ranges, Werribee Gorge, Bannockburn, and Inverleigh have a high capability for nature conservation.

The steep scarp of the Brisbane Ranges has a high landscape value, being a prominent feature visible from most areas west of Melbourne. The Ranges support good examples of red stringybark and red ironbark open forest I vegetation types as well as a small area of manna gum - swamp gum - white sallee forest with a grassy understorey of native species. The 420 indigenous species recorded in the Brisbane Ranges include 50 orchids, 14 wattles, and 16 eucalypts.

White sallee at Durdidwarrah

The northern portion of the ranges carries plant species that have affinities with East Gippsland and do not occur elsewhere in western Victoria: shiny phebalium, clustered poranthera, and pomax. Another East Gippsland species, tangled pseudanthus, is shared with the Werribee Gorge, and shiny bossiaea with the hills at Toolern Vale. Steiglitz is the only western Victorian locality for *Pomaderris ferrunginea*.

Grevillea steiglitziana and *Choristemon humilis* are both endemic in the Brisbane Ranges - the latter a diminutive heath known only from its type collection (west of Balliang). Reillys Creek, Brisbane Ranges, is one of five Victorian localities for the rare cane spear-grass, and Steiglitz one of four places in Victoria where the scented bush-pea is known to grow. The rare velvet daisy-bush survives in Stony Creek gorge, and a very isolated occurrence of rosemary grevillea is found at Nelson's Lookout in the Brisbane Ranges, where golden grevillea has its most westerly habitat. Small disjunct occurrences of fairy wax-flower are known from east of Steiglitz and Stony Creek.

Uncommon plants recorded for the Ranges include lavender grevillea at the eastern limit of its range, sticky boronia, large duck-orchid, small duck-orchid, blotched sun-orchid, Mentone greenhood, and tawny leek-orchid.

Recent mammal surveys have indicated that relatively few native species are present, although there are good populations of eastern grey kangaroo, black wallaby, and koala.

The Werribee Gorge has a high scenic value, with precipitous terrain and views of the surrounding country from several vantage points. A large number of geological features can be seen to advantage within a small area, including synclines and anticlines, igneous

intrusions and lava flows, evidence of faulting, peneplanation and glaciation, fossils, differential erosion and entrenched stream meanders. Consequently, it also has high educational value.

Dry-country plants of special interest because of their isolated occurrences in this locality include white cypress pine, fragrant saltbush, turkey-bush, and pimelea daisy-bush.

The Inverleigh and Bannockburn public lands support good remnants of the formerly widespread manna gum, yellow gum, and red gum woodlands. They have a very high value for nature conservation. Bannockburn is the type (and sole) locality for the dwarf spider-orchid and the rare crimson sun-orchid, plain sun-orchid, and green leek-orchid also occur here. The little sword-sedge, a very uncommon and localized Victorian plant, grows on both areas - the most southerly recorded occurrence. Native mammals present include the eastern grey kangaroo and koala. At least 24 orchid and 13 lily species known from the Inverleigh public lands.

Other small parcels of public land in the block, while not known to support unusual faunas and floras, have a high value for conserving the natural character of a landscape that has largely been cleared for agriculture.

Important localities in the block for tertiary fossils are the Native Hut Creek and Yarrowee River at Inverleigh, the Barwon between Inverleigh and Pollocks Ford, and the Moorabool between Maude and Fyansford.

A school camp at Steiglitz annually caters for 40 one-week courses, each of about 40 students.

(2) Recreation

The public land in the Brisbane Ranges has a moderate capability for recreat-

Grassy woodland of manna gum at Inverleigh Common

ion. It is within an hour's driving time of Geelong, Ballarat, and Melbourne's western suburbs and the growing centres of Melton, Sunbury, and Bacchus Marsh. Its main attractions are the rugged landscape and lookouts along the fault scarp, relics from the gold-mining era at Steiglitz, and wildflower displays during spring. Eastern grey kangaroos and koalas can be seen. The main activities include picnicking, pleasure driving, car rallies, orienteering, nature study, and bush-walking. Access is generally poor.

Other areas of public land have a lower capability for recreation, but they add diversity to the general landscape.

(3) Hardwood timber

Capability is generally very low. Durable species such as red ironbark, yellow gum, and yellow box have potential to continue providing small volumes of minor timber products. Areas of open forest II in the north supporting stands of messmate stringybark, brown stringybark, or narrow-leaf peppermint are capable of producing small volumes of sawlogs and larger volumes of pulpwood. These stands are close to the hardboard factory at Bacchus Marsh.

(4) Softwood timber

In general, capability is low, as rainfall is not adequate. The slightly higher-rainfall areas near Mount Egerton have a moderate capability. A seed orchard near Mount Doran is connected with a programme to breed and distribute high-quality radiata pine.

(5) Agriculture

Most public land has moderate to low capability for grazing or crop production due to topography and soil type. In hilly areas shallow stony soils are difficult to cultivate or are too steep. A high erosion hazard exists on steep cleared land.

The Brisbane Ranges have a moderate capability for continued honey production and bee-keeping. Apiarists from Geelong, Ballarat, and Melbourne use the area. Pollination for various agricultural and horticultural crops is also provided on an organized and voluntary basis. Important species include yellow gum (honey), manna gum (honey and pollen), river red gum (honey and pollen), and native ground flora (pollen). The Bannockburn Common is also useful as a build-up and holding site for bees in surrounding agricultural land.

(6) Minerals

This block contains a range of mineral deposits, many of which are on private land. The area has valuable deposits of construction materials, including several types of clays, limestones, granitic sand, gravel, scoria, and sand-

stone. These are favourably located to serve the needs of Geelong and western Melbourne.

Gold has been extracted from minor fields at Egerton and Steiglitz.

(7) Water

The potential of public land in this block to supply water is low, because of their small area and low rainfall. However, the main storages for the Moorabool system (supplying Geelong) have been sited on public land at Durdidwarrah. They receive and store water from the East Moorabool catchment in the Wombat block, via the Ballan channel, and retain a limited amount of run-off from their own catchment of about 1,300 ha in the headwaters of the Little River.

Waters of the Western Moorabool River are stored in the Bungal Dam at Lal Lal and will be used to augment future supplies to Geelong and Ballarat.

A proclaimed catchment gazetted in 1956 covers 158 ha in the headwaters of the Parwan Creek.

Elevated public land west of the Rowsley Fault acts as a minor intake area for groundwater supplies in the eastern plains.

(8) Utilities

Public land here is unlikely to be affected by possible future electricity transmission and generation facilities.

D. Hazards and Conflicts

Fire is a constant threat in the forest areas from late spring to autumn. Infestation by cinnamon fungus is severe in the Brisbane Ranges and many native plants are in danger of destruction.

Sloping land in this block suffers a general erosion hazard, particularly on Tertiary sediments. The removal of vegetation, either through clearing or by pedestrian and vehicular traffic, can lead to serious soil erosion problems.

There is a potential conflict between nature conservation and the extraction of gravel and sand in several areas.

E. Significance

Public land in this block has a high potential for nature conservation, for recreation, and in limited areas for the production of gravel. Also of significance are the Durdidwarrah water storages supplying Geelong, the high landscape value of the Rowsley scarp, and the geological importance of the Werribee Gorge.

3. WERRIBEE

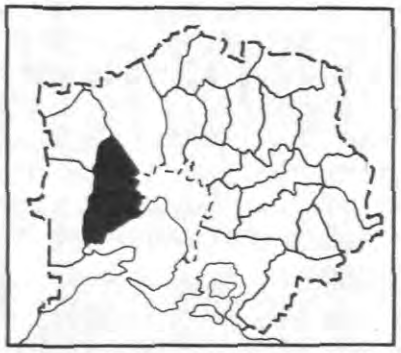
A. General

(1) Location and present tenure

Public land covers 21,450 ha (or 13% of the total area) and is distributed between three large parcels (the You Yangs, Melbourne and Metropolitan Board of Works Sewerage Farm, and the Pyrete Ranges near Bullengarook) and several smaller ones.

Tenure includes reserved forest, special reserves established under the *Lands Act*, and an area vested in the Melbourne and Metropolitan Board of Works for sewage disposal.

County of Bourke: Parishes of Bullengarook, Buttlejorrk, Coimadai, Derrimut, Deutgam, Djerriwarrh, Gisborne, Holden, Korkuperrimul, Kororoit, Maribyrnong, Merrimu, Pywheitjorrk, Tarneit, Truganina, and Yangardook



County of Grant: Parishes of Balliang, Bulban, Cocoroc, Lara, Mambourin, Mooradoranook, Moorpanyal, Moranghurk, Mouyong, Murtcaim, Parwan, Werribee, Woornyallook, and Wurdi-Youang

(2) General description

Flat basalt plains sloping gently down from the north predominate. These have been almost completely cleared for agriculture. The few major streams are deeply entrenched in the plain, while a number of low volcanic cones give local relief. The You Yangs, an isolated granite outcrop, remain as public land supporting low open forest and woodland.

(3) Present use

The You Yangs are used intensively for recreation and nature study, and about 450 ha are included in a forest park. Eucalypt plantations provide minor timber products for local use. Honey production and the extraction of sand and gravel are other important uses.

The Werribee sewerage farm is used for the disposal of Melbourne's sewage, and associated with this are intensive cattle and sheep grazing and waterfowl management.

The block contains a wildlife research station at Lara and an agricultural research farm at Werribee.

The Pyrete Ranges are used as a water catchment for the Merrimu and Djerriwarrah storages serving Melton. The area is also used for some honey production, for stone and gravel extraction, and for military training purposes.

B. Nature of the Land

(1) Climate

This is the driest area in Victoria south of the Divide. Average annual rainfall varies from about 400 mm near Werribee to about 700 mm near Gisborne. Near the coast the rainfall is evenly distributed, but inland the maximum falls occur in winter. The growing season could be expected to last from April to December, with restricted growth from June to August.

(2) Physiography and geology

Much of the land is a flat basalt plain, sloping from a general elevation of about 430 m in the north to sea level. In places it is overlain by Quaternary alluvium. Prominent features are the

Open forest of messmate stringybark in the Pyrete Ranges. Internal access is difficult

lava cones such as Mount Cotteril (204 m) and the steeper scoria cones such as Mount Anakie (399 m). The Werribee and Little Rivers and other streams crossing the plains are entrenched in channels up to 30 m below the general surface level.

The You Yangs, a series of granite hills in the south of the block, rise to an

elevation of 352 m, and alluvial fans of sand and gravel flank them on all sides.

The Pyrete Ranges in the north-west comprise an upfaulted area of Ordovician sediments. They are deeply dissected and reach an elevation of about 460 m. In places, Tertiary gravels overlie them.

(3) Soils

Reddish calcareous duplex soils are widespread in the dry area between Werribee and Melton, on alluvium as well as on basalt. In the slightly higher-rainfall areas to the north and east, grey clays and sodic duplex soils have formed on the basalt, together with black clays in depressions. Shallow gradational soils interspersed with outcropping rocks are scattered throughout the basalt.

Sodic duplex soils and leached granitic sands occur on public land at the You Yangs, while sodic duplex soils and shallow stony soils are found in the Pyrete Ranges.

(4) Vegetation

Much of the You Yangs area now comprises plantations of various eucalypts and wattles, but some indigenous manna gum, yellow gum, red box, and river red gum form a woodland with grass understorey. On the steeper rocky declivities and amoung boulders grow specimens of manna gum, eurabbie, red stringybark, red ironbark, long-leaf box, lightwood, black wattle, and drooping she-oak. There is little ground cover; but rock fern and occasional bushes of tree violet, rock correa, shiny cassinia, and scented groundsel are at home among the boulders, while on the southern slopes of Flinders Peak, snowy mintbush, kangaroo apple, and austral tobacco are common. The introduced South African boneseed is now widespread on the range. About 20 indigenous grasses, 14 orchids, and several saltbushes have been recorded on the You Yangs.

Open forest I of rather stunted eucalypts covers most of the Pyrete Ranges. The commonest tree is probably broad-leaf peppermint, accompanied by red stringybark, red box, long-leaf box, and spindly red ironbark. Open forest II of narrow-leaf peppermint and manna gum with some messmate stringybark and scent bark occurs on better-watered country to the north. Yellow box with some grey box is found on drier southern slopes, but the most noteworthy eucalypt is a stunted form of silvertop, the only known occurrence of this species west of the Dandenong Ranges. The area is rich in orchids (including elbow orchid and autumn greenhood).

More than 80% of the Werribee block consists of treeless basalt plains that were originally dry tussock grassland, but are now profoundly altered by more than 100 years of grazing and cultiv-

ation. A few surviving vestiges of near-original vegetation, generally on railway reserves, have shown that the principal native herbs were kangaroo grass, tussock grass, wallaby- and spear-grass species, windmill and panic grasses, bulbous lilies and orchids, pussy-tails, tuberous crane's-bill, blue heron's bill, blue devil, blue-bells, pink bindweed, everlastings, and such small semi-shrubs as rice-flowers. Tangled lignum formed dense thickets to 2 m high on depressed swampy ground.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including grassy woodland at the You Yangs and dry open forest at Bullengarook), agricultural land on the research and sewerage farm at Werribee, extensive areas of wetlands at the sewerage farm (including Lake Boorie), littoral areas (especially at "The Spit" south of the Little River mouth), and the adjoining open waters of Port Phillip Bay.

Common species found in this habitat are discussed in chapter 10, and listed in Appendix 3.

C. Capabilities

(1) Nature conservation

A number of areas in this block have a high value for nature conservation.

The You Yangs with their prominent rocky peaks situated on an otherwise flat plain have a high landscape value. They also have a high value for fauna. Nearly 200 bird species have been recorded there. They not only support the common general forest and grassy woodland species, but also provide refuge for inland species such as the peaceful dove, black kite, black falcon, grey falcon, black-eared cuckoo, gilbert whistler, red-capped robin, and white-fronted honeyeater, which migrate south in dry seasons.

The capability of the area for flora conservation is only moderate and has declined markedly over recent years because of destruction of natural vegetation by extensive gravel extraction, invasion by boneseed, and the activities of tourists.

One significant plant on the verge of extinction in the area is the brittle greenhood, a localized and rare species.

Lake Borrie and the adjoining sewage lagoons on the Melbourne and Metropolitan Board of Works farm have a high capability for waterfowl conservation. They provide breeding areas for species such as grey teal, chestnut teal, dusky moorhen, swamp hen, and pied cormorant, and feeding grounds for many other wetland species.

The coastal part of the farm, from Point Kirk to Point Wilson and including "The

Sharp-tailed sandpipers are among the numerous migratory waders frequenting tidal areas

Spit", has a very high value for the conservation of shore birds. This area is regarded as being the most important feeding ground for migratory waders in Victoria. Huge numbers are attracted to its salt marshes and tidal lagoons, including a number of species not commonly recorded elsewhere in south-eastern Australia, for example mongolian sand-dotterel, large sand-dotterel, knot, and great knot. The area is one of the few known winter refuges of the endangered orange-bellied parrot.

The Pyrete Ranges probably have a moderate to high capability for nature conservation, but due to limited access they have not been thoroughly assessed. Silvertop occurs at its extreme western limit in the Ranges, and many interesting orchids are also present.

Although not on public land, the occurrence of bull mallee over several hundred hectares between the Pyrete and Djerriwarrah Creeks is of great scientific interest. It also gives considerable landscape value to the area. No other mallee grows in the study area, the nearest being at Eaglehawk, 100 km to the north. Associated species of mallee affinity are feather-spear-grass, narrow thread-petal, moonah, turkey bush, rough everlasting, fragrant saltbush, and a number of insects, including the scarab beetle and various jewel beetles.

The area is probably part of a corridor used by inland birds moving south. Typical inland species such as the crested bell-bird and red-capped robin have been recorded.

In the same general area and mainly on private property are significant occurrences of the rare and localized cane spear-grass and East Gippsland blue box near Coimadai, pale twin-leaf along the banks of the Pyrete Creek, and the saltbushes *Atriplex stipitata*, *Bassia dia-*

cantha, and *Kochia villosa* near Bacchus Marsh.

The last sizeable stand of grey box and bull oak, complete with a ground flora of native grasses, covers about 160 ha on private property about 10 km south of Melton. This is a unique area of great scientific value.

Small areas of natural grassland that remain in railway reserves have a high value for flora conservation, for they represent the last remnants of a vegetation type once widespread on the basalt plains. They include swamp diuris and feather-heads at Sydenham, and rosemary grevillea, brittle greenhood, swamp diuris, tawny leek-orchid, and feather-heads between Lara and Little River.

The plain wanderer, an endangered species, is occasionally recorded on agricultural land in this block. The Serendip Wildlife Research Station plays a very important part in the conservation of native birds and mammals. Eight vascular plants were described from type material collected within this block.

Aboriginal middens are known to occur along the western shore of Port Phillip Bay.

(2) Recreation

The You Yangs have a high capability for recreation. Their main attractions are rocky granite peaks and woodlands, which are in marked contrast to the surrounding treeless plains. They are readily accessible from Geelong, Melbourne's western suburbs, and the growing towns between, and receive intensive use. The main activities are picnicking, short walks, nature study, and a permanent orienteering course.

The Melton Reservoir is used for water-skiing and boating. The few strips of shoreline along the western side of Port Phillip Bay accessible to the public are popular with boating and fishing enthusiasts.

The Pyrete Ranges have a low capability because of poor accessibility, but provide diversity in a generally treeless landscape, as do the remnants of mallee and grey box vegetation on private land.

(3) Hardwood timber

Capability is very low. Plantations of various eucalypts including sugar gums, swamp yate, and brown mallet supply a local demand for minor timber products.

(4) Softwood timber

Capability is low because of inadequate rainfall.

(5) Agriculture

Agricultural capability of the You Yangs and Pyrete Ranges is low because

of low annual rainfall, poor soils, and a high susceptibility to erosion. The State Farm at Werribee has a high capability for continued agricultural research.

The Werribee sewerage farm has a high capability for intensive production of cattle and sheep for slaughter.

The You Yangs and Pyrete Ranges have a relatively high capability for honey production. They are located close to Geelong and Melbourne respectively on remnant bushland and surrounded by agricultural land. Bee-keepers provide organized and voluntary pollination services to various local crops. The sugar gum plantation at the You Yangs is a good nectar source while cape-weed and mint-bush yield good pollen supplies. The district also assists in maintining medium-sized commerical apiaries, which are migrated to other local areas.

(6) Minerals

This block contains extensive deposits of construction materials, including basalts, gravels, sand, scoria, and limestone. They are conveniently located to meet the needs of western Melbourne and Geelong. The bulk of these deposits occur on private land but isolated parcels of public land are known to have a high potential for these deposits. Granitic sands and gravels continue to be mined in the You Yangs, but extraction rates are lower than in previous years, when duplication of the Melbourne - Geelong road was in progress. Parts of public land near Bullengarook are potentially suitable for gravel production.

A few areas of public land are potential sites for scoria pits, which, being on volcanic peaks, would be visible above the general level of the basalt plain.

Small deposits of other minerals - including diatomite, stibnite, and iron - are found near Coimadai, but capability of public land for anything but small-scale extraction appears low.

(7) Water

This block is drained by the lower reaches of the Werribee and Little Rivers and Kororoit Creek. Public land in the Pyrete Ranges acts as a catchment for reservoirs at Djerriwarrah and Merrimu, which supply domestic water to Melton. A land use determination covering 111 km^2 was gazetted for these catchments in 1962 and 1965 respectively and controls the type of land use permitted in them. Melton Reservoir supplies water to the Werribee Irrigation District. The potential of remaining public lands for surface water is low.

The small area of public land in this block does not constitute a significant groundwater intake zone. Low quantities of very saline groundwater are present on the Werribee sewerage farm.

Boneseed among granite outcrops in the You Yangs

(8) Utilities

Additional transmission easements associated with future development of both load centres and power stations are likely, but these will not traverse forested areas of public land. The Board of Works sewerage farm region is under investigation as a site for possible future power stations.

D. Hazards and Conflicts

In the prevailing dry climate, any sloping areas have a severe erosion hazard.

In the You Yangs, removal of vegetation and pedestrian traffic have led to serious soil erosion in picnic areas and along walking tracks. Erosion is also widespread on roads and gravel pits.

Invasion by South African boneseed has destroyed much of the natural vegetation of the range.

There are potential conflicts between nature conservation and the extraction of gravel and sand, and between nature conservation and some aspects of the recreational use of the area.

No obvious conflicts appear on other areas of public land.

E. Significance

The You Yangs have a high potential for recreation, nature conservation, and production of sand and gravel.

The Pyrete Ranges are an important part of the water catchment supplying Melton.

Of some significance is the lack of large areas of public land available to the public in this block, although it is within 40 km of both Melbourne and Geelong and includes growing urban centres such as Werribee and Melton.

4. WOMBAT

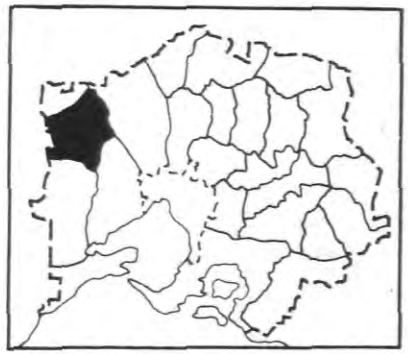
A. General

(1) Location and present tenure

Public land covers 60,160 ha (or 44% of total area), most of which remains consolidated in one large parcel, the Wombat Forest (known towards its eastern edge as the Black Forest).

Tenure is almost entirely reserved forest.

County of Bourke: Parishes of Blackwood, Bullarto, Bullengarook, Coimadai, Coornmill, Gisborne, Gorong, Korkuperrimul, Macedon, Merrimu, Moorabool East, Myrniong, and Trentham



County of Dalhousie: Parishes of Carlsruhe, Edgecombe, Lauriston, Trentham, Tylden, and Woodend

County of Grant: Parishes of Gorong, Kerrit Bareet, Korweinguboora, and Moorabool West

County of Talbot: Parishes of Bullarto, Burke, Coliban, Edgecombe, Glenlyon, and Wombat

(2) General description

The dominant feature of this block is the strongly dissected Wombat Forest, a large area of public land supporting a range of open forest vegetation types. Tongues and pockets of more fertile soil scattered throughout the forest, predominantly on basalt, have been cleared for agriculture, as have larger areas in the north and south of the block.

(3) Present use

Better-quality forest areas are utilized for hardwood sawlogs, poles, and pulp wood. Poorer-quality areas are being converted to softwood plantations in two schemes initiated in 1969 and 1970.

The entire area forms an important water catchment. Domestic supplies are obtained for Newstead, Daylesford, Trentham, Woodend, Gisborne, Melton, Bacchus Marsh, Ballan, and Geelong districts, in addition to irrigation supplies for the Coliban system and Cairn Curran, Pykes Creek, and Melton Reservoirs.

The area generally is subject to growing recreation demand for bush-walking, orienteering, sight-seeing, picnicking, pleasure driving, car rallying, and gem fossicking. Mineral springs are a particular attraction.

The Wombat Forest is one of the most productive apicultural districts in the study area.

Parts of this block are used infrequently for military training purposes.

B. Nature of the Land

(1) Climate

Average annual rainfall increases with elevation from about 600 mm to more than 1,000 mm along the Divide. The growing season typically lasts from March to January, with restricted growth from May to September.

(2) Physiography and geology

The rocks of the area are almost entirely Ordovician sandstones, mud-

The Lerderderg Gorge is a popular area for bush-walkers and picnickers

stones, and shales, overlain in places with valley flows and cappings of Pleistocene basalt. The flat ridge tops, which rise from about 610 m in the south to 760 m along the Divide and slope gently down again to the north, reflect an early Tertiary surface that has been uplifted and arched. The uplift is bounded to the east and south by the Djerriwarrah and Greendale-

Coimadai faults. In this area very strongly dissected mountainous terrain has developed where the Lerderderg River and its tributaries cross the fault scarp. Elsewhere the terrain is less strongly dissected. The highest peaks are scoria cones at Blue Mountain (873 m) and Mossops Hill (803 m).

Main streams draining the area to the south are Werribee and Lerderderg Rivers, and to the north the Loddon, Coliban, and Campaspe Rivers.

(3) Soils

Acidic duplex soils and shallow soils are widespread on public land, which occurs almost entirely on Palaeozoic sediments. Where the annual rainfall is greater than 800 mm, yellowish gradational soils occur. The more fertile soils have generally been cleared for agriculture. They usually occur on tongues of basalt, where friable reddish gradational soils predominate around Trentham, or sodic duplex soils and black clays around Ballan and Kyneton.

(4) Vegetation

Open forest III covers much of the public land along the Divide. The dominant eucalypts are messmate stringybark and narrow-leaf peppermint, often in association with candlebark and manna gum; understorey trees are chiefly blackwood and silver wattle, and taller shrubs include prickly moses, narrow-leaf wattle, hazel pomaderris, tree everlasting, common cassinia, hop goodenia, and Australian clematis.

Tree-ferns (with associated smaller ferns, blanket-leaf, copious bryophytes, and lichens) occur in sheltered gullies.

On drier sites, open forest II is widespread and interspersed with the taller forest. The principal eucalypts are messmate stringybark, narrow-leaf peppermint, broad-leaf peppermint, and candlebark, with manna gum on the valley bottoms and some brown stringybark and mountain grey gum in the east of the block. The understorey consists of various wattles, other leguminous shrubs, heaths, austral bracken, mat-rushes, and tussock grasses.

Open forest I occupies stony slopes and ridge-tops where such eucalypts as broad-leaf peppermint, red stringybark, and long-leaf box, stunted candlebark, messmate stringybark, narrow-leaf peppermint, and occasional red ironbark are conspicuous, with some eurabbie along the drainage lines. This formation is typical of the Blackwood Ranges and steep spurs of the Lerderderg River, where there is a floristically rich understorey of small wattles, bush-peas, goldfields grevillea, bushy needlewood, rosy baeckea, prickly and heath tea-trees, guinea-flowers, heaths, tussock grass, and in places austral grass-tree, horny conebush, and hairy boronia.

On wet flats in various parts of the district, swamp gum forms open forest (either I or II) or woodland, with prickly tea-tree being the main understorey shrub, accompanied by rushes and tussocky sedges.

Remnants of open forest I of white sallee and manna gum are found on private property and along roads in the Trentham-Carlsruhe area.

(5) Fauna

The animal habitats that occur on public lands in this block are the general forest habitat, including dry and wet open forests, and small areas of wetlands, including permanent streams and earth tanks.

In this block the wet open forest approaches its western limit along the Divide. An outlier occurs at Mount Cole, 70 km further west, while it is 50 km to the east before the extensive and continuous wet open forests of eastern Victoria are reached. Moreover, no stands of mountain or alpine ash with their dense layers of shrubs occur in the block. Consequently not all the animals typical of wet open forests are found. Those regularly recorded include the greater glider and red-browed tree-creeper at the western limit of their range, the yellow-bellied glider, wombat, olive whistler, rufous fantail, pied currawong, Australian ground-thrush, crescent honeyeater, pink robin, rose robin, and common bronzewing.

The species commonly seen in the other habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The Wombat Forest has a high capability for nature conservation. It is the largest and most varied of a number of forests scattered through north-central Victoria, all of which are now isolated from each other by cleared land.

It contains good examples of a wide range of open forest types and their faunas, including some wet forest types at the western limit of their range. The 19 mammals recorded in recent surveys include 8 possum species, two of which, the greater glider and bobuck, are at the western limit of their range. The planarian *Artioposthia fletcheri* has only been recorded in dry open forest and conifer plantations in this block. The red-browed tree-creeper is recorded here at the western limit of its normal range, while two other eastern species, the brush cuckoo and the white-throated warbler, have also been recorded.

In the vicinity of the Lerderderg Gorge a number of plant species occur that are either rare in Victoria or quite local-

The land planarian Artioposthia fletcheri *is endemic in the Wombat block*

ized in the western half of the State, notably: cane spear-grass, tortuous rapier-sedge (only occurrence west of Melbourne), slender saw-sedge, swamp bush-pea, hairy beard-heath (Mount Macedon is the only other occurrence in Victoria beyond East Gippsland), and violet westringia. Tylden is one of very few recorded localities for the tall wallaby-grass. Bullarto for *Pultenaea muelleri* var, *reflexifolia*, and south Bullarto for dwarf silver wattle. The New South Wales *Eriostemon scaba* was first collected in Victoria on the "Myrniong Ranges" many years ago, but it has not been observed again anywhere in this State. River leafless bossiaea is uncommon in western Victoria, but has been noted along Sailors Creek below Daylesford.

Two species endemic in the study area are found in this block. Creeping grevillea occurs at Musk, Blackwood, and near Woodend, as well as in the Kinglake block, while swamp bush-pea inhabits swampy tracts at a number of locations between Daylesford and Nar Nar Goon.

The type localities for four species of vascular plant are found within this block.

Among the youth camps in the area, four controlled by the Education Department, situated at Ashbourne, Blackwood, Greendale, and Lyonville, cater for about 4,500 children each year.

Significant fossil sites in this block are at Korkuperrimal Creek (Tertiary leaf beds) and in the area north from Blackwood and Gisborne (Ordovician).

The basalt tongue and its twin lateral streams flowing south from Mount Bullengarook are of geological interest, as are scattered outcrops of Permian glacial deposits and Triassic sediments in the south-east.

(2) Recreation

The Wombat Forest has a high capability

for recreation. It is the largest forest area readily accessible from Ballarat and Melbourne's western suburbs and includes the towns of Daylesford and Trentham. Its main attractions are varied forest landscapes, the rugged terrain of the Lerderderg Gorge in the south-east, mineral springs, waterfalls, and relics of early mining and logging eras. Access is good. Activities include picnicking, pleasure driving, car rallies, bush-walking, orienteering, and prospecting for gold and gemstones.

Limited opportunities for water-based activities are provided by Pykes Creek, Malmsbury, Lauriston, and Upper Coliban Reservoirs.

Expansion in the development of farmlets, holiday homes (for instance at Blackwood), and residential accommodation at Woodend, Gisborne, and Bacchus Marsh has led to increased local recreation demand and contributes to the reduction in tree cover on private land.

(3) Hardwood timber

Capability is low (in open forest II) to moderate (in open forest III areas). These forests have been heavily utilized for timber since the earliest days of settlement. The present forest consists of stands of regrowth resulting mainly from early logging operations. It is generally in good condition and produces sustained yield of sawlogs, pulpwood, and poles. Its value is enhanced by easy internal access and proximity to markets at Melbourne, Bendigo, and Ballarat, to the hardboard factory at Bacchus Marsh, and to a timber preservation plant at Trentham.

The forest forms a large part of the area defined in the agreement between the State Government and Hardboards (Aust.) Pty Ltd regarding the supply of pulpwood. Messmate stringybark is the main species.

(4) Softwood timber

Capability is moderate (open forest II) to high (in open forest III areas). Its value is enhanced by the relatively gentle terrain and proximity of markets at Ballarat and Melbourne. There are currently two planting schemes - in the west, commenced in 1969, at a rate of 200 ha per annum, and in the east, commenced in 1970, at a rate of 140 ha per annum. It is estimated that these plantations will have an average site index of not less than 21.5 m.

The block contains two seed orchards connected with a programme to breed and distribute high-quality radiata pine.

(5) Agriculture

Public land generally has a moderate to low capability for agriculture. In the south-east, slopes are generally steep and soils are poor and susceptible to erosion when cleared. Deeper, more productive soils are found along the Divide. The periphery of some

public land in this part of the block has good potential for agriculture. Rainfall is generally adequate for crop and pasture production, although low winter temperatures would restrict plant growth.

Capability for continued honey production in this block is high. More than 20,000 hives have been operated on 150 temporary and 50 permanent sites over the 1973 season, making this block one of the most important for apiculture in the study area. Messmate stringybark is the dominant species used, providing good yields of honey and pollen in the autumn.

The Ajax goldmine at Daylesford about 1900

(6) Minerals

Gold has been obtained from alluvial deposits buried beneath a thick cover of basalt at Daylesford, and from quartz reefs in the Daylesford and Blackwood areas. Reserves are not exhausted and may be worked again in the future. Small quantities of gravels are extracted for local construction needs.

(7) Water

Public land in this block has a high capability for surface water supply. Areas supplied from catchments in this block have been listed above.

Stage II of the Merrimu project (scheduled for commencement in 1974) will divert water from the Lerderderg River through a tunnel to Lake Merrimu, where it will augment domestic supplies to urban areas west of Melbourne. At present this water is only stored downstream for irrigation purposes in the Melton Reservoir.

A land use determination covering 3,900 ha was gazetted in 1966 for Goodmans Creek catchment, while proclaimed catchments cover all of the area north of the Great Divide and the Rosslyn catchment near Gisborne.

Development of "deep lead" mining projects in the Central Victorian Highlands revealed the presence of extensive

groundwater resources. Because of their large extent, public lands in this block provide an important groundwater intake zone for the eastern end of this deep lead system.

(8) Utilities

There is little potential for power station sites, and the area does not lie in the path of proposed electricity transmission easements.

D. Hazards and Conflicts

Fire is a constant threat from late spring to autumn. The climate and vegetation type (messmate stringybark with manna gum and candlebark) of this area combine to produce a fire hazard unequalled anywhere in the world. The situation is aggravated by the presence of dwellings and towns within and surrounding the forest areas.

An appreciable erosion hazard on steep slopes increases in intensity in the low rainfall areas in the south-east. Particularly high hazards exist in the Lerderderg Gorge area and on glacial tillites between Bacchus Marsh and Myrniong.

Blackberry and furze are problems in some of the old mining areas.

There are potential conflicts between hardwood production and softwood production between nature conservation and softwood production, and between water quality and both timber and recreational uses.

E. Significance

The Wombat Forest has a high potential for hardwood and softwood timber production, recreation, and nature conservation. It is an important water catchment for domestic and irrigation supplies.

5. LODDON

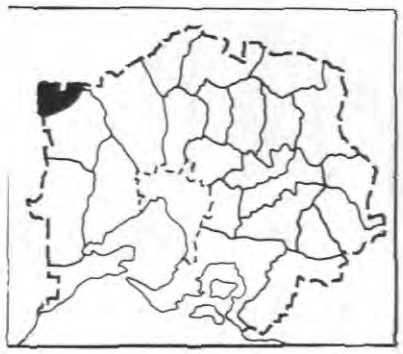
A. General

(1) Location and present tenure

Public land covers 15,320 ha (or 37% of total area) and is distributed between several fragmented parcels of similar proportions. Parcels in the north adjoin similar areas of public land outside the study area and reaching towards Castlemaine.

Tenure is predominantly reserved forest, with small areas of unreserved Crown land and special reserves under the *Lands Act*.

County of Talbot: Parishes of Burke, Campbelltown, Drummond, Edgecombe, Franklin, Glenlyon, Holcombe, Wombat and Yandoit



(2) General description

This undulating land has northerly drainage. The public land, generally supporting low open forest and confined to strongly dissected ridges of sedimentary rock, contrasts with the cleared and semi-cleared agricultural land occupying the more fertile areas along intervening valleys and basalt flows.

(3) Present use

Almost all the public land lies within the Cairn Curran catchment. The western parcels are also within the domestic supply catchment for Newstead.

There is limited use of the area for hardwood logging, apiculture, and recreation associated with pleasure motoring, picnicking, sight-seeing, and mineral springs.

B. Nature of the Land

(1) Climate

Average annual rainfall decreases with elevation from about 1,000 mm in the south to 600 mm in the north, with a winter maximum. The growing season

typically lasts from March to December, with restricted growth from May to September.

(2) Physiography and geology

Ordovician shales and slates cover most of the area, but are overlain by some valley flows of Pleistocene basalt. Among a number of volcanic cones, the most prominent is Mount Franklin. Terrain is strongly dissected and hilly except on the basalt areas, where dissection is slight and slopes gentle.

The Loddon River and Middletons and Jim Crow Creeks drain the area. Waterfalls occur where these streams cross the edge of basalt flows.

Elevations range from 600 m to less than 300 m.

(3) Soils

Sodic and acidic duplex soils, and shallow stony soils on Palaeozoic sediments, predominate. Various soils are found on the small tongues of basalt, most of which have been cleared for agriculture.

(4) Vegetation

Open forest II of messmate stringybark mixed with candlebark and narrow-leaf peppermint is found in the higher-rainfall areas to the south, and in the moister gullies. Open forest I of red

Columnar basalt at the Loddon Falls

stringybark and broad-leaf peppermint mixed with red box and long-leaf box occurs along the ridges and more generally at lower elevations in the north. Manna gum and yellow box are found along the drainage lines and on alluvial flats now largely cleared. There are occasional swamp gums along the creeks. Common understorey species include silver wattle, native cherry, daphne heath, drooping cassinia, mountain

grevillea, gold-dust wattle, heath tea-tree, narrow-leaf bitter-pea, grey everlasting, and tussock grass.

Remants of manna gum woodland with black wattle, lightwood, and sweet bursaria occur on basalt areas, but are largely confined to private property. Occasional thickets of tree violet and river bottle-brush line the major watercourses.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitats (including dry open forest and small areas of grassy woodland) and small areas of wetland (including permanent streams and earth tanks).

The common species found in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The public land of this block has a moderate capability for nature conservation.

Plant species of some interest include an isolated occurrence of scented bush-pea at Porcupine Ridge, mountain grevillea and fairy wax-flowers south-west of Taradale and at Porcupine Ridge, and occurrences of sticky boronia and a prostrate, as-yet-undescribed species of *Grevillea*. At the "Blowhole" on Sailors Creek near Hepburn Springs are the twin-flowered beard-heath (very localized in western Victoria) and *Hovea rosmarinifolia* (confined in western Victoria to this occurrence and another in the Grampians). Also uncommon in western Victoria, woolly wattle grows between Shepherds Flat and Basalt.

The fuscous honeyeater and crested bell-bird reach the limit of their range in this block. The frog *Ranidella parinsignifera* occurs in this and other norther blocks of the study area, at the southern limit of its range.

There are a number of important sites for Ordovician fossils, and the Mount Franklin scoria cone is of geological interest and landscape value.

A school camp at Hepburn Springs controlled by the Education Department caters for 1,200 children each year.

(2) Recreation

Public land in the block has a relatively low capability for recreation. It is readily accessible only from Daylesford. Its main attractions are the mineral springs at Hepburn, Mount Franklin look-out, relics of the mining era, and in spring the wild-flower displays. Several waterfalls occur, but access is poor. The forested public land adds considerable diversity to the landscape.

(3) Hardwood timber

Capability is low. Small areas of open forest II have potential to produce small volumes of sawlogs and pulpwood. Open forest I areas of yellow box, red box, and red stringybark could provide some minor timber products.

Harvesting firewood from red stringybark -red box forest : note regrowth from an earlier operation on the left

(4) Softwood timber

In general capability is low, as rainfall is not adequate. It is moderate in slightly higher-rainfall areas near Daylesford.

(5) Agriculture

Most public land has a low capability for agriculture. Slopes are often steep and stony, while in general the soils are highly erodable.

The capability for honey production in this block is high. Good nectar flows are harvested from red stringybark, red box, grey box, and yellow box. But pollen sources are not abundant and wintering conditions poor.

(6) Minerals

Gold has been mined from deep leads and quartz reefs in the Daylesford area. No significant deposits of other minerals have been reported in this block and the capability of public land is correspondingly low.

(7) Water

All public land in this block lies within the headwaters of the Cairn Curran storage on the Loddon River and is covered by a proclaimed catchment gazetted in 1962. Public land between Daylesford and Yandoit is used as a domestic water catchment for supplies to Newstead.

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Public land acts as a local recharge area for mineral springs in the Hepburn-Daylesford area. The results of tests conducted by the Mines Department have revealed that springs in this district are not suitable for intensive development or continuous pumping.

(8) Utilities

The area is unsuitable for future power station development and does not lie in the path between major load centres.

D. Hazards and Conflicts

Much of this area is susceptible to severe soil erosion. The cup moth *Doratifora vulnerans* causes serious defoliation of eucalypts in this area during dry years.

Wildfire is a constant threat from late spring to autumn. The situation is aggravated by the presence of dwellings and towns within the surrounding the forest.

E. Significance

The public lands of this block play an important part in maintaining diversity in the landscape and in protecting soil from erosion. They are within the Cairn Curran catchment, and have some value for local recreation.

6. ROMSEY

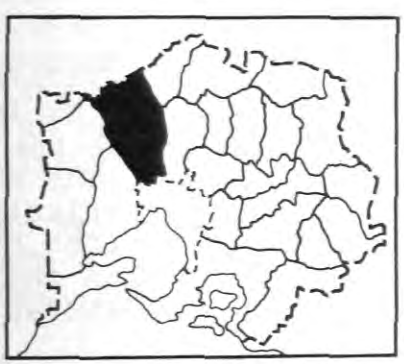
A. General

(1) Location and present tenure

Public land covers 7,260 ha (or 6% of total area) distributed between two sizeable parcels (Mount Macedon and the Cobaw Ranges) and numerous small scattered ones.

Tenure includes reserved forest over the larger parcels. Small areas of unreserved Crown land and special reserves comprise the remainder.

County of Bourke: Parishes of Bollinda, Bulla Bulla, Bottlejorrk, Bylands, Chintin, Cobaw, Darraweit Guim, Forbes, Gisborne, Goldie, Havelock, Holden, Kalkallo, Kerrie, Lancefield, Macedon, Merriang, Mickleham, Monegeeta, Newham, Rochford, Springfield, Tullamarine, Wallan Wallan, Will-Will-Rook, and Yuroke



County of Dalhousie: Parishes of Bayton, Bylands, Carlsruhe, Cobaw, Edgecombe, Forbes, Glenhope, Goldie, Lancefield, Langley, Lauriston, Moranding, Newham, Pyalong, Springfield, Tooborac, Willowmavin, and Woodend

County of Talbot: Parish of Edgecombe

(2) General description

The flat to undulating basalt plains sloping gently from the north have been almost completely developed for grazing. A number of volcanic cones give local relief, while the few major streams are deeply entrenched. The Mount William, Macedon, and Cobaw Ranges provide sharp contrast to the general landscape. The only sizeable areas of public land support a range of open forest vegetation types.

(3) Present use

The Mount Macedon area serves as domestic water supply catchment for a number of local towns. Intensive recreactional

Undulating agricultural land east of Sunbury

use includes pleasure driving, picnicking, sight-seeing, walking, rock-climbing, orienterring, and horse-riding. Pine plantations are utilized for softwood sawlogs and pulpwood.

Hardwood logging occurs on a limited scale in the Cobaw Ranges, along with apiculture. The ranges provide an important scenic element in a predominantly cleared and undulating agricultural landscape.

B. Nature of the Land

(1) Climate

Average annual rainfall varies with elevation from about 600 mm in the south to 1,000 mm at Macedon on the Divide, with a winter maximum. The growing season near Melbourne typically lasts from March to January, with restricted growth during July. With increasing elevation, lower temperatures restrict

growth for longer periods (say from May to September) and at the highest point, Macedon, growth may cease during the coldest month, July. North of the Divide, summer drought tends to include January as well as February.

(2) Physiography and geology

Most of the block comprises flat plains of Pleistocene basalt, sloping gradually from the Divide at about 550 m elevation to sea level. Lava cones such as Pretty Sally (530 m) and steeper scoria cones like Mount Holden (415 m) are prominent.

Extensive outcrops of strongly dissected Silurian and Ordovician sediments occur, especially along the deeply incised valleys of Jacksons Creek and the Maribyrnong River.

Remnants of the old Baw Baw Surface remain at Mount Macedon, where Devonian acid volcanics have resisted erosion and resulted in a steep-sided plateau at an elevation of about 920 m. Remnants of the lower-level Kinglake Surface exist at about 700 mm elevation in the Devonian granodiorites and sedimentary rocks flanking the Macedon plateau, in the Devonian granodiorites forming the Cobaw Ranges in the north of the block, and in the Cambrian rocks forming the narrow Mount William Range.

Steep-sided volcanic domes of alkalite-trachite are of interest at Camels Hump, Hanging Rock, and Brocks Monument.

Rocky hills and outcrops are characteristic of the granite country between Kyneton and Pyalong, including the Cobaw Ranges.

(3) Soil

Grey clays, sodic duplex soils, shallow gradational soils, and black clays are widespread on the gentle basaltic areas north of Melbourne. Several soils occur on public land. Reddish gradational soils have developed on the igneous rock at Mount Macedon. Sodic duplex and yellowish gradational soils are found on most areas of granitic and sedimentary rocks, but where the annual rainfall is less than about 800 mm, sodic duplex and shallow stony soils predominate. Friable brownish gradational soils occur on the highest parts of Mount Macedon.

(4) Vegetation

In the Macedon and Cobaw areas, messmate stringybark in mixture with narrow-leaf peppermint and manna gum is widespread. It occurs as open forest III on sheltered aspects of Mount Macedon and Mount Charlie and more widely at the Cobaws. Elsewhere it forms an open forest II, often with narrow-leaf peppermint becoming dominant. Understorey species include blackwood, silver wattle, sweet bursaria, and austral bracken. Swamp gum occurs on damp flats.

A limited occurrence of mountain ash open forest IV at Mount Macedon has

associated species such as tree-ferns, tough rice-flower, tree everlasting, common cassinia, and musk daisy-bush. Above this are small areas of alpine ash with a similar understorey and thickets of mountain pepper, while the highest points of Mount Macedon and the Camels Hump carry a woodland of white sallee with grassy understorey and low shrubs. There are rare occurrences, for example at Mount Charlie, of silver-leaf stringybark in mixture with broad-leaf peppermint and messmate stringybark with an understorey including silver banksia, bushy needlewood, and common heath.

Near Moranding, open forest II of red stringybark, long-leaf box, candlebark, and narrow-leaf peppermint is found, with manna gum along the gullies and yellow box on the lower slopes.

Hanging Rock carries open forest I to woodland of manna gum, with some narrow-

Grassy woodland of river red gum on public land near Oaklands junction

leaf peppermint and messmate stringybark and a scattered understorey of blackwood, silver wattle, sweet bursaria, and bracken; its moist and shaded crevices provide a good representation of mosses.

Public land near Oaklands carries woodlands of grey box (the nearest natural occurrence to Melbourne of this species) and river red gum on the wetter sites. River red gum grows along the Maribyrnong River and its tributaries, and an interesting development of yellow box grows on basalt between Jacksons and Emu Creek north of Sunbury.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat, including wet and dry open forest at Mount Macedon and the Cobaw Ranges, dry open forest at Mount Charlie and other scattered areas, and a small area of grassy woodland at Oakland. Man has considerably modified the ground flora of the woodland area, and the fauna now inhabiting it resembles that inhabiting the surrounding agricultural land.

The wet open forests in the Macedon area adjoin those of the Wombat block. Together, these forests form a western outlier of this type of habitat, separated by about 50 km from its main occurrence in the east of the State, so they do not support a full complement of typical species. Those that do occur include the bobuck at the western limit of its range, the greater glider, wombat, red-browed tree-creeper, olive whistler, rufous fantail, pied currawong, Australian ground thrush, crescent honeyeater, pink robin, rose robin, and common bronzewing.

The species commonly seen in the other habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The public land in the Macedon area has a high capability for nature conservation, being an isolated western outlier of wet open forest types.

It is the only locality in western Victoria for both alpine ash and small-leaf star-hair, and one of only two in the west for hairy beard-heath. The endemic dwarf silver wattle grows on Mount Macedon and Mount Charlie, while the uncommon grass *Amphibromus archeri* has been recorded near the foot of Mount Macedon. The shiny filmy-fern and veined bristle-fern are epiphytes on the trunks of soft tree-ferns in Stony Creek, Mount Macedon - a remote habitat.

Black gum must be the rarest of its genus in Victoria, the only occurrences being in the railway enclosure about a mile south of Woodend. An isolated stand of silver-leaf stringybark on damp

flats near Mount Charlie is the only record west of Melbourne.

Other areas of public land have a moderate to low capability for nature conservation. *Haloragis rubra* is a very rare plant, known solely from the Sunbury and Wimmera districts, while the Mallee species white cypress pine, desert cassia, and pale twin-leaf occur in declivities of Jacksons Creek near Sydenham. The rare purple diuris has been noted on railway land at Riddell and Lancefield.

The cockatiel and dollar bird are both uncommon visitors to the northern parts of this block during the summer months. The frog *Ranidella parinsignifera* is found in the northern parts of this and other nearby blocks at the southern limit of its distribution.

Mount Macedon is the type locality for two species of vascular plants.

Geological features of special scientific and educational interest abound in this block. They include Mount Holden, Red Rock, Aitken Hill, Mount Ridley (north of Craigieburn), the Giants Grave (Jacksons Creek below Gisborne), Jacksons Creek from Sunbury to Deep Creek and Deep Creek from Konagaderra Creek to its junction with Jacksons Creek (this is one of the most important excursion areas to the north-west of Melbourne and includes the Organ Pipes), granite tors at Mount Gellibrand, Crowes Hill, Hanging Rock, Camels Hump, and Brocks Monument.

The block contains a number of important sites for Cambrian, Ordovician, and Silurian fossils.

The most significant anthropological feature in the study area is the Aboriginal axe-stone quarry at Mount William. Also of importance is an axe-grinding site about 3 km east of Macedon.

School camps at Wallan and near Lancefield, controlled by the Education Department, cater for 1,500 children each year. There are other youth camps in the Macedon area.

(2) Recreation

The Macedon area has a high capability for recreation. The main attractions are lookouts, rock outcrops, and a variety of natural forest and softwood plantation areas. Occasionally it has winter snow. It is readily accessible from Melbourne's north-western suburbs. Activities include pleasure driving, picnicking, bush-walking, horse-riding, rock-climbing, and orienterring.

Hanging Rock provides opportunities for picnicking, sight-seeing, and rock-climbing. Koalas can be readily seen, and a racecourse occupies public land.

Stream frontages (for example along the Maribyrnong River and Mollisons Creek)

and the abandoned Lancefield railway line could provide opportunities for bush-walking, but access is at present limited. About 70,000 visitors were recorded at Greenvale Reservoir in 1972.

Other areas have a relatively low capability for recreation, except in the form of pleasure driving through agricultural land.

Expansion in the development of farmlets and residential accommodation in the Woodend, Gisborne, and Sunbury areas is causing increased local recreation demand.

(3) Hardwood timber

Open forest III and IV areas on Mount Macedon have a high capability, but their total area is very small. Main species are mountain ash, messmate stringybark, and manna gum.

Open forest III areas of messmate stringybark, manna gum, and narrow-leaf peppermint in the Cobaws have been utilized for timber since the early days of settlement. They have a moderate capability to produce sawlogs, poles, and pulpwood. However, the total area is small and the present forest is in a degraded condition.

(4) Softwood timber

Capability at Mount Macedon is high, but the area is very small. Existing plantations at Upper Macedon have an average site index of about 26 m, while those at the foot of the Mountain average about 21.5 m. The Cobaws have a moderate to high capability, and a site index of about 24 m could be expected.

Hanging Rock looking south to the Macedon Range. This area is popular for picnics and rock-climbing

Other public land areas have a low capability.

(5) Agriculture

Most public land is too steep for agricultural development. However, the acidic duplex and yellowish grada-

tional soils on the Cobaw plateau would have a high potential for grazing and crop production.

Honey production is concentrated on public land at Mount Macedon and the Cobaw Ranges. These areas and the adjoining Wombat forest are particularly important, as the predominant and most useful tree - messmate stringybark - usually flowers during late summer and autumn, a time when no alternative sources of honey and pollen are available.

(6) Minerals

Extensive deposits of basalt and granitic sands occur mainly on private land in this block. Small parcels of public land adjacent to the metropolitan area have a high capability for production of basalt. Good-quality granitic sands, capable of serving about a 35-km market radius, occur in the area between Mount Cobaw and Pyalong, but have little occurrence on public land. Small deposits of diatomite have been mined near Newham, Moranding, and Mickleham.

(7) Water

Public lands in the Macedon area are of considerable significance as catchments supplying water to the local towns of Gisborne, Lancefield, Macedon, Mount Macedon, Romsey, Sunbury, and Woodend. These catchments have been proclaimed and are covered by Land Use Determinations gazetted between 1960 and 1962. The north-western part of this block is within the Eppalock catchment, which was proclaimed in 1960. However, the contribution of the public land here to total run-off in the catchment is relatively low.

Small yields of high-quality groundwater have been recorded at Mount Macedon. Areas of public land in this block are too small to act as significant groundwater intake zones.

(8) Utilities

The public land does not appear to be suitable for development of future power stations, nor do any large parcels lie in the path between possible future power stations and load centres.

D. Hazards and Conflicts

Fire is a constant threat in the forested areas during summer. The situation is aggravated at Mount Macedon by the presence of dwellings within and surrounding the forest area, and the large numbers of recreation visitors to the district.

Appreciable erosion hazard exists on steep slopes, particularly in the low-rainfall areas, where considerable gullying and salting, or sheet erosion on steep basalt scarp, can occur.

In the Macedon area there are potential conflcits between softwood and hardwood

timber production, between timber harvesting and recreation, between softwood production and nature conservation, and between water quality and both timber and recreational uses.

E. Significance

Public lands around Macedon have a high value for recreation and nature conservation. They are an important source of water for surrounding towns. Also of significance are the high landscape value of the slopes surrounding the Macedon plateau and the Cobaw Ranges, the importance of a number of geological features, particularly in the Organ Pipes vicinity, and the lack of public land in the area adjoining Melbourne's north-western suburbs.

7. PUCKAPUNYAL

A. General

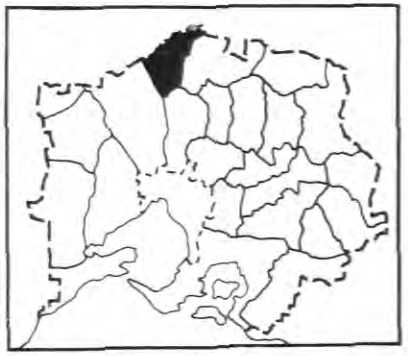
(1) Location and present tenure

Public land covers 1,360 ha (or less than 2% of total area) and is confined mainly to one consolidated parcel, which adjoins larger areas of public land outside the study area near Heathcote.

County of Anglesey: Parishes of Avenel, Mangalore, and Seymour

County of Dalhousie: Parishes of Broadford, Glenaroua, Glenburnie, Lowry, Moranding, Northwood, Panyule, Puckapunyal, Pyalong, Seymour, Tooborac, and Warrowitue

County of Maira: Parish of Avenel



(2) General description

This largely undulating to hilly terrain on the northern slopes of the Divide has been almost entirely cleared for grazing. Small areas of public land on steep slopes not suitable for agriculture remain at Mount Piper and near Puckapunyal. They support low open forest or grassy woodland. Flat land, now largely cleared for agriculture, occurs on the Goulburn flood plain.

(3) Present use

The Puckapunyal area is used for military training purposes and as a minor source of honey and durable timbers. It also has a low level of recreation usage, including picnicking and orienteering

B. Nature of the Land

(1) Climate

In this relatively dry area, average annual rainfall decreases with elevation from about 700 mm in the south to 550 mm in the north, with a winter maximum. Growing season at the higher elevations typically lasts from March to December,

with restricted growth from June to August. Around Seymour it may last from April to November, with restricted growth from June to August.

(2) Physiography and Geology

Silurian and Devonian sedimentary rocks cover most of the area.

Generally strongly undulating hilly terrain predominates, but in places such as Mount Piper the terrain becomes strongly dissected, with slopes up to 40°.

Long tongues of Pleistocene basalt follow old valleys originating near Kilmore and Broadford and merging towards Seymour, and flat to undulating terrain has developed on these valley flows. Present-day streams follow each margin of the basalt.

Recent alluvium is found in the larger valleys to the north. Main streams are Gardiners, Mollisons, Sugarloaf, and Sunday Creeks. Elevations range from 420 to 140 m.

(3) Soil

Sodic duplex soils are widespread and these, together with shallow stony soils, predominate on the public land.

Grey and black clays are common on the few basaltic areas, while reddish calcareous duplex soils occur on alluvium around Seymour.

(4) Vegetation

Public land near Puckapunyal carries a grassy woodland. Eucalypts include long-leaf box, red stringybark, red ironbark, red box, grey box, and yellow box. On moister intervening flats and along watercourses, river red gum and yellow box occur. Various wattles, including three spinescent species, provide a sparse understorey of taller shrubs; daphne heath forms the dominant low shrubbery on stony hillsides and ridge-tops; elsewhere floor is tussocky with silvertop wallaby-grass, tussock grass, and wire rapier-sedge in some quantity. A few orchids and lilies are also conspicuous in their season, but ferns are very poorly represented.

More than 100 indigenous vascular plants have been recorded in the open forest I at Mount Piper, an isolated conical hill. Red stringybark is the dominant eucalypt and occurs in mixture with red ironbark, particularly on the lower slopes, with red box on all but the southern aspects, with long-leaf box on all but the northern aspects, and with broad-leaf peppermint on the southern slopes. Messmate stringybark is found at higher elevations on the eastern aspects, while yellow box occurs on the surrounding flats.

Small wattles, including lightwood and spreading wattle, other leguminous shrubs, mountain grevillea, some heaths, and showy guinea-flower contribute to

Brown phascogale, a common inhabitant of most timbered country in the study area

the sparse understorey, which also includes tussock-forming grasses (five being species of *Danthonia)*.

A few small reserves along the Goulburn River near Northwood carry river red gum woodland, with ancillary communities of water plants, and on higher ground a woodland-open forest I of red stringybark and grey box.

(5) Fauna

The animal habitats that occur on public land in the block are the general forest habitat (including dry open forest at Mount Piper and grassy woodland near Puckapunyal) and wetlands (including the Goulburn River and its billabongs).

Small areas of grassy woodland along the Goulburn have been considerably modified by Man and now support species more typical of the surrounding agricultural land.

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

No recent surveys have been made of the fauna on this land.

C. Capabilities

(1) Nature conservation

The public land in this block has a low to moderate capability for nature conservation.

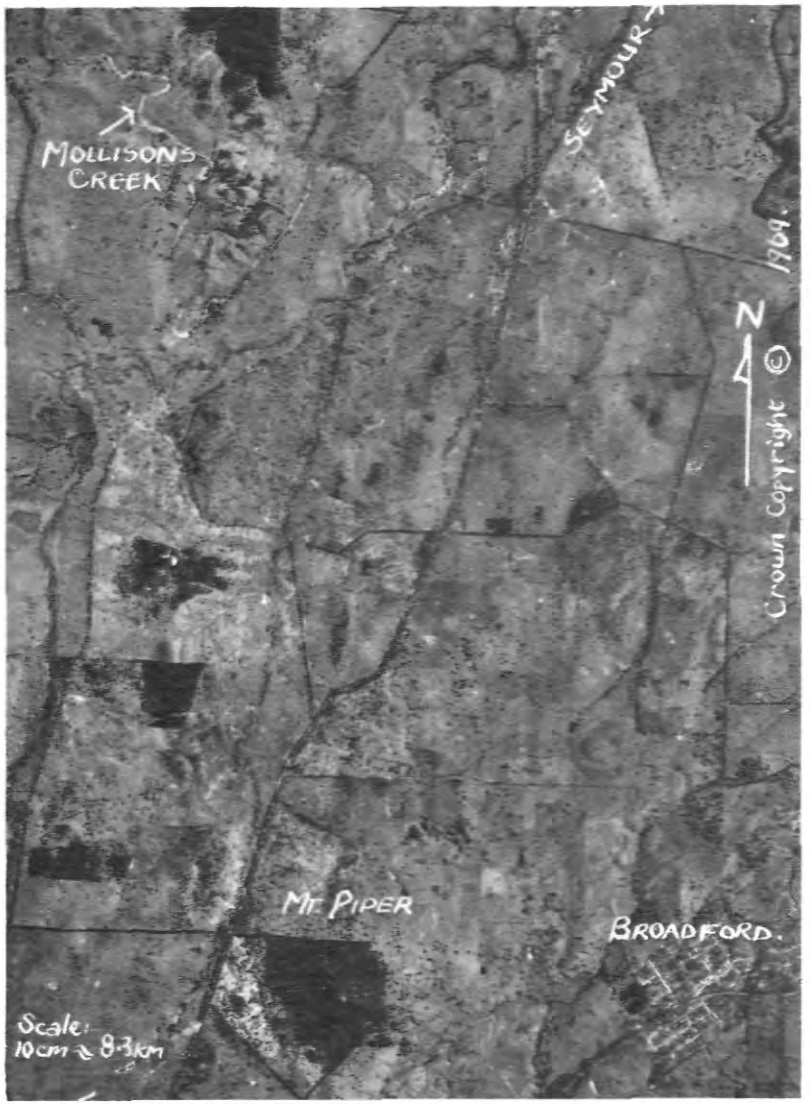
There are no plants of significant record in the block; however, the uncommon lemon starbush has been recorded at Mount Piper, the blue finger-flower occurs in the small Boultan Wildflower Sanctuary near Tallarook, and the uncommon wire rapier-sedge is found at Puckapunyal. The effect of changes in elevation and aspect on open forest I vegetation types can be readily demonstrated on the conical Mount Piper.

The frog *Ranidella parinsignifera* occurs in this and adjoining northern blocks in the study area at the southern limit of its range while *Litoria peroni*, a common frog on the Murray, reaches its southern limit on the Goulburn River near Seymour.

The crested bell-bird is found on public land in the north of the block and the dollar bird is occasionally recorded along the Goulburn River.

(2) Recreation

The main blocks of public land have a low capability for recreation, but add diversity to the generally cleared landscape. Pleasure driving is popular and remnants of vegetation left along road easements give the landscape much of its pleasing character. There is local



Remnants of natural vegetation along roads near Mount Piper

interest in waterfowl along the Goulburn River, and orienteering near Tooborac.

(3) Hardwood timber

Capability is very low, but red ironbark, grey box, and yellow box areas could provide some minor timber products.

(4) Softwood timber

Capability is low because of inadequate rainfall.

(5) Agriculture

The public land has a low capability for agriculture. Slopes are often steep and stony, while in general the soils are highly erodable.

It has a high capability for honey production and a medium capability for pollen build-up. Although its total area is small, it adjoins more extensive areas to the north of the study area. The important species are grey box, red stringybark, and red ironbark, while red box and long-leaf box are also of value.

(6) Minerals

Granitic sand deposits occur in the Pyalong area, but capability of public land for mineral extraction is low. Although river gravels have been taken from the Goulburn River, potential for continued production is low. Antimony mineralization may be present.

(7) Water

Capability for surface water production is negligible. Public land is too restricted in area to act as a significant groundwater intake zone.

(8) Utilities

Public land west of Puckapunyal lies in the path of a possible future transmission easement linking Bendigo with a possible future pumped-storage generating station in the Seymour-Trawool region.

D. Hazards and Conflicts

Much of this area is susceptible to severe soil erosion in the form of sheeting, gullying, and tunnelling. Salting is common in the drainage lines.

E. Significance

The public lands in this block play an important part in maintaining diversity in the landscape and in protecting soil from erosion.

8. STRATHBOGIE

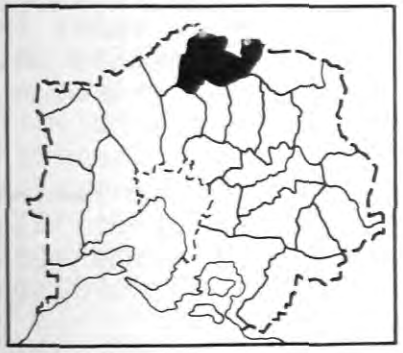
A. General

(1) Location and present tenure

Public land covers 6,730 ha (or 5% of total area) and is distributed between one large parcel (the Tallarook forest) and several smaller scattered areas, including the Switzerland Ranges.

Tenure includes reserved forest on the large parcel, with remaining areas held as unreserved Crown Land.

County of Anglesey: Parishes of Avenel, Dropmore, Garratanbukell , Ghin Ghin, Gobur, Kerrisdale, Killingworth, Kobyboyn, Mangalore, Merton, Molesworth, Switzerland, Tallarook, Traawool, Whanregarwen, Windham, Worrough, Yarck, and Yea.



County of Dalhousie: Parishes of Broadford, Lowry, and Seymour

County of Delatite: Parishes of Avenel, Monea South, and Tarcombe

(2) General description

Surrounding a hilly granite plateau with frequent rock outcrops, steep slopes drop onto the flat flood plain of the Goulburn River and the valleys of its tributaries. Most of the land has been cleared or semi-cleared for grazing. The one big area of public land remaining, at Mount Tallarook, and several smaller areas on the steep slopes of the plateau support open forest vegetation.

(3) Present use

The Tallarook forest is used for the production of hardwood sawlogs and some honey. Part of it provides a reserve catchment supplying domestic water to Seymour. The limited recreational use includes pleasure driving, picnicking, walking, and nature study. The area is used for military training purposes.

Other areas are used in a minor way for honey production, recreation, and gravel

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Semi-cleared grazing land near Reedy Creek: note granite outcropping and spread of bracken

extraction. River gravels are mined from the Goulburn River to supply local and Melbourne markets.

B. Nature of the Land

(1) Climate

Average annual rainfall varies from about 1,000 mm on the plateau to 600 mm on the plains. Growing season on the plateau typically lasts from March to December, with restricted growth from June to August. On the plains at Seymour it extends from April to November, with restricted growth from June to August.

(2) Physiography and geology

The dominant feature of this block is a dissected granitic plateau - a remnant of the Kinglake Surface. Elevations are generally about 520-610 m, with the highest peak (Mount Tallarook) reaching 805 m. Terrain is strongly undulating with frequent rock outcrops.

Steep slopes drop away from the edge of the plateau, where surrounding metamorphosed and sedimentary Devonian rocks have been steeply dissected, giving slopes up to 40° and local differences in relief of 300 m.

The Goulburn River has cut a narrow gorge 370 m deep and 10 km long through the plateau. Recent deposits of alluvium cover its flood plain. Other streams draining the area are Hughes, Mill, and Godfrey Creeks.

(3) Soils

Sodic duplex and acidic duplex soils, both often associated with shallow stony soils, are widespread. Reddish calcareous duplex soils occur on alluvium around Seymour, and yellowish gradational soils on granite areas where the annual rainfall exceeds 800 mm.

(4) Vegetation

The plateau areas of the Tallarook forest support open forest III, grading into open forest II on the drier sites.

Messmate stringybark is the dominant eucalypt and occurs in varying mixture with narrow-leaf peppermint, manna gum, and eurabbie. The understorey includes silver wattle, prickly moses, hop bitter-pea, hop goodenia, and austral bracken.

On the surrounding rocky slopes, an open forest I contains red stringybark in mixture with long-leaf box, red box, and broad-leaf peppermint. The understorey is very sparse, but includes wedge-leaf hop-bush, tussock grass, showy guinea-flower, rock fern, and austral bracken. Some yellow box and grey box with black and golden wattles occur on the deeper soils at the foot of the slopes.

The other scattered areas of public land carry remnants of the same vegetation types. Some cleared blocks now support austral bracken or on southern aspects burgan. Remnants of river red gum woodland occur along the Goulburn River.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including wet and dry open forest at Mount Tallarook and dry open forest on a number of smaller areas) and wetlands (including a number of small permanent streams, the Goulburn River, and its billabongs).

In this block the wet open forests are at their northern limit and consequently do not support a full complement of typical species. Those that do occur include the greater glider, yellow-bellied glider, wombat, long-nosed bandicoot, red-browed tree-creeper, olive whistler, rufous fantail, pied currawong, Australian ground-thrush, crescent honeyeater, and common bronzewing.

The species commonly seen in the other habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature Conservation

The Tallarook forest has moderate capability for nature conservation. This sizeable area supports a range of open forest vegetation types and their fauna, typical of those that once covered the Strathbogie plateau. *Dillwynia juniperina* occurs in open forest I in the Tallarook forest, apparently the most westerly occurence in Victoria for this unusual and attractive shrub. Hickory wattle, a very localized species in Victoria, has been recorded in the Avenel-Mount Bernard area.

Other areas of public land, although small and scattered, play an important part in maintaining diversity in the landscape and provide refuge for some native animals.

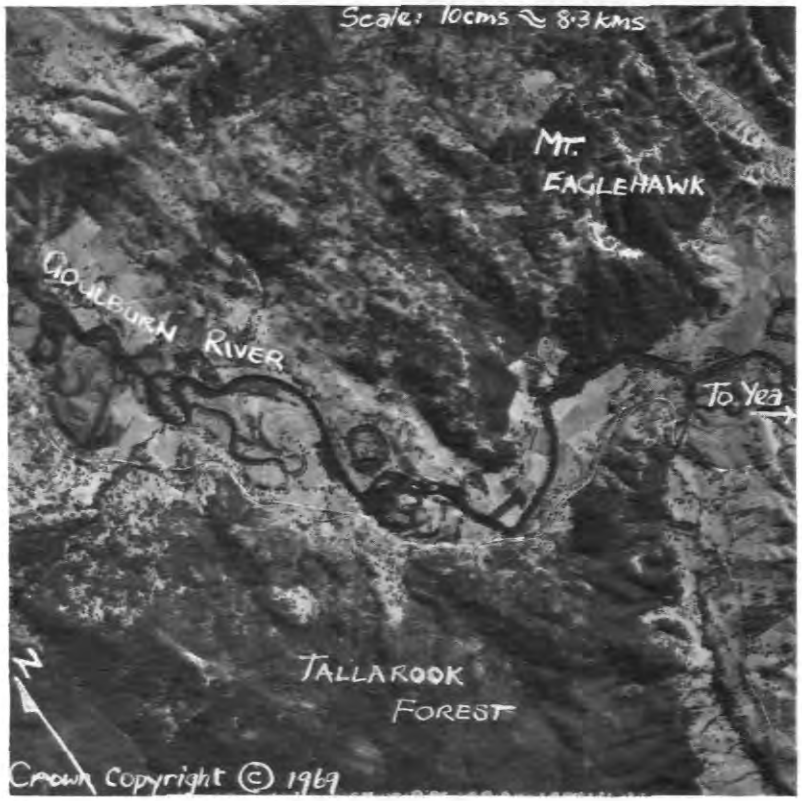
The frog *Ranidella parinsignifera* is found at its southern limit in this and

adjoining blocks in the northern part of the study area. The dollar bird, a summer migrant from northern Australia, is recorded along the Goulburn Valley.

The Goulburn gorge is of geogolical interest.

(2) Recreation

The Tallarook forest has a moderate capability for recreation. Main attractions are scenic lookouts, rock outcrops,



The Goulburn River gorge

and a variety of forest types. Eastern grey kangaroos can readily be seen. Activities include pleasure driving, sight-seeing, picnicking, and bush-walking. Access is at present poor.

Canoeing is popular along the Goulburn River and there is local interest in waterfowl. The Switzerland Ranges offer opportunities for bush-walking and picnicking, but access is at present poor.

(3) Hardwood timber

Capability is moderate in the Tallarook forest. In this area open forest III of messmate stringybark, narrow-leaf peppermint, eurabbie, and manna gum is capable of producing sawlogs, poles, and pulpwood. The present forest is largely regrowth following early logging operations.

Other areas of public land have a generally low capability.

(4) Softwood timber

Capability in the open forest III areas is high and a site index of about 26 m could be expected. The area is somewhat isolated from major plantation projects, and no planting schemes are current.

(5) Agriculture

The capability for agriculture is high on the plateau areas of the Tallarook

forest. Elsewhere public land tends to be on steep rocky terrain, which has a low capacity for agriculture. Much of the existing agricultural land on plateau areas in this block has considerable scope for increased production.

There is a limited capability for continued honey production in an expanded industry. Public land occurs in isolated small blocks and problems arise from the use of insecticides on adjacent agricultural areas.

Heaviest yields of honey come from the summer-flowering river red gum and eurabbie, but yellow box and red stringybark are also important species. The area offers good conditions for building up hives prior to moving to autumn flows elsewhere.

(6) Minerals

The area contains deposits of granitic sands in the vicinity of the Switzerland Ranges and widespread hill gravels. Stream gravels mined at four main sites along the Goulburn River are used in local concrete manufacture, and also exported to Melbourne as decorative stone.

Sands and gravels are used locally for road construction.

Molybdenum flakes have been reported near Yea, but potential for extraction of this mineral appears low.

Red gums on grazing land along the Goulburn River flood plain

(7) Water

Public land at Mount Tallarook supplies water to Seymour and has a high capability for continued surface water production.

Other fragmented and small areas also lie within the Goulburn River catchment, but have relatively low run-off and their capability for surface water production is negligible.

Public land in this block acts as only a minor groundwater untake zone.

(8) Utilities

Public land in the Seymour-Trawool area is under investigation as a possible site for a pumped-storage power station. Its topographic features give it a high capability for this use. The path of possible easements linking a power station in this area with Bendigo and Melbourne would cross other public land, while that in the Switzerland Ranges would lie in the path of a possible transmission line linking Eildon with Bendigo.

D. Hazards and Conflicts

Fire is a constant threat in the forested areas during summer. An appreciable erosion hazard exists on sloping ground, particularly on drier areas, where sheeting and gullying are common.

In the Tallarook forest there is a potential conflict between hardwood and softwood timber production, and between use of the area for military training purposes and recreation.

E. Significance

The Tallarook forest has value for hardwood timber production, recreation, and nature conservation. Also of significance is its use for military training purposes, as a catchment for supply of water to Seymour, and as a possible site for a future power station.

Other public lands play an important part in maintaining diversity in the landscape and in protecting soil from erosion.

9. EILDON

A. General

(1) Location and present tenure

Public land covers 27,150 ha (or 28% of total area) and is distributed between one large parcel and several smaller scattered areas.

Tenure includes unreserved Crown land, reserved forest and national park on the large parcel; remaining areas are unreserved Crown land.

County of Anglesey: Parishes of Alexandra, Brankeet, Doolam, Eildon, Maintongoon, Merton, Molesworth, Thornton, Wappan, and Yarck.

County of Delatite: Parishes of Beolite, Delatite, Doolam, Loyola, Maindample, Mansfield, and Wappan

County of Wonnangatta: Parishes of Boorolite and Howqua West

(2) General description

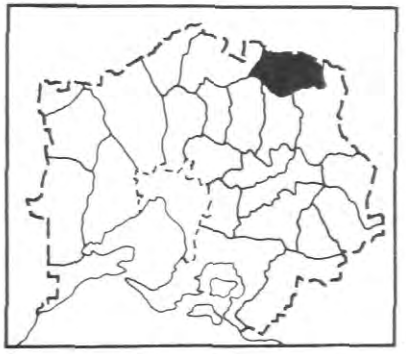
Most public land lies within the Eildon catchment. Land adjacent to the storage is used intensively in places for recreation, including water-based activities, pleasure driving, picnicking, bush-walking, and camping. Fraser National Park lies on the western side of the Lake and pine plantations have been established on the south bank of the Delatite arm.

Areas other than the national park support honey production. Two separate electricity transmission easements traverse public lands.

B. Nature of the Land

(1) Climate

Rain-shadow areas around Mansfield and Alexandra lie in the lee of the Black Range and Cerberean plateaus. Average annual rainfall here is below 700 mm.



At higher elevations it reaches 1,200 mm. Growing season in the drier area typically lasts from April to December, with restricted growth from June to August. With increased elevation and rainfall, it may last from March to January with restricted growth from May to September.

(2) Physiography and geology

The dominant feature is strongly dissected terrain developed on Silurian, Devonian, and Carboniferous sediments. Higher-level areas - at elevations of about 600-800 m - are remnants of the Kinglake Surface. The confluence of the Goulburn River with its major tributaries the Delatite, Howqua, Jamieson, and Big Rivers occurs in this block, although now submerged below Lake Eildon.

Downstream from Eildon, the Goulburn and minor tributaries such as the Johnson, Spring, and Home Creeks have developed wide flat flood plains, which are in marked contrast to the surrounding terrain. Their elevation is about 120m.

(3) Soils

Acidic duplex soils and shallow stony soils predominate. Friable reddish gradational soils occur on Palaeozoic sediments where annual rainfall exceeds 800 mm. Sodic duplex soils are found on the drier, gentler areas, for example near Mansfield.

(4) Vegetation

An open forest I consisting of various mixtures of red stringybark, red box, broad-leaf peppermint, and long-leaf box occupies the steep exposed slopes and stony ridges that predominate in this block. Moister sites, for instance on some southerly aspects, carry narrow-leaf peppermint, while eurabbie occurs along the drainage line. Yellow box is present on the lower slopes. A mixture

Looking south-west from Fraser National Park across Goulburn Valleu to the Blue, Cathedral, and Black Ranges : note the steep, cleared slopes in foreground

of white box with some long-leaf box is found at the Papps.

Limited areas of deeper soils support open forest II or III of messmate stringybark mixed with mountain grey gum, narrow-leaf peppermint, and candlebark. Understorey species include blackwood, silver wattle, common cassinia, and, in the sheltered gullies, tree-ferns, musk daisy-bush, and fireweed groundsel.

Softwood plantations have been established largely on former farmland, along the southern shore of the Delatite arm.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including large areas of dry open forest with pockets of wet open forest and small areas of grassy woodland) and wetlands (including the Goulburn and its billabongs and Lake Eildon and its tributary streams).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The public land adjoining Lake Eildon has a moderate capability for nature conservation, supporting a range of dry open forest environments. No species of special significance have been recorded. Other areas of public land have a low capability because of their small size.

Eastern grey kangaroos

The frog *Ranidella parinsignifera* is found at its southern limit in this and adjoining blocks in the north of the study area.

Important fossil sites occur at the South Blue Range (upper Devonian fish beds) in the Yea-Eildon area (lower Devonian, particularly plant graptolite beds), and Howes Creek (lower Devonian limestone).

Subdivision and urban development on the shores of Lake Eildon, Bonnie Doon

(2) Recreation

Lake Eildon with its immediate hinterland has a very high capability for recreation, and currently attracts large numbers of visitors, mainly from Melbourne, 130 km away.

Main attractions are a large inland water body with some 500 km of shoreline, swift-flowing tributary streams, relatively dry climate, and rugged and forested surrounding terrain. Combinations of similar opportunities closer to Melbourne are very restricted. Eastern grey kangaroos are commonly seen, for example at Fraser National Park.

Activities - mainly water-based - include boating, water-skiing, and fishing, but the hinterland provides good opportunities for camping, picnicking, day and extended bush-walking, pleasure driving, and sight-seeing. Access is best to the northern and western shores. Holiday resort subdivisions are scattered around the lake. These will tend to induce more regular use of the lake and extend the length of stay of some visitors, as well as having a localized adverse effect on water quality.

Other public lands have a low capability for recreation, but add diversity to the landscape.

(3) Hardwood timber

Capability is generally low. Small areas of durable species such as yellow box provide some minor timber products for local use. Stands of open forest II and III could produce small volumes of sawlogs, but their total area is very small and distribution scattered.

(4) Softwood timber

Capability is generally low: however, small areas with acidic duplex soils have a moderate capability, and friable reddish gradational soils now supporting open forest III have a high capability. Existing plantations, established mainly on former farmland, have an average site index of about 26 m. No planting plans are current for this block.

(5) Agriculture

Most of the land suitable for agriculture in this block has been cleared and is sown with improved pasture. Agricultural production is predominantly sheep for wool, with beef and sheep for meat along the northern, western, and south-western boundaries. Dairy and beef cattle are grazed along the Goulburn River valley.

Capability of the remaining areas of public land for agricultural use is relatively low. Steep slopes and poor soils generally make these areas unsuitable for clearing and pasture improvement. Erosion is also a significant hazard. Grazing is prohibited is Fraser National Park. A parcel of about 400 ha of public land north of Howqua is currently held under grazing licence.

Capability for honey production in this block is moderate. Heaviest yields come from red stringybark, river red gum, and eurabbie, but red box, yellow box, messmate, and candlebark are also valuable. Although access to public land on the eastern side of Lake Eildon is difficult, this area has potential for increased utilization, particularly for pollen build-up purposes prior to moving to autumn flows elsewhere.

Apiarists have noted a serious decline in the prosperity of hives following the use of insecticides in adjoining areas.

Adverse effects are more pronounced on small pockets of public land, roadside reserves, and stream frontages that are surrounded by agricultural land.

(6) Minerals

Alluvial deposits of cassiterite (tin ore) have been worked in streams draining from granitic rocks near Maindample.

Phosphate rock has been mined at Phosphate Hill south-west of Mansfield for use as a low-grade phosphatic fertilizer. The extreme east of the block falls within the mineralized zone

that extends from Walhalla to Lake Eildon, and copper has been located in this region.

(7) Water

This block includes the Lake Eildon storage, although the bulk of its catchment lies further east and south. Public lands adjacent to the lake do not make a substantial contribution to water supply, but are significant for the protection of water quality.

A proclaimed catchment gazetted in 1957 covers the eastern two-thirds of this block.

Public lands west of Eildon catchment are drained by tributaries of the Goulburn River, but have negligible capability for surface water production.

The block does not contain significant quantities of groundwater resources.

(8) Utilities

Existing easements linking power stations at Kiewa and the Snowy Mountains with Melbourne traverse public land, but at present there are no proposals to enlarge these. The block has little potential for the development of future power stations.

D. Hazards and Conflicts

Fire is a constant threat in the forested areas during summer. An appreciable erosion hazard exists on steep slopes, particularly in the drier areas.

St. Johns wort is a serious problem in those parts of the block where clearing, grazing, or recreational use have disturbed the natural vegetation.

There is a potential conflict between recreational use of the area and maintenance of catchment values.

E. Significance

The most significant feature of this block is Lake Eildon. Apart from being the major storage in the Goulburn Irrigation District, the lake and its hinterland have a high potential for recreation. Much of the public land plays an important part in protecting soil from erosion.

10. DISAPPOINTMENT

A. General

(1) Location and present tenure

Public land covers 28,820 ha (or 27% of total area), the bulk of which is confined to one large consolidated area, the Mount Disappointment forest.

Tenure includes reserved forest, unreserved Crown land, and several small special reserves under the *Lands Act*. A large area is vested in the Melbourne and Metropolitan Board of Works as water catchment.

County of Anglesey: Parishes of Derril, Flowerdale, Kerrisdale, Kinglake, and Windham

County of Bourke: Parishes of Bylands, Kalkallo, Keelbundoora, Merriang, Morang, Toorourrong, Wallan Wallan, Wollert, Yan Yean, and Yuroke

County of Dalhousie: Parishes of Broadford, Bylands, Clonbinane, Glenburnie, Moranding, and Willowmavin

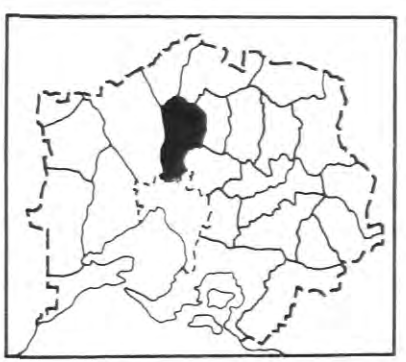
County of Evelyn: Parishes of Kinglake, Linton, and Toorourrong

(2) General description

The dominant feature is a granite plateau that straddles the Divide. Almost entirely public land, this area supports a tall open forest, with low open forest on the steep slopes surrounding the plateau. The remaining areas, consisting of hilly terrain in the north and a flat to undulating plain in the south have been largely alienated and cleared for grazing. Melbourne's northern expansion is encroaching into the southern part of this block.

(3) Present use

The eastern half of the Broadford forest is used exclusively as one of Melbourne's water supply catchments.



The western and northern parts of this area are utilized for hardwood timber (sawlogs, poles, and pulpwood), water catchment for Kilmore, Wallan, and Broadford, and recreation associated with pleasure driving, picnicking, and wildflowers.

The area contains several youth camps.

Hill gravels are extracted for local construction purposes. Honey production is not significant.

B. Nature of the land

(1) Climate

Average annual rainfall varies from about 1,000 to 1,200 mm on the plateau, falling to below 700 mm on the plains. Growing seasons on the plateau typically last from March to January, with restricted growth from May to September. The period of restricted growth decreases towards the plains, and near Melbourne may only last during July.

(2) Physiography and geology

The main feature is a dissected plateau developed on Devonian granodiorite. It is part of the extensive Kinglake Surface and slopes gently to the north, with elevations ranging from 730 to 550 mm. Terrain is undulating. Steep slopes drop away from the edge of this plateau where sedimentary Devonian rocks (frequently metamorphosed) have been strongly dissected to give a mountainous terrain. Radial drainage is well marked, the main streams being Sunday Creek and tributaries of King Parrot Creek and Plenty River.

Flat to gently undulating basaltic plains, in places overlain by Quaternary alluvium, cover the southern part of this block.

(3) Soils

Grey clays, sodic duplex soils, shallow gradational soils, and black clays occur on the basaltic plains in the south. Elsewhere, sodic duplex soils, acid duplex soils, and shallow stony soils are widespread and are the typical soils found on public land. Yellowish gradational and some reddish gradational soils are found on the plateau, while at the higher elevations friable brown gradational soils occur.

(4) Vegetation

The higher-elevation plateau areas carry open forest IV of mature and regrowth mountain ash, with marginal areas of good messmate stringybark and mountain grey gum. Species in the understorey include hazel pomaderris and ferns such as mother shield-fern, hard water-fern, and austral bracken. Small trees such as blackwood, silver wattle, Christmas-bush, banyalla, prickly currant-bush, musk daisy-bush, and blanket-leaf are only occasional, but there is a great

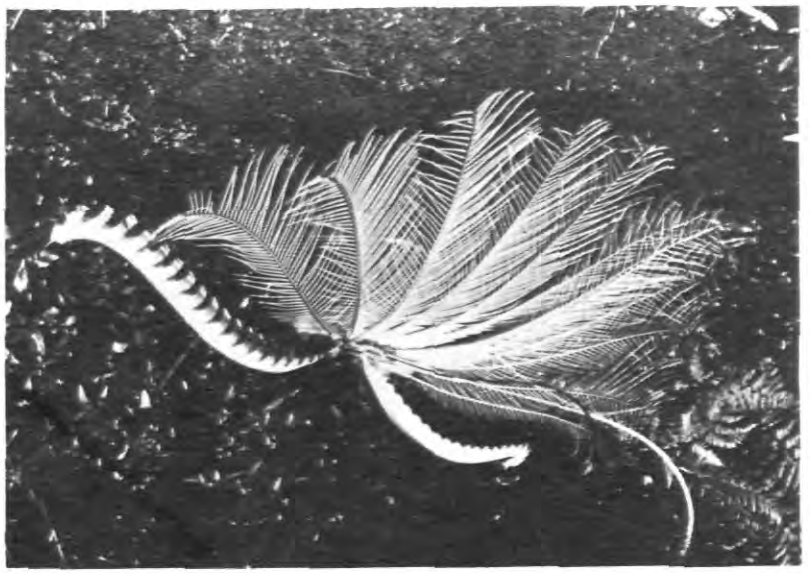
wealth of terrestrial and wood-inhabiting bryophites and fungi.

In the artificial openings made by firebreaks, numerous low herbs become conspicuous, for example, forest starwort, common buttercup, bidgee-widgee, small St. Johns wort, ivy-leaf violet, forest pennywort, and austral forget-me-not.

At lower elevations on the plateau, the ash forests give way to an open forest III of messmate stringybark and mountain grey gum with some manna gum and narrow-leaf peppermint. The understorey chiefly comprises blackwood, silver wattle, mountain correa, hazel pomaderris, elderberry panax, Christmas-bush, tough rice-flower, rough coprosma, and snowy daisy-bush.

This grades into open forest II with much the same dominant species, but such other understorey shrubs as narrow-leaf, spike, and varnish wattles, Mueller and rough bushpeas, star-hair, and hop goodenia.

Red stringybark, in mixture with narrow-leaf peppermint and candlebark, also forms an open forest II in some areas. Open forest I is typical of the steep drier terrain around the plateau edge, where broad-leaf peppermint, red stringybark, and long-leaf box are dominant eucalypts; the subordinate shrubberies and ground flora are more varied.



The superb lyrebird reaches its western limit in the wet forests of this block

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including dry and wet open forests) and wetlands (including permanent streams and earth tanks).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3. Some of the species typical of wet forest habitats further east but not known to occur in this block are Leadbeaters possum, wonga pigeon, large-billed scrub-wren, satin bower-bird, Lewin honeyeater, and black-faced flycatcher.

C. Capabilities

(1) Nature conservation

The Mount Disappointment forest has a high capability for nature conservation. It supports a wide range of open forest vegetation types and their faunas, and is the western limit along the Divide of the main stands of mountain ash. The superb lyrebird and the grass *Deyeuxia frigida* reach their western limit here, while balm mint-bush apparently extends no further north. Of particular value is a stand of mature mountain ash covering about 200 ha in the Wallaby Creek catchment. Trees in the area exceed 80 m in height and are in almost virgin condition, having escaped the logging and wildfires that have affected most other ash stands in the study area.

Mount Disappointment is the type locality, in part, for ten vascular plant species.

A number of important fossil sites are found in Silurian rocks in the west of the block.

The area contains several youth camps.

The forested southern and western scarp of the plateau are an important feature in the landscape viewed from the Hume Highway and areas north of Melbourne.

Several fine remnants of natural vegetation persist along roads through cleared agricultural land. River red gums on private property in the Woodstock area are a notable feature of the landscape.

(2) Recreation

The Mount Disappointment forest has a high capability for recreation. Main attractions are a variety of forest types containing lookouts, relics of mining and early logging eras, fern gullies, and spring displays of wattle and wildflowers. Activities include pleasure driving, picnicking, sightseeing, bush-walking, and orienteering. Access is restricted in the Wallaby Creek catchment and is limited elsewhere due to lack of all-weather roads.

The area can expect increased pressure with Melbourne's northward expansion. During 1972 about 149,000 visitors were recorded at Toorourrong Reservoir picnic grounds.

Mineral springs occur near Donnybrook.

(3) Hardwood timber

Capability is moderate to high. Open forest II and III of messmate stringybark, narrow-leaf peppermint, and mountain grey gum have a moderate capability for producing sawlogs, poles, and pulpwood. The present stands are regrowth, resulting from past logging operations and wildfires.

Open forest IV of mountain ash on the higher parts of the plateau and its southern slopes has a high potential to produce sawlogs and pulpwood. A large proportion of the existing ash forests comprises regrowth resulting from the wildfires in 1920, 1926, and 1939. Most of the open forest IV is within the Wallaby Creek catchment and consequently has not been subjected to timber utilization.

(4) Softwood timber

The plateau areas are suitable for softwoods. In the drier northern part, capability is moderate and a site index of about 21.5 m could be expected. In the southern areas capability is high and site indices up to 27 m could be expected. Some of the sites now occupied by mountain ash would be suitable for Douglas fir. There are small areas of conifer plantations in the Wallaby Creek catchment.

(5) Agriculture

Moderate capability exists on parts of the Mount Disappointment plateau for sheep and cattle production. Rainfall is moderate and the friable reddish gradational soils are well suited to pasture growth, but low winter temperatures would restrict growth.

At present, apiculture is not a significant use in this block. Internal accessibility is poor and vegetation types resemble those occuring more extensively outside the study area. Given its proximity to Melbourne and continued strong honey prices, this block could be subject to greater use in the future.

(6) Minerals

This block contains working deposits of scoria near Beveridge and potentially large deposits of basalt in the Bald Hills. Hill gravels occur on the western flank of the public land, and small deposits of antimony have been mined at Clonbinane.

Public land on this western flank in particular is favourably located to supply construction material for the Hume Highway realignment through Heathcote Junction.

(7) Water

The capability of continued surface water production on public land in this block is high.

Water from Silver and Wallaby Creek catchments to the east of Mount Disappointment is diverted via aqueduct to Toorourrong and Yan Yean Reservoirs, forming an important part of Melbourne's water supply. Public access into these catchments is prohibited.

A Land Use Determination was gazetted in 1965 to protect the small domestic

Aqueduct transporting water from Wallaby Creek catchment into Toorourrong Reservoir

catchment west of Mount Disappointment, which serves Kilmore and Wallan.

The value of public land in this block as a groundwater intake zone has not been accurately determined, but low yields of poor-quality water (5,000 mg T.D.S. per litre) have been recorded in the area north of Melbourne.

(8) Utilities

Mount Disappointment forest lies directly in the path of a transmission easement that may be required to link Melbourne with a possible pumped-storage power station in the Seymour-Trawool region.

D. Hazards and Conflicts

Fire is a constant threat in the forest areas during summer. An appreciable erosion hazard exists on steep slopes, particularly on lower Devonian and Silurian sediments.

There are potential conflicts between hardwood production and softwood production, between timber production and some aspects of nature conservation, and between catchment values and both timber production and recreation.

E. Significance

A large part of the public land in this block forms a catchment supplying water to Melbourne. Because this area has remained relatively undisturbed, it has a high capability for reference and nature conservation purposes. Other significant features of the block are its high potential for hardwood timber production and recreation, and the high landscape value of the southern and western slopes of the Kinglake plateau.

11. BREAK O'DAY

A. General

(1) Location and present tenure

Public land covers 11,000 ha (or 19% of total area). It is confined almost entirely to a narrow strip running across the block and connecting with large parcels of public land to the east and west in adjoining blocks. Several very small isolated parcels are scattered through the northern part of this block.

Present tenure is mainly unreserved Crown land with two smaller parcels of reserved forest and one small reserve (Wombelano Falls) that forms an isolated part of the Kinglake national park.

County of Anglesey: Parishes of Billian, Flowerdale, Kinglake, Windham, Woodbourne, and Yea

(2) General description

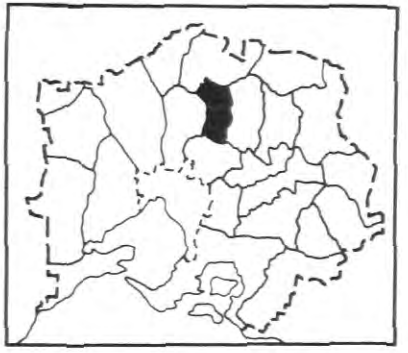
Very hilly terrain with a generally northern aspect descends from a flat plateau along the Divide to the Goulburn River flood plain in the north. Areas of public land supporting a range of open forest types remain on the strongly dissected terrain dropping from the plateau edge. Land has been almost entirely cleared for grazing in the north and on parts of the plateau.

(3) Present use

Scattered hardwood logging occurs throughout the better forest areas.

Softwoods have been established on 400 ha in a recently commenced plantation scheme in the west of the block. About 550 ha of private property have been purchased in this area for plantation purposes.

There are some recreation visits associated with bush-walking, pleasure driving, picnicking, and nature study.



An electricity transmission easement (159 m wide) transverses public land between Kinglake Central and Glenburn.

A small national park area around the Wombelano Falls is relatively inaccessible and has not been developed for recreation.

B. Nature of the Land

(1) Climate

Average annual rainfall varies from more than 1,200 mm on the Kinglake plateau to about 700 mm in the rain-shadow around Yea, with a pronounced winter maximum. Growing seasons on the plateau typically last from March to January, with restricted growth from May to September. In the drier northern parts the season could extend from March to December, with restricted growth from June to August.

(2) Physiography and geology

Strongly dissected mountainous and hilly terrain, descending from the Kinglake plateau in the south to the Goulburn flood plain in the north, predominates. A narrow offshoot of the plateau extends north to Mount Robertson. The undulating terrain of the Kinglake plateau has an elevation of about 450 -550 m. Tributaries of the Yea River and King Parrot Creek drain the area. They drop quickly from the strongly dissected edge of the plateau to an elevation of about 300 m, where they have formed relatively flat mature valleys that slope slowly to the wide flood plain of the Goulburn River at an elevation of about 150 m.

Sedimentary rocks of Silurian and lower Devonian age underlie the entire area. There are Recent alluvial deposits along the Goulburn River and the valleys of the main streams.

(3) Soils

Friable reddish gradational soils are widespread on the Kinglake plateau, much of which has been cleared for agriculture. Steep slopes carry shallow stony soils. Some of the gentle slopes have pockets of heavy clay soils. In the north, there are some yellowish gradational soils while duplex soils occur in areas where annual rainfall is less than 800 mm.

(4) Vegetation

Open forest III of messmate stringybark with mountain grey gum and narrow-leaf peppermint covers much of the public land in this block. The common understorey species include silver wattle, narrow-leaf wattle, hop goodenia, dusty miller, common cassinia, austral indigo, Christmas bush, various bush-peas and parrot-peas, tussock grass, and forest wire-grass. In some of the gullies and more sheltered sites on the plateau the forest may exceed 40 m in height and in these areas small pockets of mountain

ash occur with blackwood, blanket-leaf musk daisy-bush, prickly currant-bush, and tree-ferns as common components of the understorey.

A low heathy woodland of broad-leaf peppermint over small grass-tree and silver banksia occurs on the pockets of heavy clay soils.

Drier sites along the northern edge of the plateau support open forest II of messmate stringybark and narrow-leaf peppermint, merging into open forest I of red stringybark with broad-leaf peppermint and long-leaf box on the lower and steeper slopes. These drier forests support a low understorey in which bushy needlewood, silver and hair-pin banksia, prickly broom-heath, honey-pots, gorse bitter-pea, and austral grass-tree are frequently encountered.

Eurabbie has a scattered distribution, in drainage lines, along the northern slopes from the plateau.

Open forests II and I of red stringybark and red box with some eurabbie and grey box are found on small parcels of public land in the north.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including both dry and wet open forest) and wetlands (including permanent streams and earth tanks).

Ploughshare wattle, a small spreading shrub found in the drier forests

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3. Some of the species typical of wet open forest habitats further east but not known to occur in this block are Leadbeaters possum, wonga pigeon, large-billed scrub-wren, satin bower-bird, Lewin honeyeater, and black-faced flycatcher.

C. Capabilities

(1) Nature conservation

The main parcel of public land in this block has a moderate capability for nature conservation. It includes a range of open forest vegetation types and forms a link between similar but larger areas in the adjoining Disappointment and Black Range blocks. Noteworthy are small, steep-sided fern gullies, which contrast markedly with the surrounding dry open forest that covers the Kinglake plateau. These support a number of orchids such as veined helmet orchid, alpine greenhood, and maroon-hood. Pockets of heathy woodland also add diversity to this block. Remnants of natural vegetation on small parcels of public land and along roads in the north of the block have a high value for conserving the natural character of a landscape that has largely been cleared for agriculture.

The Kinglake area contains a number of important localities for lower Devonian fossils. The Wombelano Falls are of geological interest.

(2) Recreation

The main parcel of public land has a moderate capability for recreation. It has few outstanding features in compari-

The terrestrial bush-rat is a common but unobtrusive inhabitant of the forest areas.

son with other blocks in the forested mountain zone, but does offer a limited range of open forest vegetation types, some areas of rugged terrain, and small waterfalls. Current usage is low. The area is close to Melbourne's north-eastern suburbs, but at present access to and within the public land is poor. Main activities include walking, nature study, some pleasure driving, and picnicking. Trail bikes make increasing use of the area.

Roadside vegetation through the cleared northern parts of the block give the landscape much of its pleasing character.

Development of farmlets and holiday homes in the Kinglake, Glenburn, and Flowerdale areas will cause increased local recreation demand.

(3) Hardwood timber

Capability is moderate on the plateau in the open forest III areas and low on the northern slopes, where open forest I and II occur. The forests of this block are within the APM forest area. The existing stands are generally in a degraded condition as a result of past wildfires and utilization. Messmate stringybark is the main commercial species.

(4) Softwood timber

The plateau areas have a high capability. On steep slopes to the north capability is moderate to very low. The block is within the Central Zone defined by the Forests Commission for planning purposes. One planting scheme is current in the block. The planting rate is 200 ha per year, and 400 ha had been established by March 1973. Average site index is estimated to be about 23 m.

(5) Agriculture

Capability for agriculture on the Kinglake plateau is high, although most suitable areas on good soils have already been alienated and cleared for grazing and production of potatoes and strawberries. Capability is moderate in open forest III areas where slopes are gentle, but low towards the north where the terrain is strongly dissected with stony shallow soils. There is a moderate capability for honey production, especially along the northern edge of the plateau and the lower steeper slopes where red stringybark and some scattered eurabbie occur. Access is generally adequate.

(6) Minerals

Known mineral resources on public land are negligible. Minor amounts of rock and hill gravels are used for local construction and road maintenance purposes.

(7) Water

Public land lies north of the Divide within the Goulburn basin and is drained

by tributaries of the Yea River and King Parrot Creek. It only comprises a small part of the total catchment.

Annual average surface run-off on public land ranges from about 100 to 300 mm in the southern parts.

Water quality from public land is good, with a salinity level of about 66 mg per litre. Development of farmlets and holiday homes in the valley of King Parrot Creek is posing a threat to the quality of the water in downstream areas.

This area does not contain any major storages, although water from it is used in the Goulburn Irrigation District. The present situation is unlikely to change.

Good sources of groundwater in the Palaeozoic sediments of this block only occur in areas of high rainfall. These are generally on forested land where there has been little groundwater exploitation. However, the Kinglake area contains a number of high-yielding bores used for irrigation and domestic purposes. Individual bores have yielded up to 7.6 l of good-quality water per second, with salinities less than 200 mg per litre. Elsewhere, low yields of poor quality have been obtained, and most bores sunk into bedrock are used for stock watering.

(8) Utilities

Public land on the plateau edge south of Glenburn is one of a number of areas being investigated as possible sites for a pumped-storage power station. A short easement would be necessary to connect it with the existing transmission grid.

D. Hazards and Conflicts

Fire is a constant threat in the forest areas from late spring to autumn. An appreciable erosion hazard exists on steep slopes, increasing in intensity towards the drier areas. The gentle country in the north with sodic duplex soils is also erosion-prone.

There are potantial conflicts between softwood and hardwood timber production and between timber production and some aspects of both nature conservation and recreation.

E. Significance

Public land in this block has a high potential for softwood production and recreation. Its main value for nature conservation is as a link between areas of similar habitat in the adjoining Disappointment and Black Range blocks. Small parcels of public land and road reserves in the north of the block play an important part in maintaining diversity in an otherwise cleared landscape.

12. BLACK RANGE

A. General

(1) Location and present tenure

Public land covers 64,630 ha (or 74% of the total block). It runs in a broad north-south band along the spine of the block and is separated from public land in the east by a narrow strip of alienated land. It is contiguous with public land in adjoining blocks along parts of its southern and western boundary. It includes the Toolangi, Murrindindi, and Black Range forests.

Tenure is predominantly reserved forest, bounded in the west and north-east by a narrow, discontinuous strip of unreserved Crown land.

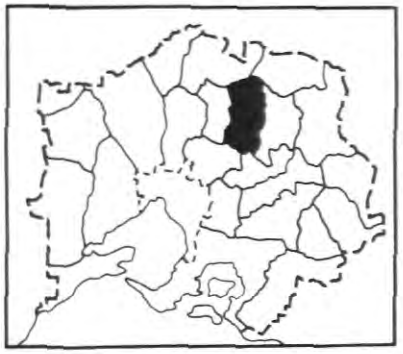
County of Anglesey: Parishes of Acheron, Alexandra, Billian, Buxton, Glendale, Granton, Killingworth, Kinglake, Mohican, Molesworth, Murrindindi, Nar-be-thong, Niagaroon, Taggerty, Tarrawarra North, Whanregarwen, Woodbourne, and Yea

(2) General description

The dominant feature is a granite plateau decreasing gradually in elevation to the north. The plateau and its surrounding steep slopes are almost entirely public land supporting extensive stands of tall to very tall open forest. The lower areas of hilly terrain adjoining the plateau have been largely cleared for grazing, and areas near Taggerty and Narbethong have been converted to pine plantation.

(3) Present use

Hardwood logging over the past decade has been confined to clear-felling pockets of mature trees and thinning of regrowth stands in the ash forests, and selective felling and (following wildfires) salvage felling in the stringybark zone. Products have been sawlogs, poles, and pulpwood. Large unstocked



areas resulting from repeated wildfires have been reforested with ash species. Two areas totalling 2,190 at Taggerty and Narbethong have been converted to softwood plantation.

Recreation is associated with bush-walking, pleasure driving, picnicking, and car rallies but is not intensive. Limited picnic facilities have been established at a number of scenic points. Two electricity easements traverse the northern section of public land. The Army uses temporary camps at Siberia Junction for training purposes and other parts of the Black Range for bivouacs.

B. Nature of the Land

(1) Climate

Average annual rainfall varies from about 1,400 mm on the highest parts of the plateau to about 700 mm in rain-shadows around Yea and Alexandra. Some snow falls could be expected in the highest areas from June to October. Growing seasons on the plateau typically last from March to January, with restricted growth from June to August.

(2) Physiography and geology

The Black Range plateau (part of the Kinglake Surface) is the main feature of this block. Developed on upper Devonian granodiorite and surrounded by lower Devonian sediments, it has a general elevation of about 860 m and slopes gently to the north. Its undulating terrain is drained by the Murrindindi and Yea Rivers. The rectangular stream pattern, controlled by the major joint planes in the rocks, is very obvious. The high ridge between Mount Tanglefoot (1,040 m) and Mount St. Leonard (1,027 m) is composed of upper Devonian acid volcanics and is a remnant of the old Baw Baw Surface. Numerous waterfalls occur around the plateau edge, where steep strongly dissected terrain descends to the broad mature valleys of the Yea and Acheron Rivers at an elevation of about 240 m. These valleys slope gently to the wide flood plain of the Goulburn River at an elevation of about 150 m. There are Recent alluvial deposits along the main valleys.

(3) Soils

Friable reddish gradational soils are widespread on the plateau, while extensive areas of friable brown gradational soils occur at higher elevations along the Divide. Steep slopes, especially surrounding the plateau, carry shallow soils. Reddish and yellowish gradational soils are found on the cleared agricultural land, and in the north where rainfall is less than 800 mm, duplex soils occur on both public and private land.

(4) Vegetation

The higher-rainfall areas in the south of the block support an open forest IV

of mountain ash with some shining gum, mountain grey gum, and messmate stringybark. Most of the present stands are regrowth resulting from wildfires, substantial areas regenerated following those of 1905, 1911, 1918, 1922, 1926, and 1939.

Frequent understorey trees are blackwood, silver wattle, mountain hickory wattle, *Acacia frigescens*, and hazel pomaderris, with extensive development of taller shrubs such as forest lomatia, elderberry panax, golden tip, mountain correa, tough rice-flower, privet mock-olive, Christmas-bush, common cassinia, and tree everlasting. Forest wire-grass, Australian clematis, purple apple-berry, giant mountain grass, and red-fruit saw-edge are also frequent.

In fern gullies, growth is luxuriant and dominated by austral mulberry, forest zieria, balm mint-bush, prickly currant-bush, musk and snowy daisy-bushes, blanket-leaf, and banyalla. In the highest-rainfall areas, some of the gullied have a closed forest of myrtle beech with some blackwood and sassafras. Extensive unstocked areas within the ash forest are covered with a closed forest or scrub of undergrowth species and bracken.

Bordering the ash forest, large areas of open forest III extend along the plateau towards Mount Cunningham. Stands of messmate stringybark with narrow-leaf peppermint and mountain grey gum predominate, although in large areas narrow-leaf peppermint is the major species, and some places carry pure stands of manna gum. Pure stands of eurabbie are found in Limestone Creek. The understorey in this forest type is less luxuriant than in the open forest IV, but includes many of the same species in addition to narrow-leaf wattle, hop bitter-pea, hop goodenia, handsome flat-pea, prickly moses, and dusty miller.

Mountain ash with cleared understorey on the northern side of Maroondah catchment

Peripatus leuchartii, *a shy creature of the wet forests*

Drier sites around the plateau edge carry open forest II of messmate stringybark or narrow-leaf peppermint in various mixtures with candlebark, manna gum, and broad-leaf peppermint. At lower elevations and on steep slopes, these forests merge into open forest I in which the chief eucalypts are broad-leaf peppermint with candlebark, and red stringybark with red box and some eurabbie.

Tall shrubberies are unusual in these drier forests, but there is a scattered ground cover of smaller shrubs such as bushy needlewood, varnish and myrtle wattle, showy guinea-flower, narrow-leaf bitter-pea, common correa, mountain grevillea, sweet buraria, and common heath. Small light-demanding herbs are more conspicuous than in the taller forest, for example, stinking pennywort, austral carrot, small poranthera, kidney weed, variable plaintain, and yam daisy.

River flats support an open forest of narrow-leaf peppermint and manna gum in which blackwood and burgan are common understorey species. Swamp gum, prickly and mountain tea-trees, Christmas bush, and rosemary everlasting are the major riparian species. Rock and necklace ferns, pale-fruit ballart, and magenta storksbill are common among exposed granite slabs.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including extensive areas of wet open forest and some areas of dry open forest) and wetlands (including permanent streams and earth tanks).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3. Some of the species typical of wet open forest habitats further east but not known to occur in this block are Leadbeaters possum, wonga pigeon, large-billed scrub-wren, satin bower-bird, and black-faced flycatcher.

C. Capabilities

(1) Nature conservation

The public land of this block has a moderate to high capability for nature conservation. It provides good examples of wet open forest habitats other than alpine ash that have developed on granitic parent materials on the northern slopes of the Divide.

A stand of shining gum crowns the summit of Mount St. Leonard, where this species reaches its western limit. The endemic dwarf silver wattle also occurs in this summit area. A small colony of red-stem wattle is apparently at the south-western limit of its distribution around the head of Scrubby Creek, while the uncommon grass *Deyeuxia frigida* shares this same stony habitat. Also uncommon and localized, wiry bossiaea occurs on the banks of the Murrindindi River above its confluence with Falls Creek. Narbethong (at "The Hermitage") is one of five known Victorian localities for the almost subterranean and seldom-seen fairy lanterns.

The type locality for the endemic Buxton gum is on private property on swampy flats of the Acheron River about 3 km south of Buxton. Apart from this very restricted habitat of a few hectares, the species is known only from a much smaller occurrence on pastoral flats of the Yarra River, north-west of Yering. This site is also on private property.

School camps controlled by the Education Department at Woodbourne and Buxton cater for almost 1,400 children each year.

The forested scarps surrounding the plateau are important landscape features in the Acheron and Yea valleys.

(2) Recreation

The public land of this block has a high capability for recreation. Main attractions are a variety of forest types, including fern gullies, lookouts, waterfalls, mountain streams, and spring displays of wattles and wildflowers. Activities include bush-walking, pleasure driving, picnicking, car rallying, sight-seeing, horse-riding, nature study, and fishing. Trail bikes are making increasing use of the area.

Access within public land is good, although access to the area is generally not well known.

(3) Hardwood timber

Open forest IV areas in the south of this block have a high to very high capability. They consist mainly of regrowth forests resulting from the 1939 wildfires, although significant areas have also resulted from earlier fires. About 1,340 ha are at present unstocked and could be reforested. The value of the forests is enhanced by the relatively flat plateau terrain of the area and

their proximity to Melbourne. Mountain ash is the main commercial species.

Open forest III areas on the northern parts of the plateau have a moderate capability, They consist mainly of regrowth forests resulting from early wildfires and logging, and in many places have been extensively damaged by subsequent wildfires. Messmate stringybark is the main commercial species.

Open forest I and II areas on the steep slopes surrounding the plateau have a low capability.

All but the nothernmost forests of this block are within the APM forest area.

(4) Softwood timber

Open forest IV and III areas below about 950 m elevation have a high to very high capability. Small areas of open forest II on the dry slopes surrounding the plateau have a moderate to low capability. The block is in the Central Zone defined by the Forests Commission for planning purposes.

Two planting schemes are current in the block (one near Narbethong, the other near Taggerty) with a combined planting rate of 600 ha per year. Plantation area in this block at March 1973 was 2,190 ha (including the Narbethong plantation commenced in 1933). Existing plantations are estimated to have an average site index of about 24 m.

(5) Agriculture

Capability for agricultural production is high on the better soils and higher-rainfall parts of the plateau, but low temperatures during the winter months at the highest elevations would restrict growth. Capability is moderate on undulating northern parts of the plateau surface where soils are suitable for improved pasture. Steep slopes with shallow stony soils are generally unsuitable for agriculture.

The most suitable sites for honey production occur in the drier zones at lower elevations around the edge of the plateau. Red stringybark, eurabbie, messmate stringybark, and river red gum are the most important species. Over the past 12 years, 23 sites (mainly on public land) have been utilized.

(6) Minerals

Known mineral resources on public land are negligible. Minor quantities of local rock and hill gravels are used for local construction and road maintenance purposes.

(7) Water

Public land lies north of the Divide within the Goulburn basin, and is drained by the Murrindindi and Yea Rivers and tributaries of the Acheron River, together with numerous smaller streams.

Average annual surface run-off on public land is about 500 mm in the southern part of the block, and falls to less than 100 mm in the north.

Average annual discharge from the catchment of the Yea River above Devlins bridge is 115,000 Ml. Public land in this and adjoining Break O'Day block covers about 43% of the catchment. Water quality is good.

Discharge from the headwaters of the Murrindindi River above Cowells gauging station is 59,000 Ml and comes entirely from public land. Water quality is good, with a low salinity reading of about 57 mg T.D.S. per litre.

Public land in this block covers about 25% of the Acheron catchment above Taggerty, where the average annual drainage is 342,000 Ml. Water quality is good.

The block does not contain any major water storages or diversions, although surface run-off contributes to the Goulburn Irrigation District. There are no proposals for water use that would alter the present situation.

Good sources of groundwater occur only in the higher-rainfall areas. These are generally on forested public land and have not been utilized. Water quality is invariably better in the granite rocks than in the surrounding Palaeozoic sediments.

Wilhelmina Falls on the western edge of the Black Range plateau

(8) Utilities

Public land on the plateau edge south-east of Woodbourne (Murrindindi Region) is one of a number of areas being investigated as possible sites for a pumped storage power station. A short easement would be required to connect the power station with the existing transmission grid.

D. Hazards and Conflicts

Fires post a constant threat in the forest areas from late spring to autumn. Public land in this block, being on the northern slopes of the Divide and having a long perimeter, is particularly vulnerable to wildfires sweeping in from the agricultural lands to the north and west. On days of extreme fire danger, a wildfire in this block would pose a serious threat not only to the valuable hardwood forests within the block itself but also to the forests and catchment areas in the adjoining blocks further south.

This situation occurred in January 1939 and was almost repeated in January 1969.

An appreciable erosion hazard exists on steep slopes, increasing in intensity towards the drier northern areas.

There are potential conflicts between hardwood production and softwood prodection, and between timber production and some aspects of both nature conservation and recreation.

E. Significance

Public land in this block has a high potential for hardwood and softwood timber production, recreation, and nature conservation. The steep slopes surrounding the plateau have a high landscape value, and there are possible sites for pumped-storage power stations.

13. CERBEREAN

A. General

(1) Location and present tenure

Public land covers 65,380 ha (or 66% of the total block). Alienated land is confined to the north-west corner and western boundary. Public land adjoins that in the Upper Goulburn and Donna Buang blocks, and includes the Marysville and Rubicon forests.

Tenure is predominantly reserved forest bordered on the west by small areas of unreserved Crown land, particularly near Marysville and the Cathedral Range. There are also several small special-purpose reserves.

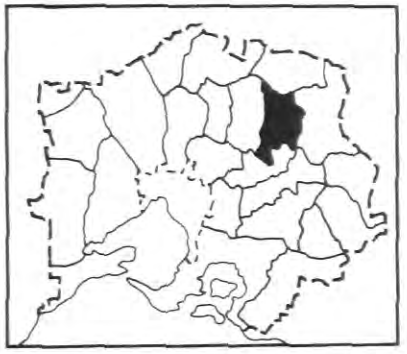
County of Anglesey: Parishes of Acheron, Alexandra, Banyarmbite, Buxton, Eildon, Enochs Point, Granton, Lodge Park, Nar-be-thong, Steavenson, Taggerty, Taponga, Thornton, and Torbreck

(2) General description

The dominant feature is a large plateau with three main extensions to the north. The plateau and its surrounding steep slopes are almost entirely public land. They support extensive stands of very tall open forest with significant areas of sub-alpine vegetation at higher elevations in the south and east. The lower hilly country has been largely cleared for grazing.

(3) Present use

Hardwood logging over the past decade has been confined to clear-felling pockets of mature trees and minor thinning in a few regrowth stands in the ash forests and scattered selective fellings in the stringybark zone. Sawlogs and pulpwood have been the main products. There are no softwood plantations on public land.



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Recreation occurs over much of the land, but there are several distinct nodes of attraction, including Cathedral Range, Marysville, and Lake Mountain.

Four hydroelectric power stations on the Rubicon River connect with the main State Transmission grid.

A fish Hatchery and Research Station has been located on Snobs Creek and is responsible for the raising and distribution of trout and some native species in streams throughout Victoria. It also conducts research into the breeding habits of native fish species.

B. Nature of the Land

(1) Climate

Average rainfall on the plateau varies from about 1,200 mm to more than 1,400 mm in the higher areas. Along the northern and eastern edges of the plateau the rainfall drops markedly to about 700 mm near Alexandra. Regular snow-falls can be expected over much of the plateau from June to October, and at the highest elevations around Lake Mountain and Mount Torbreck persistent snow may lie for most of this period.

Over much of the plateau growing seasons could be expected to be unaffected by summer drought, but low temperatures would restrict growth from May to October with no growth over July and August. At the highest elevations the

Picnic area in mountain ash forest along the scenic Acheron Way

periods of restricted growth and no growth could start as much as a month earlier. On the flats of the Goulburn valley, growing seasons typically last from March to December with restricted growth from June to August.

(2) Physiography and geology

The Cerberean plateau is the dominant feature of this block. It consists of upper Devonian acid volcanics that have been mildly dissected. The plateau forms part of the Baw Baw Surface and slopes gently from about 1,400 m along the Divide to about 1,100 m in the north. Highest points are at Lake Mountain (1,433 m) and Mount Torbreck (1,514 m).

The main streams draining the area are the Taggerty, Little, Royston, and Rubicon Rivers and Snobs Creek. These streams cross the edge of the plateau in numerous waterfalls, where steep strongly dissected terrain drops to the broad valley of the Acheron and Goulburn Rivers at elevations of approximately 200 m.

Dissected remnants of the Kinglake Surface are found on the surrounding lower Devonian sediments at the Cathedral Range (814 m) and in the Paradise Plains-Mount Strickland area (about 970 m).

There are recent alluvial deposits in the Acheron and Goulburn valleys.

(3) Soils

Friable reddish gradational soils are widespread on the plateau, while extensive areas of friable brown gradational soils occur at the higher elevations. Peats and organic loams are found at Lake Mountain and to a lesser extend at Mount Torbreck. Steep slopes, especially surrounding the plateau, carry shallow stony soils. Friable reddish and yellowish gradational soils are found on the cleared agricultural land, but duplex soils replace them in the lower-rainfall areas in the north.

(4) Vegetation

Open forest IV (including extensive regrowth stands from the 1939 bushfires) covers a large proportion of this block. Mountain ash is the chief species at elevations of about 490-950 m, beyond which the eucalypt layer passes into alpine ash that in turn grades into low open forest of white sallee above about 1,340 m. Shining gum is prominent at elevations between about 900 and 1,050 m.

In the mountain ash zone, blackwood, silver wattle, mountain hickory wattle, *Acacia frigescens*, blanket-leaf, and hazel pomaderris occur frequently as understorey trees, together with extensive development of undergrowth species such as elderberry panax, Christmas bush, mountain correa, balm mint-bush, prickly current-bush, red fruit saw-

Forested public land at the northern end of Royston Range

sedge, tough rice-flower, handsome flat-pea, giant mountain grass, forest wire-grass and tree ferns.

In the alpine ash zone, hop bitter-pea, mountain hickory wattle, derwent speed-well, golden tip, balm mint-bush, rough coprosma, sticky and cascade everlast-ings, long-leaf wax-flower, and mother shield-fern are prominent in the under-storey. Valleys and sheltered flats support groves of myrtle beech and sass-afras, rich in ferns, epiphytic mosses, hepatics, lichens, and fungi, while mountain tea-tree is conspicuous in gully heads and along streams. Un-stocked areas resulting from repeated fires and supporting a closed forest of various wattles and hop bitter-pea are conspicuous near Lake Mountain.

Sub-alpine complexes are found at Lake Mountain, Mount Bullfight, and Mount Torbreck. At Lake Mountain the complex comprises open forest I and woodland, dry wet heaths, herbfield, grassland, and sedgefield (including moss-bogs), while in the other areas only the open forest and woodlands occur.

Frequent shrubs in the open forest-woodland of white sallee and in the drier heath communities are alpine pep-per, alpine oxylobium, leafy bossiaea, alpine phebalium, alpine mint-bush, alpine wattle, mountain beard-heath, and cascade everlasting. On wet heath, mountain and alpine baeckeas, alpine bottlebrush, candle heath, alpine heath and snow heath dominate the low shrub-bery, while such rosetted herbs as silver astelia, grass trigger-plant, snow daisy, violet fleabane, billy-buttons, and alpine podolepis are shared between the wet heath and herb-field.

In the sedgefield and box areas, sphagnum moss, various sedges, tuft-rushes, spreading rope-rush, silver astelia, sky lily, raspworts, and matted nertera form tangled cushions, with occasional rosettes of alpine sundew

and three conspicuous orchids - veined sun-orchid, alpine leek-orchid, and mauve leek-orchid.

Open forest III grows at lower elevations towards the edge of the plateau and more extensively in the Mount Gordon area. Narrow-leaf peppermint, the chief eucalypt, occurs in pure stands and in various mixtures with messmate stringybark, mountain grey gum, eurabbie, manna gum, and candlebark. The understorey is often dense and includes silver wattle, blackwood, varnish wattle, hazel pomaderris, common cassinia, tree everlasting, prickly bush-pea, handsome flat-pea, hop goodenia, Christmas bush, wiry bauera, forest wire-grass, and bracken.

Small areas of open forest II around the plateau edge grade quickly into open forest I on the steep northern and western slopes and on the Cathedral Range. The predominant eucalypts in these drier forest areas are broad-leaf peppermint and red stringybark, with some narrow-leaf peppermint, long-leaf box, candlebark and red box. The sparse understorey includes silver wattle, burgan, purple coral-pea, narrow-leaf bitter-pea, showy guinea-flower, amd mountain grevillea. Lemon bottlebrush, sticky boronia, and round-leaf mint-bush occur among rocks along the crest of the Cathedral Range.

Manna gum and swamp gum are found along the river flats, while public land in the north of the block carries small remnants of grassy woodland in which river red gum, yellow box, and red box are the dominant eucalypts.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitats (including sub-aplpine complex, extensive areas of wet open forest, and some dry open forest), wetlands (including permanent streams and earth tanks), and small remnants of grassy woodland near Alexandra and along some stream frontages.

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

Public land in this block has a high capability for nature conservation, especially in the sub-alpine areas. It provides a very wide variety of sub-alpine, wet open forest communities that have developed mainly on acid volcanic parent materials over an elevational range of about 1,300 m. On the eastern side of Mount Torbreck, plant communities change rapidly as the land surface drops 1,000 m over a distance of about 3 km.

Lake Mountain is the closest example of sub-alpine communities to Melbourne.

Being easily accessible and only 90 km from the city, it has a high value for education. At least 150 indigenous vascular plants are involved in this rather restricted complex, and one-third of these species occur no further west on the Australian mainland.

Such typical alpine and sub-alpine genera as *Hierochloe*, *Oreobolus*, *Herpolirion*, *Orites*, and *Clemisia* are all represented. It is the type locality for an alpine sedge and daisy, *Oreobolus oxycarpus* and *Brachycome obovata* respectively, both bog plants associated with the localized *Pultenaea fasciculata*, snow-drop wood-sorrel, and turquoise coprosma. The last two species mentioned have only been recorded from Lake Mountain and the Baw Baw areas on the Australian mainland.

The rare alpine grass *Deyeuxia parviseta* is known only from two spots in the State, Mount Buller and Lake Mountain, while the endemic Victorian genus *Wittsteinia* is represented by its only species, the Baw Baw berry, found also on Mount Donna Buang, the Baw Baw plateau, and near Mount Cobbler.

On Mount Torbreck, alpine fescue and royal bluebell attain their most westerly occurrences. The rare fern *Asplenium trichomanes* grows against the main waterfall on Snobs Creek, while the Cathedral Range provides an isolated habitat for sticky boronia, lemon bottle-brush, and *Pultenaea mollis*.

Leadbeaters possum was rediscovered in 1961 at Tommys Bend near Lake Mountain. It has since been recorded in the wet open forests in other parts of this block and in Donna Buang, Upper Yarra, Thomson, and Bunyip-Latrobe blocks. Its northern limit appears to be just north of Mount Margaret. The rare snail *Mulathera fordei* and *Victaphanta atramentaria*, a species endemic in the study area, have been recorded in the southern part of this block.

The Cathedral Range has considerable geological interest. The forested scarp on the north and west of the plateau is a prominent feature of the landscape in the Acheron and mid Goulburn valleys.

Leadbeaters possum

(2) Recreation

The public land of this block has a high capability for recreation. Main attractions are sub-alpine zones, wet open forests (including dense fern gullies), waterfalls, scenic lookouts, rock outcrops, and mountain streams. Activities include bush-walking, picnicking, nature study, rock-climbing (Cathedral Range), camping, fishing, and snow sight-seeing and limited snow sports (Lake Mountain). Four-wheel-drive vehicles and trail bikes make increasing use of the area. Picnic facilities have been established at a number of scenic sites, especially around Marysville where walking tracks link lookouts and waterfalls with the town, and at Lake Mountain.

Access to public land is good in the Marysville area, by means of the Maroondah Highway, Acheron Way, and the Lake Mountain-Woods Point Road, but poor elsewhere at present.

Snow-fields at Mount Torbreck appear potentially suitable for limited recreational use. Trout hatcheries at Snobs Creek are open for public inspection.

(3) Hardwood timber

Open forest IV areas, which cover most of this block, have a high to very high capability. They consist mainly of regrowth resulting from the 1939 wildfires.

Graded walking tracks allow access to spectacular waterfalls and lookouts in the Marysville district

Near Lake Mountain, about 1,500 ha are at present unstocked and could be reforested. The very extensive distribution of uniformly high-quality stands,

the relatively flat plateau terrain of the area, and their proximity to Melbourne enhance the value of the forests. Alpine ash and mountain ash are the main commercial species.

The relatively small areas of open forest III, for example west of Marysville, have a moderate capability. Messmate stringybark and narrow-leaf peppermint are the main commercial species.

The forests of the block are within the APM forest area.

(4) Softwood timber

Much of the block is above 950 m elevation and is therefore not suitable for commercial plantations of radiata pine, as the species is very susceptible to snow damage. Below this elevation, open forest IV and III areas have a high to very high capability. At present no planting schemes are operating in the block, nor are there any existing plantations. The block is within the Central Zone defined by the Forests Commission for planning purposes.

About 500 ha of radiata pine has been established on private property near Cathedral Range over recent years.

(5) Agriculture

Agricultural capability over most of the volcanic plateau is moderate to low. Soils on lower parts of the plateau are suitable for pasture, and rainfall is adequate, but low temperatures during winter restrict the growing season. At higher elevations, around Mount Torbreck and Lake Mountain, cold restricts the growing season further, and soil fertility is reduced. Shallow stony soils on steeper slopes adjoining the plateau are also unsuitable for agriculture.

Friable reddish and yellowish gradational soils and acidic duplex soils in the Acheron and Goulburn valleys have been cleared for pasture and some crop production.

There is a moderate to high capability for continued honey production in parts of this block, especially on the steeper western and northern slopes at lower elevations where red stringybark occurs. Other important species are messmate stringybark, manna gum, alpine ash, and river red gum. Good build-up conditions often occur in the more elevated areas around Lake Mountain and Federation Range. Access within public land is generally adequate. Over the past 12 years apiarists have utilized 28 sites, mainly on public land.

(6) Minerals

Alluvial deposits of cassiterite (tin ore) are worked in streams draining from granitic rocks near Buxton. Total production of tine concentrates has only

been 2.3 tonnes. Large-scale production in the future is unlikely.

Ilmenite and zircon are present in sand deposits along the Acheron River upstream from the Maroondah Highway. The estimated reserves of 8 million m^3 of mineral sand are small in comparision with deposits elsewhere in Australia.

Small quantities of wolframite have been mined near Wilkes and Opas Creeks southeast of Marysville, and limited mining is likely during times of high wolframite prices.

(7) Water

Public land lies north of the Divide within the Goulburn basin and is drained by the Acheron, Steavenson, and Rubicon Rivers, Snobs Creek, and tributaries of the Big River.

Average annual run-off varies from about 750 mm in the high-rainfall areas along the Divide to about 100 mm in the drier northern areas.

Public land in this block covers about 56% of the Acheron catchment above Taggerty, where the average annual discharge is 342,000 Ml. The Rubicon and Big Rivers and Snobs Creek discharge annual averages of 108,000 Ml, 322,000 Ml, and 36,000 Ml respectively, entirely from public land. Water quality in all cases is high, with very low salinity levels.

Waters from Acheron, Rubicon, and Snobs catchments form part of Goulburn Irrigation District supply, while discharge from the Big River enters Eildon storage. Investigations are being made into the feasibility of diverting headwaters of the Big River to serve the water needs of Melbourne and Latrobe Valley.

Water from Snobs Creek provides all the requirements of the Snobs Creek Fish Hatchery. The site for the hatchery was selected after investigations to find a stream with water of a suitable quality and temperature, and an assured flow.

A proclaimed catchment for Eildon storage, gazetted in 1957, covers the Big River catchment.

Acid igneous extrusives comprise the bulk of public land and contain groundwater in fracture joints and shears. These rocks tend to be hard and compact, making drilling difficult and expensive. Water quality appears good, but the quantities obtained have been small.

(8) Utilities

Capability of this block for future electricity generation or transmission is low, apart from the continued generation of hydroelectric power at Rubicon.

D. Hazards and Conflicts

Fire is a constant threat in the forest areas during summer. Public land in

this block, being on the northern slopes of the Divide and having a long perimeter, is particularly vulnerable to wildfires sweeping in from the agricultural lands to the north and west. On days of extreme fire danger a wildfire in this block would pose a serious threat not only to the valuable hardwood forests within the block itself but also to the forests and catchment areas in the adjoining blocks further south.

This situation occurred in January 1939 and was almost repeated in January 1969.

Erosion hazard is high in sub-alpine areas (where destruction of vegetation can lead to severe wind and water erosion) and appreciable on steep slopes, increasing in intensity towards the drier northern areas.

Blackberry is a problem along most streams throughout the area.

There are potential conflicts between timber production and some aspects of both nature conservation and recreation, between hardwood and softwood production, and between recreation and some aspects of nature conservation.

E. Significance

Public land in this block has a very high potential for hardwood timber production, recreation, and nature conservation. The sub-alpine areas are of special importance for nature conservation and recreation, being the most westerly occurrence of such land type and the closest to Melbourne. The steep slopes surrounding the plateau have a high landscape value. Other features of significance are the high potential of low land areas in the Acheron Valley for softwood production, high water yield from the area, and the Snobs Creek Fish Hatcheries.

14. UPPER GOULBURN

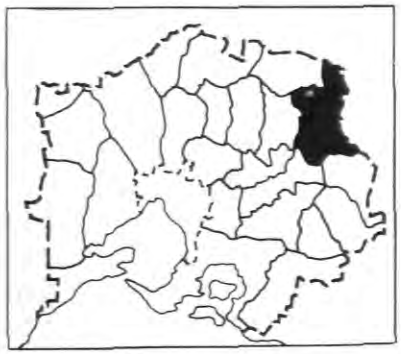
A. General

(1) Location and present tenure

Public land covers 132,490 ha (or 86% of the total block) and adjoins public land in Cerberean, Upper Yarra, and Thomson blocks, and areas to the east outside the study area. Alienated land is confined to the extreme north-eastern corner in small scattered pockets associated with early gold-mining settlements.

Tenure is divided between reserved forest (in the Big River catchment) and unreserved Crown land (in the Goulburn River catchment).

County of Anglesey: Parishes of Banyarmbite, Howqua West, and Thornton



County of Delatite: Parishes of Beolite and Delatite

County of Wonnangatta: Parishes of Boorolite, Changue, Darlingford, Enochs Point, Goulburn, Howqua, Jamieson, Kevington, Knockwood, Lauraville, Lodge Park, Matlock, St. Clair, Taponga, Tarldarn, Warrambat, and Youarrabuk

(2) General description

Very steep strongly dissected mountain terrain predominates. Virtually the entire block is public land, supporting mainly a low open forest with tall open forest occurring at higher elevations along the Divide.

(3) Present use

Some hardwood logging operations occur on scattered, more accessible locations throughout. Mining for precious minerals, including gold, also occurs in isolated locations within the mineralized zone between Jamieson and Woods Point.

Recreation is associated with pleasure driving, car rallies, the use of Lake

Eildon, fishing, canoeing, and deer-hunting. Historic relics associated with early mining are a notable attraction. About 34,000 ha in the parishes of Goulburn, Howqua, Kevington, Knockwood, Lauraville, Warrambat, and Jamieson are held under grazing licence.

About 51,000 ha in the Big River area is used for military training purposes.

B. Nature of the Land

(1) Climate

Average annual rainfall at higher elevations along the Divide exceeds 1,400 mm. In the marked rain-shadow in the Big River valley, rainfall drops to about 800 mm in the lee of the Cerberean plateau. At the higher elevations regular snow-falls can be expected from June to October, but the snow seldom persists. In these areas the growing season could be expected to be unaffected by summer drought, but low temperatures would restrict growth from May to October, and prevent growth during July and August. At lower elevations the season could be expected to last from March to January, with restricted growth from May to September.

(2) Physiography and geology

Strongly dissected mountainous terrain developed on closely folded lower Devonian and Silurian sediments predominates. These sediments are intruded by quartz porphyry dykes. Remnants of the Kinglake Surface are widespread, particularly in the south where, at an elevation of about 1,150 m, the Gregory plateau remains only slightly dissected. High points at Mount Matlock (1,384 m), Mount Terrible (about 1,300 m), and Mount Selma (1,457 m) are remnants of the Baw Baw Surface. Over most of the area a dendritic stream pattern has developed, giving rise to steep-sided valleys with narrow undulating interfluves. The major stream such as the Goulburn and Big Rivers are entrenched up to 600 m below the interfluves. The lowest elevation in the block is 300 m at Lake Eildon.

(3) Soils

Friable brown gradational soils are widespread at higher elevations along the Divide. Elsewhere yellowish and some reddish gradational soils occur, except on steep slopes, where shallow stony soils have developed, and in the drier northern areas, where acidic duplex soils are found.

(4) Vegetation

The very rugged terrain in the northern part of this block results in marked changes in the structure of the vegetation over short distances. Below about 750 m, open forest I predominates, although this grades quickly into open forest III on sheltered sites and along the main streams.

The chief eucalypts in the open forest I are broad-leaf peppermint with long-leaf box and some candlebark, while at the lowest elevations in the north red stringybark is found in mixture with red box, long-leaf box, and in places eurabbie. The sparse understorey includes silver wattle,narrow-leaf bitter-pea, common cassinia, austral bracken, tussock grass, and in places, extensive patches of burgan.

Narrow-leaf peppermint predominates in the open forest III, occurring in pure stands and in mixture (especially along the creeks) with mountain grey gum, manna gum, and some eurabbie. Silver wattle, hop goodenia, handsome flat-pea, common cassinia, and austral bracken are prominent in the low understorey. Manna gum, swamp gum, blackwood, and burgan are common along the main streams.

Above about 750 m, open forest III starts to predominate, although vegetation can still change rapidly with changes in aspect and open forest I or II in which broad- or narrow-leaf peppermint and candlebark predominate can be found up to the sub-alpine zone. Mountain grey gum, narrow-leaf peppermint, and messmate stringybark are the chief eucalypts in this zone. There are also isolated occurrences of silvertop. The dense understorey includes silver wattle, mountain hickory wattle, narrow-leaf wattle, hop bitter-pea, hop goodenia, hazel pomaderris, Christmas bush, and forest wire-grass.

Wet open forest along the Big River road

Open forest III of narrow-leaf peppermint can extend in places right to the top of the Divide, where it usually occurs in mixture with candlebark or, in the gullies, mountain grey gum. At these higher elevations the gullies support a luxuriant undergrowth including blackwood, musk daisy-bush, blanket-leaf, and tree ferns.

Extensive areas of alpine ash open forest IV are found on the relatively flat plateau terrain at elevations above 950 m.

The stands are almost all regrowth resulting from the 1939 fires. Common understorey species are elderberry panax, silver wattle, Muellers bush-pea, mountain hickory wattle, hop bitter-pea, diggers speedwell, Tasman flax-lily, and tussock grass.

In this block, open forest IV of mountain ash is restricted to a few sheltered southerly aspects above about 800 m, for example at the head of the Goulburn and Big Rivers. The understoreys in these ash forests resemble those described for the adjoining Thomson block (18).

Small areas of white sallee open forest I or woodland occur on the higher peaks such as Mount Matlock, Mount Singleton, and Mount Selma.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitats (including both wet and dry open forest) and wetlands (including Lake Eildon and also many permanent streams).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

This block has a moderate capability for nature conservation. It provides extensive examples of dry open forest habitats and fast-flowing mountain streams, and adjoins similar areas continuing to the north-east along the northern slopes of the Divide. Some relatively undisturbed areas with difficult access have a high value for reference.

Velvet pomaderris and the rare Omeo gum, which is endemic in Victoria, reach the western extremes of their ranges on the Howqua River (near Frys) and Frenchman Creek (west of Mount Matlock) resepctively.

The frogs *Litoria maculata* and *L. phyllochroa*, both at the western limit of their range, inhabit rocky reaches of the upper Goulburn River and its tributaries. A variety of fresh-water-invertebrate species - including *Bulinus* sp., the small bivalve *Pisidium* sp., and the large mussel *Velesunio* sp. - have also been recorded in these streams.

The block contains important Silurian fossil sites at McAdam Gap and Enochs Point.

Private property at Delatite in the north of the block is the type locality, wholly or in part, for four species of vascular plants.

View from the Eildon-Jamieson road across the Howqua arm to Goughs Bay

(2) Recreation

The main features of this block are its rugged and forested terrain, numerous mountain streams, poor accessibility and distance from major population centres. Consequently it has a high value for wilderness-type recreation activities. At present it is used for bush-walking and camping and increasingly by four-wheel-drive vehicles and trail bikes. Where access is good, along the Eildon-Jamieson and Jamieson-Woods Point roads, pleasure driving, picnicking, and fishing are popular. The more remote areas of this and adjoining blocks offer some of the best opportunities for deer-shooting in the State.

The lower reaches of the Jamieson, Goulburn, Howqua, Delatite, and Big Rivers are used for canoeing. A number of relics of the early gold-mining era remain within the block.

(3) Hardwood timber

Open forest IV areas on the Gregory plateau have a high capability. They consist mainly of regrowth resulting from the 1939 wildfires. The value of these forests is enhanced by the relatively flat terrain and the large areas of similar forest in the adjoining Upper Yarra and Thomson blocks. Alpine ash is the main commercial species.

Open forest III areas at lower elevations have a moderate capability. They are generally in a degraded condition as the result of repeated wildfires and past utilization. In many places they are on steep rugged terrain, making access difficult.

Open forest I areas in the northern half of the block have a low capability, and are generally on steep slopes with difficult access.

Forests in the southern half of this block are within the A.P.M. forest area.

(4) Softwood timber

Open forest III areas have a high capability. However, in places they are on steep slopes, access is difficult, and they are remote from the major plantation projects.

Most of the open forest IV areas are above 950 m and are therefore unsuitable for commercial plantations of radiata pine, as the species is very susceptible to snow damage.

The open forest I areas that cover the northern half of this block are unsuitable for radiata pine.

No planting schemes are currently operating in this block, nor are there any existing plantations.

(5) Agriculture

Capability for agriculture is generally low, although some pockets have moderate suitability. In the south, higher areas receive rainfall in excess of 1,400 mm, but have a restricted winter growing season and low soil fertility, especially on steeper slopes. Further north, at lower elevations, capability for agriculture improves, especially in pockets of yellowish and friable reddish gradational soils.

Access within the block is poor and the necessary developemnt costs for agricultural production would be very high.

There appears to be a moderate capability for honey production, especially in areas of lower elevation. The most important species are red stringybark,

river red gum, red box, and eurabbie. Access to some areas of public land is poor.

(6) Minerals

Metallic ores with the greatest commercial potential at present are those of gold, copper, platinum, and palladium. There are minor occurrences of zinc and cobalt ores. The Al goldmine at Gaffenys Creek, is currently the only one in operation, but high-quality reserves are thought to be present in the mineralized zone between Jamieson and Woods Point. Future mining will depend largely on fluctuating gold prices, and extraction will be largely by underground operations. Hill gravels and rock are extracted for local construction projects.

(7) Water

Public land lies north of the Divide and is drained by the Big and Goulburn Rivers and the lower reaches of the Jamieson, Howqua, and Delatite Rivers, all of which flow directly into Lake Eildon. A proclaimed Water Catchment, gazetted in 1957, covers the entire block.

Average annual run-off increases from about 100 mm in the north to more than 750 mm in wetter areas along the Divide.

Public land in this block accounts for about one-third of Lake Eildon's total catchment and the water it provides makes a very important contribution to the volume available for storage.

The water currently supplies the Goulburn Irrigation System, but headwaters of the Big River are under investigation as a possible long-term additional source for demands south of the Divide.

Good sources of groundwater have only restricted occurrence in the predominantly lower Devonian and Silurian sediments. Water quality varies, but is better in higher-rainfall areas in the south. Most of the potentially suitable areas remain forested and have not been subject to groundwater exploitation.

Fishing from the banks of the Delatite River

(8) Utilities

Public land in this block is not likely to be affected by further elecrticity generation and/or transmission facilities.

A proclaimed Military Training Area covers 51,000 ha in the Big River disstrict adjacent to Lake Eildon, and is used intermittently for army training exercises.

D. Hazards and Conflicts

Fire is a constant threat in the forest areas from late spring to autumn. An appreciable erosion hazard on steep slopes increases in intensity towards the drier northern areas. Blackberry is a problem along most streams throughout the area.

Mining operations can pose a threat to water quality.

There are potential conflicts between timber production and some aspects of both nature conservation and recreation, and between water quality and some recreational activities.

E. Significance

The steep rugged terrain and difficult access of much of this block give it a high value for reference and for wilderness-type recreation activities. More accessible parts, such as Lake Eildon and the main river valleys, have a high potential for other recreational activities. Plateau areas in the south have a high potential for hardwood timber production.

Other significant features of the block are the mineral zone stretching from Woods Point to Lake Eildon, the presence of historic towns and relics of past mining activities, and the use of the land for military training purposes.

Much of the public land plays an important part in protecting soil from erosion. The block forms a large part of the Eildon catchment.

15. KINGLAKE

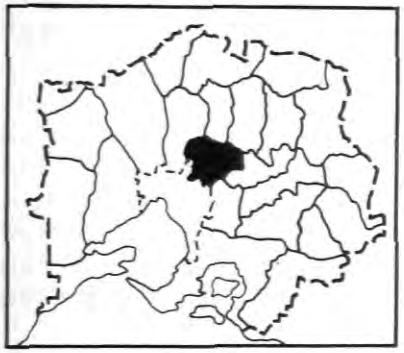
A. General

(1) Location and present tenure

Public land covers 13,190 ha (or 16% of the total block). It froms a discontinuous fragmented belt running east-west, on the southern side of the Divide. There are also a number of small outlying parcels closer to Melbourne.

Tenure includes national park, reserved forest, water catchment vested in the Melbourne and Metropolitan Board of Works, and small areas of special purpose reserves and unreserved Crown land.

County of Bourke: Parishes of Keelbundoora, Morang, Toorourrong, and Yan Yean



County of Evelyn: Parishes of Burgoyne, Gracedale, Greensborough, Gruyere, Kinglake, Linton, Mooroolbark, Morang, Nillumbik, Queenstown, Sutton, Tarrawarra, Tarrawarra North, Tourourrong, Warrandyte, Yan Yean and Yering

(2) General description

Strongly dissected hill country with a generally southern aspect descends from the Kinglake plateau in the north to the Yarra valley in the south. Public land supporting open forest is mainly confined to a narrow belt of steep country on the southern edge of the plateau. Elsewhere the land has been cleared in part for agriculture and urban development. Areas of gentle terrain on basalt plains in the west and in the Yarra valley to the east have been completely cleared for grazing.

(3) Present use

A large area of public land comprises Kinglake National Park, with much of the remainder used for water conservation - part of Melbourne's water supply (Yan Yean storage) and small catchments supplying Hurstbridge and Healesville.

A potato research station near Toolangi occupies public land.

A large number of recreation trips associated with pleasure driving, picnicking and bush-walking are directly influenced by the proximity of Melbourne's northern suburbs.

B. Nature of the Land

(1) Climate

Average annual rainfall is about 1,200 mm on the Kinglake plateau in the north, but decreases with elevation to about 700 mm near Melbourne. Growing seasons on the plateau typically last from March to January, with restricted growth from May to September. With warmer temperatures at lower elevations the period of restricted growth decreases.

(2) Physiography and geology

Strongly dissected hilly terrain, descending from the Kinglake plateau in the north to the Brighton coastal plain in the south, predominates. Closely folded Silurian and lower Devonian sediments underlie most of the block.

The undulating terrain of the Kinglake plateau has an elevation of about 450-550 m. Along its southern edge, a steep strongly dissected escarpment merges into the lower and less steeply dissected Nillumbik terrain.

Mason Falls in Kinglake National Park, accessible by a graded walking track

The many flat ridge-tops at an elevation of about 200 m, from Whittlesea through Kangaroo Ground to Christmas Hills, are remnants of the Nillumbik Surface.

Slow differential uplift along the Yarra Fault has resulted in the Yarra River cutting a narrow gorge throught the higher western side, while upstream it has spread out forming a wide flood plain - the Yarra Flats. Flat volcanic

plains extend into the western part of the block, and around Whittelsea and Yan Yean alluvial deposits fill the old valley of the Plenty River, which was temporarily dammed by the basalt flows.

(3) Soils

Acidic and sodic duplex soils and shallow stony soils occur over much of the block close to Melbourne. With increased rainfall at higher elevations, friable reddish and yellowish gradational soils are found and on the Kinglake plateau these have largely been cleared for agriculture. In the west, grey clays, black clays, sodic duplex soils, and shallow gradational soils developed on basalt and alluvium have also been largely cleared for agriculture.

(4) Vegetation

Open forest III predominates on the reddish gradational soils of the plateau, Messmate stringybark, narrow-leaf peppermint, and mountain grey gum are the chief eucalypts. Common understorey plants include silver wattle, prickly moses, narrow-leaf wattle, handsome flat-pea, common cassinia, dusty miller, hop goodenia, austral bracken, and forest wire-grass.

Small areas of mountain ash open forest IV occur in the sheltered southern and eastern aspects of the steep gullies at the edge of the plateau. In these areas the luxuriant undergrowth includes small trees such as blackwood, hazel pomaderris, blanket-leaf and sassafras, many tall shrubs including holly lomatia, elderberry panax, austral mulberry, musk and snowy daisy-bush, Australian clematis, and wonga vine, and numerous ferns. Many of these species also occur in the valleys and along creeks in the open forest III.

With decreasing elevation on the dissected terrain to the south of the plateau, the wet open forests quickly grade into dry open forests. Open forest II containing various mixtures of messmate stringybark, narrow and broad-leaf peppermint, candlebark, and red stringybark appears first on the ridges, but at lower elevations is confined to the lower slopes and valleys.

The drier sites support open forest I in which the chief eucalypts are red stringybark and broad-leaf peppermint mixed with red box, long-leaf box, and candlebark. The low understorey includes austral and small grass-trees, hill and silver banksias, mountain grevillea, bushy needlewood, gorse bitter-pea, spreading wattle, myrtle wattle, common correa, common beard-heath, horny cone-bush, prickly tea-tree, and tussock grass.

Yellow box occurs on some of the valley flats at the lower elevations, while public land near St. Andrews carries small areas of red ironbark.

Remnants of river red gum woodland occur on the basalt and alluvial areas in the west of the block, the largest areas on public land being within the Yan Yean catchment. Manna and swamp gums are widespread throughout the block along streams and in swampy areas, while silver-leaf stringybark has a scattered distribution through the open forest I areas. Swamp paperbark and tree violet are common riparian shrubs.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitats (including wet open forest, dry open forest, and some remnants of grassy woodland at Yan Yean) and wetlands (including a few permanent streams and the Yan Yean reservoir).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

Some species typical of wet open forest habitats further east but not known to occur in this block are Leadbeaters possum, wonga pigeon, large-billed scrub-wren, satin bower-bird, lewin honeyeater, and black-faced flycatcher.

C. Capabilities

(1) Nature conservation

The public lands of this block have a high capability for nature conservation They provide fairly large remnants of the dry open forest communities that formerly covered the southern slopes of the Divide, and include pockets of wet open forest communities in sheltered gullies.

A rare epiphytic orchid for the study area, *Sarcochilus australis*, occurs in the Jehosaphat Valley. Isolated occurrences of red ironbark at Panton Hills (mainly on private property) and of woolly wattle near Wild Dog Hill are the nearest of these species to Melbourne. Masons Falls area supports a number of significant plants - mountain gentian and cliff cudweed at a much lower elevation than usual for these sub-alpine species, the uncommon lacy pomaderris, and the endemic creeping grevillea - none occurring any nearer to Melbourne. Apart from the small type community of Buxton gum in the Black Range block, the only natural occurrence of this rare endemic tree consists of a few scattered individuals on the Yarra Flats north-west of Yering, where the uncommon shrub *Pomaderris vacciniifolia* is also found.

The rare white-footed dunnart was recorded in 1968 a few kilometres south of Christmas Hills. A stable population of 2,000-3,000 eastern grey kangaroos lives in the Yan Yean catchment area. Colonies of bell-miners along the Plenty River south of Janefield, and along Diamond Creek south of Hurstbridge, are at the western limit of the species. The Plenty Gorge, The Nobs at St. Andrews,

the Yarra Fault scarp at Christmas Hills, and remnants of the Nillumbik Surface between Christmas Hills and Kinglake, are of geomorphic interest.

There are several youth camps in the Kinglake-Toolangi area.

The type localities of two vascular plant species lie within this block.

(2) Recreation

The public land in this block has a high capability for recreation. It is in close proximity to Melbourne's expanding north-eatern suburbs. Main attractions are a range of open forest vegetation types, rugged terrain, scenic lookouts, waterfalls, and ready access. Activities include driving for pleasure, picnicking, nature study, and walking. The picnic area at Yan Yean Reservoir currently attracts about 126,000 visitors each year.

The white-footed dunnart, an uncommon inhabitant of the drier forest areas

Proposed water storages at Yarra Brae, Watsons Creek, and Sugarloaf Creek could provide opportunities for controlled land and water-based recreation.

Roads in this and adjoining blocks to the north and east have potential for development to accomodate the demand for day or half-day car trips through a variety of scenic land types.

Development of farmlet, holiday home, residential accomodation in the Whittlesea, Kinglake, and Yarra Glen areas will cause considerable increase in local recreation demand.

During periods of peak demand many roads are congested and existing recreation sites overcrowded.

(3) Hardwood timber

Open forest III areas on the plateau have a moderate capability, however their total area is not great. Messmate stringybark is the main commercial species. Open forest I and II areas

have a low capability and are often on steep slopes with difficult access.

Forests in the eastern half of this block are within the APM forest area.

(4) Softwood timber

Open forest III areas on the plateau have a high capability. Open forest II areas have a moderate capability, but the terrain is generally steep and broken and consequently they are often mixed with open forest I areas unsuitable for radiata pine. No planting schemes operate in the area at present. A few hectares of mature plantations remain around the Yan Yean Reservoir.

(5) Agriculture

Capability for agriculture on public land remaining on Kinglake plateau is moderate, although most of the suitable areas have already been cleared for pasture and some crop production. Shallow stony soils with low fertility reduce agricultural suitability on the steeper slopes.

Agricultural capability is moderate in the west of the block at lower elevations, where growing season is less restricted and soils on basalt and alluvium are relatively fertile. But very little public land remains in this area.

There is a moderate to high capability for continued honey production at lower elevations in this block where open forest I and II predominate. Yellow box on some river flats and remnants of river red gum land, together with red stringybark, yield good honey flows.

(6) Minerals

Known mineral deposits are of little significance in this block.

Stibnite has been mined in small quantities at Steels Creek, but further exploration and production are tied closely to fluctuating market prices.

Construction project needs are met partly from local supplies.

Wintering colonies of bent-winged bats are found in old mine shafts and tunnels

(7) Water

Public land lies south of the Divide within the Yarra basin and is drained by the headwaters of the Plenty River, Diamond Creek, and Steeles Creek.

Annual rainfall on public land increases eastwards from about 700 mm to 1,200 mm, with average run-off increasing from less than 100 mm to about 250 mm.

Yan Yean storage and catchment on land vested in the Melbourne and Metropolitan Board of Works receives water via Toorourrong Reservoir, whose catchment comprises the Silver and Wallaby Creeks north of the Divide and a branch of the Plenty River south of the Divide. It is the earliest-established part of Melbourne's water supply system.

Local town supplies to Hurstbridge and Healesville are obtained from small catchments partly covering public land. A Land Use Determination gazetted for Micks Creek in 1973 covers 500 ha.

Yarra Brae is under investigation for construction of a reservoir on the Yarra River, upstream from Warrandyte. This project is the first stage of a proposed development that includes the additional construction of two off-river storages at Sugarloaf and Watsons Creek, north of Yarra Brae in the Christmas Hills. Part of Kinglake National Park lies within the proposed Watsons Creek catchment.

It will be necessary to provide some treatment - clarification, filtration, and sterilization - for water from Yarra Brae before it enters Melbourne's supply system because its catchment covers private land. The situation creates the possibility for controlled recreational use of the storage.

The Kinglake areas has a concentration of high-yielding irrigation bores in bedrock. The deeply weathered Silurian and Devonian sediments and high rainfall produce favourable groundwater conditions. On agricultural land, yields up to 7.6 l per second with good water quality (less than 200 mg T.D.S. per litre)have been recorded, but there is little utilization in the forested areas. Public land, however, acts as an aquifer recharge zone for this area.

(8) Utilities

The block is traversed by a proposed electricity transmission easement associated with future power station development in the Latrobe Valley. However, it is unlikely that any significant areas of public land will be affected.

D. Hazards and Conflicts

Fire is a constant threat in the forest area from late spring to autumn. An appreciable erosiion hazard on steep slopes extends to gentler slopes in the drier southern part of the block.

There are potential conflicts between hardwood and softwood timber production, between timber production and some aspects of both nature conservation and recreation, between recreation and some aspects of nature conservation, and between catchment values and recreational uses.

E. Significance

The main parcels of public land here have a high potential for recreation and nature conservation. Other significant features are the Yan Yean Reservoir, water catchments supplying Hurstbridge and Healesville, the possibility of additional water supply installations in connection with Yarra Brae, Watsons Creek, and Sugarloaf Creek, and the scarcity of public land in this region fringing Melbourne's north-east suburbs.

Many small parcels of land supporting remnants of natural vegetation in the south of the block play an important part in maintaining the natural character of the land.

16. DONNA BUANG

A. General

(1) Location and present tenure

Public land covers 46,270 ha (or 67% of the total block). It contains the headwaters of several important tributaries of the Yarra between Healesville and Warburton, and is contiguous with public land in adjoining blocks to the north and east.

Tenure includes two large catchment areas vested in the Melbourne and Metropolitan Board of Works, reserved forest, and several small areas of special purpose reserves and unreserved Crown land.

County of Evelyn: Parishes of Brimbonga, Glenwatts, Gracedale, Gruyere, Manango, Monda, Wandin Yallock, Warburton, Woori Yallock, Yering, and Yuonga

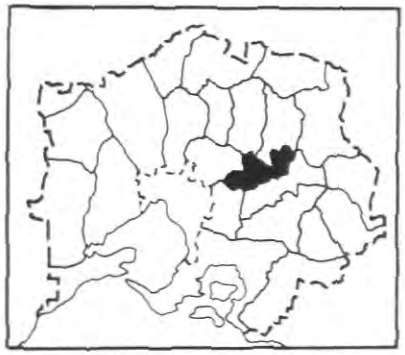
(2) General description

Mountainous terrain with a generally southern aspect descends from a relatively flat plateau along the Divide in the north to the valley flats of the Yarra in the south and west. Most of the mountain and plateau areas are public land supporting very tall open forest.

A small area of sub-alpine vegetation occurs at Mount Donna Buang. The valley areas have been cleared or partly cleared for agriculture and some urban development.

(3) Present use

A large proportion of public land in this block is used either exclusively or in large part to supply water for Melbourne. Areas at Coranderrk, North Maroondah, and Armstrongs Creek are being used for hydrological research. Several smaller catchments serve local



Healesville, Mount Riddell, and the Acheron plateau from near the confluence of Yarra and Watts Rivers

domestic needs at Healesville, Launching Place, Warburton, and Millgrove.

The main recreation attractions include the Sir Colin McKenzie Wildlife Sanctuary near Healesville, pleasure driving along the Maroondah Highway and between Healesville and Warburton (through the Yarra Valley and over Mount Donna Buang), and snow sight-seeing and, limited snow sports on Mount Donna Buang during the winter months. The Yarra River is popular for canoeing, fishing, and picnicking. Good picnic facilities have been established at a number of scenic sites, particularly at Maroondah, Donnellys Creek, Coranderrk, Fernshaw, Yarra Junction, Warburton, and Mount Donna Buang.

B. Nature of the Land

(1) Climate

Average annual rainfall exceeds 1,400 mm over the higher parts of the Acheron plateau, but drops to about 1,000 mm at lower elevations in the west. Regular snow-falls can be expected over the highest parts from June to October, and around Mount Donna Buang snow may persist for short periods. Growing seasons at low elevations typically last from March to January, with restricted growth from May to September. At higher elevations they are unlikely to be affected by summer drought, but low temperatures restrict growth from May to October and may prevent it during June and August.

(2) Physiography and geology

The deeply dissected Acheron plateau is the dominant feature of this block. Composed of upper Devonian acid volcanics, it has a similar origin to the adjoining Cerberean plateau but has been more strongly dissected by its main streams, the Coranderrk Creek and the Watts and O'Shannassy Rivers. However, flat ridges at an elevation of about 1,150-1,200 m around Mount Donna Buang (1,250 m), Mount Ritchie, Poley Range, and Mount Observation still reflect the old Baw Baw Surface. Remnants of the lower Kinglake Surface are also evident at elevations of about 970-850 m along the Divide at Paradise Plains and Mount Monda.

Erosion of the softer Silurian and lower Devonian sediments surrounding the southern edge of the plateau has resulted in a very steep and prominent escarpment, which, near Warburton, falls about 900 m in 4 km to the wide flats of the Yarra River.

(3) Soils

Friable brown gradational soils occur at the higher elevations on the Acheron plateau. At lower levels friable reddish and some yellowish gradational soils are found, with acidic duplex soils occurring in the lower-rainfall areas in the west, and shallow stony soils on the steep slopes.

(4) Vegetation

Open forest IV covers most of the public land in this block. Alpine ash is the dominant eucalypt in areas above 950 m elevation along the Donna Buang and Poley Ranges and on the Divide. The understorey often includes silver wattle, elderbery panax, rough coprosma, mountain hickory wattle, Derwent speedwell, golden tip, common cassinia, tall rice-flower, mother shield-fern, and tussock grass.

Elsewhere mountain ash is the dominant species down to an elevation of about 300 m, or even lower in sheltered situations. The dense understorey includes blackwood, silver wattle, *Acacia frigescens*, blanket-leaf, hazel pomaderris, mountain correa, banyalla, elderberry panax, musk daisy-bush, Christmas bush, austral mulberry, tough rice-flower, tall sword-sedge, forest wire-grass, and numerous ferns. Sheltered gullies support a closed forest of myrtle beech, sassafras, and blackwood.

On the highest peaks small areas of white sallee open forest I occur. Shining gum is frequently found in mixture with the two ash species at elevations of about 900-1,000 m, while lemon bottlebrush occurs among rocky outcrops, as at Ben Cairn.

At lower elevations open forest III is found, grading into open forest II on drier sites. Messmate stringybark and mountain grey gum are the dominant eucalypts in sheltered locations, while elsewhere messmate stringybark is found mixed with narrow-leaf peppermint, silver top, and occasionally brown stringybark. Silver wattle, blackwood, prickly moses, varnish wattle, narrow-leaf wattle, dusty miller, snowy daisy-bush, prickly bush-pea, tall sword-sedge, red-fruit saw-sedge, and forest wire-grass are common species in the understorey.

Broad-leaf peppermint and long-leaf box occur as open forest I on dry spurs in the west of the block, while silver-top appears in similar situations at higher elevations in the east. Manna gum is found on the flats and lower slopes along the main streams, and swamp gum forms pure stands on low-lying flats.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitats (including extensive areas of wet open forest, pockets of sub-alpine complex at Mount Donna Buang, and small areas of dry open forest at low elevations in the west) and wetlands (including a number of permanent streams and dams).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The public lands here have a high capability for nature conservation. They provide extensive examples of a variety of wet open forest communities that have developed on acid volcanic parent materials on the southern slopes of the Divide.

Two very interesting sub-alpine shrubs on Mount Donna Buang, the endemic Baw Baw berry and alpine westringia, appear no further west. Narrow-lip spider-orchid, spurred helmet-orchid, and white caladenia, all rare species, have been found near Healesville.

Myrtle beech gullies in this block, for example at Cumberland Falls and Cement Creek, are noteworthy for their wealth of fern and bryophyte species, lichens, and fungi.

Carex alsophila, a sedge endemic in the Melbourne area, occurs along stream banks and on flats in the mountain forests of this and adjoining blocks.

Of particular value are stands of wet open forest in the Maroondah and O'Shannassy catchments where human disturbance has been kept to a minimum. Most of the O'Shannassy catchment was not severely burnt by the wildfires of 1926 and 1939 and still supports an over-mature and relatively open forest of mountain ash.

The block includes, the type localities, wholly or in part, for 12 plant species.

Leadbeaters possum has been recorded at a number of locations in the wet open forest of this block as far west as Mount Dom Dom and Ben Cairn. The Sir Colin McKenzie Sanctuary at Healesville has high educational value. The cicada

The observation tower and amenities at Mount Donna Buang. Winter snow-falls attract large crowds

bird, a rare summer migrant from northern Australia and the islands, has been recorded in this block at the southern limit of its range. A number of beetle species have only been recorded in the Warburton-Donna Buang area. The rare caddisfly *Megogata necopina* and the particularly ancient stonefly *Thaumatoperea robusta* have been recorded here also.

Small parcels of public land in the west of the block have a high value for nature conservation, as they include remnants of the dry open forests that formerly covered the area.

An Aboriginal cemetery on public land at Coranderrk (near Healesville) is of great historic interest.

There are a number of youth camps in the Healesville, Yarra Junction, Warburton, and McMahons Creek areas.

(2) Recreation

This block has a high capability for recreation. Main attractions are heavily forested terrain with numerous fern gullies and look-outs, mountain streams, spring displays of wattle, and occasional winter snow-falls. Attraction is further enhanced by its close proximity to the north-eastern suburbs, and ready access from both the Maroondah and Warburton Highways.

Recreation activities are confined generally to the main roads and southern fringe of public land, as access to water catchment areas is restricted. Main activities include pleasure driving, picnicking, bush-walking, and nature study. Intermittent snow-falls at Mount Donna Buang attract many visitors over the winter months. Competitive and pleasure canoeing is popular on sections of the Yarra River downstream from Warburton. The Sir Colin McKenzie Sanctuary near Healesville attracts large numbers of visitors to its wildlife display. Other popular areas include the picnic reserves at Maroondah Reservoir (which currently attracts about 226,000 visitors each year), Fernshaw (106,000 visitors), and Coranderrk (80,000 visitors).

During periods of peak demand, many roads are congested and recreation sites overcrowded.

Development of farmlet, holiday home, and residential accommodation in the Healesville-Warburton area will cause an increase in local recreation demand.

(3) Hardwood timber

The open forest IV areas that cover most of this block have a high to very high capability. They include stands of regrowth resulting from the 1939 and earlier wildfires, as well as extensive areas of old growth, especially in the O'Shannassy catchment, which escaped the worst of these fires. Timber harvesting within this forest type has been

restricted to Armstrongs and Cement Creeks and to limited areas on the south face of Mount Donna Buang.

The value of these areas is enhanced by their proximity to Melbourne and the extensive distribution of uniformly high-quality stands. Mountain ash is the main commercial species.

Open forest III areas at lower elevations have a moderate capability. Messmate stringybark is the main commercial species.

The forests of this block are within the APM forest area.

(4) Softwood timber

Open forest IV areas below about 950 m have a high to very high capability. Open forest III areas at lower elevations also have a high capability and merge with open forest II areas having a moderate capability on the drier spurs. However, these areas are remote from existing plantation schemes.

At present, no planting programs operate in the block. There are a few hectares of mature plantations at Maroondah Reservoir and small areas of various ages at Cement Creek.

(5) Agriculture

Parts of the Acheron plateau have a moderate capability for agriculture. Rainfall is high and soils reasonably fertile, but low winter temperatures at higher elevations restrict the growing season. Rainfall and growing season are also adequate for agriculture on the few remaining areas of public land at lower elevations where friable reddish and yellowish gradational soils occur.

Beekeepers have made little use of this area, mainly because of the limited access, difficulty of finding suitable sites with water, and the lack of well-known pollen, or nectar, producing species. Parts of the block probably have a moderate capability, as messmate stringybark, is a useful species and alpine ash has been successfully worked in other localities.

(6) Minerals

There are no mineral deposits of known significance in this block. Most public land has been unavailable for mineral extraction or exploration because it forms part of Melbourne's closed water supply catchment.

(7) Water

Public land lies south of the Divide and is drained by headwaters and tributaries of the Yarra River. Average annual surface run-off increases from about 250 mm in the west to more than 750 mm at the eastern extreme. These conditions, influenced by the steep topography, give this area a very large stream dis-

The Yarra River below Warburton, with Mount Victoria in the background

charge, while its location close to Melbourne enhances the significance of these water resources.

Water resources on public land are in large part committed to the provision of domestic supply to Melbourne. Main storages include Maroondah (22,075 Ml) and O'Shannassy (4,200 Ml), which together comprise about 4% of Melbourne's total storage capacity (including Cardinia).

There are diversion weirs at Cement (east branch), Donnelly, Sawpit, Armstrongs Coranderrk, and Graceburn Creeks. These catchments, together with those of O'Shannassy and Maroondah, cover about 35,000 ha or one-third of the total catchment area used for Melbourne's water supply.

The catchments at Cement and Armstrongs Creeks are operated by the Board of Works under a lease with the Forests Commission. The other areas are operated by the Board under vesting or Crown grant. Small catchments providing local urban supplies to Healesville, Warburton, Launching Place, Millgrove, and Yarra Junction lie mainly on public land, but in some cases include private property. The Healesville catchment of 200 ha is covered by a Land Use Determination gazetted in 1966.

(8) Utilities

The western part of this block is traversed by a proposed electricity transmission easement associated with future power station development in the Latrobe Valley. It is unlikely, however, that any significant areas of public land will be affected.

D. Hazards and Conflicts

Fire is a constant threat in the forest areas over the summer months. An erosion hazard affects steep slopes. Mountain ash forests in this block have suffered attacks from plagues of phasmatid insects in recent years, but have

not been as severely infested as the forests further south. There are potential conflicts between catchments values and both timber production and recreational activities.

E. Significance

A large part of the public land in this block forms catchments supplying water to Melbourne and to a number of local towns. Because these areas have remained relatively undisturbed, they have a high capability for reference and nature conservation purposes. Most of the public land also has a high potential for recreation and for hardwood timber production. The southern and western slopes of the Acheron plateau have a high landscape value.

17. UPPER YARRA

A. General

(1) Location and present tenure

Public land covers 70,550 ha (or 75% of the total block). The eastern part contains the headwaters of the River Yarra and adjoins public land in Donna Buang, Upper Goulburn, Thomson, Tyers, and Bunyip-Latrobe blocks. The western edge is fragmented, with several outlying parcels.

Tenure is predominantly reserved forest, a large proportion of which is operated by the Board of Works as a water catchment area. There are also small areas of special purpose reserves and unreserved Crown land.

County of Evelyn: Parishes of Beenak, Brimbonga, Corrnburt, Gembrook, Nangana, Warburton, Woori Yallock, and Youarrabuk

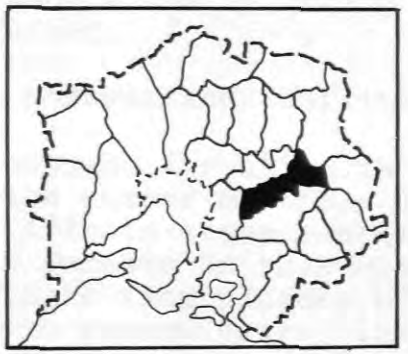
(2) General description

Mountainous terrain with a generally northern aspect descends from the Yarra watershed in the east and south to the river itself in the north. Most of the block is public land, supporting tall open forest at higher elevations. Areas of more undulating terrain in the west have been partly cleared for agriculture and some urban development.

(3) Present use

More than half the public land is used exclusively for water conservation, the Upper Yarra Dam being the largest on-river storage in Melbourne's water supply system. The Board of Works operates diversions on McMahons and Starvation Creeks under the provisions of a lease from the Forests Commission. Also, several smaller domestic catchments supply water to Yarra Junction, Warburton, and Gembrook-Emerald.

Timber and water harvesting have been



prominent activities in this block over the past 60 years.

Recreational use of land is associated with scattered picnic sites and popular walking tracks, particularly near Warburton, Upper Yarra, and Powelltown. Horse-riding and trail bike riding are also popular activities.

A fauna reserve at Yellingbo preserves habitat for the helmeted honeyeater - the State's faunal emblem.

B. Nature of the Land

(1) Climate

Average annual rainfall exceeds 1,400 mm over most of this block, but drops to about 1,200 mm at lower elevations in the west. In the east regular snowfalls can be expected on the Gregory plateau from June to October, but the snow seldom persists. Growing seasons over much of the block are unlikely to be affected by summer drought, but low temperatures would restrict growth from May to October and at the highest elevations prevent growth during July and August. Summer drought is likely to prevent growth in the drier western parts of the block during February.

(2) Physiography and geology

Strongly dissected mountainous terrain descending from the Gregory plateau to the valley of the Yarra River predominates. The plateau, part of the Kinglake Surface, forms an extensive undulating area at an elevation of about 1,000-1,100 mm in the east of the block. Elsewhere along the Yarra watershed the plateau surface, although more deeply dissected, is still obvious. It slopes down to the west, the broad flat ridges near Cumberland having elevations of above 880 m while those along the Yarra-Bunyip divide are at about 760-820 m. Active erosion by the headwaters of the Yarra has resulted in a steep escarpment along the western edge of the plateau.

With decreasing general elevations to the west, the terrain moderates and becomes less mountainous. Closely folded lower Devonian sediments underlie the north of the block, while in the south upper Devonian granites predominate. In the far west of the block, undulating terrain has developed on Silurian sediments and remnants of older basalt flows.

(3) Soils

Friable brown gradational soils occur at the higher elevations. At lower levels friable reddish and yellowish gradational soils are found, with some acidic duplex soils occurring in the lower-rainfall areas in the west, and shallow stony soils on the steep slopes.

(4) Vegetation

Open forest IV is found throughout the higher peaks of this block, descending

to a general elevation of about 600 m or, on sheltered southern slopes (for example at Mount Bride and in parts of the upper Yarra catchment), to about 400 m. On the Gregory and Toorongo plateaus above 950 m, alpine ash is the dominant eucalypt. Below this elevation, and extending west along the Yarra watershed to Starling Hill and Mount Beenak, are forests of mountain ash.

Common species in the dense understoreys are silver wattle, mountain hickory wattle, blackwood, *Acacia frigescens*, blanket-leaf, hazel pomaderris, snowy daisy-bush, musk daisy-bush, notched phebalium, balm mint-bush, mountain correa, elderberry panax, prickly currant-bush, giant mountain grass, forest wire-grass, and numerous ferns.

Mountain grey gum and messmate stringybark become increasingly common at the lower elevations of open forest IV. Shining gum in pure stands or mixed with the two ash species is prominent in the 900-1,000 m elevation zone.

Closed forest of myrtle beech, sassafras, and blackwood is found in the sheltered gullies. Scrubs of common cassinia, hop goodenia, and austral bracken, or closed forests of silver wattle and blackwood resulting from repeated wildfires, cover large areas on the Toorongo plateau and near Powelltown.

Areas of tussock grassland with very stunted shrubs of myrtle beech, blackwood, and mountain tea-tree occur on parts of the Toorongo plateau, while some swampy drainage lines in this area support a wet heath dominated by candle heath.

The rugged terrain at lower elevations in this block, especially in the upper Yarra catchment, gives rise to rapid changes in vegetation over short distances, for example open forest IV on the south side of a spur may quickly give way to a stunted open forest I on the northern slope. Generally, however, open forest III predominates. On sheltered aspects and in gullies mountain grey gum and messmate stringybark are the dominant eucalypts.

Messmate stringybark and narrow-leaf peppermint are found on more exposed sites, while silvertop in various mixtures with messmate stringybark, brown stringybark, and narrow-leaf peppermint tends to dominate the ridges and the steep northern slopes as far west as Gembrook.

Common understorey species are silver wattle, common cassinia, Christmas bush, hazel pomaderris, cherry ballart, handsome flat-pea, wiry bauera, prickly moses, narrow-leaf wattle, hop goodenia, broom spurge, dusty miller, hairpin banksia, prickly tea-tree, prickly bush-pea, tall sword-sedge, red-fruit saw-sedge, and forest wire-grass. The drier sites carry common correa, myrtle wattle, spreading wattle, rough bush-

pea, bushy needlewood, gorse bitter-pea, and tussock grass.

Manna gum occurs on flats and lower slopes along the main streams, where understorey species often include burgan, scented paperbark, and sweet bursaria.

At lower elevations in the west of the block, open forests I and II contain red stringybark and narrow- and broad-leaf peppermints as the chief eucalypts along the drier ridges. Narrow-leaf bitter-pea, sweet bursaria, cherry ballart, hairpin banksia, and tussock grass are often present in the understorey.

The superb blue wren requires scrubby cover and open areas for feeding

Messmate stringybark and narrow-leaf peppermint with some brown stringybark form an open forest II or III on the better sites, with an understorey of prickly moses, prickly tea-tree, narrow-leaf wattle, Christmas bush, and common cassinia, while some poorly drained areas support silver-leaf stringybark with thatch saw-sedge, forest wire-grass, and prickly tea-tree.

Swamp gums and manna gums with an understorey of blackwood, prickly tea-tree, woolly tea-tree, and scented paperbark border the lower reaches of streams such as Cockatoo and Sheep Station Creeks, which flow into the Yarra River.

(5) Fauna

The animal habitats that occur on public land in the block are the general forest habitats (including extensive areas of wet open forest and small areas of dry open forest on steep northern aspects and at low elevations in the west) and wetlands (including several permanent streams and the Upper Yarra Reservoir).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The public land in this block has a high capability for nature conservation. It

provides examples of a variety of wet open forest habitats that have developed on granitic and sedimentary parent materials over a wide range of elevations and aspects. Small parcels of public land in the west support remnants of vegetation types that formerly covered much of the lowland areas. Large areas in the Upper Yarra catchment have remained relatively undisturbed by Man.

A very isolated occurrence of jungle bristle-fern has been noted in the eastern head of Shepherds Creek at Gembrook, the nearest other locality being on Wilsons Promontory. The only known colony in Victoria of the saw-sedge *Gahnia grandis* is on Tomahawk Creek north of Gilwell Park, while a small uncommon rapier-sedge *Lepidosperma tortuosum* also grows nearby. The very localized endemic lily *Astelia australiana* has been noted along the upper reaches of Tomahawk and McCraes Creeks and also occurs in the adjoining Bunyip-Latrobe block.

Hovea rosmarinifolia is an attractive feature of the Gilwell Park area, but has not been found in other parts of the block. *Carex alsophila*, a sedge endemic in the Melbourne area, occurs on stream banks and on flats in the mountain forests of this and adjoining blocks.

Leadbeaters possum has been recorded in wet open forest at several locations near Starling Gap and in the extreme east of the block. The snail *Victaphanta atramentaria*, endemic in this and adjoining blocks, has also been recorded in the wet open forests.

The lesser long-eared bat is one of the more common forest bats found in the study area

The endemic helmeted honeyeater is only found in the extreme west of this block along Cockatoo, Sheep Station, and Woori Yallock Creeks. It is an endangered species and much of its remaining habitat is on private property. This area is also the closest locality to Melbourne where greater yellow-bellied, sugar, and feathertail gliders can all be seen in the one place.

The contact zone of the granite massif and Silurian sediments at Warburton and the ranges of the Yarra-Bunyip divide are of considerable value from geological, geomorphological, and educational points of view. The block includes the type localities, in whole or in part, for four species of native vascular plants. The Warburton-Upper Yarra Reservoir area and the Yarra Track are important locations for lower Devonian and Silurian fossils. Of particular significance are quarries near the Triangle, where *Baraguanathia* sp., one of the earliest land plants, is found.

There are a number of youth camps in the block at Gembrook, Gilwell Park, Yarra Junction, Warburton, and McMahons Creek.

(2) Recreation

The capability of public land in this block for recreation is high because of the large area of forested mountain environment and its location adjacent to expanding urban development in Melbourne's eastern fringe and the Berwick-Pakenham corridor.

Current recreation uses on public land are confined to the west of the block because of the upper Yarra, McMahons Creek, and Starvation Creek catchments. Activities include bush-walking, especially along abandoned forest tramways (for example, Big Pats Creek to Starling Gap), orienteering, off-road driving, and nature study.

Pleasure motoring and picnicking are confined to a few main roads and to a number of developed picnic areas such as those at Kurth Kiln and Ship Rock, or the larger site at Upper Yarra dam, which attracted about 117,000 visitors during 1972. Internal access on public land is limited for two-wheel-drive vehicles. The eastern part of the block provides good habitat for deer. However, because it is a sanctuary, shooting is illegal.

Falls Creek in the east of the block has some spectacular falls in the rapid descent from the Gregory plateau.

(3) Hardwood timber

Open forest IV areas have a high to very high capability. Open forest III areas have a moderate capability. The present forests consist mainly of stands of regrowth resulting from early logging operations and wildfires in 1926, 1932, and 1939. The relatively flat terrain of the plateau areas and the proximity to Melbourne enhance their commercial value. There are about 2,100 ha of unstocked ash sites suitable for commercial reforestation in the Powelltown area. Small areas of these have been reforested in recent years. The mixed-species forests at lower elevations are generally in a poor condition as a result of past wildfires and utilization.

Timber harvesting has been a prominent activity in this block during the past

60 years. The block is within the APM forest and mill areas.

The main commercial species are mountain ash, alpine ash, messmate stringybark, and mountain grey gum.

(4) Softwood timber

Open forest IV areas below 950 m and open forest III areas of messmate stringybark have a very high capability, however these areas are often on steep slopes, and are remote from existing plantation schemes. Capability is high on most other open forest III areas, but generally only moderate to low on silvertop and open forest II areas. Open forest I areas are not suitable for radiata pine.

There are no planting schemes operating in the area, nor are there any existing plantations.

(5) Agriculture

Capability for agriculture is generally low except at the margin of existing areas of production. Although rainfall increases towards the east, growing season is reduced with elevation during winter months. A large part of the upper Yarra catchment is also topographically unsuitable.

The drier western zone is subject to a short period of summer drought. The western portion of public land is relatively close to the metropolitan area in a zone of "farmlet" subdivision.

Beekeepers have made little use of this area, mainly because of the limited access, difficulty of finding suitable sites with water, and the lack of well-known pollen- or nectar-producing species. However, parts of the block have a moderate capability, with messmate stringybark and possibly alpine ash being useful species.

(6) Minerals

Mineral exploration and utilization have been restricted to the southern part of public land in this block, but known mineral deposits here are of little significance. Alluvial deposits of cassiterite have been worked near Beenak from Tynong-Powelltown granite.

Large reserves of construction material (granite sands) appear to be conveniently located for the future urban expansion of Melbourne's eastern and south-eastern suburbs.

(7) Water

Public land contains the headwaters and numerous tributaries of the Yarra River. Average annual surface run-off increases from about 250 mm in the west to more than 870 mm in the east. Topography and climate combine to produce a very large and relatively reliable annual discharge from surface streams. The location of

these water resources in proximity to Melbourne makes them even more valuable.

Public land in the eastern part of the block provides a very significant contribution to Melbourne's water supply. Most of the stream flow is already harnessed for water production. The upper Yarra storage reservoir, with a capacity of 200,325 Ml, represents almost one-third of total storage capacity in the system (including Cardinia). The upper Yarra, McMahons Creek, and Starvation Creek catchments cover 40,000 ha, or 40% of catchment area used to supply Melbourne's water.

The first stages of a tunnel, now nearing completion, will divert headwaters of the Thomson River into the upper Yarra storage to augment Melbourne's water supply. Construction of the Yarra Valley conduit is proceeding, to increase the transfer capacity from the Upper Yarra Reservoir into major reservoirs at Silvan and Cardinia.

In addition to Board of Works areas, several domestic catchments - with a combined area of 2,600 ha on Four Mile, Britannia, and McCraes Creek - supply water to Warburton, Yarra Junction, and the Gembrook-Emerald district. A Land Use Determination for McCraes Creek was gazetted in 1965.

Older volcanics in the western part of this block have a good capacity for groundwater. High-yielding bores of

Trail bikes make use of these electricity transmission easements near Egg Rock

good-quality water have been sunk on adjacent private land.

No groundwater exploration has occurred on public land further to the east, although rainfall and geological conditions appear potentially suitable.

(8) Utilities

An existing 146-m easement carrying two single-circuit 500-kV transmission lines traverses public land in the west of this block. Proposals for two additional separate electricity transmission easements here are under investigation. One 128-m easement for three single-circuit 550-kV lines is planned in association with future load centre development. A narrower one is associated with possible future power station development in the upper Latrobe region (see Bunyip-Latrobe block).

D. Hazards and Conflicts

Wildfire is a constant threat in the forest areas from late spring to autumn. Plagues of the stick insect *Didymuria violescens* have seriously damaged mountain ash stands in this block periodically since 1961. Blackberry is a problem along many of the streams in the area. There is an erosion hazard on steep slopes.

There are potential conflicts between catchment values and the use of land for recreation and timber production, between hardwood timber production and some aspects of nature conservation and recreation, and between recreation and the stricter forms of nature conservation.

E. Significance

Much of the eastern part of the block forms a major part of the catchments supplying water to Melbourne. The public land also has a high capability for hardwood timber production and for recreation. Because they have remained relatively undisturbed, catchment areas (particularly upper Yarra) have a high value for nature conservation.

18. THOMSON

A. General

(1) Location and present tenure

Public land covers 89,800 ha (or 99% of the total block). It adjoins public land in surrounding blocks and along the study area's eastern boundary.

Tenure is predominantly unreserved Crown land, but a significant area of special purpose reserve covers the eastern part of Baw Baw plateau above 1,220 m.

County of Tanjil: Parishes of Baw Baw, Binnuc, Bullung, Butgulla, Moolpah, Moondarra, Numbruk, Telbit, Toombon, Walhalla, and Wurutwun

(2) General description

Plateau areas along the Thomson watershed encircle a large basin area of steep mountainous terrain. Extensive stands of very tall open forest cover the plateau, with large areas of subalpine vegetation on the higher parts such as Baw Baw. Various mixtures of tall and low open forest occur elsewhere, depending on aspect and elevation.

(3) Present use

The mountain forests have provided an important source of sawlogs over the past 40 years, while the mixed-species forests have been utilized for more than a century.

A section of the upper Thomson catchment has supplied part of Melbourne's water requirements since 1967; however water supply for Melbourne will become a major use in 1974, when work now nearing completion comes into operation. Goldmining has been a significant activity in this block, and at present further mineral exploration is being carried out in the mineralized belt between Walhalla and Woods Point.

Numerous natural features in the block have attracted recreation visits for many years. These include mountain streams for canoeing and fishing, snow-fields on the Baw Baw plateau, and the rugged remoteness suitable for bush-walking. There are many signs of increased recreation visits, and a growing interest in relics of early mining days. The Baw Baw plateau above 1,220 m is reserved under the *Lands Act* as an alpine reserve.

B. Nature of the Land

(1) Climate

Average annual rainfall exceeds 1,400 mm, on the Gregory and Baw Baw plateaus, but drops to about 1,000 mm in the lee of these. Regular snow-falls can be expected on the plateaus from June to October, and on the Baw Baw plateau persistent snow may lie for most of the season. Growing seasons are unlikely to be affected by summer drought, except on exposed northern aspects and low elevations, but low temperature could restrict growth from May to September and prevent growth during July and August over much of the area, while on the Baw Baw plateau restricted growth would be likely from May to October, with no growth from May to September.

(2) Physiography and geology

The dominant features of this block are the plateau surfaces that surround the

The Thomson Valley and Baw Baw plateau from Cast Iron Point

Thomson watershed. The higher and more prominent of these is the Baw Baw plateau, where undulating terrain varies in elevation from about 1,370 to 1,530 m. The pronounced rectangular pattern of shallow valleys follows joint planes in the upper Devonian granodiorite that comprises the plateau. Outlying remnants of the Baw Baw Surface occur at Mount Selma and Mount Useful (both about 1,450 m). The more extensive and lower

Gregory plateau is part of the Kinglake Surface. Its undulating terrain has an elevation of about 1,000-1,100 m.

Elsewhere in the block, strongly dissected mountainous terrain developed on closely Silurian and lower Devonian sediments drop away from the plateau edges to the Thomson and Aberfeldy Rivers, which drain the block. For more than 25 km above their confluence, these streams are separated by a narrow ridge capped with remnants of older basalt. In places the lava residuals are now more than 500 m above the twin lateral streams. The Thomson reaches an elevation of about 130 m at the eastern boundary of the study area.

(3) Soils

Friable brown gradational soils are widespread on the Gregory and Baw Baw plateaus, while the higher parts of the Baw Baw plateau carry peats and organic loams. Elsewhere, friable reddish gradational, yellowish gradational, and acidic duplex soils are found, with shallow stony soils occurring on the steep slopes.

(4) Vegetation

Sub-alpine vegetation covers the Baw Baw plateau and descends to elevations of about 1,300-1,100 m (depending on aspect and exposure) on the northern slopes. It is described in block 22 - Tyers. Sub-alpine vegetation is also found in several other parts of the block. Open forest I of white sallee occurs on Mount Selma and Mount Singleton. The low understorey includes dusty daisy-bush, grass trigger-plant, snow daisy, Mueller bush-pea, and alpine oxylobium.

At Mount Useful a variety of low open forest, woodland, herbfield, and grassland vegetation is found. The dominant eucalypts are white sallee and ash mallee, with some black sallee. On exposed sites they form a stunted mallee-like shrub.

Shrubs in the area include alpine phebalium, alpine oxylobium, alpine wattle, sub-alpine beard-heath, Mueller bush-pea, alpine pepper, lilac berry, coral heath, and *Leucopogon gelidus*. Snow daisy, grass trigger-plant, eye-bright, mountain gentian, and tussock grass are conspicuous in the herbfields and grasslands.

Extensive areas of open forest IV occur on the Baw Baw plateau below the sub-alpine zone, and on the Gregory plateau. They descend to a general level of about 450 m elevation, but may only reach about 1,000 m on steep northern slopes while extending down to about 250 m in sheltered gullies.

Alpine ash is the dominant eucalypt above 900 m. The relatively open understorey includes silver wattle, mountain hickory wattle , hop bitter-pea, dusty daisy-bush, elderberry panax, rough

coprosma, mountain tea-tree, tree everlasting, Tasman flax-lily, Derwent speedwell, Mueller bush-pea, mother shield-fern, and tussock grass.

Below 900 m, mountain ash is the dominant eucalypt. Shining gum is common in the junction zone between the two ash species. Common plants in the dense understorey are blackwood, silver wattle, mountain correa, hazel pomaderris, blanket-leaf, musk and snowy daisy-bush, prickly currant-bush, forest zieria, banyalla, mountain pepper, austral mulberry, Christmas bush, forest wire-grass, and numerous ferns. Myrtle beech is found in the sheltered gullies together with sassafras and blackwood. At lower elevations, and on slightly drier or more exposed sites, mountain ash gives way to messmate stringybark and mountain grey gum.

Pockets of open forest IV occur in the sheltered heads of gullies on the southern slopes of Mount Useful and of the Divide between Matlock and Mount Selma. Alpine ash is the chief eucalypt, although some mountain ash grows along the lower margins of the stands in sheltered gullies if they fall below 900 m elevation. Mountain grey gum is typicallv found in the gullies in these areas together with a dense understorey including blanket-leaf, musk daisy-bush, and numerous ferns.

The very rugged terrain over much of the remainder of the block gives rise to very rapid changes in vegetation over short distances. Generally, open forest III predominates on sheltered or southern slopes, while open forest I predominates on exposed, western, or northern slopes, particularly if they are steep.

On the more favourable sites messmate stringybark (in mixture with mountain grey gum) is the dominant eucalypt. Less favourable sites usually support narrow-leaf peppermint (mixed with candlebark) at higher elevations, while silvertop (sometimes mixed with white stringybark) tends to predominate on the spurs below 900 m elevation and on steep slopes, where it may become quite stunted. Broad-leaf peppermint is found on some exposed ridges.

Common understorey species in the drier areas include silver wattle, varnish wattle, large-leaf bush-pea, prickly bush-pea, sweet bursaria, narrow-leaf wattle, sunshine wattle, common cassinia, tree everlasting, hop goodenia, handsome flat-pea, hop bitter-pea, cherry ballart, prickly moses, Christmas bush, forest wire-grass, and tussock grass.

River flats support narrow-leaf peppermint and some manna gum, with blackwood, Christmas bush, prickly currant-bush, burgan, mountain tea-tree, blanket-leaf, forest wire-grass, fishbone water-fern, and silky fan-fern being common species in the understorey.

The less strongly dissected terrain of the Erica plateau in the south of the block carries open forest III and II. The chief eucalypts are silvertop, messmate stringybark, mountain grey gum, and narrow-leaf peppermint, with white stringybark, brown stringybark, and yertchuk being less prominent. Understorey species are similar to those described above for open forest I and II areas.

Dense stand of ash mallee with an alpine oxylobium understorey - Mount Useful

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitats (including sub-alpine complex, wet open forest, and dry open forest) and wetlands (including a number of permanent streams and small pools and bogs in the sub-alpine areas).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

This block has a high to very high capability for nature conservation. It provides good examples of a wide range of sub-alpine, wet open forest, and dry open forest habitats that have developed on the northern slopes of the Baw Baw granite massif and the rugged sedimentary terrain of the Thomson and Aberfeldy basins.

The sub-alpine areas of the Baw Baw plateau have very high conservation value and are discussed in Tyers block. The head of Talbot Creek carries one of the only two known occurrences on the Australian mainland of the extremely rare clubmoss *Lycopodium scariosum*.

Mount Useful supports the best stand in Victoria of the very localized ash mallee, which is almost at the western

limit of its range. Black sallee, which is also found there, occurs no further west. The tree hakea and oval-leaf grevillea occur along the Thomson and Aberfeldy River valleys near Walhalla at the south-western limit of their range.

Mount Useful is the type locality (in part) for two species of vascular plants.

Leadbeaters possum has been recorded in several localities in wet open forest in the upper Thomson area. The smoky mouse, originally recorded only in the Otways, has recently been found in wet open forest in the upper Thomson and near Aberfeldy.

The frog *Philoria frosti* is endemic in areas above 1,310 m elevation in the Baw Baw plateau. The frogs *Litoria citropa, L. maculata, L. phyllochroa and Pseudodhryne dendyi* have all been recorded in the Aberfeldy or Thomson valleys at the south-western limit of their range.

The snail *Victaphanta atramentaria* is endemic in wet open forests of this and adjoining blocks to the west.

The eastern edge of the Baw Baw plateau is a prominent feature of the landscape in the Thomson Valley.

Coopers Creek (limestone), Walhalla (plant fossils), Thomson River (plant graptolite beds), McAdam Gap, and the Mount Easton-Matlock area are important locations for lower Devonian, Silurian, and Ordovician fossils.

A school camp controlled by the Education Department at Walhalla caters for about 300 children each year, while a site at Coopers Creek has not yet been developed.

(2) Recreation

This block has a high capability for a wide range of recreational activities. Main attractions are rugged forested terrain, scenic lookouts, mountain streams, sub-alpine areas, and many relics of historic interest. Access generally within the block is poor and consequently the present level of use is generally low. The block contains only one main road, running through Walhalla and Aberfeldy to Matlock. It lies more than 150 km from Melbourne's eastern suburbs, making the journey a long day trip, but is more accessible to growing population centres in the Latrobe Valley.

Present activities include canoeing, bush-walking, camping, fishing, and some pleasure driving and sight-seeing, particularly in association with the historic mining centre at Walhalla. Four-wheel-drive vehicles and trail bikes use the area increasingly. The more remote areas are suitable for wilderness-type activities and, together with similar areas in the adjoining Upper Goulburn block, offer some of the best opportun-

The Thomson River near Walhalla is popular with canoeists

ities for deer-shooting in the State. The Tri-State Walking Track commences at Mount Erica and traverses this block.

Snow-field recreation is growing at a fast rate on the Baw Baw plateau (for details see Tyers block).

(3) Hardwood timber

Open forest IV areas have a high to very high capability. Their commercial value is enhanced by the relatively flat plateau terrain and the extensive distribution of uniformly high-quality stands in this and adjoining blocks. The present forest consists mainly of stands of regrowth resulting from the 1939 fires. Open forest III areas have a moderate capability, but stands are generally in a poor condition as a result of past utilization and wildfires, and they are often on steep slopes with difficult access. Open forest I areas have a very low capability.

Timber harvesting has been a prominent activity in parts of this block since the 1860s. Initial operations provided for the needs of mining communities, particularly Walhalla and Coopers Creek, but since the 1930s there has been large-scale logging of ash areas, including salvage of trees killed by the 1932 and 1939 wildfires.

The block is within the A.P.M. forest and mill areas. The main commercial species are alpine ash, mountain ash, messmate stringybark, and silvertop.

(4) Softwood timber

Open forest IV areas below 950 m and open forest III areas of messmate stringybark have a very high capability. Capability is high in most other open forest III areas, but generally only moderate to low in silvertop and open forest II areas. Open forest I areas are not suitable for radiata pine without inten-

sive preparation and fertilizing. Suitable areas are often on steep slopes and are remote from existing plantation schemes.

There are no planting programmes operating in the area, nor are there any existing plantations.

(5) Agriculture

Capability for agriculture is generally low. Large areas are topographically unsuitable for clearing, while the growing season is severely restricted during winter, especially at higher elevations.

Beekeepers have made little use of this area, mainly because of the limited access, difficulty of finding suitable sites with water, and the lack of well-known pollen - or nectar-producing species. Parts of the block probably have a moderate capability, as messmate and white stringybark are useful species and alpine ash and white sallee have been successfully worked in other localities.

(6) Minerals

This block lies within a mineralized zone extending north-south through Walhalla and Woods Point to Jamieson. Exploration licences currently cover much of the area. Gold is the most important mineral, occurring in relatively high-quality gold-bearing quartz reefs. There is no commercial production at present, but currently uneconomic reserves could be worked if gold prices continue to rise. Workings would be underground.

Small quantities of copper have been mined sporadically at Coopers Creek, along with valuable by-products of platinum, palladium, gold, and silver. The mine is currently operating.

Lenses of lower Devonian limestone have been worked at Coopers Creek as a source of lime, but further operations are unlikely.

(6) Water

Public land lies south of the Great Dividing Range and is drained by tributaries of the Thomson and Aberfeldy

Walhalla, 1973

Rivers. Average rainfall and run-off in the north-west corner are among the highest in the study area because of the influence of the Baw Baw plateau, where snow falls during the winter months.

There is a large discharge of good-quality water from public land. Existing utilization of stream flow, however, is confined to small irrigation commitments downstream and to the diversion from 1,705 ha of catchment via the upper Thomson channel into the upper Yarra storage for Melbourne's supply. It has been in operation as an interim measure since 1967.

Stages I and IA of the Thomson River development will be completed by 1974 and stage II by 1977. Construction of a tunnel and the Swingler diversion dam below the confluence of the Jordan and Thomson Rivers will divert stream flow, after allowance for downstream diversion, into the upper Yarra storage reservoir. The catchment area upstream of Swingler dam is about 33,000 ha and was proclaimed in 1973.

Investigation of the Thomson stage III project has commenced. This project comprises an extension of the stage II tunnel southwards from Swingler dam, a major dam on the Thomson River, and a tunnel to divert the Aberfeldy River into the Thomson upstream of the dam.

No groundwater surveys have been conducted. Possible reserves are unlikely to be significant in relation to surface water resources.

(8) Public utilities

Two areas (the Cascade and lower Thomson regions) are being investigated as possible sites for power stations using pumped storage. Easements of less than 40 m would be required to link both these sites with the existing Tyers terminal station, while the Cascade site would need links with proposed developments in the upper Latrobe region also.

D. Hazards and Conflicts

Wildfire is a constant threat in the forest areas over the summer period. A high erosion hazard exists in sub-alpine areas, where destruction of the vegetation can lead to severe wind and water erosion. There is also a hazard on the steep slopes that predominate in this block.

Blackberry is a problem along most streams throughout the area.

There are potential conflicts between catchment values and the use of land for hardwood timber production, mining, or recreation, between hardwood timber production and some aspects of nature conservation and recreation, between the stricter forms of nature conservation and use of the land for mining or recreation, and between different types of recreational activity.

E. Significance

Water diverted from the upper Thomson part of this block now supplies part of Melbourne's water requirement and the amount will markedly increase in 1974 and again in 1977. Current proposals are for almost the entire block to become part of the supply catchment for both Melbourne and the Latrobe Valley region by 1985. A large part of the block, particularly on the Gregory plateau and the slopes of the Baw Baw plateau, has a very high capability for hardwood timber production.

The block also has a high capability for nature conservation, especially in the sub-alpine areas, and for many recreational pursuits, including snow sports and (in the more remote or rugged areas) wilderness-type activities. Also of significance is the mineralized zone from Walhalla and Coopers Creek northwest to Matlock, the numerous relics of early mining and timber harvesting operations, the suitability of land in the Cascade Creek region for a pumped-storage power station, and the high landscape value of the eastern escarpment of the Baw Baw plateau.

19. DANDENONG

A. General

(1) Location and present tenure

Public land covers 7,880 ha (or 13% of the total block). It occurs in several large physically separated parcels, including Ferntree Gully National Park, Sherbrooke Forest Park, and Silvan, Lysterfield, and Cardinia reservoirs. In addition, there are numerous smaller areas.

Tenure is divided between national park, reserved forest, several special purpose reserves, land controlled by the Board of Works, and unreserved Crown land.

County of Evelyn: Parishes of Gembrook, Monbulk, Mooroolbark, Nangana, Narree Warren, Wandin, Yallock, Woori Yallock, and Yering

County of Mornington: Parishes of Berwick, Eumemmerring, Gembrook, Monbulk, Mooroolbark, Nar-nar-goon, Narree Warren, Pakenham, and Scoresby

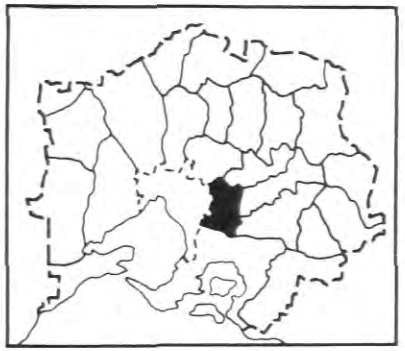
(2) General description

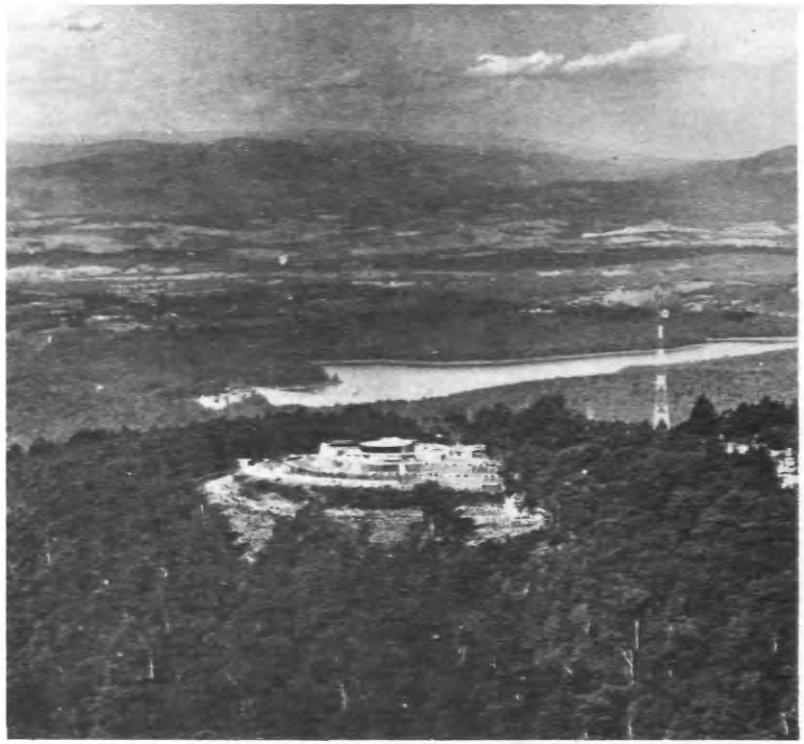
The dominant feature is the Dandenong Ranges. They support low open forest on the exposed slopes, and tall to very tall open forest on the more gentle terrain at higher elevations. Most of the strongly undulating country that surrounds the ranges has been cleared or partly cleared for agriculture and extensive urban development, forming a varied and scenically attractive landscape.

(3) Present use

Off-river storages at Silvan and Cardinia can hold water from the upper Yarra, O'Shannassy, Yarra tributary, Coranderrk, and Thomson catchments before final reticulation in Melbourne suburbs.

The Dandenong Ranges are a very popular recreation area in close proximitv to a





Restaurant and lookout at Mount Dandenong with Silvan reservoir behind it

large rapidly growing suburban population. All of the public land areas available for recreation are well patronized, with evidence of overcrowding at some sites. They contain numerous picnic sites, panoramic views, wildlife displays, and intersting walking tracks.

Ferntree Gully National Park, initially reserved in 1882, has been extended in recent years. In addition, a Forest Park at Sherbrooke and numerous other small reserves provide for public recreation and wildlife preservation, including part of a fauna reserve at Yellingbo, which preserves habitat of the helmeted honeyeater - the State's faunal emblem.

In recent years a significant area of freehold land has been acquired for fire protection and other public purposes.

B. Nature of the Land

(1) Climate

Average annual rainfalls reach more than 1,200 mm in the Ranges, but drop to about 1,000 mm in the surrounding areas. Growing seasons typically last from March to January, with restricted growth from May to September.

(2) Physiography and geology

The Dandenong Ranges are a dissected plateau composed of upper Devonian acid volcanics. They are a remnant of the Kinglake Surface and have a general elevation of about 500-600 m. Mount Dandenong (622m) is the highest peak. Steep slopes fall away from the western edge of the Ranges. Undulating hilly terrain developed on Silurian and lower Devonian sediments, upper Devonian granite, and Tertiary older basalt covers the remainder of the block. The many flat ridges at elevations of about 250-350 m reflect the now dissected Nillum-

bik Surface. Recent alluvial deposits occur in the valleys of the Woori Yallock, Olinda, Cardinia, and Dandenong Creeks, which are the main streams draining the area.

(3) Soils

Small areas of friable brown gradational soil occur in the Dandenong Ranges. Friable reddish gradational soils are widespread, particularly on outcrops of basalt and dacite extending east to Gembrook, and have been largely cleared for agriculture. Shallow stony soils occur on the steep slopes, while the lower-rainfall areas carry acidic duplex and yellowish gradational soils, with sodic duplex soils on the lowest gentler slopes.

(4) Vegetation

Open forest IV of mountain ash is found on the eastern slopes of the Dandenong Ranges, descending in sheltered locations to an elevation of about 230 m. At lower elevations and on the more exposed ridges, it is mixed with messmate stringybark and mountain grey gum. Common species in the dense understorey include silver wattle, blackwood, musk daisy-bush, blanket-leaf, hazel pomaderris, tough rice-flower, austral mulberry, Christmas bush, tree everlasting, common cassinia, prickly currant-bush, banyalla, mock olive, elderberry panax, wonga vine, purple apple-berry, forest wire-grass, and numerous ferns.

On the upper western and northern slopes and below the ash zone on eastern and southern slopes, open forest III occurs. The chief eucalypts are messmate stringybark and narrow-leaf peppermint, with mountain grey gum in sheltered gullies. Silver wattle, prickly moses, cinnamon wattle, golden tip, sweet bursaria, snowy daisy-bush, wiry bauera, dusty miller, and hop goodenia are common understorey species. Manna gum is found on flats and lower slopes along the streams.

Dry open forests I and II occur on the exposed western and northern slopes of the Ranges. Red stringybark, long-leaf box, messmate stringybark, and narrow-leaf peppermint are the chief eucalypts. The low open understorey includes austral indigo, rough bush-pea, prickly tea-tree, myrtle wattle, common correa, spreading wattle, erect guinea-flower, silky daisy-bush, common flat-pea, tussock grass, and kangaroo grass.

Remnants of a variety of open forest types are found on the many small areas of public land in other parts of the block. Swampy drainage lines support swamp and manna gums, with a dense understorey in which scented paperbark, woolly tea-tree, prickly, tea-tree, and prickly moses are common.

In the south, silver-leaf stringybark, swamp gum, and narrow-leaf peppermint form an open forest I that merges into heathy woodland. Yellow and furze

The spotted pardalote - a common species in timbered areas

hakea, silver banksia, black she-oak, prickly tea-tree, and myrtle wattle are frequent in the understorey.

Narrow-leaf peppermint, often mixed with messmate stringybark, is the chief eucalypt on better-drained sites. In these areas understorey species include cherry ballart, silver wattle, blackwood, common cassinia, narrow-leaf wattle, sweet bursaria, and tussock grass.

Dry ridges support broad-leaf peppermint and long-leaf box with understorey species such as common cassinia, common heath, common correa, thatch saw-sedge, common flat-pea, and tussock grass.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitats (including both wet and dry open forest), wetlands (including a few permanent streams and a number of reservoirs - Silvan, Cardinia, and Lysterfield), and cleared agricultural land now reverting to bushland in Lysterfield and Cardinia catchments.

The species commonly seen in these habitats are discussed in chapter 10, and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The public lands of this block have a very high value for nature conservation, supporting remnants of a wide range of wet and dry open forest and grassy woodland habitats.

The area between Mount Evelyn and Lysterfield is especially rich botanically, containing 414 species of native vascular plants and the type localities (in part) for 13 species. A small colony of the slender tree-fern survives along Sassafras Gully, the nearest other specimens being at Tarra Valley to the east and the Calder River near Cape Otway to the west. A rather similar distribution obtains with the rare epiphytic orchid *Sarcochilus australis*, at Kallista, but even more isolated is the East Gippsland

Beyeria viscosa, a few bushes of which still inhabit the western declivities of Mount Dandenong. Victoria's first record of the very rare fairy lanterns was from Sherbrooke Falls, and few other localities are known to date.

The uncommon small helmet-orchid, cobra greenhood, and brittle greenhood have been noted on private land in the vicinity of Mount Morton, and nearby Courtney's Road runs through privately owned bushland rich in orchid species. White stringybark is at its westerly limit near Croydon.

Colonies of broad-tooth rat are known in wet open forest on private property at Kalorama and near Belgrave. The endemic helmeted honeyeater, an endangered species, is only found in the extreme east of the block along the Woori Yallock Creek (see block 17 - Upper Yarra). The black-faced flycatcher, lewin honeyeater, and the rare sooty owl have been recorded in the Dandenong Ranges at the western limit of their range.

The snail *Victaphanta atramentaria*, endemic in this and adjoining blocks, inhabits the wet open forests. Many rare and interesting insects have been recorded in the Dandenong Ranges and east to Cockatoo.

Of special importance are the superb lyrebirds of Sherbrooke Forest. Their tameness enables them to be readily observed by both tourists and students.

Areas of geological or geomorphological significance are the western scarp of the Dandenong Ranges (sequence of upper Devonian lavas), Berwick and Narre-Warren North quarries (sub-basaltic sands and fossil plant remains), Cave Hill Quarry (the section through fossiliferous limestone sand, and basalt), and the ridges along the Yarra-Westernport divide.

The many youth camps in this block are mostly concentrated in the Basin-Belgrave Heights area, with others at Mount Evelyn, Emerald, and Berwick.

The western scarp of the Dandenong Ranges has a high landscape value.

(2) Recreation

Although limited in area, public land in this block is very significant for Melbourne's recreation needs and is a landscape element of considerable prominence. The main attractions are a wide range of natural features, close proximity to Melbourne and its expanding eastern suburbs, and ready access to and within public land.

There is a high level of recreation associated with pleasure driving, picnicking, scenic lookouts, walking tracks, garden and wildlife displays, and horse-riding. Picnic areas at Sherbrooke forest currently attract about 150,000 visitors each year, while those at Silvan Reservoir cater for about

136,000. Water-based activities will be possible with the completion of work adjacent to Cardinia storage. These could be augmented following the phasing out of Lysterfield reservoir from service in the Mornington Peninsula water supply system.

During periods of peak demand, roads are congested with recreation traffic, and most of the recreation areas are used to capacity.

Several commercial recreation enterprises have been established on private land in this block during recent years. These undoubtedly relieve some of the pressure that otherwise would be focussed on public land, as well as extending the range of recreation activities in the area.

(3) Hardwood timber

Open forest IV and open forest III areas have high to moderate capabilities respectively. However, both types cover very limited areas.

The main commercial species are mountain ash and messmate stringybark.

(4) Softwood timber

Open forest IV areas and open forest III areas of messmate stringybark have a very high capability. Other open forest III and open forest II areas with narrow-leaf peppermint have a high capability, while the remaining open forest II has only a moderate to low capability. Open forest I is unsuitable for radiata pine. The area available is very limited and is remote from existing plantation schemes.

There are several small mature softwood plantations in the Dandenong Ranges, but their combined area is very small. No planting programmes operate in this block.

(5) Agriculture

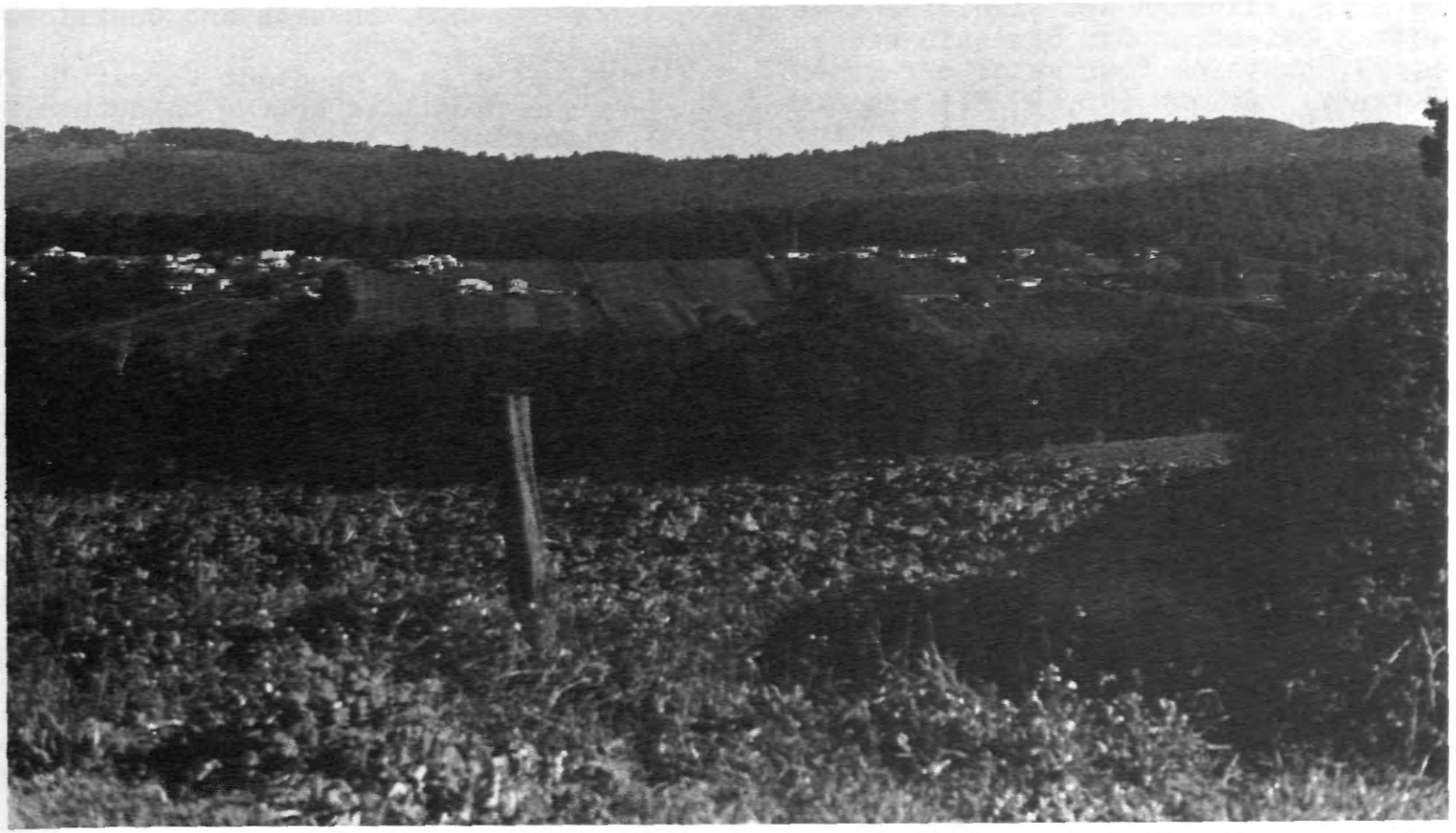
Capability for agriculture is generally low except in a few very small areas. Most of the potentially productive land has already been cleared for pasture and intensive crop and apple production.

Capability for continued honey production in the Lysterfield catchment is high. The main species responsible for producing relatively large nectar flows include prickly tea-tree and silver-leaf stringybark. Build-up conditions are provided partly by adjacent agricultural land.

Capability of public land at higher elevations is low.

(6) Minerals

Although this block contains very important deposits of construction material (hornfels, dacite, and limestone) strategically located to serve Melbourne's



A mixture of agricultural, urban, and timbered areas produces a diversified landscape typical of the Dandenongs

eastward expansion, production from public land is negligible. Mineral exploration and production are effectively excluded from almost all public land in the block, although these areas appear to contain commercial quantities of construction material.

Ruby and sapphire occur in the heads of Cardinia Creek south-west of Emerald.

(7) Water

Public land lies south of the Divide within the Yarra and Bunyip basins.

The area, although not significant as a surface catchment for domestic water supply, contains four major off-river storages. Silvan (40,000 Ml) and Cardinia (287,000 Ml) are linked by pipeline and aqueducts to catchments in the headwaters of the Yarra and Thomson Rivers. They can hold 54% of Melbourne's total storage.

Lysterfield and Upper Beaconsfield reservoirs are supplied from the Bunyip-Tarago catchments, and supply water to the Mornington Peninsula. The services of Lysterfield reservoir will, however, be phased out as the Board of Works assumes responsibility for supplying the Dandenong-Springvale area from Cardinia storage.

Groundwater of good quality is obtained from bores in the Lysterfield area. Largest flows come from bores situated along valleys where granitic sands overlie unweathered granite. In the Wandin Yallock-Silvan area, very good-quality water with yields as high as 25.3 l per second is obtained from the older volcanics. In both areas the water is used for irrigation, stock, and occassionally domestic purposes.

(8) Utilities

There are no proposals for major transmission easements or future power station developments in this block.

D. Hazards and Conflicts

Wildfire is a constant threat in forest areas from late spring to autumn. The situation is aggravated by the presence of dwellings and towns within the surrounding forest areas, and the high use of the area for recreation. The erosion hazard is low to moderate, tending to increase with slope or dryness.

There are conflicts between some aspects of nature conservation and recreation, between different types of recreational activity, and between hardwood timber production and some aspects of both nature conservation and recreation.

Problems associated with the urban expansion in this block include the gradual curtailment of the area's rural landscape, increasing invasion of natural areas by exotic species, including vermin and weeds, and the need for improved roads and services.

E. Significance

This block is of particular significance because of its proximity to the eastern suburbs and to the Berwick growth corridor. The very limited amount of public land in the block is under considerable pressure for nature conservation and a wide range of recreational activities. Major off-river storages for Melbourne's water supply are at Silvan and Cardinia.

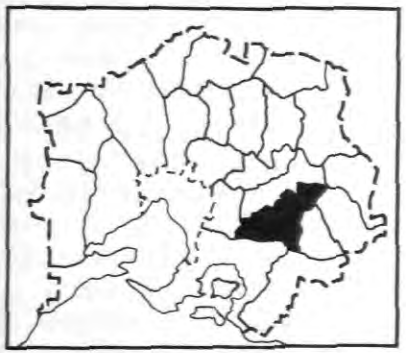
20. BUNYIP - LATROBE

A. General

(1) Location and present tenure

Public land covers 64,400 ha (or 58% of the total block). It occurs as one large consolidated parcel containing the headwaters of the Bunyip and Latrobe Rivers, and numerous small outlying parcels to the south. The northern boundary of the main parcel adjoins extensive areas of public land in the Upper Yarra and Tyers blocks.

Tenure is predominantly reserved forest, with small areas under special purpose reserve, unreserved Crown land, and land vested in the State Rivers and Water Supply Commission.



County of Buln Buln: Parishes of Drouin East, Drouin West, Ellinging, Fumina, Jindivick, Nayook, Nayook West, Neerim, Noojee, Noojee East, and Toorongo

County of Mornington: Parishes of Bunyip, Gembrook, Nar-nar-goon, Tonimbuk, and Tonimbuk East

(2) General description

Very hilly to mountainous terrain with predominantly southern aspect descends from the Bunyip and Latrobe watersheds in the north to the Westernport Sunkland in the south. Much of the block is public land supporting tall to very tall open forest. Areas of low open forest and woodland occur at lower elevations. Undulating terrain in the south has been cleared or partly cleared for agriculture and some urban development.

(3) Present use

Public land in the Bunyip-Tarago catchment provides water for Mornington Peninsula and western Gippsland, while the headwaters of the Latrobe provide water for Noojee and the Yallourn storage.

Hardwood logging of ash, messmate stringybark, and silvertop has been a prominent activity over the last 60 years on most of the public land. Sawlogs and pulpwood are the main products.

Softwood plantations at Loch Valley now cover about 900 ha and currently produce sawlogs and pulpwood.

Recreation use of this area, confined mainly to the southern part of the block, includes fishing at Tarago Reservoir and along mountain streams, canoeing, pleasure driving, and picnicking. The Labertouche area is noted for its spring wildflower displays. Use of the area by trail bikes is increasing.

B. Nature of the Land

(1) Climate

Average annual rainfall over most of the block is about 1,200 mm. It may exceed 1,400 mm in the areas of highest elevation, while in the lower southern areas it is about 1,000 mm. Regular snowfalls could be expected from June to October on the highest parts in the east, but the snow seldom persists. Growing seasons over most of the area are unlikely to be affected by summer drought, but low temperatures could restrict growth from June to August at low elevations in the south or from April to October (with no growth during July and August) at high elevations on the Gregory plateau.

(2) Physiography and geology

Strongly dissected mountainous terrain developed on upper Devonian granite predominates. Highest elevations are in the east, where the hard metamorphic rocks of the Toorongo Range (an outlying remnant of the Baw Baw Surface) reach 1,248 m at Mount Toorongo. Extensive remnants of the Kinglake Surface are also found in this area, where the undulating terrain of the Toorongo plateau (a southerly extension of the Gregory plateau) has an elevation of about 970-1,100 m. More dissected remnants of the Surface are found at decreasing elevations to the west along the Yarra-Latrobe divide and in the Beenak Ranges south of Powelltown.

The now dissected Nillumbik Surface, sloping from about 500 m in the north-east to about 250 m in the south-west, is reflected in the numerous broad, flat ridges of the hilly terrain in the southern part of the block. Extensive areas of undulating terrain developed on older basalt in the Neerim area are part of this Surface.

The flat alluvial deposits of the Kooweerup swamp extend into the block along the Bunyip River at an elevation of about 45 m.

(3) Soils

Extensive areas of friable brown gradational soil occur at higher elevations,

particularly in the east. Elsewhere friable reddish and yellowish gradational soils are widespread, with shallow stony soils on the steep slopes. Considerable areas of friable reddish gradational soils that have developed on basalt in the Noojee-Drouin area have been cleared for agriculture.

(4) Vegetation

Open forest IV covers much of the block. Mountain ash is the dominant eucalypt, although in some localities shining gum occurs over large areas, and alpine ash is found in the east at elevations above about 950 m.

Common species in the dense understorey include silver wattle, blackwood, mountain hickory wattle, *Acacia frigescens*, blanket-leaf, Christmas bush, elderberry panax, austral mulberry, mountain correa, balm mint-bush, hazel pomaderris, musk daisy-bush, forest zieria, tough rice-flower, notched phebalium, prickly coprosma, hop goodenia, common cassinia, handsome flat-pea, giant mountain grass, forest wire-grass, twining silkpod, Australian clematis, and numerous ferns.

In the alpine ash areas the understorey is less dense and frequently consists of mountain hickory wattle, Tasman flax-lily, tussock grass, elderberry panax, rough coprosma, mountain tea-tree, Derwent speedwell, and mother shield-fern. Sheltered gullies support a closed forest dominated by myrtle beech with some sassafras and blackwood.

At the lower elevational range of open forest IV, mountain grey gum and messmate stringybark become increasingly frequent as the dominant eucalypts. Closed forests of silver wattle and blackwood, or scrubs including common cassinia, hop goodenia, and austral bracken, have developed over large areas in the east of the block following repeated fires. A tussock grassland with very stunted shrubs of myrtle beech, blackwood, and mountain tea-tree occurs near Mount Toorongo.

Open forest III predominates below a general level of about 400 m elevation, although on dry aspects it is found at higher elevations, and in sheltered gullies the open forest IV may descend to about 200 m. Messmate stringybark, in mixture with mountain grey gum (which may form pure stands) and narrow-leaf peppermint, is widespread. Common understorey species include silver wattle, blackwood, prickly moses, prickly bush-pea, prickly currant-bush, common cassinia, hop goodenia, sweet bursaria, wiry bauera, handsome flat-pea, and forest wire-grass.

Silvertop in various mixtures with brown stringybark and messmate stringybark is confined mainly to the ridges, and in these areas the understorey includes rough bush-pea, hairpin banksia, common correa, bushy needlewood, austral grass-

tree, prickly tea-tree, myrtle wattle, broom spurge, and forest wire-grass.

Flats up to 200 m wide fringe a number of streams in the open forest IV and III zones. These support dense stands of scented paperbark up to 10 m in height with an understorey of coral fern, hard water-fern, and fishbone water-fern. Good examples occur along Big Creek and the Ada, Little Ada, and upper Bunyip Rivers.

Dense stands of scented paperbark occur on flats fringing streams in the wet forest areas of this block

In the south of the block, heathy woodland has developed on yellowish gradational soils, which are thought to be very old and now infertile remnants of an old erosion surface. Silver-leaf stringybark and broad-leaf peppermint are the chief eucalypts. Common species in the heathy understorey are heath tea-tree, golden spray, silver banksia, furze hakea, yellow hakea, hairpin banksia, myrtle wattle, sweet wattle, spike wattle, broom spurge, pale wedge-pea, thatch saw-sedge, silky guinea-flower, trailing goodenia, blunt-leaf heath, rosy baeckea, spreading wattle, heath milkwort, and small grass-tree. Dense thickets of scented paperbark, pink swamp-heath, red-fruit saw-sedge, and pouched coral fern are found along the drainage lines.

Open forest II, with messmate stringybark, narrow-leaf peppermint, and silvertop as the chief eucalypts, borders the woodland areas. Lemon bottlebrush and burgan are found on rocky heights such as at Spion Kop and Seven-acre Rock, while swamp gum and manna gum are frequently encountered along streams at lower elevations.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitats (including extensive areas of wet open forest, heathy woodland east of Gembrook, and small areas of dry open forest at low elevations), wetlands (in-

cluding a number of permanent streams and the Tarago Reservoir), and small areas of open grassland at high elevations on the Toorongo plateau.

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

Much of the public land in this block has a very high value for conservation, as it supports significant areas of heathy woodland, an environment that has very restricted occurrence, as well as good examples of a range of wet open forest habitats that have developed on granitic parent materials on the southern slopes of the Divide.

The forest sedge *Carex alsophila*, endemic in the study area, is restricted to stream banks and damp flats in the wet open forests of this and the adjoining Tyers, Upper Yarra, Donna Buang, and Cerberean blocks. Tree geebung, another endemic species has a similar distribution and is often associated with myrtle beech. Gully grevillea is confined in Victoria to the wet open forests on the eastern tributaries of the Bunyip River (especially Rysons Creek).

The localized and endemic *Astelia australiana* has only been recorded in wet gully heads of the upper Latrobe River and the Bunyip River, McCrae Creek, and Tomahawk Creek watersheds. The species is now much reduced, apparently by the ravages of severe wildfires.

A grassy area on the Toorongo plateau

Long pink-bells, endemic in the Emerald-Baw Baw region, is found in the vicinity of Gentle Annie and Seven-acre Rock. Other species of interest in this area are *Hibbertia asterotricha*, blue dampiera, fairy fan-flower, and rough star-hair.

Four species reach their most westerly Victorian limit in this block - sunshine wattle (heads of Cannibal Creek), fringed beard-heath (between heads of Diamond and Cannibal Creeks), the tree-fern epiphyte *Fieldia australis* (Blue Ranges south-east of Beenak), and yert-chuk (near Mount Towt).

Wet peaty flats along the Diamond and upper Cannibal Creeks support such interesting and localized plants as swamp bush-pea (a species endemic in the study area), pigmy clubmoss, large-flowered rapier-sedge, and spurred helmet-orchid. Bristly shield-fern and the epiphytic orchid *Sarcochilus australis* occur at the source of the Bunyip River, and the rare sun-orchid *Thelymitra retecta* on upper reaches of the Loch River.

The block contains the type locations for seven species of vascular plants.

Leadbeaters possum has been recorded in wet open forest in Pioneer Creek (at the south-western limit of its known distribution) and at several localities north of Noojee. The broad-tooth rat has recently been recorded in wet open forest in the head of the Back Creek, at Pennys Saddle, and in the Loch Valley plantation.

The snail *Victaphanta atramentaria*, endemic in this and adjoining blocks to the north, inhabits wet open forest. A number of rare and interesting insect have been recorded in the Mount Beenak-Mount Towt area. The wonga pigeon has been recorded in this block at the south-western limit of its range. The southern emu-wren is found in heathy woodland areas.

The upper Latrobe, Tarago, and Bunyip basins contain interesting geological and geomorphological features.

The short-nosed bandicoot - a common marsupial in the heathy woodlands

Some small parcels of public land in the south of the block support remnants of vegetation types that formerly covered the area.

Youth camps are situated in the Tynong North, Nayook, and Neerim South areas.

(2) Recreation

The capability for recreation in this block is high, particularly in the southern part, which adjoins the future urban growth corridor of Berwick-Pakenham-Warragul and is already heavily used. The area offers a wide range of rugged open forest and heathy woodland environments, including fern gullies, wildflower displays, rocky scenic lookouts, and mountain streams. At present internal access on public land is poor.

Pleasure driving, bush-walking, picnicking, orienterring, horse-riding, and nature study are all popular activities in parts of the block. Fishing is popular in some streams and along the shoreline of Tarago Reservoir, while the wide reaches of the Latrobe are used for canoeing. Use of the area by four-wheel-drive vehicles and trail bikes has increased rapidly over the past few years.

The Toorongo Falls and wildflower reserves at Labertouche are well-known attractions, while picnic facilities have been developed at a number of scenic sites.

Young ash eucalypts (middle) occupy a site near Seven-acre Rock after clearing and burning of a dense stand of silver wattle (right background) and aerial seeding. Older natural ash regrowth can be seen on the left

(3) Hardwood timber

Capability is high to very high in open forest IV and moderate in open forest III areas, but very low in open forest II and heathy woodland areas. The existing forest consists largely of stands of regrowth resulting from early

logging operations and from wildfires in 1926 and 1939. About 9,000 ha of unstocked ash sites, mainly in the Toorongo plateau area, have resulted from repeated wildfires. Open forest III stands are generally in poor condition, having suffered from past logging operations and wildfires.

Timber harvesting has been a prominent activity in this block over the past 60 years. The block is within the APM forest and mill area.

The main commercial species are mountain ash, messmate stringybark, silvertop, and mountain grey gum.

(4) Softwood timber

Open forest IV areas below 950 m and open forest III areas of messmate stringybark have a very high capability. Most other open forest III areas have a high capability, while silvertop and open forest II areas have only a moderate to low capability. Open forest I and heathy woodland are not suitable for radiata pine.

The Loch Valley plantation, first established in 1933, has been expanded in recent years and now totals about 900 ha, with an average site index of about 26 m. It lies within the Latrobe Valley zone defined by the Forests Commission for planning purposes. No planting schemes are currently operating in the block.

(5) Agriculture

Capability for agricultural production, except in pockets adjacent to cleared land, is generally low. Most areas of friable reddish gradational soils on suitable terrain have already been alienated for pasture and crop (potato) production. Growing seasons at higher elevations in this block are restricted by low winter temperatures, and many areas are topographically unsuitable for clearing.

The southern zone of public land adjoins rural holdings being subdivided for "farmlets".

Beekeepers have made little use of this area, mainly because of the limited access, difficulty of finding suitable sites with water, and the lack of well-known pollen- and nectar-producing species. Parts of the block probably have a moderate capability, as the heathy woodlands contain useful species such as silver-leaf stringybark, prickly tea-tree, and silver banksia. Messmate stringybark is widespread at lower elevations, and alpine ash, which occurs in the east of the block, has been successfully worked in other localities.

(6) Minerals

The southern zone of public land in this block has a high capability for the production of granitic sands. Large reserves occur as gravel outwash. The

area is strategically located in relation to future demand for construction material in Melbourne's south-eastern suburbs, the Berwick-Warragul corridor, and Westernport.

The only other mineral of significance is cassiterite (tin ore) in alluvial deposits that are being worked in Rysons Creek. Current production is low, but continued small-scale operations are likely given improved market price for metals.

Ruby, sapphire, and topaz occur in the William Wallace Creek area east of Gembrook.

(7) Water

Public land lies south of the Great Dividing Range and is drained by the Bunyip-Tarago catchments and headwaters of the Latrobe River. Average annual runoff increases from about 125 mm in the south to more than 750 mm in the high-elevation areas around Mount Toorongo.

Average annual discharges of the Latrobe River (107,000 Ml) and of the Toorongo River (38,000 Ml) near Noojee are comparatively high for the size of catchment drained. Water from this source is used downstream in the Yallourn storage.

Water from headwaters of the Bunyip and Tarago Rivers supplies urban needs on the Mornington Peninsula and in western Gippsland. Major works include the Tarago Reservoir (capacity 37,000 Ml) and diversion weirs on the Bunyip River.

The Bunyip-Latrobe catchment forms part of a wider area under investigation by the Parliamentary Public Works Committee of Inquiry into alternative water resources to meet urban and industrial water needs on the Mornington Peninsula and in the Latrobe Valley.

In evidence to this inquiry, it was stated that augmentation to the Tarago supply will be needed by 1977, given the present rate of growth in water needs. Proposals involving different combinations of water from the upper Latrobe, from the lower Bunyip, and from the Thomson River via Cardinia are being studied and will be resolved in the near future.

Groundwater is drawn from older volcanics on private land in the Drouin-Warragul area. Public land further north acts as an aquifer recharge zone contributing to groundwater reserves in the Kooweerup district.

(8) Utilities

An existing 146-m easement carrying two single-circuit 500-kV transmission lines traverses the southern part of public land. Further north, a 128-m easement associated with future load centre development is being investigated and this would pass through public land also. Public land in the upper Latrobe region

is being investigated as a possible site for a power station using pumped storage. It would require 37-m or 55-m easements to connect it with the transmission grid and with a possible power station in the Cascade region.

D. Hazards and Conflicts

Wildfire is a constant threat in forest areas from late spring to autumn. Erosion hazard is moderate on the steeper slopes. Plagues of the stick insect *Didymuria violescens* have seriously damaged mountain ash stands in this block periodically since 1961. Blackberry is a problem along many of the streams in the area.

There are potential conflicts between hardwood timber production and some aspects of nature conservation, between catchment values and the use of the land for both timber production and recreation, and between gravel extraction and nature conservation.

E. Significance

Public land in this block supplies water to the Mornington Peninsula and a number of towns in western Gippsland. Much of the land has a high capability for hardwood timber production. The southern half of the block has a very high volume for nature conservation and, because of its location, for recreation. The block contains large reserves of sand and gravel along the southern edge of public land, and possible sites for a pumped-storage power station in the upper Latrobe region.

21. SHADY CREEK

A. General

(1) Location and present tenure

Public land covers 16,730 ha (or 24% of the total area). It occurs in one large parcel physically separated from surrounding areas, except for a narrow link in the north-east. There are also several small fragmented parcels in the south-west.

Tenure is divided between reserved forest in the western half and unreserved Crown land in the east.

County of Buln Buln: Parishes of Darnum, Drouin East, Fumina, Neerim, Neerim East, Tanjil, and Yarragon

(2) General description

Strongly dissected hill country predominates. One large parcel of public land remains, supporting vegetation ranging from very tall open forest in the sheltered gullies to small areas of heathy woodlands on some infertile soils. Much of the land on better soils or more moderate terrain in the west and south has heen cleared or partly cleared for agriculture.

(3) Present use

Production of hardwood for both sawlogs and pulpwood is the major use of public land in this block. A softwood plantation being established in the vicinity of Neerim East now covers 40 ha.

The few recreation attractions in the area attracts a relatively small number of visits.

B. Nature of the Land

(1) Climate

Average annual rainfall over most of this block varies from about 1,200 to 1,000 mm. Low temperatures from about May to September are likely to restrict

growth, and there may be a short period of summer drought during February.

(2) Physiography and geology

Dissected hilly terrain developed on lower Devonian sediments predominates. In the west, the block contains extensive areas of undulating terrain on flows of older basalt, while in the east similar terrain occurs on basalt residuals capping the Tanjil-Latrobe divide. The many broad flat ridges on both these rock types reflect the now dissected Nillumbik Surface, which slopes from about 500 m in the north to about 250 m in the south.

Moderate dissection of Tertiary gravels and sands in the Latrobe Valley in the south of the block has produced an undulating terrain, which merges into the flat alluvial deposits of the Moe swamp at an elevation of about 60 m.

(3) Soil

Yellowish gradational soils with shallow stony soils on steep slopes predominate on public land. Friable reddish gradational soils developed on basalt have largely been cleared for agriculture. Grey clays occur on the low-lying areas around Trafalgar.

(4) Vegetation

Open forest III predominates in this block. The main vegetation types are messmate stringybark in various mixtures with narrow-leaf peppermint and mountain grey gum, and silvertop in various mixtures with messmate stringybark, brown stringybark, and yertchuk. The latter type grades into open forest II or even open forest I on the drier ridges. The dense low understorey includes narrow-leaf wattle, hop goodenia, handsome flat-pea, wedge-leaf everlasting, prickly bush-pea, prickly tea-tree, common cassinia, tree everlasting, prickly moses, cherry ballart, sweet bursaria, wiry bauera, austral bracken, and forest wire-grass.

The gullies and sheltered aspects carry open forest IV, with mountain grey gum as the chief eucalypt although there are some areas of mountain ash. The luxuriant undergrowth includes blackwood, silver wattle, Christmas bush, blanket-leaf, hazel pomaderris, elderberry panax, austral mulberry, and numerous ferns.

Heathy woodlands occur on a number of ridges in the centre of the block. They have developed on yellowish gradational soils, which are thought to be very old and now-infertile remnants of an old erosion surface. Stunted broad-leaf peppermint is the dominant eucalypt. The heath includes thatch saw-sedge, heath tea-tree, silver and hairpin banksia, common heath, furze hakea, heath wattle, and spike wattle. Swampy valley flats support dense thickets of scented paperbark, red-fruit saw-sedge,

swamp selaginella, and pouched coral-fern.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including large areas of wet open forest with smaller areas of dry open forest and heathy woodland) and wetlands (including the Latrobe River).

There have been no detailed surveys of animals in this block. The species commonly seen in the habitats represented are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The main parcel of public land has a moderate capability for nature conservation. It includes examples of a limited range of wet forest habitats and small areas of dry forest and heathy woodlands habitats that have developed on sedimentary parent materials. The area has not been intensively studied.

The heathy woodland areas are not as rich botanically as those in the adjoining blocks to the east and west, but do yield some unusual species, such as the rough comb-fern. The wedge-leaf everlasting is widespread in open forest areas at the western limit of its range. The Latrobe River in the south-eastern sector of the block is the type locality in part for four species of vascular plants. *Microtis holmesii* has only been recorded from the railway reserve west of Moe.

The tree goanna occurs in the drier forest areas.

Some small parcels of public land and road reserves in the south of the block support remnants of vegetation types that formerly covered the area.

A school camp controlled by the Education Department at Neerim South caters for about 1,400 children each year.

Heathy woodlands add diversity to the habitats in this block

Latrobe River below Hawthorn Creek - a popular area for fishermen and canoeists

(2) Recreation

Public land in this block has a moderate capability for recreation. It has no outstanding natural features, but offers a limited range of open forest environments. Internal access is poor. Present recreational activities are limited to canoeing and fishing along the Latrobe River and to several picnic sites.

The area is close to expanding population centres in the Latrobe Valley.

(3) Hardwood timber

Open forest III areas, which predominate in this block, have a moderate capability. Capability is high in the small areas of open forest IV, but low or very low in open forest I and II areas and heathy woodlands. Present stands are in poor condition as a result of past utilization and wildfires.

The block is within the A.P.M. forest and mill areas. Main commercial species are messmate stringybark and silvertop.

(4) Softwood timber

Capability is very high in open forest IV areas and open forest III areas of messmate stringybark, high in most other open forest III areas, but only moderate to low in silvertop and open forest II. Open forest I and heathy woodland areas are not suitable for radiata pine.

The block is within the Latrobe Valley zone defined by the Forests Commission for planning purposes. Plantations commenced at Neerim East in 1972 now cover 40 ha. The current planting programme is 160 ha annually.

(5) Agriculture

Capability for agriculture is generally low except in pockets adjacent to exist-

ing clearing. Much of the land is steeper than desirable for agriculture, and the growing season is not only limited in the winter months, but also could be affected by a short summer drought.

There is some evidence of pressure for 'farmlet' subdivision in areas peripheral to public land.

Beekeepers have made little use of this area, mainly because of the limited access, difficulty of finding suitable sites with water, and the lack of well-known pollen- and nectar-producing species. Parts of the block probably have a moderate capability, with messmate stringybark, white stringybark, and yertchuk being regarded as useful species.

(6) Minerals

The northern part of this block is within the upper Latrobe tinfield, in which stream deposits and deep leads have been worked in a small way since the 1870s. Gold has also been obtained from the Shady Creek and Willow Grove areas. The block still has some prospects for both these minerals in deep leads. It also has potential for sand and road-construction material.

There may be deposits of clays formed on the weathered lower Devonian, or in the south from outcropping clays of the Latrobe Valley coal measures.

(7) Water

Public land lies south of the Great Dividing Range and is drained by tributaries of the upper Latrobe. Average annual surface run-off increases from about 250 mm near Warragul to more than 500 mm in the north.

Average annual discharge of the Latrobe at Willow Grove gauging station is 244,000 Ml. The upstream catchment (580 km^2) is mostly public land. Salinity records are not available, but water quality is generally good.

At present this section of the Latrobe River contains no major storages, although there is some diversion for local irrigation uses. The Yallourn storage is downstream in the adjoining block. A proposal to construct a large storage on the river above Willow Grove is under investigation. It would be used to augment industrial water requirements associated with expanding SEC generating capacity at Yallourn and Hazelwood.

The entire water resources of the Latrobe are currently the subject of a detailed inquiry by the Parliamentary Public Works Committee.

Public land acts as an intake for artesian water in Tertiary sands and gravels, and these sources are currently being tapped, within the township itself, to augment Trafalgar's domestic water supply. The water is of very good

quality and flows at 1.3-1.9 l per second.

Exploration to find reserves suitable for augmenting Moe's town supply are in progress.

(8) Utilities

The route of a proposed electricity transmission easement 128 m wide carrying 3 single-circuit 500-kV lines traverses the main parcel of public land. It is under investigation in association with future load centre development at Melbourne.

D. Hazards and Conflicts

Wildfire is a constant threat in forest areas from late spring to autumn. Blackberry is a problem along many of the streams in the area. A moderate erosion hazard exists, particularly on the dissected slopes.

There are potential conflicts between hardwood and softwood timber production, and between timber production and some aspects of nature conservation.

E. Significance

Public land in this block has value for hardwood and softwood timber production. It also has value for recreation because of its location close to the Latrobe Valley, but has fewer natural attractions than adjoining blocks.

Remnants of natural vegetation along roads and on small parcels of public land in the south of the block have a high value for nature conservation and for maintaining diversity in the landscape.

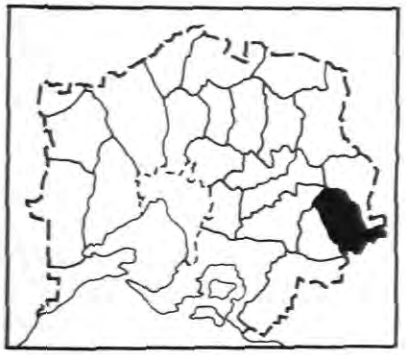
22. TYERS

A. General

(1) Location and present tenure

Public land covers 75,910 ha (or 79% of the total block). It occurs in one large parcel contiguous with public land in adjacent blocks to the north. Alienated land is confined to a strip along the western and southern edges, and a fragmented area around Erica and Moondarra.

Tenure is predominantly reserved forest, but with large areas of unreserved Crown land, several small special purpose reserves, and an area around Moondarra Reservoir vested in the Latrobe Valley Water and Sewerage Board.



County of Buln Buln: Parishes of Bullung, Fumina, Fumina North, Narracan, Neerim East, Tanjil, Toorongo, and Yarragon

County of Tanjil: Parishes of Boola Boola, Bundowra, Fumina North, Moondarra, Numbruk, Tanjil, Tanjil East, and Telbit

(2) General description

Mountainous terrain descends from the Baw Baw plateau in the north to the Latrobe Valley in the south. Most of the block remains public land and supports extensive stands of tall open forest, with sub-alpine vegetation at higher elevations. Low open forest and heathy woodland occur at lower elevations.

(3) Present use

Public land in the Tyers catchment supplies water for urban and industrial uses in the Latrobe Valley. Water rerequirements for the Yallourn thermal power stations are augmented by the Yallourn storage, which is also used extensively for water-based recreation. Much of the water stored here comes from

catchments in the Shady Creek and Bunyip-Latrobe blocks.

Timber harvesting has been a prominent activity in this block over the past 40 years.

Softwood plantations in the vicinity of Moondarra cover a total of 900 ha.

One of the major recreation areas is the Baw Baw plateau, which is becoming

A young softwood plantation near Moondarra. Soil and nutrient conditions along lines of burnt debris favour early growth.

increasingly popular for snow sports, bush-walking, and nature study. The area above 1,220 m elevation is reserved under the *Forests Act* as an alpine reserve.

Mountain streams are used for canoeing and fishing.

There are only a few picnic sites, one of the most popular being at Moondarra Reservoir.

B. Nature of the Land

(1) Climate

Average annual rainfall exceeds 1,400 mm on the Baw Baw plateau, but decreases with elevation to about 1,000 mm in the Latrobe Valley. Regular snowfalls can be expected above 950 m elevation from June to October, and on the Baw Baw plateau persistent snow may lie for most of this time. The growing season is unlikely to be affected by summer drought, except at lower elevations during February. Low temperatures will restrict growth from June to August in the Latrobe Valley, but with increasing elevation the period will increase and on the Baw Baw plateau it may last from April to October, with no growth from May to September.

(2) Physiography and geology

The dominant feature of this block is the Baw Baw plateau. Its undulating

terrain varies in elevation from about 1,370 to 1,530 m. Joint planes in the upper Devonian granodiorite of the plateau have caused the pronounced rectangular pattern of shallow valleys.

The lower Devonian sediments to the south of the plateau have been strongly dissected to give steep mountainous terrain, which falls rapidly to a general level of about 500 m and then more gradually to about 300 m.

The many broad flat ridges at these elevations are remnants of the dissected Nillumbik Surface, which slopes down gradually to the south and west. In the Erica area, an undulating terrain has developed on a number of residuals of older basalt on this Surface.

Moderate dissection of extensive areas of Tertiary gravels and sands in the Latrobe Valley, in the south of the block, has produced an undulating terrain, which merges into the flat alluvial deposits of the Moe swamp at an elevation of about 60 m.

The main streams draining the block are the Tanjil and Tyers Rivers.

(3) Soils

Extensive areas of friable brownish gradational soils occur at higher elevations while peats and organic loams are found on the Baw Baw plateau. Elsewhere friable reddish and yellowish gradational soils are widespread, with shallow stony soils on the steep slopes. Acidic duplex soils occur on undulating ridge tops in the centre and south.

(4) Vegetation

Plateau areas above about 1,200 m support a sub-alpine complex of white sallee woodland or open forest I, heaths, herbfield, grassland, and sedgefield. Frequent shrubs (often forming dense thickets up to 1.5 m in height in the open forest, woodland, and drier heath communities) are alpine pepper, Muellers bush-pea, sub-alpine beardheath, Baw Baw berry, and dusty daisybush. Other common shrubs are alpine mint-bush, shining coprosma, lilacberry, alpine oxylobium, alpine grevillea, and leafy bossiaea. A ground cover of Tasman flax-lily, scaly everlasting, grass trigger-plant, creeping cudweed, mountain woodruff, and tussock grass covers the more open areas.

On the wet heath, alpine baeckea, mountain baeckea, candle heath, snow heath, alpine heath, and alpine bottlebrush form dense low shrubberies. In the sedgefields and bogs, sphagnum moss, various sedges, tuft-rushes, spreading rope-rush, silver astelia, and matted nertera form tangled cushions. Tussock grass, alpine wallaby-grass, snow daisy, grass trigger-plant, glacial eye-bright, mountain gentian, and creeping cudweed are the common species found in grassland and herbfield.

The plateau also carries patches of low closed forest dominated by mountain tea-tree and stunted myrtle beech. At its lowest elevations, the white sallee open forest is mixed with tingaringy gum.

Open forest IV predominates between about 1,200 and 370 m elevation. Above 950 m the forests are dominated by alpine ash. The understorey includes elderberry panax, silver wattle, snowy daisy-bush, rough coprosma, Tasman flax-lily, mother shield-fern, and hard water-fern. Below 950 m mountain ash predominates, with a dense understorey commonly including mountain hickory wattle, silver wattle, blackwood, hazel pomaderris, mountain correa, austral mulberry, musk daisy-bush, blanket-leaf, tree everlasting, notched phebalium, forest ziera, handsome flat-pea, and forest wire-grass. Shining gum occurs in the junction zone between the two ash species.

The more sheltered gullies contain closed forest of myrtle beech with some blackwood and sassafras.

Open forest IV of messmate stringybark and mountain grey gum becomes increasingly common at the lower elevations, and may also be encountered on northern and western aspects at elevations up to about 820 m. Closed forests of silver wattle, *Acacia frigescens*, and mountain hickory wattle have developed over large areas around Tanjil Bren following repeated wildfires.

Open forest III predominates below about 320 m, although in gullies and on sheltered aspects an open forest IV (often of mountain grey gum with an understorey of blanket-leaf, musk daisy-bush, and ferns) persists down to about 240 m.

On the more favourable sites, the chief eucalypts are mountain grey gum, messmate stringybark, and narrow-leaf peppermint. The understorey includes mountain hickory wattle, silver wattle, cherry ballart, Christmas bush, elderberry panax, prickly bush-pea, prickly moses, hop goodenia, narrow-leaf wattle, common cassinia, tree everlasting, red-fruit saw-sedge, and forest wire-grass.

Various mixtures of silvertop, brown stringybark, messmate stringybark, yertchuk, and white stringybark are found on the less favourable sites. In these areas the dense low understorey often includes varnish wattle, narrow-leaf wattle, large-leaf bush-pea, wedge-leaf everlasting, prickly tea-tree, prickly bush-pea, rough bush-pea, common cassinia, hop goodenia, common heath, handsome flat-pea, broom spurge, forest wire-grass, and thatch saw-sedge.

This vegetation type merges into open forest II on ridge tops and dry aspects, especially at lower elevations, and in such areas the understorey contains a number of species typical of dry forests, such as common correa, myrtle wattle, burgan, and small grass-tree.

At lower elevations the main valleys support open forest III of narrow-leaf peppermint with some manna gum, while the stream-side vegetation includes silver wattle, hazel pomaderris, mountain tea-tree, Christmas bush, dusty miller, tall sword-sedge, silky fan-fern, and fishbone water-fern.

Heathy woodland is found on infertile soils in the south of the block. Stunted broad-leaf peppermint and yertchuk are the chief eucalypts, while the dense heath includes heath and prickly tea-trees, silver and hairpin banksias, heath wattle, common heath, prickly broom-heath, small grass-tree, broom spurge, and tangled dodder-laurel.

Drainage lines support dense thickets of scented paperbark, pouched coral-fern, pink swamp-heath, woolly tea-tree, and red-fruit saw-sedge.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including sub-alpine complex, extensive areas of wet open forest, and smaller areas of dry open forest and heathy woodland at low elevations) and wetlands (including a number of permanent streams and the Yallourn and Moondarra Reservoirs).

The species commonly seen in these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

Public land in this block has a very high value for nature conservation. It includes examples of a wide range of sub-alpine, wet open forest, dry open forest, and heathy woodland habitats that have developed on the southern slopes of the Baw Baw massif. Elevation range is almost 1,500 m, and parent materials include granite, basalt, and both Palaeozoic and Tertiary sediments.

The sub-alpine complex has high botanical significance. Two Tasmanian species

The Mountain grasshopper - a colourful inhabitant of sub-alpine regions

- tiny flannel-flower and *Euphrasia gibbsiae* - have no other Victorian habitat. Turquoise coprosma is shared only by the Baw Baws and Lake Mountain in mainland Australia, creeping coprosma extending also to Mount Lovick and The Bluff. Baw Baw berry occurs only on the Baw Baw plateau, Mount Donna Buang, Lake Mountain, and near Mount Cobbler. A number of other alpine and sub-alpine species range no further west: snow wallaby-grass *Carex jackiana*, alpine ballart, alpine marsh-marigold, Gunns alpine buttercup, snowdrop wood-sorrel, spinning gum, tingaringy gum, mountain mitrewort, *Leucopogon gelidus*, alpine cotula, and alpine groundsel.

The Moe district contains remarkably disjunct occurrences of rush lily and globe-hood sun-orchid. *Microtis biloba* has only been recorded in Victoria from the Tyers River near Gould, where it is locally common on damp inundated flats.

Leadbeaters possum has been recorded at a number of locations in wet open forest, the most easterly being on the southern slopes of Mount Erica. The broad-tooth rat has been recorded in sub-alpine vegetation near Mount Baw Baw and in wet open forest on the Gregory plateau. Tiger cats have been recorded in the Willow Grove area. The frog *Philoria frosti* is only known from the Baw Baw plateau above 1,310 m elevation. The frog *Heleioporus australiacus* has been recorded in the Rintoul Creek area at the western limit of its range.

Litoria phyllochroa is found along rocky streams in the east of the block, at the south-western limit of its range, while *Pseudophryne dendyi*, also at the south-western limit of its range, has been recorded in the Mount Lookout area.

The snail *Victaphanta atramentaria*, endemic to this and adjoining blocks to the north and west, inhabits wet open forest.

Several rare insects have been recorded in the wet open forest and marginal dry open forests of this block. They include moths (particularly Hepialidae), the butterflies *Candalides goodingi* and *Hesperilla chaostola*, which are both mainly restricted to this area, and a genus of caddisflies, named *Tanjilana*, known only from near Tanjil Bren. The rare butterflies *Neolucia mathewi* and *N. hobartensis* are found on the Baw Baw plateau.

Rintouls Creek in the extreme east of the block is an important site for Mesozoic fossil plant remains.

A school camp controlled by the Education Department at Yallourn North caters for about 3,000 children each year. Other youth camps are at Moondarra and Tyers Junction.

(2) Recreation

The Baw Baw plateau, covering about 8,000 ha, is the closest reliable snow-

field to Melbourne and the Latrobe Valley. It is used for both downhill and cross-country skiing, but has best potential for the latter. Trails have been marked for cross-country skiing and these are also used for summer hiking. Several huts are located on these routes. Downhill ski runs, tows, and private lodges have been developed on the western edge of the plateau near Mount Baw Baw and are serviced by road access and a chairlift. No roads cross the plateau, but roads have been constructed on either side.

The number of summer visitors is also growing in connection with bush-walking, sight-seeing, and nature study. Capability of the plateau for additional recreation appears high, although there will be concomitant problems of waste disposal, deterioration of walking tracks, and disturbance to natural conditions without careful management.

Lower parts of the block offer rugged forested terrain, including fern gullies and mountain streams.

Canoeing, fishing, camping, and limited pleasure driving and picnicking occur in this area. Yallourn storage provides opportunities for water sports.

Although the southern part of this block does not contain any outstanding natural features, it will be subject to increasing recreation pressure as the population centres in the Latrobe Valley grow.

After repeated wildfires, dense stands of wattle now cover large areas that formerly carried mountain ash

(3) Hardwood

Open forest IV areas have a high to very high capability. Their value is enhanced by the extensive distribution of uniformly high quality stands in this and adjoining blocks. The present forest consists mainly of stands of regrowth resulting from the 1939 fires. Open forest III areas have a moderate capability, but stands are generally in a poor condition as a result of past utilization and wildfire.

At Boola Boola stands of open forest III and II, in a degraded condition as a result of previous utilization and wildfires, have been progressively clear-felled and regenerated. This operation, commenced in 1948, has been proceeding at the rate of about 400 ha per year and provides part of APM's pulpwood needs as well as some sawlogs.

Open forest I, sub-alpine, and heathy woodland areas have a very low capability.

Timber harvesting has been an important activity in this block since the 1930s and has included the salvage of ash stands killed in the 1926 and 1939 fires. The block is within the APM forest and mill areas. Main commercial species are mountain ash, alpine ash, messmate stringybark, and silvertop.

(4) Softwood

Capability is very high in open forest IV areas below 950 m and open forest III areas of messmate stringybark, high in most other open forest III areas, but only moderate to low in silvertop and open forest II areas. Open forest I, heathy woodland, and sub-alpine areas are not suitable for radiata pine.

The block is within the Latrobe Valley zone defined by the Forests Commission for planning purposes. A plantation commenced in 1969 at Moondarra now covers about 500 ha. Average site index is estimated to be about 21.5 m. The Latrobe Valley Water and Sewerage Board have established about 400 ha of pine since 1961 on acquired farmland within the Moondarra catchment. There are no planting schemes currently operating in this block.

(5) Agriculture

Capability for agriculture on public land is generally low except in pockets adjacent to existing clearing. A large area of land is topographically unsuitable for clearing. Growing season is normally free from summer drought, but the length of winter restriction in plant growth increases with elevation.

There is some evidence of pressure for "farmlet" subdivision in areas peripheral to public land.

Beekeepers have made little use of this area, mainly because of the limited access, difficulty of finding suitable sites with water, and the lack of well-known pollen- or nectar-producing species. Parts of the block probably have a moderate capability, as messmate stringybark, white stringybark, and yertchuk are useful species, and alpine ash and white sallee have been successfully worked at other localities.

(6) Minerals

This block includes Tanjil goldfield, which still has some potential for deep-

lead mining. It also has potential for reef mining of gold or copper. Good deposits of gravel, sand, and rock are suitable for road construction material.

Deposits of clay occur in the southern part of the public land, where the fine clays of the Latrobe Valley coal measures outcrop.

(7) Water

Public land in this block lies south of the Divide and is largely drained by headwaters of the East Tanjil, West Tanjil, and Tyers Rivers. The Baw Baw plateau is the dominant topographic feature influencing water resources in this block.

Average annual run-off increases from about 125 mm in the south to more than 850 mm on the plateau.

Average annual discharge records indicate that this area is relatively efficient in the production of surface water per unit area of catchment, with the bulk of catchments occurring on public land. Average annual discharge on the Tanjil River passing the gauging station at Tanjil South is 150,000 Ml. Discharge on the Tyers at Gould is 132,000 Ml. Although salinity recordings are not available, water quality upstream of Yallourn is good.

Moondarra Reservoir (37,000 Ml capacity) on the Tyers River serves urban and industrial requirements at Traralgon, Morwell, and Yallourn. Yallourn storage on the Latrobe River is used as cooling water for SEC power stations at Yallourn and for urban supplies after treatment. Minor diversions are made for local irrigation use.

Currently, the Parliamentary Public Works Committee is studying proposals to construct storages on the Tanjil River near Blue Rock and on the Tyers upstream from Moondarra. Both projects would be used to augment water supply for growing urban-industrial demands in the Latrobe Valley. They are being considered as part of the current inquiry into water resources of the Latrobe River, and alternative means of meeting water requirements of the Mornington Peninsula and the Latrobe Valley.

Geological conditions and rainfall create a moderate capability for groundwater on public land. This area is an intake zone for aquifers in the Latrobe Basin that are being used for industrial, stock, and possible future urban consumption.

(8) Utilities

Proposals for several easements traversing public land are being investigated. One, 128 m wide, linking terminal stations at Tyers and Donnybrook would be associated with future load centre development. One 37 m wide would link a possible power station site in the lower

Thomson region with the Tyers terminal, while two others 37 m wide would link a possible power station site in the Cascade region with the Tyers terminal and with a possible power station site in the upper Latrobe region.

D. Hazards and Conflicts

Wildfire is a constant threat in the forest areas over the summer period. A high erosion hazard threatens sub-alpine areas, where destruction of the vegetation can lead to severe wind and water erosion, and a moderate erosion hazard exists on steeper slopes. Blackberry is a problem along most streams throughout the area.

There are potential conflicts between catchment values and the use of land for hardwood timber production and recreation, between hardwood timber production and some aspects of nature conservation and recreation, between the stricter forms of nature conservation and recreation, and between different types of recreational activity.

E. Significance

Public land in this block is a major source of water for the Latrobe Valley. Much of it has a very high capability for hardwood timber production, and land in the south has a high capability for softwood timber production.

The block also has a very high value for nature conservation, especially the sub-alpine areas, and for many recreational pursuits including snow sports. The slopes of Mount Erica are an important landscape feature.

23. WESTERNPORT

A. General

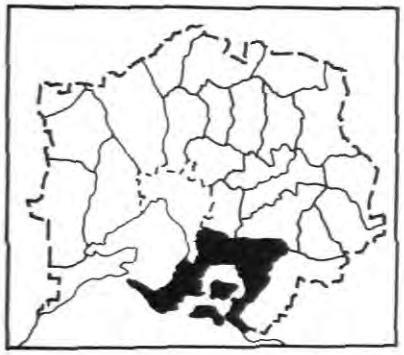
(1) Location and present tenure

Public land totals 14,830 ha (or less than 6% of the total area) and comprises one large parcel on French Island and numerous small dispersed parcels on the mainland and Phillip Island.

Tenure includes unreserved Crown land (around Westernport Bay and French Island) and numerous small special reserves under the *Lands Act*.

County of Buln Buln: Parishes of Drouin West, Longwarry, and Yannathan

County of Mornington: Parishes of Balnarring, Berwick, Bittern, Bunyip,



Corinella, Cranbourne, Eumemmerring, Fingal, Flinders, Frankston, French Island, Jeetho West, Jumbunna, Kangerong, Koo-wee-rup, Koo-wee-rup East, Lang Lang, Lang Lang East, Lang Warrin, Lyndhurst, Moorooduc, Nar-nar-goon, Nepean, Pakenham, Phillip Island, Sherwood, Tyabb, Wannaeue, Wonthaggi, Woolamai, Yallock, and Yannathan

(2) General description

Flat to undulating terrain encloses Westernport Bay and Mornington Peninsula and has been largely cleared for intensive agriculture and urban development. The long shore-line contains a range of beach, cliffed, and mangrove coastal environments. Heathy woodland and saltmarsh on public land cover large parts of French Island. Public land on the mainland is confined to a narrow coastal reserve and a few small isolated parcels supporting low open forest and woodland.

(3) Present use

Intensive recreation pressure is focused along the shore-line of Mornington Peninsula. Part of the large area of public land on French Island is used as

Arthurs Seat behind Dromana is a significant landscape feature on the Mornington Peninsula

a penal settlement, while the remainder is not actively used,although naturalists visit it infrequently.

The small remaining pockets of public land on Phillip Island are used for water-based recreation activities, the protection of wildlife, and wildlife displays.

Sand is extracted from several isolated parcels near Grantville, Lang Lang, and Cranbourne. Granite-quarrying occurs at Arthurs Seat. Altogether about 1,500 ha are held under various licences and leases. Grazing licences near Wonthaggi (560 ha) and Bass (370 ha) and extraction leases near Lang Lang (580 ha) cover the largest areas.

B. Nature of the Land

(1) Climate

Average annual rainfall varies from about 700 to 1,000 mm, with a slight winter maximum. The growing season at sheltered places along the coast typically lasts from March to January, with relatively little restriction of growth in winter. With increases in elevation, short periods of restricted growth could be expected in the coldest months. Around Warragul slightly higher summer rainfall gives rise to year-round moisture availability, but cold restricts growth from June to August.

(2) Physiography and geology

The Mornington Peninsula horst, bounded by Selwyns and Tyabb faults, forms the western part of this block. It is part of the Southern Uplands, and contains extensive areas of Tertiary sands, gravels, and basalts, with some outcrops of Ordovician and Silurian sandstones and shales. Terrain is generally undulating with elevations mainly between 150 and 180 m. Resistant Devonian granites form prominent high points at Mount Eliza, Mount Martha, and Arthurs Seat (which at 317 m is the highest point in the block).

Point Nepean is composed of calcareous dunes, which have a maximum elevation of about 50 m.

The Westernport sunklands, bounded by the Tyabb and Heath Hill faults, cover the remainder of the block. Very flat fluviatile and swamp deposits of Recent origin extend over much of the sunklands. Elevations are mostly less than 10 m. In the east, Tertiary sands and gravels cover slightly higher land (about 20 m elevation) near Lang Lang and on French Island. Gently dissected Tertiary basalts cover most of Phillip Island, where elevations are generally 45-60 m.

(3) Soils

On the Mornington Peninsula a wide variety of rocks gives rise to diverse soils including acidic duplex, yellowish gradational, and friable reddish gradational soils, with sodic duplex soils predominating in drier areas. Calcareous sands occur along the coast, while adjoining areas of leached sand extend inland in places for several miles and are commonly found on public land. Grey clays and black clays predominate in the area of the former Kooweerup swamp. Leached sands, sodic duplex, acidic duplex, and some yellowish gradational soils occur, particularly in the east and on French Island. Peat soils are often formed along drainage lines and in low-lying swampy areas. Dark saline soils occur extensively around the shores of Westernport. On Phillip Island, sodic duplex and friable reddish gradational soils predominate.

(4) Vegetation

This block originally supported a very varied vegetation. For example a recent survey of the Mornington Peninsula recognized 25 plant associations. Remnants of most types remain on the scattered areas of public land. This report describes only five broad structural types.

The foreshore reserves carry wet and dry coastal complexes. Coast tea-tree scrubs that contain wirilda, moonah, coast beard-heath, and small-leaf clematis are widespread, particularly on Commonwealth land at Point Nepean. Historical evidence indicates that these areas were formerly woodlands of moonah and drooping she-oak. Clearing of she-oak for fuel and other disturbances have apparently led to an invasion of coast tea-tree. Also unconsolidated dune areas support hairy spinifex and coast fescue, stable ones carry coast tea-tree, coast beard-heath, and coast banksia (particularly good examples of this occur on Commonwealth land at Stony Point), and cliff areas support coast tea-tree, coast beard-heath, sallow wattle, white correa, variable groundsel, and seaberry salt-bush.

Wet coastal vegetation is found along the northern and western shores of West-

ernport Bay and French Island. Species include white mangrove, shrubby glasswort, beaded glasswort, marsh saltbush, creeping brookweed, trailing hemichroa, austral sea-blite, salt couch, swamp paperbark, and prickly tea-tree.

Inland, sandy rises, for example on Quail Island and near Cranbourne, carry woodlands or open forest I of manna gum or narrow-leaf peppermint, with swamp gum in depressions and along drainage lines. The understorey is often dense and includes prickly tea-tree, heath tea-tree, burgan, silver banksia, wedding bush, common heath, prickly broom heath, and austral bracken. Dense shrubberies of swamp and scented paperbarks, prickly tea-tree, pink swamp heath, and several twig-rushes are typical of wet flats. Silver-leaf stringybark grows on some of the damp flats.

More fertile clayey soils carry an open forest I or II, containing messmate stringybark with some narrow-leaf peppermint. The understorey often includes black wattle, prickly moses, hop goodenia, narrow-leaf wattle, and tussock grass.

Heathy woodlands cover much of French Island. They are rich in species, common widespread ones being silver banksia, scrub she-oak, prickly tea-tree, swamp and scented paperbarks, small grass-tree, sweet wattle, common flat-pea, tufted blue-lily, slender yellow-eye, thatch saw-edge, stiff rapier-sedge, and slender bog-rush. Low-lying areas have a scattered overstorey of narrow-leaf peppermint with some manna and swamp gum, while swamp boronia, blunt-leaf heath, pink swamp-heath, swamp goodenia, bordered panic, spreading rope-rush, coarse twine-rush, and various twig-rushes become prominent in the understorey.

On more elevated areas, messmate stringybark and narrow-leaf peppermint form the overstorey and species such as common aotus, showy bossiaea, and broom spurge become more plentiful.

A number of swamps occur in the north of the Island and these have a characteristic vegetation that includes erect marsh-flower, water milfoil, common and tiny duckweed, glaucous goosefoot, and various rushes.

Small areas of open forest II also occur on the Island. Messmate stringybark is the dominant eucalypt and the understorey includes low shrubs such as bushy needlewood, silver banksia, large-leaf bush-pea, and pink beard-heath, while austral bracken and forest wire-grass form a ground cover.

(5) Fauna

The animal habitats that occur on public land in this block are the general forest habitat (including dry open forest in scattered areas and heathy woodland in scattered areas and more extensively

at Quail Island and French Island), dry coastal complex (at many points along the coast from Mount Eliza to Crib Point, from San Remo to Cape Patterson, and on Phillip Island), wetland areas (including swamps at Rhyll and on French Island), littoral areas (from Crib Point to San Remo but especially at Tooradin-Quail Island, on the northern shores of French Island, and at Rhyll), and adjoining open waters of ocean and bay.

Many of the small parcels of public land have become isolated and modified by Man and do not carry a full complement of species. This is especially so for mammals. Often the species are more typical of those inhabiting the surrounding agricultural and urban lands.

The common species of these habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

The many small and isolated areas of public land on the mainland part of this block must be regarded as having a high value for nature conservation, as they support remnants of the various dry open forest woodland, wetland, and coastal environments that once covered the area. Quail Island has colonies of several infrequent orchids, including *Microtis bipulvinaris* and *Caladenia congesta*.

The Penguin parade at Phillip Island attracts visitors from throughout the study area and beyond

Although small in area, this island affords an interesting gradation of habitats - from fringing mangrove through salt-marsh to manna gum woodland, tea-tree scrub, and heath, with occasional fresh-water ponds. Point Nepean carries dense shrubberies of coast tea-tree and moonah with subordinate shrubs of thyme rice-flower and turpentine bush. The only Victorian records of rare bitter-bush are at the Port Phillip Heads.

The higher parts of Arthurs Seat and steep ancillary gullies, mostly privately owned, have great scientific import-

ance. Rich floristically, this small highland region contains the only fern-gully association in the block, tree-ferns and king fern being significant.

Of special interest on public land are the occurrences of orange-tip caladenia (which reaches its western limit at Cranbourne) and of the banded greenhood and green leek-orchid at Arthurs Seat, and an isolated western occurrence of sweet pittosporum at Grantville.

At Tyabb on private property, one of the two known Victorian colonies of New Holland mouse survives, while the Boneo Swamp is one of seven known Victorian localities where the mourning skink has been found.

The frog *Crinia haswelli* has been recorded in the Tyabb area at the western limit of its distribution. The spiny-cheeked honeyeater reaches its eastern limit on the Peninsula, while the grey-crowned babbler, now rarely seen south of the Divide, is still recorded near Baxter.

The littoral zones around the northern end of Westernport Bay, French Island, and Phillip Island have a very high value for nature conservation.

The littoral zones in the northern part of the Bay are vital to the stability of the coastline in this area. They provide feeding grounds for a large number of species, including migratory waders.

The relative size of public land areas of French Island, combined with their relative isolation from human influence, gives them a particularly high value for conservation. They support examples of many of the heathy woodland and wet and dry coastal environments that formerly occurred on the mainland. Of special interest are the apparent absence of mammal species commonly recorded in similar habitats on the mainland, the presence of the potoroo (now locally extinct on the adjoining mainland), and records of breeding by the short-tailed shearwater, little pied cormorant, Australian pelican, caspian and fairy terns, white and straw-necked ibis, blue-billed duck, and swamp harrier.

Uncommon or rare bird species found on the island include white-breasted sea-eagle, spotless crake, king quail, tawny-crowned honeyeater, southern emu-wren, and Cape Barren goose. It is one of the few known winter refuges for the endangered orange-bellied parrot. The littoral zone and lagoons provide feeding grounds for many migratory waders, including a number of species not commonly recorded elsewhere in south-eastern Australia - mongolian dotterel, large sand dotterel, whimbrel , grey-tailed tattler, terek and pectoral sand-pipers, and lesser knot.

The northern shores of French Island support the best remaining occurrences in Victoira of white mangrove. Other plants of interest include: the

extremely localized bog clubmoss, needle bog-rush, and the sedge *Schoenus tesquorum;* isolated western records of bordered panic, green midge-orchid, and sweet pittosporum; hill xanthosia at the western limit of its range; banded greenhood, a species with a very disjunct distribution; and an isolated eastern record of blotched sun-orchid.

The small remaining areas of public land on Phillip Island have a very high value, as they support large breeding colonies of the koala, Australian fur seal, little penguin, and short-tailed shear-water. Rhyll swamp provides feeding grounds for many water-birds, including migratory water species, and supports breeding colonies of spoonbills, ibis, and cormorants. Cape Woolamai is noteworthy for the only occurrence in the study area of crimson-berry (a type of epacrid), and shore spleenwort. Moonah attains the eastern limit of its range in the scrub at Forest caves beach on Phillip Island.

One of the few Victorian records of the swamp antechinus is from coastal vegetation near the mouth of the Powlett River.

Of the 29 species of vascular plants that have their type localities in this block, 26 are attributable to Robert Brown, who collected on the Mornington Peninsula in 1802 and 1804.

Important fossil sites are Gunyoung Creek - Sunnyside Beach (Tertiary and lower Cretaceous), Fossil Beach (Tertiary), and near Flinders (Tertiary).

There are many youth camps on the Mornington Peninsula and on Phillip Island. At Somers, one camp alone, controlled by the Education Department, caters for more than 3,000 children each year.

(2) Recreation

Many of the small areas of public land on the Mornington Peninsula have a very high capability for recreation. They are readily accessible from the south-eastern suburbs, and adjoin popular holiday resorts such as Rosebud, Sorrento, and Somers. Main attractions are the variety of ocean and safe bay beaches, lookouts, and diverse landscapes. Most activities are water-based, including swimming, surfing, boating, skiing, and fishing, but bushland areas backing the coast enhance the beach environment and provide opportunities for camping and picnicking. Provided access is maintained, there are also opportunities for long and varied coastal walks. Inland areas offer opportunities for sight-seeing and picnicking as well as adding diversity to the landscape.

Other public lands fringing Westernport lack beaches and so have a low capability, although they are popular for fishing.

The lack of access combined with the relatively large size of public lands on

Old defence establishments on Commonwealth land at Point Nepean

French Island give them a high value for recreation activities requiring solitude.

Public land on Phillip Island has a high capability for recreation. Main attractions are ocean and bay beaches and fauna displays, including seals, koalas, penguins, and mutton-birds.

(3) Hardwood timber

Capability is low. Virtually no suitable public land remains.

(4) Softwood timber

Capability is low as the few sizeable parcels of public land remaining are on

leached sands. Isolated blocks on gradational soils have a moderate capability. Plantations established on French Island in the 1920s proved unsuccessful.

(5) Agriculture

Capability for agriculture production on the many small scattered pieces of public land that remain is low. Moderate capability appears to remain on parts of French Island, but access is difficult at present.

A low capability exists for apiculture, with local apiarists operating on small isolated parcels of public land.

(6) Minerals

This block is an important source of construction material for the south-eastern metropolitan and Westernport urban markets. The main products include granite, sands, and clays.

A significant amount of production takes place from public land at Lang Lang, Cranbourne, and Arthurs Seat. These areas also have reserves of the materials and thus have a high capability for mineral production. Conditions under which permits for quarrying are granted include stringent environmental controls and requirements for reclamation.

Public land on French Island is a particularly valuable potential source of sands and clays. At present it is uneconomic to transport these to the mainland, but their significance will undoubtedly increase if urban/industrial development occurs in Westernport.

Zircons, rubies, and sapphires are found near Merricks North and Point Leo, while agates occur along the south coast of Phillip Island. Deposits of metallic

Industrial development on the shore of Westernport near Hastings

minerals have been reported from Arthurs Seat (molybdenum), Langwarrin (limonite), and French Island (siderite).

(7) Water

Capability for surface water production from public land is negligible. Although rainfall is adequate, public lands are too small, fragmented, and generally low-lying to produce substantial run-off. Water to Devil Bend storage is piped from Tarago Reservoir in the Bunyip-Latrobe block.

Although groundwater resources are used intensively for agriculture and some urban supplies in this block, the small extent of most public land in this zone makes only a very local contribution to groundwater recharge. The larger area of public land on French Island is an exception, and serves as an intake for local supplies. These show marked variation in yield and quality over the island, depending on local geology.

(8) Utilities

Public land along the foreshores of Westernport Bay, French Island, and the south-east coast has high capability for possible future power station development. The availability of large quantities of cooling water in sites protected from harsher coastal conditions (wind, salt spray, etc) combines with the area's location adjacent to existing and potential load centres, and to supplies of natural gas and oil, to enhance this capability.

Several small parcels of public land lie in the path of transmission easements associated with both future load centre development and possible future power stations.

The effluent outfall from the south-eastern sewerage scheme is at Boags Rocks, west of Cape Schanck.

D. Hazards and Conflicts

The coastal dunes are very prone to wind erosion once their protective vegetation is removed. Heavy recreational use of beaches and dunes is causing serious erosion problems.

A high soil salting hazard exists in swales on sodic duplex soils, particularly on Phillip Island and parts of Mornington Peninsula. Boneseed is widespread on the Port Phillip Bay side of the Peninsula. Native vegetation near roads and buildings in some areas is being invaded by several aggressive weeds including the rampant climbers ivy groundsel and smilax asparagus.

Many uses of public land in this block conflict, due to the land's limited extent, its range of natural resources, the widely varying needs of the developing urban areas, and the large number of people seeking recreational opportunities in the area. Obvious conflicts occur

between quarrying and other uses, between nature conservation and some forms of recreation, and between various forms of recreation.

E. Significance

The most significant feature of the mainland part of this block is the lack of public land. Such public land as does exist is under considerable pressure for recreation (especially along the coast) and for nature conservation. Certain parcels of land also have a high value for the production of sand and clay.

Salt-marsh and mangrove areas, apart from their significance for nature conservation, are important in maintaining the stability of the coast.

French Island, because of its relatively undisturbed state, has a high value for reference and nature conservation purposes. It also has a high potential for the production of sand and clay.

Phillip Island has a high capability for recreation and for nature conservation, areas of particular importance being animal breeding colonies at Rhyll Swamp and along the southern coast.

The few pockets of private property and areas of Commonwealth land that have remained in a relatively undisturbed condition also have a high value for nature conservation.

24. STRZELECKI

A. General

(1) Location and present tenure

Public land totals 2,020 ha (or less than 2% of the total area) and is confined to several small parcels.

Tenure includes reserved forest and special reserves under the *Lands Act*.

County of Buln Buln: Parishes of Allambee, Allambee East, Darnam, Drouin East, Drouin West, Kirrak, Koorooman, Korumburra, Leongatha, Longwarry, Moe, Narracan, Narracan South, Poowong, Poowong East, Warragul, and Yannathan

County of Mornington: Parishes of Corinella, Jeetho, Jeetho West, Jumbunna, Jumbunna East, Kangwak, Kirrak, Korumburra, Lang Lang East, Longwarry, Poowong, Poowong East, Wonthaggi, Wonthaggi North, Woolamai, and Yannathan

(2) General description

Steep hill country of the Southern Uplands covers most of the block and has been cleared for grazing. Remnants of tall open forest with ferns are found in some of the steeper gullies.

(3) Present use

The bulk of public land is occupied by softwood plantations and an agricultural research station at Ellinbank.

Recreation is restricted to pleasure driving, picnicking, and walking.

B. Nature of the Land

(1) Climate

Average annual rainfall varies with elevation, from 900 mm near the coast to 1,100 mm on the uplands. The growing season can be expected to last from

March to January, with restricted growth from May to September.

(2) Physiography and geology

The strongly dissected mountainous terrain of the Strzelecki Range dominates this block. It comprises uplifted Cretaceous sandstone, shale, and coal, bounded by the Heath Hill and Yarragon faults in the north and Kongwak fault in the south, and forms part of the Southern Uplands. It rises to about 490 m elevation along its northern edge, from a southern edge at 180-240 m.

Gently undulating terrain is found on the extensive areas of Tertiary basalt that cover land at Warragul and south of Moe, where uplift was not so great. Tertiary and Quaternary sands, clays, and gravels cover the flat coastal plain in the south of the block.

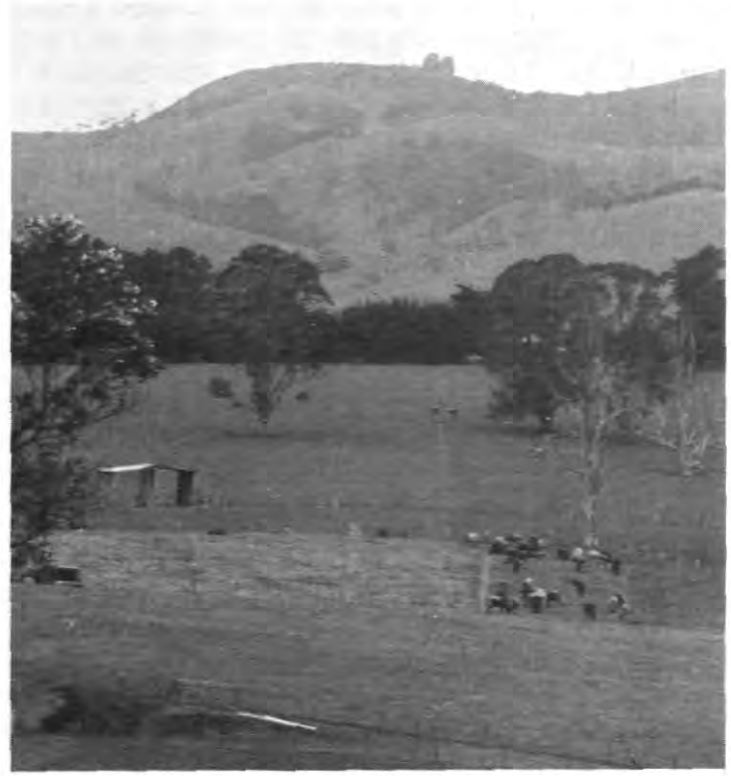
The Bass, Lang Lang, Moe, Tarwin, and Powlett Rivers and the Narracan Creek drain the block.

(3) Soils

Sodic duplex soils predominate at lower elevations, with a succession of yellowish gradational soils and friable brown gradational soils at higher elevations. Grey clays are found on low-lying areas, while friable reddish gradational soils have developed on the areas of basalt, notably in the Warragul and Thorpdale districts.

(4) Vegetation

Only remnants of mountain ash open forest IV and of open forest III (either of messmate and mountain grey gum or of manna gum) remain. Commonly associated trees are blackwood and silver wattle accompanied by a dense, often closed shrubbery of tree everlasting and common cassinia. Tree-ferns and smaller ferns are present in quantity along the deeper



The cleared slopes of the Yarragon fault scarp rise abruptly beyond the Ellinbank research farm

sheltered gullies, underlying such small trees as blanket-leaf, musk daisy-bush, hazel pomaderris, southern sassafras, and Christmas-bush. Australian clematis is a frequent vine - more conspicuous on partially cleared land or former farms now reverting to forest.

(5) Fauna

The animal habitats that occur on public land in this block are agricultural land at the Ellinbank research farm, small areas of wetlands, including permanent streams and dams, and only small remnants of the general forest habitat, including wet open forest near Mount Worth. The wet open forest remnants do not support a full complement of species. Those known to occur include superb lyrebird, pilot bird, king parrot, pink robin, rose robin, eastern whipbird, Australian ground-thrush, crescent honeyeater, and pied currawong.

The common species of the other habitats are discussed in chapter 10 and are listed in Appendix 3.

C. Capabilities

(1) Nature conservation

Although very small, the public lands in this block must be regarded as having a high value for nature conservation as they support remnants of the wet open forest vegetation types that once covered the Strzelecki Ranges.

Of special interest are an isolated western occurrence of red passion-flower at Mount Worth, the only known Victorian occurrences of the extremely rare filmy maidenhair at Mount Worth and near Korumburra, and an isolated occurrence of bog gum near Outtrim. There are records, probably on private property, of the uncommon lizard orchid from Drouin and Athlone, and the type specimen and only collection of *Thelymitra murdochae* between Wonthaggi and Inverloch.

The giant Gippsland earthworm *Megascolides australis* is unique to an area of about 25 km near Loch. The frog *Litoria maculata* is found along rocky streams in the head of Foster Creek near Korumburra at the south-western limit of its distribution. The broad-toothed rat has been recorded just outside the study area near Leongatha in a remnant of messmate stringybark wet open forest.

Fossil remains of fish and bird feathers have been found in a road cutting through Cretaceous sediments near Coonwarre.

(2) Recreation

This block has a number of intrinsic features (such as rugged terrain, lookouts, waterfalls, and fern gullies) that give it, in a number of places, a high potential for recreation. It also adjoins the rapidly developing urban complex of the Latrobe Valley and backs onto the ocean beaches from San Remo to

Steep terrain cleared for agriculture - a typical Strzelecki landscape

Inverloch. However, with the exception of areas near Mount Worth, it contains virtually no public land.

(3) Hardwood timber

Capability at present is low, as there is virtually no public land. However, the area formerly supported open forest III and IV, principally of messmate stringybark and mountain ash, which have been almost entirely cleared and alienated. Small blocks purchased by the Crown have been reforested and have a high capability for producing sawlogs and pulpwood.

(4) Softwood timber

This block has a high capability for softwood production, but there is very little public land. The existing plantations at Allambee and Childers (established on former farmland) have an average site index of about 27.5 m.

(5) Agriculture

The few small areas of public land have a low capability for agriculture, except for Ellinbank Dairy Research Station south of Warragul. This station is of substantial benefit to the surrounding dairying industry on private land.

The block has a low capability for apiculture because of the small amounts of public land and their partial conversion to pine plantation.

(6) Minerals

The small pockets of public land in this block have a low capability for mineral production. Black coal has been mined in the area, but although reserves estimated at 6 million tonnes occur near Wonthaggi, further mining is unlikely. Small bauxite deposits are widespread near Mirboo North outside the study area. Low-grade deposits of limonite (hydrated iron oxides) have also been reported near Narracan and Mirboo North.

Rock deposits in the northern part of this block would be suitable for future

highway construction in the Latrobe Valley.

(7) Water

Public lands are too small and fragmented for significant surface water production. Several catchments in this block serve urban populations on Phillip Island, Strzeleckis, and parts of the Latrobe Valley (Moe and Trafalgar), but these occur almost exclusively on private land.

The value of public land as a groundwater intake zone is minimal.

(8) Utilities

No public land lies in the path of the proposed additional easements between Hazelwood power station and Melbourne.

D. Hazards and Conflicts

Steeper slopes in agricultural country and along roads are susceptible to landslip.

There is a potential conflict between conserving remnants of the natural vegetation and timber production.

E. Significance

The most significant feature of this block is the almost complete absence of public land in an area that has a high potential for a number of uses including softwood and hardwood production, recreation, and nature conservation. Much of the potential associated with these last two uses could be realised if the area of public land in this block was expanded.

APPENDICES

Appendix 1

WATER QUALITY

A. CRITERIA AND OBJECTIVES FOR PUBLIC WATER SUPPLIES IN AUSTRALIA COMPARED WITH THE 1958 WORLD HEALTH ORGANIZATION STANDARDS FOR DRINKING WATER

Characteristic	W.H.O. standards 1958		Criteria for Australian public water supplies	
	Permissible	Excessive	Treated	Untreated
Physical and chemical				
Colour mg/l	5	50	5	50
Turbidity mg/l	5	25	5	25
Taste and odour	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
Total dissolved solids mg/l	500	1,500	500	1,500
Total iron mg/l	0.3	1.0	0.3	1.0
Zinc mg/l	5.0	15.0	5.0	5.0
Copper mg/l	1.0	1.5	0.3	1.0
A.B.S. mg/l			0.5	0.5
pH	7.0-8.5	6.5-9.2	7.0-8.5	6.5-9.2
Fluoride (F) mg/l	approx. 1.5		1.5	
Nitrate (NO_3) mg/l	approx. 45		45	

Toxic compounds	Maximum allowable concentrations	
Chromium (hexavalent) mg/l	0.01	0.05
Arsenic (As) mg/l	0.2	0.05
Lead (Pb) mg/l	0.1	0.05
Selenium (Se) mg/l	0.05	0.01
Barium (Ba) mg/l		1.00
Cadmium (Cd) mg/l		0.01
Cyanide (CN) mg/l	0.01	0.01
Silver (Ag) mg/l		0.05
Chloroform-soluble carbon-filter extract mg/l		0.20
Bacterial count *Escherischia coli* per 100 ml	M.P.N.* of coliforms in 100-ml portions Chlorinated Untreated 90% 1 90% 10 100% 10 100% 20	As for W.H.O standards
Radiological requirements		
alpha emitters	30×10^{-6}, uc/ml	As for W.H.O. standards
beta emitters	30×10^{-6}, uc/ml	
Strontium 90		
Rhodium 226		

* M.P.N. - Most Probable Number, obtained by the multiple-tube method of testing.

Footnotes

(a) Problems associated with iron content are greatly affected by the physical state of the iron compounds present, consequently permissible levels may vary depending on the nature of the supply.

(b) Sampling and testing methods to be in general agreement with American Public Health Association (A.P.H.A.) methods.

B. INDUSTRIAL AND AGRICULTURAL STANDARDS

The following table provides a guide for groundwater users on the upper limits of salinity that are acceptable for various purposes.

Uses	Upper limits of salinity (mg/l)
Irrigation	
Citrus, legumes, garden plants	1,000
Vines, grass, cabbages	1,500
Cotton, lucerne	2,500
Livestock	
Poultry	3,500
Pigs	4,500
Horses	6,500
Milking cows and ewes	7,000
Beef cattle	11,000
Dry sheep	15,000
Secondary industry	
Rayon	100
Paper	150
Petroleum	350
Carbonated beverages	850

Source: Groundwater Investigation Programme Report, Victorian Mines Department, 1971.

Appendix 2

NATIVE VEGETATION

A. MOSS FLORA

SPECIES NAMES, THE TYPES OF WHICH CAME WHOLLY OR PARTLY (p.p.) FROM THE MELBOURNE STUDY AREA
Prepared by J.H. Willis

Genera and species are arranged alphabetically. Block localities of type material are given wherever known. Types of names now relegated to synonymy are included, and the accepted name is indicated in parenthesis. A type from within the Melbourne suburban region, which is excluded from the study area, is marked by #. Collections labelled "Australia Felix", "Victoria", and "Gippsland" are included as being most probably from the Melbourne study area.

Acaulon integrifolium C. Muell. (Yarra River)
Anacalypta brachyodus Hampe (Westernport - Arthurs Seat, Yarra River) (= *Desmatodon convolutus*)
Atrichum ligulatum (Mitt.) Mitt. (Bunyip-Latrobe - Bunyip and Tarago Rivers)

Barbula
crispata Hampe (Romsey - Mt. Macedon) (= *Calyptopogon mnioides*)
glaucula Broth. p.p. (Heyington; also Nowra in N.S.W.) (? = *B. unguiculata*)
luehmannii Broth. (Torquay - Loutitt Bay)
melbourneana C. Muell. (Fitzroy near Melbourne) (= *Tortula muralis*)
pandurasfolia C. Muell. & Hampe ("Australia Felix") (= *Tortula princeps*)

Bryum
amblyacis C. Muell. p.p. (Thomson - Stringers Creek near Walhalla; also Genoa River)
cupulatum C. Muell. p.p. ("Victoria"; also St. Vincent Gulf in S.A.) (= *B. pachytheca*)
flavifolium C. Muell. (Tyers - near Moe River)
luehmannianum C. Muell. (Donna Buang - Fernshaw)
plebejum C. Muell. (Port Phillip)
robustum Hampe (Bunyip-Latrobe - *Tarago River)
subaenum C. Muell. ("Australia Felix") (= ? *B. pachytheca*)
subtomentosum C. Muell. and Hampe p.p. ("Near Melbourne"; also Richmond and Brisbane Rivers) (= ? *B. billardieri*)
wallaceanum C. Muell. p.p. (Wombat - Daylesford; also Omeo)

Camptochaeta ramulosa (Mitt.) Jaeg. p.p. (Bunyip - Latrobe - *Tarago River, also Steep Bank River, Brisbane River, etc.) (= *Pototrichum ramulosum* (Mitt.) Dus.)

Campylopus erythropoma Duby ("Victoria")

Catharinea muelleri C. Muell. and Hampe (Dandenongs - "Dandenong Range", Bunyip - Latrobe - Bunyip River) (= *Atrichum ligulatum*)

Cryphaea
crenulata Mitt. p.p. (Bunyip - Latrobe - *Tarago River; also Tas.) (= *Cyptodon ovalifolius*)
squarrulosa Hampe (Bunyip - Latrobe - *Tarago River) (= *Cyptodon ovalifolius*

Dawsonia
intermedia C. Muell. (Kinglake - Upper Yarra River)
victoriae C. Muell. ("Victoria") (= *D. longiseta*)

Desmatodon reflexidens (Hampe) Jaeg. (Yarra River)

Dicranum
nudum Hampe (Bunyip - Latrobe - *Tarago River)
polychaetum Hampe (Yarra River) (= *Dicranoloma dicarpum*)
polysetum Hampe p.p. (Yarra River; also Victoria Range) (= *Dicranoloma dicarpum*)
suberectum Hampe (Bunyip - Latrobe - *Tarago River) (= *Dicranoloma menziesii*)

Didymodon rubiginosus (C. Muell.) Broth. (Yarra River)

Ditrichum affine (C. Muell.) Hampe ("Victoria") (= *D. difficile*)

Ephenerum grosso-ciliatum C. Muell. ("Near Melbourne")

Fabronia tayloriana Hampe (Disappointment - Mount Disappointment)

Fissidens
elamellosus C. Muell. and Hampe (Yarra River) (= *F. taylori*)
macrodus Hampe (Yarra River)
semilimbatus C. Muell and Hampe (Yarra River) (= *F. taylori*)

Funaria
bullata Broth. (Heyington railway station)
perpusilla Broth. (Heyington railway station) (= *F. producta*)
varia (Mitt.) Broth. ("Victoria" - probably near Melbourne)

Glyphomitrium adamsonii Mitt. (Melbourne)

Glyphothecium muellerianum Hampe (Bunyip - Latrobe - Tarago River) (= *G. sciuroides*)

Grimmia
atricha C. Muell. (Melb) (= *G. readeri*)
callosa C. Muell. & Hampe p.p. ("Australia Felix"; also Barossa Range)
obtusata (C. Muell. & Hampe) Par.("Australia Felix")

Hypnodendron leiopyxis C. Muell. (Tyers - Moe River) (= *H. spininervium* subsp. *archeri*)

Hypnum
lamprostachys Hampe (Bunyip - Latrobe - *Tarago River) (= *Plagiothecium denticulatum*)

* = Tarwin River: F. Mueller

pseudomurale Hampe (Tyers - Moe Swamp) *(= Rhynchostegium* sp.)
suberectum Hampe (Bunyip - Latrobe - Tarago River) *(= Thuidium furfurosum* var. *sparsum)*
trachychaetum F. Muell. ("Australia Felix")*(= Rhynchostegiella muriculata)*
walterianum Hampe (Romsey - Mount Macedon) *(= H. cupressiforme filiforme)*

Isopterygium walterianum Hampe (Romsey - Mount Macedon) *(= Hypnum cupressiforme* var. *filiforme)*

Leptotrichum semilunare C. Muell. p.p. (Donna Buang - Fernshaw; Tyers - Tyers and Moe Rivers; also Hume River) *(? = Ditrichum difficile)*

Macromitrium eucalyptorum C. Muell. & Hampe (Bunyip - Latrobe - Bunyip River))*(= M. tenue)*

Macromitrium luehmannianum C. Muell. (Tyers - Moe River) *(= M. tenue)*

Mielichhoferia australis Hampe p.p. ("Gippsland"; also Grampians) *(= M. ecklonii)*

Neckera aurescens Hampe p.p. (Bunyip - Latrobe - Tarago River; also Brodribb River) *(? = N. pennata)*

Papillaria
flavo-limbata (C. Muell. & Hampe) Jaeg. ("Australia Felix")
fluva (Mitt.) Jaeg. (Bunyip - Latrobe - Tarago River)

Physcomitrium
firmum Mitt. (Upper Goulburn - Delatite) *(= P. integrifalium* seq.)
integrifolium C. Muell. & Hampe (Upper Goulburn - Delatite)

Pohlia clavaeformis (Hampe) Broth. (Disappointment - Mount Disappointment)

Polytrichadelphus arnoldii (Hampe) Jaeg. (Cerberean - Mount Arnold) *(= P. magellanicus)*

Polytrichum australasicum C. Muell. & Hampe ("Australia Felix") *(= Pogonatum subulatum)*

Pottia
\# *melbourniana* Dix. ex. Weymouth p.p. (Melbourne; also Glenorchy, Tas.) *(= P. truncata)*
\# *readeri* C. Muell. (Melbourne) *(= P. truncata)*
\# *subphyscomitrioides* Broth. p.p. (St. Kilda Road and Heyington in Melbourne; also Port Esperance, Tas.) *(= P. truncata)*

Pterygophyllum hepaticaefolium (C. Muell & Hampe) Jaeg. p.p. (Dandenongs - Dandenong Range; Bunyip - Latrobe - Bunyip River; also Steep Bank River) *(= P. dentatum)*
subrotundum (Hampe) Jaeg. (Disappointment - Mount Disappointment) *(? = P. dentatum)*

\# *Rhacopilum purpurascens* Hampe. p.p. ("near Melbourne"; also Mount Elephant) *(= R. tomentosum)*

Rhynchostegium
dentiferum (Hampe) Jaeg. ("Gippsland") *(= R. laxatum)*
laxatum (Mitt.) Par. ("Gippsland")
pseudomurale (Hampe) Jaeg. (Tyers - Moe Swamp)

Sauloma zetterstedtii (C. Muell.) Jaeg. ("Australia Felix") *(= ? S. tenella)*

Sphagnum
comosum C. Muell. p.p. (Dandenongs - Berwick; also Waterloo Marshes, N.S.W.) *(= S. subsecundum)*
laticoma C. Muell. ex Warnst. (Donna Buang - Blacks Spur) *(= S. subsecundum)*
whiteleggei C. Muell. p.p. (Bunyip - Latrobe - Bunyip River; also Blue Mountains and Braidwood district, N.S.W.) *(= S. cristatum)*

\# *Tortella dakinii* J. H. Willis (Warrandyte)

Tortula
adusta (Mitt.) Mitt. ("Gippsland")
flexo-marginata (C. Muell. & Hampe) Mitt. ("Australia Felix")
\# *luteola* Mitt. (Yarra River) *(= Barbula pseudopilifera)*
subspiralis (Hampe) Broth. ("Australia Felix")
redderi (C.Muell.) Broth. (Werribee - near Melton)

Trachyloma diversinerve Hampe (Yarra River) *(? = T. planifolium)*

Zygodon hymenodontiodes C. Muell. (Tyers - Moe River) *(= Z. intermedius)*

B. VASCULAR FLORA

SPECIES NAMES, THE TYPES OF WHICH CAME WHOLLY OR PARTLY (p.p.) FROM THE MELBOURNE STUDY AREA

Prepared by J. H. Willis

Species are arranged in accordance with the system of Engler and Prantl. Block localities of type material are given wherever known. Types of names now relegated to synonymy are included, and the accepted name is indicated in parenthesis. A type from within the Melbourne suburban region, which is excluded from the study area, is marked by #.

Monocotyledons

Triglochin minutissima p.p. (Port Phillip; also Murray River, S.A., and Stirling River, W.A.)

Tetrarrhena juncea (Westernport - Arthurs Seat)

Dryopoa dives (Bunyip-Latrobe - between the Bunyip and *Tarago Rivers)

Agrostis adamsonii (Melbourne)

Deyeuxia densa (Yarra River; also Moroka Valley, Wilsons Promontory; S.A.)

Amphibromus gracilis (Yarra River flats between East Kew and North Balwyn)

Danthonia duttoniana (Werribee-Werribee, as seed cultivated at Waite)

Baumea juncea p.p. (Westernport - Nepean Peninsula)
Lepidosperma congestum p.p. (Westernport - Nepean Pen.)
Carex
- *tereticaulis* p.p. (Disappointment - Mount Disappointment; also Hopkins River, Ararat, Mount William, Portland; and S.A., Tas., and N.S.W.)
- *alsophila* (Donna Buang - Mount Juliet and Mount Arnott; Upper Yarra-sources of Yarra River; Bunyip - Latrobe - sources Tarago and Latrobe Rivers; Tyers - Baw Baws; Upper Goulburn - sources of Goulburn River)

Lepyrodia muelleri p.p. ("beyond Prahran"; also lower Latrobe River, Mount Gambier, etc.)

Xyris gracilis p.p. (Westernport - Nepean Peninsula)

Juncus homalocaulis p.p. (Wombat - Black Forest; also Wimmera, Port Jackson, New England)

Astelia australiana (Bunyip-Latrobe - Upper Bunyip River)

Hypoxis glabella (Westernport - near Arthurs Seat)

Thelymitra
- *macmillanii* (Westernport - "between Mount Eliza and Mount Martha")
- *murdochae* (Strzelecki - between Wonthaggi and Inverloch)

Diuris fastidiosa (Tottenham)

Microtis
- *biloba* (Tyers - Moe)
- *bipulvinaris* (Westernport - Quail Island)
- *holmesii* (Tyers - Moe)
- *oblonga* p.p. (Donna Buang - Healesville, Ringwood; also Grampians, etc.)

Prasophyllum
- # *dixonii* (South Oakleigh) *(= P. nigricans* forma)
- # *colemanae* (Bayswater
- # *brainei* (Ringwood)
- *pyriforme* (Kinglake - Wonga Park north of Croydon) *(? = P. gracile)*
- *frenchii* (Dandenongs - "between Yarra River and Dandenong Ranges")

Eriochilus autumnalis p.p. (Westernport - near Arthurs Seat) *(= E. cucullatus)*

Caladenia
- *cordiformis* p.p. (Dandenongs- Dandenong; Donna Buang-Healesville; Greensborough, Ringwood, Cheltenham, Geelong, Gisborne, Oakleigh, etc.) *(= C. clavigera)*
- *pumila* (Brisbane Ranges - Bannockburn)
- *praecox* (Kinglake - Diamond Creek; also Greensborough, Ringwood, Bayswater, and Croydon) *(= C. angustata)*

Pterostylis
- # *toveyana* (Mentone)
- *mackibbinii* p.p. (Westernport - Cardinia Creek, Brighton Bluff; also King Island, southern Tas., St. Vincent Gulf) *(= P. cucullata)*
- *gracilis* (Dandenongs - Ferntree Gully, Wandin; Donna Buang - Healesville; also Greensborough, Wilsons Promontory, Tas.) *(= P. foliata)*
- *alpina* (Dandenongs - Mount Dandenong; Donna Buang - Watts River)
- *decurva* (Dandenongs - Ferntree Gully, Belgrave; also Ringwood)

Dicotyledons

Australina muelleri (Upper Goulburn - Delatite River)

Persoonia arborea (Bunyip - Latrobe - upper reaches of *Tarago and Latrobe Rivers; Tyers - upper reaches of Tyers River, Tanjil River, Baw Baws)

* = "Tarwin River": F. Mueller

Isopogon ceratophyllus (Westernport - near Arthurs Seat)

Grevillea
barklyana (Bunyip - Latrobe - watershed between Bunyip and Tarago Rivers, vicinity of Ryson and Lawson Creeks)
repens (Donna Buang - Watts River; Wombat - Loddon River near Daylesford)
steiglitziana (Brisbane Ranges - near Steiglitz)
chrysophaea ("Australia Felix" - probably Brisbane Ranges)

Hakea nodosa (Westernport - near Arthurs Seat)

Lomatia ilicifolia (Westernport - near Arthurs Seat)

Thesium australe p.p. (Westernport - Nepean Peninsula)

Chenopodium pseudomicrophyllum p.p. (Werribee - Bacchus Marsh; also Barossa Ranges and Enfield, S.A.)

Kochia crassiloba p.p (Werribee - Bacchus Marsh; also Adelaide, S.A.)

Lampranthus tegens (mouth of Yarra River)

Cassytha pubescens p.p. (Westernport - Nepean Peninsula)

Cuphonotus antipodus p.p (Wombat - Black Forest; also Mount Alexander)

Cardamine laciniata p.p. (Yarra River, Darebin Creek, etc.)

Tetratheca stenocarpa (Upper Yarra - 2 km east of Gembrook)

Acacia
aculeatissima p.p. ("towards Goulburn and Broken River" also Ballarat)
frigescens p.p. (Donna Buang - Poley Range; also Result Creek near Bonang)
alpina p.p. (Thomson - Mount Useful; also Mount Wellington)
nano-dealbata (Donna Buang - Poley Range and Mount St. Leonard)

Oxylobium procumbens p.p. (Disappointment - Mount Disappointment; Upper Goulburn - Delatite; Wombat - Black Forest, etc.)

Pultenaea
muelleri (Bunyip - Latrobe - Bunyip River; Tyers - Baw Baws; Thomson - Mount Useful)
angustifolia p.p. (Romsey - Mount Macedon; Upper Yarra - Gembrook, etc.) *(= P. mollis)*
weindorferi (Dandenongs - Mount Evelyn)

Platylobium alternifolium p.p. (Disappointment - Mount Disappointment; also Mount Ben Nevis and Mount William)

Glycine latrobeana ("around Port Phillip")

Boronia muelleri (Bunyip - Latrobe - sources of Bunyip River, near Ryson Creek)

Asterolasia asteriscophora p.p. (Disappointment - Mount Disappointment; also Buffalo Creek)

Polygala veronicea p.p. (Eildon - "King River to Goulburn River") *(= P. japonica)*

Pomaderris
vacciniifolia (Donna Buang - Watts River)
elachophylla (Shady Creek - Latrobe River; Tyers - Tyers River)
subrepanda p.p. (Yarra River) *(= P. racemosa)*

Hibbertia
australis (Torquay - Marcus Hill near Point Lonsdale)
sericea (Westernport - near Arthurs Seat)

Pimelea
octophylla (Westernport - near Arthurs Seat)
glauca p.p. (Westernport - near Arthurs Seat)
phylicoides (Port Phillip)
axiflora ("Australia Felix")

Eucalyptus
macrorhyncha p.p. ("near Melbourne"; also between Goulburn and Ovens Rivers, Macalister River, Mount Ligar, Avon River)
regnans (Dandenongs - Sassafras Creek)
st-johnii (Werribee - Lerderderg River near Bacchus Marsh)
nitens p.p. (Tyers - Mount Mueller; also Delegate River and Nimmitabel, N.S.W.)
crenulata (Black Range - about 1.5 km south of Buxton, on Acheron Flats)
behriana (Werribee - near Bacchus Marsh)

Callistemon paludosus p.p.

Kunzea peduncularis p.p. (Yarra River, Brighton, etc.) *(= Leptospermum phylicoides)*

Callitriche
muelleri (Shady Creek - Latrobe River)
sonderi (Werribee - "Swamps near Station Peak")
brachycarpa p.p. (Disappointment - Mount Disappointment; also Apollo Bay)
umbonata p.p. ("plains near Melbourne"; Darebin Creek; also Tas.)
cyclocarpa ("Yarra Yarra")

Astrotricha asperifolia p.p. (Shady Creek - Latrobe River; also Grampians)

Panax angustifolius p.p. (Dandenongs - Dandenong Ranges; Romsey - Mount Macedon; also Mount Buffalo) *(= Tieghemopanax sambucifolius)*

Hydrocotyle
geraniifolia (Disappointment - Mount Disappointment; Dandenongs - "Dandenong Rangs to west Gippsland")
pterocarpa p.p. (Disappointment etc. - Mount Disappointment to Ovens River)
capillaris p.p. (Port Phillip, etc.; also Hopkins River, S.A.)

Platysace heterophylla p.p. ("across Prahran", also Gippsland, Glenelg River, etc.)

Gaultheria appressa p.p. (Donna Buang - Mount Donna Buang; Tyers - Mount Mueller; also Bogongs and Cobboras)

Wittsteinia vacciniacea (Tyers - Baw Baws)

Choristemon humilis (Brisbane Ranges - near Balliang)

Leucopogon gelidus p.p. (Upper Yarra - sources of Yarra River; Tyers - Mount Baw Baw; also Barkly Range and Cobberas)

Acrotriche prostrata (Dandenongs etc. - "Dandenong Ranges to Delatite River")

Limonium australe p.p. (Westernport - Nepean Peninsula)

Sebaea albidiflora p.p. (Brighton, near mouth of Yarra River; also Port Fairy; Georgetown, Tas. etc.)

Cynoglossum suaveolens p.p. (Westernport - Nepean Peninsula)

Wilsonia humilis p.p. (Westernport - Nepean Peninsula)

Veronica
notabilis p.p. (Dandenongs - Dandenong Ranges; also Sealers Cove, Tas., N.S.W.)
calycina p.p. (Westernport - near Arthurs Seat)

Prostanthera
melissifolia p.p. (Torquay - near Loutitt Bay; also sources of Barwon River to Cape Otway)
hirtula p.p. (Disappointment - Mount Disappointment; also Mount Buffalo and Grampians)

Lycopus australis p.p. Westernport - near Arthurs Seat)

Mentha laxiflora (Port Phillip - collected by R. C. Gunn)

Plantago varia p.p. (Westernport - near Arthurs Seat)

Asperula euryphylla (Dandenongs - Dandenong Ranges)

Wahlenbergia
stricta p.p. (Westernport - near Arthurs Seat)
tadgellii (Torquay - Torquay)

Pratia platycalyx p.p. (St. Kilda, Brighton, etc.)

Lobelia pratioides p.p. (Werribee - Station Peak, Yarra River; also Castlemaine, Pyrenees, Wando Vale, Tas.)

Hypsela tridens (Eildon - Goulburn River)

Velleia paradoxa p.p. (Westernport - near Arthurs Seat)

Goodenia
humilis (Westernport - near Arthurs Seat)
geniculata p.p. (Westernport - near Arthurs Seat)

Scaevola
suaveolens p.p. (Westernport - Nepean Peninsula)
pallida (Westernport - Nepean Peninsula)

Calotis anthemoides (Werribee - "muddy localities in neighborhood of Station Peak")

Olearia asterotricha p.p. (Dandenongs - Dandenong Ranges; Disappointment - Mount Disappointment; also Grampians)

Helichrysum
pseudoferrugineum (Donna Buang - Blacks Spur) *(= H. dendroideum)*
cuneifolium p.p. (Shady Creek - Latrobe River; also Snowy and Genoa Rivers)

Leptorhynchos tenuifolius p.p. ("open forests of Australia Felix")

Rutidosis leptorrhychoides (Werribee - Little River near Station Peak)

Senecio vagus (Dandenongs - Dandenong Ranges; Disappointment - Mount Disappointment; Upper Goulburn - Delatite)

Bedfordia arborescens (Donna Buang - Blacks Spur)

C. ENDANGERED SPECIES

ENDANGERED SPECIES OF NATIVE VICTORIAN VASCULAR PLANTS
KNOWN TO OCCUR IN THE MELBOURNE STUDY AREA

Prepared by J. H. Willis

Species endemic in the study area are discussed in Chapter 9 - Vegetation

I. Plants not seen for many years or, if still present, now extremely rare

Eleocharis minuta	Mouth of Yarra River
Eriostemon scaber	Near Myrniong
Zieria aspalathoides	Near Mount Macedon; also Mount Tarrengower and "Goulburn River"

II. Extremely localized plants, chiefly restricted to very few colonies or even individual specimens

Actinotus bellidioides	Baw Baws near Mount Whitelaw
Adiantum diaphanum	Lang Lang River, Moonlight Creek near Mount Worth, Korumburra district
Amphibromus gracilis	Yarra River near Heidelberg; also Walwa
Adriana quadripartita	Port Phillip Heads
Brachycome trachycarpa	Near Werribee; also Dimboola
Caladenia leptochila	Healesville, Cheltenham; also Ballapur, Wilsons Promontory
Calochilus herbaceus	Anglesea; also Portland district and Cravensville
Coprosma moorei	Baw Baws near Mount Baw Baw, Lake Mountain
Cyathodes juniperina	Cape Woolamai; also Wilsons Promontory, Rabbit and Doughboy Islands
Euphrasia gibbsiae	Mount Baw Baw and Mount Mueller
Gahnia grandis	Tomahawk Creek, near Gembrook
Grevillea barklyana	Upper eastern tributaries of Bunyip River
Haloragis rubra	Sunbury; also "Wimmera"
Lycopodium scariosum	Baw Baws at Mount Erica; also Bogong High Plains
Lycopodium serpentinum	French Island; also western Grampians and Maramingo Creek near Genoa
Mitrasacme montana	Baw Baws; also Bogong High Plains
Nicotiana maritima	Melbourne area; also far south-west coast

Olearia pannosa	Torquay, Anglesea, Brisbane Ranges; also Rushworth, Heathcote, and Wedderburn districts
Orebolus oxycarpus	Lake Mountain; also Snowy Plains near Mount Howitt
Prasophyllum viride	French Island; also Mallacoota district
Psoralea parva	Lara, Inverleigh; also Wimmera and Sale
Pultenaea graveolens	Steiglitz, Porcupine Ridge; also Grampians and Baillieston
Putidosis leptorhynchoides	Keilor basaltic plains; also near Craigie
Eucalyptus neglecta	West of Mount Matlock; also several locations to the east
Schoenus fluitans	Barwon near Geelong; also far west Victoria
Schoenus turbinatus	West of Anglesea; also Grampians and Howe Range
Stipa breviglumis	Lerderderg, Coimadai, Brisbane Ranges; also St. Arnaud and Rushworth districts
Thelymitra mucida	Anglesea
Thelymitra retecta	Healesville, Toorongo River; also Upper Delegate River
Thesium australe	Lancefield, Delatite; also Wando Vale and several locations in the east and north-east
Thismia rodwayi	Snerbrooke, Wallaby Creek, Narbethong; also Yarra Valley and Gorae West

Appendix 3

FAUNA

A. BIRD LIST

This appendix lists the native birds recorded in the area and indicates the habitats in which they are most likely to be observed, and their status. Species recorded in the area only as accidental, vagrant, or beach-washed specimens have not been included in the list, as land use changes in the study area will have no significant effect on the populations of these species.

Species that have special significance in this area (and are referred to in Chapter 10 or in the block descriptions) are indicated with an asterisk (*). Nomenclature and systematic arrangement of the species follow the "Index of Australian Bird Names" (C.S.I.R.O. 1969). In the list, horizontal lines are used to separate families.

Habitat types

Wet open forest (WOF):	open forest III and IV of alpine ash, mountain ash, and messmate - gum
Dry open forest (DOF):	open forest I and II of stringybark, peppermints, and box (O = sparsely timbered or cleared areas within this type of forest)
Grassy woodland (GW):	red gum, yellow gum, box ironbark and mallee
Heathy woodland (HW):	heathland with stunted peppermints and stringybark
Sub-alpine complex (SAC):	snow gum open forest and woodland, heath, herbfield, and grassland
Dry coast complex (DCC):	tea-tree and banksia scrub, and dune grasslands
Grassland (G):	natural grassland, cereal crop, pasture and fallow in the dry zone west and north of Melbourne
Agricultural land (AL):	semi-cleared and pasture land in the higher rainfall areas
Wetlands (W):	swamps, marshes, lakes, rivers, and tanks
Littoral habitat (LH):	beaches, mudflats, mangroves, reefs, estuaries, and salt marsh
Ocean and bays (OB):	
Urban (U):	city buildings, streets, and gardens

Status

The codes given below are used to denote status or manner of occurrence, on a relative basis, with reference to available habitat within the study area. The estimates are based on general experience rather than actual counts. The situation is changing constantly.

The first letter in the code indicates distribution of suitable habitat:

W = habitat widespread in the study area

R = habitat restricted to relatively few parts of the study area

The second letter in the code indicates population density within the areas of suitable habitat:

C = commonly observed

U = uncommonly observed

R = rarely observed

N = nomadic, number observed varying greatly from time to time

Additional letters may be used to indicate:

S = migratory species observed in the study area during summer

W = migratory species observed in the study area during winter

H = commonly uses hollows in trees for nest site

Species	Habitat												Status
	WOF	DOF	OW	HW	SAC	DCC	G	AL	W	LH	OB	U	
*Little penguin						X				X	X		RC
Wandering, albatross											X		RU
Black-browed albatross											X		RC
White-capped albatross											X		RR
Giant petrel											X		RC
Fairy prion											X		RU
*Short-tailed shearwater						X					X		RCS
*White-faced storm-petrel						X					X		RU
*Australian pelican									X		X		RU
Australian gannet											X		RC
Darter									X				RU
Black cormorant									X	X			WC
Little black cormorant									X	X			WC
*Pied cormorant									X	X			RC
*Little pied cormorant									X	X			WC
Black-faced cormorant										X			RU
Little grebe									X				WC
Hoary-headed grebe									X		X		RU
Great crested grebe									X		X		WR
White-necked heron									X				WU
White-faced heron									X	X			WC
Cattle egret									X				WR
White egret									X	X			WC
Little egret									X				WR
Plumed egret									X	X			WR
Nankeen night heron									X				RC
*Little bittern									X				RR
Brown bittern									X				RR
White ibis									X	X			WC
Straw-necked ibis									X	X			WC
Glossy ibis									X				WR
Royal spoonbill									X	X			WU
Yellow-billed spoonbill									X	X			WC
Black swan									X	X			WC
Freckled duck									X				RR
Cape barren goose									X	X			RR
Mountain duck								X	X	X			WCH
Black duck									X				WCH
Grey teal									X	X			WC
Chestnut teal									X				WUH
Blue-winged shoveler									X	X			WC
Pink-eared duck									X				WCN
White-eyed duck									X				WC
Wood duck								X	X				WCH
Blue-billed duck									X				RR
Musk duck									X	X			WC
Black-shouldered kite							X	X					WCN
*Letter-winged kite							X						RR
Fork-tailed kite		O	X				X	X					WR
Whistling eagle		O	X	X			X	X	X				WC
Grey goshawk	X	X		X									RU
Australian goshawk	X	X	X	X	X								WC
Collared sparrowhawk	X	X	X	X	X								WU
Australian little eagle		O	X	X			X	X					WU
Wedge-tailed eagle	X	X	X	X	X		X	X					WC

Species	Habitat												Status
	WOF	DOF	OW	HW	SAC	DCC	G	AL	W	LH	OB	U	
White-breasted sea eagle									X	X			RR
Spotted harrier							X		X				RR
Swamp harrier									X	X			WC
Black falcon		O	X				X	X					WR
Peregrine falcon		O	X	X	X			X				X	WU
Little falcon		O	X	X	X			X				X	WU
Nankeen kestrel		O	X	X	X	X	X	X				X	WC
Brown hawk		O	X	X	X	X	X	X					WC
Stubble quail							X	X	X				WC
Brown quail				X			X	X	X				WR
*King quail				X			X		X				RR
Painted quail		O	X										WC
Little quail		O	X				X						WRN
*Plain wanderer							X						RR
*Brolga							X		X				RR
Lewin water rail									X				RR
Banded landrail							X		X				WR
Marsh crake									X				RU
Australian spotted crake									X				RC
*Spotless crake									X				RR
Black-tailed native hen									X				WUN
Dusky moorhen									X				WC
Swamphen									X				WC
Coot									X				WC
Australian painted snipe									X				RRS
Pied oystercatcher										X			RC
Sooty oystercatcher										X			RU
Spur-winged plover							X	X	X	X			WC
Banded plover							X		X				WU
Red-kneed dotterel									X				RR
Hooded dotterel										X			RC
Red-capped dotterel									X	X			WC
Double-banded dotterel									X	X			RCW
*Mongolian sand dotterel										X			RRS
*Large sand dotterel										X			RRS
Black-fronted dotterel									X				WC
Eastern golden plover										X			RCS
*Grey plover										X			RRS
Turnstone										X			RRS
Japanese snipe							X		X				WCS
*Whimbril										X			RRS
*Little whimbril										X			RRS
Eastern curlew										X			RCS
Little greenshank									X	X			RRS
Greenshank									X	X			RCS
*Wood sandpiper									X				RRS
Common sandpiper									X	X			RRS
*Grey-tailed tattler										X			RRS
*Terek sandpiper										X			RRS
*Knot										X			RRS
*Greater knot										X			RRS
Sharp-tailed sandpiper									X	X			WCS
*Pectoral sandpiper									X	X			RRS
Red-necked stint									X	X			WCS
*Long-toed stint									X	X			RRS
Curlew sandpiper									X	X			WUS
*Sanderling										X			RRS

Species	Habitat												Status
	WOF	DOF	GW	HW	SAC	DCC	O	AL	W	LH	OB	U	
*Broad-billed sandpiper										X			RRS
*Black-tailed godwit										X			RRS
*Bar-tailed godwit										X			RCS
White-headed stilt									X	X			WC
*Banded stilt									X	X			WR
Avocet									X	X			WU
Southern stone curlew		O	X										RU
Australian pratincole							X						RRS
Southern skua											X		RRW
Pomarine skua											X		RRS
Arctic skua											X		RUS
Pacific gull										X			RC
Southern black-backed gull										X			RR
Silver gull									X	X		X	WC
Whiskered tern									X				WCS
*White-winged black tern									X				RR
*Caspian tern									X	X			RU
Gull-billed tern									X				WRS
Common tern										X			RRS
White-fronted tern										X			RRW
*Fairy tern										X			RU
*Little tern										X			RC
*Crested tern										X			RC
*Peaceful dove		O	X				X						RU
*Diamond dove		O	X				X						RR
Common bronzewing	X	X	X	X	X								WC
Brush bronzewing		X		X		X							WU
*Crested pigeon			X				X						RU
*Wonga pigeon	X				X								WU
Rainbow lorikeet	X	X	X	X									WRNH
Musk lorikeet	X	X	X	X									WCNH
Purple-crowned lorikeet	X	X	X	X									WCNH
Little lorikeet	X	X	X	X									WCNH
Swift parrot	X	X	X	X									WCNH
Yellow-tailed black cockatoo	X	X	X	X	X								WCH
Gang-gang cockatoo	X	X			X								WCH
Sulphur-crested cockatoo		X	X				X	X					WCH
*Little corella			X				X						RRH
*Long-billed corella			X				X						RRH
Galah		O	X				X	X					WCH
*Cockatiel			X				X						RRSH
King parrot	X												WUH
Crimson rosella	X	X	X	X	X			X					WCH
Eastern rosella		O	X					X					WCH
Red-rumped parrot		O	X				X						WCH
Elegant parrot			X				X						RRH
Blue-winged parrot	X	X	X	X			X	X					WCH
*Orange-bellied parrot						X				X			RRH
*Budgerygah			X				X						WUHS
Pallid cuckoo	O	O	X					X					WCS
*Brush cuckoo	X												WRS
Fan-tailed cuckoo	X	X	X		X								WC
*Black-eared cuckoo		O	X				X						WR
Horsfield bronze cuckoo	O	O	X	X			X	X					WCS
Golden bronze cuckoo	X	X	X		X								WCS
Powerful owl	X	X											WUH
Barking owl		O	X					X					WUH
Boobook owl	X	X	X					X					WCH

Species	Habitat												Status
	WOF	DOF	GW	HW	SAC	DCC	O	AL	W	LH	OB	U	
Barn owl		X	X				X	X				X	WCH
Masked owl	X	X											WRH
*Sooty owl	X	X											WRH
Eastern grass owl							X						RRH
Tawny frogmouth	X	X	X					X					WC
Owlet nightjar		O	X										WCH
*Spotted nightjar			X										RR
*White-throated nightjar		X	X	X		X							WR
Spine-tailed swift	X	X	X	X	X	X	X	X	X	X	X	X	WCS
Fork-tailed swift	X	X	X	X	X	X	X	X	X	X	X	X	WUS
Azure kingfisher									X				WR
Laughing kookaburra	X	X	X					X					WCH
Red-backed kingfisher			X										RRHS
Sacred kingfisher		X	X						X				WCHS
Rainbow bee-eater		O	X										WCS
*Dollar bird		O	X										WRHS
Superb lyrebird	X	X											WC
Singing bushlark							X	X					WU
Welcome swallow	X	X	X	X	X	X	X	X	X	X		X	WC
Tree martin			X				X	X					WCHS
Fairy martin			X				X	X	X	X			WCS
Australian pipit					X		X	X					WC
Black-faced cuckoo-shrike	X	X	X		X		X	X					WC
Little cuckoo-shrike		O	X										WU
Cicada bird	X	X											RRS
White-winged triller		O	X										WUS
Australian ground-thrush	X	X				X							WC
Spotted quail-thrush		O	X										WC
*Grey-crowned babbler		O	X										RR
White-browed babbler		O	X										WU
Golden-headed fantail-warbler							X		X				WC
Little grassbird									X	X			WC
Reed warbler									X				WCS
Brown songlark							X	X					WUS
Rufous songlark		O	X										WUS
Superb blue wren	X	X	X	X	X	X						X	WC
*Southern emu-wren				X									RH
*White-throated warbler		O	X										RRS
*Western warbler		O	X										RR
Weebill		O	X										WC
Striated thornbill	X	X	X		X								WC
Little thornbill		O	X										WU
Brown thornbill	X	X	X	X	X	X							WC
Buff-rumped thornbill		O	X					X					WC
Yellow-rumped thornbill		O	X				X	X					WC
White-browed scrub-wren	X	X	X	X	X	X							WC
*Large-billed scrub-wren	X												WR
*Heath wren			X	X									RR
*Field-wren				X			X		X	X			WR
Whiteface			X				X						RU
Speckled warbler		O	X										WU

Species	Habitat												Status
	WOF	DOF	GW	HW	SAC	DCC	G	AL	W	LH	OB	U	
*Pilot bird	X												WU
*Rufous bristle-bird	X			X		X							RC
White-fronted chat							X		X	X			WC
Jacky winter		O	X										RC
Scarlet robin	X	X	X		X			X					WC
*Red-capped robin			X										RR
Flame robin	X	X	X		X		X	X					WC
*Pink robin	X	X											WR
Rose robin	X	X											WR
Hooded robin		O	X										RU
Southern yellow robin	X	X	X		X	X							WC
Grey fantail	X	X	X	X	X	X		X					WC
Rufous fantail	X	X											WUS
Willie wagtail		O	X	X			X	X	X				WC
Leaden flycatcher	X	X	X										WRS
Satin flycatcher	X	X											WUS
Restless flycatcher		O	X				X						WU
*Black-faced flycatcher	X												RRS
Golden whistler	X	X	X			X							WC
Rufous whistler	X	X	X			X							WC
Gilbert whistler			X										RR
Olive whistler	X					X							WU
Grey shrike-thrush	X	X	X	X	X	X		X					WC
Shrike-tit	X	X	X										WC
Eastern whipbird	X												WC
Orange-winged sittella		X	X										WC
Brown tree-creeper		O	X										RCH
White-throated tree-creeper	X	X	X		X			X					WCH
*Red-browed tree-creeper	X												WUH
Mistletoe bird	X	X	X					X					WC
Spotted pardalote	X	X	X		X								WC
Yellow-tipped pardalote		O	X										WU
Eastern striated pardalote		O	X										WC
Striated pardalote		O	X										WC
Grey-breasted silvereye	X	X	X		X	X		X					WC
*Lewin honeyeater	X												WU
*Singing honeyeater				X		X							RU
Fuscous honeyeater		O	X										RC
Yellow-faced honeyeater	X	X	X	X	X			X					WC
White-plumed honeyeater			X									X	WC
White-eared honeyeater	X	X	X	X	X	X							WC
Yellow-tufted honeyeater		O	X										RC
*Helmeted honeyeater			X										RR
Brown-headed honeyeater	X	X	X		X								WC
White-naped honeyeater	X	X	X		X			X					WC
Black-chinned honeyeater			X										RU
Little friar-bird		O	X										RR
Noisy friar-bird		O	X										RR
Crescent honeyeater	X	X		X	X	X							WC
New holland honeyeater			X	X		X							WC
*Tawny-crowned honeyeater				X		X							RR
*Painted honeyeater			X										RR
Regent honeyeater		O	X										WU
Eastern spinebill	X	X	X	X	X	X						X	WC
*Bell miner		X											RC
Noisy miner		O	X					X					WC

Species	Habitat												Status
	WOF	DOF	GW	HW	SAC	DCC	G	AL	W	LH	OB	U	
*Spiny-cheeked honeyeater			X	X		X							RC
Little wattle-bird				X		X							RC
Red wattle-bird	X	X	X	X	X	X		X				X	WC
*Beautiful firetail				X		X							RR
Diamond firetail		O	X										RU
Red-browed finch	X	X	X	X									WC
Zebra finch			X				X						WR
Olive-backed oriole	X	X	X										WC
Magpie lark		O	X					X	X			X	WC
White-winged chough		X	X										WC
Masked wood-swallow		O	X										WUS
White-browed wood-swallow		O	X										WUS
Dusky wood-swallow		O	X	X				X					WCR
Pied currawong	X	X			X								WC
Grey currawong	X	X	X		X								WC
Grey butcher-bird	X	X	X		X								WC
Black-backed magpie	O	O	X				X	X				X	WC
White-backed magpie	O	O	X		X		X	X				X	WC
*Satin bower-bird	X												WR
Australian raven	X	X	X					X				X	WC
Little raven		O	X		X		X	X				X	WC

Introduced Species

Domestic pigeon								X				X	RC
Spotted turtledove								X				X	RC
Skylark							X	X					WC
Red-whiskered bulbul												X	RR
Blackbird	X	X		X		X		X				X	WC
Song thrush												X	RC
House sparrow						X	X	X				X	WCH
Tree sparrow								X				X	RCH
Goldfinch	O	O	X	X	X	X	X	X				X	WC
Greenfinch						X	X	X				X	WC
Starling			X			X	X	X				X	WCH
Indian mynah								X				X	WCH

B. MAMMAL LIST

This list has been prepared from information supplied by Mammal Survey Group - Victoria, Mammal Survey Group - FNCV, National Museum - Melbourne and Fisheries and Wildlife Department.

Habitats - as defined in chapter 10 (Fauna) and at the head of the bird list (Appendix 3A)

Abundance - R = rare
U = uncommon
C = common

* indicates feral and exotic species

Scientific name	Common name	Habitat												Abundance	Habits and biology						
		Wet open forest	Dry open forest	Grassy woodland	Heathy woodland	Sub-alpine complex	Dry coast complex	Natural grassland	Agricultural land	Wetland	Littoral	Ocean and bay	Urban		Diurnal	Crepuscular or nocturnal	Arboreal	Scansorial	Terrestrial	Aquatic	Aerial
Tachyglossus aculeatus	Echidna	X	X	X	X		X							C	X				X		
Ornithorhynchus anatinus	Platypus									X				U		X				X	
Dasyurus maculatus	Tiger cat	X	X											R		X		X			
Phascogale tapoatafa	Tuan	X	X	X										U		X		X			
Antechinus flavipes	Yellow-footed antechinus		X	X										U		X			X		
Antechinus minimus	Swamp antechinus						X							R		X			X		
Antechinus stuartii	Brown antechinus	X	X	X	X	X	X							C		X		X			
Antechinus swainsonii	Swainsons antechinus	X			X	X	X							C	X	X			X		
Sminthopsis crassicaudata	Fat-tailed dunnart			X				X	X					U		X			X		
Sminthopsis leucopus	White-footed dunnart		X	X	X		X							U		X			X		
Isoodon obesulus	Short-nosed bandicoot		X		X		X		X					C		X			X		
Perameles nasuta	Long-nosod bandicoot	X	X			X								C		X			X		
Vombatus ursinus	Wombat	X	X	X	X	X			X					C		X			X		
Phascolarctos cinereus	Koala	X	X	X	X									C		X	X				
Trichosurus caninus	Bobuck	X												C		X		X			
Trichosurus vulpecula	Brush-tailed possum		X	X	X	X			X				X	C		X	X				
Pseudocheinus peregrinus	Ring-tailed possum	X	X	X	X	X	X						X	C		X	X				
Petaurus australis	Yellow-bellied glider	X	X											U		X	X				
Petaurus breviceps	Sugar glider	X	X	X	X	X								U		X	X				
Petaurus norfolcensis	Squirrel glider		X	X										R		X	X				
Schoinobates volans	Greater glider	X	X											C		X	X				
Gymnobelideus leadbeateri	Leadbeater's possum	X												U		X	X				

Scientific name	Common name	Habitats												Abundance	Habits and biology						
		Wet open forest	Dry open forest	Grassy woodland	Heathy woodland	Sub-alpine complex	Dry coast complex	Natural grassland	Agricultural land	Wetland	Littoral	Ocean and bay	Urban		Diurnal	Crepuscular or nocturnal	Arboreal	Scansorial	Terrestrial	Aquatic	Aerial
Acrobates pygmaeus	Feather-tailed glider	X	X	X	X	X	X							C		X	X				
Cercartetus nanus	Eastern pigmy possum	X	X		X	X	X							U		X	X				
Macropus giganteus	Great grey kangaroo		X	X	X		X	X	X					C		X			X		
Macropus rufogriseus	Red-necked wallaby				X		X							U		X			X		
Wallabia bicolor	Black wallaby	X	X		X	X	X		X					C		X			X		
Potorous tridactylus	Potoroo				X		X							U		X			X		
Pteropus scapulatus	Red fruit bat													R		X					X
Pteropus poliocephalus	Grey-headed fruit bat													U		X					X
Taphozous flaviventris	Yellow-bellied bat													R		X					X
Nyctophilus geoffroyi	Lesser long-eared bat													R		X					X
Nyctophilus timoriensis	Greater long-eared bat													C		X					X
Miniopteris schreibersii	Bent-winged bat													C		X					X
Eptesicus pumilis	Little bat													C		X					X
Chalinolobus gouldii	Gould's wattled bat													C		X					X
Chalinolobus morio	Chocolate bat													C		X					X
Pipistrellus tasmaniensis	Tasmanian dipistrelle													U		X					X
Myotis adversus	Large footed bat													U		X					X
Nycticeius greyi	Little broad-nosed bat													R		X					X
Tadarida australis	White striped bat													U		X					X
Tadarida planiceps	Little flat bat													R		X					X
Lepus europaeus *	Hare							X	X					U		X			X		
Oryctolagus cuniculus *	Rabbit	X	X	X	X	X	X	X	X					C		X			X		
Rattus fuscipes	Bush rat	X	X	X	X	X	X							C		X			X		
Rattus lutreolus	Swamp rat	X	X		X	X	X							C		X			X		
Rattus norvegicus *	Sewer rat								X				X	C	X	X			X		
Rattus rattus *	Black rat				X	X			X				X	C	X	X			X		
Mus musculus *	House mouse			X	X		X	X	X				X	C		X			X		
Hydromys chrysogaster	Eastern water rat									X	X			C		X				X	
Mastacomys fuscus	Broad-toothed rat	X	X			X								U		X			X		
Pseudomys fumerus	New Holland Mouse				X		X							R		X			X		
Pseudomys novae-hollandiae	Smoky mouse													R		X			X		
Arctocephalus forsteri	New Zealand fur seal											X		U						X	
Arctocephalus pusillus	Australian fur seal											X		C						X	

Scientific name	Common name	Habitat											Abundance	Habits and biology						
		Wet open forest	Dry open forest	Grassy woodland	Heathy woodland	Sub-alpine complex	Dry coast complex	Natural grassland	Agricultural land	Wetland	Littoral	Ocean and bay	Urban		Diurnal	Crepuscular or nocturnal	Arboreal	Scansorial	Terrestrial	Aquatic	Aerial
Mirounga leonina	Southern elephant seal											X		R						X	
Hydrurga leptonyx	Leopard seal											X		U						X	
Lobodon carcinophagus	Crab-eater seal											X		R						X	
Eubalaena glacialis	Southern right whale											X								X	
Balaenoptera edeni	Bryde's whale											X								X	
Balaenoptera musculus	Southern blue whale											X								X	
Physeter catodon	Sperm whale											X								X	
Kogia breviceps	Pigmy sperm whale											X								X	
Mesoplodon grayi	Gray's beaked whale											X									
Orcinus orca	Killer whale											X								X	
Pseudorca crassidens	False killer whale											X								X	
Globicephala melaena	Southern pilot whale											X								X	
Delphinus delphis	Common dolphin											X								X	
Tursiops truncatus	Bottle-nosed dolphin											X								X	
Canis familians	Dingo	X	X			X								R		X			X		
Vulpes vulpes *	Fox	X	X	X	X	X	X	X	X					C		X			X		
Felis catus *	Cat	X	X	X	X		X	X	X					C		X			X		
Cervus elephas *	Red deer		X	X										R					X		
Cervus unicolor *	Sambar deer	X	X			X								C					X		
Dama dama *	Fallow deer		X	X										R					X		

C. REPTILE LIST

This list has been prepared from information supplied by P. A. Rawlinson, National Museum - Melbourne, and Fisheries and Wildlife Department.

Habitats - as defined in chapter 10 (Fauna) and at the head of the bird list (Appendix 3A), except that a habitat type "rocky outcrop" has been substituted for "oceans and bays".

Abundance - R = rare
U = uncommon
C = common

Scientific name	Common Name	Habitat											Abundance	Habits and biology												
		Wet open forest	Dry open forest	Grassy woodland	Heathy woodland	Sub-alpine complex	Dry coast complex	Natural grassland	Agricultural land	Wetland	Littoral	Rocky outcrops	Urban		Diurnal	Nocturnal	Ground dwelling	Water dwelling	Arboreal or scansorial	Fossorial or burrowing	Thigmotherm	Heliotherm	Oviparous	Viviporous	Cold temperate Bassian	Cool temperate Bassian	Warm temperate Bassian
Chelodina longicollis	Snake necked tortoise									X				C	X			X					X				X
Emydura macquarrii	Murray River short-necked tortoise									X				U	X			X					X				X
Amphibolurus barbatus	Bearded dragon			X										U	X		X					X	X				X
Amphibolurus diemensis	Mountain dragon		X											R	X		X					X	X		X	X	
Amphibolurus muricatus	Tree dragon		X	X	X		X					X		C	X		X		X			X	X				X
Physignathus lesueurii	Gippsland water dragon									X				C	X		X	X				X	X				X
Tympanocryptis lineata	Earless dragon							X						R	X		X					X	X				X
Underwoodisaurus milii	Thick tailed gecko			X								X		U		X	X				X		X				X
Phyllodactylus marmoratus	Marbled gecko			X								X	X	C		X			X		X		X				X
Delma fraseri	Mimicking snake lizard			X				X	X					R	X		X				X		X				X
Delma impar	Spinifex lizard			X				X	X					U	X		X				X		X				X
Anotis maccoyi	McCoy's skink	X	X			X								C	X		X			X	X		X			X	
Ctenotus robustus	Large striped skink			X				X				X		C	X		X					X	X				X
C. uber orientalis	Eastern copper-tailed striped skink			?										?	X		X					X	X				X
Hemiergis decresiensis	Three toed skink		X	X				X				X		C	X		X			X	X			X			X
Leiolopisma delicata	Delicate skink		X	X	X								X	U	X		X			X	X		X			X	X
L. entrecasteauxi	Grass skink		X	X		X	X	X	X			X		C	X		X					X		X	X	X	
L. guichenoti	Garden skink	X	X	X	X			X	X				X	C	X		X					X	X			X	X
L. mustelinum	Weasel skink	X	X		X		X						X	C	X		X			X	X		X			X	X
L. metallicum	Metallic skink	X		X	X	X	X						X	U	X		X					X		X	X	X	
L. trilineatum	Three lined skink		X	X	X		X							U	X		X					X	X			X	X
L. weekesae ? (probably undescribed species)		X	X			X								C	X		X					X		X		X	X
Lerista bougainvillii	Bougainville's skink		X	X	X							X		U	X		X			X	X			X			X
Pseudemoia spenceri	Spencer's skink	X				X						X		C	X				X			X		X	X	X	
Sphenomorphis tympanum	Water skink W.T. form		X	X						X				C	X		X	X				X		X			X
	C.T. form	X	X			X				X				C	X		X	X				X		X	X	X	

Scientific name	Common name	Habitat											Abundance	Habits and biology											
		Wet open forest	Dry open forest	Grassy woodland	Heathy woodland	Sub-alpine complex	Dry-coast complex	Natural grassland	Agricultural land	Wetland	Littoral	Rocky outcrops	Urban		Diurnal	Nocturnal	Ground dwelling	Water dwelling	Arboreal or scansorial	Fossorial or burrowing	Thigmotherm	Heliotherm	Oviparous	Viviporous	Cold temperate Bassian	Cool temperate Bassian	Warm temperate Bassian
Egernia cunninghamii	Cunningham's skink		X	X								X		C	X		X					X		X			X
Egernia luctuosa	Mourning skink				X		X			X				R	X		X			X		X		X			X
Egernia saxatilis intermedia	Black rock skink	X	X									X		C	X		X		X			X		X		X	X
Egernia whitei	White's skink		X	X	X		X					X		C	X		X					X		X	X	X	X
Tiliqua nigralutea	Southern blue-tongue	X	X	X	X		X							C	X		X					X		X		X	
Tiliqua scincoides	Common blue-tongue		X	X			X	X	X				X	C	X		X					X		X			X
Varanus varius	Tree goanna	X	X	X										U	X		X		X			X	X				X
Australaps superba	Highland copperhead	X	X			X				X				C	X		X					X		X	X	X	
	Lowland coppperhead		X	X	X		X		X	X				C	X		X					X		X		X	
Cryptophis nigrescens	Small-eyed snake		X	X								X		C		X	X				X			X			X
Drysdalia coronoides	White-lipped snake	X	X	X	X	X	X							C	X		X					X		X	X	X	
Notechis scutatus	Tiger snake	X	X	X	X		X	X	X	X			X	C	X	X	X					X		X		X	X
Pseudechis porphyriacus	Red-bellied black snake		X	X					X	X				C	X		X					X		X			X
Pseudonaja textilis	Brown snake		X	X	X			X	X			X	X	C	X		X					X	X				X
Suta dwyeri	Dwyer's snake		X	X								X		R	X		X				X			X			X
Suta flagellum	Little whip snake			X				X	X					C	X		X				X			X			X
Typhlops nigrescens	Blind snake		X	X								X		U						X	X		X				X
Typhlops proximus	Blind snake		X	X								X		R						X	X		X				X

D. AMPHIBIAN LIST

This list has been prepared from information supplied by A. J. Brook, M. J. Littlejohn and the Fisheries and Wildlife Department

Habitats - as defined in chapter 10 (Fauna) and at the head of the bird list (Appendix 3A)

Abundance - R = rare
U = uncommon
C = common

* indicates species requiring rocky streams

Scientific name	Habitat												Abundance
	Wet open forest	Dry open forest	Grassy woodland	Heathy woodland	Sub-alpine complex	Dry coast complex	Grassland	Agricultural land	Wetland (swamps)	Littoral	Ocean and bays	Urban	
Crinia haswelli				X		X							R
Geocrinia victoriana	X	X	X		X			X	X			X	C
Heleioporus australiacus	X	X											R
Limnodynastes dumerili	X	X	X	X		X	X	X	X			X	C
Limnodynastes peroni		X	X	X				X	X			X	C
Limnodynastes tasmaniensis		X	X	X		X	X	X	X			X	C
Litoria aurea raniformis		X	X	X			X	X	X			X	C
Litoria citropa	X												R
Litoria ewingi	X	X	X	X		X		X	X			X	C
**Litoria lesueuri*	X	X						X					C
**Litoria maculata*	X												R
Litoria paraewingi		X	X					X	X				C
Litoria peroni									X				U
**Litoria phyllochroa*	X	X											U
Litoria verreauxi verreauxi		X	X	X				X	X			X	C
Litoria verreauxi alpina					X								C
Neobatrachus pictus			X	X			X	X	X				U
Philoria frosti					X								R
Pseudophryne bibroni		X	X				X	X	X				C
Pseudophryne dendyi	X	X											C
Pseudophryne semimarmorata		X	X	X				X	X			X	C
Ranidella parinsignifera		X	X					X	X				C
Ranidella signifera	X	X	X	X	X	X	X	X	X			X	C

E. LAND PLANARIANS

This list has been compiled by L. Winsor

Habitats - as defined in chapter 10 (Fauna) and at the head of the bird list (Appendix 3A)

Abundance - R = rare
U = uncommon
C = common

Scientific name	Habitat												Abundance
	Wet open forest	Dry open forest	Grassy woodland	Heathy woodland	Sub-alpine complex	Dry coast complex	Grassland	Agricultural land	Wetland	Littoral	Ocean and bays	Urban	
Artioposthia fletcheri		X											R
Geoplana adae		X											U
Geoplana atrata									X				R
Geoplana dendyi	X												U
Geoplana dubia		X											R
Geoplana frosti	X	X											C
Geoplana hoggii	X	X							X				C
Geoplana howitti		X			X	X		X					U
Geoplana mediolineata		X						X					C
Geoplana m'mahoni	X	X											U
Geoplana munda		X						X	X				C
Geoplana quadrangulata								X	X				U
Geoplana quinquelineata		X						X					C
Geoplana sanguinea	X	X						X	X			X	C
Geoplana spenceri	X												C
Geoplana sugdeni		X						X					C
Geoplana sulphureus	X	X						X	X				C
Geoplana ventrolineata									X			X	U
Geoplana ventropunctata	X												R
Geoplana walhallae	X												U
Geoplana warrugulensis	X	X						X					R
Placocephalus kewensis												X	R
Rhynchodemus simulans									X				R

APPENDIX 4

NOXIOUS WEEDS

The following list shows the species of noxious weeds recorded in the Melbourne study area. Distribution of the various species is indicated for each block by the number of parishes in which the species is known to occur. The total number of parishes within each block is shown at the head of the species list.

Weed Species	BLOCK																								
	Torquay	Brisbane Ranges	Werribee	Wombat	Loddon	Romsey	Puckapunyal	Strathbogie	Eildon	Disappointment	Break O'Day	Black Range	Cerberean	Upper Goulburn	Kinglake	Donna Buang	Upper Yarra	Thomson	Dandenongs	Bunyip - Latrobe	Shady Creek	Tyers	Westernport	Strzelecki	Number of blocks in which weed species is found
(Number of parishes in block)	14	35	29	25	8	37	14	23	16	20	6	17	12	13	18	10	7	11	13	14	7	14	33	27	
African feather grass																									-
Amsinckia				4	1	1																			3
Apple of Sodom	4	3	13	1		4	1									1			1				6	3	10
Bathurst burr	1	8	19	6	2	20	11	10	9	10	4	9	4	4	8	2			3		3	2	4	4	21
Bindweed	8	8	5	5	2	6	2	1		2						1									10
Blackberry	10	16	14	19	8	27	8	20	15	16	6	17	12	10	18	9	7	11	13	14	7	14	33	27	24
Black knapweed	5																			1	1			1	4
Boneseed	13	7	7	1		1	1			2					10	6	3		11	1			20	3	14
Boxthorn	11	23	27	8	3	17	5	4	8	11	1	6	3	3	10	1			8	1	1	3	26	18	22
Buffalo burr																									-
Californian burr																									-
Caltrop			1				2	1	1					1											5
Camel thorn			1			6																			2
Cape broom	2	9	12	14	6	21	5	11	8	14	6	11	5	7	13	8	6	2	13	4	3	5	18	14	24
Chilean cestrum																									-
Chinese scrub				4	5	10	12	11	6	11	5	5	3	1	6				1				3		14
Colocynth																									-
Devil's claw (purple flower)			4																						1
Devil's claw (yellow flower)																									-
Dodder																									-
Drooping prickly pear			6																						1
English broom	3	3	6	12	4	11	3	3	4	7	2	3	2	7	7	5	5		10	6	6	3	10	9	23
Erect prickly pear	1		9			3	1	1	1				1												7
Fennel	6	9	10	3	1	8	1		2	4			1	1	8	6	2		7	4	3	1	15	16	20
Five-spined saltbush		5	11	1		5																			4

Weed Species	BLOCK																								Number of blocks in which weed species is found
	Torquay	Brisbane Ranges	Werribee	Wombat	Loddon	Romsey	Puckapunyal	Strathbogie	Eildon	Disappointment	Break O'Day	Black Range	Cerberean	Upper Goulburn	Kinglake	Donna Buang	Upper Yarra	Thomson	Dandenongs	Bunyip - Latrobe	Shady Creek	Tyers	Westernport	Strzelecki	
(Number of parishes in block)	14	35	29	25	8	37	14	23	16	20	6	17	12	13	18	10	7	11	13	14	7	14	33	27	
Flax-leaved broom	9	5	1												5	4	2		10	12	6	5	25	12	12
Furze	12	26	11	21	8	35	10	14	10	16	5	10	2	4	13	4	2		11	5	3	4	24	11	23
Great mullein	1	7	3	1	1	4		8	5	1	4	7	1	1	3	2		2	6	6	3	1	5	6	22
Hawthorn		7	6	12	8	27	7	7	7	14	1	6	5	1	10	3	1		11	9	4	2	20	22	22
Hemlock	4	16	4	10	1	6		5	5			5	4	7	7	7	4	2	8	7	7	7	10	22	21
Hoary cress	8	8	12	6	1	8	3	3	2	5	1	2	1		5	1			3		1	1	3	3	20
Horehound	5	17	25	6	1	21	13	18	11	14	5	9	5	2	7	4		2	4	3	7	2	6	8	23
Italian blackberry	2	1	4	10	2	4				2	2	1		4	5	6	3	11	9	9	7	13	14	26	20
Ivy-leaf sida																									-
Khaki weed																									-
Musk weed																									-
Noogoora burr						1																			1
Nut-grass	2						1	8	1	2		7							2						7
One-leaf cape tulip	4	3	1	1		1	3	4		1					1					1			10	5	12
Onion weed	5	7	9			2									3	1							2		7
Ox-eye daisy	1	2		1										2				1		8	4	2	2	13	10
Pampas lily of the valley		1	2			3									2	1			2				4		7
Paterson's curse	2	7	20	5	2	20	10	12	8	8	2	7	5	1	9	3			7	4	4	2	18	10	22
Perennial ragweed																									-
Poverty weed																									-
Prairie ground cherry		2	6	3			6	4		2															6
Ragwort	3	3				1		1		1	1				2	5	5	3	7	11	7	9	19	25	16
St. John's wort		3	1	3	4	3	9	17	16	7	5	11	8	13	6	6	2	1	4	6	4	2	9	11	23
St. Peter's wort						3									1	1	2		6	1					6
Sand mustard		10	18	1	1		2	1													1	1		1	9
Serrated tussock	1	2	5			2				2					2										6
Skeleton-weed	10		2	1	1	1	7	13	5	2		1	1	1											12
Soursob	3	13	13	3	3	10	5	13	4	7	4	8	1	2	8	3	1		9	8	3	2	21	12	23
Spiny broom		4		1																1			5		4
Spiny burr-grass																									-

Weed Species	BLOCK																								Number of blocks in which weed species is found
	Torquay	Brisbane Ranges	Werribee	Wombat	Loddon	Romsey	Puckapunyal	Strathbogie	Eildon	Disappointment	Break O'Day	Black Range	Cerberean	Upper Goulburn	Kinglake	Donna Buang	Upper Yarra	Thomson	Dandenongs	Bunyip - Latrobe	Shady Creek	Tyers	Westernport	Strzelecki	
(Number of parishes in block)	14	35	29	25	8	37	14	23	16	20	6	17	12	13	18	10	7	11	13	14	7	14	33	27	
Spiny emex	2	2	12																				1		4
Spiny rush		15	5	6	4	16	9	4		3	1	1													10
Stinkwort	5	7	13	1	3	12	10	20	11	13	5	11	6	5	13	5	1		10	4	4	4	27	15	23
Sweet briar	13	27	22	18	8	36	10	17	15	19	5	11	7	12	15	6	2	1	11	11	6	7	32	27	24
Tangled hypericum		2																							1
Thistle, artichoke	2	3	11			17	2			9					8	1			2						9
Thistle, golden			6	3	3	6			1					1											6
Thistle, hard head		1	2					2	1			2													5
Thistle, illyrian							1	1																	2
Thistle, nodding																									-
Thistle, perennial	2	3	3	4		5									1	2	2	1	4	8	6	5	16	24	15
Thistle, saffron		10	20	4	2	27	10	14	13	13	3	10	7	7	2				1				2		16
Thistle, Saint Barnaby's							1	1		1															3
Thistle, scotch		4	15			3		7		1															5
Thistle, slender	13	30	19	19	8	33	14	23	16	15	5	12	6	11	12	4		4	8	8	7	11	18	27	23
Thistle, soldier					2																				1
Thistle, spear	14	29	23	20	8	35	12	22	15	15	5	13	7	11	14	7	4	4	12	9	7	11	31	27	24
Thistle, spotted or variegated	14	34	26	23	8	36	13	20	13	18	5	11	4	10	15	7	4	3	10	10	7	10	26	27	24
Thistle, star			4							2					2										3
Thistle, stemless		3	1																						2
Thorn apple	11	1	11	2	1	4									1	2			1	2		1	4	4	13
Tobacco																									-
Topped lavender																									-
Tree of heaven			1	3	3	1	3	13	8	2	4	10	3	2			1		1	1			3	3	17
Tufted honeyflower		2	3																						2
Tutsan	1		2	3		2			5	1	3	7	5	7	5	2	2		5	1		1	4	14	18
Two-leaf cape tulip		1	1	1		3	1	1		3					1					1			1		10
Wheel cactus																									-
Whitehorse nettle		3	3																						2
Wild garlic	1	5	9	2	1	3	3	1	2	1		1	2	1											13
Wild mignonette	2	20	17	6		7	1	1	2			1	3										1		11
Wild teasel	6	11	3		1	4		1												1	3	7	3	5	11
Wild watsonia	2	2		3		9	2	8	5	9	2	7	5	2	12	5	3		10	10	4	6	26	23	21
Water hyacinth								1	1			1													3

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