Land Conservation Council Victoria **North Eastern Study Area, Districts 3, 4 and 5** Price $3.00

REPORT

on the

NORTH-EAST AREA DISTRICTS 3,4 & 5

Land Conservation Council, Victoria
Melbourne: October, 1974.

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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 North Eastern Area, District 3, 4 and 5 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 had 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 Victorian 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 purpose 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 of any other land however vested) in any water supply catchment area.

(2) In making any recommendations 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 economically 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 investigations 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 purposes 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 recommendations 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 National Park Service; 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, universities, industries, apiarists, members of fauna, and flora study groups, outdoor recreation and sporting organizations, and many individuals with expert knowledge in fields such as botany or zoology. Their assistance is gratefully acknowledged.

The North-east Apiarists Association, the National Museum, Messrs. D.V. Beardsell and W.D. Sheppard, and the government bodies listed above provided photographs for use in this report.

PART I INTRODUCTION

AIMS AND METHODS

This report brings together information that is relevant to decisions regarding the future use of public land in the three study districts.

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.

Existing information collected from published reports, government departments, public authorities, private organizations, and individuals has been supplemented by short-term surveys of mammals and plants.

Although public land has been emphasized, the report considers all land in the study districts to place public land in perspective.

The text is divided into four main sections. Part I, an introductory section, outlines the conservation and ecological principles that are followed and gives a brief description and history of the area.

Part II describes the main features of the environment for the whole study districts. Maps included show physiography, geology, and topography. Another map in a pocket at the back of this report delineates plant communities. Mammal, bird, and reptile habitats are described in terms of these communities.

The final chapter of this part considers the system of grouping features of the landscape together to give mappable areas in which the environmental features (climate, soil, vegetation, etc.) are uniform within the limits significant for a particular form of land use. These areas - called land systems - are shown on the land systems map.

Part III deals with the main forms of land use that are likely to make demands on public land. Hazards associated with these land uses, such as soil deterioration and fire, are also discussed. Primary production, minerals, and recreation maps are included in this section.

Part IV provides more detailed information and, for convenience, the study districts have been divided into 12 blocks. The information is set out in a consistent format of headings so that the reader can readily find specific information for any block and compare it with others.

A number of appendices give details of fauna, flora, and climatic data for the study districts and information on water quality standards.

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 populations 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.

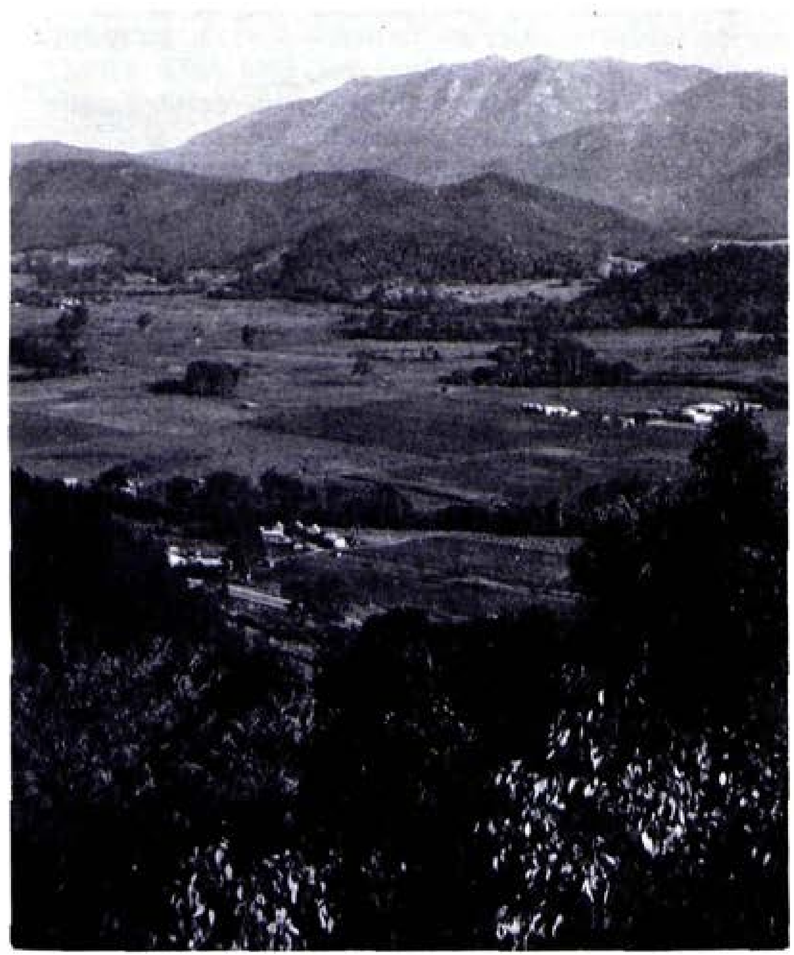
Review and reassessment of land will become necessary as society and technology change.

THE STUDY DISTRICTS

The study districts cover an area that includes the Shires of Beechworth, Chiltern, and Yackandandah and parts of the Shires of Bright, Myrtleford, Oxley, Towong, and Wangaratta. The perimeter of this area, which can be seen on the location map and on the other large-scale maps throughout the report, follows several different features. These include roads, rivers, shire boundaries, and, for about 32 km in the south, the 37° South parallel. The rural city of Wodonga has been included in this descriptive report for convenience, since the city boundary bisects a large block of public land.

Public land within the study districts comprises about 421,400 ha - about 50% of the total area - mainly on the higher ground. It covers very large continuous areas in the south, but towards the north it is principally located on isolated hills, separated from one another by the predominantly agricultural land in the valleys.

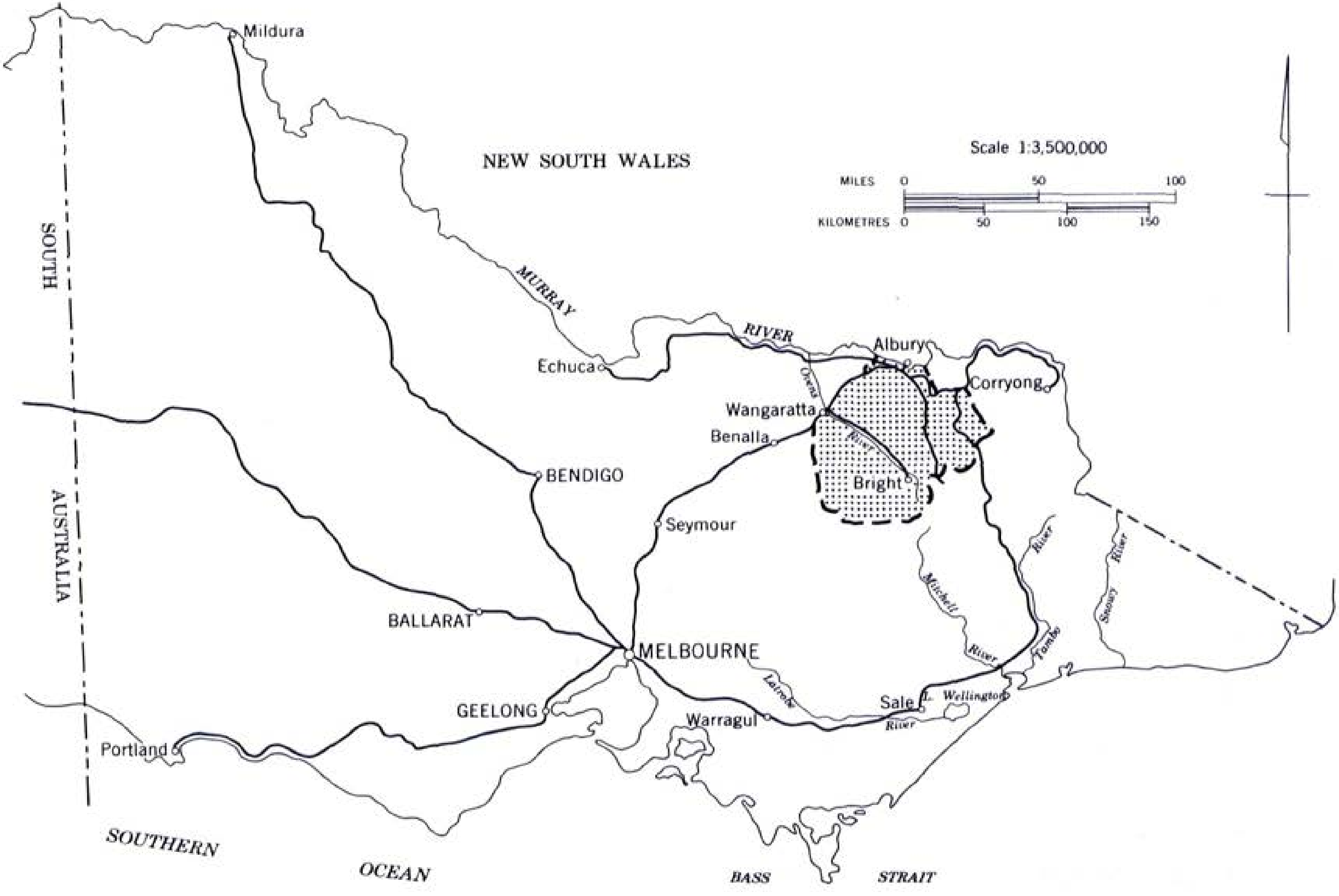
The land in the east, in the Tallangatta Creek and Mitta Mitta valleys, forms part of the Hume catchment area and has been proclaimed as such under the *Soil Conservation and Land Utilization Act*



Tobacco farms in the Ovens valley, with Mount Buffalo in the background

LOCALITY PLAN

LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5



1958. The other main streams in the districts are the Kiewa, Ovens, and King Rivers. The two dams - Lake William Hovell and Lake Buffalo, on the King and Buffalo Rivers respectively - have been built to regulate river flows.

Population

Approximately 25,000 people live in the study districts, where the main towns are Beechworth, Myrtleford, and Bright. The population has been increasing gradually in absolute numbers, although it now represents only approximately 1% of the State's total and this proportion has been declining. Two large urban centres just outside the districts, Wangaratta and Wodonga, are both growing. Between 1954 and 1971 Wodonga had a 50% increase in population and Wangaratta's population increased by 68%. Wodonga forms part of the planned Albury--Wodonga growth complex. Tables 1 and 2 give the statistics for the area.

Employment

Agriculture and forestry and their related industries provide the main forms of employment within the area. The tourist trade is growing and tourism is likely to make a very significant contribution to employment in the future.

TABLE 1

POPULATION OF MAIN URBAN CENTRES

	1954	1961	1966	1971
Beechworth	3,153	3,508	3,555	3,119
Bright	N/A	N/A	747	858
Mount Beauty*	2,216	1,509	1,568	1,571
Myrtleford	1,538	2,123	2,545	2,741
Wangaratta*	10,715	13,784	15,268	15,586
Albury--Wodonga (Victoria part)*	5,259	7,498	8,653	10,528

* Outside the study districts

TABLE 2

POPULATION STATISTICS FOR LOCAL GOVERNMENT AREAS
AT CENSUS, JUNE 30

	1954	1961	1966	1971	Area (ha)
Beechworth Shire	4,417	4,845	4,806	4,506	77,216
Part of Bright Shire	N/A	N/A	N/A	1,254	
Chiltern Shire	1,613	1,652	1,522	1,400	49,792
Myrtleford Shire	2,658*	3,770	4,374	4,434	71,280
Oxley Shire	4,356	5,185	5,318*	5,642	279,825
Part of Wangaratta Shire	N/A	N/A	N/A	938	
Rural City of Wodonga +	10,924	12,968	11,878	13,074	34,733
Yackandandah Shire	3,131	3,063	3,063	2,971	111,197
Part of Towong Shire	N/A	N/A	N/A	2,155	
Total for study districts				23,300	
Total including Wodonga				36,374ƒ	

* This figure and those for preceding years have been adjusted becuase of a change in the boundaries of the local government area

\+ Outside the study districts

ƒ Represents 1.04% of the State's population

Wangaratta and Wodonga are becoming increasingly industrialized, with a wide range of employment opportunities.

Transport

The Hume Highway - the main arterial link between Sydney and Melbourne - is the route to the area. Access to the north of the study districts through Albury--Wodonga is improved by the convergence of a number of main highways, including the Murray Valley, Riverina, and Olympic Highways and the Alpine Way. Roads within the study districts tend to follow the main valleys. The ranges tend to restrict east--west movement.

Commercial air services operate eight flights a day from Albury to and from the capital cities. In addition, an airfield lies at Wangaratta and numerous authorized landing areas lie within the districts.

The railway system in the districts is restricted to freight services. Wodonga and Wangaratta are on the main Sydney--Melbourne line and have comprehensive rail services.

Power

Several major transmission lines traverse the study districts. They run from the Snowy Mountain and Kiewa Hydro-electric schemes to the South Morang terminal station near Melbourne and to the terminal station at Glenrowan. In addition, a terminal station at Dederang and zone sub-stations at Myrtleford and Bright service local demands.

HISTORY

The Aborigines

Aboriginal inhabitants were never numerous in the district and probably totalled several hundred at the time of the first European settlement. The Pangerang and Yaitmenthang tribes inhabited the area. The Aborigines lived in the valleys, where game was most plentiful, although they used the high country at Buffalo for a short period each year to harvest the Bogong moth.

Settlement meant that they lost their land. Inevitably they clashed with the settlers, who believed that the Aborigines were there for their benefit and should serve their ends or forfeit any right to remain. The official returns of 1862 show that only about 60 remained in Victoria east of the Goulburn River.

Discovery and early settlement

In 1824 Hume and Hovell, on their expedition to Port Phillip Bay, became the first white men to pass through the districts. (Their route is shown on the recreation map.) The main exploration and initial settlement of the area started 12 years later. William Wyse, the first pastoralist to cross the Murray River, took up a run at Bonegilla for C.H. Ebden. Most of the area was taken up by pastoralists within a few years.

These were hard times for the squatters. They required substantial finance to purchase their stock and materials and many of them, being inexperienced or unsuited to the life, failed. They were fairly mobile and frequently moved. Some of their runs changed hands many times in a few years. For example, Hurdle Creek run was in 13 different names in just 43 years. After 1847 they received a degree of security of tenure, and the discovery of gold in 1852 (with its consequent gold-rushes) gave them a profitable market for their stock and made them a relatively rich as well as priviledged class.

Mining

Alluvial gold was discovered about February 1852 in Spring Creek. The population increased dramatically and by the end of 1852 Beechworth had 20,000 people. Victoria's population increased to almost half a million by 1858.

McEVOY MINE. ELDORADO, 1861.

Underground deep-lead mining was later replaced by sluicing operations

Alluvial gold was soon discovered in many parts of the area. The surface deposits were worked out quite rapidly, but deep-lead and reef mining proved more durable, and Myrtleford remained an important centre of reef mining until 1900. During the early mining years, anti-Chinese feelings caused some problems. The worst incidents were on the Buckland goldfields in 1857.

The result of the Victorian gold rushes was the conversion of Victoria from a pastoral extension of New South Wales and Tasmania into a bustling and wealthy colony.

Much alluvial materials was removed by sluicing; sluicing works near Beechworth

Transport and communication

The present Hume Highway became the established route between Melbourne and Sydney. The first mail run between the cities was in 1838. The Murray River was important for river traffic, especially during the gold rush, with Albury and Wahgunyah providing the nearest ports. The river declined in importance as a transport route as the railway and roads were developed.

Railways caused a considerable change in the transport within the region. The Melbourne--Wodonga line reached Wangaratta in October 1873 and Wodonga later the same year. Branch lines were subsequently constructed in the district; one line reached Beechworth in 1876, and another reached Myrtleford in 1883, extending to Bright in 1890. The narrow-gauge line from Wangaratta to Whitfield was completed in 1899.

The railway system declined in importance with the development of motorized transport. The Whitfield and Beechworth --Yackandandah lines were closed in 1953 and 1954 respectively.

Bushranging era

Daniel Morgan in the 1850s was one of the first bushrangers in the area. During the 1870s and '80s feuds between the selectors and squatters, with all the ensuing bitterness, led to a renewal of bushranging and violence. This was the period of Harry Power and the Kelly gang.

Improvements in education and living standards, together with a narrowing of class differences that came with the end of squatters tenure in 1880 and closer settlement, reduced the tension in the community and helped to bring this era to a close.

Local government

The original shires were proclaimed by 1874. In May 1960 Myrtleford Shire was constituted from a portion of Bright Shire. On March 30, 1973, Wodonga Shire was proclaimed a rural city.

Agriculture

The early settlers grazed sheep and cattle on native pastures. They favoured cattle in this area because problems with liver fluke made sheep uneconomic. The gold-rush of the 1850s revolutionized farming by providing a large local market. Miners stimulated the growth of dairy-farming and cash cropping of cereals and vegetables.

Once the initial alluvial gold deposits had been worked out, many miners turned to farming. Cereal production became important and dual-purpose sheep were maintained on the arable land. Beef was grown on areas unsuitable for cultivation and horse-breeding was important. Hop- and tobacco-growing became established. The general pattern of agriculture that emerged by the 1880s was basically the same as today's.

However, agriculture has generally become more intensive since then and yields and quality of agriculture products have improved. Production from pastures was greatly increased by the widespread use of subterranean clover and super-phosphate fertilizer during the 1920s and by the introduction of myxomatosis in the early 1950s.

Mount Buffalo National Park

Hume and Hovell commented upon its visual impact when they named this "singularly formed mountain" Buffalo. Early interest in the mountain led to areas of it being temporarily reserved in 1897 and 1908 before the current area of 11,000 ha was gazetted as a National Park in 1948.

Forests

Initially forests were a hindrance to the development of land for agriculture and were destroyed by axe and fire. However, timber became important for mining, especially when deep-lead mining was at its height, and it became necessary to prevent the uncontrolled use of forests for timber.

The 1869 *Land Act* contained a schedule for land reserved for timber production. Areas had been set aside before this time, especially for red gum, but many of these reserves were created to protect the squatters' runs against selection rather than for timber.

The first conifer plantation was started at Bright on dredged river gravels in 1916.

The Myrtleford plantation was established in 1927 to utilize land infested with St. John's wort, and the Stanley plantation commenced in 1930 on old goldworkings. These plantations have been

Freeburgh Dredge, 1950

greatly increased since then and better-quality land is now normally used.

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PART II

NATURE OF THE LAND

PHYSIOGRAPHY

Introduction

The study area lies on the northern slopes of the Eastern Highlands and includes a small area of the Northern Plains.

Most of it is mountainous, grading down to hills and plains towards the north. The form of these hills has been governed to some degree by their component rock types and also by the fault and warping movements that have had important effects on landscape evolution in this area.

The study area comprises four distinct regions. In the south-west the hills contain some hard, resistant sedimentary and volcanic rocks of Upper Devonian and Lower Carboniferous age. The central region has developed from more erodable sedimentary rocks, but also contains granite intrusions that are surrounded by elevated rims of sedimentary rocks hardened by metamorphism. The third region, the eastern section of the study area, is composed of metamorphic rocks that are relatively resistant to weathering and of granitic material that has been considerably eroded. Faulting has been an important element in forming the topography of this eastern region. The fourth region comprises plains, and is the beginning of the Riverine Plain.

These areas are shown on the phyiography map in the pocket at the back of this report.

The south-western region

The sedimentary rocks contain resistant Upper Devonian and Lower Carboniferous conglomerates in nearly horizontal beds. Erosion has left this material capping some of the hills; the edges form steep scarps while the tops are fairly flat, as can be seen clearly at Power's Lookout.

The sedimentary rocks dip gently to the east forming a syncline. This sloping plateau lies just east of Cheshunt South and continues to slope for about 5 km to the axis of the syncline. East of the synclinal axis sediments rise steeply to form a ridge, which includes the peaks of Mount Typo and Mount Warrick. In the western side of this region are hard resistant volcanic rocks, and to the south the sediments outcrop again. Here the hills are broad with gently undulating tops. The rivers have cut deep

South-west physiographic region: the Wabonga plateau in the middle ground is composed of hard carboniferous sedimentary rocks

valleys with steep sides and have frequently taken courses in the more erodable rocks. This region forms part of the Tolmie Highlands.

Central region

The hills from the ridge at Mount Typo eastwards to the southern part of the Ovens River are composed of relatively soft Ordovician sedimentary rocks, such as mudstone, and form sharp ridges and spurs. The streams have a dendritic drainage pattern that is characteristic of drainage in these rocks. The hills south of Mount Buffalo are typical of this area. In the north, the hills are lower and eventually submerge beneath the alluvial deposits of the Riverine Plain. The Chiltern Hills are the most northern representatives of these Ordovician sedimentary rocks in the study area.

Within the sedimentary rocks are areas of granitic rocks. During their intrusion the surrounding rocks were metamorphosed. This hardened them and has thereby increased their resistance to erosion. These aureoles consequently tend to stand out as hills when the rivers erode away the softer surrounding rocks.

The granites of the area are of two types, firstly a very resistant form found at Mount Buffalo, Mount Stanley, Mount Emu, and in the Beechworth--Mount Pilot area, and secondly a more-eroded type, which forms the Pinnacles and the land immediately to the north and east of this. Mount Buffalo, Mount Emu, and Mount Stanley are high areas (above 1,000 m). The Buffalo plateau is a remnant of an old erosion surface that has been preserved by the resistant nature of the Mount Buffalo granite. Most of the surrounding sedimentary rocks there have been removed by stream action. To the north, the Beechworth--Mount Pilot granites form an area of rolling hills at a lower level than the granite masses further south, but at the northern end the Pilot range rises steeply from the valley of Black Dog Creek. In the south, at Beechworth, the granite abutts sedimentary rocks of equal or slightly higher elevation.

The metamorphosed sediments originally surrounding the granites have left some interesting features in the form of crescent-shaped ranges. The study area contains three of these: one lies around the Murmungee basin south of Beechworth, another forms the south side of Happy Valley, and the third - the crescent-shaped hills north of Black Dog Creek - includes Skeleton and Cheesley Hills.

The original igneous intrusion in the Murmungee basin is now covered by alluvial deposits. The igneous intrusion that metamorphosed the sediments on the south of Happy Valley is visible to the north at the Pinnacles and the hills immediately to their west. The crescent of hills in the Chiltern area has a similar structure and is the remains of an aureole formed during the intrusion of the Mount Pilot granite, which can be seen to the south across the valley of Black Dog Creek.

Eastern region

The eastern region is mainly composed of metamorphic rocks with some sections of igneous and sedimentary rocks.

These metamorphic rocks are more resistant to erosion than the sedimentary rocks of the central region. They have also been subjected to a sub-rectangular pattern of faulting, which has moved blocks relative to one another and has been important in locating the drainage system.

Central physiographic region: an aureole of metamorphic rock comprising the crescent shaped hills (background) surrounds the Murmungee basin (foreground)

In the north-west of the section, the large block of the Barandundas forms a range about 12 km long. The streams draining this are consequent and form a radial pattern. By comparison the Draper Hill area to the north is much lower and dissected by well-developed branched streams, including the Huon and House Creeks. The Barandundas are separated from the hills to the east by the broad Yackandandah Creek Valley, which has developed on eroded granitic material.

Looking across the Mudgeegona Valley from Mount Stanley to the mountainous eastern region: Mount Jack in the foreground with the Kiewa Valley behind and the ridge to the east of this visible through the Glen Creek Valley

The hills on either side of the Kiewa River form a more or less continuous chain increasing in altitude. Notable peaks include Mount Big Ben on the west and Mount Tawonga and Mount Emu (east) on the east. The numerous faults in the area have acted as a focus for erosion and have therefore been important in determining the position, shape, and size of these hills.

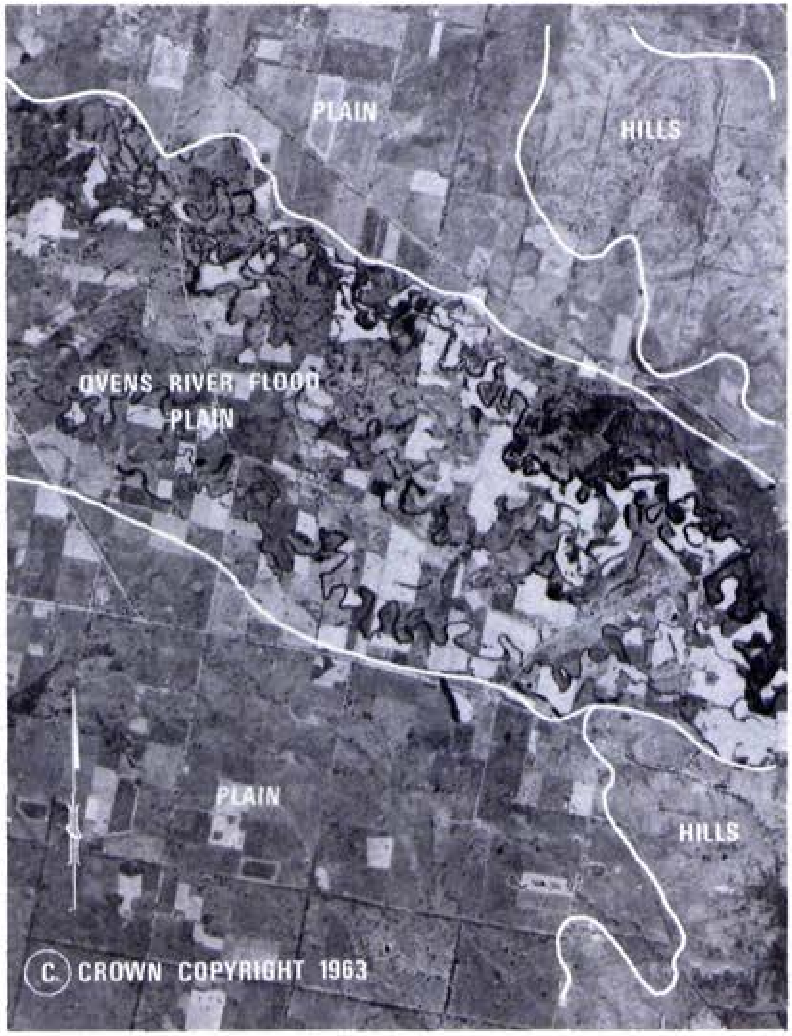
In the north-east, between Mitta Mitta River and Tallangatta Creek lies a block of eroded granitic rock; although still hilly, Honeysuckle Creek and several other creeks are developing valleys in it. This block is almost completely surrounded by metamorphic rocks.

The main rivers and creeks of this region follow the line of faults. Mitta Mitta River lies in a valley that has right-angled bends and straight sections. Tributaries such as Glencoe and Little Snowy Creeks also follow faults, hence they flow south-east and north-east respectively. Tallangatta Creek follows a fault north-west, while the Kiewa Valley is bounded by faults and many of its tributaries, for example Running and Glen Creeks, follow fault lines.

Plains

The north-west of the study area includes the beginnings of the Riverine Plain. The plains are composed of alluvial deposits, often more than 50 m thick. Alluvial cones and broad alluvial fans have been deposited on the fringe of the higher country during Quaternary times.

The larger rivers have formed flood-plains on their way to the Murray with characteristic river terraces and ox-bow lakes.



Plains region: Ovens valley flood-plain near Markwood

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GEOLOGY

Introduction

In the earlier Palaeozoic era, the study area occupied part of a trough that formed during the early stages of activity of the Tasman Geosyncline. When sedimentation ceased, the deposits were deformed and, in part, metamorphosed and subsequently exposed by uplift.

Later, several phases of igneous activity, tectonic deformation, and denudation preceded limited sedimentation and volcanic activity.

Intermittent fault block movement and local sedimentation followed a long period of erosion.

Ordovician

The oldest rocks known to outcrop in the study area are of Middle to Upper Ordovician age. These yellow-brown, brown and greenish black claystones, siltstones, and sandstones were deposited in a thick, repetitive marine sequence in the Wagga Trough.

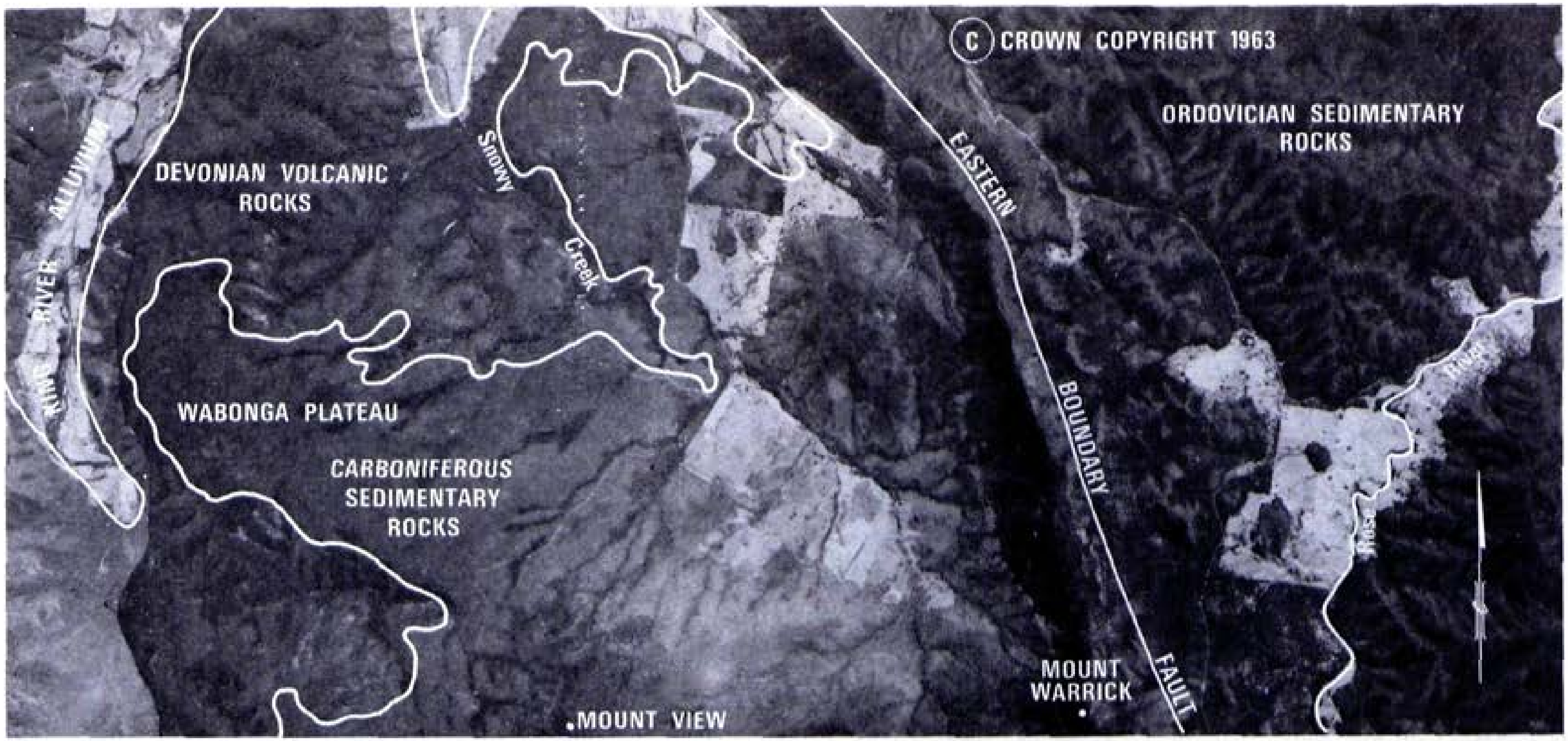
Compressed casts of graptolites, in diagnostic assemblages, have been used to date the sediments. These casts have either a carbonaceous or a pyritic composition.

The generally fine grain-size of the rocks, the lack of conglomerates in the sedimentary sequence, and the presence of some graptolite shales suggest that deposition took place in deep water under reducing (anaerobic) conditions. Hence, fresh rock is a grey colour whereas weathered rock is yellow-brown or brown. Some of the sandstones have been shown to be turbidity-current deposits.

The sequence does not contain rocks of a volcanic origin, although granitic detritus has been identified in the coarser constituents of some of the sandstones.

Towards the end of the Ordovician, the sediments were folded, jointed, and faulted. The folds are closely spaced and their plunge varies.

Evidence suggests that several phases of deformation occurred. The sediments exhibit at least two cleavages and are distinctly foliated. It is difficult to measure the total stratigraphic thickness because of the deformation.



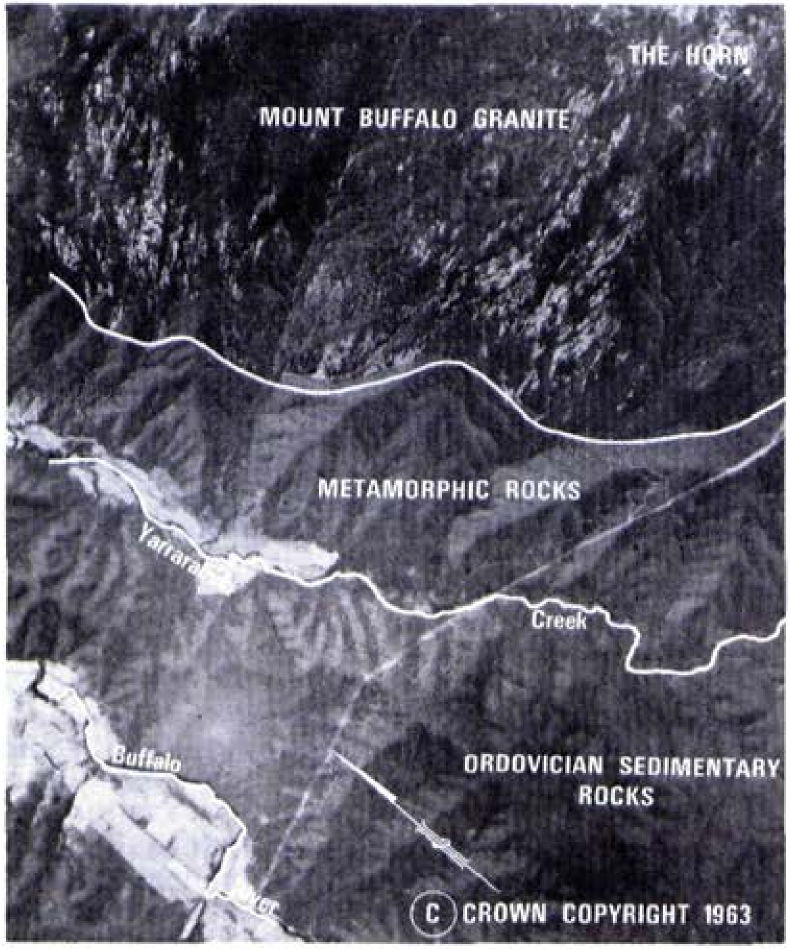
Eastern boundary fault - Ordovician sedimentary rocks to the east and Upper Devonian volcanic and Carboniferous sedimentary rocks to the west

Movement along the faults is thought to have persisted intermittently to the Tertiary. The crush zones of the faults vary in width. Crush zones can seldom be seen in outcrop because the rock in them is fractured and sometimes ground into rock flour, rendering the material susceptible to rapid weathering. The persistent movement of the faults, their linear form, and the younger faults contributed to the present-day basin and range topography. Topographic expression of these faults is commonly in the form of scarps.

Subsequent to this period of tectonic deformation, a belt of the sediments extending from Wodonga 160 km in a south-south-easterly direction was regionally metamorphosed to slates, schists, and gneisses. These rocks were subsequently faulted.

The schists sometimes exhibit metamorphic zoning and two types predominate:

* those having a knotted texture, which is due to the segregation of large crystals from the finer groundmass (porphyroblasts)



Mount Buffalo granite is surrounded by metamorphic rocks that grade into Ordovician sedimentary rock

Granite tors on Mount Buffalo

* biotite--sillimanite schists, in which biotite is the main dark-coloured mineral

The composition of the gneisses also varies. Some are relatively homogeneous whereas others are distinctly porphyroblastic. It is considered that the gneisses form the core of the metamorphic complex and the schists the edges.

Silurian

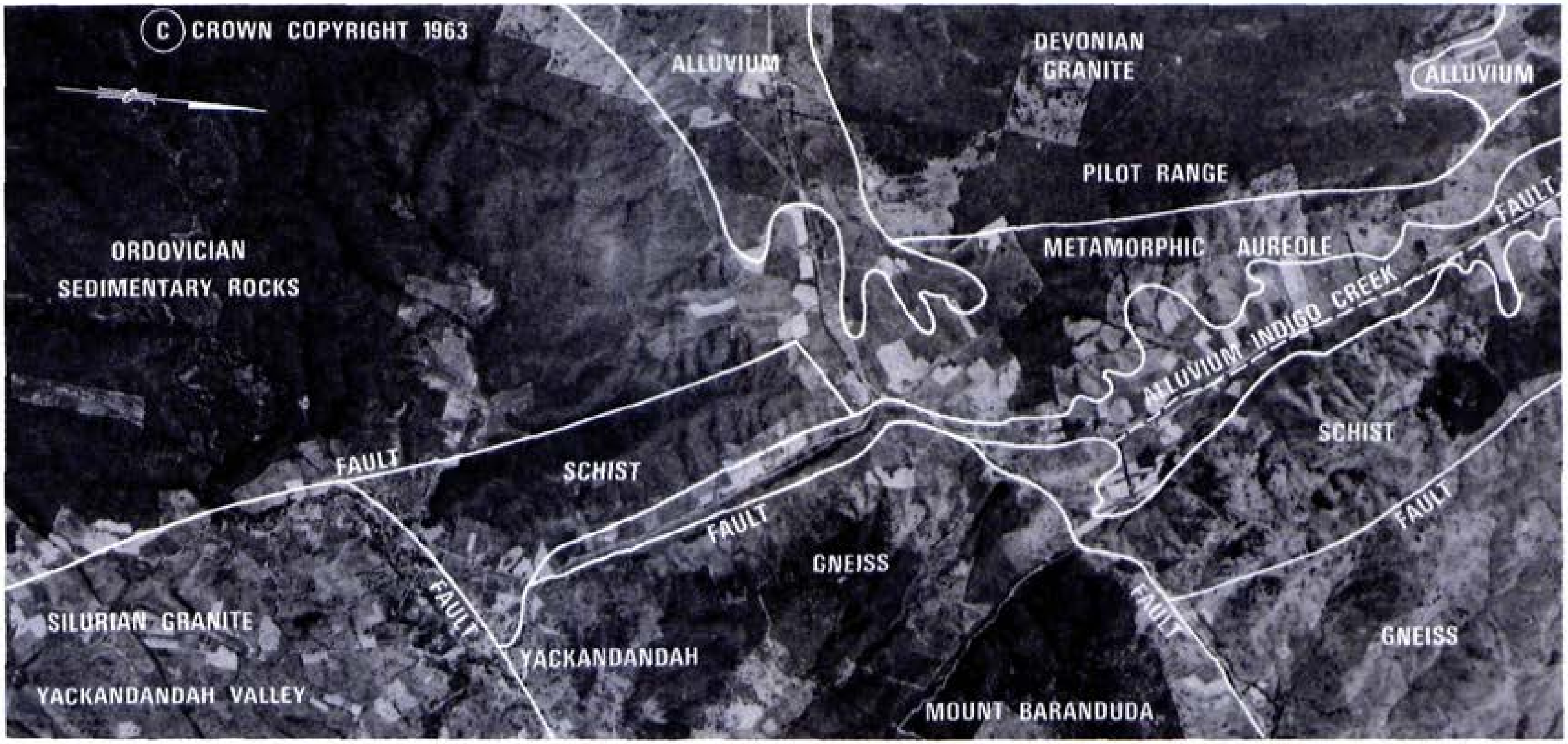
Subsequent to the principal metamorphism, the country rocks were uplifted and exposed. In nearby areas, thick rhyolites and ignimbrites (Mitta Mitta River volcanics) containing inclusions of the country rock (xenoliths) were extruded.

Afurther phase of tectonic deformation in the Upper Silurian resulted in extensive faulting and re-activation of the older fault systems.

Several granitic and dioritic plutons with associated dykes were intruded late in the Silurian. The granite east of Yackandandah is typical. The fresh granite has large white and grey crystals of quartz and feldspar and has less biotite than the younger granites. Some of the gold and tin mineralization may date from these intrusions.

Devonian

The older rocks remained exposed during this period. To the south-west, cauldron-like structures developed in local



Yackandandah and Indigo valley area: contact metamorphic rock surrounds the Devonian granite of the Pilot Range. Sedimentary and metamorphic rocks are separated by faults and vary in altitude. Silurian granites lie in the Yackandandah Valley basin subsidence. Rhyolites and rhyodacites were intermittently extruded into these, while sandstones and conglomerates were deposited during the intervening periods.

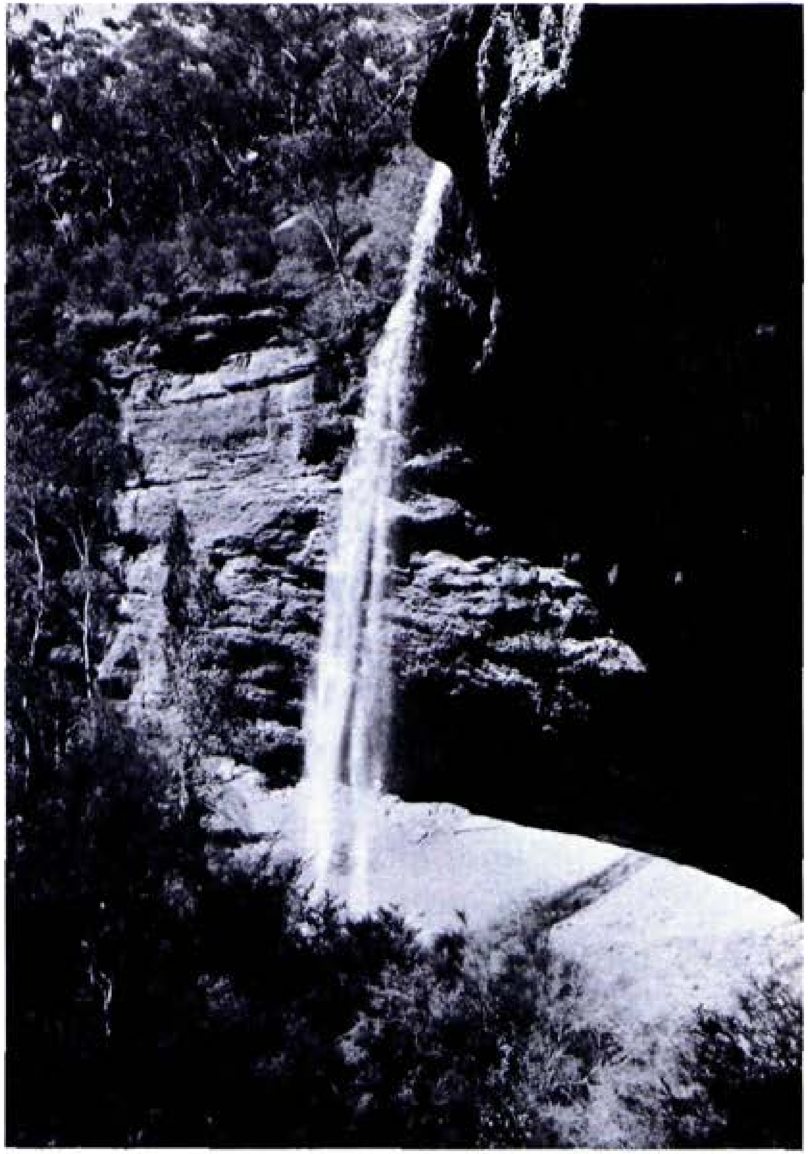
Granitic and granodiorite plutons with associated dykes intruded the country rock. These plutons outcrop over large areas, for example the Pilot Range batholith. When weathered these rocks develop a pinkish tinge. When fresh, the large-crystalled rocks have a white and grey colour and contain abundant biotite. Most of the mineralization is attributed to this intrusive phase.

The dykes associated with the plutons are of three main types:

* granite dykes - coarse-grained texture (Some are auriferous, but none are stanniferous.)
* pegmatite dykes - commonly consist of quartz, feldspar, muscovite, and perhaps tourmaline and garnet (tin ore usually accompanies greisen.)
* quartz porphyry - diorite dykes (these may be many miles long and auriferous in the quartz-rich zones.)

Carboniferous and Permian

Outliers of these rocks outcrop in the south-west of the study area. Conglomerates, "red" sandstones, siltstones,



Paradise Falls, a 30-metre cliff face of horizontally bedded Carboniferous sedimentary rock - mainly conglomerates.

and shales, deposited in a sub-aerial environment, have been correlated on a lithological basis with the Carboniferous sediments of the Mansfield Basin. These outliers may be the remains of formerly more extensive basin deposits.

Tillites, sandstones, conglomerates, and arkosic clays of both marine and glacial origin occur near Greta and Byawatha. Deep water bores drilled through the alluvial plains south-east of Wangaratta revealed the presence of these Permian beds at depths between 44 m and 165 m below the surface. These beds have a thickness of between 2 m and 168 m. They are generally either flat-lying or gently tilted and are extensively faulted.

At Laceby, one of the bores passes through the Permian beds into sediments believed to be of Carboniferous age. These deposits have been preserved in a down-faulted block and subsequently covered with younger alluvium.

A long period of weathering and denudation followed in the Mesozoic era.

Tertiary and Quaternary

The auriferous and stanniferous placer deposits accumulated during these two periods. Although some basalt of the Older Basalt Series was extruded north of Myrrhee, these two periods represent erosive phases in the geologic history of the area.

Movement of fault blocks, such as the Ovens River fault block, persisted. Thick deposits of alluvium accumulated in the downthrown blocks and several deep-lead systems were formed. The leads are represented by sands, pebble conglomerate, and coarse fluvial gravels. Parts of the alluvial sequence contain productive groundwater aquifers. The deposits are good clay, sand, and gravel sources.

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CLIMATE

The districts lie between 36° and 37° South latitude and are affected by the fluctuating polar front, where warm tropical air seasonally alternates with cool, southern, ocean air.

The principal air masses have maritime sub-polar and maritime tropical origins, but air of continental tropical origins also affects the climate in the region. Precipitation is principally associated with fronts and, although ample in winter, falls below potential evapotranspiration in summer.

During winter a succession of depressions to the south creates frequent frontal activity. These depressions bring relatively dry cool air or, on occasions, showery weather with hail and snow (the "cold outbreaks"). In the summer the main location of the polar front moved southwards, and consequently the prevaili g weather in the region is warm and dry. Summer rain is erratic and infrequent, but the few falls are often heavy because the warmer air can carry large quantities of water.

The whole area is occasionally affected by weak surface depressions, which bring general rain when preceded by a flow of moist air in the higher levels of the atmosphere. This occurs mainly in the summer. Also in summer, anticyclones remaining semi-stationary over the Tasman Sea bring hot dry air from the interior. The resulting very hot, dry, windy periods can last several consecutive days, creating high bush-fire danger. The northerly winds intensify as the southerly change approaches, which can be dry or bring rain and thunderstorms.

The prevailing winds throughout the year are westerlies, coming either from the north-west or south-west, but southerlies and northerlies increase from September to February. Easterlies are more common in late summer than at other times.

The topography of the districts generally modifies the prevailing weather. With increasing altitude, barometric pressure and temperature fall. The normal temperature lapse rate is 6.0° C per 1,000 mm, although it may be higher. Wind speeds increase with altitude are often modified by local terrain - air can be funnelled through valleys and gaps. Local relief also influences the quantity of sunshine received and creates microclimates (southern slopes are usually cooler than northern aspects of the same hill).

High land forms an obstacle to the moist west winds and tends to intensify the rainfall, and thunderstorms are more frequent. The orographic effect gives rise to rain-shadows on the lee side of the hills.

Clear skies increase the rate of radiant heating and cooling, resulting in larger diurnal temperature variations in the higher flat areas than occur in the surrounding low country. Night-time frosts are common even when day temperatures are well above freezing.

Mountainous regions are more subject to fogs than lower country. These are mainly low cloud, but radiation fogs occur in valleys on still clear nights, and both fog and cloud drip contribute to precipitation.

Precipitation

Precipitation is influenced by topography, as illustrated in the map at the back of this report. Rain is the main form of precipitation. Above 1,400 m a large proportion of the winter precipitation falls as snow, and much of the high ground is snow-covered during part of the winter. Hail is more common in winter, but summer hail-storms with large stones may be heavy and destructive. Figure 1 indicates average precipitation, most of which (65%) occurs during winter.

Table 5 of Appendix 2 illustrates the variability of the rainfall, which is more reliable in summer.

High-intensity rainstorms are normally short, and their duration and intensity are not recorded. However, Figure 2 shows the average rainfall per wet day and can be taken as a very approximate guide. In conjunction with Figure 1, it indicates that the high-intensity storms mainly occur in summer.

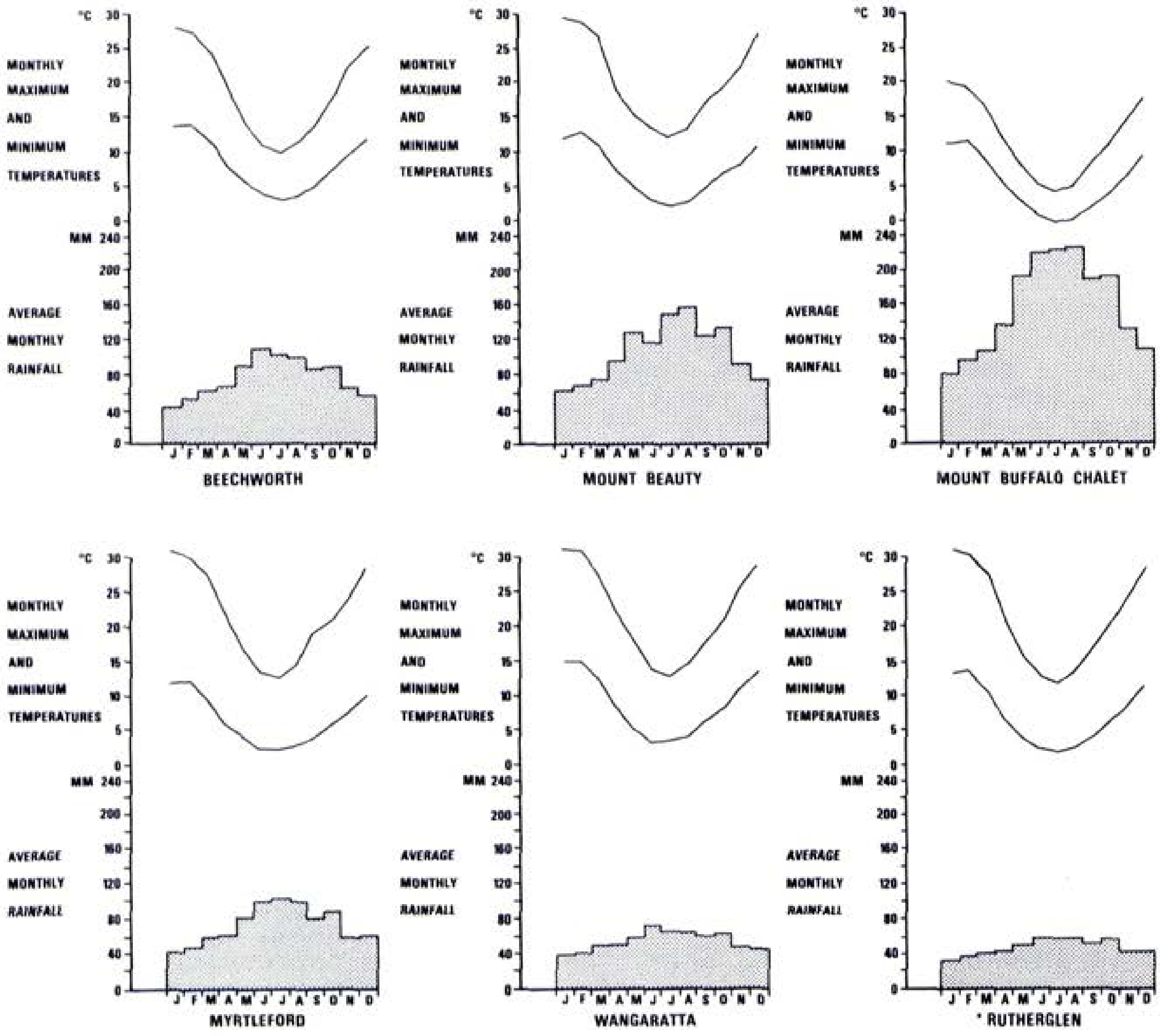
The lower-lying areas and river flats flood regularly. This flooding is local and normally of short duration in the winter months.

Temperature

Figure 1 also indicates temperatures experienced in the area. The relation between altitude and minimum temperature is complex and influenced by local topography.

During clear nights radiation cooling at higher altitudes is rapid. Cold air sinks under the influence of gravity and displaces warmer air in the valleys and on lower ground. This cold air can collect in depressions and cause frost pockets, which consequently have a spotty geographical distribution. Table 3 gives the incidence and variability of general frosts in the region and illus-

FIG. 1 AVERAGE MONTHLY RAINFALL AND MONTHLY MAXIMUM AND MINIMUM TEMPERATURES



* OUTSIDE THE STUDY DISTRICTS

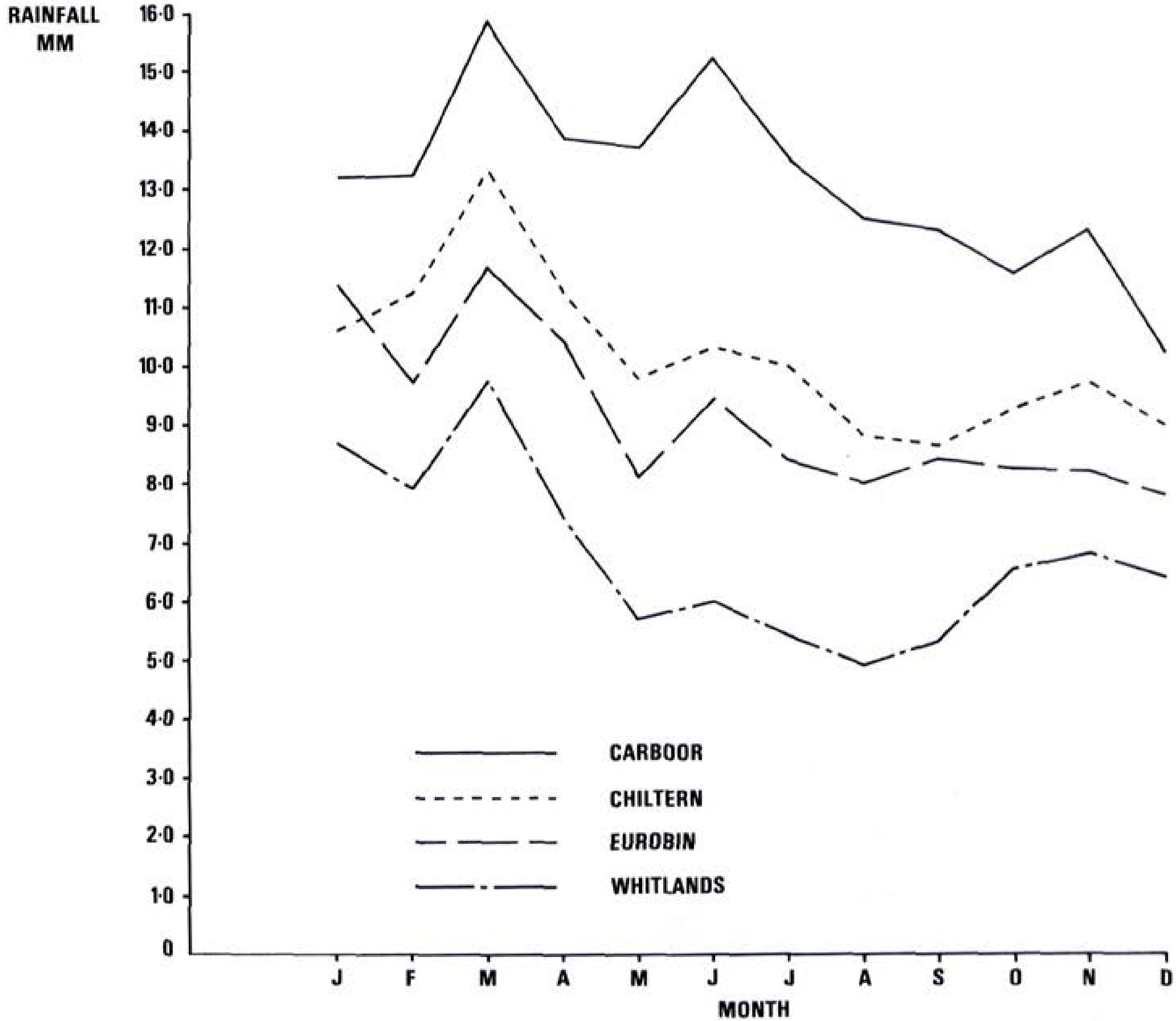


FIG 2 AVERAGE RAINFALL PER WET DAY

TABLE 3

OCCURRENCE OF FROST

Station	Average frost-free period	First 2.2° C			First 0° C			Last 0° C			Last 2.2° C		
	Days	1	2	3	1	2	3	1	2	3	1	2	3
Beechworth	148	Apr 4	30	Jan 16	May 28	29	Mar 21	Sep 18	23	Nov 11	Nov 6	20	Dec 21
*Benalla	233	May 13	13	Mar 9	Jun 17	21	May 6	Aug 5	17	Sep 4	Sep 21	18	Nov 11
Mt.Buffalo	44	Jan 28	25	Jan 3	Mar 26	26	Jan 8	Nov 25	13	Dec 23	Dec 14	9	Dec 29
Mrytleford	127	Mar 19	26	Jan 8	Apr 29	16	Mar 1	Oct 21	29	Nov 23	Nov 11	12	Dec 10
*Rutherglen E. F.	182	Apr 15	17	Feb 26	May 17	14	Mar 24	Sep 12	15	Nov 11	Oct 14	17	Nov 30
*Wangaratta	235	May 10	11	Mar 24	Jun 7	14	Apr 23	Aug 18	14	Oct 22	Sep 16	12	Oct 24

* Outside the study districts
1. Average date of occurrence (calculated on the 10-year period 1930--39).
2. Mean deviation from average date (days)
3. First or last date of occurrence

N.B. 2.2° C in the meteorological screen indicates a light frost at ground level and 0° C indicates a heavy frost

Source: Frost in the Australian region. J.C. Foley. *Commonwealth Meteorological Bureau, Bulletin* No. 32, 1945.

trates the relative frostiness of the mountainous areas.

Humidity

As Table 4 indicates, the study area is not generally humid. The low humidities exacerbate the moisture deficiency in the summer months. However, occasionally during the summer, humid subtropical air comes in from the Tasman Sea, and has a detrimental effect on some of the agricultural crops in the area.

Climate and Plant Growth

In addition to biotic, physiographic, and edaphic factors, climate forms part

TABLE 4

AVERAGE INDEX OF MEAN RELATIVE HUMIDITY

Station	Number of years recorded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beechworth	30	49	50	55	64	72	75	75	72	64	50	55	53
Mount Buffalo	25	54	60	64	70	73	79	82	80	71	67	61	60
Myrtleford	13	56	61	65	70	70	76	76	72	72	73	68	60
Rutherglen *	27	60	56	62	71	77	83	82	79	80	70	69	64
Wangaratta	32	41	43	52	61	71	77	75	73	66	60	50	43

* Outside study districts

Source: "Climatic Averages, Australia." (Commonwealth Bureau of Meterology: 1956.)

of the environment that affects plant growth. The principal factors are temperature, length of the frost-free period, moisture, sunshine, and wind.

There is normally an optimum temperature range in which an individual type of plant grows best. The optimum varies with the stage of growth. For crop plants, temperature affects quality as well as quantity of growth. The average period during which this is continuously above freezing is the growing season for an area, although the actual length depends on the individual crop and its frost tolerance.

Moisture conditions are very important. Moisture in the soil that is available for plant growth acts as a reservoir. Precipitation adds to this reserve and transpiration decreases it.

The effect of precipitation in increasing soil moisture varies because of surface *run-off*, and surface evaporation. Effective use of soil moisture depends on evaporation demands; a given measure of soil moisture will sustain plant growth for a shorter period in hot dry weather than in cool humid conditions.

Individual plant species vary in moisture requirement during the year and also in their ability to use soil moisture and unseasonal rain.

Figure 3 illustrates the potential growing period for pasture, taking into account average seasonal temperature and an estimate of the average rainfall available.

Sunshine as an energy source for photosynthesis has an important influence on plant growth. The intensity and duration of sunshine as well as day length influence the types of plants that grow and flower best in the region.

The average number of hours of sunshine increases going north. In January the southern part of the study area receives about 300 hours, whereas the north of the region has more than 325 hours for the month.

In winter the *humid* westerly winds bank cloud up on the mountainous regions. This distorts the average incidence of sunshine, and so in July the high country receives, on average, 125 hours of sunshine compared with a little more than 150 hours for the low lands in the west and *north of the districts*.

The effects of wind on plant growth are mainly indirect - transport of moisture, heat, pollen, and seeds for example - but direct mechanical damage can be important. High winds can damage fruit and nut crops, and also forest trees. Occasionally tornadoes occur on flat land.

Climate clearly has an important effect on the incidence of plant diseases and pests.

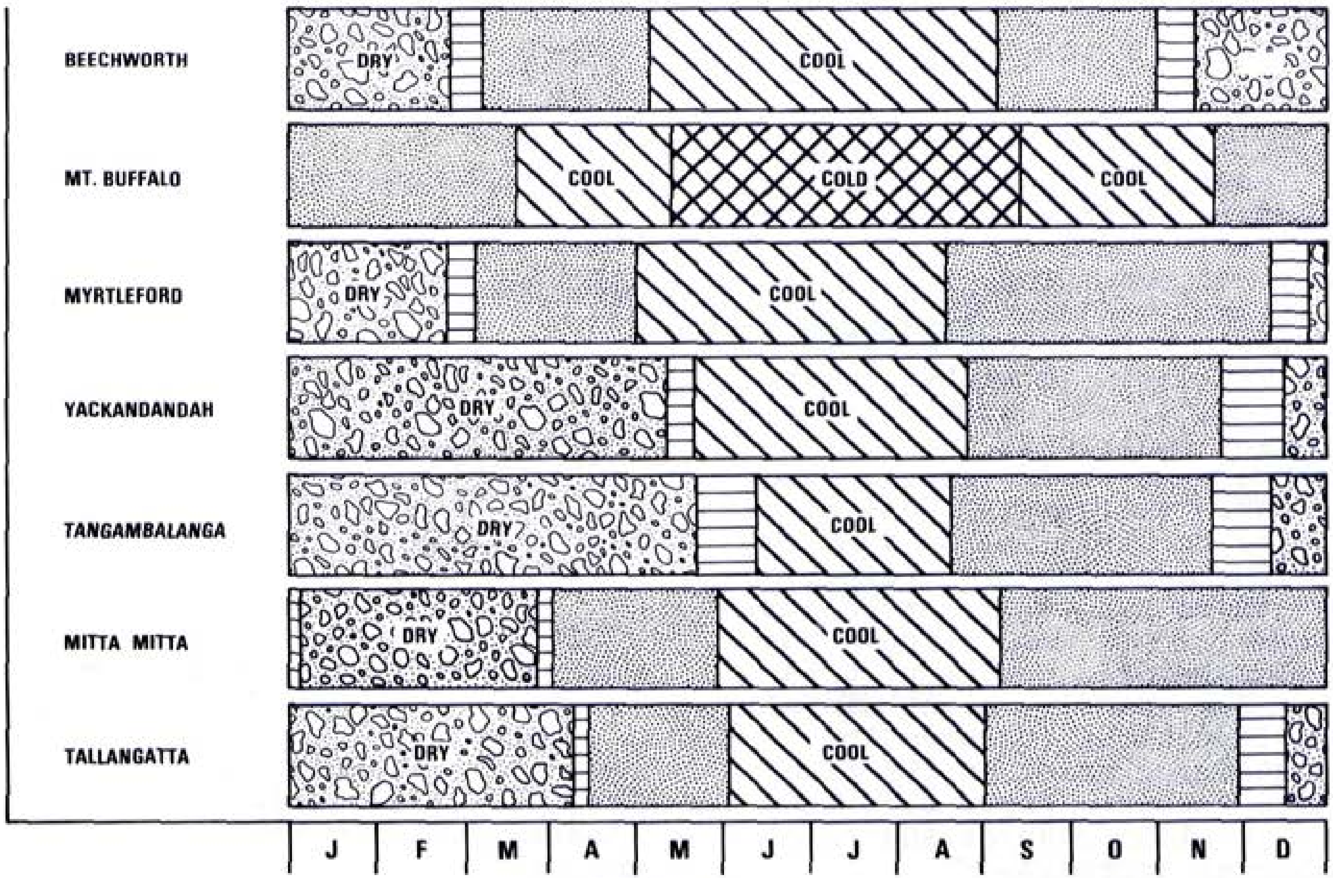


FIG. 3 GROWING SEASON

DIAGRAMMATIC REPRESENTATION OF THE POSSIBLE EFFECTS OF MOISTURE AND TEMPERATURE ON THE GROWTH OF A TYPICAL PASTURE SPECIES AT VARIOUS LOCATIONS IN THE STUDY AREA ASSUMING THE AVAILABILITY OF SOIL MOISTURE IS 50 MM

PERIOD OF PLANT GROWTH

GROWTH LIMITED BY LOW TEMPERATURES (COOL CONDITIONS)

GROWTH STOPPED BY VERY LOW TEMPERATURES (COLD CONDITIONS)

PERIOD OF REPLENISHMENT OR REDUCTION OF SOIL MOISTURE: MOISTURE STRESS FOR PLANT GROWTH DECLINING OR DEVELOPING

GROWTH STOPPED BY DRY CONDITIONS

Climate and Human Activity

Industrial

Climate has an important effect on the location of industry. Once an industry is established in an area, climatic factors can influence costs. For example, uncomfortably hot conditions in summer involve additional building and running costs to maintain normal cool working conditions. Similarly in winter, heating, frost-proofing, and absenteeism can become important additional costs. Industry, for a number of reasons, tends to be situated in valleys. Stable air has an affinity for valleys and temperature inversions are common. Stagnation of air about towns can cause air pollution problems. Climate also affects the rate at which materials and structures deteriorate. For example, high rainfall and freezing conditions increase the costs of maintaining roads in the high country, while the warm dryer climate in the Riverine plain reduces the rate at which material corrodes.

Recreation

Climate has an influence on life styles in the region. Long hours of sunshine and little rain in the summer permit the planning of outdoor activities including recreational pursuits. Activities associated with water are popular and so are activities in the wooded hilly country, where cooling breezes moderate the temperatures and the air tends to be cleaner. In winter, cooler weather and snow on the higher country changes the pattern of outdoor activity, and other forms of outdoor recreation come into vogue. Figure 4 - hythergraphs for some of the weather stations in the area - illustrates diagramatically the approximate effect of temperature and rainfall on body comfort.

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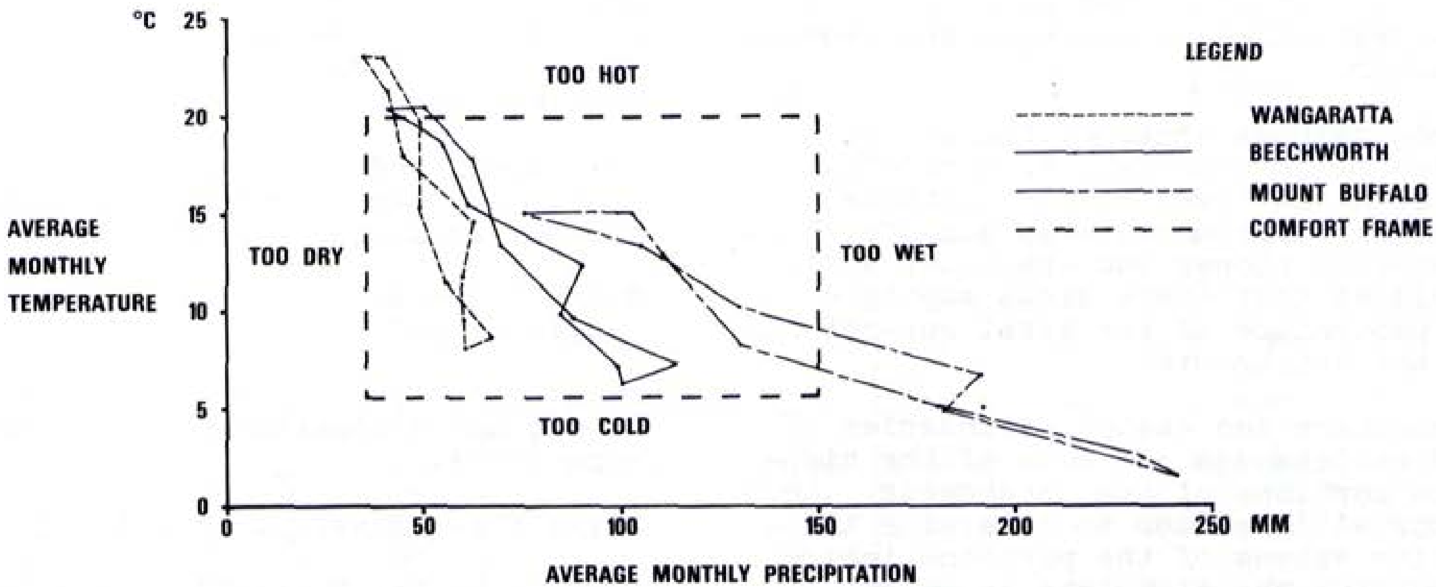
FIG. 4 HUMAN COMFORT

HYTHERGRAPHS FOR THREE STATIONS WITH A COMFORT FRAME SUPERIMPOSED



WATER RESOURCES

Surface Water

This region contains parts of some of the more highly productive water catchments of the State. Catchment yields are related firstly to precipitation rates and secondly to the percentage of this precipitation lost as evaporation, transpiration, deep seepage, and impounded water.

The mountainous areas of the districts receive higher rainfall (see rainfall map) than the lower valley sections and are also more conducive to run-off, having steeper slopes and shallower soils. It follows that these areas supply a high percentage of the total run-off from the catchments.

The southern and eastern boundaries of the districts cut off some of the high-return portions of the catchments. Some attemps will be made to determine the relative values of the portions inside and outside the districts as water sources, although it is obvious that each catchment is more properly considered as a unit.

The principal catchment basins are as follows:

* Mitta Mitta River
* Kiewa River
* Ovens and Buffalo Rivers
* King River
* Fifteen-mile Creek

Each of these basins is discussed separately. References to water quality normally refer to water quality (total dissolved solids) in the lower valley sections of each basin.

Some small and relatively dry catchments in the northern section of the districts are not included in these discussions.

Table 5 presents records of some of the gauging stations in the region.

Water quality criteria for domestic, stock, and irrigation purposes appear in Appendix 3.

Mitta Mitta River catchment basin

The 18% of the Mitta Mitta catchment lying within the North Eastern Districts 3, 4, and 5 contributes 22% of the mean annual flow. This above-average contribution is unusual, as the lower reaches of a river basin normally contribute less per km^2 than the upper reaches. It

TABLE 5

SURFACE WATER RESOUCES

GAUGING STATION	SERIAL NUMBER	OPERATIONAL	ANNUAL DISCHARGE (megalitres)			SALINITY* at various river flows■				
			Maximum	Minimum	Mean	Maximum Salinity	River Flow	Minimum Salinity	River Flow	Mean Salinity
Buffalo River at Lake Buffalo	403,220	Sept. '63 to date 9 water years	679,400	70,930	427,450	36 @	110	14 @	127	24
Dandongadale River at Matong North	403,218	Jan. '64 to date 9 water years	102,980	11,580	71,090	55 @	44	17 @	163	25
Fifteen Mile Creek at Greta South	403,213	Dec. '58 to date 14 water years	79,080	8,660	49,880	65 @	159	21 @	286	33
Kiewa River at Kiewa	402,220	Jan. 1886 to date 87 water years	2,076,860	166,340	636,910	75 @	183	12 @	1,641	29
King River at Whitfield	403,203	Jan. '25 to Dec. '72. 45 water years	885,120	57,480	325,750	42 @	125	16 @	736	24
Mitta Mitta River at Tallandoon	401,204	Jan. '36 to date 37 water years	3,222,600	273,830	1,291,420	50 @	499	15 @	7,831	29
Ovens River at Bright	403,205	Jan. '25 to Dec. '33, Mar. '44 to date. 37 water years	656,710	45,760	232,420	57 @	5,472	20 @	232	29
Ovens River at Myrtleford	403,210	Jan. '62 to date 11 water years	966,930	99,300	538,870	50 @	692	12 @	526	27
Ovens River at Wangaratta	403,200	Jan. '41 to date 32 water years	4,153,750	222,030	1,598,590	138 @	95	23 @	1,947	48
Reedy Creek at Woolshed	403,221	Jan. '65 to date 8 water years	41,740	2,450	27,550	88 @	7	54 @	166	70
Rose River at Matong North	403,217	Sept. '62 to date 10 water years	101,130	9,450	68,270	41 @	100	17 @	42	23
Tallangatta Creek Bullioh	401,205	Jan. '36 to date 37 water years	354,380	9,500	97,490	97 @	237	39 @	440	52
Yackandandah Creek Osbornes Flat	402,204	Jan. '65 to date 8 water years	60,640	10,360	41,260	86 @	46	23 @	37	56

* measured in milligram per litre

■ measured in megalitres per day

results from the rain-shadow conditions that occur over much of the Upper Mitta Mitta catchment. The average annual discharge per unit area for the portion of catchment within the districts is 330 Ml per km^2.

The Mitta Mitta River is comparitively reliable, contributing 22% of its average annual discharge during the 6 months December to May inclusive, including 9% during the 3 months January to March. Analyses of water samples taken quarterly at Tallandoon since 1949 indicate that the water is suitable for all purposes (irrigation, stock, domestic, and industrial). High turbidity for short periods after rain may lessen the suitability of the water for domestic purposes.

Kiewa River catchment basin

The districts contain 73% (1,298 km^2) of the total Kiewa catchment, which contributes approximately 40% of the mean annual flow of the Kiewa River, but not the section of catchment above Tawonga. The part within the study area has an average annual discharge of 240 Ml per km^2, while the part outside it (including the highly water-productive Mount Bogong, Mount Feathertop, and Mount Hotham areas) returns an average of 920 Ml per km^2 annually.

The Kiewa River is also comparitively reliable, 22% of the average annual discharge at Kiewa occurring during the 6 months December to May inclusive and 8% during the 3 months January to March.

During the 1967/68 drought, with all use of water for irrigation prohibited, the stream ceased to flow in its lower section for short periods, and releases from the State Electricity Commission storages were used to re-charge it.

Analyses of quarterly water samples taken at Kiewa since 1949 indicate that the water is of good quality and suitable for all purposes. Occasional turbidity readings have indicated that, during short periods, the water is just within the upper limits normally accepted for domestic use.

Ovens and Buffalo Rivers catchment basin

Of the total catchment above Wangaratta, 83% (3,290 km^2) is within the districts, and the average annual discharge for the whole of this and the King Catchment is 275 Ml per km^2.

The 680 km^2 of catchment outside the districts is part of the mountainous upper portion with good water-production characteristics. This area includes parts of Mount Hotham, the Barry Mountains, Mount Selwyn, and Mount Cobbler.

However, much highly productive water catchment lies within the districts, including Mount Buffalo and the high range between the Buffalo and Buckland Rivers, parts of the Black Range and other mountains between the Rose and King Rivers, and some areas on the north side of the catchment including part of Mount Porepunkah and the Mount Stanley areas.

The Ovens River at Wangaratta yields 14% of its average annual discharge during the 6 months December to May inclusive, with 3½% during the 3 months January to March.

Analyses of samples taken quarterly at Wangaratta (including water from King River) indicate good-quality water suitable for most uses. Colour and turbidity may prohibit domestic use at times.

King River catchment basin

Of a total catchment area of 1,600 km^2, 1,340 km^2 (or 84%) is within the districts. The remaining 260 km^2 outside is highly productive of water, contributing nearly 900 Ml per km^2, and embraces part of Mount Sterling, Mount Speculation, and Mount Cobbler.

No direct measurement of discharge is made in the lower reaches of the King River. However, a reliable estimate can be made from a series of adjacent measuring stations. This estimate gives an average annual flow of 500,000 Ml or 300 Ml per km^2, slightly higher than the average annual discharge per unit area of the Ovens and Buffalo catchment.

The catchment is also slightly more reliable, 16% of the average annual discharge being delivered during the 6 months December to May inclusive, with 4% during the 3 months January to March.

Snow on Mount Buffalo: some of the winter precipitation is held as snow, delaying run-off until is melts in spring

Water quality is good and the water may be used for all purposes, although high turbidity and colour may lessen its suitability for domestic use at times, particularly in the lower section of the stream. The mean salinity of samples

The King River near Whitfield

taken at Whitfield over a period of 6 years is 24 mg per 1.

Fifteen-mile Creek catchment basin

This catchment covers a total area of about 460 km^2, and most of it is within the districts. The western boundary of the districts approximates its western edge. The portion above the gauging station at Greta South is 220 km^2 in area, and yields an annual average of 49,882 Ml or 227 Ml per km^2. The portion below Greta South is relatively unproductive, reducing the average for the whole catchment to probably about 130 Ml per km^2 - a dry catchment by comparison with most others in the study area.

Of the average annual discharge at Greta South, 15% occurs during the 6 months December to May inclusive, with 3% during January to March. The stream has heavy irrigation commitments that often suffer restrictions, and during the summer months the stream regularly ceases to flow in its lower section.

Water quality is fair, being suitable for all purposes except domestic. Fifteen-mile Creek forms part of the supply to Glenrowan and this supply is generally good although it has high bacterial counts at times, particularly when creek flows are low. The mean salinity of samples taken at Greta South over a period of 6 years is 33 mg per l.

Groundwater

The alluvial deposits (probably the only sediments capable of yielding useful quantities of groundwater in the study districts) contain two types of aquifer. The first occupies a shallow surface layer, and really forms part of the surface water system. The second type occupies deep sand layers that meander across the valleys.

Shallow unconfined gravel aquifers exist throughout most of the valleys. They occur at or near the surface and can be as much as 6 m thick. The main intake of the aquifer is probably located along the beds and banks of the streams flowing through it. Wells situated near the streams or their abandoned meanders have been successful in tapping large quantities of water, although less favourably sited wells fail during dry seasons.

Fifteen-mile Creek: water quality is fair with high bacterial counts at times

The alluvial deposits occupy and partly fill the ancient valley system. The greater proportion of them comprise unsorted impervious mixtures of boulders, sand, and clay. Permeable sand lenses occur to a limited extent and probably follow a meandering pattern within the more impervious material. They are more common and more extensive closer to course-grained source rock such as granite. These deep aquifers are difficult to locate, and appear to be confined to the deepest sections of the alluvial deposits, which are about 30 m thick at Harrietville and deepen to 60 m at Myrtleford and 120 m at Wangaratta.

The groundwater in the area is of good quality. In general it contains less than 200 mg of total dissolved solids per l. The quantity of groundwater is limited; Thompson (1970) estimated that, between Bright and Myrtleford, a total of about 1,600 Ml of water passed through the system per year and that, because of the limited water storage in the system, only about 1,200 Ml of water could be withdrawn (in excess of the total amount transmitted) in any one year without commencing to deplete the aquifer system. However, Thompson suggested that these figures were too high because they assumed that the aquifer extended completely across the full width of sediments in the valley, which is not the case.

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VEGETATION

The natural vegetation of an area is determined largely by the environmental factors of the site and can therefore be a useful guide in assessing land use capabilities.

The whole of the study area was originally covered by forests except for sub-alpine vegetation on Mount Buffalo and the woodlands on the Riverine plain. The forests and woodlands have been cleared or thinned on nearly all of the private land. The remaining native forests on the public land have retained their essential character, although nearly all have been influenced to varying degrees by European settlement - for example, by logging, grazing, and the introduction of new plant and animal species.

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 the vegetation map shows their distribution on public land.

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 recognizable in the field and each unit reflects the operation of a certain set of environmental factors. Complexes have been mapped where several distinct structural classes form a mosaic over large areas.

Heath, Herbland (Sub-alpine Complex)

This complex includes all the sub-alpine communities without trees. It occurs, in these study districts, only on the Buffalo plateau.

Sedge fen

In this community, the plants grow in water or permanently saturated soil. Hummock-forming mosses are absent. It is a common form of vegetation along all the perennial drainage lines that have a relatively flat gradient. Sedge *(Carex gaudichaudiana)* dominates most of the fens on the Buffalo plateau.

TABLE 6

VEGETATION UNITS

Map symbol	Structural form	Major species of tallest stratum	Associated tree species
1	Sub alpine complex; heath, herbfield	Snow grass, Sedge, Sphagnum moss, Heaths, Billy button, Alpine baeckea, Rusty pod, Mountain gentian, Leafy bossiaea	
2	Dry Heath	Myrtle tea-tree, Common fringe myrtle, Violet kunzea, Buffalo sallow wattle, Lemon wattle bush	Brittle gum
3	Open Forest I Woodland I	Snowgum	
4	Open Forest I and II	Snowgum, Candlebark	Broad-leaf peppermint
5 (r)	Open Forest IV (=regrowth)	Alpine Ash	Candlebark, Snowgum, Bogong gum, Narrow-leaf peppermint
6	Open Forest III and IV	Messmate stringybark	Manna gum, Candlebark, Narrow-leaf peppermint, St. John's blue gum
7	Open Forest III	Narrow-leaf peppermint	Manna gum, Candlebark, Brittle gum, Broad-leaf peppermint, Red stringybark
8a	Open Forest II	Broad-leaf peppermint	Candlebark, Red stringybark, St. John's blue gum, Narrow-leaf peppermint, Long-leaf box, Brittle gum
8b	Open Forest II	Broad-leaf peppermint	Brittle gum, Long-leaf box
9a	Open Forest II	Long-leaf box	Candlebark, Red box, But-But, Broad-leaf peppermint, Red stringybark, Yellow box, Grey box
9b	Open Forest I	Long-leaf box	Forest red gum, Black cypress pine, Red box, White box, Red stringybark
10	Open Forest II Open Forest I	Red iron bark	Red stringybark, Red box, White box, Grey box
11	Open Forest II	Grey box	Red box, Red stringybark, Yellow box
12	Open Forest I	Black cypress pine	Blakely's red gum, Long-leaf box, Red stringybark
13a	Open Forest II Woodland II	Blakely's red gum	White box, Long-leaf box, Yellow box, Red box, But-But
13b	Open Forest I Woodland I	Blakely's red gum	
13c	Open Forest II Woodland II	River red gum	
14	Open Forest II	Swamp gum	Black sallee

Sphagnum moss bog

Sphagnum moss (*Sphagnum* spp.) is the dominant vegetation. The community is in a constant state of cyclic change in a series of hummocks and hollows. The hollows are normally waterlogged, but shrubs such as candle heath (*Richea continentis*) and swamp heath (*Epacris paludosa*) may become established on the hummocks.

These bogs are unstable and sensitive to damage by trampling or alteration of the drainage pattern.

Sphagnum moss bog seems to thrive where the rockiness of the drainage line prevents stream entrenchment.

Wet heath

Wet heath occurs on the wetter parts of the high valley plains and may have snow grass (*Poa* spp.). The most common shrubs are alpine baeckea (*Baeckea gunniana*) and drumstick heath (*Epacris breviflora*). There are indications that this vegetation may not be a climax type, but instead develops as a bog community gradually dries out to become a grassland.

Snow grass grassland

This comprises a closed sward of closely associated but discrete tussocks of snow grass with abundant overlapping leaves. Herbs such as billy button (*Craspedia glauca*) and mountain gentian (*Gentianella diemensis*) occur occasionally. Shrubs such as rusty pods (*Hovea longifolia*) and leafy bossiaea (*Bossiaea foliosa*) often form a narrow strip between the grassland and the sub-alpine woodlands on the slopes.

Heath Mossland

Heath mossland grows on the steep rocky faces of the scarps at mid-elevation on

Sub-alpine complex on Mount Buffalo: in the foreground a bog, on the slope grassland and heath with snow gum woodland on the right.

Mount Buffalo, where it clings to rocky crevices and shallow soils formed from rock detritus. Occasional small trees of brittle gum *(Eucalyptus mannifera)* occur, but the predominant vegetation is a dry heath composed of such species as myrtle tea-tree *(Leptospermum myrtifolium)*, violet kunzea *(Kunzea parvifolia)*, lemon bottlebrush *(Callistemon pallidus)*, Buffalo sallow wattle *(Acacia phlebophylla)*, and common fringe myrtle *(Calytrix tetragona)*.

Dry heath on shelving rock with brittle gum in the background

The continued accumulation of soil material that results in the development of deeper soils favours species with a higher moisture requirement. These generally grow more rapidly and produce more complete cover than do the shrubs, and so the shrub community is eventually excluded.

The deep rooting of the woody perennials in the rock crevices is essential for the stability of the soils in these areas, which are thus extremely susceptible to erosion if the vegetation is disturbed. Wildfire is especially damaging to this community.

Snow Gum Open Forest 1 and Woodland 1

This community occurs in sub-alpine environments generally above 1,200 m elevation on exposed rocky outcrops and as a grassy woodland on flatter areas in elevations up to about 1,700 m.

Rainfall varies from 760 to 2,000 mm per annum and winter snow may persist for up to 4 months. The wide precipitation range indicates that other factors must be exerting control over the distribution. It seems most likely that the duration of winter snow and low temperatures during the growing season are the important factors.

Snow gum *(Eucalyptus pauciflora)* is the principal tree species. It occurs as a multi-stemmed mallee varying in height from about 2 to 10 m. The understorey varies from a sward of snow grass to a dense leguminous shrub layer. This range is probably due to the pattern of fire occurrence. Shrubs that occur include hickory wattle *(Acacia obliquinerva)*, alpine wattle *(A. alpina)*, alpine oxylobium *(Oxylobium alpestra)*, and hop bitter-pea *(Daviesia latifolia)*. Other common species include box micrantheum *(Micrantheum hexandrum)*, alpine pepper *(Drimys xerophila)*, and shrubby platysace *(Platysace lanceolata)*.

Buffalo sallee *(Eucalyptus mitchelliana)* is endemic to the Buffalo plateau and occurs in the snow gum woodland in the lower part of the range, predominantly in the very rocky areas.

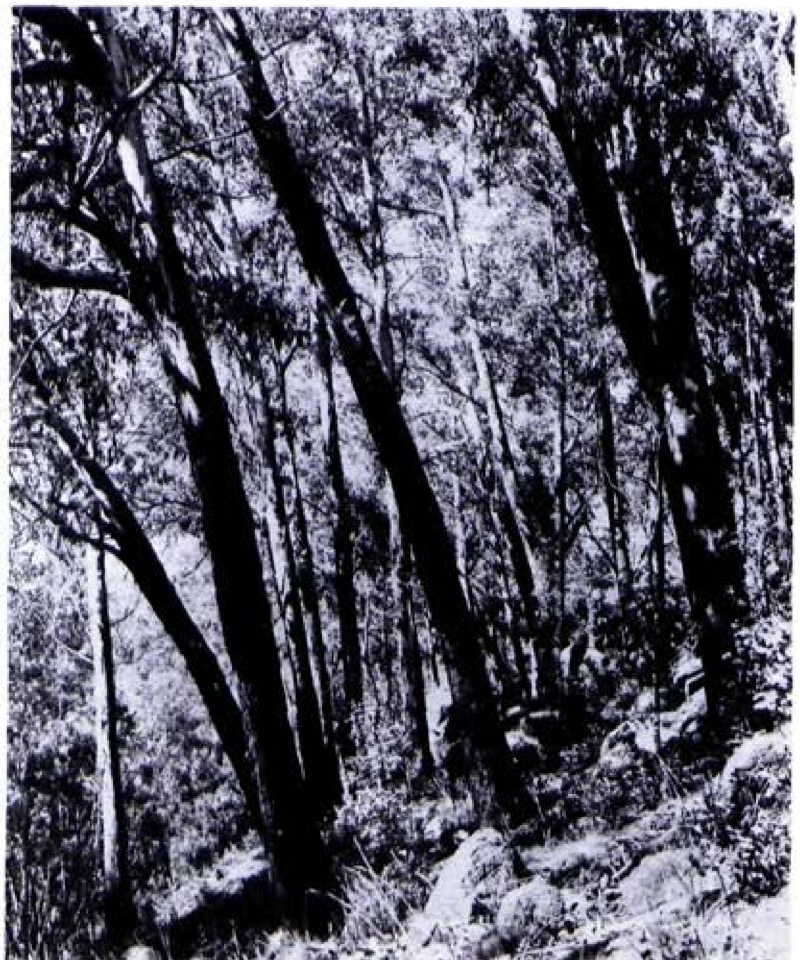
Candlebark--Snow Gum
Open Forest I and II

This unit varies in form: in some places it may approach an open forest up to 25 m tall and in others is transitional to a stunted sub-alpine woodland. Candlebark *(Eucalyptus rubida)*, mountain gum *(E. dalrympleana)*, and snow gum are the principal trees.

It occurs between about 900 and 1,400 m elevation and appears to be restricted to areas where soil moisture is less than optimum for alpine ash *(E. delegatensis)*. It often occurs within the alpine ash forest on dry, exposed ridges and grades into broad-leaf peppermint open forest II at lower elevations on the drier aspects.

Snow gum--candlebark open forest II on Mount Buffalo

Candlebark and mountain gum are usually tall trees, but the snow gum is generally a multi-stemmed mallee some 5--10 m tall. The ground flora (usually a more or less closed sward of snow grass with a heavy forest litter) may contain scattered or numerous shrubs of hop bitter-pea and handsome flat-pea on warmer sites or leafy bossiaea and common oxylobium *(Oxylobium ellipticum)* on cooler sites.



Alpine ash with slight fire damage growing on a rocky site on Mount Buffalo

Alpine Ash Open Forest III and IV

Alpine ash grows in virtually pure relatively even-aged stands on sheltered sites at elevations of about 1,000--1,400 m. The most extensive stands in the study districts are on the Mount Buffalo plateau, but the species is widely distributed in small stands wherever a suitable site exists.

Other species occur in mixture with it as the site conditions become marginal. At the lower, or warmer, end of the range, these may include broad-leaf peppermint *(E. dives)*, Bogong gum *(E. chapmaniana)*, candlebark, and narrow-leaf peppermint *(E. radiata)* in varying proportions. At the cooler end of the range, on drier sites, mountain gum and sometimes snow gum occur within the alpine ash stands.

Beneath the tall tree canopy, the subordinate strata consist of small trees of silver wattle *(Acacia dealbata)* and hickory wattle and shrubs such as hop bitter-pea, alpine oxylobium, and elderberry panax *(Tieghemopanax sambucifolius)*.

In some communities the shrub layer is almost absent and ground cover comprises forest litter and scattered herbs and grasses, mainly tussock grass *(Poa* spp.)

Seed dormancy and the occurrence of wildfire regulate the distribution of alpine ash. The dormancy of the seed is broken only by low temperature, and suitable conditions are found where snow lies for at least a few weeks in winter. This occurs at the lower end of the range of winter snowfall. Annual precipitation ranges from 1,000 to more than 1,500 m. The forest attains its best form on deep well-drained soils where soil moisture is adequate.

Messmate Open Forest III and IV

Messmate *(Eucalyptus obliqua)* is confined to the south-west of the study area, where it occupies the deeper soils of the sheltered gullies and plateaux.

The elevation ranges from 600 to 1,000 m, and average annual rainfall is about 1,250 mm.

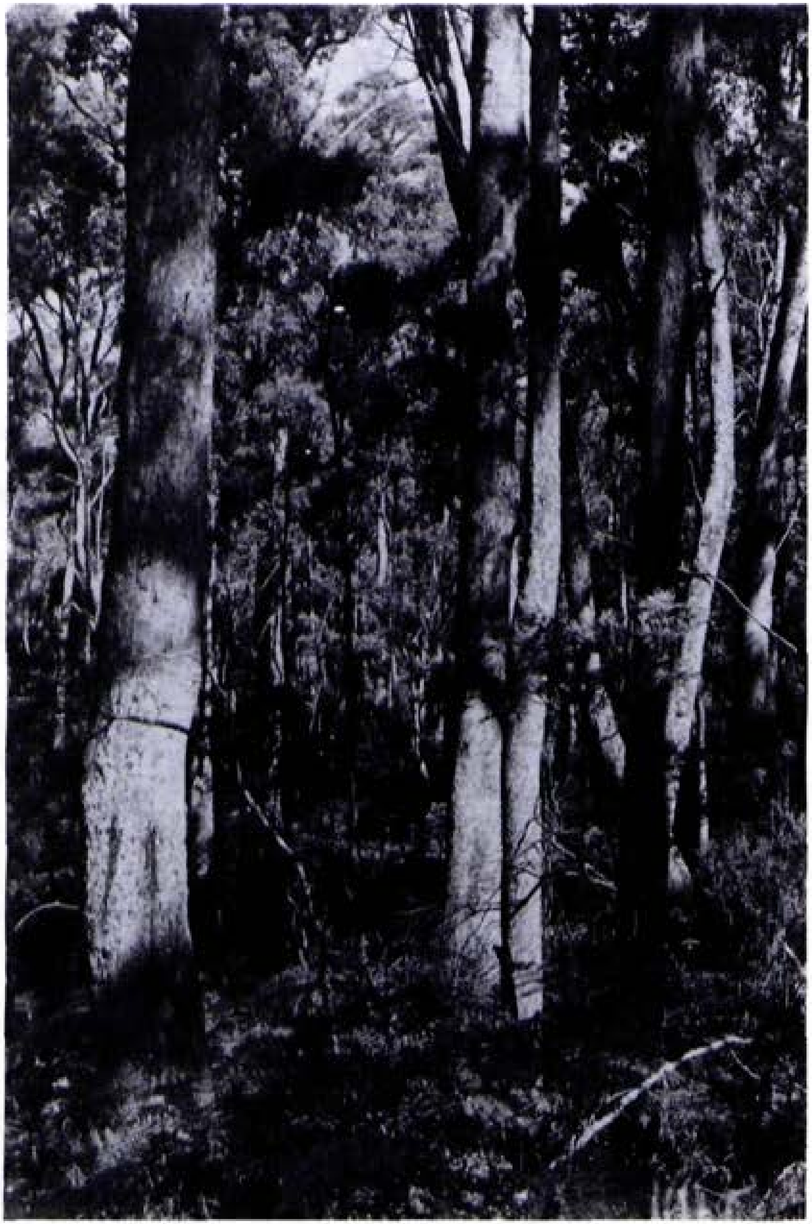
The species occurs either in pure stands or in mixtures with narrow-leaf peppermint, St. John's blue gum - sometimes called eurabbie - *(E. St. Johnii)*, manna gum *(E. viminalis)*, and mountain gum. Stand height generally exceeds 30 m.

The understorey comprises tussock grass, bracken *(Pteridium esculentum)*, dogwood *(Cassinia aculeata)*, and silver wattle, with such species as musk *(Olearia argophylla)* and hazel pomaderris *(Pomaderris aspera)* in the moist gullies.

Narrow-leaf Peppermint Open Forest III

This unit occupies a large proportion of the forest area in the districts. The principal species is narrow-leaf peppermint, but it is rarely found in pure stands. Moister sites usually carry candlebark, manna gum, and blue gum as associated species. On drier sites the associated species usually comprise

Messmate stringybark open forest III near Whitlands



Narrow-leaf peppermint open forest III

broad-leaf peppermint, brittle gum, and sometimes red stringybark *(E. macro-rhyncha)*.

Narrow-leaf peppermint requires moderately high soil moisture status throughout the year and usually grows in deep well-drained soil at elevations ranging from 460 to 1,100 m, where annual rainfall ranges from about 1,020 mm to more than 1,270 mm. It may also be found in locally moist situations in lower-rainfall areas.

The understorey usually comprises a dense cover of austral bracken *(Pteridium esculentum)* 1--1.5 m tall with a taller (3--7 m) scattered to dense layer of silver wattle. On moister sites small trees and shrubs form a layer 4.5--9 m tall composed of species such as hazel pomaderris *(Pomaderris aspera)*, blackwood *(Acacia melanoxylon)*, dogwood, and musk daisy-bush *(Olearia argophylla)* with soft tree-ferns *(Dicksonia antarctica)* and various others such as fishbone water-fern *(Blechnum nudum)* and austral king fern *(Todea barbara)* underneath.

On drier sites the understorey is mainly a sward of tussock grass with various herbs such as austral crane's bill *(Geranium solanderi)*, ivy-leaf violet *(Viola hederacea)*, Austral bear's ear *(Cymbonotus preissianus)*, prickly starwort *(Stellaria pungens)*, and bidgee-widgee *(Acaena anserinifolia)*. Scattered bracken and silver wattle may also be present.

Broad-leaf Peppermint Open Forest II

Grassy understorey

This unit is widely distributed in the study districts. It occurs on the ridges and northerly aspects of the foothills where rainfall exceeds about 900 mm and on the southerly aspects in areas further north with rainfall of about 700--900 mm.

The principal species, broad-leaf peppermint, is found over the whole range of elevation from 300 to 1,100 m. It is associated with several other eucalypts, depending upon the elevation, soil, and aspect.

At the lower elevations and on generally drier sites, it is commonly associated with red stringybark and also with red box *(E. polyanthemos)* and long-leaf box *(E. goniocalyx)* as the vegetation gradually changes to the box type. As elevation and rainfall increase, candlebark and brittle gum replace the red stringybark. The broad-leaf peppermint extends up to the edge of the snow gum country and the northern and western aspects of several mountains in the study area. It is typically replaced by narrow-leaf peppermint on the deeper soil and in sheltered aspects at lower elevations and by alpine ash on similar sites at higher elevations.

Where tree heights reach about 24--28 m, the understorey is usually bracken and tussock grass with scattered dogwood and silver wattle. Where the heights are lower (18--24 m) the understorey is commonly grassy with scattered shrubs and herbs, including handsome flat-pea, gorse bitter-pea *(Daviesia ulicifolia)*, mountain grevillea *(Grevillea alpina)*, and austral bugle *(Ajuga australis)*.

Broad-leaf peppermint open forest II is a common forest type in the area

Heathy understorey

The community is found only on the Carboniferous sediments in the south-west of the study districts. Its principal

Long-leaf box open forest II near Barambogie

tree species are broad-leaf peppermint and brittle gum, and associated species are long-leaf box and narrow-leaf peppermint.

The understorey is 0.5--1.5 m tall and typically heathy, being composed of such species as small grass-tree *(Xanthorrhaea minor)*, daphne heath *(Brachyloma daphnoides)*, star-hair *(Astrotricha ledifolia)*, small-leaf parrot-pea *(Dillwynia retorta)*, holly lomatia *(Lomatia ilicifolia)*, handsome flat-pea, and gorse bitter-pea.

Long-leaf Box

Open forest II

The tree canopy of this unit is usually 15--28 m tall. The main tree species are long-leaf box and red stringybark. The form is generally limited to elevations below about 600 m and it occurs on the exposed dry ridges in areas where rainfall is about 760 mm annually, but is confined to the gullies in the drier areas north of the study districts.

Red stringybark occurs widely in the study districts and grows on freely drained soils where the annual rainfall varies from 630 mm to 1,020 mm. It is most commonly found in association with box eucalypts, although it is found as an associated species in all the vegetation units in the study districts except those at high elevation and on very wet sites.

Red box *(E. polyanthemos)*, Blakely's red gum *(E. blakelyi)*, but-but *(E. bridgesiana)*, black cypress pine *(Callitris endlicheri)*, broad-leaf peppermint, and narrow-leaf peppermint can occur as associated species.

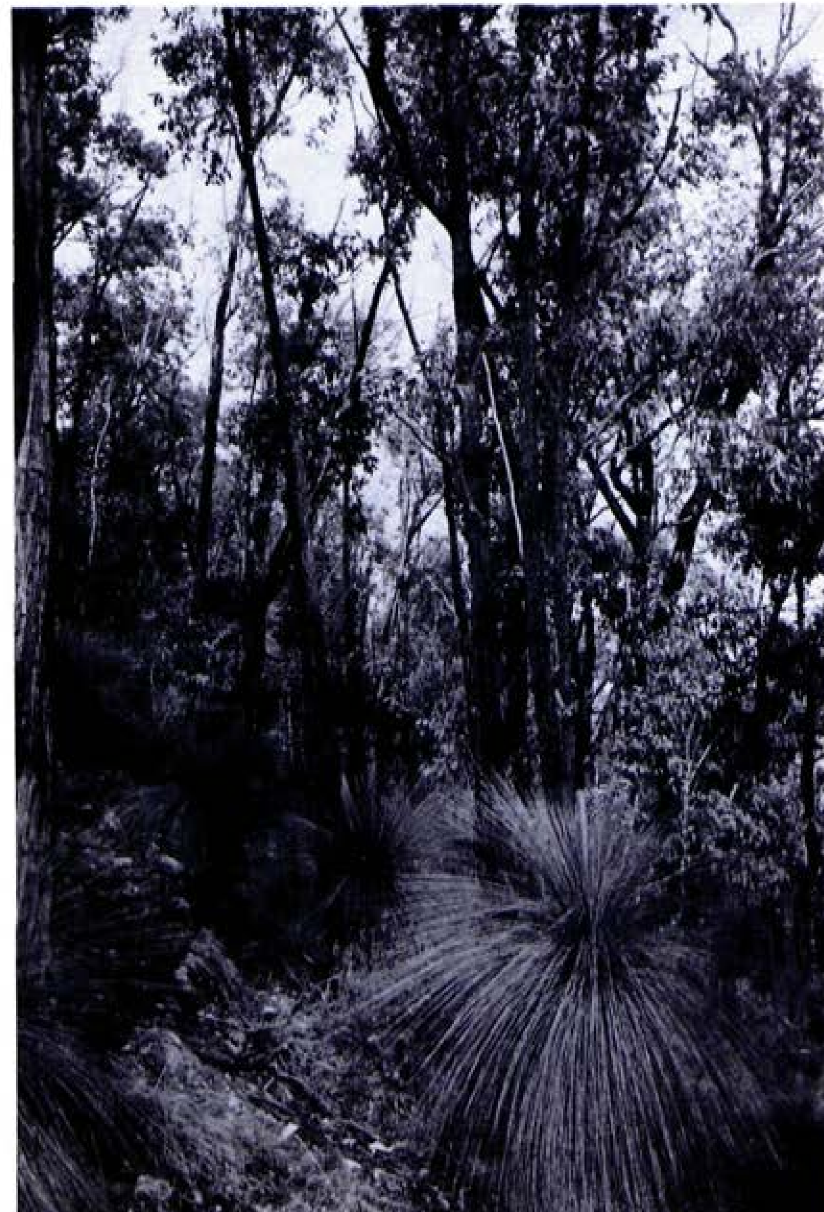
The understorey is variable; in some areas it consists of a sward of tussock grass with scattered wattle *(Acacia* spp.), but can be litter or heathy shrubs includings various species of bush-pea *(Pultenaea* ssp.), acacias, and heaths such as daphne heath *(Brachyloma daphnoides)* and urn heath *(Melichrus urceolatus)*.

Open forest I

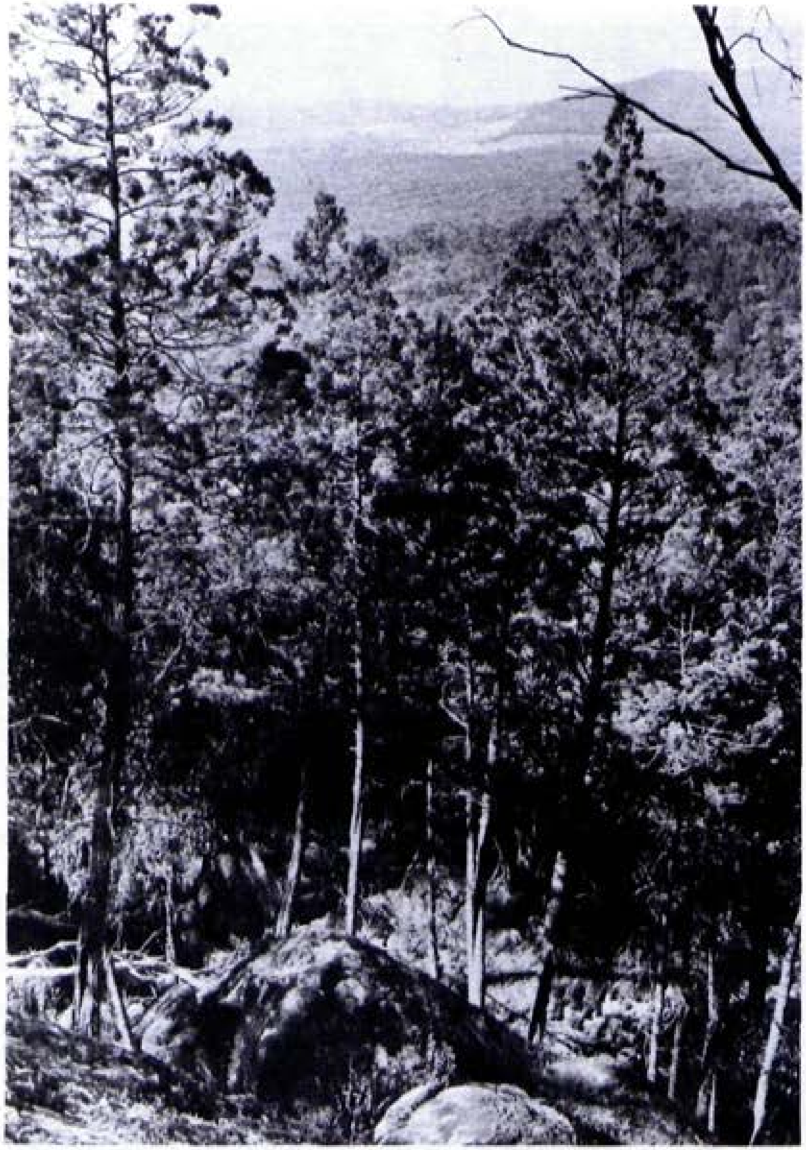
The principal tree species are the same as those in the previous unit, but they are generally less than 15 m high.

Associated tree and understorey species indicate a drier environment than in the taller form, and include black cypress pine and red box and shrubs including austral grass-tree *(Xanthorrhoea australis)*, dagger wattle, *(Acacia siculiformis)*, woolly wattle *(A. lanigera)*, and grevillea *(Grevillea* ssp.). Some sites may not have a shrub layer but only a scattering of tussock grass or even litter alone covering the forest floor.

This type is commonly found on the dry exposed ridges in the north of the study area where soils are shallow and stony.



Long-leaf box open forest I with austral grass-trees in the understorey, near Tallangatta Creek.



Black cypress pine near Mount Pilot, growing between granite boulders; this species often forms pure stands.

Black Cypress Pine Complex

The structural forms of this complex comprise open forest I, closed to open heath, and open mossland. The complex occurs in this study area around Beechworth, Eldorado, and Mount Pilot on the rocky granite outcrops.

Its principal tree species is the black cypress pine; associated species are Blakely's red gum, long-leaf box, red box, and red stringybark. The understorey vegetation is normally sparse and much of the area is covered by a layer of litter. Understorey species include nodding blue lilly *(Stypandra glauca)* and guinea flowers *(Hibbertia* spp.). The noxious weed St. John's wort *(Hypericum perforatum)* is common and often dominates the ground flora.

The fringes of the rocky areas carry a closed to open heath composed mainly of common fringe myrtle *(Calytrix tetragona)* and heath-myrtle *(Micromyrtus ciliata)*, with other species such as rock fern *(Cheilanthes tenuifolia)*.

The open mossland occurs on the rock outcrops and consists of moss and lichens.

Red Ironbark Open Forest I and II

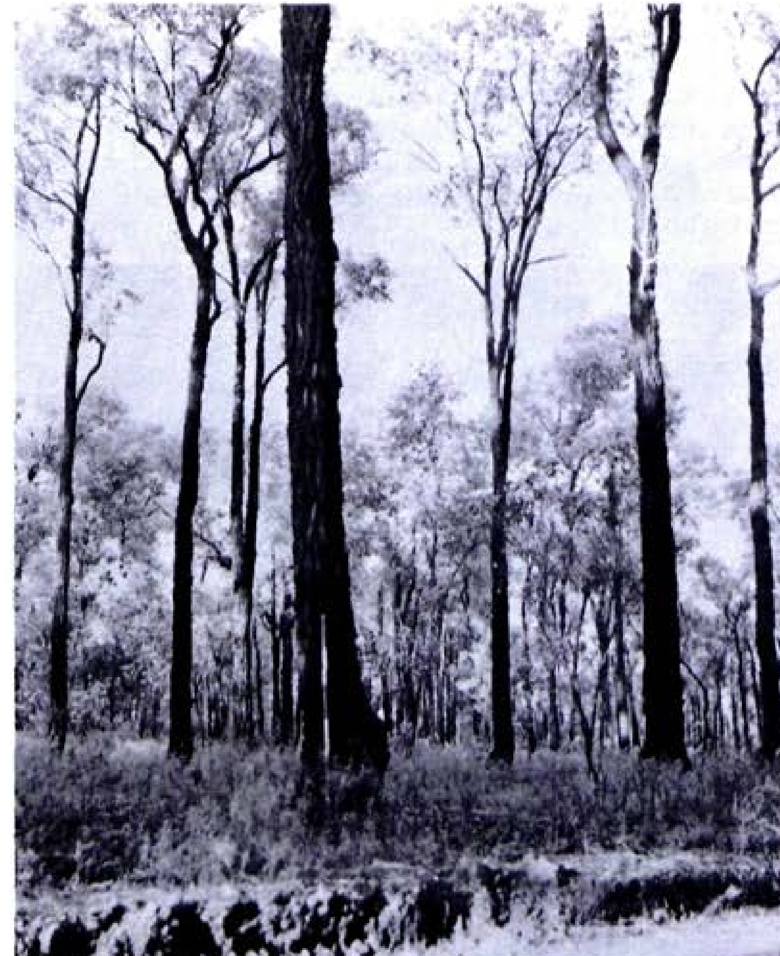
Red ironbark *(E. sideroxylon)* grows in this study area only on soils developed from sedimentary rock in the hills surrounding Chiltern. Annual rainfall averages about 685 mm and the elevation range is from 200 to 400 m. On the dry ridges red ironbark is present in pure stands, and on the slopes it is in mixture with red stringybark, red box, white box *(E. albens)*, and Blakely's red gum. Red stringybark may predominate on steep slopes with a southerly aspect. Tree heights vary from 8 to 25 m depending on soil depth. Soils are generally shallow and usually have an abundance of quartz gravel on the surface.

The understorey is typically drought-resistant and open and consists chiefly of leguminous and epacridaceous plants.

Commonly occurring species are golden wattle *(Acacia pycnantha)*, gold-dust wattle *(A. acinacea)*, narrow-leaf bitter-pea *(Daviesia virgata)*, small-leaf parrot-pea *(Dillwynia retorta)*, woolly grevillea *(Grevillea lanigera)*, and golden everlasting *(Helichrysum* spp. aff. *bracteatum)*. Ground species include tussock grass, silvertop wallaby-grass *(Danthonia pallida)*, and shell grass *(Briza maxima* and *B. minor)*.

Grey Box Open Forest II

An open forest of grey box *(E. microcarpa)* has developed on soils derived from the Ordovician sediments around Chiltern in association with the red ironbark forests of that area. The grey box grows in areas where the concentration of drainage results in excessive



Red ironbark open forest II on a hilly site in the Chiltern forest.

wetness in winter. Soils typically have a yellowish or greyish clay at a shallow depth. Associated species are Blakely's red gum, yellow box *(E. melliodora)*, red stringybark, and red box. Tree heights are about 15--25 m. The understorey is generally sparser than in the red iron-bark type, although the species are the same. Weeds such as St. John's wort and shore thistles *(Carduus* spp.) are common in both types.

Grey box open forest II near Chiltern

Blakely's Red Gum

Open forest II

Most forest of this type has been cleared for agriculture; the remaining

Small pockets of Blakely's red gum open forest II occur in drainage lines near Eldorado areas exist as small pockets along the drainage lines in the Eldorado--Warragee area below 600 m. These areas have abundant soil moisture, but are better drained and less liable to flooding than river red gum sites.

Blakely's red gum usually grows in pure stands, but may be associated with long-leaf box, but-but, yellow box, grey box, and mealy stringybark *(E. cinerea)*.

The understorey has a sparse layer consisting mainly of silver wattle and a ground flora of rush *(Juncus* spp.), spreading flax-lily *(Dianella revoluta)*, wallaby grass *(Danthonia* spp.), and various introduced species such as shell grass.

Open forest I

The small fruited form of forest red gum *(E. tereticornis)* now known as Blakely's red gum, or sometimes hill gum, is found in pure stands or in mixture with black cypress pine on granite soils in the Eldorado area, and in mixture with red ironbark on the sedimentary soils of the Chiltern foothills. It occurs on shallow soils where shelving granite or massive sandstone lies at or near the surface.

Associated species are red stringybark, long-leaf box, and red box.

Trees are generally about 8--18 m high and have widespread crowns branching

Extensive areas of Blakely's red gum occur on the granite hills near Eldorado.

from a short bole. Although the unit is normally an open forest, small areas can have a woodland structure.

River Red Gum Open Forest II

River red gum *(E. camaldulensis)* once formed a widespread open forest on the extensive alluvial flats of the lower reaches of the main rivers in the study area. It has been largely cleared for agriculture, and the vegetation type is now confined to river frontages and other public land in these areas. Regular flooding and a moderately high water table are necessary requirements for the species.

The understorey consists of a ground flora of hygrophilous plants such as slender knot weed *(Polygonum minus)*, water pepper *(P. hydropiper)*, and curled dock *(Rumex crispis)*, as well as rushes. These, together with tussock grass and other grasses (mainly introduced species), form a continuous ground cover.

River red gum, now confined to river frontages, has either an open forest or a woodland form.

Swamp gum open forest II growing on riparian land in the cooler hilly regions.

Swamp Gum Open Forest II

At elevations higher than about 300 m, the stream flats and areas of poor drainage may carry swamp gum *(E. camphora)*. Black sallee *(E. stellulata)* occurs with or near the swamp gum but on better-drained sites.

Understories in the poorly drained sites vary from a moss bed *(Sphagnum* spp.) and coral heath *(Epacris microphylla)* at the higher altitudes to common reeds *(Phragmites australis)* at the lower altitudes. Small trees such as mountain tea-tree *(Leptospermum grandifolium)* and blackwood may be present, and also ferns such as alpine water-fern *(Blechnum pennamarina)* and fishbone water-fern.

This community is difficult to map adequately at the scale of 1:100,000 because it commonly occurs as a strip along streams and may be only a few yards wide.

Softwood Forests

About 3% of the public land in the study districts is forested with exotic softwood plantations. The major species is radiata pine *(Pinus radiata)*, with smaller areas of several other conifers such as Corsican pine *(P. nigra)*, western yellow pine *(P. ponderosa)* and Douglas fir *(Pseudotsuga menziesii)*. Tree heights range up to about 42 m depending on age and soil fertility.

Grassland--Bracken

Small areas of public land have been cleared in various parts of the study districts for a variety of purposes. Vegetation on these areas consists of native or introduced grasses and may also include bracken *(Pteridium esculentum)*, blackberries *(Rubus fruticosus)*, and silver wattle.

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FAUNA

This chapter is divided into three parts. After a section of habitats, the vertebrate portion briefly discusses the distribution of major faunal groups within the study districts. More specific information on individual species is given in the appendices. The invertebrate portion gives a general account of the invertebrate fauna of the major habitats.

Habitats

Clearly a correlation exists between animal communities and particular plant formations, in that the animal species composition is relatively homogeneous throughout a specific plant formation. It is therefore convenient to present the distribution of terrestrial vertebrates in terms of faunal communities representative of particular formations.

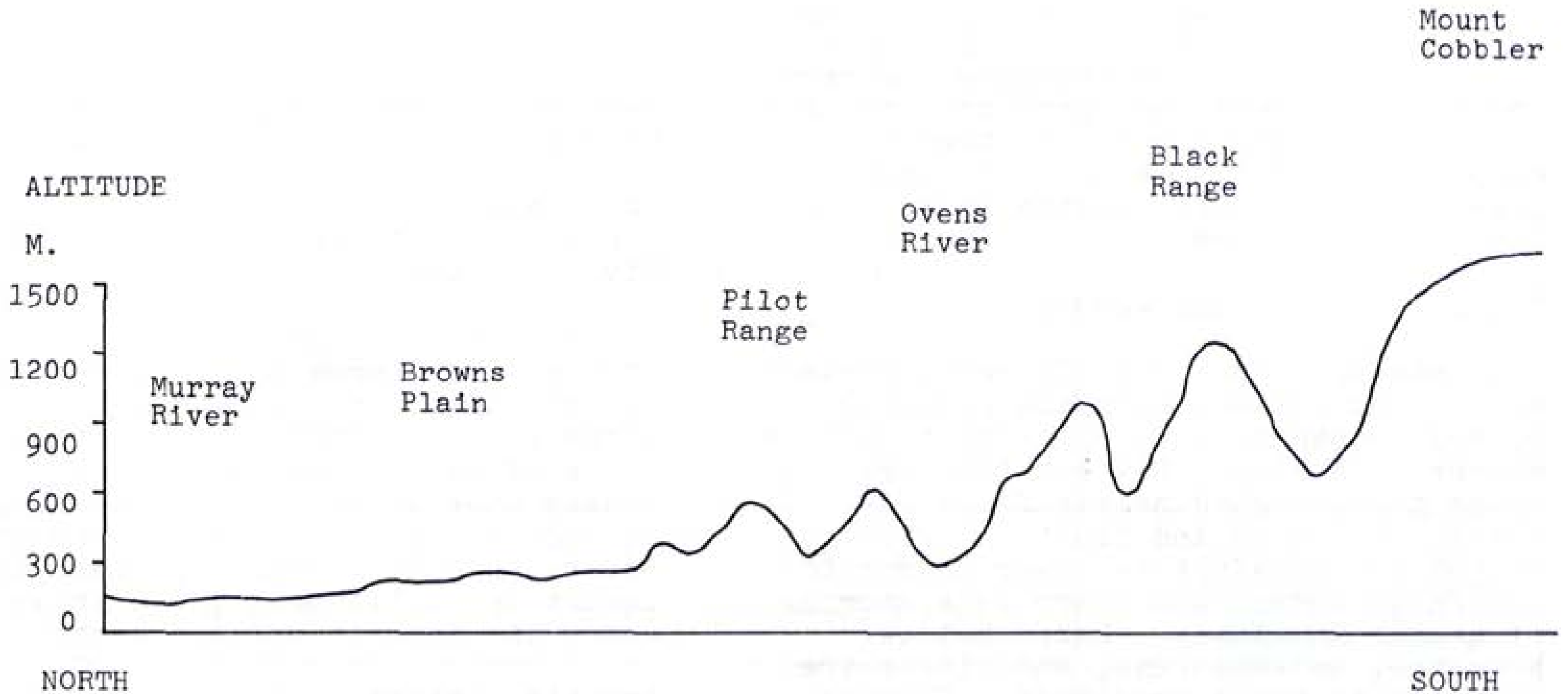
The study districts contain part of the wet and dry open forest and woodland regions of the south-eastern highlands of Australia, savannah woodlands (now mainly agricultural land) of Victoria's northern plains, and a small portion of the Murray River flood-plain woodlands.

Figure 5 illustrates how these various formations relate to each other along an altitudinal cross-section through the study area. However, it does not indicate the aquatic habitats (swamps, temporary ponds, farm ponds, natural lakes, reservoirs, and rivers.) Table 7 shows the vegetation mapping units within the plant formations.

Wet open forests

The dominant eucalypts of these forests follow an altitudinal flowering sequence: swamp gum (300 m) flowers in autumn, St. John's blue gum and narrow-leaf peppermint (300--900 m) in spring, and messmate and alpine ash (750--1,400 m) in late summer. The forests contain many hollow branches, dense tree crowns, and tall and low moist shrub strata. The ground usually has a well-developed forb and grass layer, deep litter, and many large moist decaying logs. They produce large quantities of eucalyptus foliage, buds, flowers, and hard seeds, and yield moderate quantities of nectar. However, the shrubs, forbs, and grasses have low hard-seed and succulent-fruit production.

Fig. 5. Plant Formations along
an altitudinal Cross-section



Topography	Flood-plain	Plains	Foothills	Northern Mountain Slopes		Plateau
				Slopes facing north-west	Slopes facing south-east.	
Plant Formation	Murray River Flood-plain Woodlands	Northern Plains (Agricultural)	Dry Open Forest and Woodlands	Open Forests		Alpine
				Dry open forest	Wet Open forest	

Dry open forests

Most of the eucalypts in these forests flower in spring and summer, with only long-leaf box flowering over autumn and winter. Large hollow branches are rare here: tree crowns are open; tall and low scrub strata and the grass stratum are poorly developed. The forests have sparse ground cover, scattered litter, and few large logs.

Dry open forest and woodland

The principal eucalypts flower over late summer and autumn, with the exception of red ironbark, which flowers from late winter to spring. Box and ironbark trees produce good nectar flows but little hard seed and fruit. Highest nectar and eucalyptus-flower production occurs in summer and there is a shortage of nectar in winter. Large hollow branches, understoreys, and litter are uncommon in these woodlands. However, some wildlife utilize small hollows and thorny bushes.

Agricultural land

Savannah woodlands and temperate woodlands once had discontinuous distributions over the northern and basaltic plains of Victoria. Today these plains are mainly agricultural land. The study districts contain a small portion of the northern plains , which is mainly under pasture with scattered trees (savannah woodland). Consequently, the wildlife recorded will be discussed as belonging to agricultural lands and will include animals associated with urban habitats.

Murray River flood-plain woodland

Periodic flooding along the major rivers of the Murray system produce woodlands and wetlands of considerable importance to wildlife. The northern boundary of the study districts follows the Murray River for about 50 km.

The woodland species provide dense crowns, many large hollow branches, many fallen logs, and litter. They flower after flooding and produce large quantities of nectar and hard seeds. The grassy understorey is well developed, providing thick cover and abundant grass seeds. Animals inhabiting seasonal swamps and billabongs are discussed under the aquatic habitat sections.

Aquatic habitat

This habitat occurs within each of the above regions and, although it is relatively uniform, four types can be distinguished.

The mountain streams flow rapidly over shallow rock and gravel beds. In simple soaks near their sources, dense sedge and fern communities form swampy conditions.

Rivers such as the Rose, Buffalo, and King have shallow clear, cool waters

TABLE 7

FAUNA HABITATS: VEGETATION MAPPING UNITS

PRESENTED BY PLANT FORMATIONS

Plant formation	Major species of tallest stratum and map symbol		Structural form	Locality
Wet open forest *	Snow gum--candlebark	4	Open forest I & II	Widespread in the hilly and mountainous country
	Alpine ash	5	Open forest IV	
	Messmate stringybark	6	Open forest III & IV	
	Narrow-leaf peppermint	7	Open forest III	
	Swamp gum	14	Open forest II	
Dry open forest +	Broad-leaf peppermint	8a & b	Open forest III	Widespread on the dry northerly aspects of the hilly and Mountainous country
	Long-leaf box	9a & b	Open forest I & II	
Dry open forest and woodland +	Long-leaf box	9b	Open forest II	Chiltern Forest and Pilot Range
	Red ironbark	10	Open forest I & II	
	Grey box	11	Open forest II	
	Black cypress pine	12a & b	Open forest I & II and woodland I & II	
Murray River flood-plain woodland	River red gum	13c	Open forest II and woodland II	Murray River flood-plain

* Wet open forest is approximately synonymous with the term wet sclerophyll forest.

\+ Dry open forest is approximately synonymous with the term dry sclerophyll forest.

that flow rapidly over gravel and sand beds. Overhanging vegetation is present but there is little aquatic plant growth.

The larger rivers, especially the Murray, have deep, turbid, slow-flowing waters with mud and silt beds; large submerged logs are common. Periodic flooding along the river banks creates temporary conditions of warm shallow waters favourable for aquatic plant and animal growth.

Temporary ponds and farm dams are common in the agricultural lands. Mud bottoms, turbid waters, and sparse plant growth characterize conditions in these. When they overfill and roadside drains and hollows are flooded, the drowned pasture provides breeding areas for amphibians and feeding places for waterbirds.

Vertebrates

More than 300 native vertebrate species have been recorded in the study districts. (This is about half the total number of terrestrial and fresh-water vertebrate species recorded in Victoria.) They include more than 200 species of birds about 30 of native mammals, 44 of reptiles, 22 of fish, and 16 of amphibians.

Birds

More than 210 bird species have recently been recorded in the study area; 134 of these are recorded as breeding. Appendix 5A lists these species by common name, following the nomenclature of the C.S.I.R.O. (1969), together with information regarding habitat affinities, breeding, and feeding. Details of sources of information precede the Appendix. It is emphasized that this account is far from complete and is intended only for general descriptive purposes.

Wet and dry open forest

About 105 species have recently been recorded in these forests, inhabiting a variety of feeding zones. Most feed on nectar when available, but usually supplement this with insects and occasionally seeds and fruits. Eleven of the honeyeaters have also been recorded as nesting in the area.

Ten species of the Australian warbler family inhabit these forests. All are insectivorous: some forage in the tree canopies and branches, while others feed on insects in shrubs and on the ground.

All of them breed in the study area. They usually build nests in shrubs of trees, but the white-browed scrub-wren may also nest on the ground or in the debris near the ground, and the buff-rumped thornbill nests in holes in trees or under the bark.

Nankeen kestrel, a common raptor that breeds in the area

The parrots and cockatoos are also represented by ten species, but some (the sulphur-crested cockatoo, galah, eastern rosella, etc.) are more characteristic of the savannah woodlands (agricultural areas) and usually occur near cleared land. Most feed on seeds and fruit, but some also take nectar and roots. Four species (gang-gang cockatoos, galahs, and crimson and eastern rosellas) are recorded as nesting in the study area, typically utilizing holes in trees.

The two families of raptors (eagles--goshawks and falcons--kestrels) each have four species occurring in the open forests of the north-east. All are predatory and their diets include a variety of mammals, birds, reptiles, fish, and occasionally insects and carrion. Six of these species are recorded as nesting here; most utilize tall trees for this purpose, but the peregrine falcon often nests on rock ledges. In view of the world-wide population decline of the peregrine falcon, the apparent continued success of the species in the districts (as well as in some other parts of Victoria) deserves special mention.

Other families moderately well represented in the open forest include the

Grey-breasted silvereye

following: world flycatchers (four species of robins and the jacky winter) are insectivorous and build nests on tree or shrub branches; the flower-peckers (pardalotes, the silvereye, and the mistletoe bird) feed on insects from trees and shrubs and occasionally also eat fruit; the cuckoos (four species) feed on tree insects (mainly caterpillars) and lay their eggs in the nests of other species, which hatch and rear shrike-thrushes (four species) are insectivorous; the Australian magpies (magpies, currawongs, and the butcher-bird) feed on a variety of foods and nest on tree branches.

Tawny frogmouth feeds mainly on ground-dwelling insects

The remaining 40 species in this habitat belong to 27 different families and utilize a variety of foraging methods and nesting sites. Among them, the laughing kookaburra, black-faced cuckoo shrike, grey fantail, white-throated tree-creeper, and Australian raven are conspicuous and widespread inhabitants of the forests in the area.

Plantations of conifers have been established within the forest region. Recent work by the Forests Commission on the fauna in the pine plantations around Myrtleford (Suckling *et al.* 1973) has yielded some interesting results. Ap-

Grey shrike-thrush feeds on insects and worms pendix 4 contains a list of bird species considered to be regular inhabitants of the pine forests. Of the 25 species, 17 forage for food (primarily insects) mainly on the ground or in the shrub stratum.

Dry open forest and woodland

The most extensive examples of this habitat occur in the Chiltern Forest and Pilot Range areas. Because these are situated at the junction of the forest and woodland regions and are surrounded by agricultural land, they support a mixture of bird species, some being typical of each of these regions.

More than 125 are recorded for this habitat. Species composition follows a pattern similar to that of forests. Honeyeaters are the best-represented family (16 species), closely followed by the parrot and cockatoo family (14) and the Australian warblers (12). However, the habitat does lack shrub- and ground-dwelling species that typically inhabit areas of moist, dense undergrowth (usually associated with wet open forest), including the superb lyrebird, Australian ground thrush, pilot-bird, pink robin, eastern whipbird, and satin bower bird.

The mixture of temperate and savannah woodland (agricultural land) elements is reflected in the presence of such birds as babblers, pigeons and doves, martins, wood swallows, and weebill and of introduced species such as blackbirds, house sparrows, goldfinches, and starlings. Some typical grassland species (quail, pipit, magpie lark, etc.) have also been reported here.

Typical occupiers of this habitat that have not been recently recorded outside the Chiltern Forest in the study districts include crested bellbirds, western warblers, black-chinned honeyeaters, and painted honeyeaters. Unusual sightings of 4 species have also been recently made in the Chiltern Forest. These include the rare (in Victoria) grey goshawk and turquoise parrot; the latter species is reported as breeding there. The other two species (gilbert whistler and rose robin) are well out of their normal ranges and are probably passing migrants.

McEvely (1965) points out that Chiltern Forest occupies a border-line position between two sub-regions. Both inland dwelling species (Eyrean) and species inhabiting south-eastern Australia (Bassian) occur within this relatively small region.

Agricultural land

More than 110 species, representing 47 families, have been recorded in this habitat. Most of these are either tree- or ground-dwellers; few species inhabit shrubs. The major families are the parrot--cockatoo (9 species) and the eagle--goshawk (7 species), in contrast to the forested habitats, where the honeyeaters are the best-represented family.

Species such as quail, swallows, song-larks, and pipits are usually associated with the grassland (now primarily crop land) areas. Many wading and aquatic birds (15 species) also utilize the agricultural lands for foraging purposes.

The areas of human habitation support introduced species such as domestic pigeons, blackbirds, house sparrows, and starlings as well as some native birds (for example, willie wagtail, magpie lark, and whiteface).

Flood-plain woodland

This area is important because it provides nest sites for several bird groups. Nearly 90 species, representing a large number of diverse families, have been recorded in the habitat.

Black duck, an important game bird that breeds in the area

Aquatic species such as darters, cormorants, herons and spoonbills either nest or perch in the tall trees here. The river red gum, which is the dominant tree species, provides numerous large holes in trunks and branches for the nesting of birds such as mountain ducks, lorikeets, cockatoos, parrots, and kingfishers. A few of the raptors (eagles, falcons, etc.) sometimes utilize the tops of the tall gums for nesting. Honeyeaters are, at times, well represented and some species of fantails, whistlers, and pardolotes forage on the insect fauna associated with the large trees.

Periodic flooding of these woodlands greatly enhances their value to birds because large quantities of invertebrates immediately become available and, later, herbaceous growth is stimulated. Many aquatic birds move to these flooded areas for foraging and breeding purposes.

Aquatic habitat

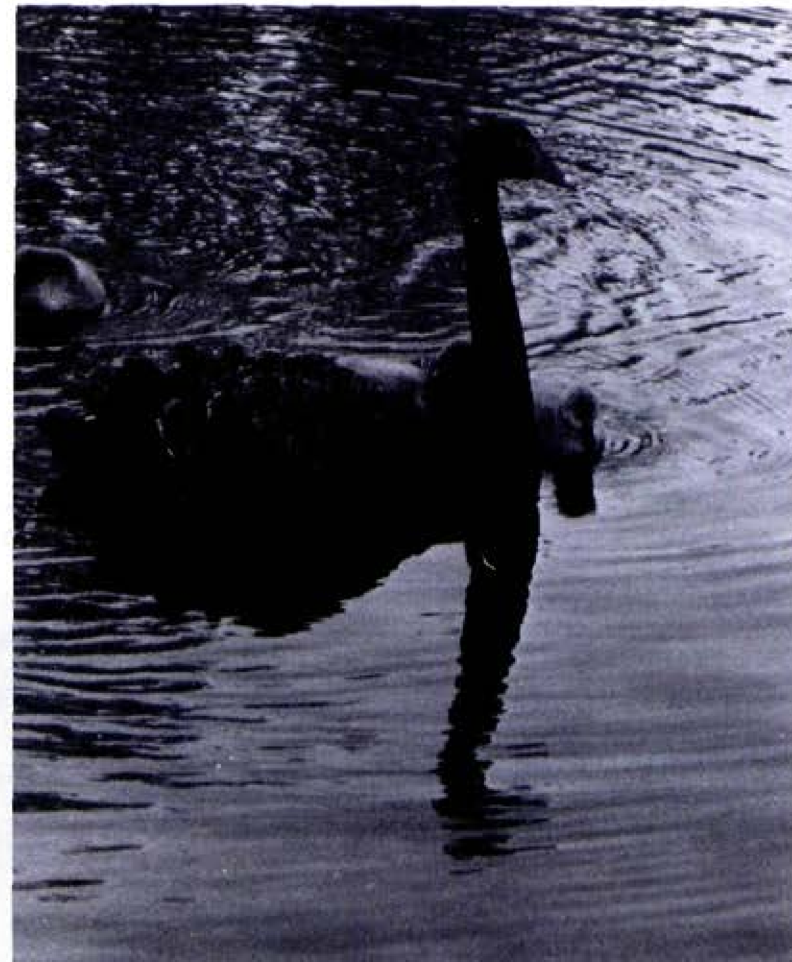
More than 65 bird species are listed as regularly inhabiting aquatic environments in the study districts. The majority of these utilize both open water and associated swamps, although a few marsh-dwellers (such as the golden-headed fantail-warbler, and little grassbird, reed-warbler, and white-fronted chat) do not utilize open-water areas.

The best represented families of aquatic birds (in terms of numbers of species) are: ducks and swans (twelve species); herons, egrets, and bitterns (seven species); and rails and waterhens (seven species).

The aquatic habitat can be divided into a number of feeding zones, each of which supports a characteristic group of aquatic birds.

The open, deeper waters of rivers, reservoirs, and farm ponds support populations of fish and crustaceans swimming at various depths below the surface. Birds such as darters, cormorants, and grebes dive and swim under the water to feed on these. Other birds utilizing these deeper waters are white-eyed and blue-billed ducks and coots, which dive to feed on submergent plants and bottom-dwelling molluscs and crustaceans. Musk ducks also feed by diving in deep water, taking insects, crustaceans, and molluscs.

Shallower near-shore waters support both emergent and submergent vegetation as well as a variety of aquatic insects, crustaceans, molluscs, and small fish. Pelicans feed on these fish and crustaceans by immersing their long necks and bills beneath the surface. Herons, egrets, spoonbills, and ibis feed by wading in these shallow waters and catching small aquatic animals. Many of the ducks and black swan feed there, utilizing a variety of feeding methods (for example, dabbling, up-ending, and filtering).



Black swan and cygnets

Also in sparsely vegetated margins of water, birds such as plovers, dotterels, snipe, gulls, sandpipers, stilts, and magpie larks forage by either probing into the mud for invertebrates or catching them as they move across the exposed beaches. The heavily vegetated swamp areas are favoured feeding areas for night herons, bitterns, rails, crakes, and waterhens.

Other feeding methods that birds use include: plunging into the water to catch fish and crustaceans (some kingfishers); flying over water or swamps and catching insects (swallows and martins); scavenging along beaches (eagles); preying upon aquatic birds and mammals (harriers and hawks); and flying close to the water and skimming insects for the surface (terns).

The black wallaby takes refuge in thick scrub during the day

Mammals

Twenty-nine native and six introduced mammal species have been recorded in the study districts (see Appendix 5B). They are discussed here as communities in major habitats, while Appendix 5C indicates the distribution, abundance, and biology of individual species, and deals with some species of uncertain status (for example, bats, tiger cats, and rock wallabies).

Wet open forest

At least 16 native mammal species occupy this type of habitat. The most common small ground mammals are the brown antechinus and bush rat. Their preferred habitat of litter and shrubs is typical of wet open forests and their distributions are correspondingly wide. A third small ground mammal found here, Swainson's antechinus, has a distribution restricted to moist creek gullies that are thick with rubble and or ground shrubs.

Echidnas occur in this habitat, but are not common.

Long-nosed bandicoots live in areas usually covered with ground shrubs such as bracken fern, but often forage in soil and humus is commonly a part of their habitat.

Wombats are common in this forest type. They prefer dense undergrowth, but their burrows can be found in most localities. Dingoes live in the densely vegetated areas, but usually use tracks or open areas while travelling.

Great grey kangaroos tend to avoid areas with dense undergrowth and are generally restricted to peripheral forest areas. Black wallabies are adapted to dense ground cover and are very common.

Two scansorial species may be present. The bobuck forages both on the ground and in the trees and is similar in its habits to its close relative the brush-tailed possum (which occupies the drier forests). The second species is the tuan, which may be present although it is not generally thought to be associated with this habitat.

Six arboreal species live in these forests. The thick understorey supports many common ring-tailed possums and provides suitable conditions for the eastern pigmy possum, which (although uncommon) has been found in several localities. Sugar and feather-tailed gliders are insectivorous and commonly inhabit the branches and outer foliage. Greater gliders are very common, while yellow-bellied gliders have only been reported once, although they probably occur in alpine ash and messmate forests. Koalas would probably survive if reintroduced.

Eastern pigmy possum occurs in the Yackandandah area

Introduced species found where are foxes and cats (which are widespread), rabbits (which are restricted to fairly clear areas), and sambar deer and pigs (which are restricted to areas around Toombullup and Tolmie).

Dry open forest and woodland

Approximately 12 native mammal species occur in this habitat. The yellow-footed antechibus is the only small terrestrial species now found in woodland. It lives in areas with litter and hollow logs and often where understorey strata are dense. Echidnas are common throughout.

Two kangaroo species are found here. The great grey kangaroo occurs throughout and is especially common near areas of improved pasture. Black wallabies have been recorded in mixed box woodland, but woodland in general is not suitable since they usually require medium to dense shrub cover.

Of the two scansorial species, brush-tailed possums occur in all woodland types that provide holes for shelter. Tuans are common and they also require hollow trees or logs in which to nest, but their smaller size enables them to use smaller holes than the brush-tailed possum.

Of the five wholly arboreal species, two-sugar gliders and feather-tailed gliders - are widespread and fairly common.

Common ring-tailed possums have been recorded in mixed box and forest red gum and usually occupy areas with either dense canopy cover or well-developed understorey. Squirrel gliders are probably the rarest possum species in Victoria. Their exact habitat requirements have not been determined, but they usually occur in woodland associations. The general north-east area is considered important for conservation of this species in Victoria and individuals have recently been recorded in the Chiltern forest. Koalas had become very rare or extinct, but have been reintroduced to the Chiltern forest and now presumably occupy the red ironbark woodland. They have recently been recorded near Myrtleford.

Four introduced species have been recorded; rabbits, house mice, foxes, and cats are all widespread and common.

Agricultural land

Few native terrestrial or arboreal mammals occur in farmland. Brush-tailed possums are the most successful, occurring in most suburban and farmland situations. Common ring-tailed possums require a denser tree or shrub growth than the brush-tailed, but occasionally live in some town and farm gardens and roadside reserves.

Wombats, great grey kangaroos, and black wallabies graze on farmland, especially in the more remote areas close to tree cover.

Most other wild mammals present are introduced species, including rabbits, house mice, cats, and foxes.

Flood-plain woodland

Seven native mammal species may occur in the small areas of flood-plain woodland still remaining.

Where drainage for agriculture has not been too great, the native terrestrial species present may include the echidna and yellow-footed antechinus.

The areas remaining are probably too small to support the large great grey kangaroo. The scansorial tuan is a possible resident. This medium to small carnivorous species feeds on small birds and mammals (and also chickens where it has the opportunity). The other scansorial species is the brush-tailed possum, which is usually very common.

Three arboreal species may be present. Common ring-tailed possums usually occupy red gum regeneration stands, sugar gliders usually occur throughout red gum woodland, and feather-tailed gliders are occasionally reported.

Five introduced species (rabbit, black rat, house mouse, fox, and cat) have all probably colonized this habitat.

Aquatic habitat

Two mammal species - the platypus and eastern water-rat - rely on the presence of surface water. The platypus inhabits most streams, including lowland rivers and mountain creeks, and has been recorded in many streams within the study districts, where it is probably common throughout. Its position is fairly secure there, although water pollution could endanger the species - especially pollution that causes the accumulation of toxic chemicals in the river mud, since it forages in this mud.

The eastern water rat is common and has a similar distribution to the platypus. Its distribution extends up the small

Common ring-tailed possum

perennial mountain streams and along drainage ditches, dams, and irrigation canals. It is not exclusively aquatic, but spends a small amount of time on dry land.

Reptiles

Forty-four reptile species have been recorded in the study districts.

Reptiles lack a major physiological characteristic that mammals and birds possess - internal temperature control or endothermy. They are ectotherms (that is, their body temperatures depend entirely on their environment) and are either heliothermic or thigmothermic. Obviously the availability of sunlight, logs, and rocks influences habitat suitability for reptiles, and hence is a major factor in determining distribution. In addition to micro-environment, food supply, reproduction, and predation influence distribution.

Little is known of specific food preferences, but, in general:

* Large reptiles (goannas and large snakes) feed on small mammals, birds, other reptiles, frogs, and carrion

* Large skinks and dragons (stumpy tails and bearded dragons) eat berries, fruit, and arthropods

* Small lizards and snakes predominantly feed on insects, although most small snake species and Burton's legless lizard feed on small skinks

* Tortoises have a varied diet of tadpoles, frogs, aquatic vegetation, and invertebrates.

Reptiles are discussed below under their respective habitats. Appendix 5D presents a species list, with summaries of available information.

Wet open forest

This habitat type contains fewer species than dry open forest because, in general, temperatures are lower and sunlight penetration is reduced. Three species, the white-lipped snake and grass and Spencer's skinks, occur in wet open forest and not in dry.

The only sub-litter inhabitant is McCoy's skink, which is widespread and common. The weasel skink may be present at lower altitudes.

Three small heliothermic skink species occupy wet open forest and a fourth, the three-lined skink, may do at lower altitudes. The garden akink, is common throughout and inhabits leaf litter, especially in more open areas.

Grass skinks are very common, especially among the bark accumulations in dense tall forest. Large colonies of these lizards gather on sunlit bark deposits and logs, even in sub-alpine areas.

Three-lined skink

Spencer's skink is totally arboreal and forages around the butts of gum trees or among the cracked wood of dead trees and stumps.

Tree dragons are uncommon, but usually occur in open vegetation without dense understorey. Blotched blue-tongues are also associated with warmer parts of the forest.

White-lipped snakes are endemic to wet open forest and sub-alpine woodland. They usually live in open grassy clearings such as sub-alpine meadows.

In wet open forest with reduced sunlight penetration, open rocky areas provide warm 'islands' and all the species mentioned above can be found here in increased numbers.

Three-toed skink

The black rock skink is restricted to such rocky outcrops in this habitat and, occasionally, species typical of dry open forest or woodland are found on them.

The copperhead snake - the only large snake in the area - occurs throughout, but is particularly common in areas with adequate sunlight penetration such as clearings or creek sides.

Dry open forest

In addition to the species subject to stream influence (see page 82), 15 others occur on the dry open forest.

These include three fossorial sub-litter skinks - McCoy's, three-toed, and weasel skinks. The first two are small elongated species with very small limbs; they occupy similar niches, but McCoy's skink is usually only found in moist areas. The weasel skink is intermediate between the true sub-litter and litter dwellers. It is a thigmotherm and forages among the dry surface layer of litter. The only other fossorial species present - the blind snake - is rare and restricted to dry areas often in association with rocks and termite mounds.

Two heliothermic litter-dwellers are the garden skink, which is very common and occurs throughout the area in leaf and twig litter, and the three-lines skink, which is uncommon and more restricted. The latter inhabits relatively open grassy or shrub-covered areas.

Two small snake species forage among the litter, rocks, and rubble. Small-eyed snakes are nocturnal and are usually found in rocky areas, whereas Dwyer's snake is usually found in open dry areas similar to woodland.

Two medium-sized lizards occur here: tree dragons are primarily litter inhabitants but also forage on the trunks of trees and in shrubs; southern blue-tongues are common throughout dry open forest.

Rocky outcrops provide ideal sites for basking and crevices for protection. The black rock skink and White's skink are most common in these areas, but they also occur, less commonly, throughout dry open forest. Striped skinks and copper-tailed skinks also occur on large expanses of rocks.

The tree goanna is not common and probably only occurs on peripheral areas.

Of the two large snake species present, copperheads are restricted to moist areas, usually in association with streams, while brown snakes prefer open, dry, usually grassy areas.

Dry open forest and woodland

The warm temperate environment and relatively sparse vegetation here provide a better habitat for reptiles than other plant formations. Excluding those associated with streams, discussed

The brown snake is common in dry forest and woodland below, approximately 24 species occur in it.

This habitat supports several burrowing or sub-litter species. The bandy bandy, a small snake, burrows in loose sandy soil while foraging for small lizards. The blind snake also burrows, and feeds on invertebrates such as termites. Bougainville's skink and the three-toed skink usually forage beneath the litter or in loose soils in search of insects. The weasel skink is intermediate between true fossorial sub-litter dwellers and the active small skinks that inhabit the litter.

The litter inhabitants include several skinks and the tree dragon: all are fast-moving heliothermic species and

Bearded dragon is found in woodland and dry open forest

forage among litter for insects. Boulenger and garden skinks are common and similar in appearance and habit, but the former occupies a drier environment. Four-fingered skinks are usually found associated with rocky areas, and three-lined skinks are often found in grassland.

Both Burton's legless lizard (which eats small skinks) and Fraser's legless lizard (which is insectivorous) live in thick litter or ground vegetation. The small-eyed snake is nocturnal and usually inhabits rocky areas. Two others, Dwyer's snake and the little whip snake, live in the warmer open areas (grass and shrubland).

Most reptiles typical of the region will also occur in rocky outcrops, often in great abundance. Some, such as the striped skink, copper-tailed skink, Cunningham's skink, and stone gecko, are almost invariably associated with rocks.

The bearded dragon commonly basks on fence posts in open areas. It escapes into a burrow near the base of its basking site when disturbed. The tree dragon, also common, is scansorial but commonly forages on the ground. The common bluetongue is omnivorous and occurs throughout grassy woodlands.

The two largest lizard species present are goannas. The tree goanna has been recorded as attaining lengths of up to 2.4 m in Victoria. This adept climber escapes into large trees if disturbed. It is widespread and, like the sand goanna, is primarily a scavenger and eats carrion. The sand goanna is usually found in areas with friable soil, into which it burrows.

The brown snake is the only large poisonous reptile found in dry open forest and woodland. It is carnivorous and feeds on small animals (such as house mice) and medium-sized reptiles (such as the bearded dragon).

Carpet snakes are found in this habitat west of the study area (particularly in rocky situations), and may be present in the study districts.

Agricultural land

Few reptiles live in farmland or town areas. In dry lowland farms Boulenger's skinks sometimes live in rubbish tips, common bluetongues occur throughout grassland; bearded dragons are common along fence lines; brown snakes are common in grassland; tiger and red-bellied black snakes occur near the rivers and creeks; and tree goannas are common, particularly in areas with scattered woodland.

In farms in the wetter foothills, garden skinks replace Boulenger's skink, and blotched bluetongues replace common bluetongues. Brown, tiger, and red-bellied black snakes occur in similar situations to those described above.

Flood-plain woodland

The presence of surface water provides suitable conditions for tiger snakes, red-bellied black snakes, and eastern water skinks.

Large trees support three small lizards, the wall skink and tree skink (which are restricted to this habitat) and the marbled gecko (which may also occur in dry woodland). Two large reptiles, the carpet snake and tree dragon, often occur in association with large trees.

All ground-dwelling species are typical of those found in surrounding woodland.

This community is drastically altered when flooding occurs. All the ground-dwellers are displaced and water-dependent species take their place.

Aquatic habitat

Few reptiles are exclusively aquatic. Three tortoise species spend a major proportion of their active time in water, but must breed on land.

The snake-necked tortoise is common and occurs in most lowland streams, dams, and swamps. The Murray River short-necked tortoise is less common, and is probably restricted to the Murray and associated major tributaries. The rarest of the three - the broad-shelled tortoise - is restricted to the Murray River in the study distrcits.

Stream influence

Communities associated with streams usually differ from those of the surrounding areas. These differences are related both to direct effects - such as the availability of water - and to the indirect effects on vegetation. The riparian land that borders the Murray River has been dealt with under the heading of flood-plain woodlands. Within the other plant formations, some reptiles are habitually associated with water. Tiger snakes and red bellied black snakes are common in swamps and on stream banks, and the eastern water skink occurs along the streams, in woodland, and in the dry open forest, where the copperhead snake also occurs.

In wet open forest the habitat suitable for copperheads is widespread, consequently it is not restricted to riparian areas. The warm temperate form of the eastern water skink inhabits stream banks at lower altitudes but is replaced at higher altitudes by the cool temperate form, which is also associated with streams in sub-alpine areas.

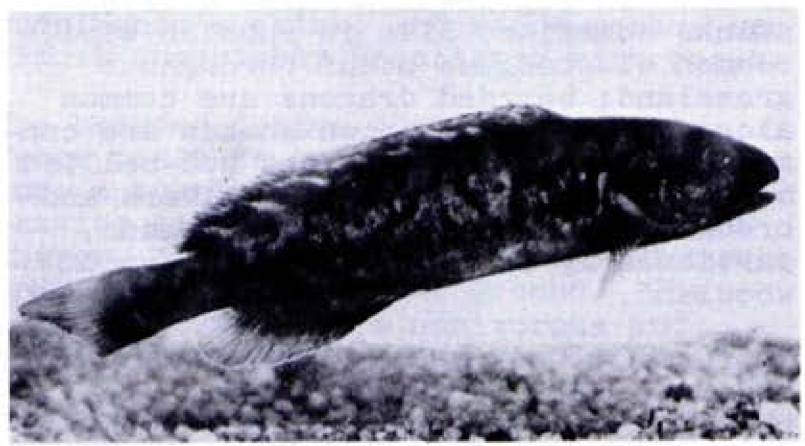
Fish

The 21 fish species recorded as occurring in the study districts may be divided into three categories, based on geographical distribution.

One group characteristically inhabits the "mountain streams" (middle sections and headstreams), where the well-oxygenated generally cool clear waters flow swiftly over gravel beds. The second group inhabits the "lowlands" (mature rivers and associated waters), where slower, more turbid, warmer waters occur and flooding is regular. The third group can utilize habitats in both these regions. Table 8 shows the species occupying these categories, and indicates typical habitats.

Both native and introduced species fall into one of three major status groups; forage, game, or undesirable.

Forage fish are usually small and are important as food for other fishes as well as water-birds and other vertebrates. They in turn prey on zooplankton and aquatic insects, thus represnting an important component of food webs.



River blackfish is common in mountain streams

TABLE 8

FISH SPECIES GROUPED IN GEOGRAPHIC REGIONS

Region	Species	Habitat types present
Lowlands	Bony bream Australian smelt Rainbow fish Mitchellian fresh-water hardyhead Murray cod Trout cod Silver perch Pigmy perch Western carp gudgeon Big-headed or flat-headed gudgeon Purple spotted gudgeon Tench Mosquito fish	Mature river sections and lakes
Mountains	Ornate mountain galaxias River blackfish Goldfish	Middle sections, headstreams, and impoundments
Wide-ranging	Macquarie perch English perch or redfin Brown trout Rainbow trout Crucian carp	All types indicated above

Ten native and one introduced forage species occur here, of which ten are generally restricted to the mature river sections and associated waters, and one is generally restricted to the headwaters and middle sections.

Of the eight game species, five are native and three are introduced.

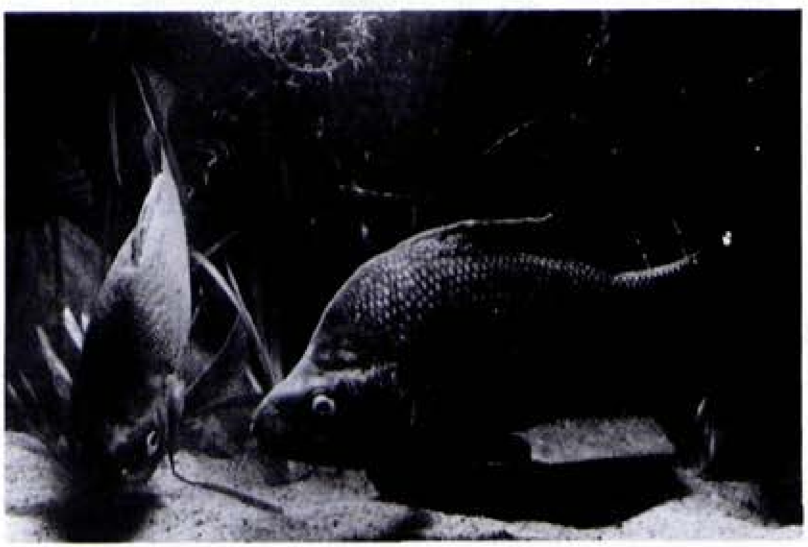
The undesirable species are all introduced and comprise two closely related ones (the Crucian carp and the goldfish) and the tench. Although the Crucian carp, goldfish and tench are not as destructive to their habitat as their relative, the European carp, they are still regarded as pest species.

Appendix 5E lists these species in terms of their distribution, status, food, spawning, and specific habitat requirements.

Clearing of land in stream catchments is likely to have a detrimental effect on native fish populations but benefit populations of some introduced fish. Water population may have detrimental effects on both. Streams above 500 m elevation represent the aquatic habitats in the study districts most closely resembling conditions before European settlement, which will persist if their forested catchments are left intact.

Amphibians

Sixteen species of amphibians have been reported from the study districts, and an annotated list of these (in Appendix 5F) provides information on their abund-



Macquarie perch (left) mainly occur in lowland streams, where Murray cod (above) is an important game fish ance and distribution, habitat requirements, and breeding and feeding habits. The combination of low temperatures, high rainfall, and moderate humidity, coupled with the availability of diverse aquatic habitats, makes the study area particularly suitable.

Based on Littlejohn's (1971) classification of amphibians occurring in zoogeographic regions, nine of these species are considered to be essentially Eyrean in origin, two Southern Bassian, and five wide-ranging.

In general, their distribution is closely related to the availability of suitable moist breeding sites. They may be divided into three categories based on regional distributions (see Table 9).

"Flood-plains" species generally require more permanent habitats for breeding such as semi-permanent marshes, lateral lakes, and farm dams, and are thus often found associated with the mature sections of some of the larger rivers.

Species inhabiting the valleys and foothills above the flood-plains can also utilize these, but in addition may utilize the less permanent or more rigorous habitats such as intermittent marshes, temporary puddles, and moist microhabitats. For example, *Limnodynastes d. dumerili* (bull frogs) and *Ranidella signifera* (brown froglet) can survive in pools in small streams, and *Pseudophryne bibroni* (Bibroni's toadlet) adults can utilize moist depressions for egg deposition.

Amphibians inhabiting the higher altitudes have special adaptations for the more rigorous environment. *Litoria lesueuri* (Lesueuer's tree frog) is generally only found in association with middle-section and headwaters streams. Its tadpoles have special morphological adaptations enabling them to survive in relatively strong currents. *Geocrinis victoriana* is less dependent on free water than most amphibians - its tadpoles can use the moisture in heavily vegetated areas.

Tadpoles are voracious feeders on algae and phytoplankton and, because of their often high numbers initially, play an important part in food webs as primary

Bullfrog, a common lowland species

TABLE 9

AMPHIBIANS IN THE STUDY DISTRICTS

Distribution	Species	Examples of habitat they may utilize
Flood-plains	*Litoria peroni* *Limnodynastes fletcheri* *L. peroni* *Neobatrachus parinsignifera* *R. sloaneri* *Uperoleia rugosa*	Intermittent and semi-permanent marshes, lateral lakes, farm dams, and mature stream sections
River valleys and foothills above flood-plains	*Litoria aurea raniformis* *L. paraewingi* *Limnodynastes tasmaniensis* *L. dumerili dumerili* *Pseudophryne bibroni* *Ranidella signifera*	Intermittent shallow marshes, farm dams, streams (mature and mid sections), temporary puddles, and humid microhabitats (such as moist vegetated depressions)
Higher altitudes	*Litoria lesueuri*	Restricted to streams (mid sections and headwaters)
	Geocrinia victoriana	Humid microhabitats (wide-ranging)

consumers (herbivores). Food preferences change at metamorphosis and adult frogs feed primarily upon terrestrial and aquatic invertebrates. Although tadpole mortality is usually high, large numbers of adult frogs emerge to exert considerable influence on local invertebrate populations. The amphibians in general provide an important food source for many other animals.

Invertebrates

Invertebrates make up approximately 95% of the animals of any area and therefore play a dominant role in the impact of total faunal elements on the ecology. They form the major elements in most food, break-down, and decay chains in both terrestrial and aquatic environments, as well as playing major roles in fertilization, depredation, and breakdown of plants.

The invertebrate fauna of the districts consists of many species of protozoa, platyhelminthes, annelids, insects, crustacea, myriapods, arachnids, and molluscs, together with many other minor groups.

Insects

Some insect groups are widespread or cosmopolitan. The distributions of others are controlled by more specific habitat requirements. The mountainous areas in the south and south-east and the intensively cultivated farm land in the north and north-west represent the habitat extremes for the study area.

Many interesting and local species are found at higher levels in mountains. These often are very restricted in distribution and suffer from destruction or modification of their natural habitat, particularly where a regular burning-off is carried out, where constant grazing is allowed, and where exotic vegetation has replaced the native.

Aquatic habitat

The insect and crustacean species found in the lowland water reservoirs and streams are generally widespread and common. But in the mountainous areas, almost each stream appears to have a more or less distinct community. Indeed, some Plecoptera *(Dinotoperla* and *Neboissoperla)* and Trichoptera *(Archaeophylax)* species are so far known only from these areas. Detailed information on Ephemeroptera is not available and an interesting as yet undescribed species of Coleoptera has been reported recently. There are many local forms of Tipulidae (Diptera) with extremely restricted distribution.

Terrestrial habitats

Similarly, the composition of terrestrial insect population displays marked differences between various altitudes. Small, isolated populations of wingless ground-living Coleoptera (family Curculinionidae) and some Lepidoptera (moths and butterflies) are well represented with local mountain forms (for example in the genera *Oriexenica* and *Ogyris*). These are of particular interest to students of insect phylogeny.

Other Invertebrates

The invertebrate fauna varies according to the extent of modification of the original flora; the more modified areas have a high proportion of introduced species and a low species diversity.

Aquatic habitats

The Murray River is the southerm limit of a number of species widespread in the Murray--Darling system such as the snail species *Vivipara hanleyi* and *Plotiopsis balonnensis*.

The Hume Weir forms a large body of fresh water; its shallow portions contain large populations of the snail *Dulinud* sp., and occasional blooms of fresh-water jellyfish have been reported.

The major rivers and creeks carry populations of the fresh-water mussel *Velesumio ambiguus*, small populations of Murray crayfish, and large densities of fresh-water limpets and pea mussels in the swifter stony upper reaches.

Swamps and billabongs in the valleys have rich and diverse aquatic invertebrate fauna with many species of leeches, worms, and molluscs.

Terrestrial habitats

Most terrestrial invertebrates are cryptozoic, living under logs, in litter, at the base of vegetation, and in similar microhabitats.

In the agricultural areas and open forest flood-plain woodland, the terrestrial molluscs are represented largely by introduced species: five of snails and six or eight of slugs. A few native snail species (family Endodontidae) still occur. Several species of land planarian (genus *Geoplana*) occur in this lowland area, principally *G. quinquelineata*.

The mountain forest area and sub-alpine region are much less modified areas with more restricted habitats and still contain a largely native fauna in a much closer to natural condition. The wetter forest areas with many logs and deep litter support several species of native molluscs, including the native slug *Cystopelta* sp., large snails (*Pygmipanda kershawi* and *Strangesta* sp.), and one or two species of camaenid, together with a number of endodontid snails. These forest areas also contain several restricted species of land planarian and land nemertean, especially *Geonemertes australiensis*.

The sub-alpine areas contain several characteristic land planarian species (*Geoplana howitti*, *G. lucasi*, and *G. sulphurea*), together with several restricted and undescribed endodontid snails.

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11. SOILS

Climate, geology, topography, vegetation, invertebrate fauna, and age of the land surface are the main soil-forming factors. Soils are a basic resource and many of their qualities cannot be replaced easily if destroyed. The uses to which they may be put depend to a large extent on their characteristics

Soil Classification

The following general-purpose classification is based on the reports published by the Soil Conservation Authority covering parts of the districts (Rowe 1967, 1970, 1972), together with unpublished reports on the remainder.

The soils have been grouped into four classes on the basis of the texture pattern of the profile: organic, uniform, gradational, and duplex (Northcote, 1971).

Organic soils normally form independently of the rock on which they occur and are normally controlled by climate and the water table. Uniform soils may exhibit some changes down the profile, but these fall within the span of one texture group. For example, a loam may change to a sandy loam.

Gradational soils become more clayey with depth, but do so gradually and the total texture change is greater than the span of one texture group - for example, from a loam to sandy clay.

Duplex soils, on the other hand, change sharply to a clayey subsoil.

The text briefly describes soil of each group (see also Table 10) and indicates their pattern of distribution. Appendix 6 explains some of the terms used in the description.

Soil Description

Organic Soils

Organic soils, under the general term peats, consist of the accumulated undecomposed and partly decomposed remains of the characteristic plants of the bogs and fens. They are usually found beneath thriving bog or fen vegetation and are associated with a high water table and permanent wetness. Dry peats occur as shallow accumulations on the extensive shelving rock around the escarpment of the mountain.

Humified peats are formed by the decomposition of peats as a result of their drying out; if humification has proceeded far enough, a fine crumb structure may develop.

Peats can retain large quantities of water. They are very acid, and when dry are light and friable and may be readily wind-eroded, especially if exposed to loosening by frost action.

Uniform Texture

Stony loams

Rock fragments predominate in a loamy soil matrix. The stones are little weathered. Because of the low proportion of soil, these loams have a low water-holding capacity but high permeability and, therefore, high initial infiltration rates. Bedrock usually occurs at shallow depth. Stony loams are common, but not extensive, on steep slopes and narrow ridge-tops, particularly on rocks that fracture readily.

Gravelly loams

These common but not extensive soils form at the base of steep slopes - where slope detritus accumulates. They are usually brown or reddish brown loams or clay loams and contain a high proportion (20--40%) of gravel or rock fragments of small size. Texture grade may decrease with depth. They have moderately high water-holding capacity and very high infiltration rates and permeability, but relatively low available water capacity. The depth to bedrock may be several metres. Gravelly loams are moderately acid and probably have slightly greater plant nutrient availability than most of the districts' soils.

Coarse sandy loams

Coarse sandy loams occur on the steeper slopes of granitic areas. They are dark greyish brown at the surface, gradually changing to dull brown or yellowish brown in the subsoil. They lack structure and, although coherence is poor when moist, they may be hard when dry. They are moderately acid and have low plant nutrient reserves and low available water capacity. Their ability to absorb rain and run-off is high, but they drain rapidly.

Undifferentiated sandy loams

These alluvial soils may have the surface darkened by organic matter; the presence of distinct current bedding and textural stratifying indicates their relatively recent origin. They therefore have some unpredictable variations in texture and colour, although predominantly sandy to loamy and brownish. Similarly, water-holding capacity and nutrient status vary. Typically, they

TABLE 10

SOILS

Texture profile	Other distinguishing features	Soil group
Organic	Accumulation of plant debris below bog and fen vegetation	Bog and fen peats
	Accumulation of plant debris from heath vegetation	Dry peats
	Decomposing bog or fen heath	Humified peats
Uniform	Coarse-textured - Predominantly stone fragments	Stony loams
	- Loams and clay loams with a high proportion of gravel	Gravelly loams
	- Coarse sandy loams on granitic gneissic rocks	Coarse sandy loams
	- Sandy, often variably bedded alluvial deposits	Undifferentiated sandy loams
	Medium-textured - Loams and fine sandy loams on alluvium, brown or greyish	Brown and greyish loams
	- Highly organic, well-structured soils from high areas	Organic loams
	Fine-textured - Dark clays with well-developed structure - lime present	Dark structured calcareous clays
	- Dark clays with well-developed structure - lime absent	Dark structured non-calcareous clays
Gradational	Soil on stream alluvium	
	- reddish	Reddish gradational soils on alluvium
	- yellowish brown	Yellowish brown gradational soils on alluvium
	Soils with bleached subsurface (A_2 horizon)	
	- reddish	Weakly bleached reddish gradational soils
	- yellowish brown	Weakly bleached yellowish brown gradational soils
	Brownish soils	
	- pale, massive, hard	Pale massive gradational soils
	- strongly coloured, weakly to moderately structured, friable	Friable brownish gradational soils
	Reddish soils	
	- on basalt	Reddish gradational soils on basalt
	- on non-basaltic material strongly structured, hard	Hard reddish gradational soils
	- moderately structured, friable	Friable reddish gradational soils
Duplex	Reddish subsoil	Reddish duplex soils
	Yellow-brown subsoil	Yellowish duplex soils

drain freely but may have a water table within 2 metres of the surface.

Brown and greyish loams

In the alluvial soils formed on stream terraces, soil-forming processes have obscured most of the alluvial stratification in the surface half metre or more. They are dark and well structured at the surface, but become less so with depth. A mottled horizon is common in the subsoil, indicating periodic waterlogging. The porosity of the subsoil is moderately high, so good permeability may be expected. The loamy textures probably ensure a moderate available water capacity.

Organic loams

Sub-alpine areas where total precipitation is high and temperatures are low, particularly in winter, carry these soils.

Typically, they are black organic loams with strongly developed crumb structure and high permeability. Their ability to absorb large quantities of rain and surface run-off and to release it slowly as subsurface flow is a notable feature, and an important one in these circumstances.

They are very acidic soils and generally poor in plant nutrients. Although the more common form has weathered rock at a relatively shallow depth, some have a non-organic, more clayey subsoil and may be more than a metre deep.

Dark structured calcareous clays

These have limited extent, usually occurring in situations where drainage from basic rocks (such as basalt) accumulates. They are heavy clays with strongly developed blocky structure. They have not been closely studied, but could be expected to have low permeability and available-water capacity, although probably moderately high fertility.

Dark structured non-calcareous clays

Also of limited occurrence, such clays occur in those parts of stream terraces where alluvial deposition was from relatively sluggish water. They are clay loams to light clays with strongly developed sub-angular blocky structure. Commonly the subsoil is less clayey and mottled. Although they are probably similar to the calcareous clays in water relations, they may have lower nutrient status.

Gradational Texture

Reddish gradational soil on alluvium

Formed in alluvial fans and intermediate level stream terraces, these may have a weakly bleached subsurface horizon. Structure is weakly developed. They are moderately fertile soils, usually with coarser-textured material below about a metre, which ensures free drainage.

Yellowish brown gradational soils on alluvium

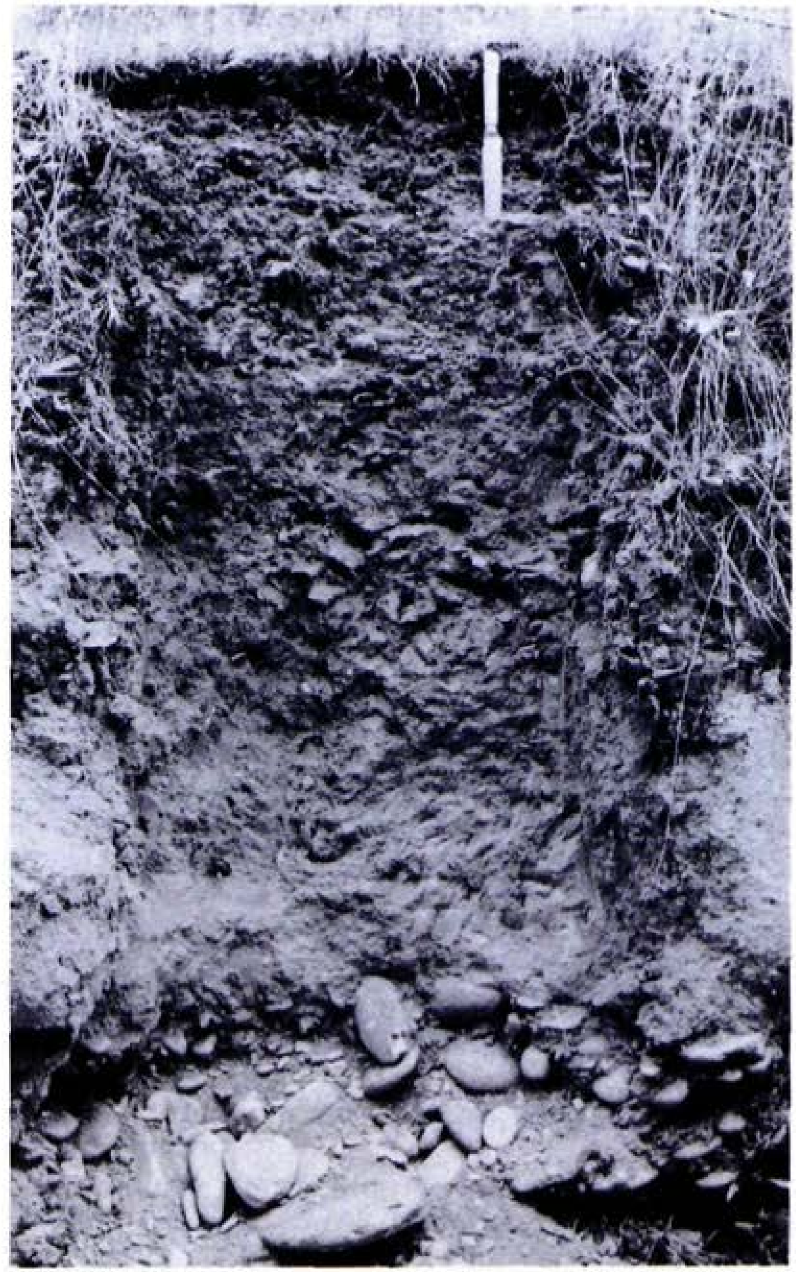
These soils are relatively extensive on the intermediate stream terraces. Their textures range from loam or sandy loam at the surface to light clay in the subsoil.

They lack structural development except in the subsoil, where weak to moderate structure is usual. A gravel layer commonly occurs below the profile at about a metre, so drainage is free. They are moderately acidic soils with reasonable fertility and moisture storage capabilities.

Weakly bleached gradational soils

Several groups comprise this category. While they differ in degree of development of structure, they are often hard to define clearly as separate groups. Two that can be separated are weakly bleached reddish gradational and weakly bleached yellowish brown gradational soils.

The soils occur mainly on lower mountain slopes and hills, and to a lesser extent on valley slopes, in the drier areas.



Yellowish brown gradational soil on alluvium

The reddish and yellowish brown groups are morphologically similar, the colour difference being mainly the result of poorer drainage in the latter. Usually a greyish brown loamy surface with moderate to weak structure overlies the paler weakly bleached horizon, which has similar texture to the surface. At depths of about 30--40 cm, the soil becomes more strongly coloured (reddish or yellowish brown) and the texture becomes more clayey. The subsoil seldom has a heavier texture than light clay, and is massive to weakly structured. In both groups porosity is relatively high.

The yellowish brown massive form has a very dispersible subsoil and thus has a higher erosion hazard than the rest of the group. A form with a highly mottled subsoil occurs in areas that suffer prolonged wetness.

The soils of the groups as a whole are moderately fertile and appear to be permeable and drain relatively freely, except where they are associated with drainage lines. Available water capacity may be relatively low, particularly in sandy-textured soils. The ability of these soils to absorb run-off is moderate; a moist soil could absorb about 12--14% of its volume before surface run-off would occur.

However, because of the weak structure of the surface, poor land use may seriously reduce the infiltration rate.

Pale massive gradational soils

These are predominantly sandy-textured and are usually associated with granitic areas, although not extensive. The texture profile may be almost uniform. Colours are pale brown and yellowish brown. The profile is massive except for possibly weak surface structure. The soils appear to have moderately low fertility and have low available water capacity. Total water-holding capacity may be moderately high, but poor surface structure results in a low infiltration rate.

Friable brownish gradational soils

This group comprises the most extensive soils of the higher-rainfall mountain areas and includes soil intergrading between the weakly bleached gradational soils and the organic loams. A typical profile has a litter layer 5--10 cm thick overlying a dark-brown friable loam with strongly developed fine structure. With increasing depth, the colour becomes paler as the influence of organic matter decreases, then usually more reddish or stronger brown, and textures change to clay loam or light clay. Soil on acid igneous parent materials is more yellowish, but that on Carboniferous "red beds" is dark red or even purplish red.

Some profiles show little texture change and approach the features of uniform soils. These soils are friable, porous, and usually relatively deeply weathered. They have high surface porosity and high permeability throughout, which results in a high capability for absorbing run-off. Available water capacity is relatively high (20--25% by volume) and total water-holding capacity is high, so even a moist soil could absorb about 30 mm of steady rain before surface run-off would occur. In these soils plant nutrients are concentrated in the surface where the cation exchange capacity is moderately high. They are moderately acidic.

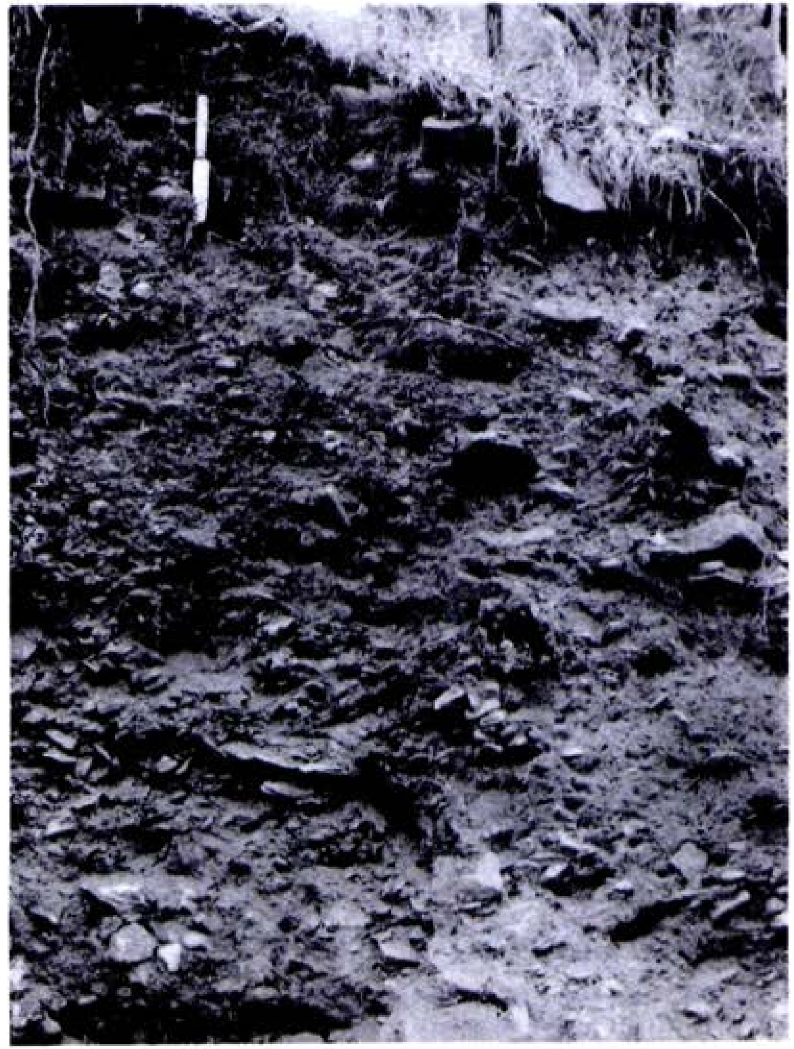
Friable reddish gradational soils

These are widespread on upper river terraces and fans, and on plateaux and broad ridge-tops where the rainfall exceeds 890 mm.

A typical profile commences with about 6 cm of dark brown loam over about 8 cm of yellowish red or reddish brown loam to clay loam that merges with depth into the dark red or reddish brown light clay.

The soil is moderately structured at the surface, but the rest is medium sub-angular blocky that breaks to very fine sub-angular blocky at the deeper levels.

Profile depth depends to a certain extent on the parent material. In deep old alluvium or colluvium it may be 2.5 cm or more, but weathered rock is generally found at about 1.2 m.



Friable brown gradational soil developed on colluvium

Generally the soils are acid to very acid and have moderate to low natural fertility.

Reddish gradational soils on basalt

Finely structured dark brown loam to clay loam at the surface gradually becomes moderately to well-structured strong reddish brown clay loam to light clay with depth. These soils are acidic and have lower than usual phosphorus and calcium contents. They have moderately high available water capacity (15--20% by volume) and additional similar storage capacity in absorbing rain or surface run-off.

Hard reddish gradational soils

While similar morphologically to those on basalt, these have lower plant nutrient status. Their well-developed structure, firm to hard consistence, and generally stronger colours also distinguish them from the friable reddish gradational soils. However, they may be expected to have similar to slightly lower water storage capacities.

These soils occur to a relatively limited extent on plateaux and older parts of the landscape. Friable reddish gradational soils occur on less-steep slopes in areas with annual rainfalls of about 900 mm or more on a range of parent materials.

Moderately structured greyish brown loamy surface soil grades to friable moderately structured subsoils of clay loam to light clay, with colours ranging about reddish brown. The soils are porous throughout and may generally have water-holding capacities comparable to or slightly less than those of the friable brownish gradational soils. They are acid with moderate fertility.

Duplex Soils

Reddish duplex soils

Although they occur extensively in the valleys of the study districts, reddish duplex soils are of limited extent on public land being found most commonly in the Chiltern area and around Beechworth and Stanley.

Red duplex soil in the north of the study area

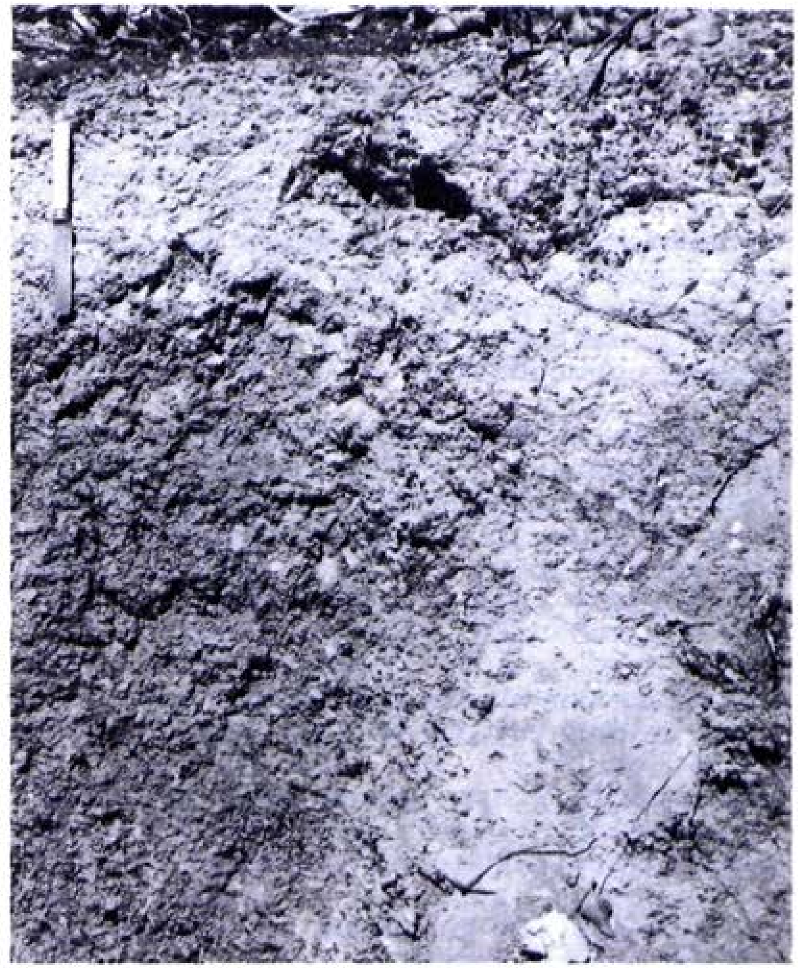
The surface horizon consists of a dark greyish brown loam or fine sandy loam, which grades into a greyish brown or brown loam. This overlies a reddish brown clay subsoil with a clear to abrupt boundary. The surface soil has no structure and sets hard when dry, although it may be relatively porous. The subsoil clays have moderately well-developed structure and are firm when moist, but harden on drying. Weathered rock may occur at a depth of 1 m or less and there may be much fragmented rock throughout the profile.

These soils have a low capacity for flood-rain storage. The surface loams have about 15% of soil volume available, but the subsoil clays have only about 5--10%. These tend to swell after a thorough wetting, which impedes further absorption. About 65 mm of rain would be available for plant growth in the first 50 cm of the soil and a further 50 mm in the next 50 cm.

Soil pH ranges from 5.5 to 5.0, with exchangeable magnesium dominant over calcium and measurable quantities of exchangeable sodium. Levels of available potassium are relatively high, but total phosphorus levels are low.

Yellowish duplex soils

Easily distinguished from the reddish duplex by their yellow or yellowish-brown subsoils, these occur in two recognizable forms.



Red duplex soils; the parent material is colluvium of Ordovician shales and mudstones

The more usual form is common on the plains in the north of the districts. The surface soil varies in depth and is usually gilgaied, except where the clay subsoil is deep. Dark, gritty loam to loam surface soil becomes pale grey, structureless, usually loam or silty loam, with increased amounts of small iron oxide concretions (buckshot) lower in the horizon. This abruptly overlies a yellowish brown heavy clay subsoil, usually with a wavy boundary between the two. Although the clay has a strongly developed structure, when wet it expands and the material becomes only very slowly permeable.

The soils have limited ability to absorb heavy rain and soon become saturated. They frequently remain waterlogged for long periods in winter. Surface soils may retain up to 20% available water by volume, but they are generally shallow and the subsoils have low capabilities.

Although the surface horizons are usually moderately to strongly acid (pH 5.5 to 4.7), the subsoils vary. Acid subsoils are common, and neutral to alkaline subsoils less so. They are highly dispersible, due mainly to the dominance of exchangeable magnesium over calcium and the presence of measurable quantities of sodium.

Cation exchange capacities are medium to low throughout the profile. Subsoils may contain substantial reserves of available potassium but total phosporus is generally low. C:N ratios are moderate (10--15).

The less common form of yellowish duplex soils usually occurs on the plains or the lower slopes of the foothills. The surface layer has a less abrupt boundary with the subsoil, which is usually yellowish brown with reddish brown mottles and is less dense. Clay content usually decreases below about 1 m. The soils are acid, but may have neutral to alkaline subsoils in low topographic positions.

References

Northcote, R.M. "A Factual Key for the Recognition of Australian Soils." (Rellim Technical Publications: Adelaide 1971.)

Rowe, R.K. "A Study of the Land in the Victorian Catchment of Lake Hume." (Soil Conservation Authority: Melbourne 1967.)

Rowe, R.K. "A Study of the Land in the Mount Buffalo National Park." (Soil Conservation Authority: Melboure 1970.)

Rowe, R.K. "A Study of the Land in the Catchment of the Kiewa River." (Soil Conservation Authority: Melbourne 1972.)

12. LAND SYSTEMS

The mapping system used in this chapter draws together environmental factors that are important in determining land use. Areas are delineated and described where climate, parent material, topography, soil, and original vegetation are uniform within the limits decided upon as significant for likely forms of land use.

The most detailed and fundamental unit of mapping - termed a land component - may be regarded as an area (such as a section of ridge-top) in which the environmental factors do not vary enough to significantly influence any of the likely forms of use.

Land components occur in a repetitive, consistent sequence or pattern - for example ridge-top site to basin floor site, and so it is practical to combine them into larger units - termed land units.

As an aid to mapping and general description, land units that have in common some significant characteristics (such as vegetation or land form) are grouped into mapping units termed land systems.

The land systems described in this report are summaries of the systems described by Rowe (1967, 1970, 1972, and unpublished reports).

References

Rowe, R.K. "A Study of the Land in the Victorian Catchment of Lake Hume." (Soil Conservation Authority: Melbourne 1967.)

Rowe, R.K. "A Study of the Land in the Mount Buffalo National Park." (Soil Conservation Authority: Melbourne 1970.)

Rowe, R.K. "A Study of the Land in the Catchment of the Kiewa River." (Soil Conservation Authority: Melbourne 1972.)

Land system	Landscape	Average annual rainfall Usefulness as source of water	Geology	Soils	Native vegetation	Hazards
Barrambogie Ba	Predominantly hilly with steep slopes mainly around the perimeter of the mapped area; limited areas of rolling plateaux and shallow basins; elevation 750 m-- 1,750 m	No records available; estimated range from 650 mm (= Springhurst) to 1,000 mm (= Beechworth)	Granite	Coarse sandy loams and pale massive gradational soils, weakly bleached on less steep slopes; some reddish and yellowish duplex soils; relic clay and weathered rock (both reddish) at depths below 1m	Generally open forest I and woodland I of Blakely's red gum, with long-leaf box on the deeper soils; open forest II of long-leaf box on the more clayey soils with higher rainfall	Erosion hazard high: clearing of slopes would result in wetter drainage-lines and headward erosion of gullies; strong regrowth of trees often clearing is a difficulty in land development
Chiltern Ch	Predominantly rolling to hilly with short, steep slopes flanking prominent ridges, small areas of longitudinal valley bottoms: elevation 750--1,000 m	About 700 m (= Chiltern)	Predominantly fine-textured sedimentary rock of Middle Ordovician age; some metamorphosed	Reddish duplex soils on convex slopes; yellow duplex soils in depressions, weakly bleached gradational soils predominate on steeply-sloping land	Generally open forest II of grey box with red stringybark, and some red ironbark, red box, long-leafed box, and Blakely's red gum; red ironbark along on the reddish soils of the ridges and Blakely's red gum in depressions	Gradational soils with poor structure erode easily; surface run off and seepage from cleared steeper areas contribute to gully erosion in drainage lines and surrounding plains, and to peak-flows, flooding, and excessive wetness
Leneva L	Rolling to hilly with steep slopes; small plateaux on spurs and more extensive plateaux on the tops; elevation 400--600 m	700--900 mm	Gneiss and schist	Reddish duplex soils on the less-steep upper slopes, weakly bleached gradational soils and some undifferentiated stony loams on steep mid-slopes; yellowish duplex soils in depressions	Originally open forest I and II of long-leaf box and some Blakely's red gum	Moderate to high sheet and gullying on all cleared slopes and moderate mass-movement hazard on those facing south
Bunjil Bj	Steep to very steep montane slopes with dissected plateaux at about 600 m--900 m elevation	700--1,000 mm	Gneiss, some schist and granite	Reddish gradational soils, weakly bleached on steep slopes and friable on plateaux	Open forest I and II of long-leaf box; open forest II of broad-leaf peppermint; some open forest III of narrow-leaf peppermint; heath; mossland; open forest I and II of Blakely's red gum	Moderate erosion hazard on steep slopes; lower on plateaux; clearing contributes to peak flows and flooding
Murray Mu	Alluvial flats at about 200 m -- 350 m with gently-sloping dissected fans and terraces some 3--9 m higher, flanked by rolling to steep hillocks	700--1,000 mm	Alluvium and colluvium of diverse origin with varying degrees of pedogentic alteration according to age. Some *in situ* weathered material	Mainly alluvial brown loams and weakly bleached gradational soils, reddish duplex soils on fans and higher terraces; undifferentiated sandy loams on flood plain, weakly bleached gradational soils on flanking slopes	Mainly woodland II and open forest of forest red gum or of river red gum; open forest II of long-leaf box	Excessive wetness leading to puddling of soil; flooding leading to difficulties of management; moderate sheet and gully erosion on hills and sides of terraces, particularly in drier areas; stream-bank erosion
Kiewa Tangambalanga Kt	Flood-plain some low terraces, elevation 160m--230m	700--875 mm	Fine-and medium-textured sediments	Yellowish-brown gradational soils on alluvium and brown loams; some undifferentiated sandy loams	Woodland II of river red gum	Excessive wetness leading to puddling of soil; flooding leading to difficulties of management; moderate sheet and gully erosion on hills and sides of terraces, particularly in drier areas; stream-bank erosion
Kiewa Mullagong Km	Low terraces and associated flood plain, elevation 230m--300m	750--1,125 mm	Medium-textured sediments	Yellowish-brown gradational soils on alluvium and brown loams; some undifferentiated sandy loams	Woodland II of river red gum; open forest II of swamp gum in southern areas	Excessive wetness leading to puddling of soil; flooding leading to difficulties of management; moderate sheet and gully erosion on hills and sides of terraces, particularly in drier areas; stream-bank erosion
Dederang Bonegilla Db	Undulating high terraces; rolling valley slopes with fans, residential hills	700--875 mm	Alluvium and colluvium of variable source and texture	Reddish and yellowish duplex soils	Woodland II of Blakely's red gum with white box in north, tending to open forest II of Blakely's red gum with red box, but but, and red stringybark elsewhere	Moderate sheet and gully
Dederang Mullindolingong Dm	Rolling to hilly valley slopes with fans; residual hills	800--1,125 mm	Alluvium and colluvium of variable source and texture	Friable reddish gradational soils; reddish duplex soils	Open forest III and II of narrow-leaf and broad-leafed peppermint, with long-leafed box on drier sites	Low sheet and gully erosion hazard
Myrtleford Murmungee Mm	Undulating high terraces; rolling valley slopes with fans, residual hills	700--875 mm	Alluvium, colluvium of very varied texture derived from sedimentary granitic and metamorphic rocks	Reddish and yellowish duplex soils and some yellowish brown gradational soil on alluvium	Woodland and open forest II of Balkely's red gum grading into long-leaf box open forest II	Moderate sheet and gully erosion hazard
Myrtleford Whitfield Mw	Rooling to hilly valley slopes with culluvial and alluvial fans and some residual hills	800--1,125 mm	Colluvium and alluvium of varies texture derived from sedimentary igneous and metamorphic rocks	Reddish duplex soils, friable reddish gradational soils, weakly bleached reddish and yellowish brown gradational soils	Narrow-lead peppermint open forest III, broad-leaf peppermint and long-leaf box open forest II, candle-bark and swamp gum in some moist cool localities	Low to moderate sheet and gully erosion hazard
Ovens O	Flood plain and associated low terraces	650--1,270 mm	Alluvium of varied texture derived from a variety of source rocks	Yellowish brown gradational soils on alluvium, brown loams and some undifferentiated sandy loams	Open forest and woodland II of river red gum; open forest II of swamp gum in southern areas	Excessive wetness leading to puddling of soil; flooding leading to management difficulties; moderate sheet and gully erosion on hills and sides of terraces, stream-bank erosion
Berringama Lucyvale Br1	Rolling to steep hillocks at about 460 m elevation with undulating to rolling dissected fans and terraces at 240 m	1,200 mm	Ordovician sedimentary, metamorphic and granitic rocks	Weakly bleached, gradational soils on hillocks with some friable brown gradational soils; reddish duplex soils on terraces and fans	Open forest II of broad-leafed peppermint; open forest III of narrow-leaf peppermint; some open forest II of long-leaf box and swamp gum	Moderate sheet erosion on hillocks; lower sheet and gully erosion on terraces and fans; stream-bank erosion
Berringama Wagra Br2	Rolling to steep hillocks at about 460 m elevation with undulating to rolling dissected fans and terraces at 240 m	750--1,000 mm	Ordovician sedimentary, metamorphic and granitic rocks	Weakly bleached, gradational soils on hillocks with some friable brown gradational soils; reddish duplex soils on terraces and fans	Long-leaf box, woodland II of Blakely's red gum and river red gum	Moderate sheet erosion on hillocks; lower sheet and gully erosion on terraces and fans; stream-bank erosion
Stanley S	Dissected plateaux at about 700--900 m with steep slopes and rolling fans	1,175--1,250 mm	Mainly Ordovician shales and mudstones	Friable reddish gradational soils, hard reddish with some friable brown gradational soils	Open forest III of narrow-leaf peppermint with candle-bark and some blue gum; open forest II long-leaf box on dry sites	Erosion hazard generally low; roading on steeper slopes may increase peak flows and stream turbidity
Twist's Creek Tc	Undulating colluvial/alluvial fans on sloping valley floors; some low hills; a few narrow terraces	875--1,000 mm	Colluvium and alluvium derived mainly from Ordovician shales and mudstones	Friable reddish gradational soils; weakly-bleached reddish and yellowish-brown gradational soils; reddish duplex soils	Open forest II of broad-lead peppermint and long-leaf box, merging to open forest III of narrow-leaf peppermint	Moderate sheet and gully erosion hazard; roading and protective burning on sloping land could lead to increased peak flows
Yackandandah Y	Dissected strath-valley-beach of rolling to hilly fans and residual hills	875--1,000 mm	Gneiss and schist	Reddish duplex soils; friable reddish gradational soils, some weakly-bleached gradational soils	Open forest II of broad-leaf peppermint, long-leaf box; narrow-leaf peppermint on wetter fringe; open forest II of forest red gum on flats	Low to moderate sheet and moderate gully erosion hazard

Land system	Landscape	Average annual rainfall Usefulness as source of water	Geology	Soils	Nature vegetation	Hazards
Big Ben B	Plateaux, dissected to rolling topography, with some hills; elevation 600--1,100 m	875--1,125 mm	Gneiss and schist usually deeply weathered	Friable reddish gradational soils, friable brown gradational soils; some stony loams	Open forest II & III of narrow-leaf and broad-leaf peppermint with candlebark gum and blue gum; some small areas of open forest IV of alpine ash; open forest II of snow gum	Low soil erosion hazard, except in steeper country
Tawonga Barenduda Tb	Steep to very steep about 300--760 m	750--1,000 mm	Granite, metamorphic and Ordovician sedimentary rocks	Weakly bleached reddish gradational soils. Pale massive gradational soils	Open forest II long-leaf box and broad-leaf peppermint	High sheet erosion hazard; could become flood source areas if ability of soils to absorb and hold water impaired
Tawonga Wernatong Tw	Steep to very steep; elevation 450--900 m	1,000--1,250 m		Friable reddish and brownish gradational soils	Open forest III narrow-leaf peppermint some open forest II broad-leaf peppermint	Moderate sheet erosion; damage by fire, roading and logging can lead to increased peak flows and stream turbidity
Tawonga Darbalong Td	Steep to very steep; elevation 600--1,300 m	1,250--1,500 mm		Friable brownish gradational soils	Open forest IV alpine ash open forest III narrow-leaf peppermint	Erosion hazard low to moderate; roading and logging unless carefully controlled, will cause long term soil damage leading to increased peak flows and stream turbidity
Bowman Bo	Hilly with steep slopes along central ridges; some less-steep slopes on piedmont surfaces in northern parts	700 mm in the northern parts to 1,100 mm in the southern parts	Ordovician fine-textured sediments	North: reddish duplex soils on gentle upper slopes, weakly bleached gradational soils on steep mid-slopes, and yellow duplex soils on poorly drained lower slopes; south: friable reddish and brownish gradational soils, plus stony loams	Generally open forest II Blakely's red gum and long-leaf box in the north grading into open forest II-III of narrow-leaf and broad-leaf peppermint in the south	High erosion hazard slopes in northern parts; annual plants tend to gain dominance in cleared areas; close association of steep and less-steep areas makes safe management difficult; in south areas roading and fire may increase peak flows and stream turbidity
Myrrhee My	Moderately steep, and steep slopes of ridges and spurs; steep basins at heads of valleys; small area of rolling plateaux	Estimated 950--1,150 mm	Ordovician fine-textured sediments with caps of Tertiary basalt on plateaux	Weak bleached reddish gradational with yellowish weakly bleached gradational soils in poorly drained sites; on basalt, friable reddish gradational soils with dark well-structured non-calcareous clays in poorly drained sites	Woodland II and open forest II of long-leaf box with red stringybark, red box and yellow box; on basaltic soils, open woodland II of long-leaf box with red box and yellow box	Steep slopes when cleared are subject to mass-movement erosion and, if poorly managed, to excessive wetness in winter, resulting in gullying of lower land
Drum-top D	Dissected foothills rising from about 300 m broad ridges at about 500 m elevation	750-1,250 m; a minor water source area	Upper Devonian acidic volcanic rocks	Shallow stony loams and friable reddish and brownish gradational soils on broad ridges and upper slopes, yellowish duplex soils on lower slopes and foothills	Open forest II of long-leaf box on ridges and upper slopes; open forest II of broad-leaf peppermint on lower slopes and foothills; open forest III of narrow-leaf peppermint in higher-rainfall parts	High on steep northern slopes with clearing or protective burning; moderate on foothills with clearing
Toombullup To	Undulating plateaux; elevation 500--900 m	1,000--1,250 mm. A moderate water source area	Upper Devonian acidic volcanic rocks	Friable brownish gradational soils; some friable reddish gradational soils	Open forest IV of messmate on plateaux tops; open forest III of narrow-leaf peppermint on surrounding gentle slopes; open forest II of swamp gum in broad drainage lines	Low erosion hazard
Wabonga W	Rolling, dissected plateaux and broad ridge tops; elevation 500--1,100 m	1,000 mm to over 1,250 mm. A useful source of water in terms of summer flow as well as total yield	Lower Carboniferous sedimentary rocks	Reddish and yellowish duplex soils; some weakly bleached gradational soils and undifferentiated stony loams; friable reddish gradational soils on higher plateaux	Mainly open forest II of broad-leaf peppermint on drier sites, with open forest of narrow-leaf peppermint in wetter areas; open forest III of messmate on plateau-tops and open forest II of swamp gum in depressions	Moderate soil erosion hazard; Winter cold and isolation are drawbacks to agricultural use of higher plateaux
Mahaikah Ma	Low hills and cappings of basalt, the foothills grade into undulating surface of underlying plateaux. Elevation; 730--970 m	1,150--1,250 mm. A useful source of water	Tertiary basalt mainly overlying Carboniferous sediments (coarse-textured in northern parts, fine-textured in southern) and some rhyodacite and rhyolite	Reddish gradational soils on basalt; elsewhere friable brownish gradational soils of variable texture (including some purplish-red soils on the Carboniferous "red beds")	Open forest II to III of narrow-leaf peppermint on basaltic soils and on other soils of finer texture; open forest II of broad-leaf peppermint on coarser-textured soils; manna gum and messmate on deeper soils in sheltered sites	Generally low erosion hazard; fertilizer requirements are higher on coarse-textured soils
King Ki	Steep to very steep mountainous ridges and spurs with narrow valleys; elevation 450--900 m	Estimated 1,000--1,300 mm; a moderately valuable source of water	Acidic lavas, predominantly rhyolite	Friable brownish and reddish gradational soils, usually shallow; stony loams are common	Ranging from open forest II of broad-leaf peppermint in drier parts to open forest III of narrow-leaf peppermint with candlebark in wetter parts	Severe following wildfire; moderate after controlled burning; increased peak flows and stream turbidity occur after fire
Koonika Ko	Deeply dissected headwaters with steep slopes; elevation 500--1,100 m	1,000--1,250 mm; a significant source of water	Lower Carboniferous sedimentary rocks	Ridges and steep west slopes, undifferentiated sandy loams; long slopes, friable brownish gradational soils; foothills, friable brownish gradational soils (Usually weakly-bleached)	Open forest II of broad-leaf peppermint on north-western slopes, elsewhere open forest III of narrow-leaf peppermint or of messmate at higher elevations; open forest IV of alpine ash and candlebark; open forest I of snow gum and broad-leaf peppermint	Severe soil erosion after wildfire and moderate after controlled burning, except at higher elevations
Pinnacles Pi	Steep to very steep slopes with inter-montane basins at various levels and small plateaux. elevation 500--1,100 m	Estimated 900--1,100 mm	Granite	Pale massive gradational soils on steep slopes; on less-steep slopes, friable reddish and brownish gradational soils, reddish duplex soils at lower elevations	Open forest III of narrow-leaf peppermint with candlebark and some broad-leaf peppermint in the higher or wetter areas; open forest II to III of long-leaf box in lower or drier parts	High erosion soil hazard; with clearing drainage lines in granite soils become very wet and liable to gullying; road drainage can lead to erosion
Mount Buffalo MB	Elevated granite block with a gently dissected plateau and surrounding peaks at 1,500--1,750 m elevation and very steep to precipitous slopes down to valleys at about 250 m elevation	Ranging from 1,000 mm with mild winter temperature to about 1,900 mm with winter snow; a very valuable source of water at higher elevations	Granite	On the plateau the soils form a sequence, from stony, shallow organic loams on rocky outcrops, through deeper organic loams on gentle slopes, to humified, fen and bog peats in depressions; on the surrounding slopes are stony, sandy loams and friable brownish and reddish gradational soils	Plateau from rocky outcrops to drainage lines: open forest I, woodland I of snow gum; closed heath; closed grassland; closed short heath on humified peats and moss beds on bogs. Surrounding slopes, from lower elevation and drier sites to higher elevation and wetter sites; open forest II of broad-leaf peppermint with red stringybark or candlebark; open forest III of narrow-leaf peppermint to 1,200 m; open forest IV of alpine ash and candlebark; above 1,500 m open forest III and II of candlebark and snow gum	Moderate to low, soil erosion hazard but access roads and logging, if uncontrolled can lead to increased stream turbidity and peak flows
Winteriga Wi	Predominatly steep to very steep slopes with small plateaux, high-level shallow basins, and broad-topped ridges up to 1,100 m	Estimated 1,150--1,300 mm	Ordovician fine-textured sedimentary rocks, with metamorphosed forms near the granite	Friable reddish and brownish gradational soils; some gravelly loams and pale massive gradational soils	From lower elevation to higher: open forest II of long-leaf box with red stringybark, blue gum and candlebark ; open forest II & III of narrow-leaf peppermint with candlebark; some open forest III and IV of alpine ash; open forest III and II of candlebark and snow gum	Moderate to low, but access roads and logging, if uncontrolled can lead to increased stream turbidity and peak flows

PART III

LAND USE

13. HAZARDS

The physical and biological entities that comprise the environment form a dynamic but balanced system that is constantly changing under the influence of external and internal forces. European settlement (and the conversion of natural bush to agricultural land) has been a powerful factor in changing the natural balance of this system. Most of the changes have been aimed at improving the environment for Man. Unfortunately some changes have not done so, and now adversely affect the ability of the environment to provide a sustained yield.

The improvement in scientific knowledge and its application have reduced the harmful effects of some of the hazards associated with these changes, but prosperity, technical innovation, and population growth are rapidly increasing the level and diversity of changes to the environment. It is thus becoming increasingly important to indentify and control the major hazards in order to conserve productivity.

Soil Deterioration

Soil is constantly, but slowly, being made by the interaction of physical and biological forces. Gradual soil removal and redeposition also occurs naturally and is part of the continuing geological process.

Use of land may speed up soil loss and/or reduce fertility. Soils vary in their resilience to erosion forces. This variability is governed by a number of factors, including the physical constituents of the soil and their cohesion, the existence of a protective covering such as vegetation, and also the local terrain and the condition of the surrounding country. The land systems and soils chapters discuss the variable susceptibility of soils to erosion and the different types of erosion that occur.

Soil deterioration involves the community in losses, which are normally long-term. The fundamental loss is the permanent reduction in production potential and, to some extent, in the inherent versatility of the land. In addition, the control and correction of soil deterioration involves direct cost.

Moreover, part of the soil from erosion is carried into streams. The resultant increased silting can increase, not only the occurrence of flooding but also the cost of water storages. Heavy deposits of silt on the river flood-plains can reduce their fertility. Increased turbidity, colour, and total dissolved solids can increase the cost of using this water for domestic and industrial purposes.

Visible erosion reduces the aesthetic appeal of the region and could affect tourism. Reduction in the quality of vegetation and wildlife habitat can occur concomitantly with soil deterioration and could reduce the value of the area for recreation.

The losses accrue in varying degrees from most land uses that may create a soil deterioration hazard - agriculture, forestry, mining, recreation, and their associated activities.

Gully erosion, Murmungee River

Agriculture is the main land use on alienated land. Most soil erosion that occurs on farming land is principally the concern of the farming community and organizations such as the Soil Conservation Authority. Possibly one of the main causes of soil erosion in the districts recently is the clearing of steep slopes, especially in areas where the soil is less able to withstand the erosion forces, without adequate precautions such as contouring.

The principal agricultural use of public land is forest grazing and apiculture. Stock trampling readily disturbs the loose, humus-rich soils of the high country and reduces their ability to withstand the forces of wind and water erosion. Much of the forest area in the districts that is leased for grazing has soils stable enough to ensure that erosion from this cause is not critical to maintaining production.

Apiculturists normally stay on the lower, more accessible country. Soil deterioration from their activities is slight and unlikely to be of much concern in the foreseeable future.

In natural forest the main period of high erosion hazard is the summer and autumn. Loss of vegetation cover increases it. Soil loss on severely burnt areas can be considerable, especially if the vegetation takes several seasons to become fully re-established.

Soil erosion can be caused by and during the construction of forest tracks and roads. Logging in forest can increase it, especially when extensive areas are clear-felled. Logging in winter can create heavy erosion locally, but the presence of moist soils, good growing conditions, and ground cover vegetation in the immediate area tends to restrict its extent.

Each area clear-felled for pine plantations is normally quite large, and is allowed to dry over the summer months before being burnt in the autumn. It is planted during the winter, and has a vegetation cover within about 12 months. Soil erosion and associated problems are likely to recur during harvesting and replanting of the area, normally 30--40 years later. The Forest Commission and Soil Conservation Authority have developed management principles to ameliorate these problems.

Mining is another form of land use that can cause erosion. Gravel mining is probably the most important, especially when large areas of land are left unvegetated for long periods. The Soil Conservation Authority and Mines Department co-operate to ensure the eventual rehabilitation of these areas.

Soil erosion can be caused by damage to vegetation and soils by wheeled vehicles. In addition to work, recreation generates an increasing amount of travel in bushlands. Some bush areas are used fairly intensively and consequently suffer from erosion that reduces their aesthetic appeal. Recreational activities such as fossicking in rivers and streams for gold and gemstones can cause erosion.

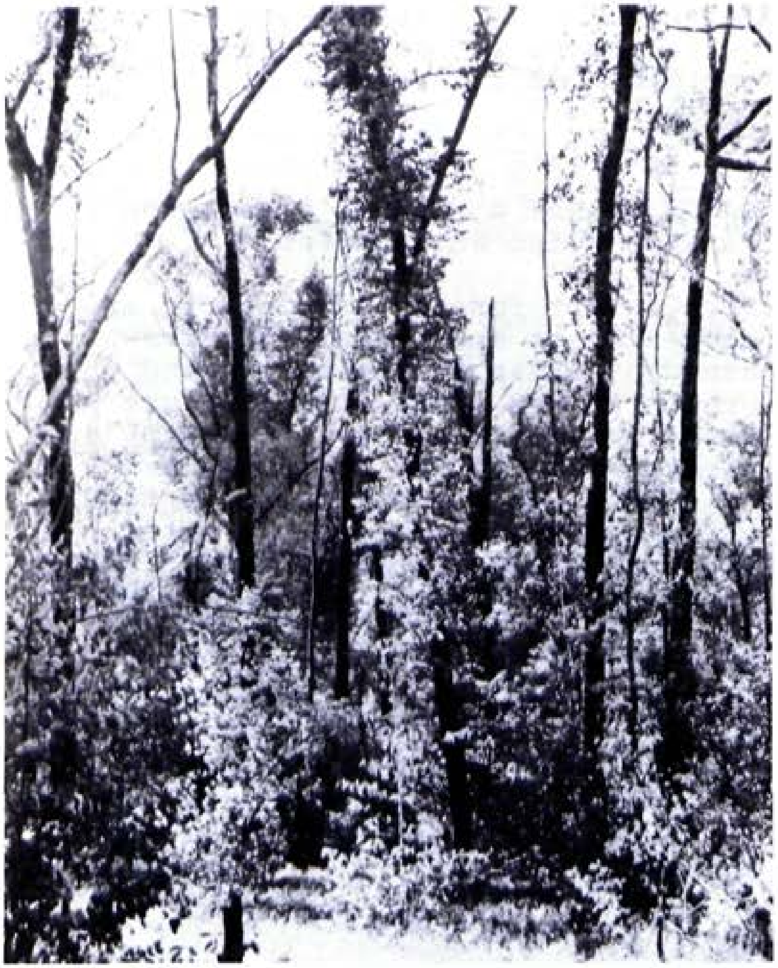
Fire

Bushfires are a natural phenomenon in the Australian environment.

The eucalypt forests of Victoria are recognized as among the most fire-hazardous areas of the world, and the forests in the study districts are no exception. Most species shed bark and leaves in quantities that result in annual fuel accumulations of up to 6 tonnes per hectare on the forest floor. Different areas of the study districts have different levels of fire hazard.

The vegetation in these areas has adapted itself to withstand the different frequencies of fire. Topographic, edaphic, and climatic factors primarily influence the fire danger.

Areas that have low fire danger and are burnt very infrequently, such as wet sclerophyll forest, contain eucalypts that are very susceptible to fire damage. Alpine ash is such a species and is adapted to infrequent but destructive fires. Intensive fire readily kills it, but produces seed-bed conditions favourable for its regeneration. Without fire, this species would eventually be replaced by other forest trees.



Long-leaf box forest recovering from fire

Drier forests are more frequently burnt. The eucalypts found there are adapted to frequent fire and are rarely killed. However, the frequency of fires greatly influences the understorey species.

Fire danger is greatest in summer, especially during prolonged periods of dry weather when hot winds from the interior blow strongly from the north. North- and west-facing steep slopes are especially prone to fire.

Fires are started by lightning and Man. Early settlers noted that Aborigines often lit them, either accidently or on purpose, possibly for hunting. The early settlers themselves used fires to help clear the forested land for agriculture. Today forests are viewed as a valuable resource, for timber, water production, soil conservation, and recreation. But the areas of natural vegetation have shrunk considerably since European settlement and fires occurring now could destroy a considerable proportion of a vegetation type. Moreover, they could destroy houses and property. Also, although forests are a renewable resource, the time required for regeneration after fire is considerable when compared with human life span and a very destructive fire now represents a complete loss of resources to this generation.

It is therefore considered necessary to exclude wildfire from the forests as far as possible.

In addition to protecting the forests of the study districts, effective fire control in this area prevents wildfires spreading over the dividing range and into the forests of eastern Victoria.

The Forests Commission carries out a programme of fuel-reduction burning on much of the public land, particularly on forest boundaries and adjacent to important timber areas. These burnings cover large areas and remove much of the accumulated shed bark and leaves that act as fuel for wildfires. In addition, the Commission is improving access by constructing and maintaining roads, tracks, and helipads.

Facilities are available for aerial dropping of chemical fire-retardants on fires in remote localities, to reduce their spread until ground crews arrive. Early detection of forest fires is helped by the eight lookout towers within and adjoining the districts.

Some 80--90% of wildfires are now started accidentally by Man. Although community co-operation in fire prevention and control is good, there is a constant danger of fire escaping into the forest from the neighbouring private property. The growing population numbers and mobility increase the danger considerably, especially as more people are travelling through the forests for recreational purposes. Their sensible actions can ameliorate the wildfire problem.

Despite the precautions taken and the facilities available to the authorities responsible for fire control, the nature and form of eucalypt forest fires make them difficult to control; in some cases very large fires can only be terminated when they have exhausted the main areas of heavy fuel accumulations, or when the weather changes, or both.

Water

North-eastern Victoria is a net provider of water for other drier parts of the country. The surplus from the study districts reaches the sea via the Murray River, but more and more of this water is being used, for irrigation (10% of the Murray River's annual flow). Quite probably a time will come when all the available water will be used for irrigation. Its quantity and quality have an important bearing on the ultimate cost and success of schemes to use it.

The use to which land is put affects its usefulness as a catchment area. Part of the study area comes under the regulations for the Hume Catchment. Changes in vegetative cover alter the rate and quantity of run-off and the recharge of groundwater.

Dense vegetation, which includes deep-rooting species, reduces surface water yield, but acts as a reservoir, releasing water, usually of good quality, over a longer period. Poor cover can result in rapid surface run-off of silt-laden

Flooding is a regular occurrence on the Ovens River flood-plain

water; such flash flooding increases the cost of collecting and later utilizing this water.

Salinity

Most irrigation areas have a salt problem already and have to use part of the irrigation water to leach the accumulated salt in the soil to below the crop rooting zone. A small increase in the salinity of irrigation water can cause considerable problems for irrigators, and necessitate the use of very large volumes of water to leach the soil to make plant growth possible. The salty water from these leaching operations finds its way back into the river via the field drainage system. It can also raise the level of the water table, thereby bringing saline groundwater into the rooting zone or producing saline conditions at the base of slopes.

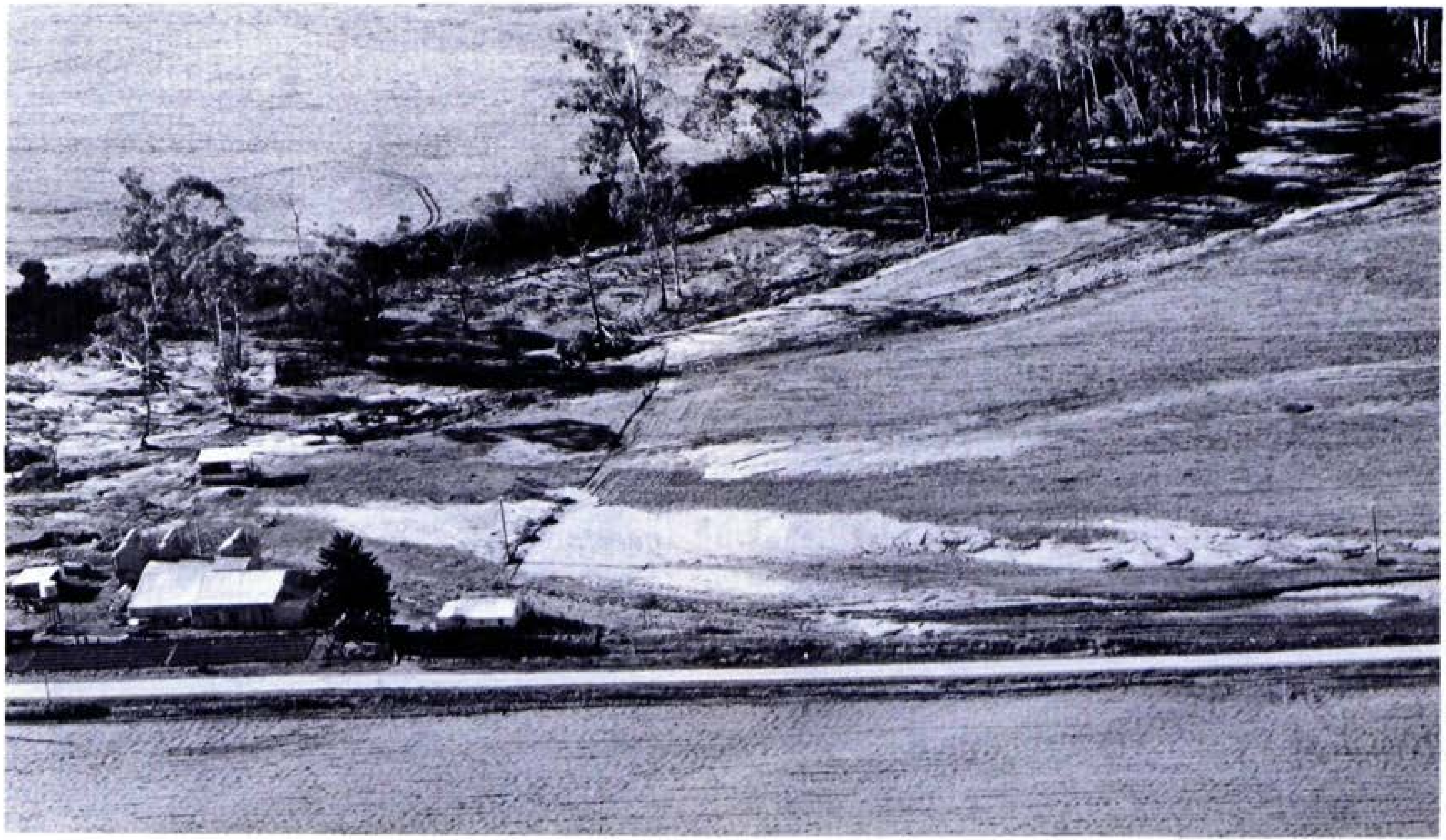
Pollution

Contamination of water is usually associated with industry and urbanization. Agriculture can contribute to water pollution through seepage of waste products and chemicals into drainage lines. Poisoning and/or eutrophication can detrimentally affect river life, reduce the recreational value of the rivers, and increase the costs of water to users in the lower reaches. Contamination is a greater problem in summer, when stream flow is at its lowest. Hops and tobacco (both irrigated and grown on river flats) consume most chemicals in the region and pose a potential river pollution hazard. Stock-watering in streams is quite common in the area and, besides causing river-bed and bank erosion, increases the danger of eutrophication and pollution.

Flooding

Floods in the study districts are not generally a problem, although the lower reaches of the streams flood regularly. However, the increasing amount of cleared land increases their frequency and severity. Changes to the flood regime can be detrimental to some aquatic animals.

Because of their size, water storages on the Buffalo and King Rivers have very little effect on the regime, but Lake Hume, which has a capacity of 3.06 million megalitres, can exert a considerable influence if it is substantially below full supply level at the time of onset of the flood. However, the storage was built to provide assured supplies for irrigation, and optimum operation for this purpose reduces its usefulness for flood mitigation.



Flood-damaged tobacco land in the King valley

Flooding could become a hazard to settlements in the future, especially if urban and industrial expansion takes place on low-lying land, notably at Wangaratta.

Biological Hazards

Fungi

Phytophthora cinnamoni, a soil-inhabiting fungus, attacks the small feeder roots of a wide range of native trees and shrubs, as well as some garden ornamentals and trees of agricultural importance, causing die-back.

Although probably introduced to Victoria at the time of European settlement, the fungus was not identified in eucalypt forest until 1969. It reduces the ability of the host plant to take up water, and produces above-ground symptoms similar to those produced by drought. It is transferred over long distances in soil adhering to machines or in soil with nursery stock, and spreads from the point of contamination down drainage lines in running water. Wet and waterlogged soils assist the fungus. Temperatures below 15° C reduce its acitivity, and at present it does not seem to be a problem in any high country. The only record of fungus in the study districts is at Cheshunt, where it has infected a walnut grove.

Control on a small scale can be achieved by soil fumigation, and soil drainage probably helps. Sanitary procedures such as fumigation or steam sterilization of nursery soil and cleaning of earth-moving and road-making machinery could reduce the spread of this fungus. Treatment of gravel from infected pits, or their abandonment, could also help.

Pest plants

A survey carried out in 1970 showed that 52 species of noxious weeds were present in the study area. Appendix 7 lists these species, which have been proclaimed under the *Vermin and Noxious Weeds Act* 1956, which incorporates a legal requirement to carry out control measures.

In agricultural areas, the effects of noxious weeds are well known and documented. On public land, however, the situation is not clear and the effects of weeds are rarely documented.

Generally, noxious weeds only colonize disturbed areas of native vegetation. Commonly they are found along creek frontages and road reserves, in grazed areas, or at sites of abandoned farms, camps, sawmills, and gold-workings. They are of concern on public land because they compete with native vegetation, impede access, and can have undesirable characteristics such as prickles, thorns, or poisonous properties. In some cases they can be aesthetically undesirable and can also act as reservoirs of infection for adjacent land.

The important weeds in the areas are blackberry and St. John's wort.

Blackberries are found throughout the districts and are especially common around streams and along water courses. Much of the soil disturbance that helped their spread, took place during gold-mining activities. Chemical control is carried out using 2,4,5-T and picloram, but many areas of public land are inaccessible to spraying teams and are not

St. John's wort is common in the drier parts of the region

Blackberries infest many stream frontages treated. Blackberries are often a problem in young pine plantations.

St. John's wort occurs in many areas. It is controlled to some extent by biological methods.

Bracken is not a noxious weed, but many people consider it a problem in pastures of low productivity. It is widespread in the districts on both public and private land.

Pest animals

The pest animals that have been proclaimed vermin under the *Vermin and Noxious Weeds Act* are rabbits, foxes, hares, dingoes, wild dogs and dogs run wild, wombats, pigs run wild, sparrows, and starlings.

Rabbits are found throughout the study districts. They are least common in native forests, but, through selective grazing, can alter the species balance of vegetation. They also graze very intensively and when numerous can severely reduce the vegetation cover and so make the land more susceptible to soil erosion. Rabbits can be a problem in establishing pine plantations, and normally these areas are baited with carrots impregnated with 1080 poison before planting.

Foxes are found throughout the study district. The are opportunist feeders, eating whatever is available. Rabbits, mice, and insects form a substantial part of their diet, but lamb predation is now generally considered to be of little economic significance. In farming areas, sheep carrion would be important but in bush areas predation on native fauna would be more important, although its effect is not known. Foxes have

Foxes are frequently caught in steel dingo traps considerable value as game animals and their pelts are valuable; they are normally trapped in dog traps, although sometimes poisoned or shot.

Hares cause little damage to land. They can compete for food with livestock on agricultural land, but their population densities are not normally very great. They occasionally damage the bark of fruit trees.

Dingoes and feral dogs attack livestock sporadically and can be a serious local pest. They mainly eat the larger native mammals, particularly wallabies and wombats, but also prey on smaller mammals and birds. The hydatid tapeworm (*Echinococcus granulosus*) is a common parasite in these pests, but their significance as reservoirs of potential infection for domestic livestock and Man is not known. Dingoes and feral dogs are most common in the larger blocks of public land to the south and east of the study districts.

Wombats can be a nuisance in farmland adjacent to bush. The main damage attributable to them is the holes they dig under fences.

Feral pigs occur in the western side of the study districts. They inhabit dense bushland, causing some soil erosion in wet areas and pollution of water.

Noxious birds are of little importance on public land, although both house and tree sparrows occur in the area and starlings are quite common. Agriculturally, they can damage seed crops and carry diseases (notably poultry diseases).

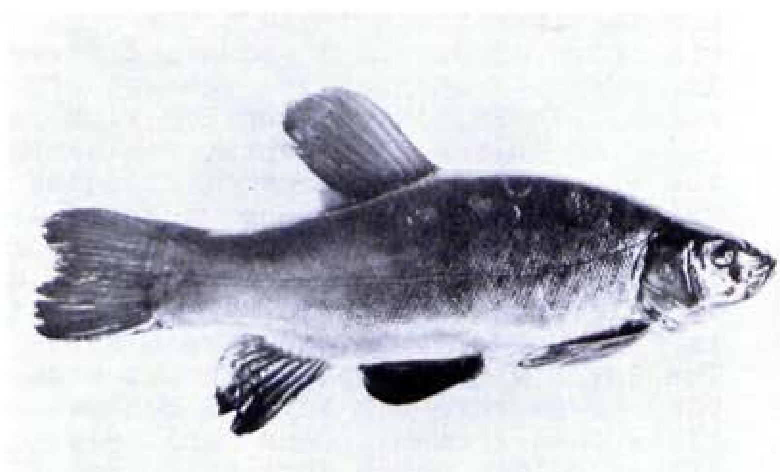
Feral cats are not declared vermin, but many people consider them a serious threat to native fauna. They thrive in the bush and are fairly common in the districts.

Direct alteration to the streams and other changes in the environment since European settlement have adversely affected the survival of native fish in the streams. Many of the changes, however, have been acceptable to introduced fish species which have moved into areas previously occupied by native fish.

Direct alterations include the construction of dams and weirs and river improvements such as the removal of snags. These, in conjunction with land clearing in the catchments, can alter the extent and frequency of flooding which is required for the successful breeding of several native species. Water discharged from the bottom of dams is cold; the water below the Hume Weir is 6° C colder than the stream above it. The lower water temperature has made the bony bream rare for several hundred miles down stream. Dams seriously affect golden perch and, to a lesser extent, the silver perch. Removing snags from rivers reduces the sites for fish to live.

Indirect changes include siltation of rivers following land clearing. Silt can suffocate fish eggs and reduces food availability to fish by killing bottom-growing plants and animals. Insecticides, washed in from agricultural land, are rarely catastrophic, but sublethal effects can gradually reduce the viability of fish populations. Herbicides used to control reeds in swamps or plant growth in irrigation cannals and along stream frontages can have similar effects.

Increase in the nitrate content of water from leached fertilizers and organic waste, including sewage, increases the quantity of decaying algae in the streams. The resulting oxygen deficiency can kill fish, but is more likely to kill fish eggs laid in deep water. For example, Murray cod, lays its eggs in sunken hollow logs in at least a metre of water. Rapid fluctuations in water level due to irrigation procedures can severely restrict the breeding of fishes that spawn in very shallow water and attach their eggs to twigs and plants. These are mainly small fish, including the western carp gudgeon, which is an important food for young Murray cod.



Tench, an introduced species of the carp family

Introduced fish species often have advantages over native fish in the new water environments. Introduced trout (*Salmo* spp.) compete with the native trout (*Galaxios* spp.) for food and also prey on them, which may account for the decline of the native trout species.

Tench (*Trinca trinca*) common in the lowland streams - are considered an undesirable species, but are less destructive to the natural aquatic environment than their relative, the European carp. European carp (*Cyprinus carpio*) are not found in the districts, but are in the Murray River below Yarrawonga.

The lower portions of the main streams in the area, that have muddy bottoms and warm slow-flowing water, are suitable and likely to become infested if the species reaches the districts.

Insects

The forests in the districts are principally of mixed eucalypt species: the areas of pure stands are not extensive. This diversity of vegetation helps to keep the pathogen--host--predator relation in balance, so plagues of insects seldom occur. It has therefore not been necessary to apply insecticides on a wide scale to control insect pests in native vegetation.

Although forest insects have not reached plague proportions, the area contains a number of species with pest potential, which under suitable conditions may become a problem locally. Prominent among these is the phasmatid *(Didymuria violescens)*, which defoliates eucalypts to some extent throughout the distircts. Its effects are greatest during dry years. During the last decade, this insect extensively defoliated mixed eucalypt forest and pure stands of alpine ash in the Kiewa hydro-electric scheme just south-east of the study area.

Pine plantations are inherently susceptible to insect plague damage because of the large areas forested with pines of uniform age and species (and variety). So far there have been only a few minor problems. The leaf case moth *(Hyalarcta huebneri)* has defoliated and killed some young trees. Bark bettle *(Hylastes ater)* an introduced species that normally helps to decompose old stumps and rotting logs - has severely damaged the root systems of some young pine trees during the winter months. Sirex wasps *(Sirex noctilio)* have not yet invaded the area, but regular inspections, good silviculture, and prompt destruction, together with an increasing programme of biological control have proved effective elsewhere in Victoria, and can be expected to be successful against possible infestations in plantations within the study area.

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14. 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, hydrological, and climate 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 hydrological weaknesses.

The influence of Man

Man is obviously 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 less obvious.

Man provides himself with supplies of food and fibre, many of which he obtains from artificial systems. He manages these 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 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 discussed below. Each has value for our edification, inspiration, and recreation; 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.

None of them necessarily requires a monopoly 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 all 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

Relatively undisturbed and isolated terrain south of Mount Buffalo 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. 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 of the Oxley plains, and the 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, and open forest areas being increasingly utilized for recreation.

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).

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.

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. 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 may have to be set aside especially for education.

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.

Species endemic in the study area and endangered species must receive high priority for preservation, as opportunities for doing so are limited.

Special values

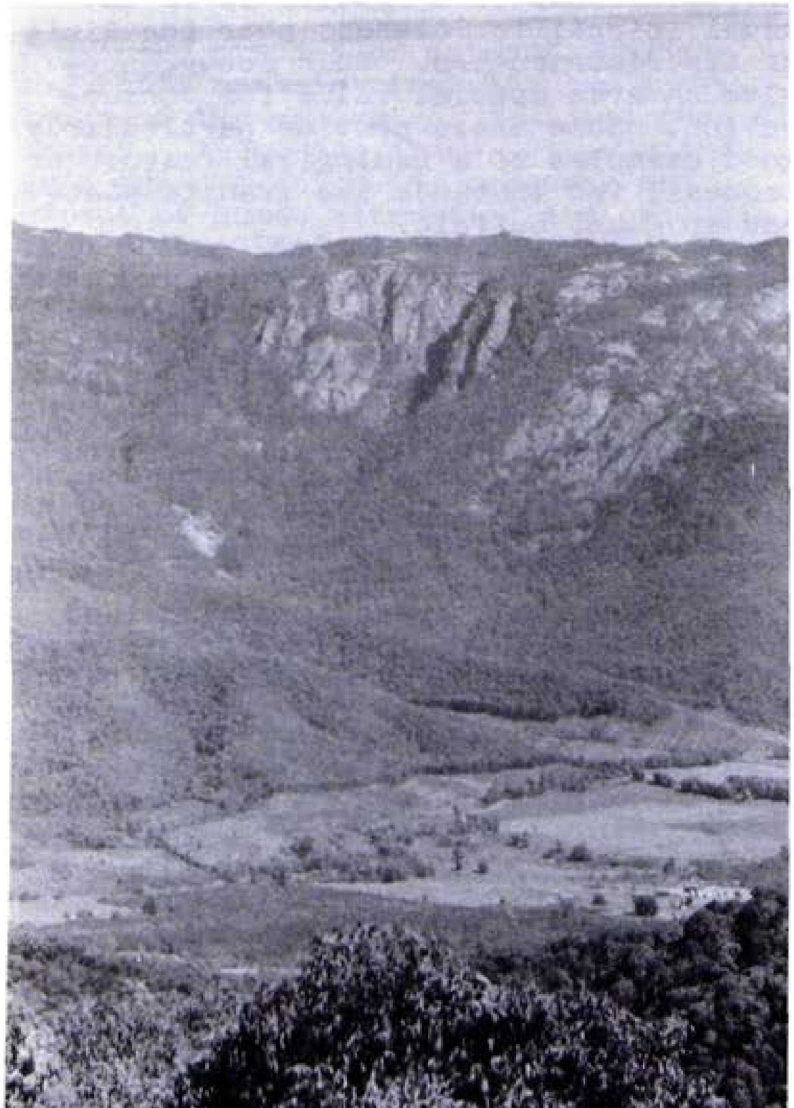
The occurrence of a species is of unusual scientific interest near the limit of its distribution. Such occurrences give an area special value for conservation. Some areas provide particularly good examples of a geological feature or process, for instance the granite plateau at Mount Buffalo.

Small areas

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

Since these small areas of public land still bear, perhaps in a modified form, 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 districts these small remnants are important along the river valleys and in the Oxley plain.

In the past, many such 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 against alienation or despoliation as they should have been.



Mount Buffalo from Mount Porepunkah

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 effects 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 large 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 practice, 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.

15. AGRICULTURE

While livestock production is the predominant rural land use in the study districts, the environment of the valleys provides conditions suitable for producing a variety of crops, and indeed, most of Victoria's tobacco and hops are grown there. The production of fruit is also substantial. The Primary Production Map shows the location, distribution, and density of each rural industry.

Livestock

Table 12 gives the numbers of each species of livestock (excluding pigs) of significance within the districts for the period 1968-69 to 1971-72.

Table 12

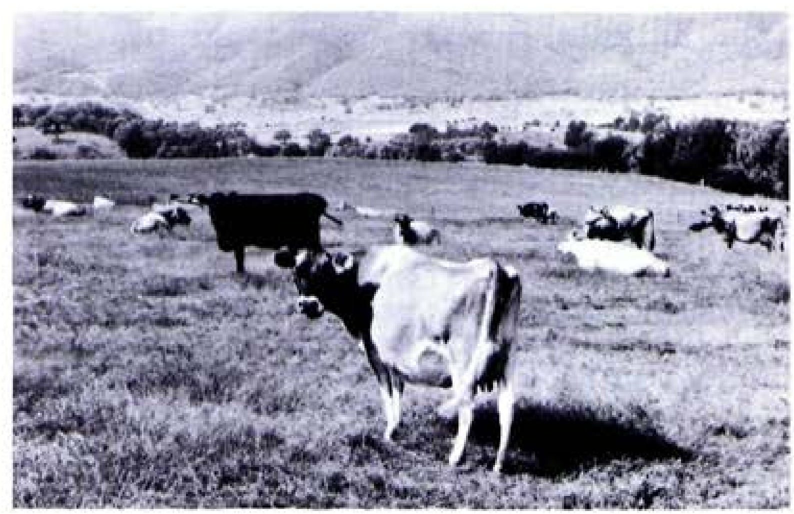
LIVESTOCK NUMBERS FOR THE DISTRICTS ('000)

	1969	1970	1971	1972
Beef cattle	158	196	219	212
Dairy cattle*	86	85	77	72
Sheep	572	562	441	414

*Cattle kept for the commercial production of milk and cream

Dairying

Of the livestock industries, dairying (in association with pig- and beef-production) predominates in the valleys of the King, Ovens, Mitta Mitta, and Kiewa Rivers and their tributaries and the Middle and other creeks. The major production area is to the middle east of the districts, which contain about 4% of Victoria's total dairy cattle. However, cattle numbers for milk and cream production have declined from 86,000 in 1968-69 to 72,000 in 1971-72.



Dairy cows in the Kiewa Valley

The pastures supporting dairying generally consist of annual and perennial species of grasses and clovers. Pasture production ranges from about 7,000 kg to 10,000 kg per hectare annually. It is greatest in spring, and most species are dead or dormant in summer unless irrigated. Many dairy-farmers practise irrigation in summer on at least part of the property. About two-thirds of production is sold as whole milk and the remainder as cream. Herd size varies from 50 to 150 head and dairy farms from 80 to 120 ha.

Pig production

Piggeries are usually associated with dairying properties specializing in cream production, but pig production is seldom more than a supplementary enterprise to utilize skim milk.

In 1972 the districts contained about 33,000 pigs, amounting to 6% of the State total.

Beef cattle

Beef cattle production is a traditional enterprise within the districts and, of the animal enterprises apart from dairying, predominates in the higher-rainfall environments. Only in the north of the districts do sheep become of greater economic importance.

Beef cattle are usually Herefords, but other breeds and crossbreeds are present.

Forest grazing

Crossbreeds of "dairy" origin are substantial to the west of the districts.

Most properties have breeding herds and produce vealers or older fat cattle. Vealer production is feasible only on the more fertile country located in the higher-rainfall areas. An unusual feature occurs in valleys adjoining alpine areas: some herds are depastured on alpine leases in summer. In spring the cattle are moved from the properties to the high plains. The cows calve during summer and cows and calves are mustered in autumn before major snowfalls occur.

About 6% of the State's beef cattle are found in the districts, but numbers have increased from 158,000 in 1968-69 to 212,000 in 1971-72.

Sheep for meat and wool production

Sheep are largely confined to the north of the area, where they may be a major source of income. Generally, wool production is confined to areas of steep topography or to properties otherwise unsuited to prime lamb production or other animal and agricultural pursuits.

Recently cleared hillside

Wool flocks comprise Merino and related types and breeds.

Prime lambs are produced mainly from first-cross Border Leicester x Merino ewes purchased from outside the districts. These ewes are first joined at 18 months of age, mainly to rams of the Polled Dorset and Dorset Horn breeds.

Lambing takes place in autumn and winter and lambs are sold at weaning before the annual pasture species mature.

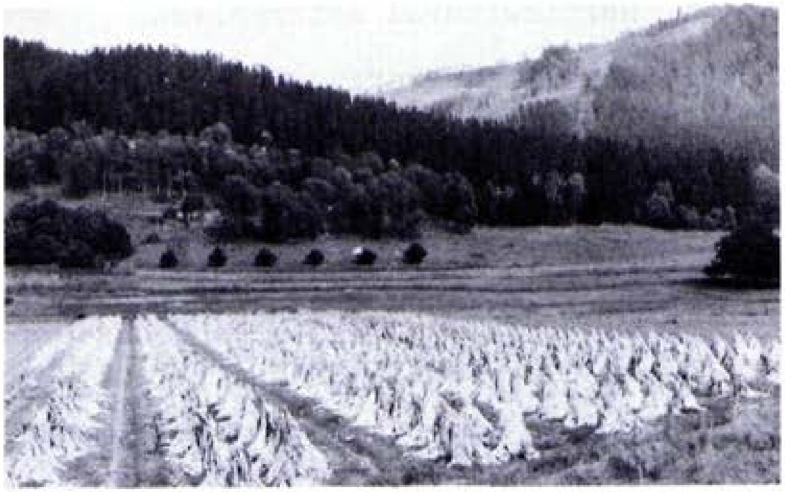
Prime lamb production may be undertaken in association with beef and cereal enterprises.

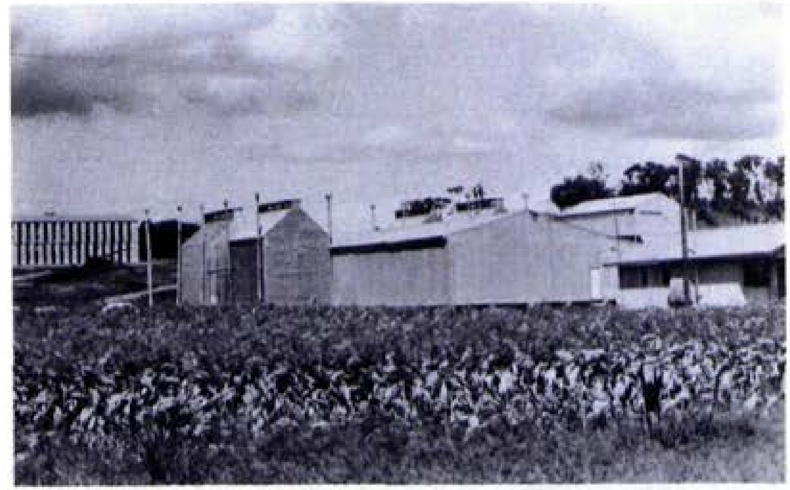
Sheep in the districts represent only 2% of the total numbers in Victoria. Indeed, sheep numbers have declined from 572,000 in 1968-69 to 414,000 in 1971-72.

Crops

Cereal production

Cereal production is largely confined to the extreme northern sector of the districts and for this reason is not of general importance. Nevertheless, some farmers would depend on cereals for a substantial part of their income. The cereal crop is generally wheat, although the coarse grains (particularly oats) may be included in the cereal rotation. Generally prime lambs are produced in association with cereal-growing.





Tobacco in the Ovens Valley, left, with softwood plantations on the hills behind; on the right, tobacco kilns and curing barns

Tobacco

Agriculturally, tobacco is the most economically significant crop in the districts, which grow most of the States production. During 1971, some 380 properties in Victoria, covering 4,200 ha, produced 7,000 tonnes of tobacco.

Tobacco production in the districts is confined to the alluvial river flats and adjacent slopes that can be irrigated. It is most highly concentrated on the middle reaches of the Ovens River, but substantial production also occurs on the Kiewa, King, and Buffalo Rivers and a number of tributary streams. The industry is labour intensive throughout the production phase and the processing operations necessary in preparing leaf for sale.

High capitalization in buildings and machinery are also inherent features, and economic production involves high fertilizer and pesticide use.

Hops

Hops have similar environmental requirements to tobacco, with gardens mainly concentrated on the middle reaches of the Ovens River and King River and its tributaries (and Fifteen Mile Creek).

Most of Victoria's hops are grown in the districts and comprise about one-third of the Australian crop.

Hop garden in Fifteen Mile Creek valley

With the introduction and general adoption of the variety Pride of Ringwood, the quality of the Victorian hops is held in high regard by brewers everywhere. Surplus production finds a ready sale on world markets.

During the 1970 season, the 350 ha of garden in bearing at that time produced more than 800,000 kg of dried hops.

Horticultural Enterprises

Horticultural enterprises are significant in the districts and comprise 690 ha of fruits, berries, and nuts. Table 13 lists the various types of crops, the numbers of growers engaged in producing each of them, and the average levels of production.

TABLE 13

HORTICULTURAL CROPS, NUMBERS OF GROWERS, AND AVERAGE ANNUAL PRODUCTION 1962--72.

Crop	No. of growers	Average annual production (tonnes)
Pome fruits	30	7,000
Cherries	10	110
Walnuts	17	79
Chestnuts and filberts	10	23
Almonds	10	5
Grapes	8	296
Citrus fruits	2	11
Olives	5	11
Strawberries	3	49

Nuts

Most of Victoria's nuts are grown in the districts; they comprise almonds, walnuts, chestnuts, and filberts.

The almond industry centred on Eldorado, has declined from an enterprise that provided 70% of Victoria's production to one now producing about 20%. Frosts, wet weather at flowering, and sporadic drought lead to reduced production in most years. Walnuts on the other hand grow well in the river valleys, with the main plantings at Stanley, Gapsted, Eurobin, and Bright. About 75% of Victoria's walnuts come from these centres. The main problem in the districts is controlling bacterial blight *(Zanthomonas juglandis)*, which stains nuts and reduces their quality.

The chestnut industry is expanding, with new plantings in the Porepunkah area. Trees grown from seedlings take up to 20 years to come into production. However, grafted trees should bear in 6--8 years.

There are only small plantings in the districts, mainly in the Bright area.

Expansion in the nut industry may be expected, but unfortunately large areas are required for viable units.

Pome fruits

Pome fruit production in the districts is centred on Stanley and Bright.

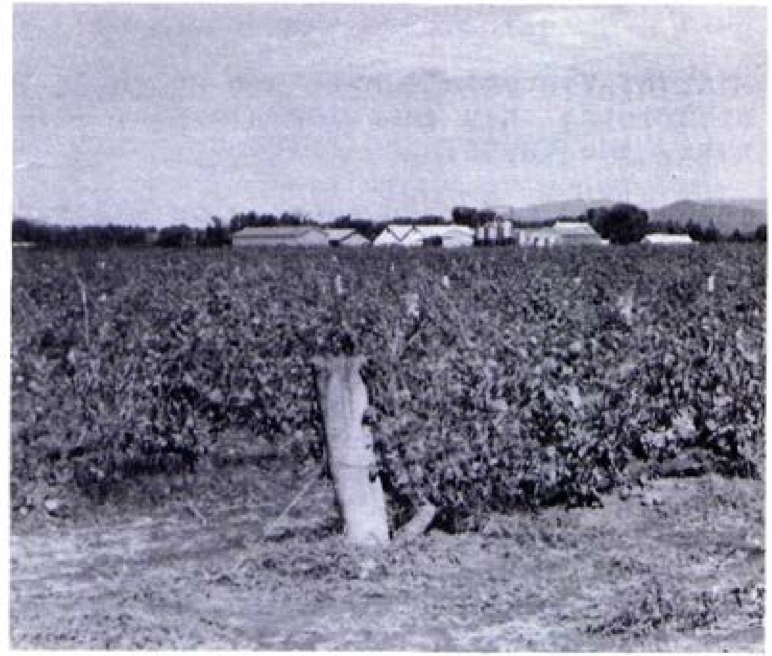
Chestnut-growing is increasing in importance

The main apple varieties are Jonathon, Granny Smith, King Cole, Delicious, and Rome Beauty. The main pear is Packham. Of the apples grown in the districts, 30% are exported, but most are placed in cool store and sold throughout the year on the Sydney market. The local industry has several problems. Frost causes losses in seven out of ten years. A native insect that lives on tree roots (fruit-tree root weevil) has caused a serious decline in production in many orchards at Stanley. Most orchards have insufficient water for irrigation, or none, and inability to irrigate adversely affects production in dry years.

Stone fruits

Cherries are the only fruit grown commercially in the districts.

Apple orchard, Stanley



Vineyard and winery on the Oxley Plain

Production is centred on Beechworth and Greta West. Most cherry varieties are grown. Normally good crops are produced but in drought years the fruit can be undersized. Late frosts can cause loss of production and the trees can be damaged by a root borer (fruit-tree root weevil).

Vineyards

The districts contain nine vineyards, two of which have facilities to produce wine. Table and fortified wines are produced.

Citrus

The area is not well suited for citrus production, but the districts have two small groves.

Olives

Olive-growing is a small and new industry in the area centred around Milawa and Whorouly. The fruit is sold fresh on the Melbourne market or is brined and sold locally.

Strawberries

There are few strawberry-growers in the area and most production is located near Wangaratta and Allans Flat. The fruit is sold in Albury and locally.

Apiculture

Early settlers brought the European honey bee *(Apis mellifera)* into the area in the late 1830s. Introduction of the Langstroth mobile-frame hive 30 years later revolutionized bee-keeping and helped to establish the industry in the districts by the turn of the century.

The north-east statistical division contained 115 registered beekeepers in the 1971-72 season. Many of these people would be part time, and for the study area only a small percentage of registered beekeepers (possibly about 30) would derive most of their income from apiculture.

Honey production varies considerably between years and probably ranges between 150,000 and 400,000 kg per year. Beeswax and pollen are also sold, and the area is important for the production of queen bees. In addition, bees are of considerable value as pollinators for many agricultural crops.

Apiculture depends mainly on the vegetation on public land, although most hive sites are on neighbouring private land. While eucalypts provide the principal source of nectar and pollen, other species of plants, both native and introduced, can be valuable.

Both the period and regularity of flowering of eucalypts vary between species, and weather affects the intensity of flowering. The majority of important eucalypts flower heavily every two or three years, although species that flower less frequently can be of economic significance when they do.

Eucalypts vary greatly in the production and quality of both nectar and pollen. Some species are important for nectar and pollen, others for only one product. Beekeepers have to move their hives to follow the flowering sequence of the eucalypts to both maintain a high rate of honey production and keep their bee colonies in good condition. Distances involved can be considerable; hives from the districts are sometimes moved to western Victoria or eastwards to the New South Wales coast, and of

Table 14

RELATIVE IMPORTANCE OF AREAS WITHIN THE STUDY DISTRICTS FOR HONEY PRODUCTION

Area		Percentage of of districts production
1	Riverine plain	17
2	Hills, south of Moyhu, west of King River	27
3	Hills, east of King River to Ovens River	13
4	Chiltern--Murray River	4
5	Pilot Range--Beechworth--Stanley	16
6	Remainder	22
	Total	100

course beekeepers from other districts and States use the study area.

The Primary Production Map indicates the approximate areas that are used for honey production. River red gum, Blakely's red gum, red stringybark, and blue gum produce the highest yields of honey per hive and also have good pollen yields.

Areas 2 and 3 include most of the foothill country and are the most important localities for honey production in the study districts. In addition area 2 is valuable for increasing bee populations and for queen-breeding.

Both areas have potential for increased use in the more remote regions. St. John's blue gum, red stringybark and peppermint are the important species.

The riverine plain in the study districts is utilized fully for honey production. Its important species are the river red gum and Blakely's red gum.

The Chiltern Forest and Murray River valley are used fully for honey production.

The Pilot-Beechworth--Stanley area is also well used for honey production and has little capacity for expansion. The area between there and the Kiewa valley is used moderately by beekeepers, and has some potential for increased production. The land to the east of the Kiewa valley is not used very extensively for honey production.

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Beehives near Eldorado

SOFTWOODS

In the north-west, the study districts contain areas of native softwoods (black cypress pine). These trees are slow-growing and are not used commercially.

Exotic softwood species were first planted on land that had been disturbed by gold-mining operations and was no longer suitable for shallow-rooted agricultural crops. Softwoods proved economically viable and the plantations expanded onto better ground. The districts now have nearly 15,000 ha of softwood plantations, with an annual average increase of 650 ha.

History

Softwood planting began in 1916 on the site of the old Bright racecourse. This land had been worked over by the gold dredges. The plantations were established with the aims of supplying timber and of controlling the noxious weeds and vermin in the area. Planting continued on similar land around Bright until 1930, by which time 1,172 ha had been established. A government-owned sawmill was built in 1931, and the first produce was obtained from thinnings of the young plantations.

As a result of strong local pressure, another plantation scheme was initiated at Myrtleford in 1927 with the planting of 120 ha on the foothills near the Ovens Railway Station. Planting began at Stanley in 1931 on land that had been mined for gold, with the aim of providing immediate employment for relief labour and of supplying timber for fruit-cases for the surrounding orchards.

During the depression, the planting schemes became an important source of employment for thousands of men on government sustenance. Large tracts of steep foothill country in each of the three areas were cleared by hand and planted with various softwood species. There was, at the time, only limited knowledge of the most suitable species to plant and some had very slow growth rates. Yellow pine *(Pinus ponderosa)* was particularly unsatisfactory.

Radiata pine *(Pinus radiata)*, the principal species planted, has proved by far the most satisfactory. However, some sites that would not now be converted to softwoods (because of low productivity or steep slopes greater than 25^{o} at higher elevations) have presented a variety of problems. They are liable to snow, hail, and wind damage; thinning operations are difficult and costly; and the site quality is generally low.

By 1939, 8,200 ha of softwoods had been established. The severe bushfires in that year destroyed 3,400 ha of the Bright population.

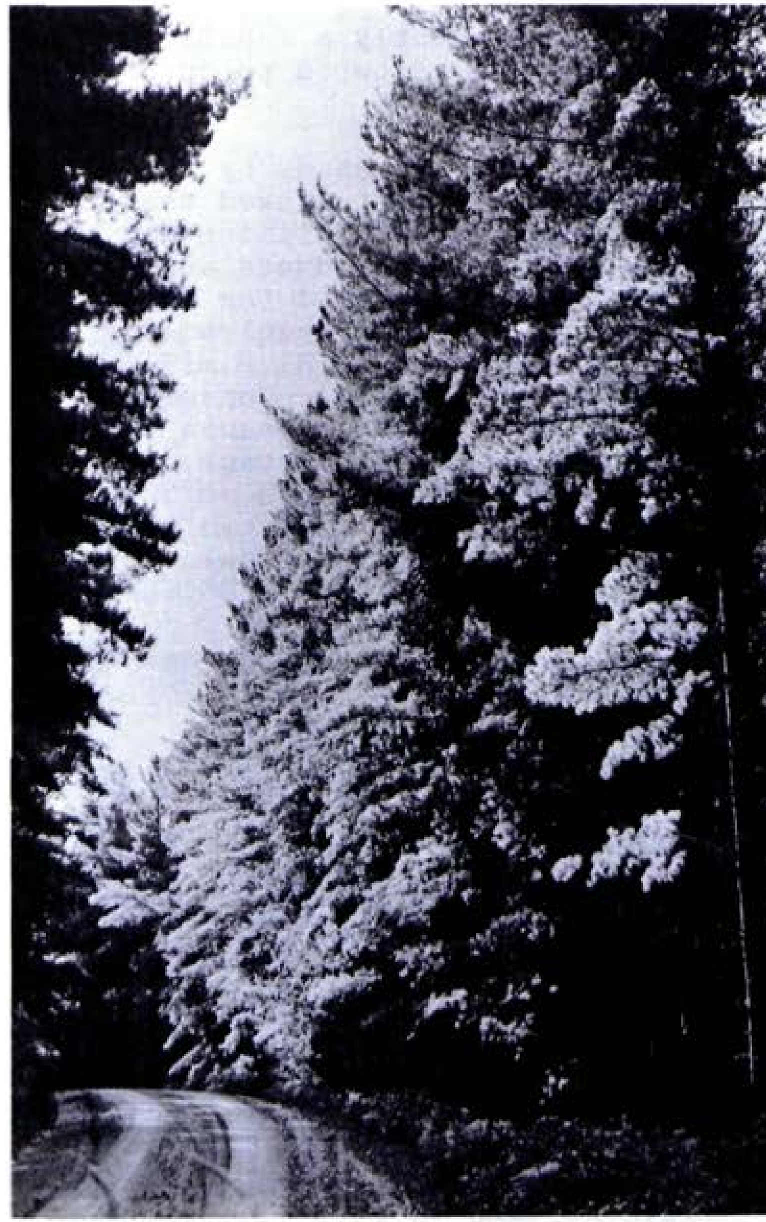
The problems associated with unsuitable species and steep slopes had already become apparent, and replanting following the bushfire was almost entirely with radiata pine, and was generally confined to elevations below 760 m.

It was completed in 1942, and for the next 20 years planting continued at a relatively low rate. In 1962 the planting rate was increased and has averaged 650 ha in each of the years since that time.

Establishment, tending, and harvesting of the plantations has provided a source of employment in the area. It is estimated that 310 men are employed directly in the Ovens plantations and associated sawmills.

Demand for softwood products

For some uses, softwood products are preferred to hardwoods because of their lightness, lack of defects, and pulping and chipping characteristics. Australia's commercial forests are mainly



Radiata pine, Stanley

hardwoods, consequently a substantial proportion of the softwood products have been imported.

In the early 1960s, a study by the Commonwealth government showed that Australia imported $200 million worth of timber and timber products annually. Also, governments accepted the estimate that Australia's annual requirements for forest products would be 31.2 million cubic metres by 2000 A.D. Consequently, for economic reasons and because of the possibility of a world shortage, they started a scheme to increase softwood plantings to 1.2 million ha, which would supply half the estimated requirement. The scheme is reviewed every 5 years.

In 1967, the Commonwealth Government passed the *Commonwealth--State Softwood Forestry Agreement Act* to ratify the Agreement made in 1966, which was renewed in 1973.

Cleared hillside recently planted with pines, Myrtleford

Under the Agreement, Victoria pays for the first 2,400 ha of softwoods planted each year. The Commonwealth provides finance for the rest with a loan that is interest-free for the first 10 years. During the first 5-year period 20,200 ha were planted in Victoria, and 23,500 ha are expected to be planted in the second period (1971--76).

Critics of the softwood programme suggest that requirements have been overestimated and that overseas developments in softwood production will ensure adequate supplies. Moreover,it is suggested that some of the economic reasons used to justify the scheme are incorrect. The principal text for this criticism is listed in the references.

The Study Districts

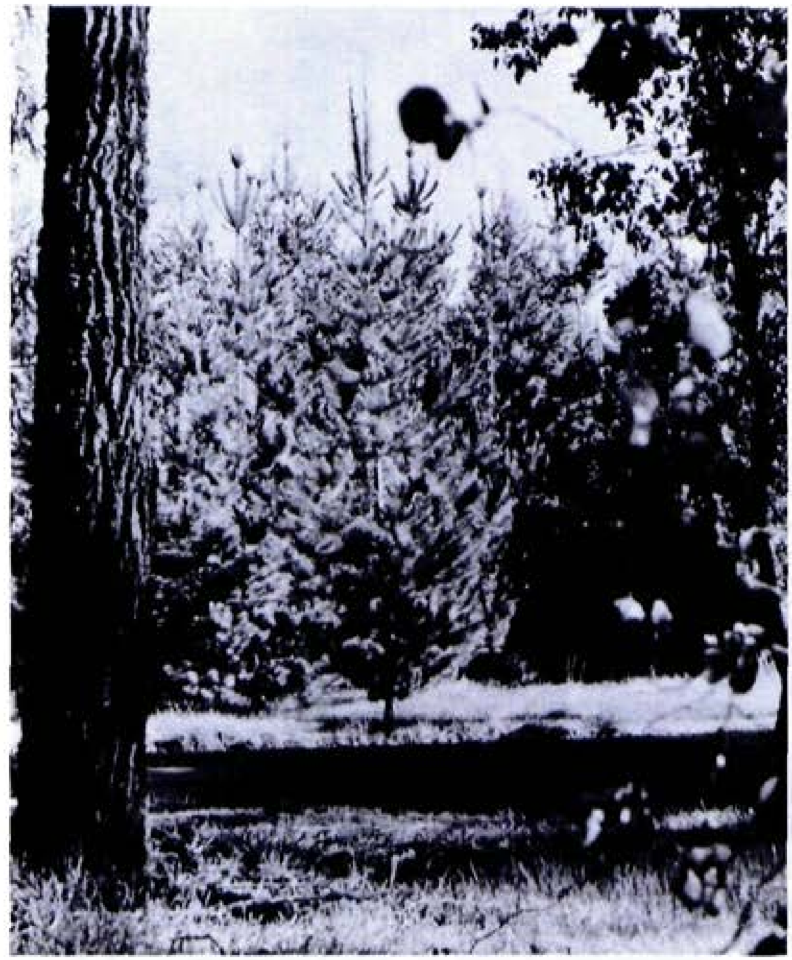
Softwood plantations have been established on public land in the Bright, Myrtleford, and Stanley localities, covering an area estimated to be 14,660 ha (36,230 acres) by September 1974, and extension is proceeding at 650 ha (1,600 acres) per annum. The three plantation schemes together comprise the Ovens Plantation Development Zone, within which it is hoped to establish a State plantation resource of at least 32,000 ha (80,000 acres). This is one of eight such zones being developed in Victoria.

The western part of the districts includes a portion of the Benalla--Mansfield Plantation Development Zone. Plantations within this zone occupied 3,670 ha in July 1973 and the expansion rate is 700 ha per annum. The Forests Commission is aiming at 28,000 ha of softwood plantations in this zone eventually. The Land Conservation Council's recommendations for North-eastern district 2 includes an area of 9,240 ha for plantations, which is sufficient land for expansion until 1983 if the present rate of annual plantings is maintained. Further plantations could be established in the south-west of this study area.

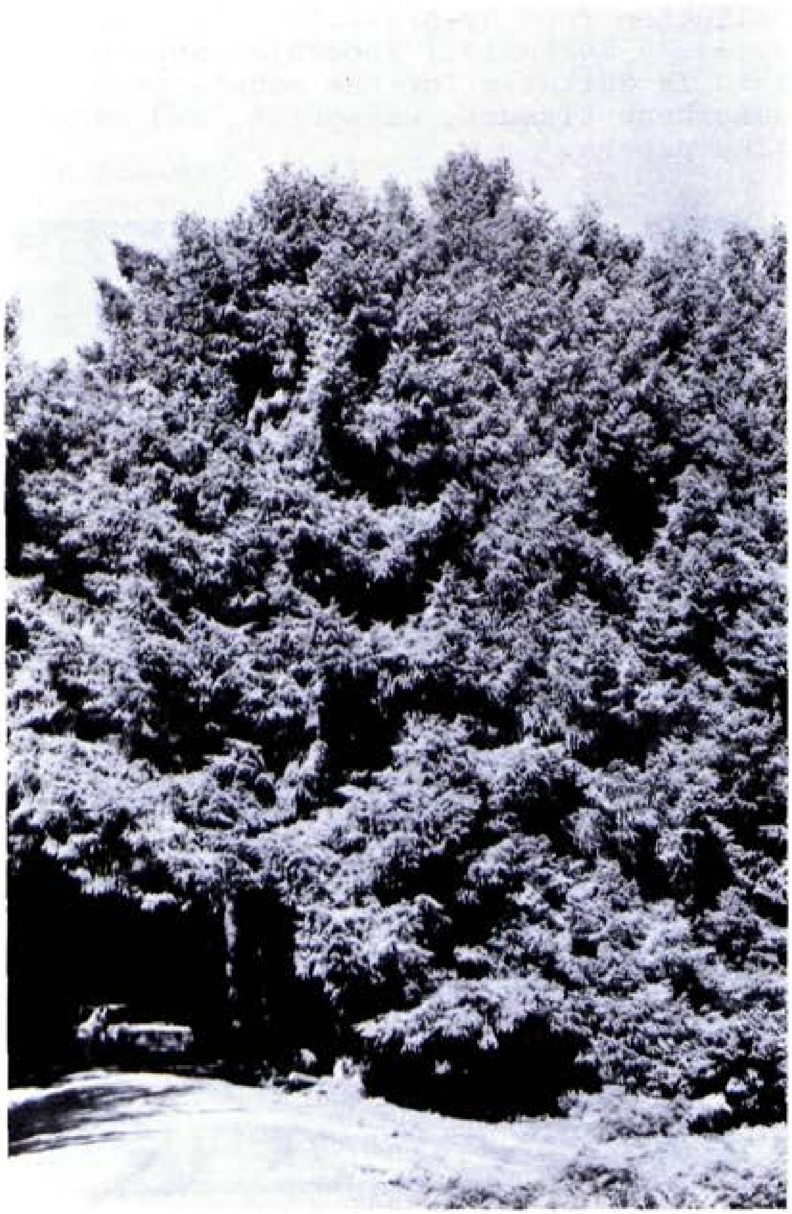
Australian Forests Industries Pty Ltd, a sunsidiary of Bowater-Scott (Australia) Limited, has recently established a sawmill and pulpmill near Myrtleford. These will convert softwood logs to a range of products, including kiln-dried lumber, preservative-treated sawn and round timber, and paper pulp. A veneer mill for the production of plywood may also be added.

The sawmill is planned to handle log allocations that are currently sawn at four separate mills at Beechworth, Bright, Myrtleford, and Porepunkah. Current production of sawlogs is about 83,800 cubic metres per annum.

A refiner--groundwood process will produce the paper pulp. This method is entirely mechanical, and has the advantages of very high yield and absence of pollution from by-products. Pulp produced by mechanical processes such as this is suitable for the manufacture of absorbent tissues, newsprint, and magazine papers.



Experimental plot of radiata pines near Chiltern



Douglas fir, Stanley

The raw materials comprise off-cuts from the sawmill, together with small or poor-quality round timbers. The water used in the process is extensively recycled, and eventually discharged into the Myrtleford township sewerage system, at which time it contains only the water-soluble components of the original wood.

A sustained supply of raw material has been guaranteed to the company under the *Forests (Bowater-Scott Agreement) Act 1971*, which commits the Forests Commission to supply softwood pulpwood from the plantations at minimum annual levels rising from approximately 35,400 cubic metres (15,000,000 sq ft) in 1974 to approximately 63,700 cubic metres (27,000,000 sq ft) in 1992.

Future timber yields

The estimated yield of softwood, (including sawlogs and pulpwood) that will become available from the plantations in the area for industrial use is about 225,000 cubic metres (95,000,000 sq ft) by 1990 and about 46,000 cubic metres (195,000,000 sq ft) by 2010.

Site conditions and productivity

Radiata pine now comprises 88% of the total planted areas. Current plantings are almost entirely of this species excpet for limited plantings of Douglas fire *(Pseudotsuga menziesii)*, which grows satisfactorily at high elevations where radiata pine is liable to snow damage. On sheltered sites where annual rainfall exceeds 1,140 mm (44 in.), temperatures are cool, and soils are deep, Douglas fir is a satisfactory plantation species that grows at a rate comparable with that of radiata pine, although it takes a much longer time to reach maturity - of the order of 50 years, compared with about 35 years for radiata pine.

For satisfactory growth of radiata pine in north-eastern Victoria, the following conditions are desirable:

* a minimum rainfall of 760 mm (30 inches)
* a neutral or slightly acid soil of at least moderate nutrient status (pH 5.6--7.4)
* soils with physical characteristics that allow vigorous root growth and with sufficient volume to support an adequate root system
* soils with good drainage, but with adequate soil moisture storage characteristics
* freedom from heavy snow-falls

Radiata pine grows quite rapidly in this region by world standards, but wide variations in growth rate occur, because of differing site factors. Plantations are assessed at 10 years of age to determine the productivity of each stand,

Radiata pines with corsican pines in the foreground, Happy Valley

so that the quantities of the various classes of log material that will become available can be estimated.

The productivity of a site is measured in terms of the average annual growth of wood volume per unit area. It is expressed in cubic metres per hectare, and is known as the Mean Annual Increment (M.A.I.).

TABLE 15

RADIATA PINE POTENTIAL PRODUCTIVITY

Vegetation map reference number	Native vegetation	Major soils	Potential Mean Annual Increment (cu m under bark to 10-cm DSE per ha)*	Suitability for plantation establishment
6	Messmate stringybark open forest III and IV	Friable brownish gradational reddish duplex	26--29	Suitable
7	Narrow-leaf peppermint open forest III above about 900 m elevation	Friable reddish gradational, friable brownish gradational	26--32	Unsuitable - snow damage lowers yields
7	Narrow-leaf peppermint open forest III below about 900 m elevation	Friable reddish gradational, friable brownish gradational, reddish duplex	20--30	Suitable
8a	Broad-leaf peppermint open forest II, grassy under-storey	Reddish and yellowish duplex, weakly bleached gradational	11--23	Marginal
8b	Broad-leaf peppermint open forest II, heathy under-	Reddish and yellowish duplex, weakly bleached gradational, undifferent-iated stony loams	8--20	Marginal because of poor drainage
9	Long-leaf box open forest I and II	Undifferentiated stony loams, weakly bleached gradational	8--20	Marginal; generally unsuitable

* DSE - small-end diameter

It is clearly impossible to determine the M.A.I. of a particular site until a stand of radiata pine is actually growing on it. However, its potential M.A.I. may be estimated with reasonable certainty from the form and composition of the native vegetation, the soil, and the climate at the site.

Table 15 shows the suitability for growth of radiata pine indicated by each of the native vegetation categories that occur in the study districts. Suitability in this instance is based entirely on potential productivity without substantial fertilizer imputs.

Other important factors such as location, access and topography are not considered in the table.

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17. HARDWOOD

Hardwood forests cover a substantial proportion of the public land within the study districts and some areas of freehold land are still forested. Although this chapter concerns timber production, these forests have of course considerable value for other uses, including water production, recreation, habitats for both animals and plants, and (where human influence is minimal) scientific study and reference.

History of Utilization

Commercial harvesting of the hardwood forest began during the gold-rush, when large quantities of wood were required for mining and building timbers and for fuel. The more accessible areas close to the mining townships were utilized first, and in the early days more-or-less nomadic operators prepared squared sections by broad-axe, split shingles, and cut large volumes of firewood. The earliest record of a licensed sawmill is the allocation in 1872 of a sawmill on the Ovens River at Porepunkah to a Mr. Henderson. Other mills were set up in the Stanley area, but by the turn of the century timber was becoming difficult to obtain by the methods available.

The methods that Sinclair's of Glen Creek used in the logging of Mount Big Ben in the early 1900s illustrate the difficulties the sawmillers of this period faced. Trees had to be felled by axe on the steep slopes and the logs were then skidded down the mountain-side in chutes to a wooden tramway constructed along a level grade near the bottom. A horse-drawn wagon carried the logs as much as 3 miles back to the mill along the tramway. Horses were also used to draw the logs from the stump to the chute. The chutes themselves required an enormous volume of timber, as they were up to 6 m wide and constructed of 30- to 40-cm-diameter logs. They were gradually extended as the logging progressed up the slope, and are said to have been more than a kilometre long in some cases. As each gully was cut out, the loggers extended the tramway and commenced a new shute in the next gully.

Since that time, the gradual introduction of efficient road transport, the crawler tractor, and the chain-saw have made logging a much more economic and less wasteful operation. Roads have gradually penetrated the more remote areas and some logging has been carried out in virtually all of the available merchantable stands of the study districts. It is estimated that these forests have yielded about 1,500,000 m^3 over the past 120 years.

Hardwood Forests

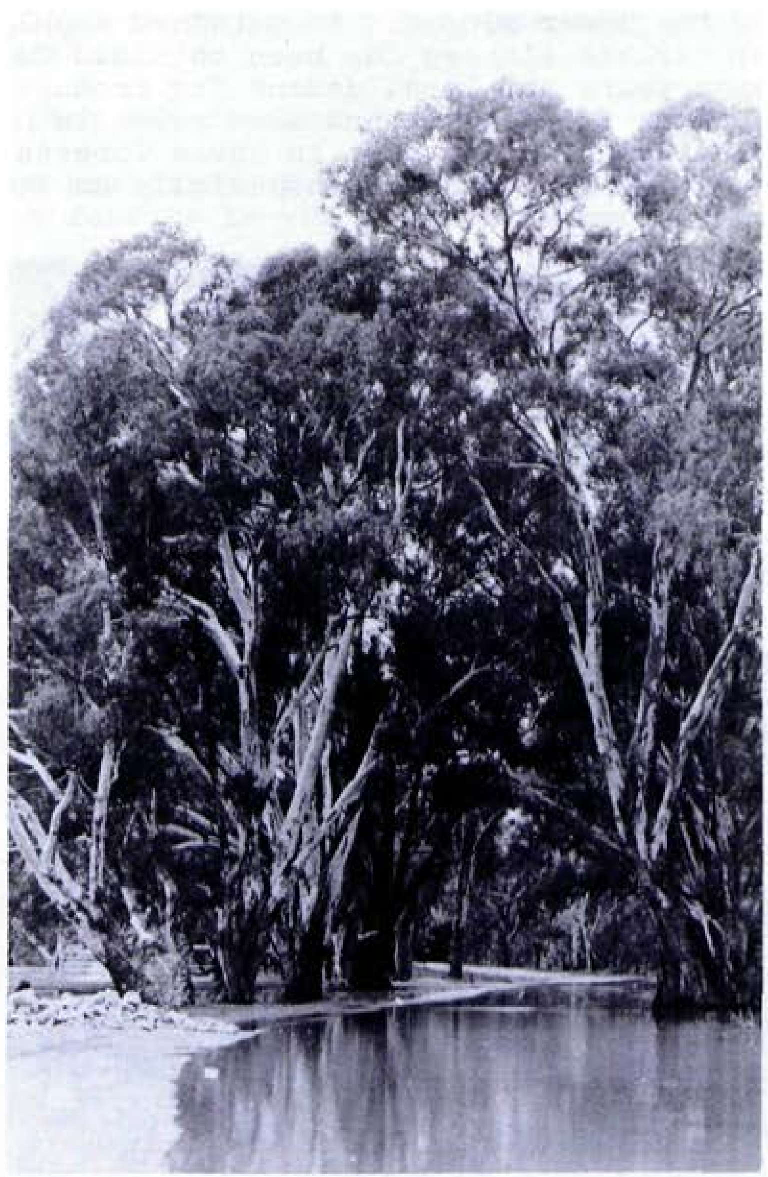
The native forests are mostly mixed eucalypts, with the species mixture controlled by varying tolerance to environmental factors such as temperature, soil depth, and soil moisture status. Therefore, a wide variety of forest types exists in the study districts.

River red gum

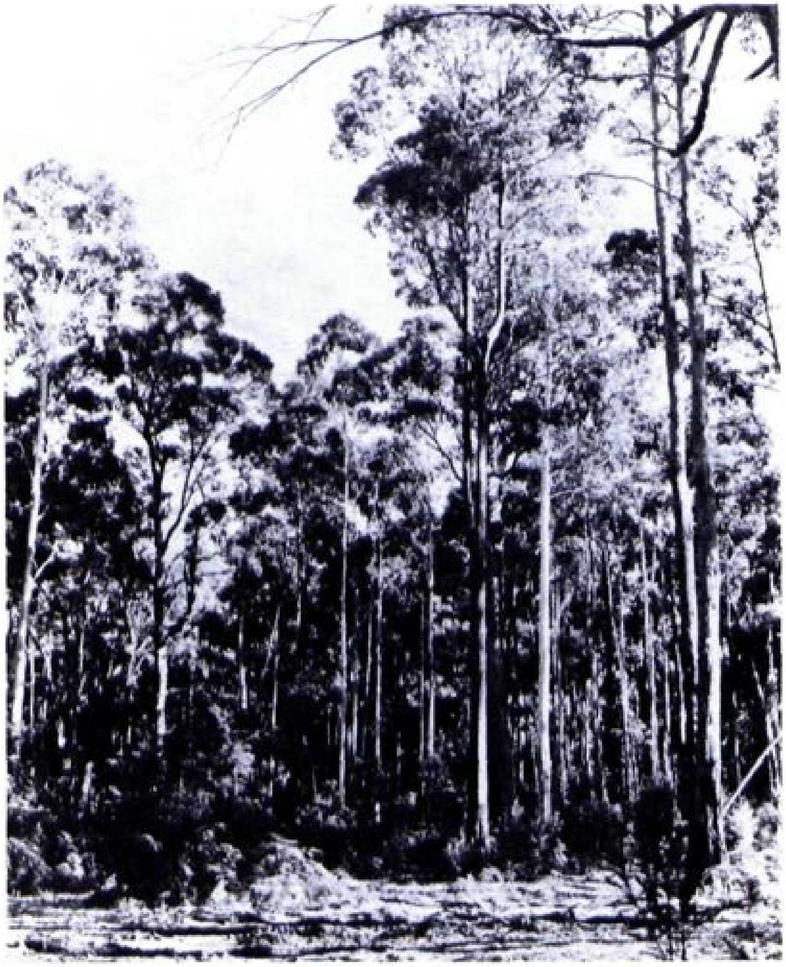
Forests of river red gum occupied the alluvial deposits of the plains region in areas subject to periodic flooding. They are now confined to small areas of public land on river beds and frontages along the Murray River and along the lower reaches of the Ovens, King, Kiewa and Mitta Mitta rivers. These forests have been important to the local population since the earliest days of settlement, supplying strong durable timber for sawmilling, sleepers and posts.

Box--ironbark

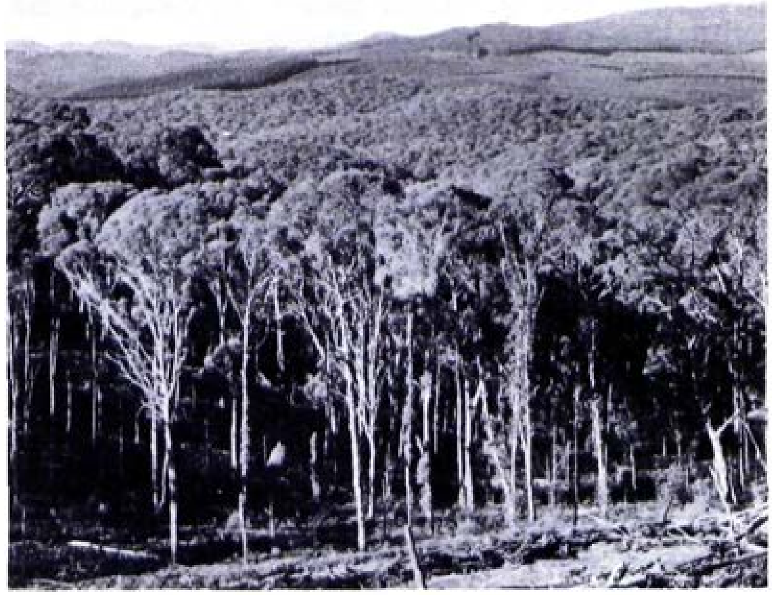
In the central region on the sedimentary foothills surrounding Chiltern, mixtures of red ironbark, red box and red stringybark occur on the poor soils of the ridges, while grey box and yellow box are more common on the deeper soils



River red gum forests have been important for the supply of durable timber of the lower slopes. A sustained supply of durable timbers has been obtained for many years and local demand for produce such as fence posts and shed poles is continuing. The trees in these forests have low growth rates, especially on the poorer soils.



Narrow-leaf peppermint forest, Tolmie



Narrow-leaf peppermint near Stanley with softwood plantations in the background

Box--stringybark

The granitic soils of the Mount Pilot--Mount Barambogie area carry a distinct forest type. The main species are long-leaf box and red stringybark with Blakely's red gum on areas of impeded drainage and black cypress pine on the dry rocky outcrops.

These forests generally grow to about 25 m tall, at a low rate. They yield a small annual supply of sawlogs.

Peppermint--stringybark

Peppermint--stringybark forests, the most widespread in the study districts, cover about 65% of the forested land. They occur over an elevation range of 300--1,100 m and are found in all but the north-west of the district. The species are usually broad-leaf peppermint with brittle gum or red stringybark on the drier aspects and narrow-leaf peppermint with blue gum or manna gum on the more sheltered sites.

Narrow-leaf peppermint attains its best development on the deep soils of plateaux such as the Stanley Plateau and the Tolmie Highlands, where tree heights often reach 40 m. Peppermint forests in such areas are capable of rapid growth rates, and well-stocked stands are suited to intensive sawlog production.

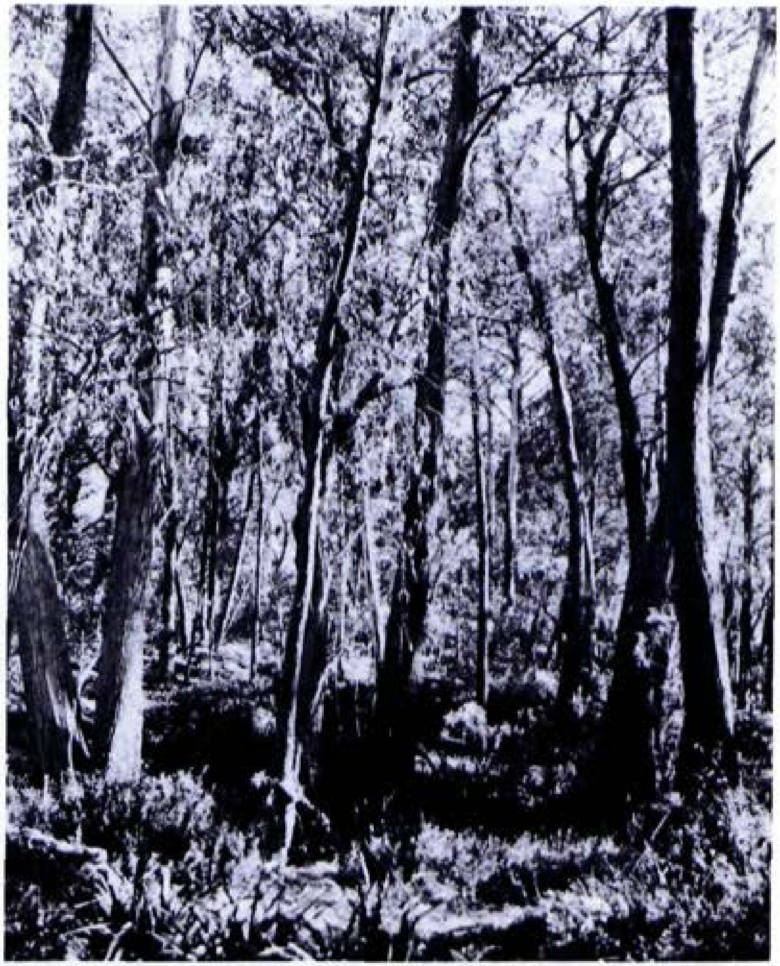
The bulk of the forest type, however, grows on the steeper foothills, where tree heights average about 30 m. Sawlog production from these areas is intermittent and on a single-tree selection basis.

Messmate forests

The south-western region on the Tolmie Highlands carries forests of messmate, either in pure stands or in mixture with narrow-leaf peppermint, confined to sheltered sites where soils are deep and annual rainfall exceeds 1,020 mm. These stands are highly productive and are suited to management for intensive production.

Alpine ash forests

The most extensive occurrence of alpine ash forests in the study districts is on



Alpine ash, Mount Buffalo

Alpine ash, Black Range

the Mount Buffalo plateau, where the National Park contains some 3,500 ha. A further 470 ha adjoins the Park.

Elsewhere in the study districts, the alpine ash forest occurs as small scattered stands wherever a suitable site exists. The species requires a deep soil on a sheltered aspect in the elevation range 1,000--1,400 m. Survival of the species on a particular site depends on the occurrence of wildfires, which kill the mature trees. Dense regeneration of alpine ash seedlings, which normally follows a fire, can be seen beneath the dead overwood on Mount Jack, where a severe fire burnt through the stands in 1968.

Variations in age of the trees reflects the fact that these foothills are fairly regularly subject to damage by wildfires.

Except on the Mount Buffalo plateau, the alpine ash forests of the study area are generally small, scattered, immature, and of poor quality.

Most stands where trees have reached sufficient size have been logged, and further production will not be possible until the regrowth stands reach merchantable size.

The candlebark--mountain gum stands that occur in association with alpine ash also yield some sawlogs on a selection basis.

Production

Sawlogs

The hardwood forests of the study districts currently produce sawlogs at the rate of 29,000 m^3 annually, which is approximately 2.2% of Victoria's annual production. Surveys indicate that this level can be maintained for at least another 11 years, after which it may decline.

The main sawlog species in the study area is narrow-leaf peppermint. Other species of significance are blue gum, manna gum, messmate, candlebark, mountain gum, and (to a lesser extent) red stringybark and alpine ash.

The sawlogs are not generally of high quality since the foothills have been frequently damaged by wildfires. Fires cause the formation of unsightly gum veins in the wood and allow termites and wood-rotting fungi to enter the tree. The sawn timber obtained is not suitable for uses such as flooring and furniture, where surface appearance is important, but is suitable for building material such as house framing and is referred to in the industry as scantling quality. Some of the forests, notably the alpine ash and the messmate, do have the potential to produce higher-quality timber if wildfires can be kept out of the stands.

The major proportion of sawlogs is converted at the sawmills within the

Logging in a narrow-leaf peppermint forest

study districts and sold throughout north-eastern Victoria and the Riverina. These sawmills handle an annual total of 117,000 m^3 (of which 75% comes from mountain areas to the south) and are generally small concerns employing 10--25 men. Townships such as Eskdale, Chiltern, and Tawnaga rely heavily on their local sawmill as a source of employment. Altogether about 314 men are

Timber mill, Mitta Mitta

Cutting red ironbark in Chiltern forest

employed in the hardwood forests and sawmills within the study districts.

Pulpwood potential

A substantial quantity of hardwood timber in the study districts, principally in the mixed eucalypt stands that have been utilized for sawlogs, could be used for pulpwood. The removal of trees suitable for this purpose, but not for sawlogs, would increase the capacity of the forest for timber production by allowing regeneration of over-mature areas, since the presence of over-mature trees inhabits the development of young stands. There is no market for hardwood pulpwood in the study districts although a demand will probably develop within the next 10 years.

Other wood products

Over the years the local community has relied on the forest area for the supply of fencing materials - strainers, posts,

TABLE 16

HARDWOOD TIMBER PRODUCTIVITY

Category	Structural form	Main timber species and distribution	Productivity-MAI* (m^3/ha/year) sawlog and pulpwood
High	Open forest IV	Alpine ash, mainly on Mount Buffalo	Potential MAI about 8.0
Moderate	Open forest III	Messmate stringybark, Tolmie area; narrow-leaf peppermint, Stanley area	Potential MAI about 3.0
Moderate to low	Open forest III	Narrow-leaf peppermint, widespread	Potential MAI about 2.5
Low	Open forest II	Broad-leaf peppermint, stringybark, and various gums, widespread	Potential MAI about 1.5

*MAI Mean Annual Increment

droppers, rails, and stays - together with poles and building materials.

The box--ironbark and the red gum forests have been particularly important in yielding strong durable material. The Victorian Railways have obtained sleepers from these forests for many years and present production averages about 4,000 per annum.

The firewood market has declined to average about 3,000 tonnes annually.

The blue gum stands provide a useful source for the supply of bridge timber -

girders, beams, and decking. Hop poles for use in the Ovens Valley are also produced from the hardwood forests of the study districts.

Capability

Intensive hardwood production involves the growing of merchantable hardwood species in perpetuity under intensive management to produce desired wood products. Suitable areas for intensive hardwood production satisfy the following criteria:

* They contain hardwood stands capable of economic production, with mature top height exceeding 29 m and a basal area of potentially merchantable trees exceeding 18 sq m per ha (square metres per hectare).
* They form a continuous compact unit of at least 80 ha containing predominantly suitable or potentially suitable sites.
* They generally have a ground slope of less than 20°.
* They do not contain significant scientific or scenic values that could be permanently degraded by timber production.

WATER UTILIZATION

Lake Hume straddles the northern boundary of the districts, which contain part of the catchment of the Mitta Mitta River, a major contributor to this storage. The Lake supplies water for irrigation and other purposes to Victoria, New South Wales, and South Australia. This source, supplemented by Goulburn River waters, services approximately 160,000 hectares of land in Victorian irrigation areas. The study districts also contain Lake Buffalo and Lake William Hovell, much smaller storages built to safeguard irrigation, urban, stock, and domestic supplies in a localized area. Lake Buffalo safeguards supplies along the Buffalo and Ovens Rivers, downstream of Lake Buffalo, while Lake William Hovell has a similar role along the King River.

Lake Hume regulates portion of the flows of the Murray and Mitta Mitta Rivers, and the completion of the Dartmouth Dam will mean further regulation of Mitta Mitta River flows. These streams have a combined mean annual discharge of 3,800,000 Ml. About 10% of that of the Buffalo River and about 6% of that of the King River is utilized for irrigation. The State Electricity Commission storages, situated outside the study districts, utilize a small percentage of the flow of the Kiewa River.

Storages and their capacities are:

Lake Hume	3,059,000 Ml*
Lake Buffalo	24,000 Ml
Lake William Hovell	12,300 Ml

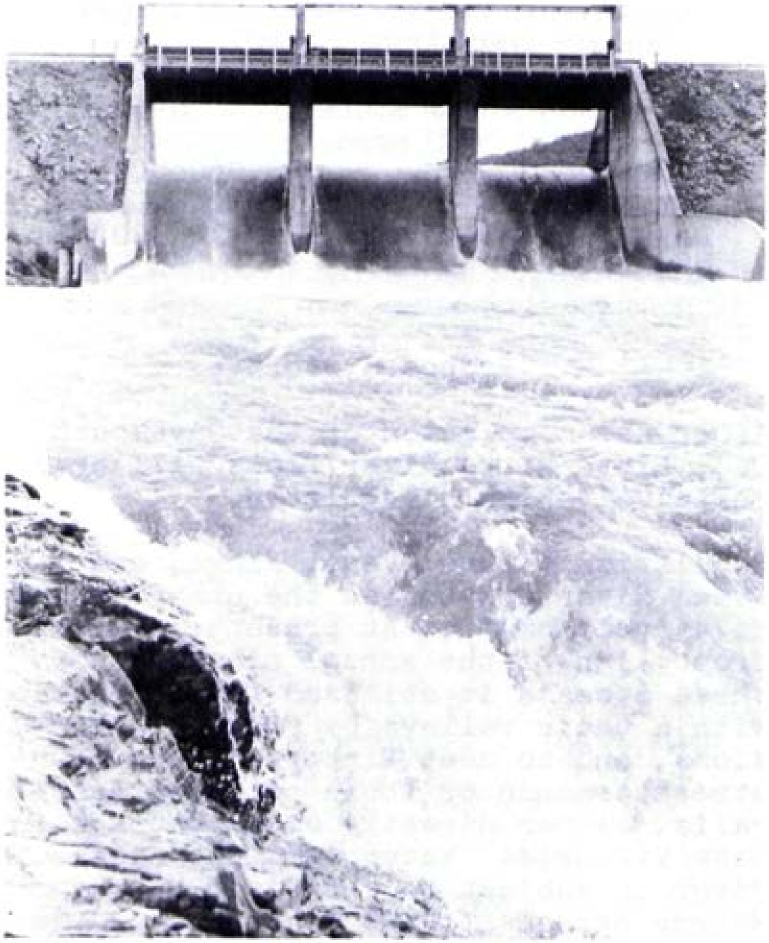
*Ml = megalitre

Proposed Storages

After the completion of the Dartmouth Dam, Mitta Mitta River flows will be relatively highly regulated.

Regulation of the Ovens, Kings, and Kiewa River systems on the other hand is relatively small. At present, a small proportion of the annual discharge of these streams is utilized for irrigation within their valleys by private diversions, and to meet Victoria's own downstream demands or those of South Australia, either directly or by storage in Lake Victoria. Water from the Kiewa River is subject to the River Murray Waters Agreement, and is shared by the States in accordance with that Agreement. Any further utilization of the

Kiewa River would be the responsibility of the River Murray Commission, and no storage possibilities appear feasible or are projected at the present time.



Spillway at Lake Buffalo

Any further water conservation projects in northern Victoria will probably be concentrated in the Ovens and King systems within the study districts. These projects may be of two types:

* relatively small storages, to safeguard development of localized areas

* relatively large storages, designed to safeguard local development and to supply the requirements of areas further downstream

Of the first type, one on the Buckland River has been investigated and its construction included in planning programmes. It would impound 10,500 Ml at an estimated cost of $3.9 m (1971), and would safeguard existing irrigation development in the Upper Ovens Valley (about 935 ha) and allow additional development up to 2,200 ha. Many streams within the districts are heavily committed to irrigation of high-return crops that would benefit from this type of storage. They include Happy Valley Creek, Barwidgee Creek, and Morses Creek (Ovens River tributaries), Black Range Creek and Boggy Creek (King River tributaries), and Running Creek and Mountain Creek (Kiewa River tributaries). A storage on Fifteen Mile Creek has also been investigated, but is not currently considered economically attractive.

Of the larger type of storage, a second stage of the Buffalo Dam (which could impound nearly a million megalitres) was estimated to cost $65 million in 1963, but inflation and rising costs would have significantly increased this figure. The construction of the Dartmouth Dam will of course defer the requirement for this larger storage for some time, but growing water supply demands will no doubt eventually warrant its construction.

Water Quality and Treatment

The Surface Water Resources section of Chapter 8 discusses the quality of water in the various stream catchments. Generally, water throughout the study districts is of good quality and suitable for most purposes. It is soft, salinities (total dissolved solids) are generally below 50 milligrams per litre (see Table 5), and all other parameters indicate good quality.

Urban and industrial use

In the upper sections of the catchments in the study districts, while the streams are flowing through native forest, the water could probably be used for urban supply without any treatment, as it is nearly sterile and free of suspended solids and discolouration. As the streams progress down through the settled lower valley sections, agricultural, urban, and industrial pollution gradually decrease water quality. The urban supply to Wangaratta is treated to remove solids and chlorine is added to sterilize it.

Thus, streams in the study districts are quite suitable for urban supply, although some treatment is probably necessary. The water is suitable with appropriate pretreatment for boiler feed and make-up, and possibly for textile industries. Without treatment it should be suitable for other industries that do not have special requirements.

Domestic use

Intermittent high colour and turbidity, particularly in the lower stream sections, may make the water unacceptable for domestic use at times.

Stock and irrigation use

All surface waters in the districts are classified Class 1 irrigation water with total dissolved solids less than 175 mg per litre, and are therefore suitable for stock watering and all types of irrigation (see Appendix 3).

Factors Causing Pollution

Three main sources may contribute pollutants to streams:

* agricultural
* urban
* industrial and mining

Agricultural

Clearing and grazing of catchments will increase the amount of soil particles

Cattle can increase stream pollution

and animal wastes in run-off to streams, while substances used to control weeds, insects, and animals may find their way into streams in quantities harmful to aquatic plants and animals and to Man. Most streams within the districts suffer from increased turbidity and silt load after rain, and there have been reports of fish losses caused by poorly controlled chemical spraying of river-side crops and the careless disposal of empty chemical containers.

Urban

Storm-water run-off and other drainage from urban areas usually contains a number of pollutants such as oil, detergents, and domestic wastes. Happy Valley Creek is noticeably polluted by drainage from the town of Myrtleford.

Industrial and mining

Pollutants from these sources include chemical and thermal wastes, and mining activities may also cause pollution by erosion. At present, industrial wastes are discharged into the Ovens River at Wangaratta.

Clearing of catchments can reduce water quality

Utilization in the Study Districts

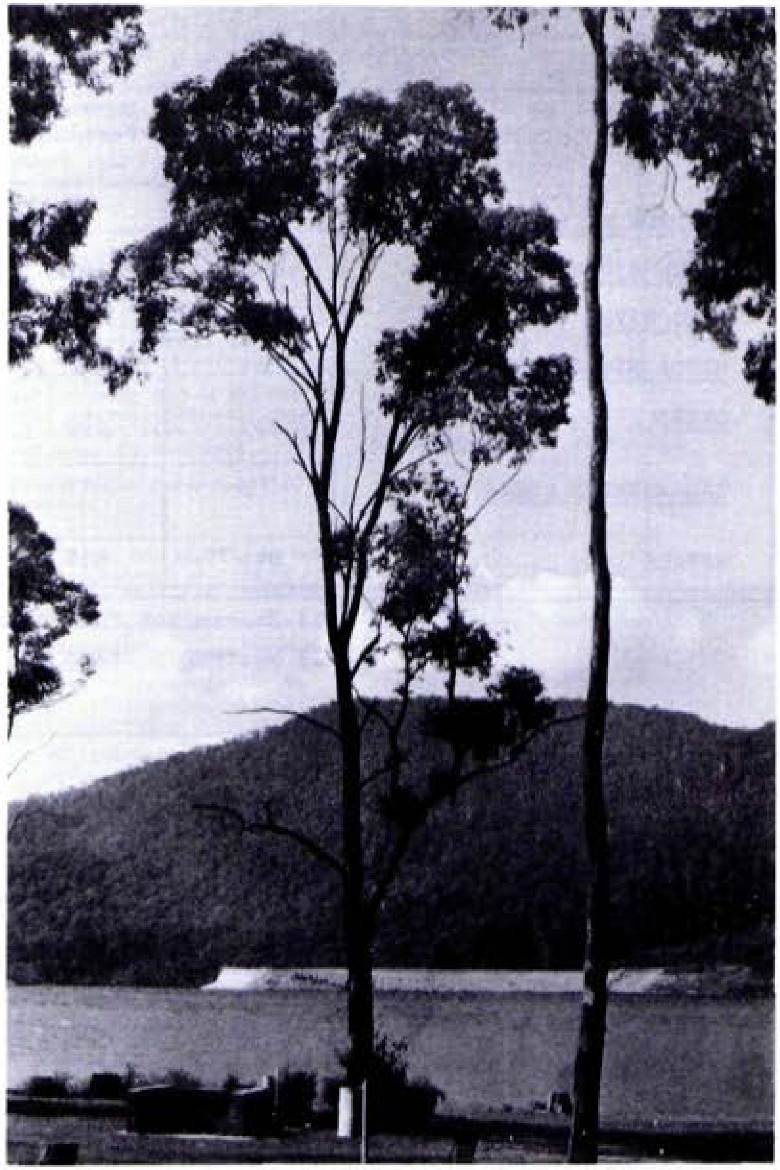
Irrigation

Although the districts lie in one of the most favoured rainfall areas of the State, the increase in irrigation over the past 15 years has completely committed the average natural flow of most streams. In some cases streams were, to some degree, over-committed, and during dry periods restrictions on irrigation use are necessary to protect the higher-priority needs for town supplies and stock and domestic use.

On two such stream systems, the Buffalo River and the King River, storages have been built to safeguard supplies and to allow for additional irrigation. Lake Buffalo was completed in 1965 and by the end of 1968, dry-period regulated flow was fully committed. The King River storage, Lake William Hovell, was completed in 1971, and by mid 1973 provided water for an additional 1,500 ha of irrigation.

The only major unregulated stream from which water is available for irrigation at present is the Mitta Mitta River. Tobacco is not grown in the Mitta Mitta Valley, whereas the other major streams in the districts have large tobacco committments.

Diverters are given authority, either by permit or licence, to irrigate a specific area or use a specific volume of water.



Lake William Hovell, a 12,300 Ml storage on the King River

TABLE 17

WATER UTILIZATION

Stream (includes tributaries)	Irrigation Licences or Permits	Domestic Permits	Industrial Permits	Area of crop irrigated (ha)					
				Pasture	Orchard	Tobacco	Hops	Misc	TOTALS
FIFTEEN MILE CREEK	38	38	-	61	-	10	69	-	140
KIEWA RIVER	140	105	3	1,685	-	257	-	63	2,005
KING RIVER (1)	111	24	4	911	-	769	24	-	1,704
MITTA MITTA RIVER (1)	61	82	4	725	-	-	-	-	725
OVENS RIVER upstream of Wangaratta	497	252	9	975	169	1,830	276	125	3,375
TALLANGATTA CREEK (2)	2	17	-	6	-	-	-	-	6
TOTALS	849	518	20	4,363	169	2,866	369	188	7,955

(1) Stream not full committed.

(2) Western portion of catchment only in Districts.

Private irrigation diversions throughout the State are being progressively metered but the King River is the only stream within the districts that already has extensive metering. The quantity of water used in any one irrigation season by an unmetered diversion is arrived at arbitrarily, based on the area watered. The formula varies with rainfall and the type of crop being irrigated.

Table 17 gives the irrigation commitments of the major stream systems in the districts and indicates the purpose of irrigation.

Urban

Many cities and towns in the study districts have reticulated water supply systems derived mainly from suface sources (see Table 18).

Groundwater

In 1968 the *Water Act* was amended to give the State Rivers and Water Supply Commission control over sources of groundwater that were fed, either wholly or in part, by seepage from surface streams. Prior to that time, many per-

TABLE 18

URBAN USE

Source of supply	Description of works	Quality of supply and treatment	Average daily demand ('000 litres)	Maximum daily Consumption ('000 litres)
BEECHWORTH Lake Kerford	Water gravitates from Lake Kerford to a 4.5-Ml service basin, and is then passed through a sand filter and conveyed to 3.4-Ml storage.	The present sand filter beds do not operate satisfactorily, causing colour problems.	1,860	5,955
BRIGHT Ovens River and Bakers Creek	Bright pumps from the Ovens River directly into the reticulation system, or uses gravity supply from two reservoirs on Bakers Creek, with a total capacity of 10.5 Ml.	Quality is generally satisfactory, with slight colour and turbidity problems. Ovens River water is chlorinated at the pump station. The reservoir supply is unchlorinated and bacteriological quality is frequently below standard.	680	2,730
CHILTERN Barambogie Creek, Springs, and bores	The 45-Ml capacity Barambogie Reservoir is filled from a catchment area and also from springs; two bores supplement this.	The water is very turbid and has a high iron content. The bore water is good quality, except for a high iron content. No treatment.	300 calculated from annual consumption	Not known
KIEWA Kiewa River	Water is pumped from the Kiewa River to separate basins of 1 Ml and 2.3 Ml capacity	No information on water quality. No treatment.	400	1,140
MOYHU King River	Water pumped from the King River supplies a 0.14-Ml elevated storage in the township.	No recent data, but quality is considered satisfactory at time of construction (1961). No treatment.	150 (Calculated from annual consumption)	Not known
MYRTLEFORD Buffalo Creek	Water flows from Buffalo Creek by gravity to a 4.5-Ml service basin in the town. Water is pumped from the town system to a 40-Ml storage basin to meet peak summer demands.	Quality is generally satisfactory, but bacteriological tests have frequently been below standard. No treatment.	3,400	6,800
SPRINGHURST Diddah Diddah Creek	A reservoir of 50 Ml on Diddah Diddah Creek. Gravity supply to the town.	Water quality generally satisfactory.	45	Not known
TALLANGATTA	Water pumped from Lake Hume to a 2.3-Ml storage gravitates to the town.	Reasonable quality other than taste and odour.	1,140	2,000
WANGARATTA Ovens River	Water pumped from the river to a 4-Ml storage is later pumped to a series of elevated storages.	Treatment includes sedimentation, filtration, and chlorination.	11,400	27,500
WHITFIELD Musk Gully Creek	Water from Musk Gully Creek gravitates to a 14-Ml storage basin.	Sometimes below standard bacteriologically. The supply is untreated.	50	140
WODONGA Wodonga Creek (anabranch of the River Murray)	Water is pumped from Wodonga Creek to a 14-Ml storage. A new 32-Ml storage is nearing completion.	Water is of reasonable quality but colour and turbidity problems occur.	5,700	23,000
YACKANDANDAH Nine Mile Creek	Water gravitates from Nine Mile Creek to a 1-Ml service basin on Walkers Saddle. *The maximum supply* available from this system is 1.1 Ml/d with a minimum of 0.9 Ml/d during summer.	Sometimes below standard bacteriologically.	640	1,000

sons who were unable to obtain authorization to irrigate directly from a stream excavated holes (commonly called dragline holes) adjacent to the stream and irrigated from that source. The use of groundwater for domestic and stock purposes in the district is widespread, but the quantities of water used are not significant.

Future requirements

As already mentioned, the growth of irrigation in this district over the past 15 years has justified the construction of two storages, which will allow for some additional development.

Two factors may influence future growth of water use within the district:

Tobacco farms, Buffalo valley

* the increased demand for high-value produce from the area

* the construction of water conservation storages arising from urban and industrial requirements

The tobacco industry, which is mainly responsible for the rapid growth of irrigation in recent years, produces to a quota system, and the expectation of large increases in quota volumes is a little uncertain. The allocation of quotas of course depends on a corresponding water availability.

Because of the high annual rainfall over most of this area, the irrigation of pasture is quite often difficult to justify economically, other than for beef production, and so pasture irrigation will probably increase only slowly, if water is available.

Increased urban and industrial regional development may eventually dictate the construction of further water conservation projects. The districts have sufficient water resources, mostly in surface streams, to meet urban and industrial requirements for many times the present population.

River Improvement

The need for river improvement

Before European settlement, the river channels in the alluvial section of the

Lake Kerford, water supply for Beechworth

districts carried the normal high flows. The very high water flows, that occurred in winter, were carried by the river and its flood-plain. Now, however, the channels are less able to cope with these because uncontrolled willow growth and silting have reduced their capacities. In addition, the clearing of the catchment has changed the flood regime and allowed run-off to concentrate in the streams far more quickly, creating higher flood peaks of shorter duration.

River Improvement Trusts

River Improvement Trusts carry out river improvement and drainage works under the *River Improvement Act*, passed in 1948, which was the first attempt in Victoria at a systematic improvement of river channels and the maintenance of works carried out. These Trusts are corporate bodies, which may enter into contracts, hold land, and generally exercise the powers of such bodies.

TABLE 19

MAJOR RIVER IMPROVEMENT TRUSTS

IMPROVEMENT TRUST	AREA	ALLOCATION 1972/73	RATING
FIFTEEN MILE CREEK	Approx. 150 km^2 Fifteen Mile Creek and anabranches, from Ovens River upstream to junction with Middle Creek	17,160	Three divisions, maximum rate of 0.75 cents in dollar down to nil
KIEWA RIVER	Approx. 120 km^2 Kiewa River from Murray River upstream to junction of East and West Branches	15,860	Uniform rate of 1 cent in dollar
KING RIVER	Approx. 110 km^2 King River from Ovens River upstream to junction of East and West Branches	14,360	Three divisions: City of Wangaratta making annual contribution in lieu of rates in first divisions; second and third divisions 0.65 cents in dollar
MITTA MITTA RIVER	142 km^2 Mitta Mitta River, Tallangatta and Fairyknowe Creeks; from Hume Reservoir to Mitta Mitta and to Buckeen Creek junction on Tallangatta Creek	18,320	Three divisions: maximum rate 0.24 cents in dollar, down to nil
OVENS RIVER	306 km^2 Ovens and Buffalo Rivers upstream of Murray River	33,460	Uniform rate of 0.5 cents in dollar

Under the *Act*, their tasks include: any work to improve and stabilize the river channel such as removing obstructions from its bed and banks; deepening, widening, straightening, diverting, or otherwise improving the river; preventing erosion and planting trees and grasses; erecting structures to deflect flows; and providing protection against flood-waters. Trusts are also empowered to cleanse a river or prevent or minimize its pollution. The State Rivers and Water Supply Commission exercises general supervision and advises the Minister of Water Supply on the operations of the Trusts.

Within the study districts

Some details of the major Trusts within the study districts are shown in Table 19. Each receives an allocation within the *Works and Services Act*, which subsidizes river improvement at the rate of 5:1 and drainage at the rate of 1:1. Trusts with gazetted streams within their districts also benefit from a frontage grant, provided on the basis of


Concrete groyne to prevent bank erosion

$12.40 per km of stream frontage. The remainder of their funds are obtained by rating.

The upper valley sections, where the streams flow through steeply graded gorge sections with little or no alluvial flats, pose few problems. The streams are not so steeply graded in the middle valley sections, but are still subject to velocities that may actively erode unprotected banks. (In many cases they have shifted course considerable distances and eroded away large areas of fertile land.) In the flatter-graded lower sections, the main problems are flooding and the possibility of lateral erosion causing breakaway courses. Blockage by snags, willows, and silting from upstream erosion has aggravated these problems.

The Trusts are therefore mainly concerned with erosion prevention in the middle sections of the rivers and snagging and channel improvement in the lower parts.

ECONOMIC MINERALS

History

Gold was discovered at Beechworth in February 1852. The rush that followed resulted in further discoveries at other localities, including Reeds Creek, Yackandandah, Bowmans Forest, Myrtleford, Buckland, Wandiligong, Freeburg, Harrietville, and Mitta Mitta.

Initially, gold-seekers worked surface stream deposits, later mining and sluicing deep leads, then quartz veins, and still later dredging deep leads.

The mining population declined from its initial peak as the richer, easier ground was worked out, and when rising costs made mining uneconomic.

TABLE 20

Number of Miners and Gold Production

Year	Number of miners	Approximate production
1864	10,196	665 kg
1883	3,807	350 kg
1917	876	1,040 kg
1935	N/A	29 kg

Deep Leads

Many of the river valleys have deep lead deposits. These were initially exploited by underground mining, but the problems and danger from water and mine collapse were considerable. Later, sluicing and dredging were used.

In the period 1856--1901, deep leads were worked down to 60 m in the Eldorado area, producing gold and tin concentrate. From the late 1880s, as a result of permitting alluvial leases larger than the 3.7 x 3.7 m formerly allowed, a number of public companies were formed, first to sluice, then to dredge alluvium in the Beechworth, Woolshed Creek Flats, and Reedy Creek areas. From 1899 to 1909 the largest venture (comprising the several Cocks Eldorado Companies) treated 1,790,000 cubic metres of gravel for gold and tin at a profit of 6.0 cents per cu m.

New equipment was brought into use in 1913 and 1934. Sluicing continued until 1941. In 1935 the largest dredge in the Commonwealth was erected; this continued working until 1954, producing 1,245 kg of gold and 800 tonnes of tin concentrate.

The derelict dredge still remains at Eldorado.

From 1898 to 1955, a total of 46 dredges worked parts of the Ovens and Buckland Valleys for gold and tin. One gold dredge was working at Freeburg until 1955 and another worked ground at Harrietville until 1954. Since then, several syndicates have carried out small sluicing operations at Clears Creek and Chappells Gully.

From 1854 onwards, large quantities of cassiterite (tin oxide) were sent from Beechworth and Eldorado to Melbourne for smelting.

Tin was discovered around Mitta Mitta in 1891, but little was done until the price of tin increased in 1911. From then to 1924 at least six small mines produced tin in the area, the main production coming from the Tallandoon Mine.

Quartz reefs

In the middle 1850s, miners turned their attention to the quartz reefs in the area, from which the alluvial mineral deposits had been released by weathering.

Notable reef mines included Pioneer Mine at Bright, Reform reef at Myrtleford, Oriental Mine at Wandiligong, and Rose Thistle, Shamrock, and Sambas Mines at Harrietville. The last-named is still working.

Molybdenum

The Everton molybdenite mine, 3 km north-east of Everton, was worked from 1917 to 1926 and again from 1937 to 1940 for a total production of 300 tonnes of 90% grade molybdenum sulphide. Nearby, a second pipe of lower grade ore was worked from 1942 to 1944 and yielded 25 tonnes of 87% grade molybdenum sulphide.

Exploration

In 1905--1906 the Mines Department carried out exploration drilling along

Derelict gold dredge, Eldorado

The Mitta Mitta Valley, showing it to contain auriferous gravels with cassiterite and tantalite down to 46 m, but these have never been worked.

Metallic Mineral Deposits

The main metallic mineral deposits present in the area are ores of gold, tin, and molybdenum.

Gold and cassiterite occur together at Beechworth, Eldorado, Woolshed Creek, Mitta Mitta, Myrtleford, Tawonga, and Tallangatta. Gold without substantial quantities of cassiterite has been found at Bright, Freeburg, and Wandiligong, and at Harrietville and in the Buckland Valley.

The Everton region may contain further deposits of molybdenite (molybdenum sulphide).

The metallic mineral deposits occur in two main ways - lodes and alluvial deposits. Gold, cassiterite, and molybdenite occur in dykes and quartz reefs associated with granitic rocks or Ordovician sedimentary rocks. Many of these lodes were sufficiently rich and persistent to support economic underground mining.

Alluvial deposits may be shallow or in deep leads. In many of the creeks in the area 1--2 metres of gravel, sand, and gritty clay covered deposits of gold and cassiterite. Most of these have been worked once, primarily for gold. The deep leads of gold and cassiterite (lying at depth under the present alluvial plains) have been worked extensively in the past, but known deposits still remain unworked.

Chiltern gold- and tin-field

Hundreds of auriferous quartz reefs in Ordovician rock have been worked down to water level. Most of them were narrow and low-grade (8 p.p.m.). The granites of the Pilot Range contain cassiterite disseminations.

The deep lead system was extensively mined for gold and tin, although it had only one payable wash zone. Various companies have carried out sufficient exploration to define roughly the course of a deep lead that runs from east to west beneath the valley of the Black Dog Creek.

Mitta Mitta gold- and tin-field

This field is a 12-km belt running parallel to the west of the Mitta Mitta River from Mitta Mitta township to Tallandoon. The whole of this belt consists of micaceous schists and quartzites of probable Ordovician age intruded by dykes of various types, some of which contain cassiterite concentrations such as the one worked in the Tallandoon Mine. The lode part of the field has been inadequately prospected; at least 24 km of tin-bearing dykes are exposed.

Although the Diggers Creek alluvium was profitably worked for gold, the rest of the alluvium has not been adequately prospected.

Beechworth--Eldorado gold- and tin-field

This field has yielded the major part of the tin ore produced in Victoria. The tin in the area is derived from the Pilot Range granite. Cassiterite occurs throughout the granite, and is also found in quartz veins in association with gold.

Most of the tin has come from alluvial workings as a by-product from gold-mining and dredging.

Associated with cassiterite and gold in the alluvium are ilmenite (iron titanium oxide) and tourmaline.

Harrietville gold-field

Part of the Harrietville gold-field lies within the study districts. Gold was mined from quartz veins and extracted from alluvial deposits. Dredging only stopped in 1954.

Buckland gold-field

Alluvial mining occurred in the Buckland River area. The richest area was from Fairley's Creek up the west branch. Later, miners worked the terrace gravels of Clear Creek and other terrace deposits downstream to Buffalo Flat.

A number of payable quartz reefs have also been worked in the Upper Buckland River.

Buffalo Creek gold-field

The main reefs occur on the spur to the west of Buffalo Creek, in an area about 5 km long to the south of Buffalo River. They lie in folded Ordovician slates and sandstones. Alluvial mining has only been carried on in Slaughteryard Creek. The remaining river flats have not been worked because of the high agricultural value of the land and because only a little gold was found in the Buffalo River.

Myrtleford, Happy Valley, Stanley, and Yackandandah gold-fields

Both alluvial and reef mining were conducted in these gold-field.

Tawonga gold-field

The Tawonga gold-field was worked in a small way in the period 1890--1910. Its chief distinction was the presence of native copper and copper pyrites in the ore.

Everton molybdenite-field

The ore bodies are confined to two dipped pipe-like structures. These were mined to 50 m. The average ore grade was 2.5% molybdenite near the surface and 0.6% at the bottom level.

Brick kilns near Chiltern use kaolin deposits

Other metals

Small amounts of other metals have been found in the study districts including antimony at Tallandoon, molybdenum at Stanley, tungsten at Barnawatha, and copper in the south-west and at Tawonga. Currently, exploration licences for minerals cover about 40% of the study districts.

Other Minerals

Phosphate

At Whitfield, a thin bed of iron phosphate dips conformably with the Ordovician slates and sandstones. Analysis shows that the anhydrous phosphate varies from 10 to 31%.

Secondary minerals include garnet, gold, limestone, limonite, and turquoise. Small amounts of turquoise were mined at Edi and Whitfield and turquoise can still be found in the locality.

Feldspar

Many pegmatite dykes occur at scattered localities in the northern part of the study area. These vary considerably in size and extent. Many of them contain a significant percentage of tourmaline.

Building stone

The Pilot Range granite has been quarried and used at Beechworth as a building stone.

Clay

The small brickworks at Chiltern uses clay from mine dumps, but this requires blending with other clays before use and supplies are limited.

Road-making Materials

The Country Roads Board, Forest Commission, and Shire Councils are the principal road-making authorities in the districts and either mine the construction materials themselves or use contracting firms.

Transporting these heavy materials is expensive, and normally mining is carried out as close as possible to the point of use, usually within 16 km. Local supply therefore, plays an important part in determining the actual materials used. Scarce or expensive materials, such as crushed rock, are often transported greater distances.

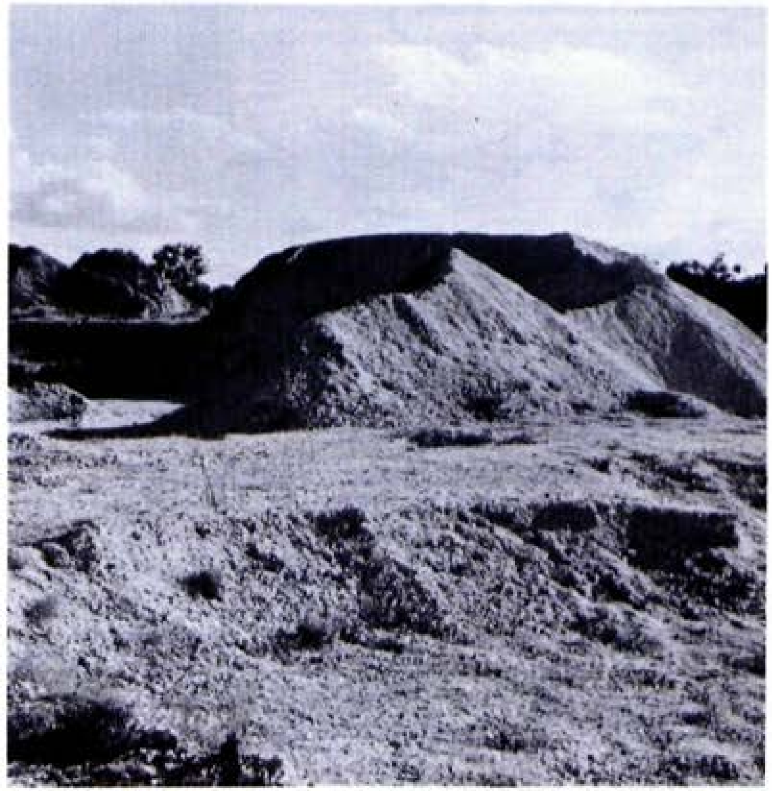
Gravels from gold-mining operations, sluicing, and deep lead mining are the most commonly used materials.

About 80% (300,000 tonnes) of the gravels used by shire councils come from these sources, which still contain considerable reserves. The quality varies, discontinuous lenses of sand, gravel, and clay exist, and plasticity can be a problem.

The Harrietville and Barwidgee Creek tailings contain a high proportion of shale fragments and consequently have too high a plasticity, while those at Eldorado and Reedy Creek contain mainly quartz sands that may be deficient in clay-binding material. Deposits of tailings also exist at Allen's Flat near Porepunkah on the Buckland River, and towards Rutherglen in the north-west.

Hill gravels occur on the lower slopes of sedimentary and metamorphic rock outcrops. They are mined at Murmungee and Baarmutha. Deposits also exist near Gapstead, Mitta Mitta, and Germantown.

Deposits of river gravel occur along all the major streams in the districts.



Mine dumps are used for road-making materials

Granitic sand pit near Beechworth

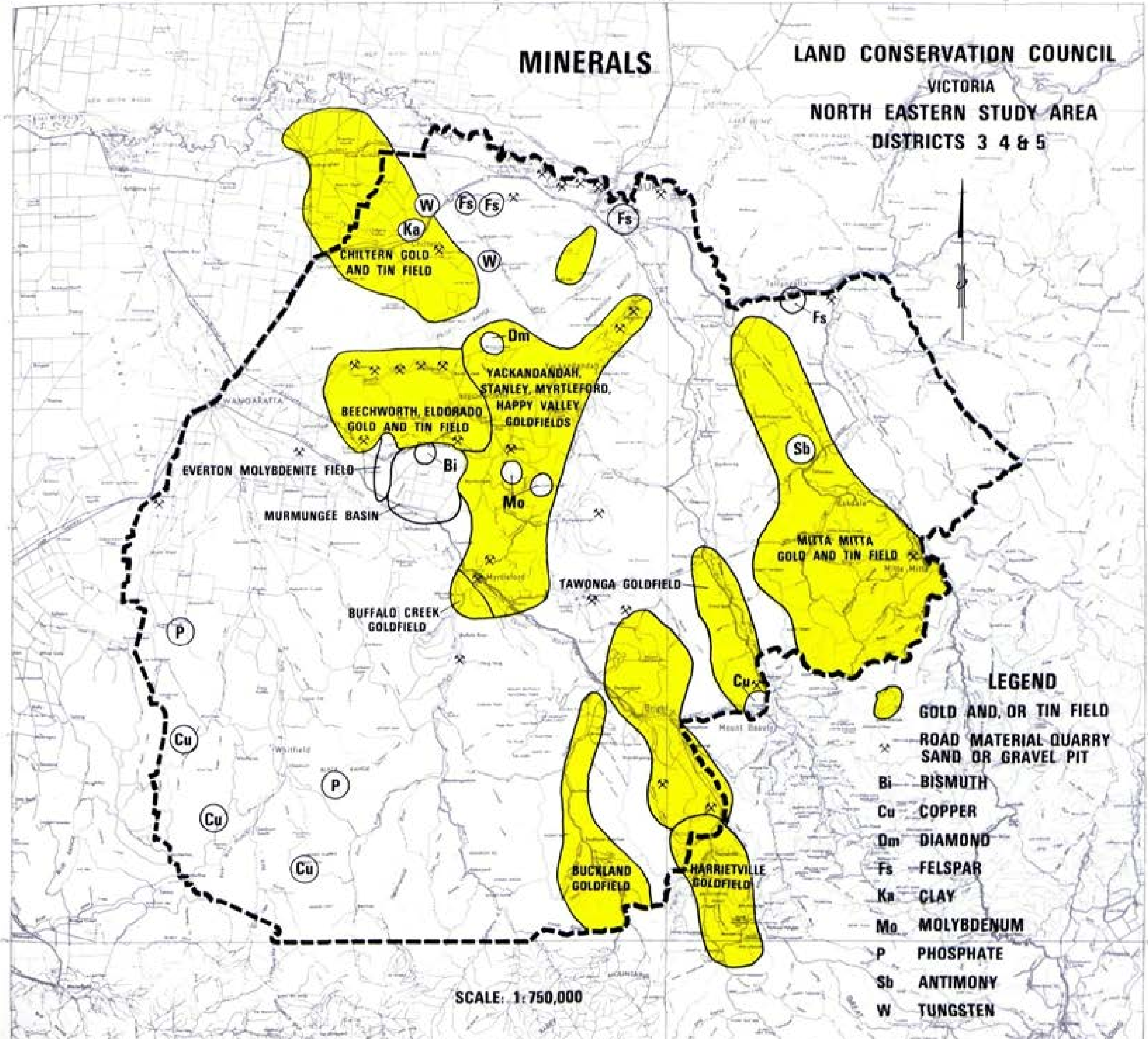
River gravels are an important resource and are taken directly from the river bed (as at Tawonga in the Kiewa River) or from shingle banks on the edge of the river (as on the Ovens River between Myrtleford and Milawa).

In addition to these two sites, heavy deposits, some of which are mined, occur at the north of Tallangatta Creek, on the Mitta Mitta River north of the Mitta Mitta township and at Tallandoon, at several sites on the Kiewa River, especially near the Murray River and Running Creek, on the Ovens River near Eurobin and Porepunkah, on the King River at Whitfield, and on the Murray River west of Wodonga.

Granitic sand pit, Happy Valley

Granite sands occur on all granite outcrops in the districts, although rarely more than 1 m thick. The quality tends to be higher on the northern slopes. Granite sands are mined near Mudgeegonga, in Happy Valley, and east of Springhurst.

Hard-rock quarries exist at Glenrowan, Skeleton Hill near Chiltern, and east of Barnawatha.


MINERALS
LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5
CHILTERN GOLD AND TIN FIELD
YACKANDANDAH, STANLEY, MYRTLEFORD, HAPPY VALLEY GOLDFIELDS
BEECHWORTH, ELDORADO GOLD AND TIN FIELD
EVERTON MOLYBDENITE FIELD
MURMUNGEE BASIN
BUFFALO CREEK GOLDFIELD
TAWONGA GOLDFIELD
MITTA MITTA GOLD AND TIN FIELD
BUCKLAND GOLDFIELD
HARRIETVILLE GOLDFIELD
WANGARATTA
SCALE: 1:750,000
LEGEND
GOLD AND, OR TIN FIELD
ROAD MATERIAL QUARRY SAND OR GRAVEL PIT
Bi BISMUTH
Cu COPPER
Dm DIAMOND
Fs FELSPAR
Ka CLAY
Mo MOLYBDENUM
P PHOSPHATE
Sb ANTIMONY
W TUNGSTEN

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RECREATION

Outdoor recreation is the aspect of leisure activity that most concerns land use. Generally, participation is increasing, with a consequent growing demand exerting pressure on land for recreation. This demand can be divided into two forms.

The first form is current demand. It is expressed as consumption; therefore its future size and direction can be estimated from current trends in user rates for recreational activities. The second form is the latent or possible demand, which is not expressed at all at the moment because of some physical, social, or personal constraints. Clearly, neither its size nor its kind can be discerned by simply examining the user rates of the recreational facilities as they now stand.

The principal influences on demand are the socio-economic, technical, institutional, and availability factors.

Socio-economic

The population of Victoria is increasing and this will involve at least a *pro rata* increase in the use of recreational facilities.

The proportion of people living in rural areas is declining. This changes the use made of the countryside for recreation by placing an increasing burden on land close to the centres of population and by concentrating use in the principal leisure hours and holiday periods.

The time given to formal education is increasing. Students have more time for outdoor recreation, and schools often encourage their participation, which will probably increase their appreciation of the environment and will certainly improve their knowledge of recreation opportunities.

Occupation affects the type and quantity of outdoor recreation chosen. The decreasing proportion of unskilled workers and the increase in professional and administrative people will increase the demand for outdoor recreation.

Technical

The increase in mobility and flexibility of travel due to private motor cars has a big impact on the demand for recreation and influences the type of activities pursued. Concomitant improvement in the road system is of particular importance on a regional scale. Radio and television programmes have stimulated the demand through their information content.

The increase in industrial efficiency and the increased use of automation in industry have both stimulated the demand for leisure and given the work force the opportunity of more leisure time.

Institutional

Two institutional groups - social institutions and the law - influence the pattern of recreation.

The trade unions have helped to shorten the working week and increase the holiday periods. The law has been important in redistributing time between work and leisure by setting statutory hours of work in industry. Other laws influence recreational pursuits more directly by providing facilities or by directly controlling recreational activities.

Availability

The availability of suitable land is obviously important in determining the level of participation. Different forms of outdoor recreation require different features. Broadly, active recreation (sports etc.) requires flat ground, open water, swimming pools, and so on while passive recreation (driving for pleasure, walking, wildlife photography, etc.) requires scenic landscapes, interesting geology, high-quality forests, plentiful wildlife, and so on.

Demand for recreation within an area

Time acts as a constraint on the use of an area for recreation. The majority of people are bound by the normal working patterns and have their leisure in definable periods: time after work, weekends, holidays, and during retirement. The time taken to reach a recreation area limits its use.

Areas that can be reached within a few minutes can be used for recreation at any time. The normal free time during the week and after work is sufficient, and these areas are often used intensively. Most day trips are normally

Swimming and picnic area at Lake Sambel, Beechworth

Picnic area, Lake William Hovell

within an 80-km radius of home, and areas further away can only be visited on holidays or during retirement. These categories can be referred to as "user-based", "intermediate", or "resource-based", respectively.

Recreation in the Study Districts

The recreation resources within the study area are owned and managed by a range of organizations, from private individuals and companies to local and State governments.

In some cases, the resources and facilities provided are complementary and together increase the use of an area; for example the commercial ski lodges and ski lifts increase the use of the Mount Buffalo National Park. In other instances they can be competitive. Generally, however, commercial and other privately owned facilities widen the range of recreational opportunities in the districts, which are of course used by both local and visiting populations.

The area provides user-based recreation for the population living within or close to the study area. Recreation reserves come into this category and can be an important resource - especially if they have facilities such as sports ovals and tennis courts.

People participating in the intermediate class of recreation are likely to be drawn from a wider area, mainly from within an 80-km radius. Numbers will probably increase greatly in the study area because of the likely growth of Albury--Wodonga. The effect of this large local population will be felt mainly at week-ends and could cause considerable pressure on recreation facilities, especially in the north of the study area in the Shires of Beechworth, Chiltern, and Yackandandah.

Resource-based recreation in the area attracts visitors from all over the country.

People visiting and touring within the districts for recreation have economic and social effects on those living in the districts. The type and level of these effects vary with the kind of visitors and their reason for visiting the area. People on a camping trip will have, for example, a different effect from those wanting to water-ski.

Tourism is an important and growing Industry for the north-east. The range of activities that interest tourists is greater than outdoor recreation and includes cultural interests, educational activities, food, and wine.

Unfortunately, increased use of land for recreation tends to alter the type of experience obtained; over-crowding, increased erosion, fire, pollution, and loss of habitats can reduce the quality of the recreation in an area. Consequently, it seems important to define the more important and vulnerable resources so that they can be preserved.

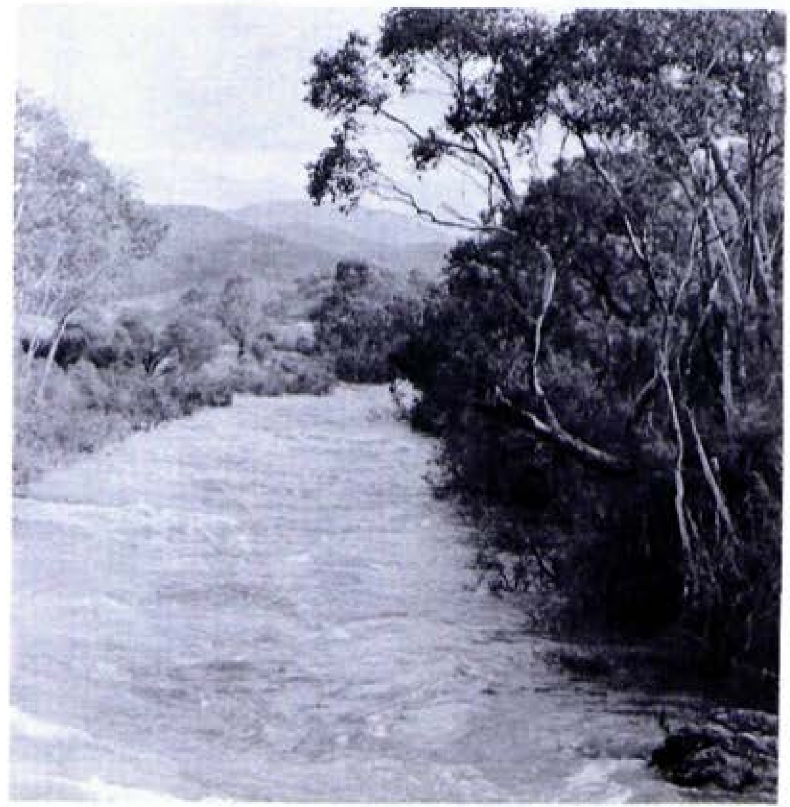
Inventory of recreation resources

The recreation map shows five regions that provide different opportunities for outdoor recreation. In addition it gives the location of some features of interest for recreation.

Flat agricultural land

The flat agricultural land of the riverine plains is traversed by the Ovens and King Rivers. It is intrinsically suitable for active recreation, and many of the small recreation reserves in the region have facilities for sports such as tennis courts and sport ovals.

The rivers and their associated lakes form an important scenic element in the landscape. The bulk of public land in the region flanks these rivers. The Ovens and King Rivers are too small for much boating, but the latter affords good fishing. The lands provide an attractive environment for a number of activities including walking and picnicking.



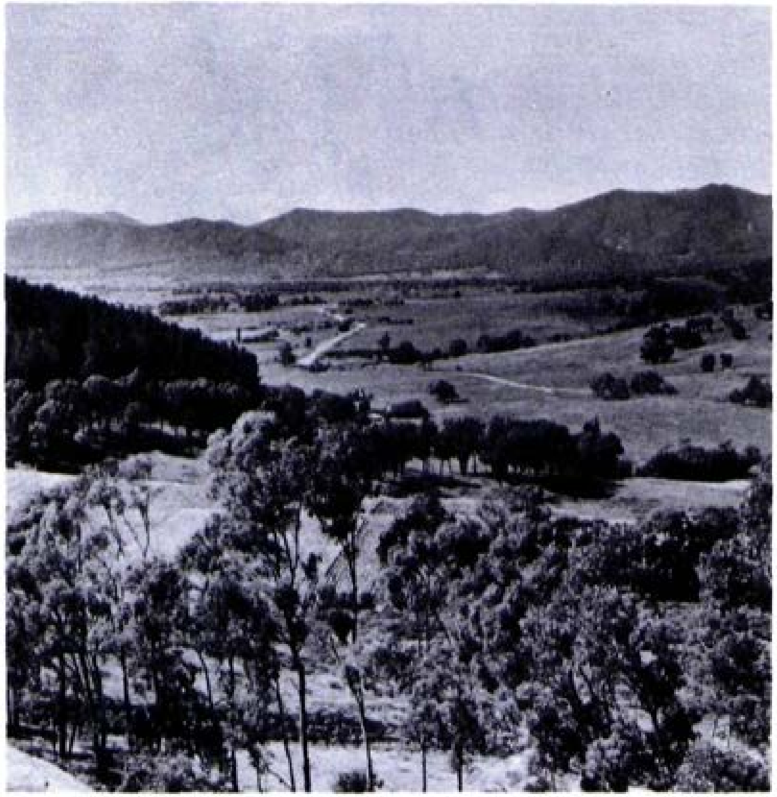
Buffalo River provides good fishing

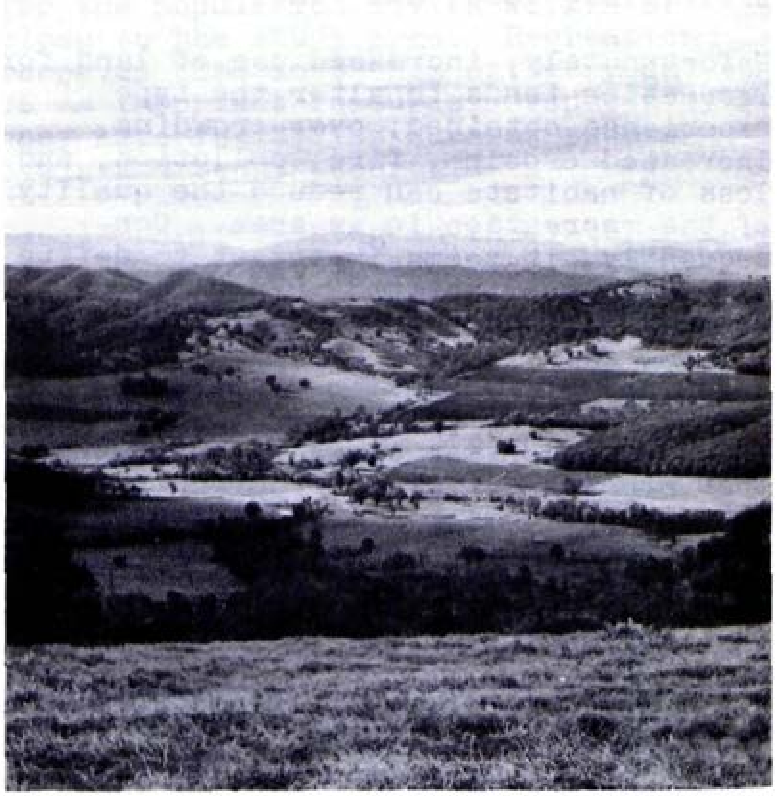
Most of the region is cleared land and the small areas of forest and river red gum woodland add diversity to the landscape and provide a habitat for wildlife.

Although the vegetation includes numerous introduced species, the woodlands are a visual reminder of a once-extensive vegetation type. Wetlands around the junction of Garden Creek and the King River are important for waterfowl, including ducks.

The low hills of Permian glacial deposits are of interest to gem collectors for the agate and jasper they contain.

Tourists also find the agriculture of the plains of some interest, especially where they can purchase produce from the proprietors, such as olives and wine.





Agricultural land Happy Valley (left) and hilly agricultural land offer opportunities for passive recreation

Hilly agricultural land

The hilly agricultural land includes the relatively narrow valleys of the Upper Ovens, King, Kiewa, and Mitta Mitta Rivers.

It offers more opportunity for passive recreation such as driving for pleasure, principally because of the many scenic views, which include a diverse agriculture - hop gardens, orchards, and tobacco farms - scenes of the surrounding mountains such as Mount Buffalo and Mount Bogong, and views of the rivers and their associated lakes.

The region contains many reminders of the gold-mining period. Sluicing, dredging, and deep-lead mining have left their mark on the landscape, often in the form of high banks or water-filled depressions. Historically interesting towns such as Beechworth, El Dorado, and Yackandandah draw a large number of people to the districts.

Gold and gemstones can still be found in some of the creeks and rivers.

The riparian land provides a habitat for waterfowl, notably along the Mitta Mitta and Kiewa Rivers. Game birds are seldom very abundant.

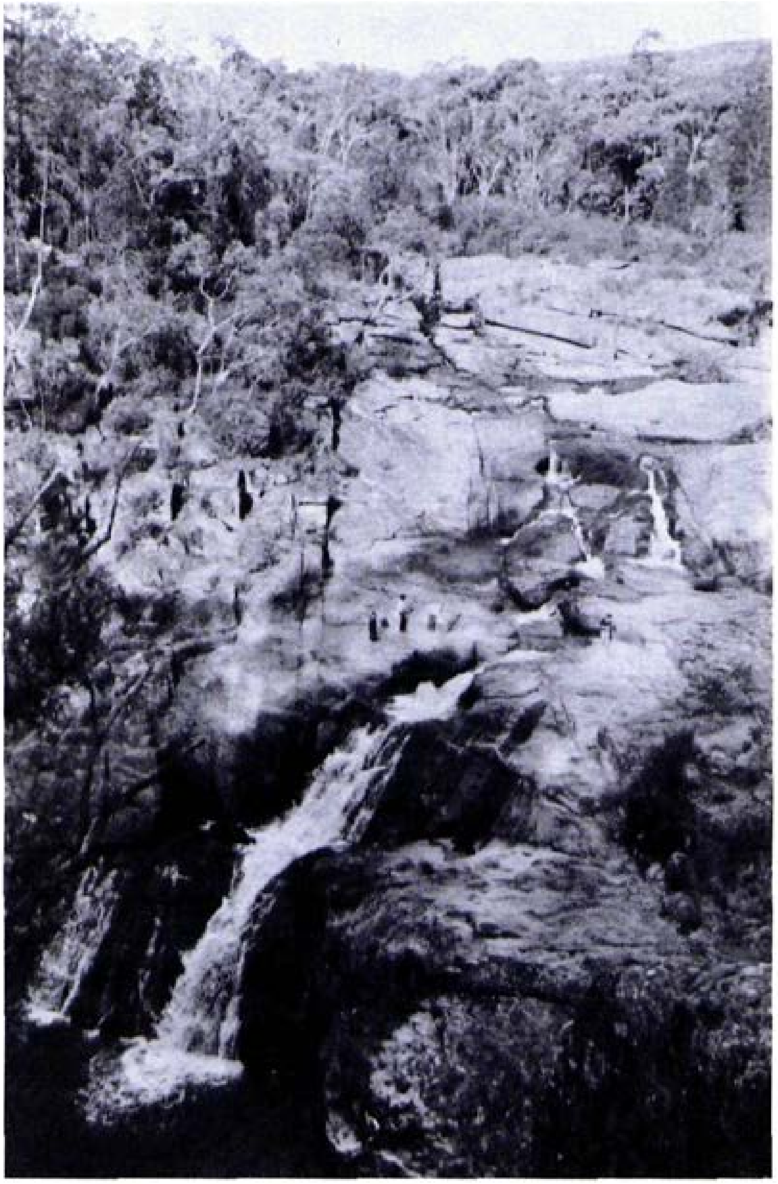
Relatively large areas of flat land within this region can support recreation. A number of facilities, such as camping sites, recreation reserves, and go-cart and minibike tracks are already provided.

Fossicking for gold and gemstones, Reedy Creek

All the rivers and lakes provide good fishing, mainly for redfin and trout. Some are used for swimming. The Mitta Mitta River is used for canoeing, and the lakes provide opportunities for boating activities including sailing and water-skiing.

Wooded and forested areas

The area has unique physiographic features such as the cliffs at Mount Buffalo and Mount Pilot and the steep rock outcrops at the Bullhead, Mount Typo, and the Pinnacles. Of the many waterfalls



Woolshed falls

it contains, the most spectacular are the Paradise and Woolshed falls.

Many of the hills contain quartz reefs that were mined for gold during last century. Numerous tunnels and shafts remain, and a few relics of the gold-processing machines can still be seen.

The forests show considerable diversity, with peppermint the most extensive, and occupy large areas - particularly in the south of the districts.

Interesting geological features here include the nearly horizontally bedded carboniferous rocks in the south-west and the extensive areas of granite in the central area. In the east, faults have produced some interesting features.

Most of the mountainous or hilly land is scenic. Land forms vary over the study area, providing landscape variety.

Forests form the principal wildlife habitat for the study area, which generally supports a large fauna. Some parts are quite isolated. The Pilot--Chiltern forest is important in that it represents, for some animal groups, the transition zone between the forested hilly country and the drier interior. In addition, it has very good access, and the locality has become popular with nature-lovers.

The streams of the region provide fishing and the forests are used for bush-walking. Some scenic points such as Powers Lookout and Mount Pilot have been moderately developed.

Sub-alpine

The main area of sub-alpine vegetation is on the high plateau at Mount Buffalo. It provides a habitat that differs significantly from those in the rest of the study area. The region is hilly, with high-quality snow gum woodland, bogs, and heaths. The plateau itself, which affords some very good views of the surrounding country, has many interesting granite boulder formations.

This region is important for winter snow sports and carries lifts and runs for skiing. The generally flat to hilly plateau is suitable for other snow sports, including cross-country skiing, and for summer activities such as bushwalking and horse-riding. Lake Catani provides some fishing.

Pine plantations

Plantations usually have good access roads, and provide a very different environment for recreation from that of native forests. For example, older conifers form a closed forest with no understorey - only a ground cover of litter.

Plantations are normally sited on flat or gently sloping land and are intrinsically good for some forms of recreation such as walking and driving. Views from some of the plantation roads are very good.

Some of the pine forests contain historical areas associated with the goldmining period, having been planted to use the land turned over in sluicing and dredging operations.

Development

Most of the recreation resources mentioned here are on public land, but its potential is bound up with the recreat-

Sub-alpine vegetation, Mount Buffalo

ion potential for the entire study area, including the freehold land. Almost all the public land is forested and hilly, and provides a recreation resource that complements that provided by the flat, cleared agricultural land. Good-quality development blends with its intrinsic qualities and can substantially improve the facilities of the region. Low-quality, ugly, or inappropriate development can easily destroy the very qualities that make the area attractive for recreation.

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LAND USE RELATIONS

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. Hazards associated with these uses have also been considered.

There is a growing demand for resources on public land from groups with a wide range of interests. In this situation 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. In many cases the requirements 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. This view is, however, a simplification and in practice each land use has unique effects on others. The main 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.
* Some activities occur for a short period, thus restricting their effects and allowing other activities to continue in the intervening periods.
* Often an activity only occurs in a small part of a wider area, thus localizing its effect. This enables other activities to continue in the general area.

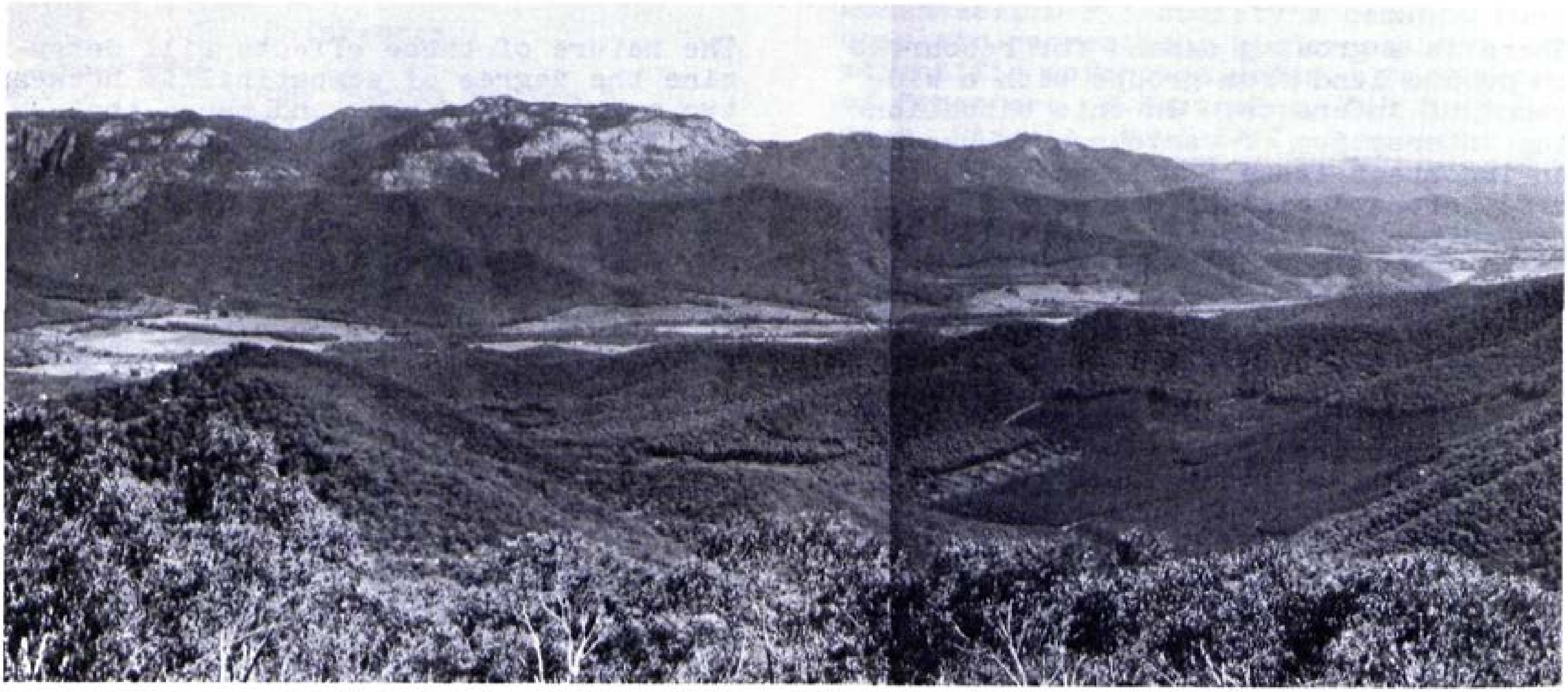
* Spill-over effects of an activity may have ramifications for other uses outside the immediate area of the activity.

* Compatibility between uses in an area changes over time as the harmful effects of one activity are lessened or increased.

* 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.

* Improved management techniques can reduce possible harmful effects of the activity on others.

Land use flexibility refers to the degree to which any one activity precludes, by its operation, other activit-



Typical land use in the Ovens Valley: native eucalypt forests on the hills, pine plantations on the flatter areas, cleared land with irrigated crops on the valley floor, and Mount Buffalo in the background ies' 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 districts. It has not been possible to deal with relations between internal aspects of each major category of use, although the same principles would apply.

Agricultural production

Agricultural activities in the study districts have in many cases introduced a diversity of visual interest that provides enjoyment for many people, including those sight-seeing, picnicking, and participating in other forms of passive recreation.

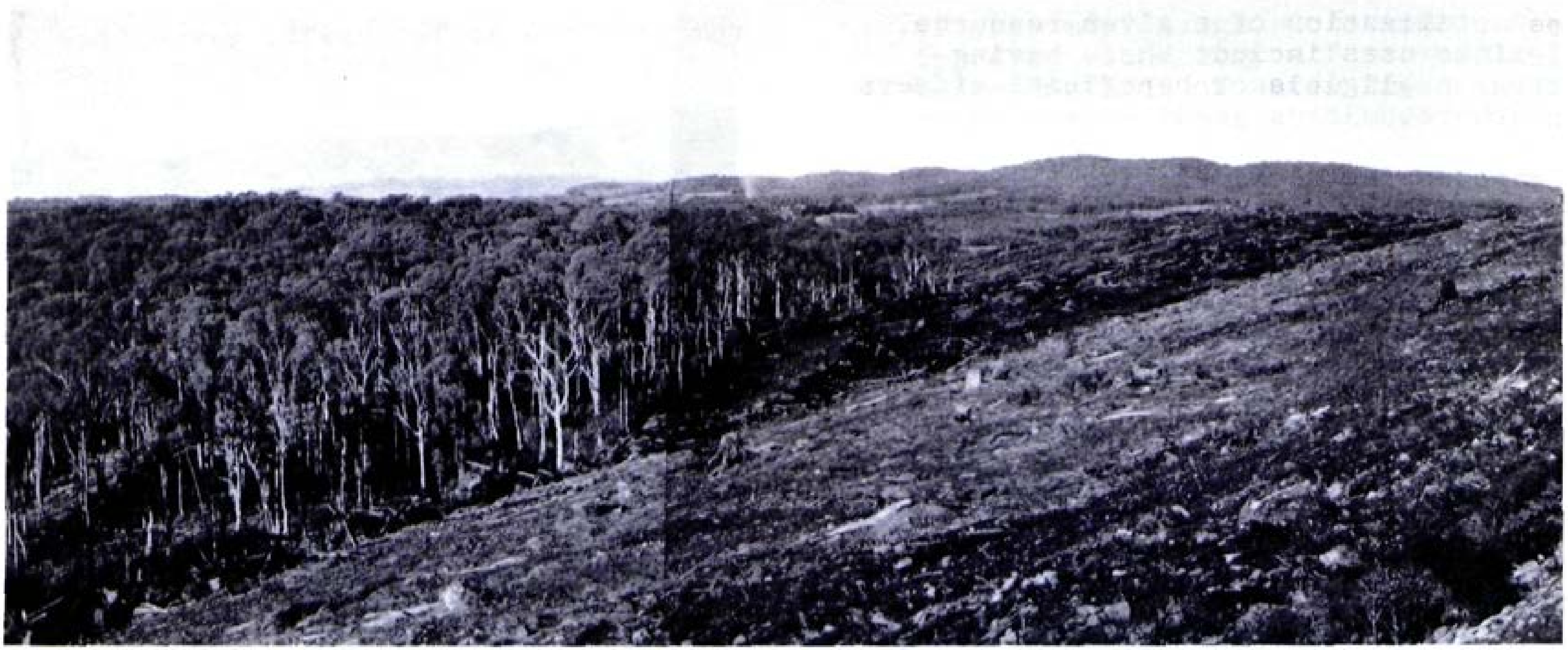
Some native animals benefit from the increased areas of grassland and of forest margins resulting from agricultural development, while others are severely reduced in numbers.

In some places agriculture has little effect on water production. However, the conversion of forests to grassland can lead to increases in total water yield, turbidity, salinity, the level of other pollutants, and fluctuations in supply. The use of additional land for agriculture would compete with timber production, apiculture, recreational activities requiring forested country, and many aspects of nature conservation.

Hop garden and cattle grazing, Fifteen Mile Creek: some agricultural practices can reduce water quality

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



Clearing narrow-leaf peppermint forest for pine plantation: a relatively inflexible land use

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. Because of their relatively open understorey, they provide good opportunities for picnicking, camping, and other recreational activities such as orienteering.

Hardwood timber production

This relatively flexible land use can be beneficial to many forms of outdoor recreation and can be compatible with water production, forest grazing, honey production, and all but the strictest 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.

Water production (including storage)

The production of water is an important use on public land. 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 stream flow characteristics.

Logging, clearing, overgrazing, and excessive traffic may cause increased surface flow, which results in stream turbidity and siltation of reservoirs, and also affects stream flows by channeling surface run-off.

Water storages increase the opportunities for some forms of recreation, such as foreshore picnicking and water-based activities, and provide a habitat for some fish and waterfowl.

The original habitats are of course lost when an area is inundated by dam waters, and a new aquatic habitat is created. Dams alter the characteristics and flood regimes of the stream and consequently affect the fish and waterfowl populations downstream.

Mining

Mining and extractive industries are scattered throughout the districts. Extractive industries are competitive with most forms of land use, through site disturbance, roading, and polluted run-off. However, the effects are usually localized. Worked-out quarries have been used as rubbish dumps.

Some of the very early mining activities have become the focus of considerable historic interest.

Public utilities and transport

In addition to water supply, these include the distribution of electricity, 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

Transmission lines, although competitive with many other uses, are useful as fire breaks

uses and have widened the range of most recreationalists. Road construction in remote areas may reduce the solitude appeal of these areas and, through greater accessibility may increase the pressures from other types of use.

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.

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, nature conservation, water production, mining, and many forms of outdoor recreation. Moreover, the presence of 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.

Outdoor recreation encompasses a wide range of activities. Most recreational activities are flexible and are compatible with a wide range of other activities, although some pursuits can become self-competitive, especially at high usage rates. However, recreation in solitude that requires undisturbed

Gravel pit: inflexible land use

forest environment is competitive with most other land uses, including low-intensity hardwood production and forest grazing, and is therefore an inflexible land use.

Nature conservation

This is a supplementary use for large areas of both public and alienated land. Being relatively flexible, it is compatible with a wide range of uses, notably recreation and water, hardwood, and honey production. It tends to be competitive with activities that radically change the natural vegetation, such as urban development, mining, and many agricultural enterprises.

Areas set aside for strict nature preservation and for scientific purposes are competitive with all other uses, except some aspects of water production, and are therefore inflexible.

PUBLIC UTILITIES

Several public services use public land within the study districts. The local population, and large nearby population centres, create a continuing need for these services.

Electricity

No power stations are sited in the districts and the State Electricity Commission neither owns nor is investigating any land there for siting future power stations. However, the districts contain a number of major transmission lines (see the public utilities map). Other distribution facilities include zone substations at Myrtleford and Bright, and a site exists for a future zone substation at Tallangatta. Also, a construction and maintenance camp at Cheshunt supervises easement patrol tracks in the region.

Possible future additions to the transmission system include a further 330-kV line running between Murray switching station and south Morang terminal station, via Dederang terminal station. This line would be constructed to provide for increased load, growth, and system reliability. Some provision has been made for it in the existing 330-kV line easement between Dederange and South Morang terminal stations, but this is not complete and additional easements adjoining the present one would be necessary for the new line.

The route of the additional 330-kV line between the Murray switching station and Dederang terminal station has not yet been selected. It is expected that a 60-m easement, separated from the existing easement by several miles, would be required to increase the security of the line against natural hazards such as lightning and forest fires. Depending on the outcome of current investigations and proposals regarding the enlarged Albury--Wodonga complex and its future power requirements, this third 330-kV line may be routed via Albury--Wodonga to Dederang terminal station.

There is also a possible future requirement for an additional line between Dederang terminal station and Shepparton terminal station, and provision has been made in the existing easement for an additional 220-kV line to be erected if required.

The power station at the Dartmouth dam project will be linked to the main transmission line network through either the

Mount Beauty or Dederang terminal station by a single-circuit 220-kV transmission line. The proposed routes for this line will probably be made public shortly and the route should be determined by the end of 1974.

Roads

The Country Roads Board and other interested bodies are currently investigating the possibility of duplicating the Hume Highway within 8 years. It appears at present that, from Bowser northwards to Wodonga, the new road can be built on the route of the present one with only small deviations at Barnawatha and Springhurst. South of Bowser, the new highway is planned to bypass the city of Wangaratta.

The other highways are continually being repaired, re-aligned, and widened. These improvements, and the new Hume Highway, will require considerable quantities of road-building materials. Information on this is included in Chapter 9 and in the appropriate block descriptions.

Gas

The Gas and Fuel Corporation is planning to construct a gas pipeline from Melbourne to Wodonga. It is hoped that planning will be completed to allow construction to commence in September 1975, and the line should be completed by the end of April 1976.

The route of the pipeline will roughly follow the Hume Highway; the section through the study districts is shown on the public utilities map. The principal portion of public land involved is at Chiltern forest, where the line will be close to the present S.E.C. transmission line easement (66-kV wood pole line).

TABLE 20

ADDITIONAL EASEMENT REQUIREMENTS

Section	Requirment
Dederang terminal station to Myrtleford	29-metre easement on the south-east side of the existing one
South-west of Cheshunt to Tolmie	20-metre easement on the north-west side of the existing one

Military

Various public and private institutions have extensive public land requirements in the study districts. Among these, the Australian Army and Australian Army Reserve use areas of public land for field training purposes to supplement operations on land owned by the Commonwealth.

Proclaimed Military Training Areas occupy forested areas east of Beechworth and in the Pilot range (as shown on the public utilities map). The use of all public land for military operations requires prior approval from the responsible managing authorities.

The regular army, the A.A.R., and school cadets use training areas intermittently throughout the year, principally for communication services, orienteering, engineering, and general manoeuvers. Normally these activities involve small numbers of men and are frequently arranged for week-ends and holiday periods.

P.M.G.

The Postmaster General's Department has small areas of land in elevated positions for telecommunication equipment. Notable sites are on the Baranduda range, at Tower Hill near Myrtleford, and on Mount Stanley and Mount Big Ben. Although there are no immediate plans for further installations of this kind, new equipment will probably be added in the future as the need arises.

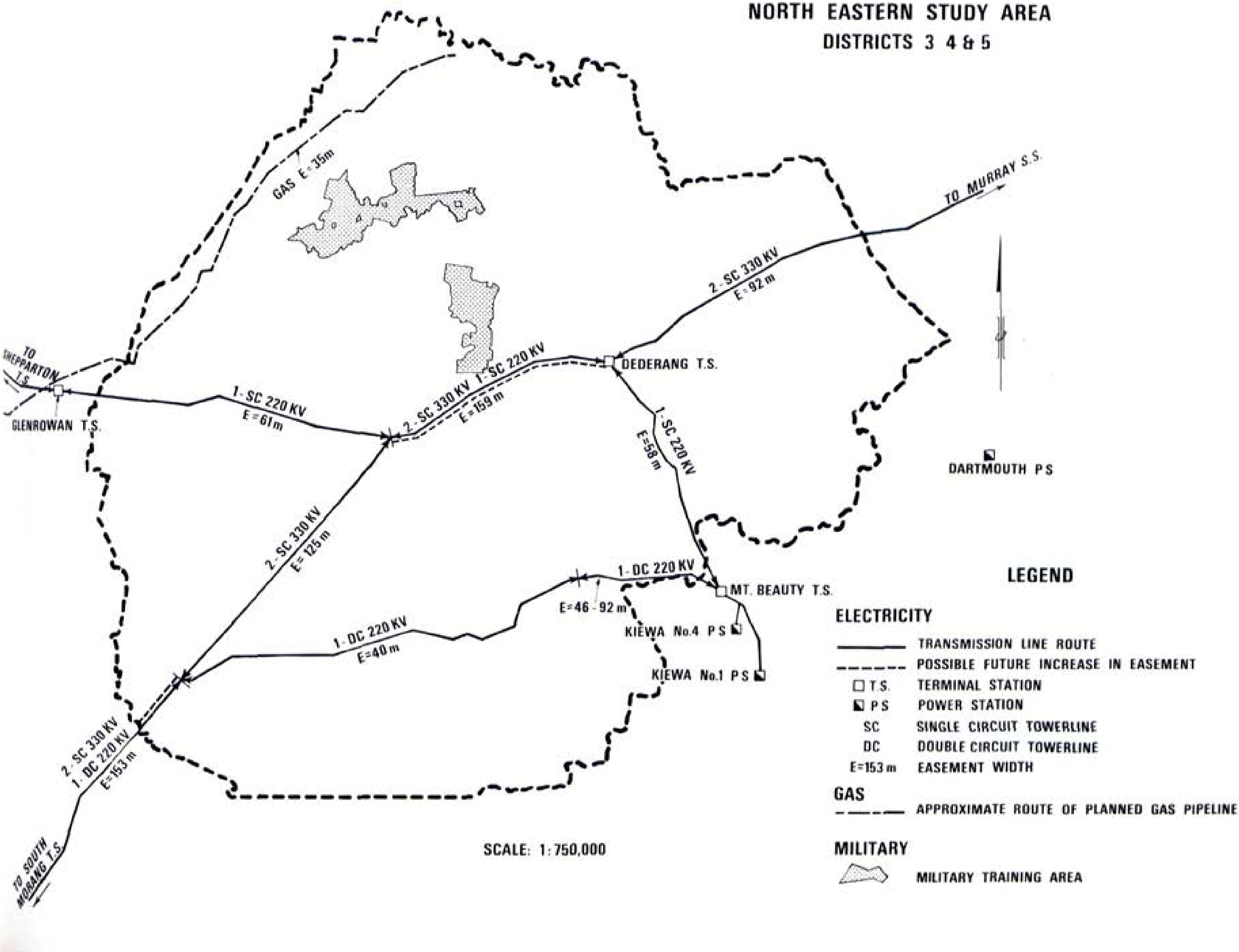
Other services

Apart from the above, many other institutional uses require small areas of public land. These include schools, cemetries, navigational beacons, and trigometric stations.

The single-circuit 330-kV transmission lines near Cheshunt

PUBLIC UTILITIES

LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5



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.

Block boundaries are shown on the map titled Public Land and Descriptive Blocks, in the back pocket of this report.

Capability

This term refers to the suitability of public land for various uses. Assessment is based on a number of considerations, including the inherent characteristics of the land, the proximity of public land to centres of population, the level of accessibility within it, the relative scarcity of the type of land, and the hazards associated with the various uses.

In most cases, this report deals with capabilities in general terms, because the amount of information available varies from block to block, and because some of the values are difficult to quantify. In assessing capability, comparisons have been made with other blocks and with other parts of Victoria.

INDIGO

General

Area and present tenure

Public land covers 4,150 ha (7% of the total area), with 94% of it in the Chiltern forest. This forest and small areas on the Murray River are reserved forest. The remaining land is unreserved Crown Land.

General description

The Murray River lies to the north, separated from the hilly southern country by wide plains that narrow eastwards. The plains are predominantly agricultural - grazing and cereal cropping. The hills in the south-east are mainly cleared and grazed while the hills in the south-west around Chiltern contain public land that supports a low open forest of box and ironbark.

Present use

The Chiltern forest is used for apiculture and hardwood logging on a limited scale. The recreational pursuits include driving for pleasure, picnicking, and nature study. A quarry site exists at Skeleton Hill.

Nature of the Land

Climate

Average annual rainfall in most of the area ranges between 625 and 750 mm. It is highest at Upper Indigo (875 mm) and decreases to the north-west; the northern side of Chiltern forest receives just below 625 mm.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
19.0	23.0	32.5	25.5

The frost-free period averages about 180 days, increasing to the north. It reaches 240 days at Albury.

Geology and physiography

In the north, the Murray River floodplain and Browns Plain form the beginning of the Riverina. The hills at Chiltern are the northernmost portion of the central physiographic region of Ordovician sedimentary rocks and granite. The hilly country in the centre of the block is part of the eastern physiographic region of metamorphic rocks.

Indigo Creek follows the fault that separates the Ordovician sedimentary rocks from the metamorphic rocks. Likewise, Middle Creek on the eastern border of the block follows a fault that separates two areas of metamorphic rock.

Soil

Reddish duplex soils occur on the slopes. Pale massive and weakly bleached gradational soils are found on steep slopes, and yellow duplex soils in depressions.

Yellowish brown gradational soils and brown loams occur in the Murray flood-plain.

Land systems

The hilly country is included in the Chiltern and Leneva land systems. The Kiewa--Tangambalanga land system describes the Murray flood-plain, while the majority of the remaining country is included in the Dederang--Bonegilla system. A small area west of Chiltern is included in the Myrtleford land system.

Vegetation

Open forest I and II of red ironbark occupies most of the Chiltern forest. Some common species are listed in Appendix 4a. The forest is an important area for orchids. On the flatter ground, principally in the north, areas of grey box open forest II border farming land.

Red ironbark with Blakely's red gum in the foreground, Chiltern forest

Tiger snakes are common near the Murray River

The south of Chiltern forest and the soils derived from metamorphic rocks near Barnawartha and Barnawartha South support open forest II of long-leaf box. The Murray River flood-plain in the north has areas of river red gum. The ground flora include many exotic species of grasses and herbs, and willows are common on the banks of the streams.

Fauna

The animals that occur in the habitats of this block are described in Chapter 10 and listed in Appendix 5.

The principal habitat on public land is the dry open forest and woodland of Chiltern forest. The flood-plain woodland of the Murray River lies in the north of the block, and the remaining land is agricultural.

The aquatic habitat is mainly associated with the slow-flowing warm turbid waters of the Murray River system, although there are other areas of water - notably small creeks (including Indigo, House, and Huon Creeks and farm dams and ponds).

The best-represented bird families in the Chiltern forest are the honeyeaters, parrots and cockatoos, and the Australian warblers. The rare grey goshawk and turquoise parrot have been recorded in this forest, and the latter species breeds there. The Murray River is very important for waterbirds. Squirrel gliders - possibly the rarest possum species in Victoria - have been recorded in the Chiltern forest. Reptiles are common in the block.

The marbled gecko, tiger snake, and red-bellied black snake are abundant in the flood-plain, the three-toed, garden, golden water, and White's skinks are common in Chiltern forest, and the tree dragon, Boulenger's skink, and brown snake are abundant in both areas. The broad-shelled tortoise is the rarest of the three tortoise species in the area and is restricted to the Murray River.

Capabilities

Nature conservation

The Chiltern forest has high value for nature conservation. The red ironbark and grey box forests are remnants of once more extensive forest types. Other examples occur in the north central part of Victoria, but the Chiltern forest is the only occurrence in these study districts. The area is also noted for its orchids.

The forest is surrounded by agricultural land and lies at the junction of the dry habitats of the interior and the wetter mountainous country. Consequently, it supports a mixture of animals species, some being typical of each of these regions.

The public land bordering the Murray River is significant for nature conservation and is especially important for its contribution to the quality of the aquatic habitat.

Recreation

Capabilities for recreation in this block are high and its location - close to Albury--Wodonga and traversed by several major highways - greatly increases its significance for recreation.

The Chiltern forest, being relatively flat terrain with an extensive network of roads, provides opportunities for many forms of recreation (mainly passive, such as picnicking). The wildflowers and birds add to the forest's attractiveness. The area has the capacity to support considerable recreation pressure, especially if actively managed to preserve the vegetation and soils.

The Murray River borders the study area and is important for fishing and aquatic

Leopard orchid - Chiltern forest

sports. The region's capacity for passive recreation depends largely on its high scenic value. Billabongs and riverine vegetation make important contributions to this value - as well as being faunal habitats - and their maintenance or improvement would contribute to the area's attractiveness. However, there is little public land along the Murray.

Agriculture

The main enterprises are cereal cropping, fat lamb production, beef cattle, and dairying. Potatoes and other vegetables are grown around Barnawartha North and Wodonga.

Production in the agricultural areas could be increased by a more widespread use of improved pasture species, and greater use of irrigation along the Murray River for pasture and intensive cropping enterprises. The public land has low capabilities for agriculture.

The Chiltern forest is an important area for apiculture. The flatter portions of the forest have capabilities (after clearing) for grazing, but productivity would be low.

Softwoods

The small experimental plots within the Chiltern forest have shown the area to be generally unsuitable for softwood production.

Hardwoods

Capabilities in the forested areas are generally low to moderate. The forests produce durable timber, but production is low because they occupy only small areas. The Chiltern sawmill depends on the Chiltern forest for supplies. There is little natural regeneration of river red gum in the Murray River flood-plain.

Water

Although the area includes portions of several stream catchments and all the catchments for the House and Huon Creeks, the low rainfall and the low hilly terrain give the block moderate to low capabilities for water catchment purposes. Aquifers exist in the Recent sediments as shallow surface and deep meandering layers. Their capabilities for water production are not known. The public land bordering the streams has some importance in helping to maintain water quality.

Minerals

Capabilities for the production of metallic minerals are probably low. Part of the Chiltern gold- and tin-field falls within this block. The alluvial and reef deposits were incompletely worked during the last century. Gold has also been found in the vicinity of House Creek. Small amounts of tungsten have been found in the Barnawartha district. Kaolinitic clays occur at

Chiltern and are used for the manufacture of bricks. Felspar deposits are located near Wodonga and Barnawartha.

The area contains large quantities of road-making materials, including river gravel and sand along the river flats (notably the Murray) and mine tailings near Chiltern. Metamorphic rocks (hornfelds) occur at Skeleton Hill and near Barnawartha.

Public utilities

The proposed route of the Gas and Fuel Corporation gas pipeline passes through part of the Chiltern forest on the southern side of the State Electricity Commission's 66-kV line easement located to the north-east of Chiltern township.

Hazards and Conflicts

Recreation can conflict with nature conservation, especially activities that create noise or damage soil and vegetation. Chiltern forest is vulnerable because of its proximity to settlement and its good access. Excessive use of the forest can reduce the value of the area for recreation. Access to stream frontages can conflict with the interests of property-owners.

Nature conservation in this area is generally compatible with many other uses at low intensity, but conflicts with some aspects of flood mitigation.

Communication facilities, such as roads, pipelines, and transmission lines, are inflexible uses of land that conflict with most other uses.

Mining operations normally conflict with other activities within the immediate area, except where river pollution or siltation occurs. However, mining activities may reduce the scenic qualities of the landscape.

Hardwood timber production at low levels is compatible with most uses. Removal of over-mature trees reduces the number of nesting sites for animals.

Fire is a constant hazard during the summer. The danger could increase with increased use of the forests for recreation. The Murray River floods regularly.

Significance

The public land in this block has significance for recreation, nature conservation, and durable timber.

KIEWA

General

Area and present tenure

Public land covers 36,305 ha (33% of the total area). Most of the Baranduda Range and Mount Big Ben is reserved forest. The southern part of the eastern parcel of land is also reserved forest. Most of the remaining public land is unreserved Crown Land.

General description

The three main parcels of public land lie on the ranges that run north--south and are separated by predominantly agricultural valleys. The main streams flow northwards. The forest types change from long-leaf box in the north, through peppermint forest, to alpine ash and snow gum at the higher altitudes on Mount Big Ben.

Present use

The western hills are used extensively for honey production, but apiculture decreases in importance eastwards. Small areas of the forests are grazed.

Hardwoods are logged in the wetter forests, mainly on Mount Big Ben. The summits of Mount Big Ben and the Baranduda Range provide telecommunication sites. A transmission line traverses the eastern parcel of public land. Recreational pursuits include driving for pleasure, picnicking, bush-walking, and nature study.

Nature of the Land

Climate

In this block, topography greatly influences rainfall. The annual average increases from 750 mm in the north to 1,000 mm in the south. Rainfall on the hills is higher, probably exceeding 1,250 mm on Mount Big Ben.

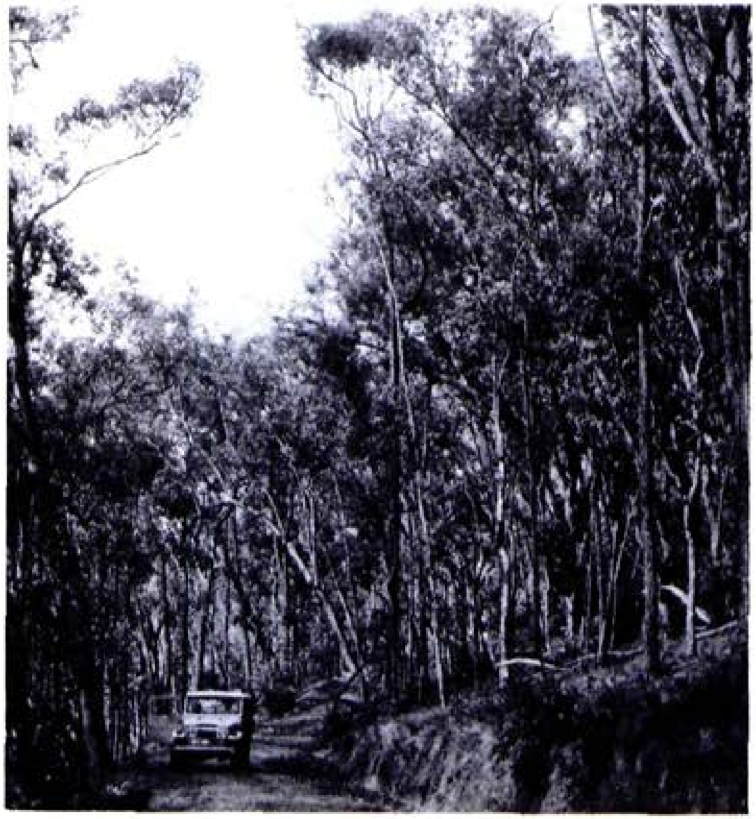
Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
17.0	22.5	35.0	25.5

The frost-free period decreases from about 200 days in the north to about 130 days in the south.

Geology and physiography

The block falls mainly within the east-



Long-leaf box forest - Mount Big Ben

ern physiographic region of metamorphic and granitic rock. Movements of faults within the area have contributed to the valley and range topography. The Baranduda Range has been uplifted relative to the surrounding country and is separated from the Mount Big Ben area by the wide and hilly Yackandandah Valley. This valley has developed on Silurian granite, which is exposed in some of the creekbeds.

The metamorphic rocks in the Mount Big Ben area are complex and much altered by faulting. Schists and gneisses are exposed in rock outcrops, often at small waterfalls and cascades in creeks. The Kiewa Valley is bordered by fault lines and, in the eastern portion of the block, Sandy, Lockharts, and Little Scrubby Creeks follow faults. In the north, an area of plains includes parts of the Kiewa and Murray River flood-plains.

Soils

The soils in the flood-plains include undifferentiated sandy loams, brown loams, and yellowish brown gradational soils on alluvium. Reddish and yellow duplex soils occur on fans and terraces. Lower hill slopes, especially in the north, have weakly bleached gradational soils. The higher mountainous areas have friable brownish and reddish gradational soils and some stony loams.

Land systems

The hilly country north of Lockharts Gap is included in the Bunjil land system. Other hilly country lies in the Tawonga--Baranduda and Tawonga--Wermatong land systems. The Big Ben land system includes the flat hilltops on Mount Big Ben and on the Baranduda Range. The valley to the south and west of Mount Big Ben is mapped within the Yackandandah land system. The land abutting Lake Hume and the Mitta Mitta Valley forms part of the Murray land system. The

Red-stem wattle, Mount Big Ben

Kiewa flood-plain lies in the Kiewa--Tangambalanga system while the remaining valley is included in the Dederang--Bonegilla system. Sandy Creek lies in the Berrinyama--Wagra land system.

Vegetation

The common forest types are narrow-leaf and broad-leaf peppermint. Typically, the narrow-leaf peppermint open forest III occurs in the wetter gullies, while broad-leaf peppermint open forest II occupies drier slopes. In addition, the drier sites (usually in the north-west of the block) carry extensive areas of long-leaf box open forest II or I. Near the summit of Mount Big Ben, narrow-leaf peppermint forest gives way to alpine ash open forest IV, with candlebark--snow gum open forest II at the summit. These forests carry a very wide variety of plant species. Appendix 4A lists the commonest species.

Fauna

The animals that occur in the habitats of this block are described in Chapter 10 and listed in Appendix 5.

The principal faunal habitats on public land are wet and dry open forests. The rest of the block is agricultural land and mainly carries pasture.

The Kiewa River is the main aquatic habitat, although the other small mountain streams add diversity. Lake Hume to the north has limited value for native fish, and the fluctuating water level precludes the development of a typical lake-side vegetation.

The eastern pigmy possum has been recorded in the Yackandandah area.

Capabilities

Nature conservation

The block has moderate to high capabilities for nature conservation. Many of the forest types in the study districts occur in it, resulting in a diverse flora. Some sections of the streams - chiefly in the south - remain in a relatively natural condition.

The Baranduda Range and Mount Big Ben are isolated by the surrounding agricultural land, and some faunal groups may not be able to survive permanently in these areas because of this spatial isolation. The public land to the east is more or less continuous with the larger blocks to the south.

There is considerable scope for improving the general knowledge of the status and interrelations of the flora and fauna in the forests of the block.

Recreation

The position of this block relative to Albury-Wodonga, its good roads, and the diverse and attractive nature of the valleys and forested hills, together with Lake Hume and streams, give it a high capability for recreation.

The hilly public land provides a forested environment with a wide range of vegetation types. Views from some points are extensive. The forests are used for bush-walking, picnicking, and driving for pleasure, and by four-wheel-drive enthusiasts; they also provide opportunities for nature study.

The streams and Lake Hume are used for fishing and to a limited extent for aquatic sports.

Access to the public land varies. The access to the telecommunication sites on the Baranduda Range and at Mount Big Ben is good. Forest tracks in the other areas generally follow the ridges, and some portions of these are unsuitable for two-wheel-drive vehicles.

Agriculture

Dairying and beef production are the most important enterprises on agricultural land and there is a potential for increased beef production through greater use of improved pasture species. Scope also exists for greater use of irrigation.

The public land has low capabilities for agriculture. Some parts of the forests are grazed, but stocking rates are low. Probably none of the public land is suitable for clearing for agriculture. Mount Big Ben and the Baranduda Range are important areas for apiculture.

Softwood

The public land is generally unsuitable for softwood production, principally because of the dryness, steep slopes, and small size of suitable areas.

However, some areas on Mount Big Ben are suitable.

Hardwood

The capability fór hardwood production in this block varies from low to moderate.

The alpine ash forest on Mount Big Ben is the most productive, although currently the area contains many over-mature and regrowth trees. Low-intensity saw-log production is possible from the remaining forests on Mount Big Ben, except for the drier forests towards the north and west, which are unproductive.

The forests in the more sheltered localities of the Baranduda Range (mainly narrow-leaf peppermint) have a capability for low-intensity hardwood production, but the steep terrain makes access difficult.

The remaining public land has a capability for low-intensity hardwood production, principally within the peppermint forests.

Water

The block includes part of the Kiewa catchment area and part of the proclaimed catchment of Lake Hume.

Moderate rainfall and hilly terrain give the block moderate capabilities for water production. Water quality is generally good, with only occasional high turbidity readings.

Minerals

Parts of the Yackandandah (alluvial) and Mitta Mitta (reef and alluvial) gold- and tin-fields lie within the block. The richer deposits have been extensively mined and no major workings are current. Antimony has been found near Tallandoon,

Lake on dredged land, Allans Flat

and there are felspar deposits near Tallangatta.

Large quantities of road-making materials occur in this block. Deposits of river gravel and sands exist in the Yackandandah Creek valley and near Tangambalanga. Dredge tailings are utilized near Allans and Staghorn Flats. Pits for mica schist exist near Huon and south-east of Bonegilla.

Public utilities

Small sites on Mount Big Ben and the Baranduda Range are used for telecommunication purposes. A 93-metre easement from Gundowring to the Mitta Mitta Valley carries two single-circuit 330-kV electricity lines. A new easement to carry an additional line may be required in the future (possibly in the next decade).

Hazards and Conflicts

Generally recreation is a flexible land use, although it conflicts with the stricter forms of nature conservation and activities that reduce the scenic qualities of the landscape.

Nature conservation conflicts with some hardwood production practices. Mining is mainly for road-mking materials and could reduce the quality of the river environs.

Easements for transmission lines and telecommunication towers conflict with most other land uses and could reduce the scenic value of the area.

Low-intensity timber production is generally a flexible land use, but conflicts with some aspects of nature conservation. Poorly conducted controlled burning and burning off can increase soil erosion. Erosion is a greater hazard in the north of the block, where dry conditions can lead to poor vegetation cover in summer. The soils in the Yackandandah Valley that developed on granitic parent material are more liable to gully erosion than those on other materials.

Wildfire is a danger during the summer months. The eastern portion of the block is strategically important for fire control because of the extensive areas of forest immediately to the south.

Significance

The Baranduda Range has significance for recreation, for nature conservation, and for its telecommunication sites. Mount Big Ben is important for nature conservation, timber production, recreation, and telecommunication sites. The eastern parcel of public land has significance for recreation, nature conservation,fire protection, and water production.

BULLHEAD

General

Area and present tenure

Public land covers 20,010 ha (38% of the total area); most of it is unreserved Crown land.

General description

Much of the land in the north is alienated, cleared, and grazed. Elevation increases southwards to where the principal parcel of public land lies. This supports peppermint open forest. The rock outcrops at Bullhead and the Mitta Mitta River are notable features.

Present use

Hardwood logging occurs in the wetter forests and some areas are grazed. Recreation includes driving for pleasure and nature study. The streams provide fishing and the Mitta Mitta River is also used for canoeing.

Nature of the Land

Climate

Average annual rainfall increases from about 820 mm in the north to 1,015 mm at Callaghan's Creek in the south.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
17.4	21.6	33.0	28.0

Minimum winter temperatures are lower in the south, where the frost-free period is probably a little over 100 days.

Geology and physiography

The block falls within the eastern physiographic region of metamorphic and granitic rock. The northern section is principally granite and forms low hilly country. Surrounding this, a rim of metamorphic rocks reaches its highest point in the south and forms cliffs at Bullhead Creek. In the very south of the block, Ordovician sedimentary rocks outcrop. These rocks are mainly shale, sandstone, and mudstone.

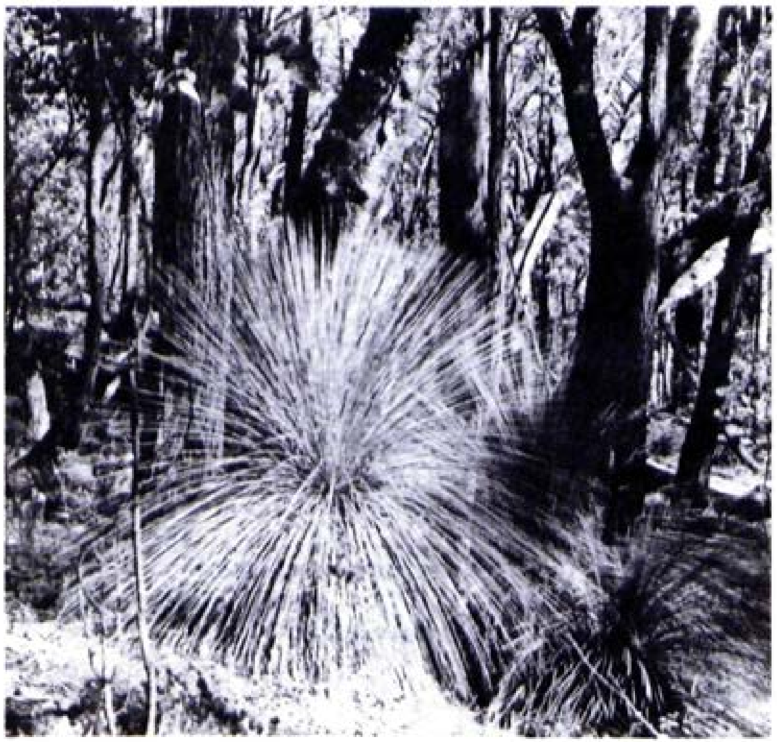
Soils

Valley soils include undifferentiated sandy loams and brown loams, and reddish duplex soils occur on fans and terraces.

Weakly bleached gradational soils occupy the slopes, especially in the north, and grade into friable brownish gradational soils in the wetter localities. Friable brownish and reddish gradational soils occur in the more mountainous country.

Land systems

The river valleys form part of the Murray land system. The northern hills lie in the Bunjil and Berringama--Wagra systems. The rest of the hills (the majority) are included in the Tawonga--Baranduda or Tawonga--Wermatong systems.



Austral grass-trees in long-leaf box forest near Honeysuckle Creek

Vegetation

The principal forest types are narrow- and broad-leaf peppermint; narrow-leaf peppermint tends to grow most extensively in the south on the sedimentary rocks. The small areas of public land in the north mainly carry long-leaf box open forest I and II, which also occurs on the steep drier parts of the metamorphic rock that surround the granite.

Fauna

The animals found in the habitats that occur in this block are discussed in Chapter 10 and listed in Appendix 5.

The main faunal habitats on public land are wet and dry open forests. Although some of the alienated land is still forested, most of it is under pasture.

The Mitta Mitta River (the main aquatic habitat) contains the rare trout cod. The flood-plain is an important wetland area for aquatic birds, especially north of Tallandoon.

Capabilities

Nature conservation

The capability for nature conservation is moderate to high. The area has some interesting geological formations, notably the cliffs at Bullhead.

The forest types - peppermint and long-leaf box - are typical for the hilly country and are common throughout the study districts. They probably support the normal flora and fauna for the habitats, although their nature, distribution, and abundance are not known in detail.

The rocky outcrops are important for reptiles. Some sections of the streams, usually at high elevation, are relatively undisturbed while other areas, mainly the Mitta Mitta, are important as waterfowl habitats.

Recreation

The capabilities of the public land for recreation are moderate, since it mainly lies in the south of the block away from the main population centres and does not have outstanding features to attract people. Moreover, the Omeo Highway is not a major tourist route.

Tourism and recreation are likely to increase in this area with the completion of the Dartmouth Dam and alterations to roads (including the Omeo Highway), and as the population of Albury--Wodonga increases.

The land provides recreational opportunities such as bush-walking and nature study within varied forest environments.

Striped marsh frog

Access - by forest tracks - is generally unsuitable for two-wheel-drive vehicles.

The Mitta Mitta Valley is an attractive area and popular for passive recreation such as driving for pleasure. The river supports canoeing and fishing. Below Tallandoon, the river and associated wetlands are important for ducks.

Agriculture

The agricultural land in the valleys is intensively used for dairying and beef production but productivity on the hilly country could be improved by better stock management and increased use of improved pasture species.

Mitta Mitta Valley, with the forested area of the block in the background

The public land has low to moderate capabilities for agriculture. Forest near Callaghans Creek is grazed and could be used more intensively. Isolated pockets of flat land have some capabilities, after clearing, for grazing.

The area is not of major importance for apiculture.

Softwood

Small areas in the south have capabilities for growing pines, but generally dryness, steep terrain, and isolation make this block unsuitable for pine plantations.

Hardwood

Capability for hardwood production is low. Narrow-leaf peppermint is the principal species logged. Many southern slopes and gullies have stands of this forest type that are capable of low-intensity production, although the steep terrain makes access difficult.

Water

Capabilities for water production are moderate. The southern mountainous areas contribute significantly to the flow of the Mitta Mitta River, while east-flowing streams drain into Tallangatta Creek. The area forms part of the proclaimed catchment of Lake Hume.

Minerals

A small part of the Mitta Mitta gold- and tin-field lies in the block. The lode part of the field has been inadequately prospected and deep leads in the Mitta Mitta Valley containing cassiterite and tantalite have not been worked. River gravels occur within this valley and are extracted downstream from Mitta Mitta. Smaller deposits of river gravels exist in the northern section of Tallangatta Creek.

Public utilities

The proposed transmission line linking the power station at Dartmouth with the rest of the system may require some easement in the south-east of this block.

Hazards and Conflicts

Non-intensive hardwood timber production is a flexible land use, although it can conflict with some aspects of nature conservation.

Clearing of native forest for agriculture conflicts with nature conservation, changes water yield, and can increase the turbidity of the streams.

Soil erosion is a significant hazard on the steeper slopes, especially on the pale massive gradational soils of the granitic areas. Sheet erosion occurs on sloping ground after loss of ground cover.

The flow regime of the Mitta Mitta River is likely to be altered with the completion of the Dartmouth Dam.

This change could have a detrimental effect on the nature conservation values of the river, notably the native fish, fauna, and riparian environs.

Significance

The block is significant for nature conservation, water production and recreation.

DORCHAP

General

Area and present tenure

Public land covers 39,375 ha (81% of the total area). The north-eastern portion is unreserved Crown land and the remainder is reserved forest.

General description

Most of this hilly to mountainous block is public land that supports mainly peppermint open forest. Long-leaf box forest occurs at low elevations in the north, and alpine ash occurs at Mount Emu.

The valley floors are alienated - mainly cleared and carrying pasture. Some crops are grown in the Kiewa Valley. Mount Bogong lies immediately to the south of the block.

Present use

The eastern portion is used for forest grazing and apiculture. The wetter forests provide some hardwood logging, although the alpine ash stands are generally immature. Recreational activities include driving for pleasure, four-wheel-drive touring, bush-walking, and nature study. The streams provide fishing.

Nature of the Land

Climate

The average annual rainfall increases towards the south; it is highest on the Mount Emu--Mount Tawonga ridge, where it probably exceeds 1,500 mm. At Mitta Mitta and Little Snowy Creek weather stations it is 1,025 mm.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
17.0	22.5	34.5	26.0

Little information is available on temperature. The frost-free period for most of the area is likely to be less than 100 days.

Geology and physiography

The block lies in the eastern physiographic region of metamorphic rock, most of which is schist. Ordovician sedimentary rocks occur on the eastern side of this block towards Mitta Mitta township and Rodda and Lords Creeks. Scrubby and Little Snowy Creeks follow probable fault lines. A prominent ridge runs from Mount Emu northwards through Mount Tawonga. The ground slopes up gradually from the Mitta Mitta River to this ridge, but steeply down to the Kiewa Valley on the western side.

Soils

The valleys contain undifferentiated sandy loams, yellowish brown gradational soils on alluvium, brown loams, some red duplex soils on the higher river terraces and fans, and weakly bleached gradational soils on the lower slopes.

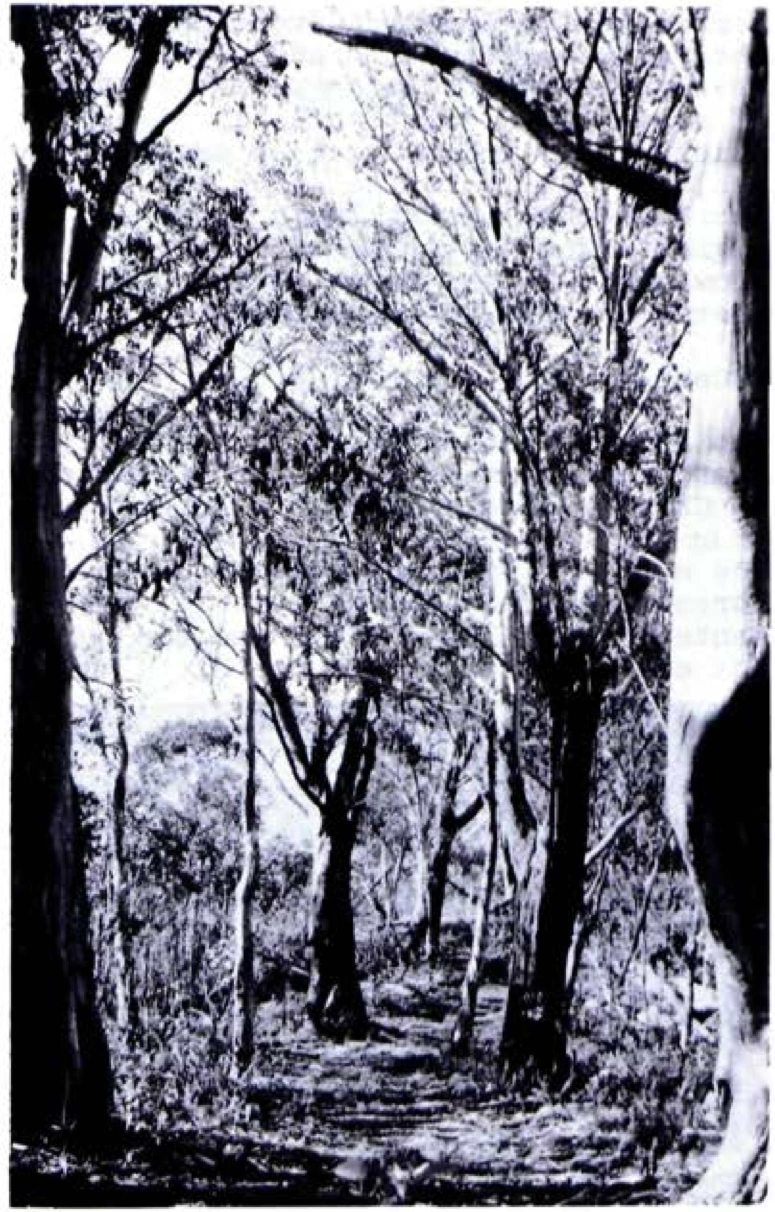
Friable reddish and brownish gradational soils occur on the mountainous country, with shallow organic loams on the higher parts of the mountains.

Land systems

The river valleys lie in the Murray and Dederang--Mullindolingong land systems. Most of the mountainous area is included in the Tawonga--Wermatong system except for small areas in the north and south, which are included in the Tawonga--Baranduda and Tawonga--Darbalang systems respectively.

Vegetation

In most of the area the forest types are narrow- and broad-leaf peppermint. The



Candlebark near the summit of Mount Emu narrow-leaf peppermint predominates in the moister areas. In addition, the creek valleys often carry narrow strips of swamp gum. Moist soils at high elevations carry substantial areas of alpine ash, especially in the south and along the Mount Emu--Mount Tawonga ridge. The highest land has areas of candlebark and snow gum. In the north at low elevation there are areas of long-leaf box forest.

Fauna

The animal species found in the habitats that occur in this block are discussed in Chapter 10 and listed in Appendix 5.

The main habitats are wet and dry open forest. The aquatic habitat is represented by the Kiewa River and the numerous creeks flowing into the Mitta Mitta River, especially Lord, Scrubby, and Little Snowy Creeks. The small areas of agricultural land lie in the river valleys and are mainly under pasture.

Swainson's antechinus

Capabilities

Nature conservation

The capabilities for nature conservation in this block are high. The area is continuous with the very large areas of public land to the south. It contains a wide range of forest and habitat types, and parts are relatively isolated and undisturbed. Some sections of the streams (chiefly the headwaters) remain relatively undisturbed. The flora and fauna are probably typical for these forests, although they are not known in detail.

Recreation.

The extensive and varied forest environment, mountainous terrain, adequate track access, and location give this block high capabilities for recreation.

The block is bordered by two main roads, the Omeo and Kiewa Valley Highways. Two tracks linking these roads pass through the block; the principal one crosses the range at Trappers Gap and is suitable for two-wheel-drive vehicles in summer, but most of the other tracks are normally only suitable for four-wheel-drive vehicles. Some parts are relatively isolated.

Oven's wattle

The wide range of forest types helps to make this area interesting for nature study, bush-walking, and four-wheel-drive touring. The streams provide good fishing, and Snowy Creek is used, after heavy rains, for canoeing. The block has historical associations with the gold- and tin-mining era.

The location of Mount Bogong immediately to the south increases the importance of maintaining the landscape of this block in a natural state and increases its value for recreation.

Agriculture

Agricultural land in this block is confined to narrow strips along the Kiewa and Mitta Mitta River valleys and is used for dairying, beef production, and some tobacco. Production could be increased by higher stocking rates and improved pasture management.

The public land has low capabilities for agriculture, but most of the block is generally steep and inaccessible and has no agricultural potential.

Softwoods

The south-eastern portion has the highest potential within the block for growing pines, but generally the capabilities for pine plantations are low because of isolation.

Hardwood

The capability for hardwood production is moderate to low. The block is logged in conjunction with the forests to the south of the study districts. The areas of alpine ash are the most productive forests in the block and have capabilities for intensive hardwood production, although the total area is not great and the steep terrain makes access to some parts difficult. Narrow-leaf peppermint and, to a lesser extent, broad-leaf peppermint forests have capabilities for low-intensity production. The long-leaf box forests in the north of the block and on dry spurs are unproductive.

Water

Capabilities for water production are moderate to high. The land to the east of the Mount Yorke--Mount Tawonga divide forms part of the proclaimed catchment for Lake Hume. The creeks to the west of this divide drain into the Kiewa River.

Minerals

Part of the Mitta Mitta gold- and tin-field lies in this block. Both alluvial and reef minerals were mined. The Kiewa Valley forms part of the Tawonga goldfield, where small amounts of copper were found in the gold-bearing ore.

River gravels occur in the Kiewa Valley and are mined near Dederang and Tawonga, where large reserves exist.

Public utilities

The transmission line linking the Dartmouth Dam power station with the rest of the transmission system may require an easement in this block.

Conflicts and Hazards

Hardwood timber production is compatible with most land uses, although it conflicts with some aspects of nature conservation.

Easements for transmission lines would conflict with most land uses, especially nature conservation, and could reduce the natural quality of this and adjoining areas for recreation. Clearing native forest for agriculture would conflict with nature conservation and water production and, if the land is too steep, could result in increased erosion and stream siltation.

Wildfire is a constant hazard in the summer months. Fires in this area may spread southwards onto the Dividing Range. Blackberries are a problem on stream frontages on the lower land.

Significance

The block has significance for recreation, nature conservation, water production, and non-intensive hardwood timber production.

POREPUNKAH

General

Area and present tenure

Public land covers 40,330 ha (62% of the total area). Most of it is reserved forest. Mount Porepunkah, the land south to the Ovens Valley and northwards to Kancoona, and an area to the east and south of Mudgeegoonga are unreserved Crown Land.

General description

The two major parcels of public land, Mount Porepunkah in the south and Mount Jack in the north, are linked by a narrow ridge at Kancoona. The valleys are cleared and mainly sown to pasture, although crops (including tobacco) are grown in the Ovens Valley.

The forests on public land vary from long-leaf box at low elevation (mainly in the north) and peppermint forest at intermediate altitudes to small areas of alpine ash at high localities. Rock outcrops at the Pinnacles are a feature in the northern parcel of public land. Softwood plantations are sited in the southern parcel.

Present use

The forests are used for grazing and apiculture, and some hardwood logging occurs.

Recreational activities include driving for pleasure, picnicking, walking, and nature study. The area has associations with the gold-rush period. Granitic sand pits are located in the northern parcel of land.

Nature of the Land

Climate

Annual rainfall increases from just over 1,000 mm in the north-west to more than 1,250 mm near the Tawonga gap in the south-east.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
15.8	23.1	34.6	26.5

The average frost-free period in the valleys probably varies between 110 and 130 days.

Geology and physiography

The western part of this block lies in the central physiographic region of sedimentary and granitic rocks. The rest is in the eastern physiographic region of metamorphic rock.

Ordovician rocks occur along German Creek and form the high ground in the south-west of the block, including Mount Porepunkah and the ridge that separates Happy Valley from the Ovens River. These sedimentary rocks are separated from the metamorphic rocks to the north by a major fault running north-west--south-east.

Schists predominate in the metamorphic rocks that have been subjected to considerable faulting. The main valleys have developed in the lines of these faults. Running Creek, for example, follows two: the upper reaches of the

Looking northwards from Mount Porepunkah across Havilah Valley to Mount Jack and the Pinnacles stream flow north-west, while the lower reaches follow the second fault and flow north-east. The metamorphic rocks that form the high ridge between Running Creek and the Kiewa Valley are exposed in road cuttings at Tawonga Gap near Mount Beauty.

The north-west contains a large area of Silurian granite, of which the most spectacular outcrop is at the Pinnacles. The granite has been eroded considerably and several wide valleys have formed within it. Differential erosion has left the more-resistant metamorphic aureole as a crescent-shaped range of hills. This feature is most noticeable on the southern side of the asymmetrical Happy Valley.

Soils

The valleys carry undifferentiated sandy loams, brown loams, and yellowish brown gradational soils on alluvium. Red duplex soils occur on the fans, terraces, and lower, less-steep slopes. Weakly bleached gradational soils on the hilly country grade into friable brownish soils in areas of higher rainfall. Friable brownish and reddish gradational soils occupy the more mountainous areas. The steep slopes in granitic areas carry pale massive gradational soils.

Land systems

The valleys are included in the Ovens, Dederang, and Yackandandah land systems. The mountainous south-east forms part of the Tawonga--Wermatong system, while the granitic hills to the north and west of the Pinnacles are included in the Pinnacles land system.

Vegetation

The bulk of the block supports narrow-leaf and broad-leaf peppermint forests. The narrow-leaf peppermint forests grow in the moister localities, often with candlebark as an associated species. St. John's blue gum occurs on the wetter southerly aspects. Broad-leaf peppermint is found on the drier aspects and ridges. Alpine ash stands occur at high elevation, with the largest areas north of the Pinnacles. Small areas of snow gum occur near the summit of Mount Porepunkah.

Long-leaf box and broad-leaf peppermint predominate in the western part of the block at low elevations, especially on the Silurian granite. Boggy ground at high elevations carries areas of swamp gum, notably at German Creek.

Fauna

The animal species found in the habitats that occur in this block are discussed in Chapter 10 and listed in Appendix 5.

The main animal habitats on public land are wet and dry open forest. The Happy Valley and Running Creeks are the main aquatic habitat. Most of the agricultural habitat is pasture, although some irrigated crops are grown, especially in the Ovens Valley. The pine plantations in the south of the block provide an additional fauna habitat.

Capabilities

Nature conservation

This block has moderate to high capabilities for nature conservation. The granite outcrops at the Pinnacles, the asymmetrical form of Happy Valley, and the fault lines east of the Pinnacles are interesting features. The area supports a wide range of forest types and habitats. Mount Jack and the areas in the headwaters of Running Creek are fairly inaccessible and parts remain relatively undisturbed. Introduced species - mainly blackberries - are common on most stream frontages. The flora and fauna are probably typical for these forests and habitats, although they are not known in detail.

Recreation

The rugged and varied terrain, locality, and good track access give this area a high capability for recreation. Bright - a popular tourist resort - is located just south of the block.

The public land is surrounded by important highways, including the Kiewa Valley and Ovens Highways, and is traversed by the Happy Valley road. Track access in the south-west (south and west of Running Creek) is good and generally suitable for two-wheel-drive vehicles. Access to the northern parcel of land is difficult.

The land carries a wide range of forest types, including small areas of snow gum. There are several conifer plantations in the Ovens and Happy Valleys. The area is mountainous with several look-out points, notably at Mount Porepunkah and at Tawonga Gap. Impressive granitic cliffs occur at the Pinnacles, and granite outcrops are common in the western section of the northern parcel of public land.

The region provides good opportunities for nature study, picnicking, driving for pleasure, and other passive forms of recreation. It also has strong historic associations, principally with the gold-mining period.

Agriculture

Productivity on the agricultural land could be increased by improving pastures for dairying and beef cattle production, and by growing more tobacco and other intensive crops, but no extra water is available for irrigation unless provision is made for the storage of winter flows.

The public land has low capability for agriculture. Forest grazing is practised in the southern parcel, but only limited areas have potential, after clearing, for grazing. The forests are important for apiculture.

Softwood

Because of the peppermint forest and moderate slopes, the eastern side of Mount Jack (House Creek area) and Mount Porepunkah (Running Creek area) have capabilities for softwood plantations, as have the remaining areas on the souther slopes of Happy Valley near Havilah.

Hardwood

The capability of this block for hardwood production varies from low to moderate.

It contains small areas of alpine ash forests on Mount Jack and on the ridges between Running Creek and the Kiewa River and Running Creek and German Creek. Although these stands are small and currently understocked with timber, and in some cases support young regrowth, they have the highest potential for hardwood production in the block.

Most of the remaining forest is narrow-leaf and broad-leaf peppermint and - where access is not too restricted by topography - has capabilities for low-intensity hardwood production. Forests on very steep ground and on drier areas to the north and west are generally unproductive.

Hop bitter-pea

Water

The area forms part of the catchment for the Kiewa and Ovens Rivers and has moderate capabilities for water production.

Minerals

Reef mining for gold has occured in the southern mountainous areas, and alluvial mining has been extensively conducted in the Ovens and Happy Valleys.

Deposits of river gravels exist along the Ovens River and are quarried near Eurobin and Porepunkah. Deposits of granite sands are worked on the northern side of the Happy Valley and near Mudgeegonga.

Public utilities

Small areas of land are used in the northern and southern corners of the block for transmission line easements.

Conflicts and Hazards

Pine plantations, being among the more inflexible types of land use, conflict with many other uses, especially with nature conservation. Leaving strips of native vegetation in watercourses within plantations assists nature conservation and also helps to prevent siltation of streams. Clearing of catchments increases run-off. Roading within the plantations can concentrate run-off, exacerbating peak flow problems.

Although recreation is generally a flexible land use, it can conflict with some aspects of nature conservation, especially at high usage rates.

Low-intensity hardwood timber production is also a flexible use, but this can conflict with some aspects of nature conservation while poorly managed controlled burning can increase soil loss.

Granitic sand pits tend to reduce the aesthetics of the area for tourism and recreation as well as increase water turbidity. Exotic plant species, used during rehabilitation work can spread into the surrounding areas of native vegetation.

Fire is a hazard during summer months. Activities that involve increased travel within the bush increase this danger. Noxious weeds are a chronic problem in many parts of the block. Soil erosion is a widespread hazard, especially on steep slopes in the granitic areas from Happy Valley northwards.

Significance

The block has significance for nature conservation, recreation, pine plantations, and water production.

STANLEY

General

Area and present tenure

The public land occupies 25,300 ha (53% of the total area). Most of it is reserved forest. Two areas - one in the very north of the block, and the other just north of Myrtleford - are unreserved Crown Land.

General description

The hilly plateau around Stanley supports orchard and grazing enterprises and a large area of softwood plantation. The slopes surrounding the plateau and parts of the plateau itself (mainly in the south-west) carry native vegetation - long-leaf box forest on the drier slopes and peppermint forest elsewhere.

Present use

The native forest is used for apiculture and hardwood logging. The town water supplies for Beechworth and Yackandandah are obtained from the northern part of the block. A transmission line traverses the southern part, and part of the block is used for military training purposes.

Recreational activities include driving for pleasure, picnicking, and nature study. The extensive track system in the plantations provides opportunities for driving, walking, and orienteering. Historic relics associated with gold-mining days are a notable attraction.

Nature of the Land

Climate

The average annual rainfall increases towards the south and east and is influenced by altitude. Woorragee and Stanley average 785 and 1,234 mm respectively.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
18.3	23.7	32.0	26.0

The frost-free period is 148 days at Beechworth and 127 days at Myrtleford. On the high country around Stanley the period is probably shorter.

Geology and physiography

This block lies within the central physiographic region of sedimentary rocks and granites. The block is mainly Ordovician sediments of sandstone, mudstones, shales, and siltstones. Devonian granite outcrops at Mount Stanley and in the surrounding locality. The Kinchington Creek and Mudgeegonga Valley, to the east of Mount Stanley, has developed on Silurian granite. To the north, at Beechworth and Woorragee, Devonian granites outcrop again. In the south-west, granite occurs but is buried below the alluvium of the Murrmungee basin.

The granitic areas are surrounded by hard contact metamorphic rock (hornfelds).

The Stanley area forms a hilly plateau with a high ridge to the east (which includes Mount Stanley) and a less-pronounced ridge in the west. The Beechworth granites to the north-west are at a slightly lower elevation, but the rest of the surrounding country is much lower, often as much as 400 m lower than the Stanley plateau.

Stanley plateau from Mount Stanley

Soils

The Valleys (mainly Barwidgee Creek) contain small areas of yellowish brown gradational soils on alluvium, brown loams, and undifferentiated sandy loams. Yellow duplex soils occur on the lower slopes where the drainage is poor, weakly bleached gradational soils on the mid slopes, and red duplex and friable reddish gradational soils on upper slopes. Friable reddish and brownish gradational soils occur on hilly land and hard reddish gradational soils on the Stanley plateau. Pale massive gradational soils occur on the steep slopes near Mount Stanley.

Land systems

The valleys and basins are included in the Ovens, Dederang, and Yackanadandah land systems. The Stanley plateau lies in the Stanley land system and the area surrounding Mount Stanley in the Pinnacles land system. The hilly country to the south of the Stanley plateau is included in the Tawonga--Baranduda system and most of the hilly land north of it in the Twists Creek system. The area in the west (from the Stanley plateau to the Murmungee basin floor) forms parts of the Bowmans land system.

Vegetation

The vegetation of the Stanley plateau area and the higher country is mainly narrow-leaf and broad-leaf peppermint

Creamy stackhousia

forest. The narrow-leaf peppermint forest occurs in the moister situations and candlebark gum is often associated with it. Broad-leaf peppermint occurs on the drier aspects.

At lower elevations in the north, long-leaf box open forest II occurs in a strip along the boundary of the public land. More substantial areas of this forest type occur to the south and south-west of the Stanley plateau near Gapstead and Barwidgee Creeks.

Fauna

The species that occur in the habitats of this block are discussed in Chapter 10 and listed in Appendix 5.

The main animal habitats are wet and dry open forest and the substantial area of pine plantations.

The aquatic habitat is represented by a number of small creeks. Yackandandah Creek is one of the largest. The block also contains a number of small dams, of which Lake Kerferd is the largest. Trout cod are found in Lake Sambell.

The agricultural habitat contains a substantial area of orchard crops.

Capabilities

Nature conservation

This block has moderate to high capabilities for nature conservation.

The granite outcrop at Mount Stanley and the metamorphic aureole east of Murmungee are interesting geological features.

The native forests are mainly long-leaf box and peppermint. There are some particularly good examples of narrow-leaf peppermint forest on the Stanley plateau.

What is known of the flora and fauna suggests that they are probably typical of these forest types.

Recreation

The public land in this block has high values for recreation because of its location close to population centres that have strong tourist attractions, its good road access, and its variety of recreational environments and historical associations.

Access within the public land is generally suitable for two-wheel-drive vehicles, and driving for pleasure and picnicking are popular pursuits. The extensive softwood plantations provide a suitable environment for a number of active and passive recreational activities. Lake Kerferd and Fletcher Dam provide fishing and sites for picnicking. Mount Stanley is an outstanding look-out point.

Many relics from the gold-mining days - such as old workings, disused mines, and occasionally machinery - can still be seen in the bush, providing a link with the historical aspects of neighbouring towns (Beechworth, Yackandandah and Myrtleford). These add considerably to the attractions of the area for tourism.

Agriculture

Beef production is the main grazing enterprise and dairying occurs on land along creeks. Productivity could be increased by improving pastures and by better stock management. Some tobacco is grown on river flats near Myrtleford and there are apple and nut orchards around Stanley. Orchard yields could be improved by more intensive use of the land and better frost control.

Capabilities for agriculture on public land are moderate. Parts of the forest in the south are grazed, and most of the land that is suitable for pine plantations would also be suitable for pasture and possibly orchards.

The native forest area is important for apiculture.

Softwoods

The capability of the block for softwoods is high. The location of the existing Stanley plantation in the centre of the block increases the significance of the surrounding suitable land for pine plantations.

Where the slopes are not too steep, most of the peppermint forests have capabilities for softwood production. This includes areas near Twists Creek in the north, most of the remaining plateau, Circular Creek basin, and the valleys south of Mount Stanley (including Basin Creek). In addition, some of the east-facing slopes (north and east of Mount Stanley) have capabilities for softwood production.

Hardwood

Capabilities for hardwood production in this block are moderate. The narrow-leaf peppermint forest is the most suitable. This and red stringybark forest have yielded a moderate quantity of sawlogs annually over a long period of time. The drier forests of long-leaf box and broad-leaf peppermint are less productive.

Water

The area has moderate capabilities for water production. The northern part of the Stanley plateau forms part of the Yackandandah Creek catchment, while the southern and western areas drain into the Ovens River.

Burning in preparation for pine planting Stanley Plantation

Town water for Beechworth and Yackandandah is obtained from Lake Kerford on Silver Creek and Nine Mile Creek respectively.

Minerals

The block falls within the Stanley--Myrtleford gold-fields and has been extensively worked for reef and alluvial gold. Significant quantities of reef gold may still exist in the north.

Small quantities of bismuthite have been found south of Stanley. The deposits suitable for road-making materials in the block are not significant, but small quantities of hill gravel occur north of Gapstead and the metamorphic rocks (hornfelds) near Murmungee may be suitable for quarrying.

Public utilities

A small site on Mount Stanley is used for telecommunication purposes. In the south of the block, an easement 159 metres wide carries three transmission lines from Dederang. An additional 330-kV line may be required, necessitating widening this easement on the south-eastern side by 29 m. The Army uses the north of the block as a training area.

Conflicts and Hazards

Pine plantations conflict with many other uses of the land. Strips of native vegetation along streams within the plantations help nature conservation and maintenance of water quality. Planting pines on skylines gives them prominence in the landscape, and inappropriate location can reduce the natural scenic qualities of surrounding areas. Clearing large areas of native vegetation for pines can cause problems with soil erosion and water quality and yield. The use of extensive areas for pine plantations alters the type of outdoor recreational activities pursued.

Recreation is a relatively flexible land use, although it can conflict with some aspects of nature conservation and may increase the danger of fire.

Transmission line easements are an inflexible land use that can reduce the scenic value of the area. Roading on easements, especially on steep terrain, may increase peak water flows and stream turbidity.

Non-intensive timber production is compatible with many other uses although it can conflict with nature conservation. Soil erosion hazard is highest on steep dry sites in the north and south of the block, especially on the slopes facing Murmungee basin. Noxious weeds are a problem throughout the block, especially in the drier localities.

Significance

The block is significant for softwood plantations, nature conservation, and recreation and as an Army training area.

PILOT

General

Area and present tenure

The public land occupies 26,150 ha (34% of the total area). Most of that east of the Chiltern--Beechworth Road, Mount Barrambogie, and the parcel south of Reedy Creek are reserved forest. The remainder is unreserved Crown land.

General description

The hilly granitic plateau of the Pilot Range with low open forest and woodland is mainly public land and contrasts with the predominantly agricultural plains that lie to the west. The granitic cliffs at Mount Pilot are a notable feature.

Present use

The forests are used for apiculture, and some areas are leased for forest grazing. The town water supplies for Chiltern and Springhurst are obtained from the northern portion of the public land (near Mount Barrambogie). Some granitic sand is mined on the northern granitic slopes.

Recreational activities include driving for pleasure, bush-walking, nature study, and fossicking for gold and gemstones. Relics from the gold-mining period are important attractions in the area.

Most of the public land is used for military training purposes.

Nature of the Land

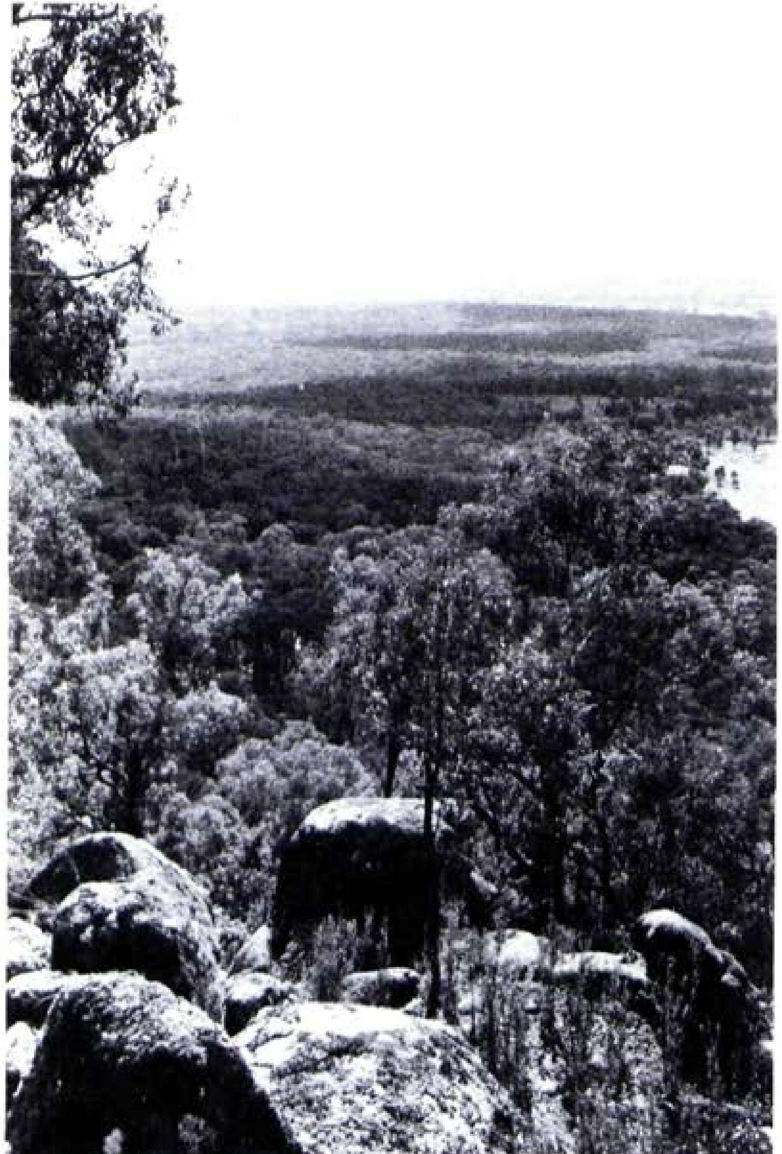
Climate

Rainfall increases towards the south-west. The bulk of the area receives between 635 and 762 mm.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
18.3	23.7	32.0	26.0

Local topography has a very important effect on frostiness in the block. Low-lying areas can be fairly cold during the winter and probably have frost-free periods of a little over 100 days, whereas other areas would have frost-free periods approaching 200 days.



Granite tors and forest north of Mount Pilot

Geology and physiography

The block lies mainly within the central physiographic region of sedimentary rock and granites, but includes part of the plains region. Most of it is Devonian granite. Granite outcrops are common throughout the region and often occur as granite tors. The most spectacular localities are at Mount Pilot and the Woolshed gorge. Partly surrounding the granite, metamorphic rocks (hornfelds) form curving hills, the most spectacular of which surrounds the Murmungee basin. Small areas of Ordovician sedimentary rocks lie north of Everton. Permian glacial deposits of sandstone, tillite, clay, and conglomerate occur at Woorragee, at Byawartha, and on the Hume Highway south of Springhurst. Small deposits of Pliocene gravels outcrop near Reedy Creek.

The plains region occurs in the south-west of the block and near Springhurst.

Soils

In the granite areas, coarse sandy loams and pale massive gradational soils occur on the steep slopes, weakly bleached gradational and some reddish duplex soils on other slopes, and yellow duplex soils in areas with poorer drainage. Other areas carry friable reddish gradational and reddish duplex soils on upper slopes, weakly bleached and friable brown gradational soils on mid slopes, and yellow duplex soils in depressions.

Land systems

The Pilot Range and all the granite areas form part of the Barrambogie land system. The hilly country to the south and east lies in the Bowmans land system, while the valleys and plains are included in the Myrtleford and Dederang-Bonegilla systems. Small areas south of Springhurst are included in the Chiltern land system.

Vegetation

The stony soil and low rainfall give rise to dry forest, which has been mapped mainly as long-leaf box open forest II with increasing amounts of open forest I towards the south-west. Blakely's red gum occurs as open forest II in the water-courses, where the soil is deeper and sometimes waterlogged. Blakely's red gum also grows on dry sites (often in pure stands) as either open forest I or woodland. Much of the higher ground and steep slopes carry extensive areas of black cypress pine. Although most of the cypress pine is in the south of the block, it occurs throughout the Pilot Range sometimes forming pure stands, but often mixed with Blakely's red gum, red stringybark, and long-leaf box.

Broad-leaf peppermint forest occurs in the north-east of the block on the flatter terrain, just north of Woorragee, where the soil is deeper and conditions more moist. Brittle gum, stringybark, and long-leaf box are common associated species.

All the forests in this block are important for wildflowers, especially orchids, but suffer from heavy infestations of noxious weeds, mainly St. John's wort.

Fauna

The animal species typical of the habitats that occur in this block are discussed in Chapter 10 and listed in Appendix 5.

The principal habitat on public land is dry open forest and woodland. Small softwood plantations are established in the north and near Beechworth. While the main aquatic habitat is Reedy Creek, other smaller creeks and ponds supplement this.

The agricultural environment is mainly pasture with scattered trees, but crops are grown in the west.

This generally dry but diverse region supports a large bird and reptile fauna. The peregrine falcon nests in the block.

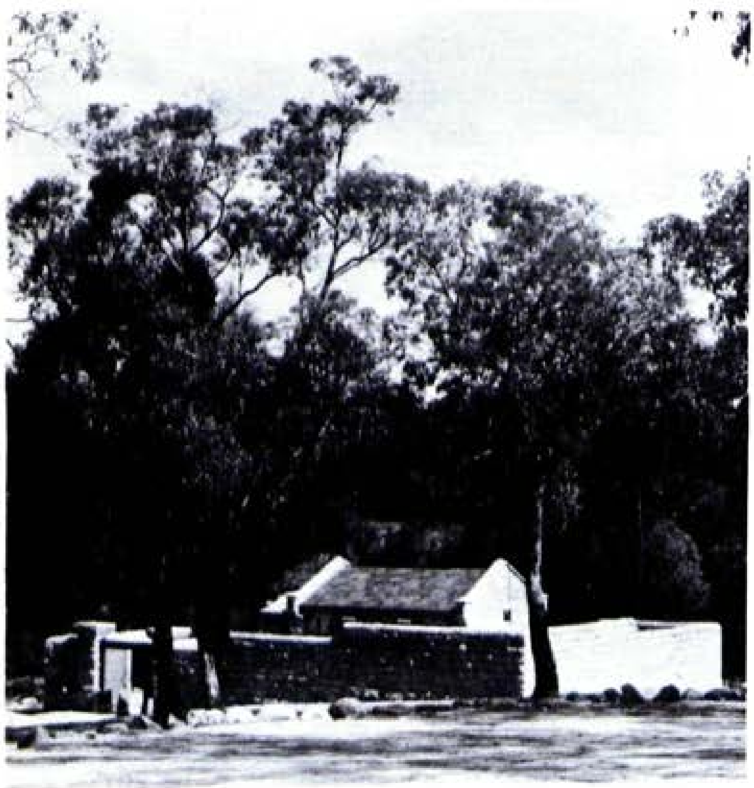
Capabilities

Nature conservation

The block has high value for nature conservation. The physiography of the area is typical of a granitic plateau.

The forest types here differ significantly from those in surrounding areas; they include black cypress pine and extensive areas of Blakely's red gum growing in drainage lines and on the drier hillsides. Although introduced plant species are common, the area has a varied and interesting indigenous flora.

The large areas of rock and woodland make it especially important for reptiles. Moderately large areas of box and peppermint forest in the north and east are particularly important for maintaining the larger mammal species in this block.



Beechworth powder magazine

Recreation

Location, topography, interesting land formations, outstanding views, attractive vegetation, and historical associations give the region high recreational capabilities.

This well-known area is located between Wangaratta and Wodonga, and the towns of Eldorado, Beechworth, and Chiltern attract tourists.

It is surrounded by important through routes, including the Hume Highway. The road linking Beechworth and Chiltern traverses the public land, which also contains many tracks that are generally suitable for two-wheel-drive vehicles and use is moderately heavy at times.

The area is mainly hilly, and views of the surrounding country are obtained from many points, especially from Mount Pilot and other granitic outcrops. Granite tors and shelving rock are important elements in the landscape. The open nature of the forests and woodlands in the area allows easy walking, especially within the Blakely's red gum and black cypress pine. Wildflower displays are an attractive element in the vegetation and the area generally offers good opportunities for nature study.

Historical aspects mainly concern the gold-mining period, and Eldorado and the Woolshed Valley are particularly interesting. Fossicking for gold and gemstones is popular in this area.

Agriculture

Beef, sheep for wool, and fat lamb production are the main agricultural enterprises and some cereals are grown in the south-west. Increased use of improved perennial grasses would raise pasture productivity, and lucerne could probably be grown more extensively in the west.

A small area of public land is grazed and there is little scope for increasing this. Only small areas of fairly flat land would be suitable for clearing and grazing. Generally the capability for agriculture on public land is low.

However, the forests are used extensively for apiculture, and honey production is high.

Softwood

Generally the area has low capabilities for softwood production, although parts of the flatter land in the north-east are moderately suitable for pine plantations.

Hardwood

The capability for hardwood production in this block is generally low, although the long-leaf box and broad-leaf peppermint forests (both open forest II) are capable of producing small (and intermittent) yields of sawlogs under low-intensity management.

Water

The capabilities for water production are moderate to low. The northern section is drained by Black Dog Creek, the central portion by Reedy Creek, and the southern by Hodgson and Burgoigee Creeks.

Springhurst obtains its water supply from the headwaters of the Diddah Diddah Creek, while Chiltern uses Barrambogie Creek. Both catchments have small dams. Chiltern water supply is augmented by bore water when necessary.

Minerals

Part of the Chiltern gold- and tin-field lies to the north of the block, principally in the valley of Black Dog Creek. Many of these alluvial deposits have been mined, but some of the deeper more difficult levels were not worked. To the south lies the Eldorado--Beechworth gold- and tin-field. Both reef and alluvial deposits have been worked and a derelict dredge still exists at Eldorado. Alluvial tin deposits are currently being worked at Clear Creek. Others have been worked on a very small scale in the last decade. To the east lies part of the Yackandandah gold-field.

Molybdenum occurs north of Everton, but the field has been extensively mined.

Granitic sand deposits occur near the granite, especially on the northern slopes near Springhurst.

Public utilities

The proposed route for the Gas and Fuel Corporation's gas pipeline passes through the agricultural land on the western side of this block. The Army uses a large proportion of the Pilot Range as a training area.

Hazards and Conflicts

Pine plantations are an inflexible land use that conflicts with most other uses, especially nature conservation. Recreation is compatible to varying degrees with most other uses. Intensive recreational sites on granitic soil tend to suffer serious soil erosion. Fossicking for minerals in the streams and on banks can accelerate erosion and reduce the aesthetics of the area.

Low-intensity timber production is compatible with most other uses. Controlled burning, however, may damage the flora of the area and increase soil loss.

Tin- and gold-mining, if not properly managed, can lead to stream pollution.

Fire is a constant hazard in these forests. Increased use of the area may increase the danger of accidental fires.

The soils in the granitic areas are highly erodable. Soils on the Ordovician sedimentary rocks have a moderate sheet and gully erosion hazard, while those on the plains have a low erosion hazard.

Noxious weeds - especially St. John's wort - are a problem throughout the area especially towards the west. Rabbits are common in the more open country, but can be found all through the forests. A potential pollution hazard arises in Reedy Creek because part of the Creek's catchment includes the Beechworth township and sewage disposal areas.

Significance

The block has significance for recreation and nature conservation, and for military training purposes.

MOYHU

General

Area and present tenure

The public land occupies 9,000 ha (8% of the total area). The parcel west of Edi is reserved forest. The other areas are mainly unreserved Crown Land.

General description

The plains in the north mainly support agriculture. Small parcels of public land are located on the hills in the south of the block that represent foothills to the more mountainous southern areas. The hills in the south-west are capped with basalt.

Present use

The area is important for apiculture and some of the area is grazed. A small quantity of hardwood timber is cut, mainly from the Moyhu timber reserve.

Recreational activities are mainly associated with the rivers and include fishing and picnicking. The hills are used for walking and nature study.

Nature of the Land

Climate

The average annual rainfall for the Oxley Plains increases from 635 mm at Wangaratta to 762 mm in the southern valleys. It increases rapidly in the foothills and reaches about 1,076 mm along the southern border of the block.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
18.0	23.2	32.6	26.2

The frost-free period is 235 days at Wangaratta. It is likely to be shorter further south, probably less than 160 days in the valleys of the foothills.

Geology and physiography

The block lies mainly within the plains physiographic region, but includes some of the central physiographic region of sedimentary rock.

The plains region consists of two distinct areas. The first is in the flood-plains of the Ovens and King Rivers. The other is the slightly higher land, between the flood-plains formed from high river terraces and alluvial fans. Within the second region, near Greta, are low hills of Permian deposits.

The low hills in the south of the block form part of the central region and mainly comprise Ordovician sedimentary rocks: sandstones, siltstone, shale and mudstone.

Parts of the hills between Fifteen Mile and Boggy Creeks and between Boggy Creek and the King River have cappings of Tertiary basalt, which gives these hills flat tops and relatively steep sides. Basalt outcrops as stony regions along the edges of these flat tops.

Soils

The flood-plains in this block have undifferentiated sandy loams, brown loams, and reddish and yellowish brown gradational soils on alluvium. The soils of the plains are mainly reddish and yellowish duplex. Also some friable reddish gradational soils occupy areas of higher rainfall, and brown loams and gradational soils on alluvium are associated with alluvial material that extends into the plains from the adjacent hills.

The hilly country contains duplex soils and weakly bleached gradational soils. In the south, friable brownish and reddish gradational soils are more common and stony loams also occur. On the basalt areas the soils are mainly reddish

Basalt caps some of the hills in the south-west. Variegated thistle (foreground) is a problem in these areas gradational, but well-structured non-calcareous clays occur in poorly drained sites.

Land systems

Most of the plains are unsurveyed, as indicated on the land systems map. In the rest of the area the flood-plains are included in the Ovens land system, the sloping valley sides in the Myrtleford land system, and the hills in the Bowmans land system, except for the two hilly basalt-capped areas in the south-west, which form part of the Myrrhee land system.

Vegetation

Most of the block is agricultural land. Stream frontages and small reserves on the flood-plains carry river red gum forest and woodland. Understorey plants include many introduced species.

The hills in the south carry dry forest, mainly long-leaf box open forest II but open forest I occurs on the drier sites. Broad-leaf peppermint red stringybark, and red box are commonly associated. Towards the south, moist localities carry broad-leaf peppermint forests. Candlebark grows in the drainage lines.

Fauna

The animal species typical of the habitats of this block are discussed in Chapter 10 and listed in Appendix 5.

Sugar glider

The most extensive habitat in the block is agricultural land, chiefly pasture with scattered trees. The main habitat on public land is dry open forest. Some of the alienated land in the south still carries forest.

The aquatic habitat is represented by the Ovens and King Rivers and by several creeks - including Boggy, Fifteen Mile, and Meadow Creeks - and their associated wetlands. Numerous dams and ponds also occur in the block.

Capabilities

Nature conservation

The public land has moderate to high capabilities for nature conservation.

The basalt flow in the south-west and the hills of Permian glacial deposits in the Oxley Plain are interesting geological features.

The flora and fauna of the southern hill country is not known in detail, but is probably typical of the long-leaf box and peppermint forests in the area. The streams and their riparian land and road reserves are important for fauna and flora, although many introduced species are present.

Recreation

The recreational capability of the public land is moderate.

Access is reasonable, since the parcels of land are not particularly large and good highways are located nearby. Tracks within the larger parcels are generally suitable for two-wheel-drive vehicles. These areas offer opportunities for nature study, picnicking, and walking.

Rivers and their riparian lands are important elements in the landscape and provide a setting for picnicking, walking, and fishing and form part of the general scenery for activities such as driving for pleasure. However, access is often restricted.

Small areas of public land have a potential for intensive recreation. The recreation reserve at Milawa, for example, has considerable use.

Beef cattle with river red gums in the background

Agriculture

Dairying, beef, tobacco and hop production are the major enterprises on river-flats and terraces, and beef and fat lamb production are the main enterprises on the plains and hilly country. Generally production could be increased by improving pasture management.

The public land has low capabilities for agriculture; it supports some forest grazing and flat or gently sloping areas could be used for grazing if cleared.

The block is very important for apiculture and is part of the most productive area in these study districts.

Softwoods

The public land in this block is generally too dry for softwood production. However, limited areas in the Moyhu timber reserve are suitable.

Hardwood

Capability for hardwood production is low. The long-leaf box and broad-leaf peppermint forests that occur on public land have low productivity, but provide timber - principally poles and fencing materials - for local consumption.

Water

The block has moderate to low capability for water production. The plains area contributes very little to average river flow. The foothill country is more important.

Public lands abutting the streams in the area are important for helping to maintain the quality of the water.

Available summer stream flow within this block is fully committed for irrigation.

Groundwater occurs throughout the valley and plains areas and both shallow and deep aquifers are present.

Minerals

Rocks containing phosphate occur near Greta South. River gravels and sand are associated with most rivers in the area. They are worked between Whorouly and Myrtleford and near Milawa on the Ovens River. Large quantities of granite are quarried at Glenrowan.

Public utilities

A single-circuit 220-kV transmission line traverses the block on a 61-m easement, mainly on agricultural land. The existing easement is adequate for an additional 220-kV line.

Conflicts and Hazards

Hardwood timber production is generally a flexible land use, although it does conflict with some aspects of nature conservation. Softwood plantations are a more inflexible use.

Mining of river gravels and sand can reduce the aesthetic value of river environs and adversely affect water quality.

Clearing steep slopes on the foothills changes the soil--water relations, which can lead to excess run-off and erosion. Steep slopes near the basalt flows in the south-west of the block are subject to mass-movement erosion if cleared or to gullying on lower land.

Significance

The public land in this block has significance for nature conservation, recreation, and apiculture.

EMU

General

Area and present tenure

The public land occupies 38,900 ha (74% of the total area). Most of it is reserved forest. The western and southern sections of the hills are unreserved Crown land. The State Rivers and Water Supply Commission has acquired some land bordering Lake Buffalo for the second stage of Buffalo Dam.

General description

This hilly to mountainous block is mainly public land. A ridge running southwards from Myrtleford increases in altitude to Mount Emu. South of Mount Emu, and separated by a saddle at Croppers gap, lies the Black Range. The public land supports a wide variety of forest types that vary from long-leaf box in the north to alpine ash at high altitude in the south. The north also has large areas of softwood plantations.

Present use

The block is used for apiculture, and logging is practised in the better hardwood forest areas. Recreational activities include driving for pleasure, walking, and nature study. The large softwood plantation areas are used for driving and walking. The streams provide good fishing. A transmission line traverses the southern part.

Nature of the Land

Climate

Rainfall increases towards the south. Average annual rainfall is 902 mm at Myrtleford and 733 mm at Whorouly; it probably exceeds 1,500 mm on the Black Range.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
16.0	22.5	36.0	2-.5

Myrtleford has 127 frost-free days. The higher ground at Mount Emu and the Black Range is likely to be frosty in winter. Snow-falls occur on the highest areas.

Geology and physiography

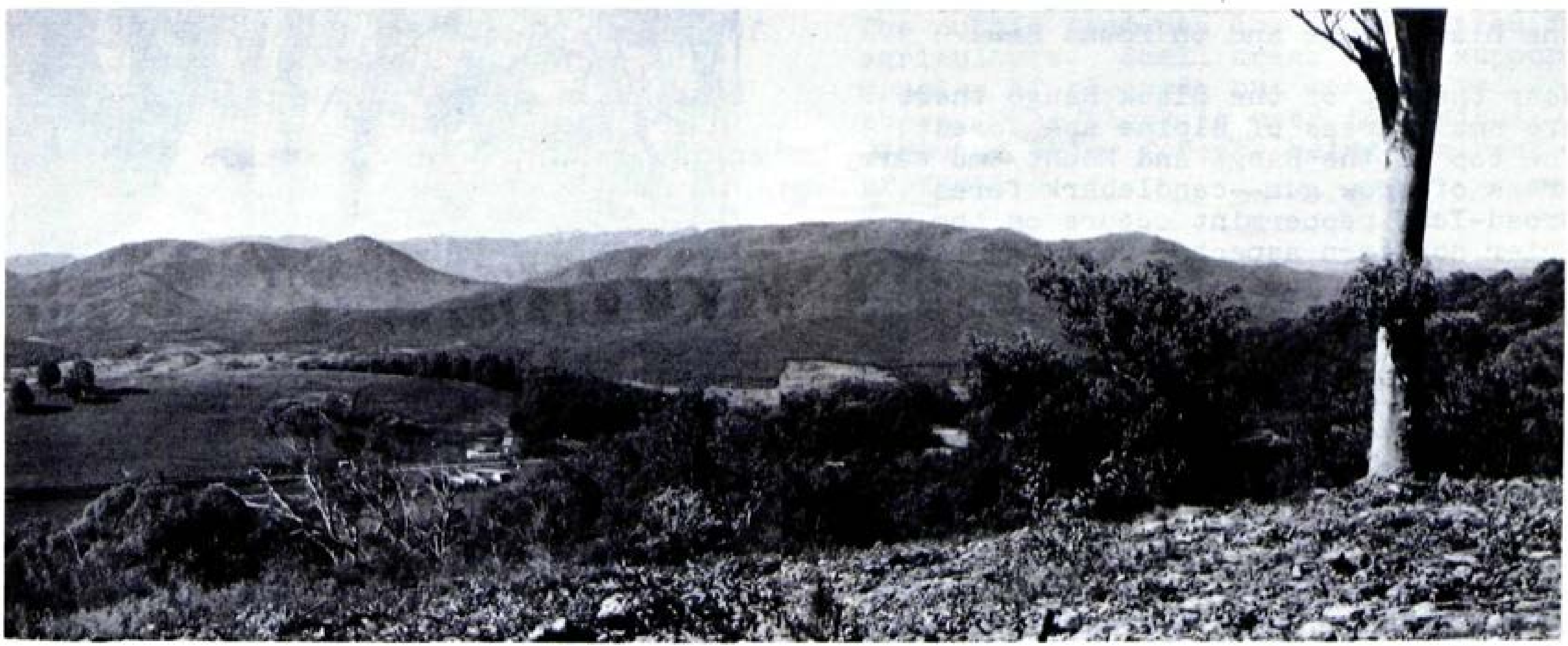
The block falls within the central physiographic region of sedimentary rocks and granite. Most of the country is Ordovician sandstone, siltstone, mudstone, and shale, but an area of Devonian granite at Mount Emu is surrounded by hard metamorphic rock (hornfeld). The highest land is in the south, on the Black Range and at Mount Emu.

Soils

The soils in the valleys include brown loams, gradational soils on alluvium, and undifferentiated sandy loams. The lower slopes, fans and high terraces have reddish duplex and friable reddish gradational soils. The hilly slopes have friable reddish and brownish gradational soils and stony loams. Pale massive gradational soils occur near the granite.

Land systems

The valley floors are included in the Ovens land system and the slopes in the Myrtleford--Whitfield and Myrtleford--Murmungee systems. The dry hilly country lies in the Bowmans system and the wetter hilly areas in the Tawonga--Wermatong land system. Mount Emu and



Mount Emu to the left, Black Range on the right, with Mount Buffalo in the background part of the Black Range are included in the Winteringa land system.

Vegetation

A large proportion of the forest in the north of this block has been cleared and planted with conifers. The remaining forest is mainly long-leaf box open forest II, with red box, red stringybark, and broad-leaf peppermint as the principal associated tree species.

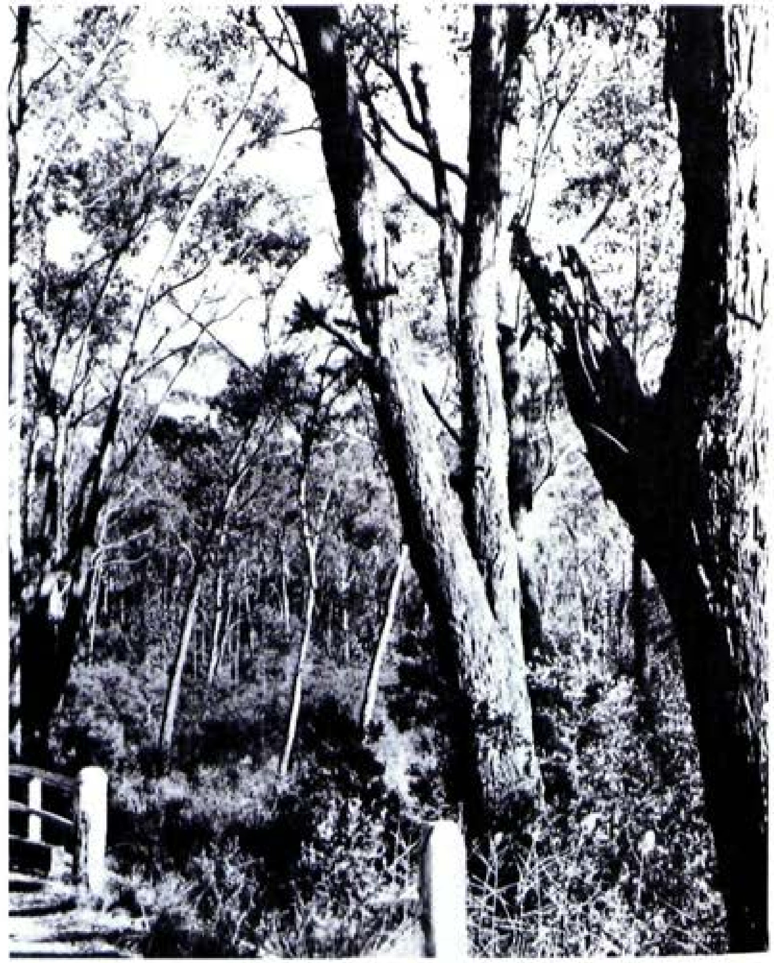
The central and southern sections of the block carry narrow-leaf and broad-leaf peppermint. Very substantial areas of narrow-leaf peppermint forest occur in the Black Range and on Mount Emu.

Near the top of the Black Range there are small areas of alpine ash forest. The top of the Range and Mount Emu carry areas of snow gum--candlebark forest. Broad-leaf peppermint occurs on the drier northern aspects, while the southern aspect of the Black Range has a small area of snow gum forest.

Fauna

The animal species typical of the main habitats in this block are discussed in Chapter 10 and listed in Appendix 5.

The main animal habitats are the extensive areas of wet and dry open forests in the south and the substantial areas of softwood plantations in the north. The aquatic habitat includes the Buffalo River and a small section of the Ovens River. Emu block contains several creeks, the largest being Black Range and Croppers Creeks. The agricultural habitat is mainly pasture, although some irrigated crops are grown on the river flats.



Swamp gum open forest II

Capabilities

Nature conservation

The block has moderate to high capabilities for nature conservation.

The Black Range and Mount Emu, consisting of granite and metamorphic rock, are interesting geological features.

The land in the north and west carries flora and fauna typical of the long-leaf box and broad-leaf peppermint forests. The pine plantations have low capabilities for nature conservation. The Black Range and Mount Emu comprise an extensive area that contains good examples of narrow-leaf peppermint, swamp gum, and candlebark--snow gum forest. The fauna is probably typical for the habitats present. No details of either the fauna or flora are known for the southern portion of the block.

Recreation

The diversity of environments, locality, and access give this block a high capability for recreation.

Access to the public land is generally good, with main roads surrounding the area. Track access in the northern portion (mainly pine plantation) is good and generally suitable for two-wheel-drive vehicles. Fewer tracks serve the south of the block, and most are only suitable for four-wheel-drive vehicles.

The plantations offer opportunities for activities such as pleasure driving, walking, and active pursuits such as orienteering. The native forests to the south provide opportunities for nature study, bush-walking, picnicking, and the use of four-wheel-drive vehicles. The streams afford fishing, and in some areas fossicking for gold and gemstones is possible.

Agriculture

Dairying, tobacco, and beef production are the major agricultural enterprises in the valleys.

The public land has low capabilities for agriculture. Small areas could support grazing if cleared, but most is too steep. The block is used for apiculture, the drier forests being the most productive.

Softwood

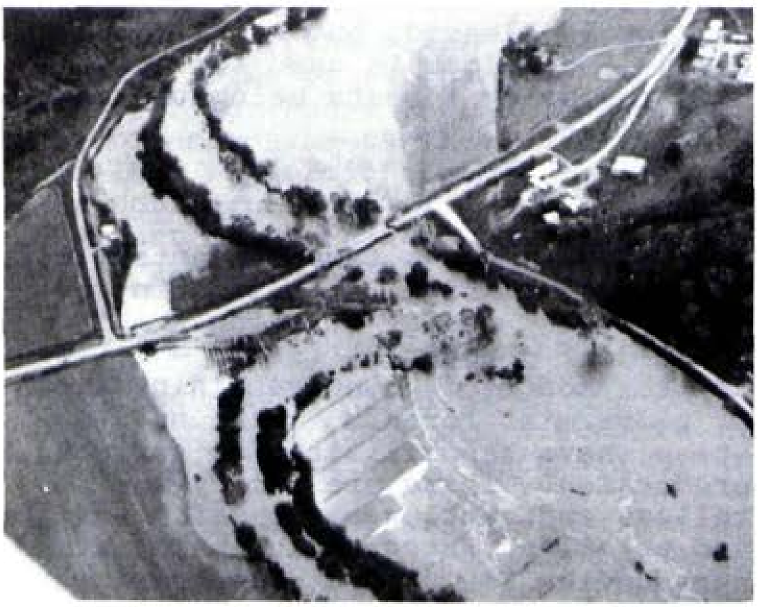
Capabilities for softwood plantations in the block are high. The land in the north-west - mainly carrying box and broad-leaf peppermint forest - is too dry for softwood. The remaining areas of peppermint forests, where not too steep, have capabilities for softwood production. These are mainly the valleys and gentler slopes of Mount Emu and the Black Range, principally areas surrounding Emu, Mayday, Croppers, and Black Range Creeks, some of the valley to the west of the Rose River, and areas abutting the northern side of the Cheshunt--Dandongadale road.

The existence of the other pine plantations within the block and the location of the softwood mill at Myrtleford favourably affect the economics of pine production in this area.

Hardwood

Capability for hardwood production varies from low to moderate.

Areas of alpine ash at the head of Croppers Creek on the Black Range, although small, have a moderate capability for



Flooding in the Buffalo River

production. The peppermint forests have some capability for low-intensity production. Towards the north the drier forests - long-leaf box and some broad-leaf peppermint - have very low productivity.

Water

The capability for water production varies from moderate in the north to high in the Black Range.

The creeks draining the area flow either westwards into the King River or eastwards into the Rose or Buffalo Rivers and thence into the Ovens River.

Minerals

Part of the Myrtleford gold- and tin-field falls within this block. Both reef and alluvial gold have been mined.

Thin layers of rock containing phosphates occur near Cheshunt, and there are also small quantities of turquoise in the same locality.

River gravels suitable for road-making occur in the streams of the area and are mined on the King River between Whitfield and Cheshunt and on the Ovens River between Gapstead and Myrtleford.

Public utilities

A 40-m easement for a double-circuit 220-kV transmission line passes through the south of the block. A 61-m easement for a single-circuit line exists in the north of the block. A 125-m easement in the west of the block carries two single-circuit 330-kV lines, and is adequate for a proposed additional 330-kV line.

Conflicts and Hazards

Pine plantations are an inflexible land use that conflicts with nature conservation and hardwood production. It also changes the capabilities for recreation and apiculture, and possibly for water production.

Non-intensive hardwood production is compatible with most land uses, although it conflicts with some aspects of nature conservation and recreation. Activities that involve travel in the bush - such as recreation - may increase the hazard of fire.

The soil erosion hazard is generally moderate (sheet and gully erosion). Poor siting of access roads and careless logging can lead to erosion with increased stream turbidity and peak flows. The hazard is greater on dry northern slopes.

Significance

The block is significant for pine plantations, nature conservation, recreation, and water production.

BUFFALO

General

Area and present tenure

The public land occupies 32,050 ha (81% of the total area). Most of it is National Park. Some land near Lake Buffalo is vested in the State Rivers and Water Supply Commission. Public land south of Eurobin is reserved forest. Most of the remainder is unreserved Crown land.

General description

Mount Buffalo is an outstanding granitic mountain, the summit of which is a hilly plateau. The granite is surrounded by metamorphic rock that merges into sedimentary rock, and these together form foothills to the mountain. The block contains a wide variety of forest types. It is bounded by the Buffalo River in the west and the Ovens and Buckland Rivers in the north and east. The valleys are mainly agricultural, and tobacco is the main crop grown.

Present use

The Mount Buffalo National Park comprises a substantial part of the block. A small portion in the north forms a catchment for the Myrtleford town water supply. A transmission line runs along the southern border. Lake Buffalo is located in the west. Recreational activities include winter sports, sightseeing, picnicking, nature study, bushwalking, and fishing.

Nature of the Land

Climate

Mean annual rainfall is 1,892 mm at Mount Buffalo Chalet. It decreases with reducing altitude, and is least in the north of the block (about 1,016 mm).

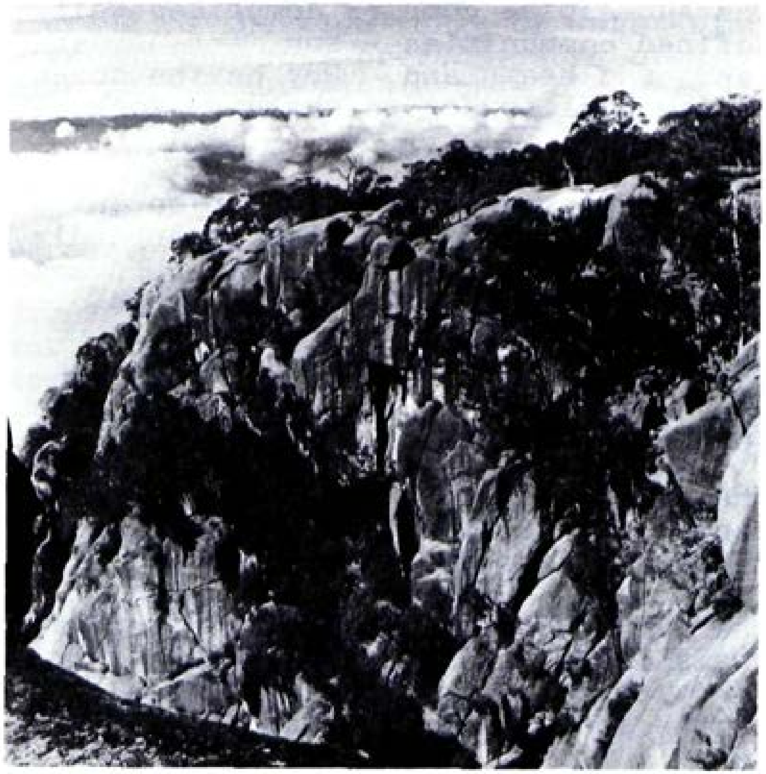
Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
15.1	22.8	35.0	27.1

The frost-free period on the plateau is 44 days, and snow falls during the three winter months.

Geology and physiography

The block falls within the central physiographic region and consists of a high granitic plateau surrounded by lower



Granite cliffs, Mount Buffalo

hills of metamorphic and Ordovician sedimentary rocks. Granite tors are common on the plateau, which is surrounded by often spectacular cliffs. Deposits of Tertiary gravels occur in the Buffalo Creek Valley and at the junction of the Ovens River and Buffalo Creek.

Soils

The river valleys contain brown loams, undifferentiated sandy loams, and gradational soil on alluvium. Reddish duplex and friable reddish gradational soils occur on the drier lower slopes, and friable brownish and reddish gradational soils and stony and sandy loams on the higher slopes. Organic loams and dry, active, and humified peats occur on the plateau.

Land systems

The granite area of Mount Buffalo is mapped as the Mount Buffalo land system. The surrounding hills lie in the Myrtleford land system, and the valley floors and sides are included in the Ovens and Dederang land systems respectively.

Vegetation

This block differs considerably from the surrounding country because of its high altitude and granitic rocks. It contains a wide range of vegetation types.

Long-leaf box forest can be found to a limited extent on the sedimentary rocks in the north. The remaining sedimentary rocks carry narrow-leaf and broad-leaf peppermint, with the narrow-leaf peppermint in the moister localities, usually below 1,000 m.

Alpine ash forests occur above about 1,000 m in areas where topography produces favourable growing conditions. Candlebark--snow gum forest occurs where growing conditions are less favourable. Above 1,400 m these forests are replaced by pure stands of snow gum.

Snow gum and granite tors on Mount Buffalo

The sub-alpine complex comprises well-defined communities - bog, fen, grassland, and heathland. Dry heaths occur at lower altitudes on shelving rock surfaces.

The uniqueness of the vegetation on Mount Buffalo is reflected in Appendix 4b, which lists the endemic and endangered species found in the area and also the type species that come from Mount Buffalo.

Fauna

The animals typical of the habitats that occur in this block are discussed in Chapter 10 and listed in Appendix 5.

The main animal habitats are extensive areas of wet and dry open forest. In addition there are areas of sub-alpine heaths and bogs and areas of dry heath.

The aquatic habitat is represented by Lakes Catani and Buffalo, and sections of the Buffalo, Ovens, and Buckland Rivers. Creeks include the Yarranab and Buffalo. The agricultural habitat is mainly pasture, although crops are grown on some of the river flats.

Capabilities

Nature conservation

The block has high capabilities for nature conservation. Altitude, topography, and geology are important factors contributing to the wide range of vegetation types and habitats present, some of which only occur within this block in the study districts. Much of the area is inaccessible and is relatively undisturbed.

Recreation

Diverse vegetation, scenic grandeur, and cool climate give this area outstanding capabilities for recreation. The region is well known and recognized for recreation and nature conservation. The whole of Mount Buffalo (including its slopes) is an important scenic feature for the surrounding country.

Lowland streams are used for fishing, and Lake Buffalo provides habitats for waterfowl and an attractive area for sight-seeing and picnicking.

Agriculture

Horticultural crops are grown in the valleys and beef is produced on the improved pastures of the river flats and terraces. There is potential for increased production of vegetables and fodder crops during spring and summer.

Tobacco production is limited by a quota system and increased hops production depends on the abilitv of the industry to export. Production is also limited by the availability of water, since the summer stream flows in the area are already fully committed for irrigation.

Generally the public land has low capabilities for agriculture. The drier forest types have some capabilities for apiculture. Some forest grazing is possible on the gentler slopes and lower slopes have some grazing potential after clearing.

Softwoods

The block has low capabilities for softwood production.

The location, close to Myrtleford and to other softwood plantations, would favourably affect the economics of growing pines in this block. Areas suitable for pine plantations exist but have not been utilized because of proximity to the Mount Buffalo National Park.

Hardwood

In addition to large areas of narrowleaf peppermint, extensive areas of good quality alpine ash forest have high productivity.

None of these forests have been logged, because of their conservation and recreation values. Drier, less-productive forests of peppermint and box occur on the lower slopes of the mountain.

Water

High rainfall and steep slopes help to make this area especially significant for water production (high capability).

The headwaters of the Buffalo Creek are used for Myrtleford town water supply. Lake Buffalo - a 2,400-Ml storage sited on the Buffalo River - safeguards irrigation, urban, stock and domestic supplies in the area. The increased

Skiing - Mount Buffalo

irrigation potential resulting from this dam is now fully committed.

The planned second stage of the Buffalo Dam (1 million Ml) has been deferred, but future water supply demands may possibly warrant its eventual construction.

Small quantities of groundwater exist in the alluvium of the valleys and the area is important for aquifer recharge.

Minerals

Both reef and alluvial gold have been mined in the Ovens River and Buffalo Creek areas. The Buckland River has also been worked for alluvial gold.

River gravels are mined for road-making materials on the Ovens River near Porepunkah and Eurobin. Tailings from the gold dredge are also mined on the Buckland River near the confluence of the Buckland and Ovens Rivers.

Public utilities

A 40-m easement in the south of the block carries a double-circuit 220-kV transmission line.

Conflicts and Hazards

Recreation is generally a flexible land use, but conflicts with some aspects of nature conservation. Compatibility decreases with the increasing intensity of recreation.

The soil erosion hazard is moderate to high. Conservation of soil depends to a great extent on maintaining vegetation cover. Organic soils are readily damaged by fire, trampling, and inappropriate siting of tracks and roads. Soil conservation is important for nature conservation, aesthetic values, and water production.

Fire is a constant hazard in the area, mainly during the summer months. Activities such as recreation that involves travel in the bush may increase the danger of fire. Fires spreading from adjoining alienated land is also a danger.

Significance

The block has significance for nature conservation, recreation, and water production.

ABBEYARD

General

Area and present tenure

The public land occupies 102,750 ha (97% of the total area). Most of it is unreserved Crown land. Some reserved forest exists near Bright; and land near Dandongadale is vested in the State Rivers and Water Supply Commission as part of the land acquired for the second stage of Buffalo Dam.

General description

The block is mainly mountainous forested land. Some of the river valleys are cleared for agriculture, and pine plantations are located near Bright. Seven major streams flowing northwards drain it and are separated by steep ridges that generally increase in altitude southwards. Barry Range and Mount Cobbler lie immediately south of the block.

Present use

Hardwood logging is practised in the better hardwood forest areas and most of the public land is leased for forest grazing. Water from a catchment in the north provides the Bright town water supply. Recreational activities include fishing, nature study, bush-walking, and driving for pleasure. Most of the recreational pressure occurs near Bright.

Nature of the Land

Climate

Most of the land in this block receives at least 1,270 mm of rain a year. The southern half receives more than 1,520 mm a year, and the average at the Abbeyard weather station is 1,543 mm.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
15.1	23.3	36.0	25.6

No information on frostiness is available for this block, but it is mountainous country bordering the Dividing Range and is likely to be subjected to frosts for a long period during the cooler months.

Geology and physiography

The block lies in the central physiographic region of Ordovician sedimentary rocks and granites. The numerous streams that drain the area have formed deep V-shaped valleys and in general have deposited little alluvium. The hillsides are steep and the ridges relatively sharp. The largest area of granitic rock outcrops at Abbeyard and is surrounded by metamorphic rocks.

Soils

Soils in the river valleys (mainly Ovens and Buckland Rivers and Morses Creek) include undifferentiated sandy loams, brown loams, and gradational soils on alluvium. The higher river terraces and lower slopes have reddish duplex and friable reddish gradational soils.

The drier parts of the hilly country have weakly bleached gradational soils that merge into friable gradational soils in the moister localities. Some organic loams occur at higher altitudes, particularly in the south. Pale massive gradational soils occur on steep slopes near the granite at Abbeyard.

Land systems

The valley floors and sides are included in the Ovens and Myrtleford land systems

Wandiligong Valley (above) contrasts with the Buckland Valley (right) respectively. The remaining country lies in the Tawonga--Wermatong and Tawonga--Darbalang land systems. A small area at Abbeyard forms part of the Pinnacles land system.

Vegetation

Nearly all the block is forested: only some areas near the rivers are cleared. The main forest types are narrow-leaf and broad-leaf peppermint. The former requires a more sheltered and moister site than the latter. Small areas of snow gum and alpine ash occur on the higher parts of the ridges in moist localities. Access to much of these forests is poor, and they have not been intensively studied botanically. Substantial areas near Bright have been converted to pine plantations.

Fauna

The animal species typical of the habitats that occur in this block are discussed in Chapter 10 and listed in Appendix 5.

The most extensive animal habitat is wet open forest, but dry open forest and softwood plantations occur. The streams forming the aquatic habitat are mainly fast-flowing, cool mountain streams and include the Rose, Dandongadale, Buffalo, Buckland, and Upper Ovens Rivers. Many permanent creeks are also present. Tiger cats have been reported from this block.

Musk daisy bush

The agricultural habitat is restricted to the narrow river valleys and is mainly pasture, although some croplands and orchards are established in the north.

Capabilities

Nature conservation

The block has high capabilities for nature conservation. It contains extensive areas of peppermint forest and small areas of alpine ash, and many of the higher valleys support stands of swamp gum. Much of it is inaccessible and some of it remains relatively undisturbed. Some of the streams are in a natural (or near natural) state. The area probably supports flora and fauna typical of these habitats, although the details are not known.

Recreation

Capability for recreation in this block is high because of the extensive areas of native bush, rugged terrain, attractive stream environs, and proximity to accommodation centres such as Bright.

Access is via the main roads in the valleys. Few tracks serve the bush, and these are generally only suitable for four-wheel-drive vehicles (except in the plantations near Bright, where tracks are numerous and suitable for two-wheel-drive vehicles). The streams provide good fishing and are often attractive areas for sightseeing and picnicking, although some stream frontages are infested with blackberries. Fossicking for gold is possible in Morses Creek and the Buckland River. Suitable tracks and look-out points make the area near Bright popular for pleasure driving and sightseeing.

Opportunities for bush-walking and nature study are good, and the inaccessible areas are suitable for wilderness experience - that is, recreation in solitude.

Agriculture

The agricultural land is located in the narrow valleys. Native and improved pastures are used for beef production and small areas of tobacco, hops, apples and nuts are grown. Coldness is a problem and orchards require frost protection to ensure crops.

The public land has low capabilities for agriculture. Generally the forests are too steep for clearing and, although flat areas would have capabilities for grazing after clearing, productivity would be low because of the short growing season. Most of the public land is leased for light forest grazing.

Softwoods

Capability for softwood production is low. Most of the suitable areas for plantations near Bright have already been used, and no further large area of public land in that locality has capabilities. Rough terrain and isolation make the rest of the block unsuitable for plantations.

Bootlace bush

Hardwood

On average, the area has low to moderate capabilities for hardwood production.

Extensive areas of peppermint forest occur, with small areas of alpine ash on the higher sheltered sections of the ridges. But the terrain is steep and access generally poor. Where access permits, these forests have a capability for low-intensity hardwood production.

Water

The high rainfall and mountainous terrain help to give this block high capabilities for water production. The area is drained by the Rose, Dandongadale, Buffalo, Buckland, and Ovens Rivers and Morses and Yarranab Creeks. Most of the catchment area is well forested, and consequently the water quality is good.

In the north, Bakers Creek supplies part of the Bright town water supply.

A dam to impound 10,500 Ml has been planned for the Buckland River to safeguard water supplies for local development. The construction date is uncertain, but will probably be after 1982.

Minerals

The Buckland and Ovens Rivers and Morses Creek were important during the goldmining period, but no commercial activity continues today.

The dredge tailings - mainly in the Ovens Valley - are used as road-making materials.

Public utilities

A 40-m easement in the north of the block carries a double-circuit 220-kV transmission line.

Conflicts and Hazards

Low-intensity hardwood production is generally a flexible land use, but conflicts with some aspects of nature conservation and may lead to soil erosion.

Recreation is generally a flexible use, except for those forms that require a natural environment (wilderness experience). Maintaining an area as wilderness, however, conflicts with uses that disturb the environment (such as forest grazing and timber production), but is compatible with others such as water production and nature conservation.

Mining of river gravels and other road-making materials, if not properly controlled, can reduce the aesthetic value of the environment, cause pollution, and conflict with nature conservation.

Water storage conflicts with most other land uses and is therefore inflexible. However, although the present environment is lost, a new environment with different capabilities is created. Native fish, for example, would be adversely affected by a dam, while waterfowl and introduced fish may benefit.

Soils in the river valley have a low hazard of gully and sheet erosion. Sheet erosion hazard on the steep mountainous areas is moderate if the ground cover is damaged. Soils on the highest slopes can be permanently damaged by inappropriate logging and roading practices.

Soils on the granite areas near Abbeyard are highly erodable. Drainage lines are liable to gully erosion if the land is cleared.

Noxious weeds are a problem on disturbed land, and blackberries are common on many stream frontages.

Significance

The block has significance for nature conservation, recreation, and water production.

PARADISE FALLS

General

Area and present tenure

The public land occupies 44,060 ha (74% of the total area). Most of that east of the King River is unreserved Crown land. The bulk of the remaining land is reserved forest.

General description

The streams in this mountainous region have dissected steep-sided valleys in an otherwise hilly plateau region. The lower portions of the main valleys and some of the flat plateau have been cleared for agriculture. Most of the remaining area is forested public land.

Outstanding features are the cliff faces on some of the steep valley sides. Lake William Hovell is located on the King River in this block.

Present use

Hardwood logging is important in the better hardwood forest areas and the block is used for apiculture. Part of the forest west of Whitfield serves as a catchment for Whitfield's town water supply. A transmission line traverses the region to the west of Cheshunt South.

Nature of the Land

Climate

The rainfall is highest in the south-east of this block, where it exceeds 1,500 mm, and decreases towards the north and west. The annual average at Whitlands is 1,400 mm.

Distribution of annual rainfall (%)

Summer	Autumn	Winter	Spring
14.9	23.3	37.0	24.8

No data on frost are available for this block, but (because of the high elevation and topography) it is likely to be subjected to frosts for a long period during the cooler months.

Geology and physiography

Most of the block lies in the south-west physiographic region. This mountainous country is composed of near-horizontally bedded Carboniferous sedimentary rocks (conglomerates and sandstones) that overlie Devonian volcanic rocks (rhyolites and rhyodacites). In addition, it contains small areas of Tertiary volcanic rocks, mainly basalt. The headwaters of the King River have dissected deep valleys with steep sides, frequently exposing both sedimentary and volcanic rocks as cliffs. The sedimentary rocks rise steeply in the east, forming a long ridge with peaks at Mount Typo and Mount Warrick.

Ordovician sedimentary rocks occur on the periphery of the block, to the north and east of the boundary fault.

Soils

Gradational soils on alluvium, brown loams, and undifferentiated sandy loams occur in the King Valley.

Red duplex and friable reddish gradational soils occur on the lower valley slopes and in the Rose River area. The Wobonga plateau carries red and yellow duplex soils with some weakly bleached gradational soils and undifferentiated sandy loams.

Stony loams are associated with deeply weathered reddish and brownish gradational soils on the broad ridge-tops - for example, between Middle, Boggy, and Fifteen Mile Creeks and the King River. Less deeply weathered friable reddish and brownish gradational soils occur on

Stony Creek Valley from Paradise Falls

the middle slopes with yellow duplex soils on the lower, less-steep slopes where drainage is poor.

Land systems

The valleys are included in the Ovens and Myrtleford--Whitfield land systems. The plateau country to the south and east forms part of the Wabonga land system. The remaining hilly country is included in the Drum Top, Toombullup, Mahaikah, King, and Koonika land systems.

Vegetation

Narrow-leaf peppermint forms a large proportion of the forests in this block. Broad-leaf peppermint forest occurs in localities with poorer growing conditions, the Wabonga plateau (near Paradise falls) carries large areas of such forest, with a heathy understorey. Messmate stringybark is found in several places, sometimes in pure stands but

Nodding blue-lily

usually mixed with narrow-leaf peppermint and manna gum. It normally occurs on the deep clay soils on flat or moderately sloping ground. Small areas of alpine ash occur in the south of the block.

Fauna

The animal species typical of the habitats that occur in this block are discussed in Chapter 10 and listed in Appendix 5.

The main animal habitats on public land are dry and wet open forest. The aquatic habitat is represented by the King River, Lake William Hovell, and many creeks, the largest of which are Fifteen Mile and Boggy. The agricultural habitat is mainly pasture with scattered trees, but some of the river flats support irrigated crops. The abundance and diversity of wildlife reflects the quality and range of habitats present. Peregrine falcons are known to nest in the block.

Capabilities

Nature conservation

The area has high capabilities for nature conservation.

The geology, topography, and altitude are important factors in the diversity of vegetation types and habitats present here. Messmate stringybark and broad-leaf peppermint with a heathy understorey only occur within this block in the study districts. Access is difficult in the south, where some inaccessible areas remain in a relatively natural condition.

Generally the flora and fauna are probably typical of the forests and habitats that occur in this area, although they are not known in detail.

Recreation

Location, access, topography, and scenic values give this block high recreational capabilities.

Public land in the block is traversed by the main Tolmie--Whitfield road, and several tracks within it are reasonable, although not always suitable for two-wheel-drive vehicles.

Significant tourist attractions include Power's look-out, Paradise falls, and Lake William Hovell. The varied and impressive topography adds to the scenic qualities of these areas, notably the plateaux, steep hillsides with cliffs, and rocky peaks such as Mount Typo.

Limited water sports are available at Lake William Hovell. (Approximately 8,000 people visited the lake between June and November 1973.) The lake and principal streams provide fishing and the area offers some duck-shooting and deer-hunting (Sambar).

There are opportunities for nature study and bush-walking. Picnicking and pleasure driving are also important.

Agriculture

The main agricultural enterprises are beef and tobacco production. There is some potential to increase production by higher stocking rates.

Generally the public land has low to moderate capabilities for agriculture. Forests near Whitlands have capabilities for grazing after clearing. The growing season for pasture in this area would extend into mid summer, but low temperatures would severely limit pasture growth during the winter months. The block is used for apiculture: the Fifteen Mile and Boggy Creek areas are important for queen bee production.

Softwoods

The location of the block makes it potentially suitable for plantations in both the Ovens and Benalla--Mansfield plantation development zones.

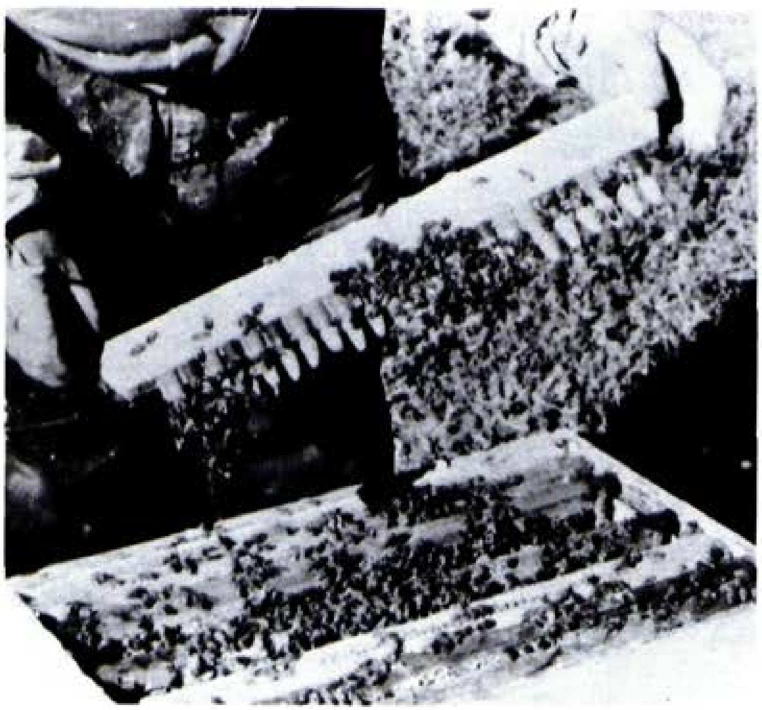
Poor soil moisture status and steep valley sides make much of the block unsuitable for softwood production. However, the basin south-west of Mount Warrick and the land between the Rose River and Mount Warrick have capabilities. Most of the south-western portion of the block (between the headwaters of Middle Creek and Whitfield--Tolmie road, and west of the West Branch of the King River) has plantation capabilities and so does the lower portion of the Boggy Creek Valley.

Hardwood

The capabilities for hardwood production vary from low to moderate.

Messmate stringybark and some of the associated narrow-leaf peppermint forest have capabilities for intensive hardwood production, especially in the vicinity of Middle and Boggy Creeks and to the west of the King River. Other areas have capabilities for less-intensive production, and consist of peppermint forest with some messmate stringybark.

Forests on the very steep hillsides are not suitable for hardwood production. Generally, long-leaf box and broad-leaf peppermint forests on the dry northern slopes and on the Wabonga plateau are unproductive.



Queen bee breeding cells

Minerals

Small finds of copper have been made in the area, but they appear to be economically uninteresting. Small deposits of hill gravels suitable for roading material occur near the Tolmie--Whitlands road.

Water

The block has moderate to high capabilities for water production. The region is drained by Middle, Fifteen Mile, and Boggy Creeks and by the King and Rose Rivers.

Lake William Hovell, sited on the King River, impounds 12,300 Ml and provides water for additional irrigation, as well as securing the local water supply (the dam was completed in 1971).

A small creek catchment immediately south of the Whitlands--Whitfield road is used for Whitfield town water supply.

Public utilities

A double-circuit 220-kV line from Bright joins two single-circuit 330-kV lines from Myrtleford just south-west of Cheshunt. The combined lines are routed south-west to Tolmie and thence on to South Morang near Melbourne. A proposed additional 330-kV line would require another 20 m of easement on the northern side of the existing easement.

Conflicts and Hazards

Softwood plantations are an inflexible land use that conflicts with most other uses, notably with nature conservation, apiculture, hardwood timber production, and some forms of recreation (although the plantation environment provides opportunities for other forms of recreation). Logging and other plantation works increase the likelihood of soil erosion and reduced water quality.

Hardwood timber production is generally a flexible use, but becomes inflexible with increasing intensity. It conflicts with some aspects of nature conservation and can adversely affect water quality.

Recreation is usually a flexible land use. Recreation that requires a natural environment is more inflexible. Overcrowding could become a problem at some popular sites, and could increase the conflict with nature conservation and maintenance of aesthetic values of these sites.

Stricter forms of nature conservation conflict with most other uses. The bulk of conservation in this area is more flexible and compatible with many other land uses at low intensities.

Mining of road-making materials can reduce the scenic value of the area and increase the hazard of soil loss and water turbidity.

Easements for transmission lines are an inflexible land use that conflicts with most other uses and can reduce the scenic value of the region if improperly sited.

Fire is a constant hazard in these forests during the drier parts of the year.

The central and southern parts of the block have easily erodable soil. Long steep slopes create a severe hazard of sheet erosion after fire. Most of the rest of the hilly country has moderate to high erosion hazards.

Soils developed on basalt generally have a low erosion hazard, as do the friable brownish gradational soils on the hilly plateau country north of Archerton.

Significance

The block has significance for nature conservation, apiculture, hardwood timber production, water production, recreation, and softwood production.

APPENDICES

APPENDIX 1

METRIC CONVERSION FACTORS

QUANTITY	METRIC UNIT	IMPERIAL UNIT	METRIC TO IMPERIAL	IMPERIAL TO METRIC
Length	millimetre (mm)	inch (in)	1 mm = 0.0394 inch	1 inch = 25.4 mm
	centimetre (cm)		1 cm = 0.3937 inch	1 inch = 2.54 cm
	metre (m)	foot (ft)	1 m = 3.281 feet	1 foot = 0.305 m (30.5 cm)
	kilometre (km)	mile	1 km = 0.6214 mile	1 mile = 1.61 km
Area	hectare (ha)	acre (ac)	1 ha = 2.47 acres	1 acre = 0.405 ha
	square kilometre (sq km) (= 100 ha)	square mile (sq mile)	1 sq km = 0.3861 sq mile (247 ac)	1 sq mile = 2.592 sq km
Mass	kilogram (kg)	pound (lb)	1 kg = 2.20 lb	1 lb = 0.454 kg
	tonne (t) (= 10,000 kg)	ton	1 t = 0.984 ton	1 ton = 1.02 t
Volume	cubic metre (m^3)	cubic foot (ft^3)	1 m^3 = 35.31 ft^3	1 ft^3 = 0.0283 m^3
		super foot (timber)	= 423.7 super feet true	1 super foot true = 0.00283 m^3
			= 332.6 super feet (Hoppus log volume)	1 super foot HLV = 0.003 m^3
	megalitre (= 1,000,000 litres)	acre feet (ac ft)	1 Ml = 0.8098 ac ft	1 ac ft = 1.235 Ml
Temperature	degree Celsius (°C)	degree Fahrenheit (°F)	1°C = 5/9 (°F - 32)	1°F = 9/5 (°C +32)
Compound Units	tonnes per hectare (t/ha)	bushels/acre	1 t/ha = 14.9 bushels/ac (wheat)	1 bushel/ac = 0.087 t/ha
			= 17.9 bushels/ac (barley)	= 0.056 t/ha
			= 22.2 bushels/ac (oats)	= 0.045 t/ha
	milligrams per litre (mg/l)	parts per million (ppm)	1 mg/l = 1.000 ppm	1 ppm = 1.000 mg/l
	litres per second l/s	gallons per hour (gph)	1 l/s = 791.7 gph	1 gph = 0.00126 l/s

Appendix 2

Climatic data

TABLE A

MEAN AND MEDIAN RAINFALL IN MILLIMETRES

Station and altitude District: Lower North-east No. 82	Years of record		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Barnawatha 198m	81	Mean	34	29	37	37	46	57	54	55	42	48	38	37	512
		Median	23	18	31	29	37	50	45	53	35	39	28	25	478
Beechworth 549m	100	Mean	44	52	62	66	90	110	103	100	77	88	64	57	921
		Median	31	41	48	51	73	100	93	93	82	87	53	46	918
Callaghan Creek	60	Mean	53	55	64	71	92	103	114	119	94	109	75	67	1015
		Median	47	40	52	56	73	95	90	116	87	108	58	62	1025
Carboor 914m	62	Mean	45	51	54	63	90	107	110	109	85	87	62	53	911
		Median	36	31	40	48	68	97	97	105	79	81	51	45	949
Chiltern P.O. 211m	88	Mean	40	43	47	49	61	77	72	70	61	63	48	48	675
		Median	26	26	35	42	54	75	64	67	62	59	37	44	669
Eldorado 177m	78	Mean	36	41	45	47	58	71	68	67	60	66	48	46	649
		Median	26	25	31	36	49	67	62	65	53	66	38	37	637
Everton	36	Mean	37	34	45	42	54	71	69	66	61	65	54	44	679
		Median	28	25	35	25	46	66	64	65	60	69	47	37	677
Indigo	69	Mean	37	36	40	44	53	66	66	64	52	56	43	43	599
		Median	24	24	26	36	47	65	59	61	49	49	36	30	586
Kergunyah South	75	Mean	47	52	64	61	81	112	102	95	80	87	62	57	896
		Median	33	37	50	56	68	110	94	89	74	83	47	53	866
King Valley	19	Mean	36	41	65	73	93	119	134	115	86	100	69	58	924
		Median	19	33	52	52	67	110	120	113	86	95	58	50	891
Middle Creek (Leneva)	56	Mean	39	40	55	55	67	102	93	83	61	80	53	51	775
		Median	34	29	49	53	52	98	77	81	59	69	40	36	761
Milawa 155m	70	Mean	38	42	46	46	59	71	71	69	59	64	45	48	656
		Median	28	27	36	31	51	63	64	67	54	62	32	40	643
Mitta Mitta 357m	49	Mean	54	55	67	65	90	124	121	113	90	104	71	68	1019
		Median	46	39	57	49	80	107	111	106	84	100	62	56	1010
Mt. Buffalo Chalet 1330m	48	Mean	82	95	106	136	192	219	223	226	190	193	134	110	1892
		Median	63	65	88	98	151	197	214	217	191	175	111	96	1896
Moyhu	57	Mean	43	45	44	49	71	89	85	78	69	71	51	45	734
		Median	26	36	36	36	56	91	73	75	63	65	40	36	733
Myrrhee 320m	30	Mean	52	53	53	75	97	110	125	126	93	93	69	47	982
		Median	41	40	35	58	67	103	115	127	100	88	61	47	998
Myrtleford 223m	65	Mean	45	48	60	61	84	104	106	102	83	91	60	60	902
		Median	37	35	51	50	65	101	98	104	77	90	48	51	917
Osbornes flat	34	Mean	43	43	58	52	72	100	100	89	73	82	55	53	850
		Median	36	30	40	39	67	85	89	82	62	67	40	47	833
*Rutherglen 183m	59	Mean	34	38	40	42	51	59	59	59	51	57	43	43	572
		Median	27	25	25	38	47	50	51	62	44	53	29	38	564
Springhurst 191m	64	Mean	36	40	45	44	53	65	59	59	52	59	44	42	587
		Median	22	28	31	37	50	56	55	61	46	54	32	32	571
Tallangatta 198	89	Mean	47	47	58	56	74	91	88	81	74	82	62	58	828
		Median	38	39	42	48	65	91	76	82	76	77	50	49	814
Tangambalanga Kiewa	68	Mean	43	41	52	51	70	95	90	83	64	77	51	49	766
		Median	31	29	45	43	57	95	81	82	56	67	39	41	734
Tallangatta Annandale 366m	84	Mean	47	45	58	56	72	94	88	85	74	81	62	61	823
		Median	40	33	45	52	63	94	77	79	69	76	56	55	827
Wangaratta 145m	93	Mean	36	38	47	47	56	71	64	63	59	61	46	43	635
		Median	25	28	33	39	47	71	57	61	51	57	38	30	615

Station and altitude District: Lower North-east No. 82	Years of record		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Whorouly 179m	43	Mean	38	52	48	55	66	72	77	82	63	74	55	51	733
		Median	27	31	40	48	52	64	60	78	62	61	50	45	731
Wodonga P.O. 164m	69	Mean	38	38	50	48	65	84	81	75	61	72	48	51	711
		Median	30	24	37	40	55	80	71	77	57	67	41	46	707
Wooragee 244m	72	Mean	40	40	54	60	76	93	92	86	73	76	53	49	785
		Median	34	26	33	48	70	89	77	89	65	72	39	44	786
Yackandandah 306m	85	Mean	46	49	62	65	91	118	112	104	87	89	62	59	943
		Median	33	30	49	51	79	113	97	98	82	82	48	51	936
Stanley State Forestry	31	Mean	56	56	68	90	136	126	158	150	116	128	92	66	1234
		Median	43	42	59	71	105	118	124	148	120	122	90	55	1258
*Towong Upper	27	Mean	53	54	70	60	90	74	105	103	34	102	83	68	947
		Median	55	54	49	61	69	71	98	96	76	96	69	57	1006
Little Snowy Creek	17	Mean	54	68	61	71	86	111	123	121	80	113	87	55	1029
		Median	30	48	60	43	61	127	118	107	64	111	84	43	1034
Mitta Mitta (Forestry) 323m	19	Mean	54	61	64	81	110	93	127	135	101	105	87	76	1080
		Median	40	42	54	60	85	80	107	123	112	103	79	66	1080
Dederang	14	Mean	42	41	57	38	94	129	100	96	92	79	51	58	903
		Median	34	23	52	19	79	114	107	95	91	60	42	45	891
Eskdale	41	Mean	52	50	62	60	79	133	106	99	96	93	67	66	965
		Median	47	39	49	59	67	133	104	92	91	81	49	58	945
*Glenrowan	24	Mean	41	32	41	36	66	98	77	67	71	67	48	51	693
		Median	28	31	35	26	57	85	84	56	61	63	30	48	663
Whitfield 246m	50	Mean	53	52	67	73	115	140	146	136	104	98	69	61	1128
		Median	45	29	48	58	89	130	132	129	97	93	58	53	1113
District: Upper North-east No. 83															
*Bogong 732m	34	Mean	74	83	93	137	183	197	247	238	167	169	126	93	1809
		Median	55	60	68	100	135	171	241	232	157	150	112	90	1777
Bright P.O. 305m	87	Mean	53	52	68	71	102	132	126	124	104	107	74	70	1084
		Median	41	37	57	62	81	126	126	123	104	106	68	58	1080
Dandongadale 344m	67	Mean	57	55	73	85	119	146	161	148	116	112	82	70	1219
		Median	42	38	53	55	89	127	154	141	107	105	72	59	1221
Eurobin About 270m	48	Mean	53	58	69	83	108	123	143	136	102	104	77	62	1116
		Median	32	39	55	67	83	121	136	131	95	92	63	51	1131
Harrietville 396m	70	Mean	66	72	77	91	134	166	173	170	140	139	96	87	1408
		Median	47	56	61	72	110	150	161	158	135	134	79	76	1386
*Mt. Beauty 366m	25	Mean	59	64	72	98	126	113	150	158	121	135	93	78	1255
		Median	41	54	65	68	89	102	142	141	107	125	83	72	1213
Smoko	56	Mean	57	61	68	80	114	126	143	147	110	114	79	69	1173
		Median	37	45	57	64	90	122	133	145	104	97	73	62	1183
Whitlands 869m	40	Mean	66	64	88	111	141	165	181	174	123	130	95	76	1404
		Median	51	36	60	91	92	150	171	170	123	117	83	61	1345
Tawonga 2	27	Mean	56	58	64	87	109	108	142	135	97	116	84	65	1122
		Median	38	51	59	67	75	100	127	125	100	102	82	65	1118
Dandongadale (Abbey-ards) About 320m	5	Mean	62	76	134	145	147	191	208	203	140	148	119	91	1543
		Median	59	58	129	111	141	216	215	202	163	140	102	65	1398
Tawonga	28	Mean	47	48	80	71	119	160	152	141	120	110	72	77	1197
		Median	47	40	59	60	106	141	144	152	117	100	62	64	1222
Myrtleford Tobacco Research Station 235m	11	Mean	51	62	52	82	115	85	120	128	110	90	70	66	993
		Median	36	49	45	66	101	86	115	124	123	89	58	60	1091

TABLE B

MONTHLY MAXIMUM, MINIMUM AND AVERAGE TEMPERATURES (^{o}C)

MONTH

Station and altitude		Number of Recorded Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Beechworth 549 m	Maximum	61	27.3	27.1	24.0	18.6	13.9	10.8	9.7	11.3	14.5	17.8	21.6	25.0
	Minimum		13.5	13.8	11.5	8.0	5.4	3.7	2.8	3.5	5.1	7.3	9.4	11.8
	Average		20.4	10.5	17.8	13.3	9.7	7.3	6.3	7.4	9.8	12.6	15.5	18.4
Benalla* 170 m	Maximum	66	31.2	30.9	27.5	22.2	17.3	13.6	12.7	14.6	17.8	21.6	25.6	29.0
	Minimum		14.8	14.7	12.3	8.6	5.8	3.9	3.4	4.1	5.5	8.2	10.5	12.9
	Average		23.0	22.8	19.9	15.4	11.6	8.8	8.1	9.4	11.9	14.9	18.1	21.0
Mitta Mitta 320 m	Maximum	2	29.8	28.7	25.5	19.9	14.6	11.3	11.3	12.6	17.0	18.9	22.3	26.1
	Minimum		11.8	12.9	10.5	6.9	3.5	1.9	1.3	1.7	3.2	5.3	6.6	8.7
	Average		20.8	20.8	18.0	13.4	9.1	6.6	6.3	7.2	10.2	12.1	14.5	17.4
Mt. Beauty 366 m	Maximum	7	28.8	28.1	26.0	19.4	15.3	12.7	11.5	12.9	17.0	18.6	21.5	26.5
	Minimum		11.4	12.1	10.3	6.5	4.2	2.4	1.6	2.1	4.3	6.5	7.6	10.4
	Average		20.1	20.1	18.2	13.0	9.8	7.6	6.6	7.5	10.7	12.6	14.6	18.5
Mt. Buffalo 1,330 m	Maximum	44	19.5	19.1	16.4	11.5	7.9	4.9	3.7	4.6	8.0	10.9	14.3	17.4
	Mimimum		10.7	11.0	8.9	5.3	2.6	0.3	-0.6	-0.2	1.8	3.7	6.3	9.1
	Average		15.1	15.1	12.7	8.4	5.3	2.6	1.6	2.2	4.9	7.3	10.3	13.3
Myrtleford 222 m	Maximum	26	30.8	30.0	27.3	21.8	17.0	13.5	12.6	14.5	17.9	20.9	24.5	28.5
	Minimum		11.7	11.8	9.3	6.0	4.1	2.4	2.1	2.8	3.8	6.0	8.0	10.1
	Average		21.3	20.9	18.3	13.9	10.6	8.0	7.4	8.7	10.9	13.5	16.3	19.3
Rutherglen* Exp. Farm 183 m	Maximum	52	31.2	30.6	27.3	21.5	16.7	13.1	12.2	13.9	17.3	21.0	25.2	29.4
	Minimum		13.7	13.9	11.0	7.2	4.3	2.7	2.2	2.9	4.4	6.6	8.8	11.8
	Average		22.5	22.3	19.2	14.4	10.5	7.9	7.2	8.4	10.9	13.8	17.0	20.6
Springhurst 190 m	Maximum	4	25.9	15.3	23.1	17.9	12.7	8.9	8.7	9.5	13.2	15.6	18.1	22.7
	Minimum		9.7	9.9	8.3	5.0	2.2	1.0	0.0	0.5	1.2	4.0	5.1	7.4
	Average		17.8	17.6	15.7	11.5	7.5	5.0	4.4	5.0	7.2	9.8	11.6	15.1
Wangaratta 150 m	Maximum	68	31.0	30.6	27.3	22.0	17.3	13.6	12.7	14.5	17.6	21.1	25.4	28.9
	Minimum		15.0	14.9	12.3	8.4	5.4	3.8	3.3	4.2	5.8	8.2	10.7	13.2
	Average		23.0	22.8	19.8	15.2	11.4	8.7	8.0	9.4	11.7	14.7	18.1	21.1
Wodonga* 164 m	Maximum	13	31.7	30.9	28.1	22.7	16.8	14.0	12.5	14.8	18.0	21.4	25.4	28.6
	Minimum		15.0	15.2	12.6	8.8	5.5	4.0	3.1	4.1	5.7	8.4	10.4	13.2
	Average		23.4	23.1	20.4	15.8	11.2	9.0	7.8	9.5	11.9	14.9	17.9	20.9

* Outside the study districts

Source: Bureau of Meteorology

TABLE C

AVERAGE NUMBER OF WET DAYS AND AVERAGE RAINFALL PER WET DAY (MILLIMETERS)

Station		JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
Callighan Creek	Days	4	4	5	7	7	8	8	9	7	9	6	5	79
	R.P.W.D.	13.02	15.30	13.72	11.54	11.54	12.76	13.14	12.59	12.26	12.60	12.40	12.04	12.63
Carboor	Days	4	5	5	7	9	11	13	13	9	11	8	6	101
	R.P.W.D.	11.43	9.65	11.74	10.49	8.10	9.51	8.56	8.07	8.49	8.22	8.35	7.96	8.93
Chiltern	Days	5	5	5	8	10	12	14	14	11	11	8	7	110
	R.P.W.D.	8.74	7.98	9.75	7.46	5.74	6.10	5.44	4.95	5.38	6.56	6.86	6.39	6.35
Dandongadale	Days	5	5	6	8	9	11	13	13	10	11	8	7	106
	R.P.W.D.	11.53	12.04	13.46	12.51	12.47	13.35	12.84	11.84	11.20	10.92	11.05	9.72	11.96
Eldorado	Days	3	4	4	6	7	8	10	10	7	8	5	4	76
	R.P.W.D.	13.29	11.75	12.32	9.40	7.55	8.22	7.01	6.40	7.84	8.99	10.82	10.60	8.80
Eurobin	Days	5	5	6	8	10	12	14	15	11	12	8	7	113
	R.P.W.D.	10.67	11.18	13.12	11.33	9.98	10.44	10.14	8.99	8.68	9.27	9.78	9.14	10.00
Smoko	Days	4	5	5	5	6	9	9	10	7	8	5	4	77
	R.P.W.D.	14.73	13.77	15.75	18.49	17.20	14.42	16.28	15.32	14.55	15.53	17.68	15.56	15.68
Tallangatta	Days	4	4	5	7	7	9	11	11	8	9	6	5	86
	R.P.W.D.	12.00	13.21	12.45	9.07	10.12	9.60	8.27	8.41	8.83	9.99	10.92	10.82	9.85
Whitlands	Days	5	5	6	8	10	12	14	14	10	12	8	7	111
	R.P.W.D.	13.26	13.21	15.79	13.91	13.84	15.39	13.55	12.68	12.40	11.45	12.45	10.38	13.17
Wooragee	Days	4	4	4	7	8	10	11	11	9	9	7	5	89
	R.P.W.D.	10.22	9.14	12.76	10.27	8.89	8.97	8.24	7.57	7.99	9.54	8.16	9.04	8.94

SOURCE: "Rainfall Statistics Victoria"
(Commonwealth of Australia, Bureau of Meteorology, 1966)

R.P.W.D. - Rainfall per wet day

TABLE D

PERCENTAGE FREQUENCY OF OCCURRENCE OF RAINFALL EQUAL TO OR GREATER THAN THE "EFFECTIVE" AMOUNT

Station	MONTH											
	Jan %	Feb %	Mar %	Apr %	May %	Jun %	Jul %	Aug %	Sep %	Oct %	Nov %	Dec %
Wangaratta	19	26	46	61	85	96	96	93	89	76	42	32
Chiltern	27	35	45	62	83	100	98	95	91	73	42	40
Wodonga	31	33	51	65	85	99	100	95	86	75	42	42
Tallangatta	38	48	54	73	90	99	99	95	93	88	60	54
Yackandandah	36	41	60	72	91	99	100	100	98	86	55	55
Beechworth	33	44	57	75	91	100	99	96	96	88	59	49
Myrtleford	40	33	60	69	93	100	100	94	96	83	58	56
Bright	44	45	68	77	93	100	100	97	98	92	73	67
Harrietville*	63	68	73	87	97	100	100	99	100	96	87	78
Whitfield	47	40	62	71	90	98	100	96	96	85	68	62
Mitta Mitta	52	50	70	76	90	100	99	95	99	90	68	65

* Outside the study districts

Source: "Resources Survey, Upper Murray Region." (Central Planning Authority: Melbourne 1949.)

Note: Effective rainfall is the amount of rain necessary to start germination and to maintain plant growth above the wilting point.

TABLE E

VARIABILITY OF RAINFALL: DATA FOR THE 30 AND 70 PERCENTILES (mm)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Beechworth	30	15.2	17.8	26.4	29.2	52.3	83.1	67.8	69.6	65.3	55.9	31.2	28.2	759.5
	70	54.4	57.2	73.4	86.6	107.4	132.1	124.1	132.1	102.9	109.2	81.3	73.4	1033.0
Bright	30	21.8	23.6	31.8	31.2	59.9	84.3	84.6	95.3	77.7	77.5	47.8	50.4	942.6
	70	75.4	58.2	88.9	89.7	117.6	169.9	154.4	144.5	124.2	126.2	88.4	82.3	1182.4
Chiltern	30	14.5	13.0	15.5	23.4	34.8	59.9	48.5	50.3	44.3	37.6	22.1	22.6	583.4
	70	47.8	47.5	56.9	62.7	72.1	101.9	89.7	82.0	70.4	82.0	56.9	59.9	722.9
Eldorado	30	9.7	9.9	14.5	19.8	30.2	47.2	43.4	45.5	38.6	46.0	21.8	21.1	532.9
	70	43.4	42.4	50.5	60.9	71.9	88.1	84.3	86.1	72.1	77.5	55.9	59.7	725.4
Harrietville*	30	34.3	36.1	35.3	47.0	77.2	108.2	123.4	112.5	107.2	98.6	55.6	50.0	1235.2
	70	85.3	85.6	115.3	112.0	168.9	211.8	207.5	219.2	164.1	165.1	105.9	114.3	1538.0
Myrtleford	30	19.8	14.5	24.9	32.5	52.3	82.6	72.9	75.7	63.0	62.2	38.1	32.0	758.2
	70	58.7	50.5	66.0	78.2	109.7	136.7	129.5	130.0	103.1	108.2	70.1	74.2	982.0
Rutherglen Post Office*	30	8.6	11.7	14.5	18.5	25.7	49.3	39.6	41.4	31.5	36.3	16.5	22.4	502.7
	70	48.0	47.8	56.1	54.4	65.3	81.3	75.9	74.4	61.2	77.0	49.5	54.4	637.0
Wangaratta	30	11.2	11.4	14.2	19.6	31.2	51.3	43.4	42.9	38.9	42.9	22.6	18.5	550.4
	70	41.4	40.1	62.7	59.9	63.8	91.9	80.8	84.6	69.9	74.7	61.5	56.4	687.3
Wodonga*	30	11.9	10.7	20.1	25.4	35.8	60.5	53.8	56.6	40.9	43.9	25.7	18.8	618.5
	70	55.9	44.2	65.5	59.4	82.6	106.4	96.8	93.0	77.5	88.6	54.3	61.0	767.1
Yackandandah	30	18.0	12.4	25.7	30.0	47.2	81.8	73.4	80.5	63.5	57.2	31.2	27.4	777.2
	70	52.8	48.0	82.0	91.2	111.2	147.6	138.7	124.7	105.2	114.0	74.4	74.4	1031.0

* Outside study districts

Source: Bureau of Meteorology

APPENDIX 3

WATER QUALITY CRITERIA
(Total Dissolved Solids Only)

Domestic (including drinking)

Above 3,000 mg/l - unsuitable
Below 750 mg/l - suitable

Many factors affect the suitability of water for domestic use; for example, hardness, turbidity, organic content, etc. Waters in the range 750--3,000 T.D.S. may be used if the chemicals they contain do not cause health problems due to toxicity or other physical effects.

Stock

Below 2,000 mg/l - suitable for all livestock, but many animals will survive on much higher concentrations.

Irrigation

Victorian waters fall into the following classes according to content of total soluble salts:

Class 1: Low-salinity water, with all methods of water application, can be used with most crops on most soils with little likelihood that a salinity problem will develop. Some leaching is required, but this occurs under normal irrigation practices, except in soils of extremely low permeability.
Total soluble salts (ppm): 0--175

Class 2: Medium-salinity water can be used if a moderate amount of leaching occurs. Plants with medium salt tolerance can be grown, usually without special practices for salinity control. Sprinkler irrigation with the more saline waters in the group may cause leaf scorch on salt-sensitive crops, especially at high temperatures in the daytime and with low water application rates.
Total soluble salts (ppm): 175--500

Class 3: High-salinity water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required, and the salt tolerance of the plants to be irrigated must be considered.
Total soluble salts (ppm): 500--1,500

Class 4: Very high-salinity water is not suitable for irrigation under ordinary conditions. For use, soils must be permeable with adequate drainage water must be applied in excess to provide considerable leaching, and salt-tolerant crops should be selected.
Total soluble salts (ppm): 1,500--3,500

Class 5: Extremely high-salinity water may be used only on permeable well-drained soils under good management,

especially in relation to leaching and for salt-tolerant crops, or for occasional emergency use.
Total soluble salts (ppm): Above 3,500

Source: "Quality Aspects of Farm Water Supplies" (Department of National Development: Canberra, 1969.)

Within the limitations imposed by the above framework, water may be suitable for irrigation provided other aspects of its chemical analysis and method of use are satisfactory.

APPENDIX 4

TABLE A

The most common plants in the study districts and their distribution within the vegetation mapping classes.

Scientific name	Major species of tallest stratum and map symbol: SNOW GUM 3	ALPINE ASH 5	NARROW-LEAF PEPPERMINT 7	MESSMATE STRINGYBARK 6	BROAD-LEAF PEPPERMINT 8a	BROAD-LEAF PEPPERMINT 8b	SWAMP GUM 14	GREY BOX 11	RED IRONBARK 10	LONG-LEAF BOX 9a	BLAKELY'S RED GUM 13a	CYPRESS PINE 12	Common name
Acacia dealbata	X	X	X	X	X	X	X			X	X	X	Silver wattle
Acacia implexa										X			Lightwood
Acacia kettlewelliae					X								Buffalo wattle
Acacia lanigera										X			Woolly wattle
Acacia longifolia		X											Sallow wattle
Acacia melanoxylon			X	X			X						Blackwood
Acacia obliquinervia	X					X							Mountain hickory wattle
Acacia pravissima							X						Ovens wattle
Acacia pycnantha								X	X				Golden wattle
Acacia rubida					X	X							Red-stemmed wattle
Acacia verniciflua					X								Varnish wattle
Acaena agnipila	X					X				X			Sheep's burr
Acaena anserinifolia	X	X	X	X	X	X	X			X			Bidgee-widgee
Acaena echinata	X												Sheep's burr
Acetosella vulgaris *	X		X										
Acianthus reniformis												X	Mosquito orchid
Acrotriche prostrata			X	X	X	X	X						Trailing ground-berry
Adiantum aethiopicum			X				X				X		Common maidenhair
Agropyron scabrum			X			X		X				X	English couch
Agrostis avenacea			X					X					Blown grass
Agrostis parviflora				X									Bent
Aira caryophyllea *	X	X	X		X	X	X	X	X	X	X	X	Silver hair grass
Ajuga australis			X		X	X							Austral bugle
Amyema pendulum			X										Drooping mistletoe
Anagallis arvensis			X			X		X	X	X		X	Pimpernel

	3	5	7	6	8a	8b	14	11	10	9a	13a	12	
Anguillaria dioica			X		X	X	X	X		X		X	Early nancy
Anthoxanthum odoratum *			X							X	X	X	Sweet vernal grass
Aphanes arvensis *	X		X										Parsley piert
Aphelia gracilis											X		Slender aphelia
Arthropodium milleflorum		X	X	X		X	X				X		Pale vanilla lily
Arthropodium minus					X			X					Small vanilla lily
Asperula conferta	X	X	X	X	X	X	X	X					Common woodruff
Asperula scoparia			X			X				X			Prickly woodruff
Asplenium bulbiferum				X									Mother spleen wort
Asplenium flabellifolium			X	X		X							Necklace fern
Astrotricha sp.			X		X	X							Star-hair
Australina muelleri		X	X	X			X						Shade nettle
Baumea rubiginosa				X			X						
Bedfordia salicina		X	X				X						Blanket leaf
Billardiera scandens				X		X							Common apple berry
Blechnum nudum		X	X				X						Fishbone water-fern
Blechnum procerum			X										Hard water-fern
Boronia nana					X	X		X					Dwarf boronia
Bossiaea buxifolia					X								Matted bossiaea
Brachycome angustifolia	X	X	X			X				X		X	Daisy
Brachycome diversifolia						X							Tall daisy
Brachyloma daphnoides									X	X	X	X	Daphne heath
Briza maxima *							X	X		X	X		Large quaking grass or shell grass
Briza minor *			X		X	X	X	X	X	X	X	X	Lesser quaking grass
Bromus mollis *			X					X		X			Soft brome
Bromus sterilis *						X							Barren brome
Brunonia australis			X		X	X			X	X			Blue pincushion
Bulbine bulbosa										X			Bulbine lily
Burchardia umbellata			X		X	X	X			X	X		Milkmaids
Bursaria spinosa					X								Sweet bursaria
Calandrinia eremaea					X							X	Small purslane
Callistemon sieberi							X						Alpine bottlebrush
Callitris endlicheri												X	Black cypress pine
Calochilus robertsonii								X					Purplish beard-orchid
Calytrix tetragona					X								Fringe myrtle
Carduus pycnocephalus *			X			X		X		X			Slender thistle
Carduus tenuiflorus *			X					X					Slender thistle
Carex appressa			X	X			X						Tall sedge
Carex breviculmis	X	X	X			X	X	X		X		X	Sedge

	1	5	7	8	8a	8b	14	11	10	9a	13a	12	
Carex gaudichaudiana											X		Sedge
Carex inversa			X		X		X	X					Sedge
Cassinia aculeata	X	X	X		X	X			X				Common cassinia
Cassinia longifolia			X			X	X						Shiny cassinia
Cassytha melantha		X	X										Coarse dodder-laurel
Centaurium minus *			X	X	X	X	X			X		X	Common centaury
Centaurium pulchellum *								X	X	X	X	X	Centaury
Centella cordifolia							X				X		Centella
Centrolepis strigosa											X		Hairy centrolepis
Cerastium glomeratum *	X		X			X			X	X		X	Mouse-ear chickweed
Cheilanthes tenuifolia				X	X				X	X		X	Rock fern
Cheiranthera linearis									X				Finger flower
Chiloglottis gunnii	X	X	X	X	X		X						Common bird-orchid
Chiloglottis reflexa					X		X						Autumn bird-orchid
Chrysanthemum vulgare *			X			X		X					Tansy
Cirsium vulgare *			X							X			Spear thistle
Clematis aristata			X	X		X	X						Australian clematis
Coprosma hirtella		X	X	X									Rough hirtella
Coprosma quadrifida		X	X	X		X							Prickly currant bush
Correa lawrenciana			X				X						Mountain correa
Corybas sp.		X		X		X				X			Helmet-orchid
Cassinia aculeata	X	X	X		X	X			X				Common cassinia
Cicendia filiformis *											X		Slender cicendia
Cotula filicula	X	X	X				X						Mountain cotula
Craspedia glauca	X		X			X					X		Common billy button
Crassula peduncularis								X					Purple crassula
Crassula sieberana					X			X	X			X	Sieber crassula
Cymbonotus preissianus		X	X	X	X	X	X			X			Austral bear-ear
Cynoglossum suaveolens	X												Sweet hounds' tongue
Cyperus lucidus			X				X				X		Leafy flat-sedge
Cyperus tenellus								X			X		Tiny flat-leaf
Danthonia sp.			X			X	X	X	X	X			Wallaby-grass
Danthonia pallida			X		X	X				X			Silvertop wallaby-grass
Danthonia penicillata													Slender wallaby-grass
Danthonia semiannularis											X		Wallaby-grass
Daucus glochidiatus			X	X	X	X		X	X	X		X	Austral carrot
Daviesia latifolia	X	X	X			X							Hop bitter-pea
Daviesia ulicifolia	X		X			X							Gorse bitter-pea
Daviesia virgata			X			X			X				Narrow-leaf bitter-pea
Desmodium varians			X										Slender tick-trefoil
Deyeuxia sp.			X										Bent grass
Deyeuxia quadriseta							X						Reed bent grass
Deyeuxia rodwayi													Bent grass
Dianella revoluta	X		X		X	X		X	X	X	X		Black anther flax lily
Dianella tasmanica		X	X	X		X	X						Tasman flax lily
Dichelachne sciurea			X	X	X	X	X	X	X	X			Short-hair plume grass

	3	5	7	6	8a	8b	14	11	10	9a	13a	12	
Dichondra repens	X	X	X	X	X	X	X						Kidney weed
Dichopogon strictus										X	X		Chocolate lily
Dichopogon fimbriatus											X		Nodding chocolate lily
Dicksonia antarctica		X	X				X	X	X				Soft tree-fern
Dillwynia retorta					X	X			X	X			Small leaf parrot pea
Dillwynia sericea									X	X			Showy parrot pea
Diuris sulphurea						X							Tiger orchid
Drosera arcturi			X										Alpine sundew
Drosera auriculata			X	X	X	X	X			X		X	Errienellam
Drosera peltata			X		X	X	X		X	X	X	X	Sundew
Cryptandra amara					X								Bitter cryptandra
Culcita dubia			X	X	X		X						Common ground fern
Echinopogon cheelii			X			X							Long-flower hedgehog grass
Echinopogon ovatus			X			X	X						Hedgehog grass
Eleocharis acuta								X			X		Common spike rush
Eleocharis atricha											X		Tuber spike rush
Eleocharis gracilis							X						Slender spike rush
Epilobium cinereum	X		X	X		X	X			X			Variable willow herb
Eucalyptus blakelyi											X	X	Blakely's Red gum
Eucalyptus camphora			X				X						Mountain swamp gum
Eucalyptus cinerea											X		Argyle apple
Eucalyptus dalrympleana		X											Mountain gum
Eucalyptus delegatensis		X	X										Alpine ash
Eucalyptus dives			X	X	X	X							Broad-leaf peppermint
Eucalyptus goniocalyx					X	X				X		X	Long-leaf box
Eucalyptus macrorhyncha						X			X	X		X	Red stringybark
Eucalyptus mannifera					X	X				X			Brittle gum
Eucalyptus neglecta			X										Omeo gum
Eucalyptus obliqua				X									Messmate stringybark
Eucalyptus pauciflora	X	X											White sallee
Eucalyptus polyanthemos										X		X	Red box
Eucalyptus radiata			X	X									Narrow-leaf peppermint
Eucalyptus sideroxylon									X				Red ironbark
Eucalyptus St. johnii		X	X	X			X						Kurabbie (St. John blue gum
Eucalyptus viminalis		X	X	X			X						Manna gum
Euphrasia collina	X												Purple eyebright
Exocarpos cupressiformis									X				Cherry ballart
Exocarpos strictus							X						Pale-fruit ballart
Galium ciliare			X										Bedstraw
Galium divaricatum													Bedstraw
Galium sp.		X		X						X		X	Bedstraw
Galium gaudichaudii													Rough bedstraw
Galium murale *			X			X				X		X	Small goose grass
Galium propinquum			X			X							Maori bedstraw
Geranium dissectum *											X		Cut-leaf crane's bill
Geranium molle *		X	X										Dove's foot
Geranium potentilloides				X			X						Crane's foot

	3	5	7	6	8a	8b	14	11	10	9a	13a	12	
Geranium solanderi	X	X	X		X	X	X	X		X	X		Austral crane's bill
Glyceria australis							X						Austral sweet grass
Glycine clandestina		X	X	X	X	X	X			X			Twining glycine
Gnaphalium gymnocephalum	X		X	X	X	X	X			X	X		Cudweed
Gnaphalium sphaericum			X										Purple cudweed
Gompholobium huegelii					X	X							Common wedge pea
Goodenia elongata				X			X						Lanky goodenia
Goodenia hederacea									X				Ivy goodenia
Goodenia pinnatifida								X					Cut-leaf goodenia
Grevillea alpina					X								Cat's claw
Grevillea lanigera									X	X			Woolly grevillea
Haloragis elata												X	Raspwort
Haloragis **sp.**						X				X			Raspwort
Haloragis heterophylla													Raspwort
Haloragis micrantha							X						Creeping raspwort
Hardenbergia violacea					X	X				X			Purple coral-pea
Helichrysum dendroideum							X						Tree everlasting
Helichrysum scorpioides			X	X	X	X				X			Button everlasting
Helichrysum semipapposum		X	X			X							Clustered everlasting
Helichrysum sp. aff. *bracteatum*								X	X				Golden everlasting
Helipterum albicans									X	X			Hoary sunray
Helipterum australe								X	X				Common sunray
Helipterum corymbiflorum										X	X	X	Sunray
Hibbertia obtusifolia	X		X	X	X	X			X	X		X	Showy guinea-flower
Hibbertia sericea					X					X			Silky guinea-flower
Hibbertia stricta									X				Erect guinea-flower
Holcus lanatus *	X		X			X	X			X			Yorkshire fog
Hovea heterophylla					X	X							Common hovea
Hydrocotyle callicarpa								X	X	X		X	Pennywort
Hydrocotyle foveolata					X					X	X		Pennywort
Hydrocotyle hirta		X	X	X	X	X	X						Hairy pennywort
Hydrocotyle laxiflora	X	X	X	X	X	X	X	X	X	X		X	Stinking pennywort
Hydrocotyle sibthorpioides							X				X		Pennywort
Hydrocotyle sp.							X						Pennywort
Hypericum gramineum	X		X	X	X	X	X					X	Small St. John's wort
Hypericum japonicum							X						Matted St. John's wort
Hypericum perforatum *	X		X			X		X		X	X		St. John's wort
Hypochoeris radicata *					X								Cat's ear
Hypolepis sp.			X	X			X						Ground-fern
Hypoxis glabella											X		Yellow star
Hypoxis hygrometrica							X						Golden weather glass
Haloragis tetragyna	X		X	X	X	X	X		X	X	X	X	Common raspwort
Helichrysum rutidolepis		X	X										Everlasting

	3	5	7	6	8a	8b	14	11	10	9a	13a	12	
Indigofera australis						X							Australian indigo
Isoetes drummondii											X		Plain quillwort
Isotoma fluviatilis											X		Swamp isotome
Juncus bufonius			X				X	X	X	X	X		Toad rush
Juncus capitatus *								X	X	X	X	X	Capitate rush
Lagenophora stipitata	X	X	X		X	X	X			X			Common lagenphora
Lepidosperma laterale										X			Sword sedge
Leptorhynchos squamatus					X								Scaly buttons
Leptospermum brevipes			X										Slender tea-tree
Leptospermum grandifolium							X						Mountain tea-tree
Leptospermum juniperinum					X		X						Prickly tea-tree
Leptospermum phylicoides			X		X								Burgan
Leucopogon stuartii			X										Sharp beard-heath
Leucopogon virgatus					X					X			Common beard-heath
Levenhookia dubia								X	X	X		X	Hairy stylewort
Lilaeopsis polyantha							X						Australian lilaeopsis
Linaria sp.									X				Toad flax
Linum marginale						X							Native flax
Lobelia dentata			X			X							Lobelia
Lolium rigidum *								X					Wimmera ryegrass
Lomandra filiformis			X		X	X		X	X	X	X	X	Wattle mat-rush
Lomandra longifolia	X	X	X	X	X	X	X			X			Spring headed mat-rush
Lomatia fraseri		X	X			X	X						Forest lomatia
Lomatia ilicifolia					X	X							Holly lomatia
Lotus pedunculatus *			X				X						Greater bird's-foot trefoil
Luzula sp.	X	X	X			X	X			X	X	X	Woodrush
Luzula australasica													Alpine field woodrush
Luzula sp.			X			X	X			X			Woodrush
Lythrum hyssopifolia			X				X	X					Small loose strife
Marianthus procumbens					X								White marianthus
Mentha australis			X								X		River mint
Mentha laxiflora			X	X			X						Forest mint
Microlaena stipoides			X		X	X	X		X	X	X		Weeping grass
Microseris scapigera						X		X	X	X		X	Yam daisy
Microtis biloba											X		Onion orchid
Microtis oblonga											X		Sweet onion orchid

	3	5	7	6	8a	8b	14	11	10	9a	13a	12	
Microtis parviflora								X	X	X		X	Slender onion orchid
Microtis sp.							X						Onion orchid
Microtis unifolia										X	X	X	Common onion orchid
Mirbelia oxyloboides			X				X						Mountain mirbelia
Monotoca scoparia			X		X	X							Prickly broom heath
Montia australasica							X				X		White purslane
Montia fontana							X						Water blinks
Myosotis australis						X							Austral forget-me-not
Myriocephalus rhizocephalus								X					Woolly heads
Myriophyllum integrifolium											X		Water-milfoil
Notelaea ligustrina		X					X						Privet mock-olive
Olearia alpicola			X										Daisy-bush
Olearia argophylla			X	X									Musk daisy-bush
Olearia lirata			X										Snowy daisy-bush
Olearia phlogopappa		X	X				X						Dusty daisy-bush
Ophioglossum coriaceum					X		X			X	X	X	Austral adder's tongue
Oreomyrrhis eriopoda	X												Australian carroway
Oxalis corniculata	X	X	X		X	X	X	X		X		X	Yellow wood sorrel
Parahebe derwentiana		X	X			X	X						Derwent speedwell
Parahebe perfoliata									X				Speedwell
Parentucellia latifolia *												X	Common bartsia
Pentapogon quadrifidus					X		X			X	X		Spear grass
Persoonia chamaepeuce	X		X	X	X	X	X						Dwarf geebung
Phragmites australis											X		Common reed
Picris hieracioides *	X												Hawkweed picris
Pimelea axiflora		X	X	X			X						Bootlace bush
Pimelea humilis						X				X			Common rice flower
Pimelea sp.						X							Tall rice flower
Pimelea linifolia			X		X								Slender rice flower
Pimelea treyvaudii			X			X							Grey rice flower
Pittosporum bicolor				X									Banyalla
Plantago lanceolata *		X				X							Ribwort
Plantago varia	X		X	X		X	X			X			Variable plantain
Platylobium formosum	X	X	X	X	X	X	X			X			Handsome flat-pea
Pleurosorus rutifolius												X	Blanket fern
Poa sp.	X	X	X	X		X	X						Poa grass
Poa labillardieri			X	X	X	X	X			X			Poa grass
Poa sieberana		X	X	X	X	X	X			X			Poa grass
Podolepis jaceoides						X							Showy podolepis

	3	5	7	6	8a	8b	14	11	10	9a	13a	12	
Polystichum proliferum		X	X	X			X						Mother shield-fern
Pomaderris aspera		X	X	X			X						Hazel pomaderris
Poranthera microphylla	X		X	X	X	X	X			X		X	Small poranthera
Pratia pedunculata		X											Matted pratia
Prostanthera lasianthos			X										Victorian Christmas bush
Prunella vulgaris			X	X			X						Self-heal
Pteridium esculentum	X	X	X	X	X	X	X			X			Austral bracken
Pterostylis falcata							X						Sickle greenhood
Pultenaea cunninghamii					X	X							Grey bush-pea
Pultenaea foliolosa									X				Bush-pea
Pultenaea juniperina		X	X			X							Prickly bush-pea
Pultenaea largiflorens									X				Bush-pea
Pultenaea sp.										X			Bush-pea
Ranunculus lappaceus		X	X			X	X			X			Australian buttercup
Ranunculus sp.		X	X				X						Buttercup
Rananculus muricatus *													Sharp buttercup
Ranunculus pachycarpus			X	X		X	X						Thick-fruit buttercup
Ranunculus pumilio			X				X	X			X		Ferny smallflower buttercup
Ranunculus sessiliflorus			X	X						X			Australian small-flower buttercup
Romulea longifolia *								X					Onion grass
Rosa rubiginosa *													Sweet briar
Rubus parbifolius		X	X	X	X	X	X						Small-leaf bramble
Rubus procerus			X										Blackberry
Rumex brownii			X			X	X	X		X			Slender dock
Schoenus apogon			X	X	X	X	X	X		X	X		Common bog-rush
Schoenus latelaminatus							X	X			X		Medusa bog-rush
Scirpus antarcticus									X				Club rush
Scirpus fluitans							X				X		Club rush
Scirpus maritimus													Sea club rush
Scirpus sp.			X				X	X			X		Club rush
Sebaea ovata			X			X	X	X		X	X	X	Yellow sebaea
Selaginella gracillima											X		Tiny selaginella
Senecio hispidulus	X		X	X	X	X				X		X	Fireweed
Senecio linearifolius		X	X	X			X						Fireweed groundsel
Senecio quadridentatus	X		X			X		X		X		X	Cotton fireweed
Solenogyne bellioides			X		X		X						Solenogyne
Sonchus asper *			X					X					Rough sow thistle
Sonchus oleraceus *								X					Sow thistle
Stackhousia monogyna	X	X	X	X		X				X			Creamy stackhousia
Stackhousia viminea						X							Slender stackhousia
Stellaria flaccida			X										Forest starwort
Stellaria palustris											X		Swamp starwort

	3	5	7	6	8a	8b	14	11	10	9a	13a	12	
Stellaria pungens	X	X	X	X		X	X			X			Prickly starwort
Stipa densiflora					X								Spear grass
Stipa hemipogon													Spear grass
Stipa sp.												X	Spear grass
Stipa variabilis									X	X			Variable spear grass
Stuartina muelleri									X	X		X	Spoon cudweed
Stylidium graminifolium	X	X	X	X	X	X	X		X	X	X		Grass trigger plant
Stylidium inundatum								X			X		Hundreds and thousands
Stypandra glauca					X							X	Nodding blue lily
*Tetratheca ciliata**	X	X	X	X		X	X						Pink bells
Tetratheca ericifolia					X								Heath pink bells
Thelymitra sp.									X	X	X	X	Sun orchid
Themeda australis	X		X		X	X	X			X			Kangaroo grass
Thysanotus tuberosus			X			X							Common fringe lily
Tieghemopanax sambucifolius		X				X							Elderberry panax
*Trifolium arvense**	X		X			X		X	X	X	X	X	Hare's foot clover
*Trifolium campestre**			X					X		X	X		Hop clover
*Trifolium cernuum**								X					Drooping flower clover
*Trifolium dubium**			X		X	X				X			Suckling clover
Trifolium glomeratum			X			X		X		X			Cluster clover
*Trifolium repens**		X	X				X						White clover
*Trifolium striatum**			X										Knotted clover
*Trifolium subterraneum**								X					Subterranean clover
Urtica incisa		X	X				X						Scrub nettle
Utricularia dichotoma											X		Fairies' apron
Velleia paradoxa								X					Spur velleia
*Verbascum virgatum**	X												Twiggy mullein
*Veronica arvensis**			X			X				X			Wall speedwell
Veronica notabilis								X					Forest speedwell
Veronica serpyllifolia			X										Tyme speedwell
Veronica subtuis							X						Speedwell
Viola betonicifolia	X					X	X						Showy violet
Viola hederacea	X	X	X	X	X	X	X			X			Ivy-leaf violet
*Vulpia bromoides**	X		X			X	X			X		X	Squirrel-tail fescue
*Vulpia myuros**			X		X	X				X		X	Ratstail fescue
Wahlenbergia sp.			X	X									Bluebell
Wahlenbergia gracilenta					X					X		X	Annual bluebell

	3	5	7	6	8a	8b	14	11	10	9a	13a	12	
Wahlenbergia stricta	X		X		X	X		X	X	X		X	Tall bluebell
Wahlenbergia tadgellii			X					X					Tadgell's bluebell
Xanthorrhoea minor					X								Small grass-tree

Note: This information comes from a short field survey. Not all vegetation mapping classes were sampled and the names given here are those plants that occur very commonly in the areas sampled.

* denotes a naturalized alien species.

sp. is used when the species could not be identified.

APPENDIX 4

TABLE B

The Species of Native Victorian Vascular Plants in Danger of Extinction within the Study Districts

* Endemic to Victoria

I Plants not seen for many years or, if still present, now extremely rare

Pterostylis woollsii (Ovens River)

II Extremely localized plants, chiefly restricted to very vey colonies or even individual specimens

Acacia dawsonii
(Mitta Mitta)
Acacia deanei
(Chiltern Forest west of township)
Agrostis meionectes
(Mount Buffalo)
Brachycome ptychocarpa
(Buffalo Plateau)
Brasenia schreberi
(Lower Mitta Mitta River)
Calochilus grandiflora
(Mitta Mitta and Mount Beauty)
Chloris ventricosa
Cyperus flavidus
(Yackandandah)
Eragrostis japonica
(King River)
Eucalyptus cinerea
(Beechworth - only occurrence north of Divide)
Hypsela tridens
(Mitta Mitta River)
Leptospermum multicaule
(Mitta Mitta River)
Pratia gelida
(Mount Buffalo)
Prostanthera decussata
(Mount Buffalo - only occurrence north of Divide)
Prostanthera walteri
(Mount Buffalo - only occurrence north of Divide)
Pultenaea tenella
(Mount Buffalo - only occurrence north of Divide)
Rhynchospora brownii
(Tawonga on Kiewa River)
Rulingia pannosa
(Buffalo Ranges)
Thesium australe
(Ovens, Mitta Mitta, and Hume Rivers)

III Plants endemic to the Buffalo Plateau (where localized but nor very rare)

Acacia phlebophylla
Baeckea crenatifolia
Eucalyptus mitchelliana

Species names, the types of which come from Mount Buffalo

Acacia dallachiana
Acacia phlebophylla
Acacia pravissima
Asterolasia asteriscophora
Baeckea crenatifolia
Brachycome ptychocarpa
Eucalyptus goniocalyx
Eucalyptus mitchelliana
Grevillea victoriae
Leptospermum micromyrtus
Olearia stricta (= O. ramulosa var. *stricta)**
Prasophyllum suttonii
Prostanthera hirtula
Ranunculus graniticola
Uncinia flaccida
Westringia senifolia (p.p.)

* accepted name

APPENDIX 5

A. BIRDS

The species are listed by common names following the nomenclature of the C.S.I.R.O. (1969). Species recorded in the area as only accidental or as vagrants have not been included in the list.

Habitats and information sources (additional to published work)

1. Aquatic.

2. Flood-plain woodland. A. M. Gilmore (pers. comm.)

3. Dry open forest and woodland. Eileen Collins (pers. comm.); fauna survey, Monash University, 1973 (Chiltern Forest and Pilot Range.)

4. Wet and dry open forest. Fauna surveys, Monash University and the Fisheries and Wildlife Division 1973 (Mount Typo, Paradise Falls, Mount Big Ben, Mount Porepunkah, Black Range, and Dorchap Range).

5. Agricultural land. Surveys, Monash University and the Fisheries and Wildlife Division, 1973.

6. Pine plantations.

Breeding records

Indication that a species is known to breed within the study districts does not necessarily imply that it breeds in all of the habitats in which it occurs.

Breeding records were obtained from (in addition to published work): Eileen Collins (pers. comm.); Fauna survey, the Fisheries and Wildlife Division, 1973; and Gilmore, A. M. (pers. comm.).

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Family	Common name	Habitat						Breeds in area	Nest location	Food
		1	2	3	4	5	6			
Pelicans	Australian pelican	X								Fish; crustaceans
Darters	Darter	X	X							Fish
Cormorants	Black cormorant	X	X							Fish; crustaceans
	Little black cormorant	X	X					Yes	Tree branches	Fish; crustaceans
	Pied cormorant	X								Aquatic animals
	Little pied cormorant	X	X					Yes	Tree branches	Fish, crustaceans
Grebes	Little grebe	X						Yes	Floats on water	Aquatic animals and plants
	Hoary-headed grebe	X								Aquatic animals and plants
	Great crested grebe	X						Yes	Floats on water	Aquatic animals and plants
Herons, egrets, bitterns	White-necked heron	X	X			X				Variety of animal life
	White-faced heron	X	X			X		Yes	Tree branches	Variety of animal life
	White egret	X	X			X		Yes	Tree branches	Fish; frogs; insects
	Little egret	X								Aquatic animals
	Plumed egret	X								Aquatic animals
	Nankeen night heron	X	X					Yes	Tree branches	Aquatic animals
	Little bittern	X								Aquatic animals
	Brown bittern	X	X					Yes	Emergent aquatic vegetation	Aquatic animals
Ibises and spoonbills	White ibis	X	X			X		Yes	Emergent aquatic vegetation	Variety of animals
	Straw-necked ibis	X	X			X		Yes	Emergent aquatic vegetation	Variety of animals
	Royal spoonbill	X								Aquatic animals
	Yellow-billed spoonbill	X	X							Aquatic animals
Ducks, swans, geese	Grass whistling duck	X								Vegetation
	Black swan	X								Aquatic plants
	Freckled duck	X								Aquatic animals and plants
	Mountain duck	X	X							Herbage; aquatic animals and plants
	Black duck	X	X			X		Yes	Ground	Herbarge; aquatic animals and plants
	Grey teal	X	X			X				Aquatic animals and plants
	Chestnut teal	X	X							Herbage; aquatic animals and plants
	Blue-winged shoveler	X	X					Yes	Ground	Aquatic animals and plants
	Pink-eared duck	X								Aquatic animals and plants
	White-eyed duck	X								Aquatic animals and plants
	Wood duck	X	X			X		Yes	Hole in tree	Herbage

Family	Common name	Habitat 1	2	3	4	5	6	Breeds in area	Nest location	Foods
Duck, swans, geese (cont'd)	Blue-billed duck	X								Aquatic animals and plants
	Musk duck	X						Yes	Emergent aquatic vegetation	Aquatic animals
Eagles, goshawks	Black-shouldered kite			X		X				Small mammals; lizards; insects
	Whistling eagle	X	X	X	X	X		Yes	Tree branches	Mammals; birds; reptiles; carrion
	Grey goshawk			X				Yes	Tree branches	Birds; mammals; insects
	Australian goshawk			X	X	X		Yes	Tree branches	Birds
	Collared sparrow hawk				X					Birds
	Australian little eagle		X	X		X		Yes	Tree branches	Mammals; reptiles; carrion
	Wedge-tailed eagle			X	X	X		Yes	Tree branches	Mammals; birds; reptiles; carrion
	White-breasted sea-eagle	X	X					Yes	Tree branches	Mammals; reptiles; fish; carrion
	Spotted harrier	X				X				Mammals; birds; reptiles
	Swamp harrier	X	X			X		Yes	Ground	Mammals; birds; reptiles
Falcons, kestrels	Black falcon									Birds
	Peregrine falcon		X	X	X	X		Yes	Rock ledges	Birds
	Little falcon			X	X	X				Birds and insects
	Nankeen kestrel			X	X	X		Yes	Rock crevices; tree branches	Mammals; birds; reptiles; insects
	Brown hawk	X		X	X	X		Yes	Tree branches	Mammals; birds; reptiles; insects
Quails	Stubble quail		X	X		X		Yes	Ground	Seeds and insects
	Brown quail					X				Seeds and insects
Bustard quails	Painted quail			X			X			Seeds and insects
	Little quail			X		X				Seeds and insects
Cranes	Brolga	X				X				Omnivorous
Rails, crakes, waterhens	Banded landrail	X		X				Yes	Grass tussocks	Molluscs; aquatic insects and plants
	Marsh crake	X								Aquatic plants; molluscs and insects
	Australian spotted crake	X								Aquatic insects and plants
	Black-tailed native hen	X								Grasses; aquatic plants and animals
	Dusky moorhen	X	X			X		Yes	Tussocks; aquatic vegetation	Aquatic insects and plants
	Swamp hen	X	X			X		Yes	Tussocks; aquatic vegetation	Molluscs; grass; aquatic plants
	Coot	X	X					Yes	Emergent aquatic vegetation	Aquatic animals and plants
Plovers and dotterels	Spure-winged plover	X	X			X		Yes	Ground	Insects; seeds; worms; crustaceans
	Banded plover	X	X			X		Yes	Ground	Insects; seeds
	Red-kneed dotterel	X								Aquatic animals

Family	Common name	Habitat 1	2	3	4	5	6	Breeds in area	Nest location	Foods
Plovers and dotterels	Black-fronted dotterel	X						Yes	Ground	Aquatic insects; crustaceans
Curlews, sandpipers snipes	Japanese snipe	X	X							Aquatic insects; worms
	Sharp-tailed sandpiper	X								Aquatic insects; seeds
	Red-necked stint	X								Aquatic insects; seeds
Stilts and advocets	White-headed stilt	X						Yes	Ground	Aquatic insects; seeds
Stone curlews	Southern stone curlew			X		X		Yes	Ground	Insects
Gulls and terns	Silver gull	X				X				Omnivorous
	Whiskered tern	X								Fish and insects
Pigeons and doves	Domestic pigeon			X		X				Seeds
	Peaceful dove		X	X		X				Seeds; herbs
	Common bronzewing		X	X	X	X		Yes	Low in tree or shrub	Seeds, berries
	Crested pigeon		X	X		X		Yes	Shrub or low tree	Seeds
	Wonga pigeon				X		X			Seeds; fruit;insects
Parrots and Cockatoos	Musk lorikeet			X	X	X				Nectar; Fruit; berries
	Purple-crowned lorikeet			X	X					Nectar; Fruit; berries
	Little lorikeet		X	X	X	X				Nectar; Fruit; berries
	Swift parrot			X						Nectar; insects; berries
	Yellow-tailed black cockatoo				X					Seeds; insects
	Gang-gang cockatoo			X	X			Yes	Hollow limb; hole in tree	Seeds
	Sulphur-crested cockatoo		X	X	X	X				Seeds; roots
	Galah		X	X	X	X		Yes	Hole in tree	Seeds; roots
	Cockatiel			X		X		Yes	Hole in tree	Seeds
	King parrot			X	X					Seeds; fruit; berries; maize
	Crimson rosella			X	X	X	X	Yes	Hole in tree	Seeds; fruit; berries
	Yellow rosella		X					Yes	Hole in tree	Seeds
	Eastern rosella		X	X	X	X		Yes	Hole in tree	Seeds; fruit; berries
	Red-rumped parrot		X	X		X		Yes	Hole in tree	Seeds
	Turquoise parrot			X				Yes	Hole in tree	Seeds
	Budgerygah					X				Seeds
Cuckoos	Pallid cuckoo		X	X		X				Tree insects (caterpillars)
	Brush cockatoo				X					Tree insects
	Fan-tailed cuckoo		X	X	X	X		Yes	Parasitic	Tree insects (caterpillars)

Family	Common name	Habitat						Breeds in area	Nest location	Food
		1	2	3	4	5	6			
Cuckoos (cont'd)	Black-eared cuckoo			X						Tree insects
	Horsfield bronze cuckoo			X	X	X		Yes	Parasitic	Tree insects (caterpillars)
	Golden bronze cuckoo			X	X			Yes	Parasitic	Tree insects (caterpillars)
Hawk owls	Barking owl		X	X		X				Mammals, birds
	Boobook owl		X	X	X	X				Insects, mammals, birds
Barn owls	Barn owl			X						Insects, mammals, birds
Frogmouths	Tawny frogmouth			X	X	X		Yes	Tree branches	Mainly ground insects
Owlet-nightjars	Owlet-nightjar				X					Mainly ground insects
Swifts	Spine-tailed swift			X	X					Flying insects
	Fork-tailed swift				X					Flying insects
Kingfishers	Azure kingfisher	X	X			X		Yes	Hole in tree or bank	Aquatic insects, crustaceans, fish
	Laughing kookaburra		X	X	X	X	X	Yes	Hole in tree	Variety of animals
	Red-backed kingfisher	X	X							Insects, reptiles
	Sacred kingfisher	X	X	X	X	X		Yes	Hole in tree or bank	Lizards, fish, insects
Bee-eaters	Rainbow bee-eater		X	X	X	X		Yes	Tunnel in sand	Flying insects
Rollers	Dollar-bird		X	X		X		Yes	Hole in tree	Flying insects
Lyrebirds	Superb lyrebird				X		X	Yes	Rock ledge, tree base, ground	Insects, worms, land molluscs
Larks	Singing bushlark	X		X		X				Ground insects
Swallows and martins	White-backed swallow	X				X		Yes	Tunnel in bank	Flying insects
	Welcome swallow	X	X	X	X	X		Yes	Under bridge,eaves, in caves	Flying insects
	Tree-martin	X	X	X		X		Yes	Hole in tree	Flying insects
	Fairy-martin	X	X	X		X		Yes	Under eaves, ledges, caves	Flying insects
Pipits	Australian pipit			X	X	X		Yes	Ground	Seeds and ground insects
Cuckoo shrikes	Ground cuckoo-shrike									Insects
	Black-faced cuckoo-shrike		X	X	X	X		Yes	Tree branches	Ground, tree and flying insects
	Little cuckoo-shrike			X						Tree and flying insects
	Cicada-bird				X					Tree insects
	White-winged triller		X	X		X		Yes	Tree branches	Ground and tree insects
Thrushes	*Australian ground-thrush*				X		X			*Ground insects and worms*
	Blackbird			X	X	X	X	Yes	Shrub	Worms; fruit; ground insects
Quail, thrushes and babblers	Spotted quail-thrush				X			Yes	Ground; low bush; boulder	Ground insects
	Grey-crowned babbler		X			X		Yes	Tree branches	Ground insects

Family	Common name	Habitat						Breeds in area	Nest location	Foods
		1	2	3	4	5	6			
Quail, thrushes, babblers	White-browed babbler			X		X		Yes	Tree branches	Ground insects
Old world warblers	Golden-headed fan-tail warbler	X								Ground insects
	Little grassbird	X						Yes	Stems of marsh vegetation	Ground insects
	Reed-warbler	X						Yes	Stems of reeds	Insects (around marsh and water)
	Brown songlark	X		X		X				Ground insects; seeds
	Rufous songlark		X	X	X	X		Yes	Ground	Ground insects
Australian warblers	Superb blue wren	X	X	X	X	X	X	Yes	Low in shrub	Ground insects; seeds
	White-throated warbler				X			Yes	Tree branches	Tree insects
	Western warbler			X				Yes	Tree branches	Tree insects
	Weebill			X		X		Yes	Low tree	Tree insects
	Striated thornbill			X	X			Yes	Tree branches	Tree insects
	Little thornbill			X	X	X		Yes	Tree branches	Tree insects
	Brown thornbill			X	X		X	Yes	Low in shrub	Shrub insects
	Buff-rumped thornbill			X	X			Yes	Hole in tree; shrub; ground	Ground and tree insects
	Yellow-rumped thornbill			X	X	X		Yes	Tree or shrub branches	Ground and tree insects
	White-browed scrub-wren			X	X		X	Yes	Ground; low shrub	Ground and shrub insects
	Large-billed scrub-wren				X			Yes	Tree branches; ferns; vines	Ground and tree insects
	Heath wren			X				Yes	Ground	Insects
	Whiteface			X		X		Yes	Hole in tree; shrub	Ground insects
	Speckled warbler			X		X		Yes	Ground	Ground insects
	Pilot-bird				X		X	Yes	On or near ground	Ground insects; worms
Australian chats	White-fronted chat	X				X				Ground insects
Old-world flycatchers	Jacky winter			X	X	X		Yes	Tree branches	Ground and flying insects
	Scarlet robin		X	X	X	X	X	Yes	Tree branches	Ground insects and worms
	Red-capped robin			X		X		Yes	Tree branches	Ground, flying and tree insects
	Flame robin		X	X	X	X		Yes	Tree branches	Ground insects and worms
	Pink robin				X					Ground insects
	Rose robin			X						Shrub and ground insects
	Hooded robin			X		X		Yes	Low tree; shrub	Ground insects
	Southern yellow robin			X	X		X	Yes	Tree branches	Ground and tree insects
Fantails	Grey fantail		X	X	X	X	X	Yes	Tree and shrub branches	Flying insects
	Rufous fantail			X	X		X			Shrub and flying insects

Family	Common name	Habitat 1	2	3	4	5	6	Breeds in area	Nest location	Foods
Fantails (cont'd)	Willie wagtail		X	X	X	X		Yes	Tree branches	Tree and flying insects
Monarch flycatchers	Leaden flycatcher				X			Yes	Dead tree branch	Tree and flying insects
	Satin flycatcher			X	X			Yes	Tree branches	Flying insects
	Restless flycatcher		X	X	X	X		Yes	Tree branches	Ground insects
Whistlers and shrike-thrushes	Golden whistler			X	X	X	X			Tree insects
	Rufous whistler		X	X	X	X	X	Yes	Shrub; tree	Tree insects
	Gilbert whistler			X						Ground insects
	Olive whistler				X		X			Tree insects
	Grey shrike-thrush		X	X	X	X	X	Yes	Ground; shrub; tree	Ground insects and worms
Shrike-tits	Shrike-tit		X	X	X	X		Yes	Tree branches	Tree insects
	Crested bellbird			X				Yes	Low in tree or in stump	Ground insects
	Eastern whipbird				X		X			Ground insects and worms
Nuthatchers	Orange-winged sittella			X	X			Yes	Dead tree branch	Tree insects
Australian tree creepers	Brown tree-creeper		X	X	X	X		Yes	Hole in tree	Tree insects
	White-throated tree-creeper			X	X			Yes	Hole in tree	Tree insects
	Red-browed tree-creeper				X					Tree insects
Flower-peckers	Mistletoe bird			X	X	X		Yes	Tree branches	Mistletoe berries; insects
	Spotted pardalote		X	X	X	X		Yes	Hole in tree; tunnel in bank	Tree insects
	Yellow-tipped pardalote									Tree insects
	Eastern striated pardalote		X		X	X		Yes	Hole in tree; tunnel in bank	Tree insects
	Striated pardalote		X	X	X	X		Yes	Hole in tree; tunnel in bank	Tree insects
Silvereyes	Grey-breasted silvereye			X	X	X	X	Yes	Shrub	Shrub insects; fruits; berries
Honeyeaters	Fuscous honeyeater			X	X			Yes	Tree branches; shrub	Insects; nectar
	Yellow-faced honeyeater			X	X			Yes	Tree branches; shrub	Insects; nectar; fruit
	White-plumed honeyeater		X	X	X	X		Yes	Tree branches	Insects; nectar
	White-eared honeyeater			X	X			Yes	Low shrub	Insetcs; nectar; fruit
	Yellow-tufted honeyeater			X	X			Yes	Low shrub	Insects; nectar
	Brown-headed honeyeater		X	X	X			Yes	Tree branches	Insects; nectar
	White-naped honeyeater			X	X			Yes	Tree branches	Insects; nectar
	Black-chinned honeyeater			X				Yes	Tree branches	Insects; nectar
	Blue-faced honeyeater		X							Insects; nectar; fruit; barries
	Little friar-bird		X	X		X		Yes	Tree branches	Insects; nectar; fruit; berries

Family	Common name	Habitat 1	2	3	4	5	6	Breeds in area	Nest location	Foods
Honeyeaters (cont'd)	Noisy friar-bird		X	X	X	X		Yes	Tree branches	Insects; nectar; fruit; barries
	Crescent honeyeater				X			Yes	Shrub, close to ground	Insects; nectar
	Painted honeyeater			X				Yes	Tree branches	Nectar; mistletoe berries
	Regent honeyeater			X	X	X		Yes	Tree branches	Insects; nectar; fruit
	Eastern spinebill			X	X			Yes	Tree branches; shrub	Insects; nectar
	Noisy miner		X	X	X	X		Yes	Tree branches	Insects; nectar; fruit; berries
	Red wattle-bird		X	X	X	X		Yes	Tree branches	Insects; nectar; fruit
Grass finches	Diamond firetail		X	X	X	X		Yes	Tree branches; shrub	Ground insects; seeds
	Red-browed finch			X	X		X	Yes	Small tree; shrub	Ground and shrub insects; seeds
	Zebra finch			X		X		Yes	Shrub	Ground insects; seeds
Weaver finches	House sparrow			X		X		Yes	Crevice; shrub	Ground insects; seeds; fruit
	Tree sparrow				X	X				Ground insects; seeds
Typical finches	Goldfinch			X	X	X	X	Yes	Low tree; shrub	Seeds; spiders
Starlings	Starling		X	X		X		Yes	Hole in tree; crevice	Insects; worms; fruit
Orioles	Olive-backed oriole		X	X	X	X		Yes	Tree branches	Tree insects; fruits; berries
Mud-nest builders	Magpie lark	X	X	X		X		Yes	Tree branches	Aquatic and ground insects; molluscs
	White-winged chough		X	X	X	X	X	Yes	Tree branches	Insects; seeds
Wood-swallows	Masked wood-swallow			X		X				Flying insects
	White-browed weed-swallow		X	X		X		Yes	Shrub; tree; stump	Flying insects
	Dusky wood-swallow		X	X	X	X		Yes	Tree branches; stump	Flying insects
Australian magpies	Pied currawong		X	X	X	X	X	Yes	Tree branches	Omnivorous
	Grey currawong				X			Yes	Tree branches	Insects; fruits; berries
	Grey butcher-bird				X					Insects; birds; reptiles
	Black-backed magpie		X	X	X	X		Yes	Tree branches	Omnivorous
	White-backed magpie			X	X	X		Yes	Tree branches	Omnivorous
Crows and ravens	Satin bower-bird				X					Ground insects; fruits
	Australian raven		X	X	X	X		Yes	Tree branches	Omnivorous
	Little raven				X					Omnivorous

B. MAMMALS

This contains a list of mammals recorded in the districts, while Appendix 5 C contains distribution, habitat, abundance, breeding and diet information for each of the species. The scientific nomenclature follows that of Ride (1970). The list records mammal species present in the area either now or in the recent past (within approximately 100 years).

Sources: (In addition to published work) Monash University (M.U.) and the Fisheries and Wildlife Division (FWD) surveys; mammal Survey Group of Victoria (MSGV) records; National Museum of Victoria (NMV) and Fisheries and Wildlife Division (FWD) collections; local residents Mrs. E. Collins (Chiltern), Mr. L. McCready (Dandongadale), and Mr. P. Sheridan (FWD) (Wangaratta).

MAMMALS LIST

MONOTREMATA

Tachyglossidae:	
Tachyglossus aculeatus	Echidna
Ornithorhynchidae:	
Orinthorhynchus anatinus	Platypus

MARSUPIALIA

Macropodidae:	
Macropus giganteus	Great grey kangaroo
Wallabia bicolor	Black wallaby
Petrogale penicillata	Brush-tailed rock wallaby
+*Potorous tridactylus*	Potoroo
Phalangeridae:	
Trichosurus vulpecula	Brush-tailed possum
T. caninus	Bobuck
Petauridae:	
Pseudocheirus peregrinus	Common ring-tailed possum
Petaurus breviceps	Sugar glider
P. norfolcencis	Squirrel glider
P. australis	Yellow-bellied glider
Schoinobates volans	Greater glider
Burramyidae:	
Acrobates pygmaeus	Feather-tailed glider
Cercartetus nanus	Eastern pigmy possum
Phascolarctidae:	
Phascolarctos cinereus	Koala
Vombatidae:	
Vombatus ursinus	Wombat
Peramelidae:	
Perameles nasuta	Long-nosed bandicoot
Dasyuridae:	
Dasyurus maculatus	Tiger cat
Phascogale tapoatafa	Tuan
Antechinus flavipes	Yellow-footed antechinus

A. stuartii	Brown antechinus
A. swainsonii	Swainson's antechinus

LAGOMORPHA

Leporidae:

**Oryctolagus cuniculus*	Rabbit

RODENTIA

Muridae:

Rattus fuscipes	Bush rat
Hydromys chrysogaster	Eastern water rat
**Mus musculus*	House mouse
**Rattus rattus*	Black rat

CHIROPTERA

Vespertilionidae:

Nyctophilus geoffroyi	Lesser long-eared bat
Eptesicus pumilus	Little bat
Chalinolobus gouldii	Gould's wattled bat
Chalinolobus morio	Chocolate bat

Bat species likely to be present not yet recorded:

Pteropodidae:

Pteropus scapulatus	Red fruit bat
P. poliocephalus	Grey-headed fruit bat

Emballonvridae:

Taphozous flaviventris	Yellow-bellied bat

Rhinolophidae:

Rhinolophus megaphyllus	Eastern horse-shoe bat

Vespertilionidae:

Nyctophilus timoriensis	Greater long-eared bat
Miniopterus schreibersii	Bent-winged bat
Myotis adversus	Large-footed bat
Nyeticeius greyi	Little broad-nosed bat

Molossidae:	
Tadarida australis	White-striped bat
T. planiceps	Little flat bat

CARNIVORA

Canidae:	
**Vulpes vulpes*	Fox
Canis familiaris	Dingo
Felidae:	
**Felis catus*	Cat

ARTIODACTYLA

Suidae:	
**Sus scrofa*	Pig
Cervidae:	
**Cervus unicolor*	Sambar deer
Bovidae:	
**Capra hircus*	Goat

\+ The locality information for this specimen record is probably erroneous (J. Dixon, National Museum of Victoria, pers. comm.).

* Introduced species

C. MAMMAL ABUNDANCE, DISTRIBUTION, FOOD, HOME RANGE, NEST SITES, AND SPECIMENS COLLECTED

Tachyglossus aculeatus (echidna)
Abundance & distribution: Widespread but uncommonly encountered. Six individuals were recorded during the 1973 wildlife surveys in the study area.
Food: Insects, chiefly termites and ants.
Home range: Movements appear related to food availability. The species is fairly sedentary if food is plentiful, but covers large distances when it is scarce.
Nest sites: Over-winter hibernation sites are dug under logs, rocks, or may be situated in rabbit burrows.
Habitat preference: It probably occurs throughout all habitat types in the study area with the possible exception of intensive farming areas (e.g. tobacco farms).
Most recent specimen: 1972 (FWD 8482); observed in 1973 surveys (MU & FWD).

Ornithorhynchus anatinus (platypus)
Abundance & distribution: Not commonly observed, probably because of its cryptic habits. Local residents report that they are common and occur in all the major streams of the area including the Murray, Mitta, Kiewa, Ovens, Buckland, Buffalo, and King Rivers.
Food: Aquatic invertebrates, chiefly crustaceans and annelids.
Nest sites: Burrows are constructed in loose soil along banks of streams. The close proximity of burrows to the ground surface, usually less than one foot and occasionally as little as a few inches, makes them susceptible to cave-ins when heavy animals such as cattle graze along river banks.
Habitat preference: Most rivers and some of their more substantial tributaries are suitable; the platypus needs permanent water, preferably with muddy substrates.
Most recent specimen: 1972 (FWD 8481).

Macropus giganteus (great grey kangaroo)
Abundance & distribution: Common and widespread, usually associated with the larger blocks of forest and woodlands.
Food: Chiefly grasses, but they also browse on sclerophyllous shrubs.
Home range: Movements are probably related primarily to food availability. They can travel long distances but are relatively sedentary if food is plentiful, movements then are limited to moving out to graze at night and returning to resting areas during the day.
Nest sites: Shelters under low dense shrubs during the heat of the day.
Habitat preferences: Associated with relatively open flat country or sloping

foothills (a variety of dominant vegetation forms are suitable). The important habitat requirements are shelter (trees and shrubs) and open grassland for grazing. Most recent specimen: 1972 (FWD 8375); observed in 1973 surveys (MU & FWD).

Wallabia bicolor (black wallaby)
Abundance & distribution: Common and widespread in the larger blocks of Crown land.
Food: Grasses and browse shrubs.
Home range: Probably fairly sedentary; in optimum areas 1 ha appears sufficient to support one animal, but this area is rarely circular and often is intricately related to adjacent home ranges (G. Edwards pers. comm.).
Nest sites: Usually takes refuge in thick scrub during the day.
Habitat preference: Generally found in the moist forest areas. Almost invariably found in or near dense undergrowth beneath a variety of dominant vegetation types, which include mixed box woodland, broad- and narrow-leafed peppermint forest, and alpine ash forest.
Most recent specimen: 1972 (FWD 8730); observed in 1973 surveys (MU & FWD).

Petrogale penicillata (brush-tailed rock wallaby)
Not recorded in the study area, but some of the older residents remember them being abundant on Mount Typo "many" years ago.

Potorous tridactylus (potoroo)
The evidence for this species being present in the area is a specimen lodged in the National Museum. The present curator of vertebrates (Miss J. Dixon) believes the specimen was mislabelled and that it probably originated from a southern coastal district.

Trichosurus vulpecula (brush-tailed possum)
Abundance & distribution: Common and widespread throughout the study area.
Food: Predominantly vegetarian; mainly fruit and leaves.
Home range: Probably several hectares per animal, but ranges overlap. Territories are marked with secretions from specialized scent glands.
Nest sites: Usually retires to hollow limbs during the day, but has been known to take refuge in drains and rabbit burrows.
Habitat preference: Usually found in dry open forest and woodland, but is also a successful resident in cultivated and urban areas.
Most recent specimen: 1973 (NMV C10801).

Trichosurus caninus (bobuck)
Abundance & distribution: Restricted distribution in the study area. The only records come from Mount Emu and near Archerton. Possibly moderately common in suitable areas.
Food: Predominantly vegetarian; mainly fruit and leaves.
Home range: Probably similar to *T. vulpecula*.
Nest sites: Usually hollows in dead or old trees.
Habitat preference: Typically occurs in wet open forest such as alpine ash areas. It inhabits the thick understorey, but often forages on the ground.
Most recent specimen: None; observed in 1973 surveys (MU & FWD).

Pseudocheirus peregrinus (common ring-tailed possum)
Abundance & distribution: Moderately common and widespread.
Food: Primarily vegetable matter; mainly fruit, seeds, and leaves.
Nest sites: Either builds a spherical nest in dense arboreal vegetation or nests in hollow limbs.
Habitat preference: Characteristically a species of dense shrub layers such as occur in wet open forest and gully vegetation. Populations also inhabit narrow-leafed peppermint forest, mixed box, red gum, and callitris pine associations.
Most recent specimen: 1972 (NMV C10503); observed during 1973 survey (MU).

Petaurus breviceps (sugar glider)
Abundance & distribution: Uncommon, but widespread.
Food: Insects and blossoms.
Home range: Large distances can be covered but only relatively small areas are needed to support populations.
Nest sites: Hollow limbs.
Habitat preference: Probably occurs in all forest and woodland communities where areas are large enough to support viable populations.
Most recent specimen: 1933 (NMV C669); observed in 1973 survey (MU).

Petaurus norfolcensis (squirrel glider)
Abundance & distribution: Rare; distribution uncertain but probably restricted. There are records from Beechworth and near Chiltern.
Food: Insects and blossoms.
Nest sites: Hollow limbs.
Habitat preference: The few available records indicate that it inhabits open dry woodland such as red gum and red ironbark associations.
Most recent specimen: 1972 (NMV C10809).

Petaurus australis (yellow-bellied glider)
Abundance & distribution: No specimens are known from this area but O'Donnell (1970) in an account of gliders in the Porepunkah area almost certainly refers to this species in mistake for the greater glider *(Schoinobates volans)*. (The MU survey reports possible sightings at the Stanley Yelbow forestry camp).
Food: Blossoms, sap, and insects.
Home range: Possibly requires a larger area than other possums, but few quantitive data have been accumulated.
Nest sites: Hollow limbs.
Habitat preference: Usually wet open forest and in the study area it is probably restricted to this forest type (with the exception of snowgum woodland).
Most recent specimen: None from the study area.

Schoinobates volans (greater glider)
Abundance & distribution: Common and widespread.
Food: Exclusively vegetarian, it shows a preference for particular species of plant, mainly eucalypts, but also eats mistletoe.
Nest sites: Hollow limbs.
Habitat preference: All wet open forest habitats including snow gum in some areas, and some dry open forest habitat such as broad-leafed peppermint. The most favoured habitat appears to be a mixture of narrow-leafed peppermint and blue gum.
Last specimen collected: 1966 (FWD P627); observed in 1973 surveys (MU & FWD).

Acrobates pygmaeus (feather-tailed glider)
Abundance & distribution: Common and widespread.
Food: Insects, supplemented by nectar and sap.
Habitat preference: All woodland and forest communities.
Last specimen collected: 1961 (FWD FF 221).

Cercartetus nanus (Eastern pigmy possum)
Abundance & distribution: Uncommon and probably restricted. Most records are from the Yackandandah area.
Food: Insects, blossoms, and nectar.
Nest sites: Hollow limbs and crevices.
Habitat preference: Usually occurs in areas with well-developed shrub strata. Occurs in a wide range of dominant vegetation types in other parts of Victoria, and probably in the study districts.
Last specimen recorded: 1968 (FWD P773).

Phascolarctos cinereus (koala)
Abundance & distribution: Uncommon and restricted. Most, if not all. koalas in the area emanate from repopulations with animals from French and Phillip Islands. Three animals were released at Wangaratta in 1928 and 21 at Chiltern in 1968.
Food: Strictly vegetarian, with a preference for leaves of particular eucalypt species.
Nest sites: None constructed.
Habitat preference: Determined mainly by the availability of suitable food trees, which, in the study area, include manna gum, messmate, swamp gum, and narrow-leafed peppermint.
Last specimen collected: 1965 (FWD 164).

Vombatus ursinus (wombat)
Abundance & distribution: Common and widespread.
Food: Strictly vegetarian: feeds on grasses, herbs, and roots.
Nest sites: Digs burrows usually under roots or rocks, some being quite elaborate and extending for as far as 20 m.
Habitat preference: Now apparently restricted to moist gully areas throughout wet and dry open forests. There is considerable evidence that they formerly burrowed on drier ridge tops but they don't appear to do so now, although territory demarcation sites are common throughout.
Last specimen collected: 1973 (FWD 8697).

Perameles nasuta (long-nosed bandicoot)
Abundance & distribution: Uncommon but fairly widespread.
Food: Omnivorous but primarily an invertebrate-eater.
Nest sites: Builds a stack of vegetation, usually in thick scrub.
Habitat preference: Characteristically inhabits wet open forest or dense shrub strata such as those formed by bracken thickets and water ferns in gullies.
Last specimen collected: 1972 (NMV C10523).

Dasyurus maculatus (tiger cat)
Abundance & distribution: Rare. There are few records from the study area. One specimen is recorded from Wangaratta and a grazier sighted an animal near Dandongadale.
Food: Carnivorous, feeding primarily on vertebrates, but insects also form a portion of the diet, particularly of young animals.
Home range: Sexually and seasonally determined. Males become hyperactive during the breeding season and probably travel many miles.

Nest sites: Probably hollow logs, caves, and perhaps arboreal crevices.
Habitat preference: Occurs in most habitat types in other Victorian areas, but its status in this study area is unknown.
Last specimen recorded: 1959 (FWD D230).

Phascogale tapoatafa (tuan)
Abundance & distribution: Uncommon but widespread.
Food: Vertebrates (E.G. birds) and insects.
Nest sites: Hollow logs and arboreal crevices.
Habitat preference: Most commonly found in drier vegetation communities such as woodland and dry open forest, but probably occurs throughout most forest habitats.
Last specimen recorded: 1970 (NMV C10295).

Antechinus flavipes (yellow-footed antechinus)
Abundance & distribution: Uncommon and restricted to the north-western half of the study area.
Food: Primarily arthropods.
Nest sites: Hollow logs.
Habitat preference: Woodland with well-developed litter; ground cover is usually essential.
Last specimen recorded: 1947 (NMV C1016); recorded in 1973 surveys (MU).

Antechinus stuartii (brown antechinus)
Abundance & distribution: Common but more or less restricted to the south-eastern half of the study area.
Food: Primarily arthropods.
Nest site: Hollow logs and arboreal crevices.
Habitat preference: Generally found in wet open forest communities with substantial development of ground litter and/or ground shrubs.
Last specimen recorded: 1973 (NMV C11255); recorded in 1973 surveys (MU & FWD).

Antechinus swainsonii (Swainson's antechinus)
Abundance & distribution: Uncommon and restricted to the ranges in the south-eastern half of the study area.
Food: Primarily arthropods, but some vertebrates (e.g. lizards) may be eaten.
Nest site: Hollow logs and probably burrows.
Habitat preference: Found in moist gully situations where ground vegetation (e.g. water fern and sedge) is well developed. This type of situation is only found in wet open forests in the study area.

Last specimen recorded: 1973 (NMV C11099); recorded in 1973 surveys (MU & FWD).

Rattus fuscipes (bush rat)
Abundance & distribution: Very common, but restricted to the wet and dry open forests in the ranges.
Food: Omnivorous, eats arthropods and some vegetable matter.
Nest site: Digs burrows or builds nests in hollow logs.
Habitat preference: Common in all forest types where the understorey is well developed. This is particularly noticeable along moist creek gullies, where the bush rat population attains its highest density.
Last specimen recorded: 1973 (NMV C11120); recorded in the 1973 surveys (MU & FWD).

Hydromys chrysogaster (eastern water rat)
Abundance & distribution: Moderately common and widespread.
Food: Arthropods, molluscs, and carrion.
Nest sites: Digs an elaborate series of tunnels, usually along a river bank.
Habitat preference: Water courses in general; although the slow warm lowland streams such as the Murray, provide the best environment. Their range extends along the fast-flowing highland rivers and streams but they are not common in these areas.
Last specimen collected: 1968 (FWD R3677).

Canis familiaris (dingo)
Abundance & distribution: Generally uncommon and restricted to ranges of the south-eastern area and the Baranduda range in the north. Rare in pure form, due to interbreeding with domestic dogs.
Food: Vertebrates, insects, and carrion.
Home range: Capable of long excursions. Nightly wanderings exceeding 45 km have been recorded.
Habitat preference: Occurs in most forest communities but shows preference for more open types rather than those with dense understorey.
Last specimen recorded: None; trapped by Officers of the Vermin and Noxious Weeds Destruction Board, in 1973.

Felis catus (cat)
Abundance & distribution: Common and widespread.
Food: Small mammals, birds, and some insects.
Habitat preference: Occurs throughout most habitat types.

Vulpes vulpes (fox)
Abundance & distribution: Common and widespread.
Food: Small to medium animals such as reptiles, mammals, birds, frogs and insects. Young foxes often feed on fruit.
Habitat preference: Occurs throughout most habitats.

Oryctolagus cuniculus (rabbit)
Abundance & distribution: Common and widespread.
Food: Grasses and herbs.
Habitat preference: Occurs, with varying density, through all habitat types.

Lepus europaeus (hare)
Abundance & distribution: Uncommon and restricted.
Food: Grasses.
Habitat preference: Open grassland, as occurs in lowland farm areas in the north-west of the study area.

Capra hircus (goat)
Abundance & distribution: Uncommon and restricted: MU survey reported a herd near Flagstaff.
Food: Grasses and shrubs.
Habitat preference: Not known, the herd observed was in mixed box forest.

Sus scrofa (pig)
Abundance & distribution: Uncommon and restricted.
Food: Omnivorous.
Habitat preference: Restricted in the study area to the wet and remote forests of the southern ranges.

Bats

Little information has been collected on bats in the study area. Only the four species listed below have been recorded, but anything up to eight additional small species and two fruit bats might be added to the list if bats were collected systematically. Small bats (microchiropterans) in general occur throughout the region. Those listed in Appendix 5B are also insectivorous. As with the four below, details of habitat specificity are not known. The horseshoe and bent-winged bats both roost in caves, but all the other species usually roost in hollow limbs and tree crevices.

The bat population in any one area is unlikely to be static. Nomadism and large-scale migrations are common to many bat species, probably including the two large fruit bats (megachiropherans) that may be recorded in the future. They are uncommon in Victoria, but both have been recorded in other north-eastern districts.

Nyctophilus geoffroyi (lesser long-eared bat).
Abundance & distribution: Probably common and widespread.
Food: Airborne insects.
Nest sites: Usually hollow limbs, but the species will occasionally nest in buildings.
Habitat preference: Probably all forest and woodland communities and certainly woodland and dry open forest areas.
Last specimen collected: 1961 (NMV C3163).

Eptesicus pumilus (little bat)
Abundance & distribution: Recorded by O'Donnell (1970) in the Porepunkah district; probably common and widespread.
Food: Airborne insects.
Nest sites: Tree hollows and crevices.
Habitat preference: Probably occurs throughout the forested areas.
Last specimen collected: None.

Chalinolobus gouldii (Gould's wattle bat)
Abundance & distribution: Probably common and widespread.
Food: Airborne insects.
Nest sites: Tree hollows and crevices; in other areas often found in the roofs of houses.
Habitat preference: Probably occurs throughout the forested areas, but is more often recorded in dry rather than wet open forest.
Last specimen recorded: 1909 (NMV C5140).

Chalinolobus morio (chocolate bat)
Abundance & distribution: Probably widespread and common.
Food: Airborne insects.
Nest sites: Tree hollows and crevices.
Habitat preference: Probably occurs throughout all forest and woodland communities.
Last specimen collected: 1972 (Forests Commission of Victoria, unpublished data).

D. REPTILES

SCIENTIFIC NAME	COMMON NAME	HABITATS: AQUATIC	FLOOD-PLAIN WOODLAND	DRY OPEN FOREST AND WOODLAND	DRY OPEN FOREST	WET OPEN FOREST	AGRICULTURAL LAND	ABUNDANCE	HABITS: NOCTURNAL	DIURNAL	GROUND-DWELLING	WATER-DWELLING	BIOLOGY: ARBOREAL	FOSSORIAL	THIGMOTHERM	HELIOTHERM	OVIPAROUS	VIVIPAROUS	DISTRIBUTION IN ZOOGEOGRAPHIC REGIONS: EYREAN	WARM TEMPERATE BASSIAN (W.T.)	COOL TEMPERATE BASSIAN (C.T.)	COLD TEMPERATE BASSIAN	MURRAY RIVER CORRIDORS
CHELYIDAE																							
Chelodina expansa	Broad-shelled tortoise	x						+	x	x		x							x				
C. longicollis	Snake-necked tortoise	x						+++	x	x		x			x		x			x			x
Emydura macquarii	Murray River short necked tortoise	x						++	x	x		x			x		x						x
AGAMIDAE																							
Amphibolurus barbatus	Bearded dragon		x	x				++		x	x					x	x		x	x			
A. muricatus	Tree dragon		x	x	x	x		+++		x			x			x	x			x	x		
GEKKONIDAE																							
Diplodactylus vittatus	Stone gecko		x	x				++	x		x				x		x		x	x			
Phyllodactylus marmoratus	Marbled gecko		x					+++	x				x		x		x		x	x			
PYGOPODIDAE																							
Delma fraseri	Fraser's legless lizard			x				++		x	x				x		x		x				
Lialis burtonis	Burton's legless lizard			x				+		x	x				x		x		x				
SCINCIDAE																							
Anotis maccoyi	McCoy's skink				x	x		++		x				x	x		x*				x		
Carlia [illegible]	Four-fingered skink		x	x				+		x	x					x	x			x			
Cryptoblepharus boutoni	Wall lizard		x					+		x			x			x	x		x				
Ctenotus robustus	Large striped skink		x	x	x			++		x	x					x	x		x	x			
C. taeniolatus	Copper-tailed skink			x				+		x	x					x	x			x			
Hemiergis decresiensis	Three-toed skink			x	x			+++		x				x	x			x		x			
Leiolopisma entrecasteauxi	Grass skink					x		+++		x	x					x		x			x	x	
L. guichenoti	Garden skink			x	x	x		+++		x	x					x	x			x	x		
L. mustelinum	Weasel skink				x			++		x				x	x		x			x	x		
L. trilineatum	Three-lined skink			x	x			++		x	x					x	x			x	x		
Lerista bougainvillii	Bougainville's skink			x				++		x				x	x			x	x	x			
Morethia boulengeri	Boulenger's skink		x	x				+++		x	x					x	x		x				
Pseudemoia spenceri	Spencer's skink					x		++		x			x			x		x			x	x	
Sphenomorphus quoyi	Quoy's water skink		x					++		x	x					x		x					x
S. tympanum (W.T.)	Golden water skink			x	x	x		+++		x	x					x		x		x			
S. tympanum (C.T.)	Water skink					x		+++		x	x					x		x			x	x	
Egernia cunninghami	Cunningham's skink			x				++		x	x					x		x	x	x			
E. saxatilis	Black rock skink				x	x		++		x	x					x		x		x	x		
E. whitei	White's skink			x	x			+++		x	x					x		x		x	x	x	
E. striolata	Tree skink		x					+		x			x			x		x	x				
Tiliqua nigrolutea	Southern bluetongue				x	x	x	+++		x	x					x		x			x		
T. scincoides	Common bluetongue			x			x	++		x	x					x		x	x	x			
VARANIDAE																							
Varanus gouldii	Sand goanna			x				++		x	x					x	x		x				
V. varius	Tree goanna		x	x	x			++		x			x			x	x		x	x			
BOIDAE																							
Morelia argus	Carpet snake		x	x				+	x	x			x		x		x						x
ELAPIDAE																							
Austrelaps superba (C.T.)	Alpine copperhead				x	x		+++		x	x					x		x			x	x	
Cryptophis nigrescens	Small-eyed snake			x	x	x		++	x		x				x			x		x			
Pseudonaja textilis	Brown snake		x	x	x			+++		x	x					x	x		x	x			
Drysdalia coronoides	White-lipped snake					x		++		x	x					x		x			x	x	
Notechis scutatus	Tiger snake		x				x	+++	x	x	x					x		x		x	x		x
Pseudechis porphyriacus	Red-bellied black snake		x				x	+++		x	x					x		x		x			x
Suta dwyeri	Dwyer's snake		x	x	x			++		x	x					x		x		x			
S. flagellum	Little whip snake		x	x				+		x	x					x		x			x		
Vermicella annulata	Bandy bandy			x				+						x	x		x			x			
TYPHLOPIDAE																							
Ramphotyphlops nigrescens	Blind snake			x	x			++						x	x		x			x			

* *Anotis maccoyi* is in fact ovoviviparous rather than oviparous

ABUNDANCE

+++ = common ++ = uncommon + = rare

E. FISHES

Scientific Name	Common Name	Occurrence and abundance: Lowlands*	Mountains**	Status: Introduced species	Game fish	Forage fish	Undesirable fish	Food: Insects	Other fish	Algae	Plant and/or animal plankton	Detritis feeders	Spawning: Optimum water temperatures	Month or season	Preferred habitat
Fluvialosa richardsoni	Bony bream	R				0		0		0	0			spring-early summer	warmer waters
Retropinna semoni	Australian smelt	U				0		0		0	0		15^oC	spring	
Galaxias planiceps	Flat-headed galaxias	U				0		0					9^oC-14^oC		
Galaxias olidus	Ornate mountain galaxias		U			0		0							cooler waters
Melanotaenia fluviatilis	Rainbow fish	UP				0		0					$22^oC - 27^oC$	spring	
Craterocephalus fluviatilis	Mitchellian freshwater hardyhead	P				0		0					23.5^oC	spring-summer	
Maccullochella peeli	Murray cod	U			0				0				20^oC	september-february	deep holes, snaggy
Maccullochella macquariensis	Trout cod	XX			0				0				20^oC	september-february	
Macquaria australasica	Macquarie perch	R	R		0			0					16.5^oC	september-february	pools, brackwaters
Bidyanus bidyanus	Silver perch	R			0					0	0		23^oC	october-january	slow waters
Nannoperca australis	Southern pigmy perch	UP				0					0				
Perca fluviatilis	English perch or redfin	C	U	0	0			0	0				11^oC	early spring	slow waters
Hypseleotris klunzingeri	Western carp gudgeon	UP				0					0		22.5^oC	spring-summer	
Philypnodon grandiceps	Big-headed or flat-headed gudgeon	UP				0					0		21^oC	spring-summer	
Mogurnda striata	Purple spotted gudgeon	UP				0					0		19^oC		
Gadopsis marmoratus	River blackfish	U	CP		0			0	0					spring-early summer	snags, undercut banks
Salmo gairdneri	Rainbow trout	U	C	0	0			0	0				$8^oC - 10^oC$	august	cool water
Salmo trutta	Brown trout	U	C	0	0			0	0				$8^oC - 15^oC$	june	cool water
Carassius auratus	Goldfish		XU	0			0	0		0	0	0	15^oC	spring-summer	slow waters
Carassius carassius	Crucian carp	C	XU	0			0	0		0	0	0	15^oC	spring-summer	slow waters
Tinca tinca	Tench	U		0			0	0		0		0	$16^oC - 20^oC$	late spring-early summer	slow waters
Gambusia affinis	Mosquito fish	C		0		0		0					27^oC		slow waters

R - Rare
U - Uncommon
C - Common
XX - Lake Sambell
Mitta Mitta River
X - Lake Buffalo

P - Patchy or variable
* - Lowland habitats include mature rivers, lateral lakes, ponds and marshes
** - Mountain habitats include headwaters and middle sections of streams

F. AMPHIBIANS

Sources of information:

1. Zoogeographic types after Littlejohn (1971).
2. Distributions: based on information supplied by Mr. A.J. Brook.
3. Abundance: Fisheries and Wildlife Division and Monash University 1973 surveys of the area.
4. Habitat preferences: a) Fisheries and Wildlife Division and Monash University surveys 1973.

   b) extracted from a variety of literature cources.
5. Breeding: extracted from a variety of literature sources.
6. Feeding: based on information obtained from specimens from the Fisheries and Wildlife Division 1974 survey.

Litoria aurea raniformis (green and golden frog)
Zoogeographic type: Wide-ranging.
Distribution: Wide distribution in lowland regions. Extends up river valleys to about 300 m.
Abundance: Common.
Habitat preference: Well-vegetated permanent dams, creeks, and rivers, especially in lowland areas (adults), shaded open waters (tadpoles).
Breeding: Larval life spans may extend from 12 to 19 months. Larvae are free-swimming.

Litoria paraewingi
Zoogeographic type: Eyrean.
Distribution: Widely distributed in lower areas, extends up river valleys to about 300 m.
Abundance: Common.
Habitat preference: Temporary and permanent dams and pools (adults), standing waters (tadpoles).
Breeding: Interbreeds with northern *L. ewingi* to form hybrids in the Mitta Mitta River region. Larvae are free-swimming.
Feeding: Take adult terrestrial insects such as beetles and aquatic larval insects.

Litoria lesueuri (Lesueur's tree frog)
Zoogeographic type: Wide-ranging.
Distribution: Mainly aasociated with rivers in higher areas.
Abundance: Common.
Habitat preference: Flowing water including high-altitude atreams. Larvae are adapted to life on fast-flowing streams.
Feeding: Foods may include beetles, spiders, gastropods, and annelid worms.

Litoria maculata
Zoogeographic type: Southern bassian.
Distribution: The only report of this species in the study area is a doubtful record of one specimen from near Glenrowan.
Abundance: Rare.

Litoria peroni (Peron's tree frog)
Zoogeographic type: Wide-ranging.
Distribution: Murray River flood-plain and extending into flood-plains of Ovens

and Mitta Mitta Rivers.
Abundance: Uncommon.
Habitat preference: More permanent waters such as dams as breeding sites.

Geocrinia victoriana
Zoogeographic type: Southern bassian.
Distribution: Favours higher altitudes in the study area. Less dependent on permanent free-water breeding sites.
Abundance: Common.
Habitat preference: Shallow shaded pools (tadpoles).
Breeding: Eggs are deposited in concealed terrestrial positions that are later flooded. From egg to metamorphosis takes 6--8 months.

Limnodynastes dumerili dumerili (bull frog)
Zoogeographic type: Eyrean.
Distribution: Widely distributed in valleys and lowland areas, tending to avoid highland areas.
Abundance: Common.
Habitat preference: Temporary and permanent dams, ponds, swamps, and running waters (adults and tadpoles).
Feeding: Food includes insects.
Breeding: Eggs are deposited in a large frothy egg mass attached to vegetation in still waters. Larvae are free-swimming and the total larval life span is 13--16 months.

Limnodyanstes peroni (Striped Marsh Frog)
Zoogeographis type: Wide-ranging.
Distribution: Restricted to lowland areas east of the Mitta Mitta River in the study area.
Abundance: Uncommon.
Habitat preference: Permanent pools and swamps.
Breeding: Eggs are deposited in very large frothy masses attached to vegetation in still water. Larvae are free-swimming.

Limnodynastes tasmaniensis (Spotted Marsh Frog)
Zoogeographic type: Eyrean.
Distribution: Widely distributed in lowland areas extending up river valleys to about 300 m.
Abundance: Common.

Habitat preference: Temporary and permanent waters including dams, ponds, and swamps.
Breeding: Eggs are deposited in a small frothy mass attached to vegetatian in still water. Larvae are free-swimming.

Neobatrachus pictus (Spade foot toad)
Zoogeographic type: Eyrean.
Distribution: Floodplains of Kiewa and Ovens Rivers.
Abundance: Uncommon.
Habitat preference: Most temporary waters.
Breeding: Larvae are free-swimming and from egg to metamorphsis takes about 4½--7 months.

Pseudophryne bibroni (Bibron's toadlet)
Zoogeographic type: Eyrean.
Distribution: Widespread in lowland areas extending up river valleys to about 300 m.
Abundance: Common.
Breeding: Eggs are deposited in concealed terrestrial positions that will later be flooded. Larvae hatch in an advanced state of development and seek out shallow shaded pools. From eggs to metamorphsis takes 6--7 months.
Feeding: Food may include small beetles.

Ranidella signifera (brown froglet)
Zoogeographic type: Wide-ranging.
Distribution: Extensive, mainly associated with rivers and flood-plains.
Abundance: Common.
Habitat preference: In general, temporary or permanent flowing or still waters; larvae prefer the bottom regions of shallow waters.
Breeding: Egg metamorphsis takes 6--10 weeks.
Feeding: Insects, including flies.

Ranidella parinsignifera and *R. sloanei*
Zoogeographic types: Eyrean.
Distribution: Flood-plains of major rivers.
Abundance: Common.
Habitat preference: More permanent flowing or still waters.

Uperoleia rugosa
Zoogeographic type: Eyrean.
Distribution: Associated with flood-plains of the Mitta Mitta River.
Abundance: Uncommon.

Limnodynastes fletcheri (Barking Frog)
Zoogeographic type: Eyrean.
Distrubtion: Restricted to flood-plains of the Murray, Ovens and Mitta Mitta Rivers.
Abundance: Uncommon.
Habitat preference: Relatively permanent open water.

APPENDIX 6

EXPLANATION OF SOIL TERMS

Soil horizon

A layer of soil material that lies approximately parallel to the surface and differs from other layers. A profile is a vertical section through all the soil horizons and extends into the parent material.

Texture

A measure of the proportions of the constituent particles in the soil (sand, silt, clay). It is assessed in the field on moist samples of the soil and may be checked against laboratory analysis for the actual proportions present.

The texture grades may be arranged in six texture groups as follows:

1. The Sands - sand; loamy sand; clayey sand;
2. The Sandy loams - sandy loam; fine sandy loam; light sandy clay loam;
3. The Loams - loam; loam, fine sandy; silt loam; sandy clay loam;
4. The Clay loams - clay loam; fine sandy clay loam; silty clay loam;
5. The Light clays - sandy clay; silt clay; light clay; light medium clay;
6. The Medium-Heavy clays - medium clay; heavy clay.

Soil structure

Refers to the combination or arrangement of primary soil particles into secondary particles, or peds, and may be graded according to the distinctness, cohesion, stability, size, and shape of these peds (or to their absence).

Infiltration rate

The soils ability to absorb heavy rain; it depends on properties at and below the surface (surface crushing, porosity, impeding horizons) and on existing moisture status of the soil.

Available water

Refers to the amount of water that the soil can store after drainage in a form available to plants. Such stored water may prolong plant growth after losses due to evapotranspiration exceed gains from precipitation.

Air porosity

The proportion of the soil volume filled by air several hours after rain.

Carbon:nitrogen ratio

Indicates the amount of available nitrogen. Ratios of less than 12 seem to be desirable for the satisfactory growth of most crops, and pastures, but in virgin soil the ratio often exceeds 20.

The Cation exchange capacity (C.E.C.)

A measure of the soils ability to hold nutrients in a form available to plants. It bears a close relation to the organic matter and clay fraction of the soil. Ions such as phosphate or calcium can be exchanged for other ions in the soil and may thus be available for plant growth.

Soil pH

Its degree of acidity (or alkalinity) - the higher the pH, the more alkaline in the soil.

Gilgaied

Refers to calcarious clay soils with a local relief of mounds and depressions.

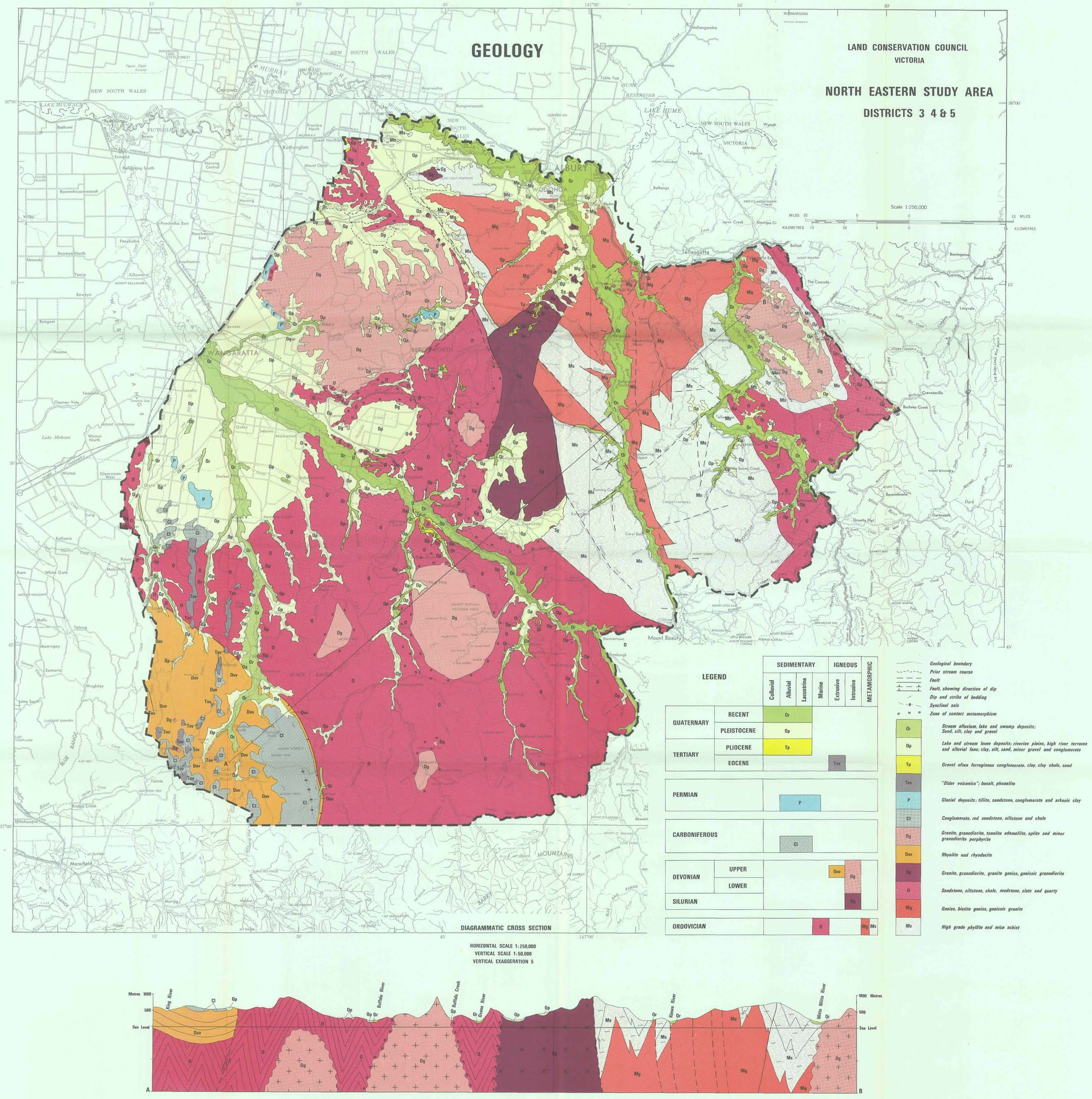
APPENDIX 7

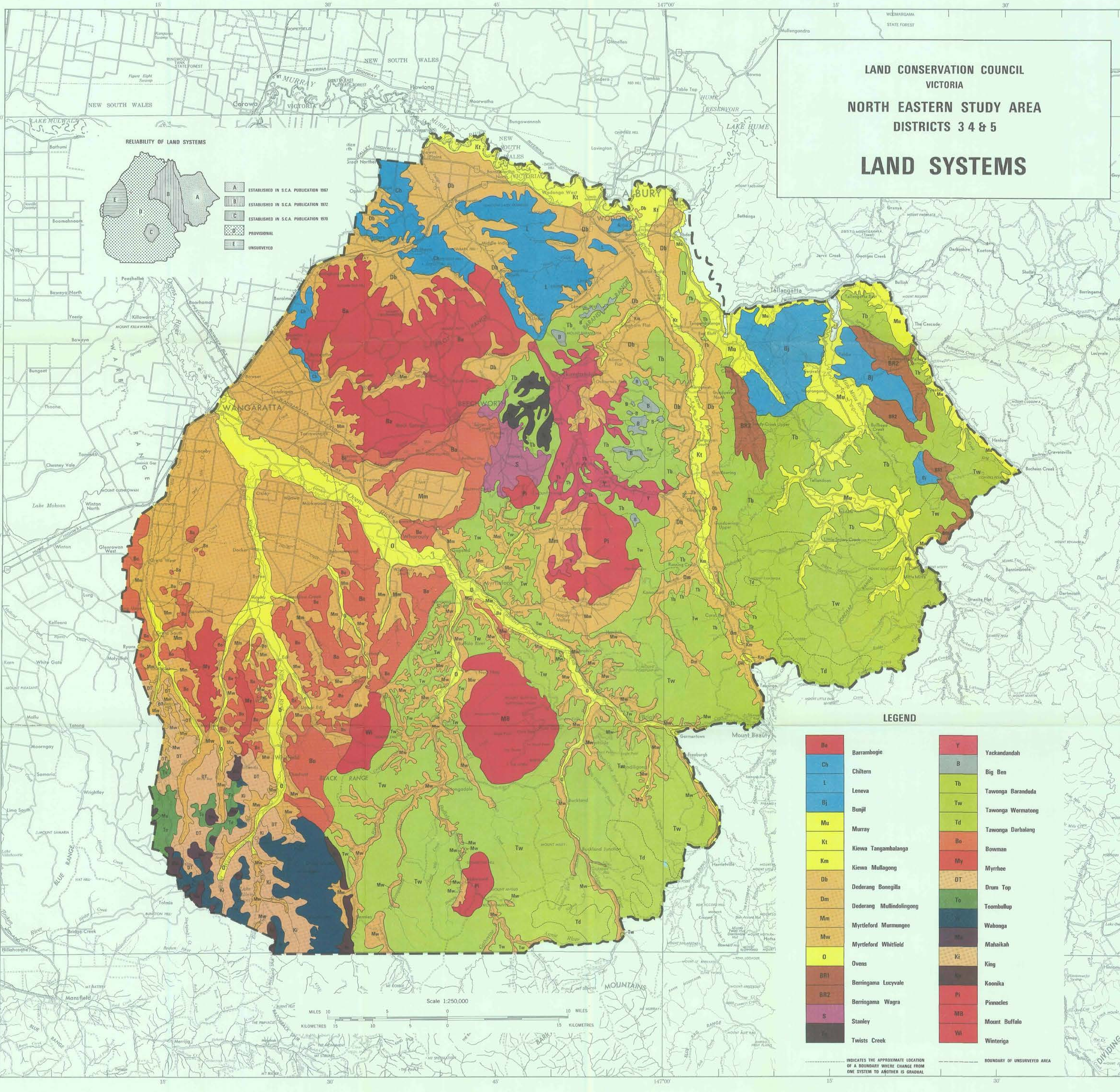
NOXIOUS WEEDS

The following list shows the species of noxious weeds recorded in the North-eastern Study Area Districts 3, 4, and 5. 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.

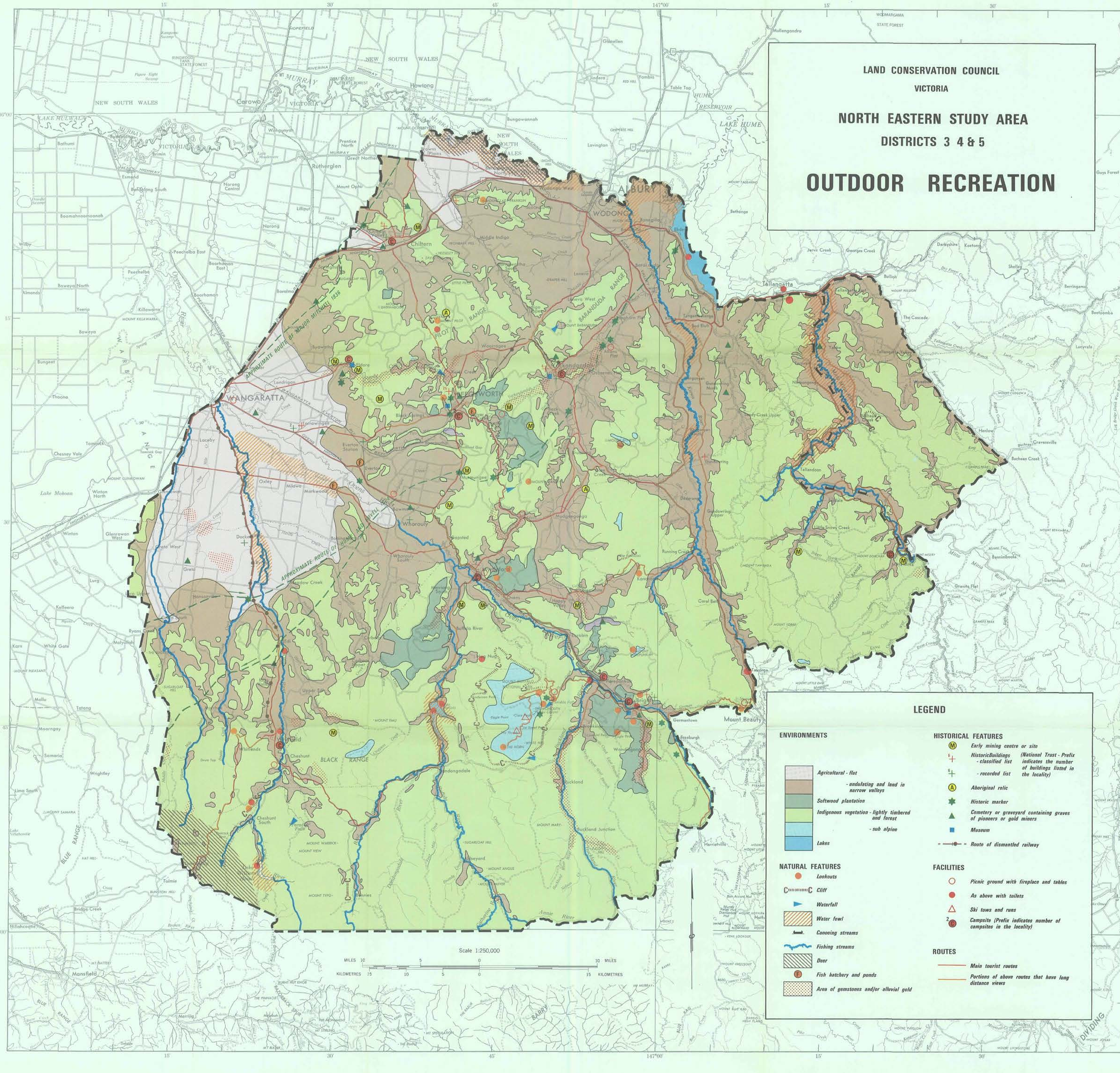
Weed Species	Block: Indigo	Kiewa	Bullhead	Dorchap	Pore-punkah	Stanley	Pilot	Moyhu	Emu	Buffalo	Abbeyard	Paradise Falls
(Number of parishes in block)	(9)	(13)	(4)	(11)	(8)	(7)	(4)	(8)	(7)	(5)	(12)	(8)
Amsinckia *Amsinckia* spp.				2	1							
Apple of Sodom *Solanum sodomeum*	1	1	1									
Bathurst burr *Xanthium spinosum*	9	12	4	7	5	4	3	4	4	4	2	1
Bindweed *Convolvulus arvensis*	3	2		1	2	1		1	7	4		
Blackberry *Rubus* spp.	8	13	4	9	8	4	4	7	7	5	12	8
Boxthorn *Lycium ferocissimum*	2	1		1				4	1			
Caltrop *Tribulus terrestris*	4	2		2				1				
Camel thorn *Alhagi camelorum*	1											
Cape broom *Genista monspessulana*	2	6	2	3	5	4	3	1	2	4	5	
Chilean cestrum *Cestrum parqui*				1				3	1			3
Devils claw (purple flower) *Proboscidae louisianica*		1										
Drooping prickly pear *Opuntia vulgaris*	1											
English broom *Sarothamnus scoparius*	1	4	1	2	3				1		3	
Erect prickly pear *Opuntia stricta*				2	1							
Fennel *Foeniculum vulgare*	1	1		1	1	3			1	3		
Furze *Ulex europaeus*	2	6		8	5	1		3	1			
Great mullein *Verbascum thapsus*	2			6	3	1		2		2	1	4
Hawthorn *Crataegus monogyna*	6	7	2	6	8	6	2	4	4	5	9	1
Hemlock *Conium maculatum*	1	2	2		1	3	2		1	2	2	3
Horehound *Marrubium vulgare*	9	10	2	6	5	3	1	1		1	2	1
Italian or cutleaf blackberry *Rubus laciniatus*	6	3		2	3	2	1				2	2
Khaki weed *Alternanthera repens*				1								
Noogoora burr *Xanthium pungens*	5	6		4	2			3	1	1		
Nut-grass *Cyperus rotundus*				1								
One-leaf cape tulip *Homeria breyniana*				4	2	1		1		1	1	
Pampas lily-of-the-valley *Salpichroa origanifolia*								1				
Paterson's curse *Echium lycopsis*	9	11	3	11	8	5	2	7	4	4	4	3
Prairie ground cherry *Physalis lanceolata*				1	1							
St. John's wort *Hypericum perforatum*	9	13	4	11	8	7	4	8	7	5	12	7
Sand mustard or sand rocket *Diplotaxis tenuifolia*	3	1										
Skeleton-weed *Chondrilla juncea*	9	13	4	11	8	7	3	3	4	4	6	2
Soursob *Oxalis pes-caprae*	9	5	1	5	4					1		1
Spiny broom *Calycotome spinosa*	1	1										
Spiny rush *Juncus acutus*	4	1						1				
Stinkwort *Inula graveolens*	9	12	2	10	7	6	1	3	4	5	3	2
Sweet briar *Rosa rubiginosa*	9	13	4	11	8	7	4	7	7	5	12	7
Thistle, saffron *Carthamus lanatus*	6	8	3	2	3	4	2	2	2	4	5	1
Thistle, Saint Barnaby's *Centaurea solstitialis*	3			2								1
Thistle, scotch *Onopordum acanthium*							1					1
Thistle, slender *Carduus tenuiflorus*	7	13	4	10	7	7	2	8	7	5	10	8
Thistle, spear *Cirsium vulgare*	6	12	2	9	8	7	3	8	6	5	9	8
Thistle, spotted or variegated *Silybum marianum*	9	13	4	7	8	7	3	8	6	5	9	8
Thorn apple *Datura* spp.	4	9	2	1	2	7	2	3	6	5	8	2
Tobacco *Nicotiana tabacum*				4	3	6	1	3	5	5	6	2
Topped lavender *Lavandula stoechas*	3	5		3	3							
Tree of heaven *Ailanthus altissima*	5	6	2	4	4	4		4	3	4	4	
Tutsan *Hypericum androsaemum*	1	2			1	1		1	2	1	1	6
Two-leaf cape tulip *Homeria miniata*	2	2		3	1			1				
Wheel cactus *Opuntia robusta*				2								
Wild mignonette *Reseda luteola*				1								
Wild teasel *Dipsacus fullonum*				1	1							
Wild watsonia *Watsonia bulbillifera*	3	13		2	2			1	1			

C. H. Rixon, Government Printer, Melbourne

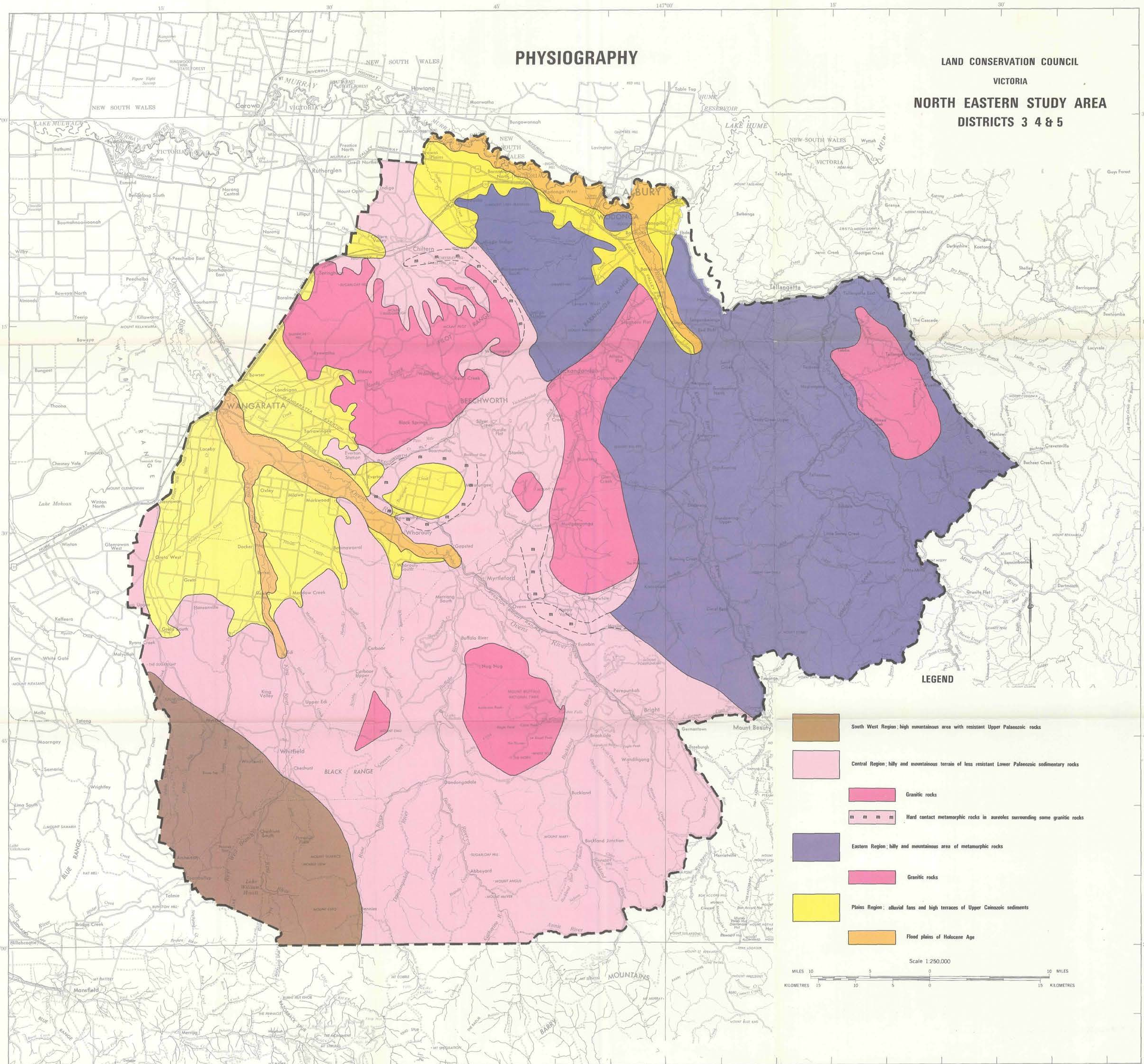

GEOLOGY
LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5
Scale 1:250,000
LEGEND
SEDIMENTARY
IGNEOUS
METAMORPHIC
Colluvial
Alluvial
Lacustrine
Marine
Extrusive
Intrusive
QUATERNARY
RECENT
PLEISTOCENE
TERTIARY
PLIOCENE
EOCENE
PERMIAN
CARBONIFEROUS
DEVONIAN
UPPER
LOWER
SILURIAN
ORDOVICIAN
Geological boundary
Prior stream course
Fault
Fault, showing direction of dip
Dip and strike of bedding
Synclinal axis
Zone of contact metamorphism
Qr Stream alluvium, lake and swamp deposits; Sand, silt, clay and gravel
Qp Lake and stream levee deposits; riverine plains, high river terraces and alluvial fans; clay, silt, sand, minor gravel and conglomerate
Tp Gravel often ferruginous conglomerate, clay, clay shale, sand
Tov "Older volcanics"; basalt, phonalite
P Glacial deposits; tillite, sandstone, conglomerate and arkosic clay
Cl Conglomerate, red sandstone, siltstone and shale
Dg Granite, granodiorite, tonalite adamellite, aplite and minor granodiorite porphyrite
Duv Rhyolite and rhyodacite
Sg Granite, granodiorite, granite gneiss, gneissic granodiorite
O Sandstone, siltstone, shale, mudstone, slate and quarty
Mg Gneiss, biotite gneiss, gneissic granite
Ms High grade phyllite and mica schist
DIAGRAMMATIC CROSS SECTION
HORIZONTAL SCALE 1:250,000
VERTICAL SCALE 1:50,000
VERTICAL EXAGGERATION 5
WANGARATTA
BEECHWORTH
ALBURY
WODONGA
LAKE HUME
NEW SOUTH WALES
VICTORIA
Mansfield
Mount Beauty
King River
Buffalo River
Ovens River
Kiewa River
Mitta Mitta River
Sea Level

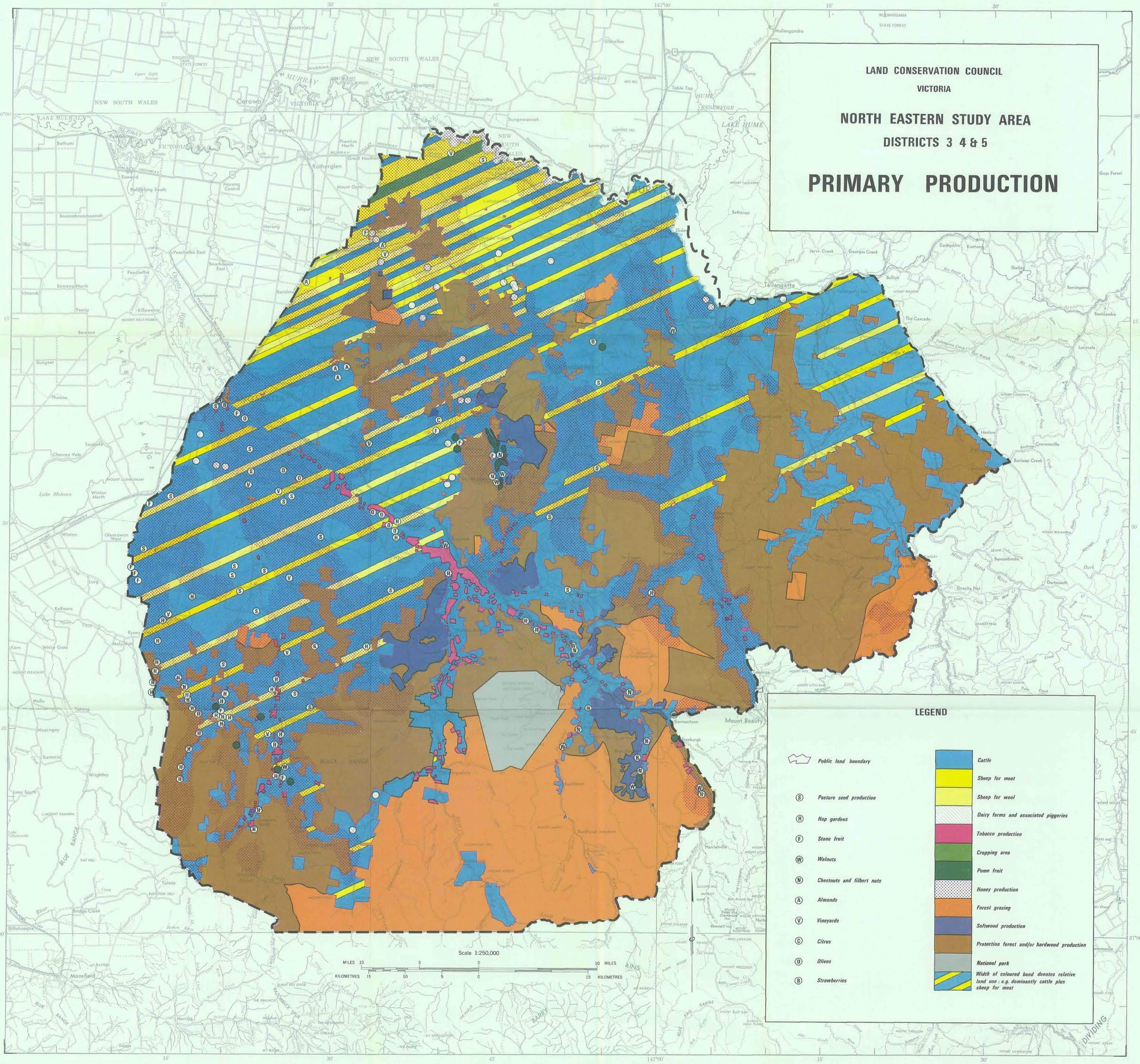


LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5
LAND SYSTEMS
RELIABILITY OF LAND SYSTEMS
A ESTABLISHED IN S.C.A. PUBLICATION 1967
B ESTABLISHED IN S.C.A. PUBLICATION 1972
C ESTABLISHED IN S.C.A. PUBLICATION 1970
D PROVISIONAL
E UNSURVEYED
LEGEND
Ba Barrambogie
Ch Chiltern
L Leneva
Bj Bunjil
Mu Murray
Kt Kiewa Tangambalanga
Km Kiewa Mullagong
Db Dederang Bonegilla
Dm Dederang Mullindolingong
Mm Myrtleford Murmungee
Mw Myrtleford Whitfield
O Ovens
BR1 Berringama Lucyvale
BR2 Berringama Wagra
S Stanley
Twists Creek
Y Yackandandah
B Big Ben
Tb Tawonga Baranduda
Tw Tawonga Wermatong
Td Tawonga Darbalang
Bo Bowman
My Myrrhee
DT Drum Top
To Toombullup
Wabonga
Mahaikah
Ki King
Koonika
Pi Pinnacles
MB Mount Buffalo
Wi Winteriga
INDICATES THE APPROXIMATE LOCATION OF A BOUNDARY WHERE CHANGE FROM ONE SYSTEM TO ANOTHER IS GRADUAL
BOUNDARY OF UNSURVEYED AREA
Scale 1:250,000
MILES
KILOMETRES
NEW SOUTH WALES
VICTORIA
WANGARATTA
ALBURY
BEECHWORTH
LAKE HUME
BLACK RANGE
MOUNTAINS
DIVIDING



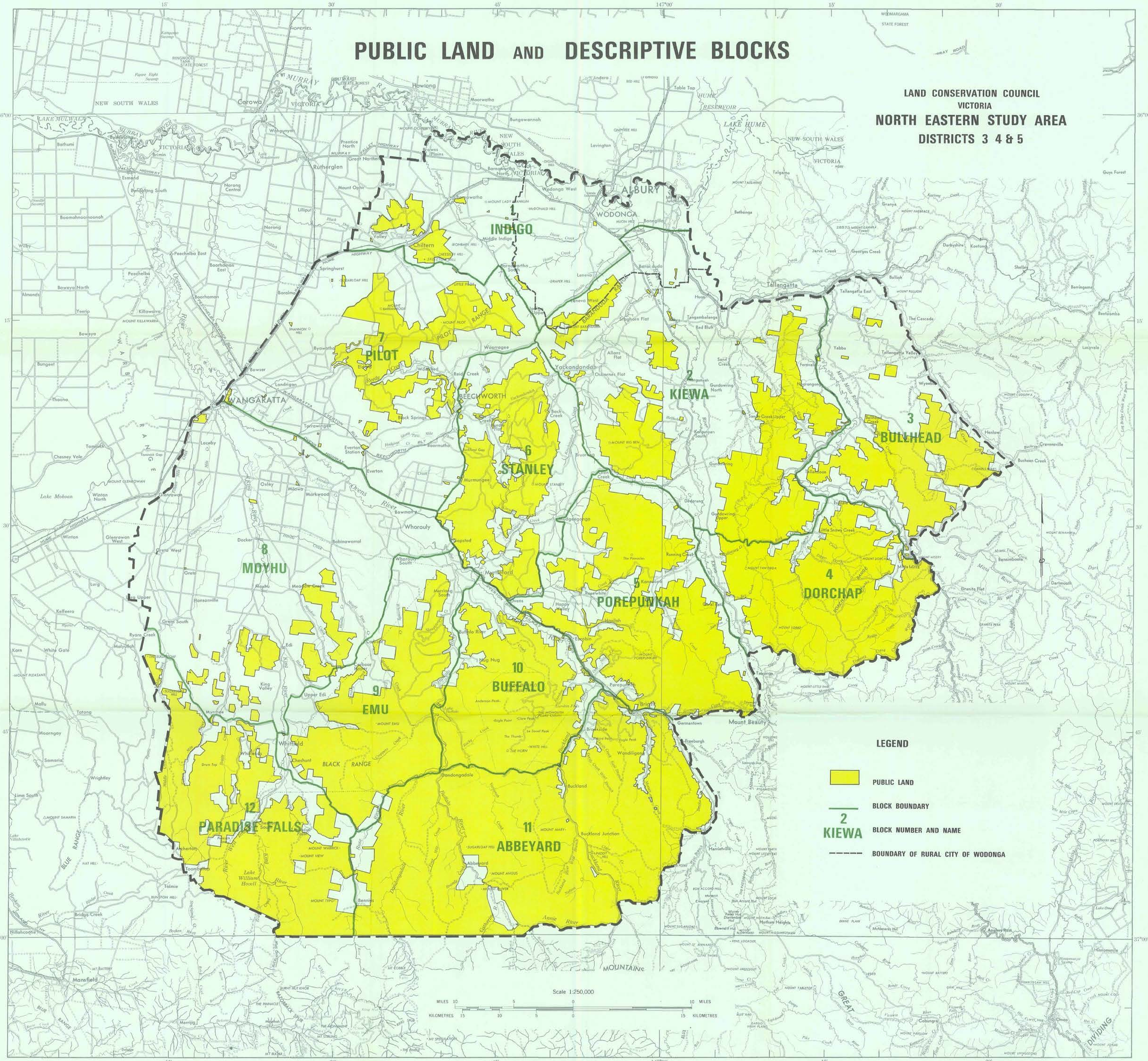
LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5
OUTDOOR RECREATION
LEGEND
ENVIRONMENTS
Agricultural - flat
- undulating and land in narrow valleys
Softwood plantation
Indigenous vegetation - lightly timbered and forest
- sub alpine
Lakes
NATURAL FEATURES
Lookouts
Cliff
Waterfall
Water fowl
Canoeing streams
Fishing streams
Deer
Fish hatchery and ponds
Area of gemstones and/or alluvial gold
HISTORICAL FEATURES
Early mining centre or site
HistoricBuildings - classified list
- recorded list
(National Trust - Prefix indicates the number of buildings listed in the locality)
Aboriginal relic
Historic marker
Cemetery or graveyard containing graves of pioneers or gold miners
Museum
Route of dismantled railway
FACILITIES
Picnic ground with fireplace and tables
As above with toilets
Ski tows and runs
Campsite (Prefix indicates number of campsites in the locality)
ROUTES
Main tourist routes
Portions of above routes that have long distance views
Scale 1:250,000
MILES
KILOMETRES
APPROXIMATE ROUTE OF MAJOR MITCHELL 1836
APPROXIMATE ROUTE OF HUME AND HOVELL
WANGARATTA
ALBURY
WODONGA
BEECHWORTH
Chiltern
Rutherglen
Mount Beauty
Mansfield
LAKE HUME
NEW SOUTH WALES
VICTORIA

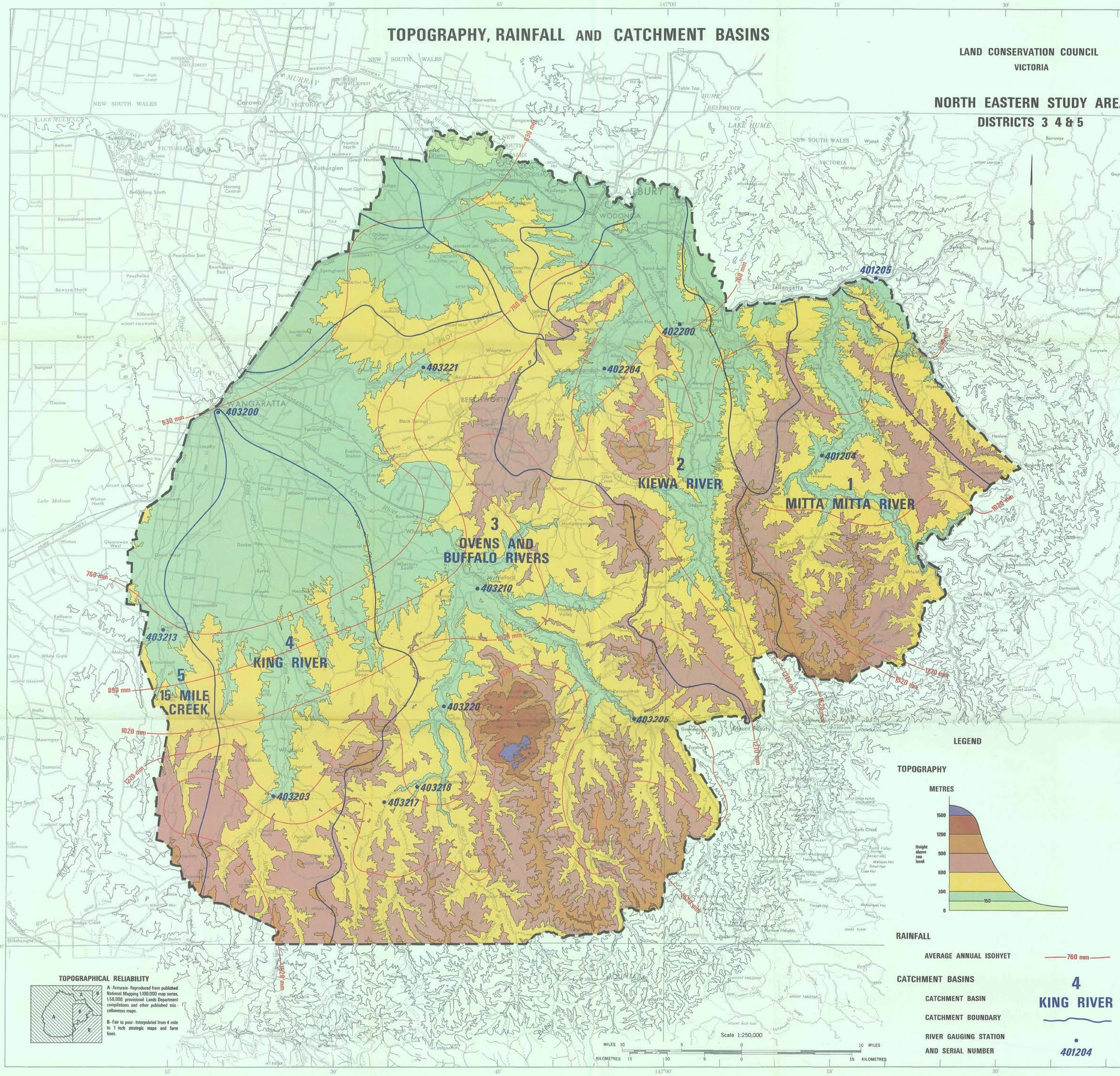

PHYSIOGRAPHY
LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5
LEGEND
South West Region; high mountainous area with resistant Upper Palaeozoic rocks
Central Region; hilly and mountainous terrain of less resistant Lower Palaeozoic sedimentary rocks
Granitic rocks
Hard contact metamorphic rocks in aureoles surrounding some granitic rocks
Eastern Region; hilly and mountainous area of metamorphic rocks
Granitic rocks
Plains Region; alluvial fans and high terraces of Upper Cainozoic sediments
Flood plains of Holocene Age
Scale 1:250,000
MILES 10 5 0 10 MILES
KILOMETRES 15 10 5 0 15 KILOMETRES
WANGARATTA
BEECHWORTH
WODONGA
ALBURY
NEW SOUTH WALES
VICTORIA
LAKE HUME
Myrtleford
Bright
Mansfield



LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5
PRIMARY PRODUCTION
LEGEND
Public land boundary
(S) Pasture seed production
(H) Hop gardens
(F) Stone fruit
(W) Walnuts
(N) Chestnuts and filbert nuts
(A) Almonds
(V) Vineyards
(C) Citrus
(O) Olives
(B) Strawberries
Cattle
Sheep for meat
Sheep for wool
Dairy farms and associated piggeries
Tobacco production
Cropping area
Pome fruit
Honey production
Forest grazing
Softwood production
Protection forest and/or hardwood production
National park
Width of coloured band denotes relative land use: e.g. dominantly cattle plus sheep for meat
Scale 1:250,000
MILES 10 5 0 10 MILES
KILOMETRES 15 10 5 0 15 KILOMETRES
NEW SOUTH WALES
VICTORIA
MURRAY
LAKE HUME
Tallangatta
Mount Beauty
Mansfield
BLACK RANGE

PUBLIC LAND AND DESCRIPTIVE BLOCKS



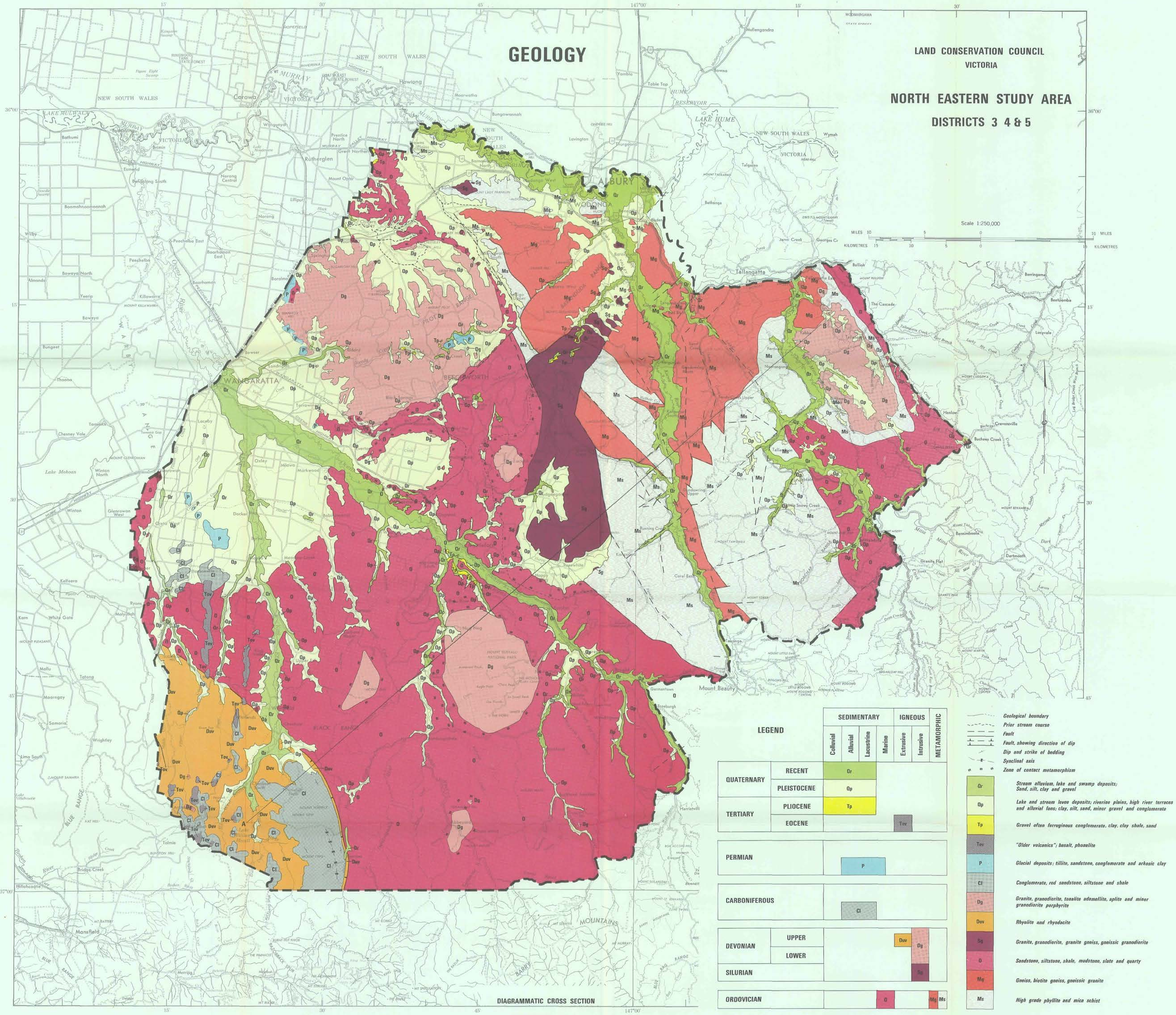

TOPOGRAPHY, RAINFALL AND CATCHMENT BASINS
LAND CONSERVATION COUNCIL
VICTORIA
NORTH EASTERN STUDY AREA
DISTRICTS 3 4 & 5
1
MITTA MITTA RIVER
2
KIEWA RIVER
3
OVENS AND
BUFFALO RIVERS
4
KING RIVER
5
15 MILE
CREEK
401205
401204
402200
402204
403221
403200
403210
403213
403220
403206
403203
403217
403218
WANGARATTA
BEECHWORTH
WODONGA
ALBURY
LAKE HUME
NEW SOUTH WALES
VICTORIA
630 mm
760 mm
890 mm
1020 mm
1270 mm
LEGEND
TOPOGRAPHY
METRES
1500
1200
900
600
300
150
0
Height above sea level
RAINFALL
AVERAGE ANNUAL ISOHYET
760 mm
CATCHMENT BASINS
CATCHMENT BASIN
CATCHMENT BOUNDARY
RIVER GAUGING STATION
AND SERIAL NUMBER
4
KING RIVER
401204
Scale 1:250,000
MILES 10 5 0 10 MILES
KILOMETRES 15 10 5 0 15 KILOMETRES
TOPOGRAPHICAL RELIABILITY
A - Accurate - Reproduced from published National Mapping 1:100,000 map series, 1:50,000 provisional Lands Department compilations and other published miscellaneous maps.
B - Fair to poor - Interpolated from 4 mile to 1 inch strategic maps and form lines.

VEGETATION UNITS

Map Symbol	Structural forms	Major species of tallest stratum	Associated tree species	Common species of lower strata
1	Sub-alpine complex: Heath Herbfield	Snow-grass, Sedge, Sphagnum moss, Heaths, Billy button, Alpine baeckea, Rusty pod, Mountain gentian, Leafy bossiaea		
2	Dry heath	Myrtle tea-tree, Common fringe-myrtle, Violet kunzea, Buffalo sallow-wattle, Lemon wattle-bush	Brittle gum	
3	Open forest I Woodland I	Snowgum		Snowgrass, Hickory wattle, Alpine wattle, Alpine oxylobium, Hop bitter-pea
4	Open forest I Open forest II	Snowgum Candlebark	Broad-leaf peppermint	Snowgrass, Bracken-fern, Mother shield-fern, Hop bitter-pea, Handsome flat-pea, leafy bossiaea, Common oxylobium, Silver wattle
5 5r	Open forest IV	Alpine ash, Regrowth	Candlebark, Snowgum, Bogong gum, Narrow-leaf peppermint	Snowgrass, Bracken-fern, Hop bitter-pea, Alpine oxylobium, Elderberry panax, Hickory wattle, Silver wattle
6	Open forest III Open forest IV	Messmate stringybark	Manna gum, Candlebark, Narrow-leaf peppermint, Blue gum	Tussock grass, Bracken-fern, Common cassinia, Musk, Hazel pomaderris, Silver wattle
7	Open forest III	Narrow-leaf peppermint	Manna gum, Candlebark, Brittle gum, Broad-leaf peppermint, Red stringybark	Tussock grass, Ivy-leaf violet, Austral cranes-bill, Bidgee-widgee, Common cassinia, Soft tree-fern, Fishbone water-fern, Blackwood, Silver wattle
8	Open forest II	Broad-leaf peppermint	Candlebark, Red stringybark, Blue gum, Narrow-leaf peppermint, Long-leaf Box, Brittle gum,	Tussock grass, Handsome flat-pea, Gorse bitter-pea, Mountain grevillea, Austral bugle
8b	Open forest II	Broad-leaf peppermint	Brittle gum, Long-leaf box	Small grass-tree, Daphne heath, Star-hair, Small-leaf parrot-pea, Holly lomatia, Handsome flat-pea, Gorse bitter-pea
9a	Open forest II	Long-leaf box	Candlebark, Red box, But-but, Broad-leaf peppermint, Red stringybark, Yellow box, Grey box	Tussock grass, Bush pea, Daphne heath, Urn heath, Guinea-flowers, Lightwood, Silver wattle
9b	Open forest I	Long-leaf box	Blakely's red gum, cypress-pine, Red box, White box, Red stringybark	Tussock grass, Small grass-trees, Woolly wattle, Woolly grevillea
10	Open forest II Open forest I	Red iron-bark	Red stringybark, Red box, White box, Grey box	Tussock grass, Shell grass, Wallaby grass, Woolly grevillea, Golden everlasting, Small-leaf parrot-pea
11	Open forest II	Grey box	Red box, Red stringybark, Yellow box	Tussock grass, Wallaby grass, St. Johns wort, Thistles, Woolly grevillea, Small-leaf parrot-pea
12	Open forest I	Black cypress-pine	Blakely's red gum, Long-leaf box, Red stringybark	Tussock grass, Nodding blue-lily, Guinea-flowers, Common fringe-myrtle, Heath myrtle, Rock fern
13a	Open forest II Woodland II	Blakely's red gum	White box, Long-leaf box, Yellow box, Red box, But-but	Wallaby grass, Shell grass, Rock fern, Rushes, Spreading flax-lily, Silver wattle
13b	Open forest I Woodland I	Blakely's red gum		Wallaby grass, Shell grass, Rock fern, Rushes
13c	Open forest II Woodland II	River red gum		Tussock grass, Knot weed, Rushes, Dock, Smart weed
14	Open forest II	Swamp gum	Black sallee	Fishbone water-fern, Alpine water-fern, Mountain tea-tree, Coral heath, Reeds, Blackwood, Sphagnum
15	Softwood	Exotic conifers		
16	Cleared land	Grassland, bracken		

VEGETATION UNITS

Map Symbol	Structural forms	Major species of tallest stratum	Associated tree species	Common species of lower strata
1	Sub-alpine complex; Heath Herbfield	*Snow-grass, Sedge, Sphagnum moss, Heaths, Billy button, Alpine baeckea, Rusty pod, Mountain gentian, Leafy bossiaea*		
2	Dry heath	*Myrtle tea-tree, Common fringe-myrtle, Violet kunzea, Buffalo sallow-wattle, Lemon wattle-bush*	*Brittle gum*	
3	Open forest I Woodland I	*Snowgum*		*Snowgrass, Hickory wattle, Alpine wattle, Alpine oxylobium, Hop bitter-pea*
4	Open forest I Open forest II	*Snowgum Candlebark*	*Broad-leaf peppermint*	*Snowgrass, Bracken-fern, Mother shield-fern, Hop bitter-pea, Handsome flat-pea, leafy bossiaea, Common oxylobium, Silver wattle*
5 5r	Open forest IV	*Alpine ash Regrowth*	*Candlebark, Snowgum, Bogong gum, Narrow-leaf peppermint*	*Snowgrass, Bracken-fern, Hop bitter-pea, Alpine oxylobium, Elderberry panax, Hickory wattle, Silver wattle*
6	Open forest III Open forest IV	*Messmate stringybark*	*Manna gum, Candlebark, Narrow-leaf peppermint, Blue gum*	*Tussock grass, Bracken-fern, Common cassinia, Musk, Hazel pomaderris, Silver wattle*
7	Open forest III	*Narrow-leaf peppermint*	*Manna gum, Candlebark, Brittle gum, Broad-leaf peppermint, Red stringybark*	*Tussock grass, Ivy-leaf violet, Austral cranes-bill, Bidgee-widgee, Common cassinia, Soft tree-fern, Fishbone water-fern, Blackwood, Silver wattle*
8a	Open forest II	*Broad-leaf peppermint*	*Candlebark, Red stringybark, Blue gum, Narrow-leaf peppermint, Long-leaf Box, Brittle gum*	*Tussock grass, Handsome flat-pea, Gorse bitter-pea, Mountain grevillea, Austral bugle*
8b	Open forest II	*Broad-leaf peppermint*	*Brittle gum, Long-leaf box*	*Small grass-tree, Daphne heath, Star-hair, Small-leaf parrot-pea, Holly lomatia, Handsome flat-pea, Gorse bitter-pea*
9a	Open forest II	*Long-leaf box*	*Candlebark, Red box, But-but, Broad-leaf peppermint, Red stringybark, Yellow box, Grey box*	*Tussock grass, Bush pea, Daphne heath, Urn heath, Guinea-flowers, Lightwood, Silver wattle*
9b	Open forest I	*Long-leaf box*	*Blakely's red gum, cypress-pine, Red box, White box, Red stringybark*	*Tussock grass, Small grass-trees, Woolly wattle, Woolly grevillea*
10	Open forest II Open forest I	*Red iron-bark*	*Red stringybark, Red box, White box, Grey box*	*Tussock grass, Shell grass, Wallaby grass, Woolly grevillea, Golden everlasting, Small-leaf parrot-pea*
11	Open forest II	*Grey box*	*Red box, Red stringybark, Yellow box*	*Tussock grass, Wallaby grass, St. Johns wort, Thistles, Woolly grevillea, Small-leaf parrot-pea*
12	Open forest I	*Black cypress-pine*	*Blakely's red gum, Long-leaf box, Red stringybark*	*Tussock grass, Nodding blue-lily, Guinea-flowers, Common fringe-myrtle, Heath myrtle, Rock fern*
13a	Open forest II Woodland II	*Blakely's red gum*	*White box, Long-leaf box, Yellow box, Red box, But-but*	*Wallaby grass, Shell grass, Rock fern, Rushes, Spreading flax-lily, Silver wattle*
13b	Open forest I Woodland I	*Blakely's red gum*		*Wallaby grass, Shell grass, Rock fern, Rushes*
13c	Open forest II Woodland II	*River red gum*		*Tussock grass, Knot weed, Rushes, Dock, Smart weed*
14	Open forest II	*Swamp gum*	*Black sallee*	*Fishbone water-fern, Alpine water-fern, Mountain tea-tree, Coral heath, Reeds, Blackwood, Sphagnum*
15	Softwood	*Exotic conifers*		
16	Cleared land	*Grassland, bracken*		



DIAGRAMMATIC CROSS SECTION

HORIZONTAL SCALE 1:250,000
VERTICAL SCALE 1:50,000
VERTICAL EXAGGERATION 5